2B Symbolics Common Lisp-Language Dictionary

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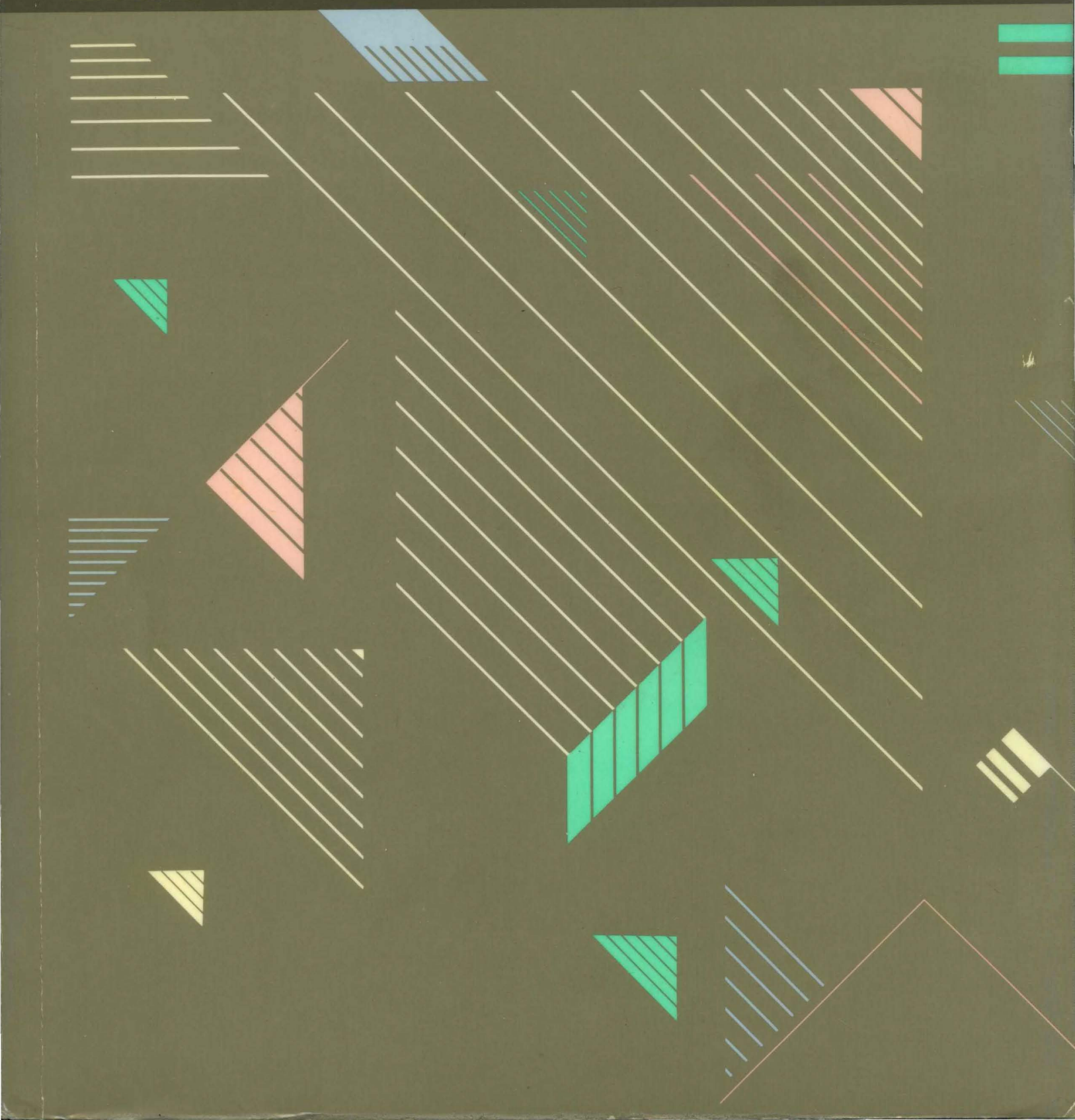

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≠ *number* &rest *numbers* *Function*

Returns **t** if *number* is not numerically equal to any of *numbers*, and **nil** otherwise. Either argument can be of any numeric type.

The following function is a synonym of ≠:

/=

≤ *number* &rest *more-numbers* *Function*

≤ compares its arguments from left to right. If any argument is greater than the next, ≤ returns **nil**. But if the arguments are monotonically increasing or equal, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type. Examples:

```
(≤ 5) => T
(≤ 1 2 3) => T
(≤ 3 6 2 8) => NIL
(≤ 5 6.3) => T
```

The following function is a synonym of ≤ :

<=

≥ *number* &rest *more-numbers* *Function*

≥ compares its arguments from left to right. If any argument is less than the next, ≥ returns **nil**. But if the arguments are monotonically decreasing or equal, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type. Examples:

```
(≥ 8) => T
(≥ 3 2 2 1) => T
(≥ 5 4 6 2) => NIL
(≥ 6.02s23 6.02d23) => T
```

The following function is a synonym of ≥ :

>=

* &rest *numbers* *Function*

Returns the product of its arguments. If there are no arguments, it returns **1**, which is the identity for this operation.

If the arguments are of different numeric types they are converted to a common type, which is also the type of the result. See the section "Coercion Rules for Numbers" in *Symbolics Common Lisp: Language* Concepts.

Examples:

```
(*) => 1
(* 4 6) => 24
(* 1 2 3 4) => 24
(* 2.5 4) => 10.0
(* 3.0s4 10) => 300000.0
```

The following functions are synonyms of * :

zl:times
zl:*$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:*$ &rest *args* *Function*

Returns the product of its arguments. If there are no arguments, it returns **1**, which is the identity for this operation.

The following functions are synonyms of **zl:*$** :

zl:times
*****

\+ &rest *numbers* *Function*

Returns the sum of its arguments. If there are no arguments, it returns **0**, which is the identity for this operation.

If the arguments are of different numeric types, they are converted to a common type, which is also the type of the result. See the section "Coercion Rules for Numbers" in *Symbolics Common Lisp: Language* Concepts.

Examples:

```
(+) => 0
(+ -8) => -8
(+ 1 2 3 4) => 10
(+ 2 5.9) => 7.9
(+ 5/2 2 2/3) => 31/6
```

The following functions are synonyms of + :

zl:plus
zl:+$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:+$ &rest *args* *Function*

Returns the sum of its arguments. If there are no arguments, it returns **0**, which is the identity for this operation.

The following functions are synonyms of **zl:+$** :

zl:plus
+

- *number* &rest *more-numbers* *Function*

With only one argument, - returns the negative of its argument. With more than one argument, - returns its first argument minus all of the rest of its arguments.

If the arguments are of different numeric types they are converted to a common type, which is also the type of the result. See the section "Coercion Rules for Numbers" in *Symbolics Common Lisp: Language* Concepts.

Examples:

```
(- 8) => -8
(- 9 3) => 6
(- 9 4 2 1) => 2
(- #C(3 4) 4) => #C(-1 4)
(- 9 5/6) => 49/6
```

The following function is a synonym of - :

zl:-$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:-$ *arg* &rest *args* *Function*

With only one argument, **zl:-$** returns the negative of its argument. With more than one argument, **zl:-$** returns its first argument minus all of the rest of its arguments.

The following function is a synonym of **zl:-$** :

-

/ *number* &rest *more-numbers* *Function*

With more than one argument / successively divides the first argument by all the others and returns the result. With one argument, / returns the reciprocal of the argument: (/ *x*) is the same as (/ 1 *x*). Arguments can be of any numeric type; the rules of coercion are applied to arguments of dissimilar numeric types.

/ follows normal mathematical rules, so if the mathematical quotient of two integers is not an exact integer, the function returns a ratio. To obtain an integer result, use one of these functions: **floor, ceiling, truncate, round.**

```
(/ 4) => 1/4
(/ 4.0) => 0.25
(/ 9 3) => 3
(/ 18 4) => 9/2 ;returns rational number in canonical form
(/ 101 10.0) => 10.1    ;applies coercion rules
(/ 101 10) => 101/10
(/ 24 4 2) => 3
(/ 36. 4. 3.) => 3
(/ 36.0 4.0 3.0) => 3.0
(/ #c(1 1) #c(1 -1)) => #c(0 1)
(/ #c(3 4) 5) => #c(3/5 4/5)
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:/ *number* &rest *more-numbers* *Function*

With more than one argument, **zl:/** is the same as **zl:quotient**; it returns the first argument divided by all of the rest of its arguments. With only one argument, (**zl:/** *x*) is the same as (**zl:/** 1 *x*).

With integer arguments, **zl:/** acts like **truncate**, except that it returns only a single value, the quotient.

Note that in Zetalisp syntax / is the quoting character and must therefore be doubled.

Examples:

```
(zl:/ 3 2) => 1       ;Integer division truncates.
(zl:/ 3 -2) => -1
(zl:/ -3 2) => -1
(zl:/ -3 -2) => 1
(zl:/ 3 2.0) => 1.5
(zl:/ 3 2.0d0) => 1.5d0
(zl:/ 4 2) => 2
(zl:/ 12. 2. 3.) => 2
(zl:/ 4.0) => .25
```

The following function is a synonym of **zl:/** :

zl:/$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:/$ *arg* &rest *args* *Function*

With more than one argument, **zl:/$** is the same as **zl:quotient**; it returns the first argument divided by all of the rest of its arguments. With only one argument, (**zl:/$** *x*) is the same as (**zl:/$** 1 *x*).

With integer arguments, **zl:/$** acts like **truncate**, except that it returns only a single value, the quotient.

Note that in Zetalisp syntax / is the quoting character and must therefore be doubled.

The following function is a synonym of **zl:/$** :

zl:/

/= *number* &rest *numbers* *Function*

Returns **t** if all arguments are not equal, and **nil** otherwise. Arguments can be of any numeric type; the rules of coercion are applied for arguments of different numeric types.

Two complex numbers are considered = if their real parts are = and their imaginary parts are =.

Examples:

```
(/= 4) => T
(/= 4 4.0) => NIL
(/= 4 #c(4.0 0)) => NIL
(/= 4 5) => T
(/= 4 5 6 7) => T
(/= 4 5 6 7 4) => NIL
(/= 4 5 4 7 4) => NIL
(/= #c(3 2) #c(2 3) #c(2 -3)) => T
(/= #c(3 2) #c(2 3) #c(2 -3) #c(2 3.0))  => NIL
```

The following function is a synonym of /= :

≠

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

1- *number* *Function*

(**1-** *number*) is the same as (**-** *number* 1). Note that this name might be confusing: (**1-** *number*) does *not* mean 1 - *number*; rather, it means *number* - 1.

Examples:

```
(1- 9) => 8
(1- 4.0) => 3.0
(1- 4.0d0) => 3.0d0
(1- #C(4 5)) => #C(3 5)
```

The following functions are synonyms of **1-** :

zl:sub1
zl:1-$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:1-$ *x* *Function*

(**1-$** *x*) is the same as (- *x* 1).

The following functions are synonyms of **zl:1-$** :

zl:sub1
1-

1+ *number* *Function*

(**1+** *number*) is the same as (+ *number* 1).

Examples:

```
(1+ 5) => 6
(1+ 3.0d0) => 4.0d0
(1+ 3/2) => 5/2
(1+ #C(4 5)) => #C(5 5)
```

The following functions are synonyms of **1+** :

zl:add1
zl:1+$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:1+$ *x* *Function*

(**1+$** *x*) is the same as (+ *x* 1).

The following functions are synonyms of **zl:1+$** :

zl:add1
1+

sys:%1d-aloc *array index* *Function*

Returns a locative pointer to the element-cell of *array* selected by the index. **sys:%1d-aloc** is the same as **zl:aloc**, except that it ignores the number of dimensions of the array and acts as if it were a one-dimensional array by linearizing the multidimensional elements.

Current style suggests that you should use **(locf (sys:%1d-aref ...))** instead of **sys:%1d-aloc**.

When using **sys:%1d-aloc** it is necessary to understand how arrays are stored in memory: See the section "Row-major Storage of Arrays" in *Converting to Genera 7.0.*

For an example of accessing elements of a multidimensional array as if it were a one-dimensional array: See the function **sys:%1d-aref**, page 7.

sys:%1d-aref *array index* *Function*

Returns the element of *array* selected by the *index*. **sys:%1d-aref** is the same as **aref**, except that it ignores the number of dimensions of the array and acts as if it were a one-dimensional array by linearizing the multidimensional elements. **copy-array-portion** uses this function.

For example:

```
(setq *array* (make-array '(20 30 50))) => #<Art-Q-20-30-50 5023116>
(setf (aref *array* 5 6 7) 'foo) => FOO

;;; The following three forms have the same effect.
(aref *array* 5 6 7) => FOO
(sys:%1d-aref *array* (+ (* (+ (* 5 30) 6) 50) 7)) => FOO
(sys:%1d-aref *array* (array-row-major-index *array*)) => FOO
```

When using **sys:%1d-aref** it is necessary to understand how arrays are stored in memory: See the section "Row-major Storage of Arrays" in *Converting to Genera 7.0.*

sys:%1d-aset *value array index* *Function*

Stores *value* into the element of *array* selected by the *index*. **sys:%1d-aset** is the same as **zl:aset**, except that it ignores the number of dimensions of the array and acts as if it were a one-dimensional array by linearizing the multidimensional elements. **copy-array-portion** uses this function.

Current style suggests that you should use **(setf (sys:%1d-aref ...))** instead of **sys:%1d-aset**.

When using **sys:%1d-aset** it is necessary to understand how arrays are stored in memory: See the section "Row-major Storage of Arrays" in *Converting to Genera 7.0.*

For an example of accessing elements of a multidimensional array as if it were a one-dimensional array: See the function **sys:%1d-aref**, page 7.

2d-array-blt *alu nrows ncolumns from-array from-row from-column to-array to-row to-column* *Function*

Copies a rectangular portion of *from-array* into a portion of *to-array*. **2d-array-blt** is similar to **bitblt** but takes (row,column) style arguments on two-dimensional arrays, while **bitblt** takes (x,y) arguments on rasters.

The number of columns in *from-array* times the number of bits per element must be a multiple of 32. The same is true for *to-array*.

This can be used on **sys:art-fixnum** or **sys:art-1b, sys:art-2b,... sys:art-16b** arrays. It can also be used on **sys:art-q** arrays provided all the elements are fixnums.

sys:%32-bit-difference *fixnum1 fixnum2* *Function*

Returns the difference of *fixnum1* and *fixnum2* in 32-bit two's complement arithmetic. Both arguments must be fixnums. The result is a fixnum.

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

sys:%32-bit-plus *fixnum1 fixnum2* *Function*

Returns the sum of *fixnum1* and *fixnum2* in 32-bit two's complement arithmetic. Both arguments must be fixnums. The result is a fixnum.

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

< *number* &rest *more-numbers* *Function*

< compares its arguments from left to right. If any argument is not less than the next, < returns **nil**. But if the arguments are monotonically strictly increasing, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type.

Examples:

```
(< 3 4) => T
(< 1 1.0)  => NIL
(< 0 1/2 2.0 3 4)  => T
(< 0 1 3 2 4) => NIL
```

The following function is a synonym of < :

zl:lessp

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

<= *number* &rest *more-numbers* *Function*

<= compares its arguments from left to right. If any argument is greater than the next, <= returns **nil**. But if the arguments are monotonically increasing or equal, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type.

Examples:

```
(<= 8) => T
(<= 3 4) => T
(<= 1 1) => T
(<= 1 1.0) => T
(<= 0 1/2 2.0 3 4) => T
(<= 0 1 3 2 4) => NIL
(<= 0 1 3 3 4) => T
```

The following function is a synonym of <= :

≤

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

= *number* &rest *more-numbers* *Function*

Returns **t** if all arguments are numerically equal.

= takes arguments of any numeric type; the arguments can be of dissimilar numeric types.

Examples:

```
(= 8) => T
(= 3 4) => NIL
(= 3 3.0 3.0d0) => T
(= 4 #C(4 0) #C(4.0 0.0) #C(4.0d0 0.0d0)) => T
```

For a discussion of non-numeric equality predicates: See the section "Comparison-performing Predicates" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

> *number* &rest *more-numbers* *Function*

> compares its arguments from left to right. If any argument is not greater than the next, > returns **nil**. But if the arguments are monotonically strictly decreasing, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type.

Examples:

```
(> 4 3.0)  => T
(> 4 3 2 1/2 0)   => T
(> 4 3 1 2 0)  => NIL
```

The following function is a synonym of > :

zl:greaterp

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

>= *number* &rest *more-numbers* *Function*

>= compares its arguments from left to right. If any argument is less than the next, >= returns **nil**. But if the arguments are monotonically decreasing or equal, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type.

Examples:

```
(>= 8) => T
(>= 4 3.0)  => T
(>= 4 3 2 1 0) => T
(>= 4 2 3 1 0) => NIL
(>= 4 3 3 2 1/2 0)  => T
```

The following function is a synonym of >= :

≥

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:@define &rest *ignore* *Macro*

This macro turns into **nil**, doing nothing. It exists for the sake of the @ listing generation program, which uses it to declare names of special forms that define objects (such as functions) that @ should cross-reference.

zl: *x y* *Function*

Returns the remainder of *x* divided by *y*. *x* and *y* must be integers.

zl: acts like **truncate**, except that it returns only a single value, the remainder.

Examples:

```
(zl:\ 3 2) => 1
(zl:\ -3 2) => -1
(zl:\ 3 -2) => 1
(zl:\ -3 -2) => -1
```

The following functions are synonyms for **zl:** :

rem
zl:remainder

Note: In programs using the Zetalisp syntax you would represent **zl:** as \. The function is represented here as **zl:** only because all objects in this manual are represented as if printed by **prinl** with ***package*** bound to the Common Lisp readtable. In Common Lisp, the backslash character (\) is the escape character and must be doubled.

zl: *x y* &rest *args* *Function*

Returns the greatest common divisor of all its arguments. The arguments must be integers.

The following function is a synonym of **zl:** :

zl:gcd

note: In programs using the Zetalisp syntax you would represent **zl:** as \\. The function is represented here as **zl:** only because all objects in this manual are represented as if printed by **prinl** with ***package*** bound to the Common Lisp readtable. In Common Lisp, the backslash character (\) is the escape character and must be doubled.

zl:^ *x y* *Function*

Returns *x* raised to the *y*th power. The result is an integer if both arguments are integers (even if *y* is negative!) and floating-point if either *x* or *y* or both is floating-point. If the exponent is an integer a repeated-squaring algorithm is used, while if the exponent is floating the result is **(exp (* *y* (log *x*)))**.

The following functions are synonyms of **zl:^** :

zl:expt
zl:^$

zl:^$ *x y* *Function*

Returns *x* raised to the *y*th power. The result is an integer if both arguments are integers (even if *y* is negative!) and floating-point if either *x* or *y* or both is floating-point. If the exponent is an integer a repeated-squaring algorithm is used, while if the exponent is floating the result is **(exp (* *y* (log *x*)))**.

The following functions are synonyms of **zl:^$** :

zl:expt
zl:^

abs *number* *Function*

Returns |*number*|, the absolute value of *number*. For noncomplex numbers, **abs** could have been defined by:

```
(defun abs (number)
  (cond ((minusp number) (minus number))
        (t number)))
```

Note that if *number* is equal to negative zero in IEEE floating-point format the above algorithm returns -0.0.

For complex numbers, **abs** could have been defined by:

```
(defun abs (number)
  (sqrt (+ (^ (realpart number) 2) (^ (imagpart number) 2))))
```

See the function **phase**, page 393.

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

acons *key datum alist* *Function*

acons constructs a new association list by adding the pair (*key* . *datum*) onto the front of *alist*. See the section "Association Lists" in *Symbolics Common Lisp: Language Concepts.* This is equivalent to using the **cons** function on *key* and *datum*, and consing it onto the old list as follows:

```
(acons key datum alist) ≡ (cons (cons key datum) alist)
```

Example:

```
(setq bird-alist '((wader . heron) (raptor . eagle))) =>
((WADER . HERON) (RAPTOR . EAGLE))

(acons 'diver 'loon bird-alist) =>
((DIVER . LOON) (WADER . HERON) (RAPTOR . EAGLE))

bird-alist =>
((WADER . HERON) (RAPTOR . EAGLE))
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

acos *number* *Function*

Computes and returns the arc cosine of the argument (that is, the angle whose cosine is equal to *number*). The result is in radians.

The argument can be any noncomplex or complex number. Note that if the

A

absolute value of *number* is greater than one, the result is complex, even if the argument is not complex.

The arc cosine being a mathematically multiple-valued function, **acos** returns a principal value whose range is that strip of the complex plane containing numbers with real parts between 0 and π. The range excludes any number with a real part equal to zero and a negative imaginary part, as well as any number with a real part equal to π and a positive imaginary part.

Examples:

```
(acos 1) => 0.0
(acos 0) => 1.5707964   ; π/2 radians
(acos -1) => 3.1415927  ; π
(acos 2) => #C(0.0 1.3169578)
(acos -2) => #C(3.1415927 -1.316958)
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

acosh *number* *Function*

Computes and returns the hyperbolic arc cosine of the argument (that is, the angle whose **cosh** is equal to *number*). The result is in radians.

The argument can be any noncomplex or complex number, except -1. Note that if the value of *number* is less than one, the result is complex, even if the argument is not complex. The hyperbolic arc cosine being mathematically multiple-valued in the complex domain, **acosh** returns a principal value whose range is that half-strip of the complex plane containing numbers with a non-negative real part and an imaginary part between -π and π (inclusive). A number with real part zero is in the range if its imaginary part is between zero (inclusive) and π (inclusive).

Example:

```
(acosh 1) => 0.0        ;(cosh 0) => 1.0
(acosh -2)  => #c(1.316958 3.1415927)
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:add1 *x* *Function*

(**add1** *x*) is the same as (+ *x* 1).
The following functions are synonyms of **zl:add1**:

1+
zl:1+$

adjoin *item list* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

You can use **adjoin** to add an element to a set provided that it is not already a member. The keywords for this function are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Note that, since **adjoin** adds an element only if it is *not* already a member, the sense of **:test** and **:test-not** have inverted effect: with **:test**, an item is added to the list only if there is no element of the list for which the predicate returns **t**. With **:test-not**, an item is added if there is no element for which the predicate returns **nil**.

When **:test** is **eql**, the default, then

```
(adjoin item list) ≡ (if (member item list) list (cons item list))
```

Here are some examples:

```
(setq bird-list '((loon . diver) (heron . wader))) =>
((LOON . DIVER) (HERON . WADER))

(setq bird-list (adjoin '(eagle . raptor) bird-list :key #'car)) =>
((EAGLE . RAPTOR) (LOON . DIVER) (HERON . WADER))

(adjoin '(eagle . oops) bird-list :key #'car) =>
((EAGLE . RAPTOR) (LOON . DIVER) (HERON . WADER))
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts*.

adjustable-array-p *array* *Function*

Returns **t** if *array* is adjustable, and **nil** if it is not. Lisp dialects supported by Genera make most arrays adjustable even ifd the **:adjustable** option to **make-array** is not specified; but to guarantee that an array can be adjusted after created, it is necessary to use the **:adjustable** option.

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adjust-array *array new-dimensions* &key (*element-type* **nil** *element-type-specified*) (*initial-element* **nil** *initial-element-specified*) (*initial-contents* **nil** *initial-contents-specified*) *fill-pointer displaced-to displaced-index-offset displaced-conformally* *Function*

adjust-array changes the dimensions of an array. It returns an array of the same type and rank as *array*, but with the *new-dimensions*. The number of *new-dimensions* must equal the rank of the array. All elements of *array* that are still in the bounds are carried over tothe new array.

:element-type specifies that elements of the new array are required to be of a certain type. An error is signalled if *array* contains elements that are not of that type. **:element-type** thus provides an error check.

:initial-element allows you to specify an initial element for any elements of the new array that are not in the bounds of *array*.

The **:initial-contents** and **:displaced-to** options have the same effect as they do for **make-array**. If you use either of these options, none of the elements of *array* are carried over to the new array.

You can use the **:fill-pointer** option to reset the fill pointer of *array*. If array had no fill pointer and error is signalled.

If the size of the array is being increased, **adjust-array** might have to allocate a new array somewhere. In that case, it alters *array* so that references to it are made to the new array instead, by means of "invisible pointers". See the function **structure-forward** in *Internals, Processes, and Storage Management*. **adjust-array** returns this new array if it creates one, and otherwise it returns *array*. Be careful to be consistent about using the returned result of **adjust-array**, because you might end up holding two arrays that are not the same (that is, not **eq**), but that share the same contents.

The meaning of **adjust-array** for conformal indirect arrays is undefined.

zl:adjust-array-size *array new-size* *Function*

If *array* is a one-dimensional array, its size is changed to be *new-size*. If *array* has more than one dimension, its size (**array-total-length**) is changed to *new-size* by changing only the first dimension.

If *array* is made smaller, the extra elements are lost. If *array* is made bigger, the new elements are initialized in the same fashion as **make-array** would initialize them: either to **nil**, **0** or **(code-char 0)**, depending on the type of array.

Example:

```
(setq a (make-array 5))
(setf (aref a 4) 'foo)
(aref a 4) => foo
(zl:adjust-array-size a 2)
(aref a 4) => an error occurs
```

See the function **adjust-array**, page 16.

sys:*all-flavor-names* *Variable*

This is a list of the names of all the flavors that have ever been created by **defflavor.**

&allow-other-keys *Lambda List Keyword*

In a lambda-list that accepts keyword arguments, **&allow-other-keys** specifies that keywords that are not specifically listed after **&key** are allowed. They and their corresponding values are ignored, as far as keywords arguments are concerned, but they do become part of the **&rest** argument, if there is one.

zl:aloc *array* &rest *subscripts* *Function*

Returns a locative pointer to the element of *array* selected by the subscripts. The *subscripts* must be integers and their number must match the dimensionality of *array*. See the section "Cells and Locatives".

Current style suggests using **locf** with **aref** instead of **zl:aloc**. For example:

```
(locf (aref this-array subscripts))
```

alpha-char-p *char* *Function*

Returns **t** if *char* is a letter of the alphabet.

```
(alpha-char-p #\A) => T
(alpha-char-p #\1) => NIL
```

For a list of other character predicates: See the section "Character Predicates" in *Symbolics Common Lisp: Language Concepts.*

alphalessp *string1 string2* *Function*

(alphalessp *string1 string2***)** is equivalent to **(string-lessp** *string1 string2***).** If the arguments are not strings, **alphalessp** compares numbers numerically, lists by element, and all other objects by printed representation. alphalessp is a Maclisp all-purpose alphabetic sorting function.
Examples:

A

```
(alphalessp "apple" "orange") => T
(alphalessp 'tom 'tim) => NIL
(alphalessp "same" "same") => NIL
(alphalessp 'symbol "string") => NIL
(alphalessp '(a b c) '(a b d)) => T
```

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts.*

alphanumericp *char* *Function*

Returns **t** if *char* is a letter of the alphabet or a base-10 digit.

```
(alphanumericp #\7) => T
(alphanumericp #\%) => NIL
```

For a list of other character predicates: See the section "Character Predicates" in *Symbolics Common Lisp: Language Concepts.*

always Keyword For loop

always *expr*

Causes the loop to return **t** if *expr* **always** evaluates non-**null**. If *expr* evaluates to **nil**, the loop immediately returns **nil**, without running the epilogue code (if any, as specified with the **finally** clause); otherwise, **t** is returned when the loop finishes, after the epilogue code has been run. If the loop terminates before *expr* is ever evaluated, the epilogue code is run and the loop returns **t**.

always *expr* is like **(and** *expr1 expr2* ...**)**, except that if no *expr* evaluates to **nil**, **always** returns **t** and **and** returns the value of the last *expr*. If the loop terminates before *expr* is ever evaluated, **always** is like **(and)**.

If you want a similar test, except that you want the epilogue code to run if *expr* evaluates to **nil**, use **while**.

Examples:

```
(defun loop-always (my-list)
  (loop for x in my-list
        finally (print  "what you going to do next ?")
        do
    (princ x) (princ " ")
        do
        and always (equal x 'a)))  => LOOP-ALWAYS

(loop-always '(b c a d)) => B NIL
```

```
(loop-always '(a a)) => A A
"what you going to do next ?" T
```

See the section "**loop** Clauses", page 310.

and &rest *body* *Special Form*

Evaluates each form one at a time, from left to right. If any form evaluates to **nil**, **and** immediately returns **nil** without evaluating any other form. If every form evaluates to non-**nil** values, **and** returns the value of the last form.

and can be used in two different ways. You can use it as a logical **and** function, because it returns a true value only if all of its arguments are true. So you can use it as a predicate:

Examples:

```
(if (and 'this 'that) "reaches this point") => "reaches this point"

(if (and (equal 1 1)(equal nil '())) "equal") => "equal"

(if (and socrates-is-a-person all-people-are-mortal)
    (setq socrates-is-mortal t))
```

Because the order of evaluation is well-defined, you can do:

```
(if (and (boundp 'x)
         (eq x 'foo))
    (setq y 'bar)) => NIL
```

knowing that the **x** in the **eq** form is not evaluated if **x** is found to be unbound.

You can also use **and** as a simple conditional form:

Examples:

```
(and) => T

(and t nil) => NIL

(and t 'hi (numberp 3.14)) => T

(when (and (setq temp (assq x y))
           (rplacd temp z)))
```

A

```
(when (and bright-day
           glorious-day
           (princ "It is a bright and glorious day.")))
```

Note: **(and) => t** , which is the identity for the **and** operation.

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

and &rest *types* *Type Specifier*

The type specifier **and** allows the definition of data types that are the intersection of other data types specified by *types.* As a type specifier, **and** can only be used in list form.

Examples:

```
(typep 89 '(and integer number)) => T
(subtypep 'bit-vector '(and vector array)) => T and T
(sys:type-arglist 'and) => (&REST TYPES) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

For a discussion of the function **and**: See the section "Flow of Control" in *Symbolics Common Lisp: Language Concepts.*

zl:ap-1 *array index* *Function*

This is an obsolete version of **zl:aloc** that only works for one-dimensional arrays. There is no reason ever to use it.

zl:ap-2 *array index1 index2* *Function*

This is an obsolete version of **zl:aloc** that only works for two-dimensional arrays. There is no reason ever to use it.

zl:ap-leader *array index* *Function*

Returns a locative pointer to the *index*ed element of *array*'s leader. *array* should be an array with a leader, and *index* should be an integer. See the section "Cells and Locatives".

However, the preferred method is to use **locf** and **array-leader** as shown in the following example:

```
(setq *array*
  (make-array '(2 3) :element-type 'character
                     :leader-list '(t nil)))

(locf (array-leader *array* 1))
```

append &rest *lists* *Function*

The arguments to **append** are lists. The result is a list that is the concatenation of the arguments. The arguments are not changed (see **nconc**). Example:

```
(append '(a b c) '(d e f) nil '(g)) => (a b c d e f g)
```

append makes copies of the top-level list structure of all the arguments it is given, *except* for the last one. So the new list shares the conses of the last argument to append, but all the other conses are newly created. Only the lists are copied, not the elements of the lists. The function **concatenate** can perform a similar operation, but always copies all its arguments . See also **nconc**, which is like **append** but destroys all its arguments except the last.

The last argument does not have to be a list, but may be any Lisp object, which becomes the tail of the constructed list. For example,

```
(append '(a b c) 'd) => (a b c . d)
```

A version of **append** that only accepts two arguments could have been defined by:

```
(defun append2 (x y)
    (cond ((null x) y)
          ((cons (car x) (append2 (cdr x) y)) )))
```

The generalization to any number of arguments could then be made (relying on **car** of **nil** being **nil**):

```
(defun append (&rest args)
  (if (< (length args) 2) (car args)
      (append2 (car args)
               (apply (function append) (cdr args)))))
```

These definitions do not express the full functionality of **append**; the real definition minimizes storage utilization by cdr-coding the list it produces, using *cdr-next* except at the end where a full node is used to link to the last argument, unless the last argument is **nil** in which case *cdr-nil* is used. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts.*

To copy a list, use **zl-user:copy-list** (or **zl:copylist**); the old practice of using

```
(append x '())
```

to copy lists is unclear and obsolete.

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append Keyword For loop

append *expr* {**into** *var*}

Causes the values of *expr* on each iteration to be **appended** together. When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

The forms **append** and **appending** are synonymous.

Examples:

```
(defun splice-list (list1 list2)
  (loop for item1 in list1
        for item2 in list2
        append (list item1) into result
        append (list item2) into result
        finally (return (append result )))) => SPLICE-LIST
(splice-list '(Let not the of minds) '(me to marriage true)) =>
(LET ME NOT TO THE MARRIAGE OF TRUE)
```

Is equivalent to

```
(defun splice-list (list1 list2)
  (loop for item1 in list1
        for item2 in list2
        appending (list item1) into result
        appending (list item2) into result
        finally (return (append result ))))  => SPLICE-LIST
(splice-list '(Let not the of minds) '(me to marriage true)) =>
(LET ME NOT TO THE MARRIAGE OF TRUE)
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **append, collect,** and **nconc** are compatible.

See the section "**loop** Clauses", page 310.

apply *function* &rest *arguments* *Function*

Applies the function *function* to *arguments*. *function* can be any function, but it cannot be a special form or a macro. Examples:

```
(setq fred '+)
(apply fred '(1 2)) => 3
(setq fred '-)
(apply fred '(1 2)) => -1
(apply 'cons '((+ 2 3) 4)) => ((+ 2 3) . 4) not (5 . 4)
```

Note that if the function takes keyword arguements, you must put the keywords as well as the corresponding values in the argument list.

```
(apply #'(lambda (&key a b) (list a b)) '(:b 3) => (nil 3)
```

See the section "Functions for Function Invocation" in *Symbolics Common Lisp: Language Concepts.* p. 511

zl:apply *function args* *Function*

Applies the function *function* to the list of arguments *args*. *args* should be a list; *function* can be any function, but it cannot be a special form or a macro.

Examples:

```
(setq fred '+)
(apply fred '(1 2)) => 3
(setq fred '-)
(apply fred '(1 2)) => -1
(apply 'cons '((+ 2 3) 4)) => ((+ 2 3) . 4) not (5 . 4)
```

Of course, *args* can be **nil**. Note: Unlike Maclisp, **zl:apply** never takes a third argument; there are no "binding context pointers" in Symbolics Common Lisp.

See the function **funcall**, page 245.

See the section "Functions for Function Invocation" in *Symbolics Common Lisp: Language Concepts.*

zl:ar-1 *array index* *Function*

This is an obsolete version of **aref** that only works for one-dimensional arrays. There is no reason ever to use it.

zl:ar-2 *array index1 index2* *Function*

This is an obsolete version of **aref** that only works for two-dimensional arrays. There is no reason ever to use it.

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aref *array* &rest *subscripts* *Function*

Returns the element of *array* selected by the *subscripts*. The *subscripts* must be integers and their number must match the dimensionality of *array*.

```
(setq this-array (make-array '(2 3) :initial-contents
                             '((a b c) (d e f))))

(aref this-array 0 0) => A
(aref this-array 0 1) => B
(aref this-array 0 2) => C
(aref this-array 1 0) => D
```

setf may be used with **aref** to set the value of an array element.

```
(setf (aref this-array 1 0) 'x) => X
(aref this-array 1 0) => X
```

zl:arg *x* *Function*

(zl:arg nil), when evaluated during the application of a lexpr, gives the number of arguments supplied to that lexpr. This is primarily a debugging aid, since lexprs also receive their number of arguments as the value of their **lambda**-variable.

(zl:arg *i***)**, when evaluated during the application of a lexpr, gives the value of the *i*'th argument to the lexpr. *i* must be an integer in this case. It is an error if *i* is less than 1 or greater than the number of arguments supplied to the lexpr. Example:

```
(defun foo nargs              ;define a lexpr foo.
    (print (arg 2))           ;print the second argument.
    (+ (arg 1)                ;return the sum of the first
       (arg (- nargs 1))))    ;and next to last arguments.
```

zl:arg exists only for compatibility with Maclisp lexprs. To write functions that can accept variable numbers of arguments, use the **&optional** and **&rest** keywords. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts.*

arglist *function* &optional *real-flag* *Function*

arglist is given an ordinary function, a generic function, or a function spec, and returns its best guess at the nature of the function's lambda-list. It can also return a second value which is a list of descriptive names for the values returned by the function. The third value is a symbol specifying the type of function:

Returned Value	*Function Type*
nil	ordinary or generic function
subst	substitutable function
special	special form
macro	macro
si:special-macro	both a special form and a macro
array	array

If *function* is a symbol, **arglist** of its function definition is used.

Some functions' real argument lists are not what would be most descriptive to a user. A function can take an **&rest** argument for technical reasons even though there are standard meanings for the first element of that argument. For such cases, the definition of the function can specify, with a local declaration, a value to be returned when the user asks about the argument list. Example:

```
(defun foo (&rest rest-arg)
  (declare (arglist x y &rest z))
  .....)
```

Note that since the declared argument list is supplied by the user, it does not necessarily correspond to the function's actual argument list.

real-flag allows the caller of **arglist** to say that the real argument list should be used even if a declared argument list exists.

If *real-flag* is **t** or a declared argument list does not exist, **arglist** computes its return value using information associated with the function. Normally the computed argument list is the same as that supplied in the source definition, but occasionally some differences occur. However, **arglist** always returns a functionally correct answer in that the number and type of the arguments is correct.

When a function returns multiple values, it is useful to give the values names so that the caller can be reminded which value is which. By means of a **values** declaration in the function's definition, entirely analogous to the **arglist** declaration above, you can specify a list of mnemonic names for the returned values. This list is returned by **arglist** as the second value.

```
(arglist 'arglist)
  => (function &optional real-flag) and (arglist values type)
```

args-info *fcn* *Function*

args-info returns an integer called the "numeric argument descriptor" of the *function*, which describes the way the function takes arguments. This descriptor is used internally by the microcode, the evaluator, and the compiler. *function* can be a function or a function spec.

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The information is stored in various bits and byte fields in the integer, which are referenced by the symbolic names shown below. By the usual Symbolics Lisp Machine convention, those starting with a single "%" are bit-masks (meant to be **zl:loganded** or **zl:bit-tested** with the number), and those starting with "%%" are byte descriptors (meant to be used with **ldb** or **ldb-test**).

Here are the fields:

sys:%%arg-desc-min-args
This is the minimum number of arguments that can be passed to this function, that is, the number of "required" parameters.

sys:%%arg-desc-max-args
This is the maximum number of arguments that can be passed to this function, that is, the sum of the number of "required" parameters and the number of "optional" parameters. If there is an **&rest** argument, this is not really the maximum number of arguments that can be passed; an arbitrarily large number of arguments is permitted, subject to limitations on the maximum size of a stack frame (about 200 words).

sys:%%arg-desc-rest-arg
If this is nonzero, the function takes an **&rest** argument or **&key** arguments. A greater number of arguments than **sys:%%arg-desc-max-args** can be passed.

sys:%arg-desc-interpreted
This function is not a compiled-code object.

sys:%%arg-desc-interpreted
This is the byte field corresponding to the **sys:%arg-desc-interpreted** bit.

sys:%%arg-desc-quoted
This is obsolete. In Release 5 this was used by the **zl:&quote** feature.

sys:%args-info *function* *Function*
This is an internal function; it is like **args-info** but does not work for interpreted functions. Also, *function* must be a function, not a function spec.

zl:argument-typecase *arg-name* &body *clauses* *Special Form*
zl:argument-typecase is a hybrid of **zl:typecase** and **zl:check-arg-type**. Its clauses look like clauses to **zl:typecase**. **zl:argument-typecase** automatically generates an **otherwise** clause which signals an error. The proceed types to this error are similar to those from **zl:check-arg**; that is, you can supply a new value that replaces the argument that caused the error.

For example, this:

```
(defun foo (x)
 (argument-typecase x
   (:symbol (print 'symbol))
   (:number (print 'number))))
```

is the same as this:

```
(defun foo (x)
  (check-arg x
    (typecase x
      (:symbol (print 'symbol) t)
      (:number (print 'number) t)
      (otherwise nil))
    "a symbol or a number"))
```

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

array &optional (*element-type* '*) (*dimensions* '*) *Type Specifier*

array is the type specifier symbol for the Lisp data structure of that name.

The types **array, cons, symbol, number,** and **character** are *pairwise* disjoint.

The type **array** is a *supertype* of the types:

simple-array
vector

This type specifier can be used in either symbol or list form. Used in list form, **array** allows the declaration and creation of specialized arrays whose members are all members of the type *element-type* and whose dimensions match *dimensions.*

element-type must be a valid type specifier, or unspecified. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

dimensions can be a non-negative integer, which is the number of dimensions, or it can be a list of non-negative integers representing the length of each dimension (any of which can be unspecified). *dimensions* can also be unspecified.

Note that **(array t)** is a proper subset of **(array *)**. This is because **(array t)** is the set of arrays that can hold any Symbolics Common Lisp object (the elements are of type **t**, which includes all objects). On the other

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hand, **(array *)** is the set of all arrays whatsoever, including for example arrays that can hold only characters. **(array character)** is not a subset of **(array t)**; the two sets are in fact disjoint because **(array character)** is not the set of all arrays that can hold characters, but rather the set of arrays that are specialized to hold precisely characters and no other objects. To test whether an array **foo** can hold a character, one should not use

```
(typep foo '(array character))
```

but rather

```
(subtypep 'character (array-element-type foo))
```

Examples:

```
(setq example-array (make-array '(3) :fill-pointer 2))
=> #<ART-Q-3 43063275>

(typep example-array 'array) => T

(typep example-array 'simple-array) => NIL
; simple arrays do not have fill-pointers.

(zl:typep #*101) => :ARRAY

(subtypep 'array t) => T and T

(array-has-fill-pointer-p example-array) => T

(arrayp example-array) => T

(sys:type-arglist 'array)
 => (&OPTIONAL (ELEMENT-TYPE '*) (DIMENSIONS '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

See the section "Arrays" in *Symbolics Common Lisp: Language Concepts*.

zl:array *x type* &rest *dimlist* *Macro*

This creates an **sys:art-q** type array in **sys:default-cons-area** with the given dimensions. (That is, *dimlists* is given to **zl:make-array** as its first argument.) *type* is ignored. If *x* is **nil**, the array is returned; otherwise, the array is put in the function cell of *symbol*, and *symbol* is returned. This exists for Maclisp compatibility.

We suggest using **make-array** in new programs.

zl:*array *x type* &rest *dimlist* *Function*

This is just like **zl:array**, except that all of the arguments are evaluated. It exists for Maclisp compatibility.

zl:array-#-dims *array* *Function*

Returns the dimensionality of *array*. For example:

```
(zl:array-#-dims (make-array '(3 5))) => 2
```

array-rank provides the same functionality.

zl:array-active-length *array* *Function*

Returns the number of active elements in *array*. If *array* does not have a fill pointer, this returns whatever **(array-total-size** *array***)** would have. If *array* does have a fill pointer that is a non-negative fixnum, **zl:array-active-length** returns it. See the section "Array Leaders" in *Symbolics Common Lisp: Language Concepts*. A general explanation of the use of fill pointers is in that section.

Note that **length** provides the same functionality for lists and vectors.

sys:array-bits-per-element *Variable*

The value of **sys:array-bits-per-element** is an association list that associates each array type symbol with the number of bits of unsigned numbers (or fixnums) it can hold, or **nil** if it can hold Lisp objects. This can be used to tell whether an array can hold Lisp objects or not. See the section "Association Lists" in *Symbolics Common Lisp: Language Concepts*.

sys:array-bits-per-element *index* *Function*

Given the internal array-type code numbers, returns the number of bits per cell for unsigned numeric arrays, or **nil** for a type of array that can contain Lisp objects.

array-dimension *array dimension-number* *Function*

Returns the length of the dimension numbered *dimension-number* of *array*. *dimension-number* should be a non-negative integer less than the rank of *array*.

array-dimension-limit *Constant*

Represents the upper exclusive bound on each individual dimension of an array. The value of this is 134217728.

zl:array-dimension-n *n array* *Function*

Returns the size for the specified dimension of the array. *array* can be any kind of array, and *n* should be an integer. If *n* is between 1 and the dimensionality of *array*, this returns the *n*th dimension of *array*. If *n* is **0**, this returns the length of the leader of *array*; if *array* has no leader it returns **nil**. If *n* is any other value, this returns **nil**.

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Examples:

```
(setq a (make-array '(3 5) :leader-length 7))
(zl:array-dimension-n 1 a) => 3
(zl:array-dimension-n 2 a) => 5
(zl:array-dimension-n 3 a) => nil
(zl:array-dimension-n 0 a) => 7
```

Use **array-dimension** in new programs.

array-dimensions *array* *Function*

array-dimensions returns a list whose elements are the dimensions of array. Example:

```
(setq a (make-array '(3 5)))
(array-dimensions a) => (3 5)
```

zl:arraydims *array* *Function*

zl:arraydims returns a list whose first element is the symbolic name of the type of *array*, and whose remaining elements are its dimensions. *array* can be any array; it also can be a symbol whose function cell contains an array (for Maclisp compatibility).

Example:

```
(setq a (make-array '(3 5)))
(zl:arraydims a) => (sys:art-q 3 5)
```

Note: the list returned by **(array-dimensions** *x***)** is equal to the cdr of the list returned by **(zl:arraydims** *x***)**.

See the function **array-dimensions**, page 30.

sys:array-displaced-p *array* *Function*

Tests whether the array is a displaced array. *array* can be any kind of array. This predicate returns **t** if *array* is any kind of displaced array (including an indirect array). Otherwise it returns **nil**.

sys:array-element-size *array* *Function*

Given an array, returns the number of bits that fit in an element of that array. For arrays that can hold general Lisp objects, the result is 31; this assumes that you are storing fixnums in the array and manipulating their bits with **dpb** (rather than **sys:%logdpb**). You can store any number of bits per element in an array that holds general Lisp objects, by letting the elements expand into bignums.

sys:array-elements-per-q *index* *Function*

Given the internal array-type *index*, returns the number of array elements stored in one word, for an array of that type.

sys:array-elements-per-q *index* *Variable*

sys:array-elements-per-q is an association list that associates each array type symbol with the number of array elements stored in one word, for an array of that type. See the section "Association Lists" in *Symbolics Common Lisp: Language Concepts*.

array-element-type *array* *Function*

Returns the type of the elements of *array*. Example:

```
(setq a (make-array '(3 5)))
(array-element-type a) => T
(array-element-type "foo") => STRING-CHAR
```

zl:array-grow *array* &rest *dimensions* *Function*

zl:array-grow creates a new array of the same type as *array*, with the specified dimensions. Those elements of *array* that are still in bounds are copied into the new array. The elements of the new array that are not in the bounds of *array* are initialized to **nil** or **0** as appropriate. If *array* has a leader, the new array has a copy of it. **zl:array-grow** returns the new array and also forwards *array* to it, like **adjust-array**.

Unlike **adjust-array**, **zl:array-grow** usually creates a new array rather than growing or shrinking the array in place. (If the array is one-dimensional and it is being shrunk, **zl:array-grow** does not create a new array.) **zl:array-grow** of a multidimensional array can change all the subscripts and move the elements around in memory to keep each element at the same logical place in the array.

array-has-fill-pointer-p *array* *Function*

Returns **t** if the array has a fill pointer; otherwise it returns **nil**. *array* can be any array.

array-has-leader-p *array* *Function*

Returns **t** if *array* has a leader; otherwise it returns **nil**. *array* can be any array.

array-in-bounds-p *array* &rest *subscripts* *Function*

Checks whether *subscripts* is a valid set of subscripts for *array*, and returns **t** if they are; otherwise it returns **nil**.

sys:array-indexed-p *array* *Function*

This predicate returns **t** if *array* is an indirect array with an index-offset. Otherwise it returns **nil**. *array* can be any kind of array. Note, however, that displaced arrays with an offset are not considered indexed.

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sys:array-indirect-p *array* *Function*

This predicate returns **t** if *array* is an indirect array. Otherwise it returns **nil**. *array* can be any kind of array.

array-leader *array index* *Function*

Returns the *index*ed element of *array*'s leader. *array* should be an array with a leader, and *index* should be an integer.

array-leader-length *array* *Function*

This returns the length of *array*'s leader if it has one, or **nil** if it does not. *array* can be any array.

array-leader-length-limit *Constant*

This is the exclusive upper bound of the length of an array leader. It is 1024 on Symbolics 3600-family computers.

```
(condition-case (err)
     (make-array 4 :leader-length array-leader-length-limit)
   (error (princ err)))
 => Leader length specified (1024) is too large.
    #<FERROR 60065043>
```

zl:array-length *array* *Function*

array-total-size provides the same functionality as does **zl:array-length**.

Returns the total number of elements in *array*. *array* can be any array. The total size of a one-dimensional array is calculated without regard for any fill pointer. For a one-dimensional array, **zl:array-length** returns one greater than the maximum allowable subscript. For example:

```
(zl:array-length (make-array 3)) => 3
(zl:array-length (make-array '(3 5))) => 15
```

Note that if fill pointers are being used and you want to know the active length of the array, you should use **length** or **zl:array-active-length** instead of **zl:array-length**.

zl:array-length does not return the same value as the product of the dimensions for conformal arrays.

arrayp *arg* *Function*

arrayp returns **t** if its argument is an array, otherwise **nil**. Note that strings are arrays.

zl:array-pop *array* &optional (*default* **nil**) *Function*

Decreases the fill pointer by one and returns the array element designated by the new value of the fill pointer. *array* must be a one-dimensional array that has a fill pointer.

The second argument, if supplied, is the value to be returned if the array is empty. If **zl:array-pop** is called with one argument and the array is empty, it signals an error.

The two operations (decrementing and array referencing) happen uninterruptibly. If the array is of type **sys:art-q-list**, an operation similar to **nbutlast** has taken place. The cdr coding is updated to ensure this.

See the function **vector-pop**, page 612.

zl:array-push *array x* *Function*

zl:array-push attempts to store *x* in the element of the array designated by the fill pointer and increase the fill pointer by one. *array* must be a one-dimensional array that has a fill pointer, and *x* can be any object allowed to be stored in the array. If the fill pointer does not designate an element of the array (specifically, when it gets too big), it is unaffected and **zl:array-push** returns **nil**; otherwise, the two actions (storing and incrementing) happen uninterruptibly, and **zl:array-push** returns the *former* value of the fill pointer, that is, the array index in which it stored *x*.

If the array is of type **sys:art-q-list**, an operation similar to **nconc** has taken place, in that the element has been added to the list by changing the cdr of the formerly last element. The cdr coding is updated to ensure this.

See the function **vector-push**, page 612.

zl:array-push-extend *array x* &optional *extension* *Function*

zl:array-push-extend is just like **zl:array-push** except that if the fill pointer gets too large, the array is grown to fit the new element; that is, it never "fails" the way **zl:array-push** does, and so never returns **nil**. extension is the number of elements to be added to the array if it needs to be grown. It defaults to something reasonable, based on the size of the array. **zl:array-push-extend** returns the *former* value of the fill pointer, that is, the array index in which it stored *x*.

See the function **vector-push-extend**, page 612.

zl:array-push-portion-extend *to-array from-array* &optional (*from-start* **0**) *from-end* *Function*

Copies a portion of one array to the end of another, updating the fill pointer of the other to reflect the new contents. The destination array must have a fill pointer. The source array need not. This is equivalent to numerous **zl:array-push-extend** calls, but more efficient.

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zl:array-push-portion-extend returns the *to-array* and the index of the next location to be filled.

Example:

```
(setq to-string
      (zl:array-push-portion-extend to-string
                                    from-string
                                    (or from 0)
                                    to))
```

This is similar to **zl:array-push-extend** except that it copies more than one element and has different return values. The arguments default in the usual way, so that the default is to copy all of *from-array* to the end of *to-array*.

zl:array-push-portion-extend adjusts the array size using **adjust-array**. It picks the new array size in the same way that **zl:array-push-extend** does, making it bigger than needed for the information being added. In this way, successive additions do not each end up consing a new array. **zl:array-push-portion-extend** uses **copy-array-portion** internally.

See the function **vector-push-portion-extend**, page 612.

array-rank *array* *Function*

Returns the number of dimensions of *array*. For example:

```
(array-rank (make-array '(3 5))) => 2
```

array-rank-limit *Constant*

Represents the exclusive upper bound on the rank of an array. The value of this is 8.

array-row-major-index *array* &rest *subscripts* *Function*

Takes an array and valid subscripts for the array and returns a single positive integer, less than the total size of the array, that identifies the accessed element in the row-major ordering of the elements. The number of *subscripts* supplied must equal the rank of the array. Each subscript must be a nonnegative integer less than the corresponding array dimension. Like **aref**, **array-row-major-index** returns the position whether or not that position is within the active part of the array.

For example:

`window` is a conformal array whose 0,0 coordinate is at 256,256 of `big-array`. The following code creates a 1/4 size portal into the center of big-array.

```
;;; -*- Syntax: Zetalisp; Package: USER; Base: 10; Mode: LISP -*-
(setq big-array (make-array '(1024 1024) :type 'art-q
                                         :initial-value 0))
(setq window (make-array '(512 512) :type 'art-q
                         :displaced-to big-array
                         :displaced-index-offset
                           (array-row-major-index big-array 256 256)
                         :displaced-conformally t))
```

For a one-dimensional array, the result of **array-row-major-index** equals the supplied subscript.

An error is signalled if some subscript is not valid.

array-row-major-index can be used with the **:displaced-index-offset** option of **make-array** to construct the desired value for multidimensional arrays.

sys:array-row-span *array* *Function*

sys:array-row-span, given a two-dimensional *array*, returns the number of array elements spanned by one of its rows. Normally, this is just equal to the length of a row (that is, the number of columns), but for conformally displaced arrays, the length and the span are not equal.

```
(sys:array-row-span (make-array '(4 5))) => 5
(sys:array-row-span (make-array '(4 5)
                                :displaced-to (make-array '(8 9))
                                :displaced-conformally t))
        => 9
```

Note: if the array is conceptually a raster, it is better to use **decode-raster-array** instead of **sys:array-row-span**.

array-total-size *array* *Function*

Returns the total number of elements in *array*. The total size of a one-dimensional array is calculated without regard for any fill pointer.

```
(array-total-size (make-array '(3 5 2))) => 30
```

Note that if fill pointers are being used and you want to know the active length of the array, you should use **length** or **zl:array-active-length**.

array-total-size does not return the same value as the product of the dimensions for conformal arrays.

array-total-size-limit *Constant*

Represents the exclusive upper bound on the number of elements of an array. The value of this is 134217728.

A

sys:array-type *array* *Function*

Returns the symbolic type of *array*. Example:

```
(sys:array-type (make-array '(3 5))) => SYS:ART-Q
```

sys:*array-type-codes* *Variable*

The value of **sys:*array-type-codes*** is a list of all of the array type symbols such as **sys:art-q**, **sys:art-4b**, **sys:art-string** and so on. The values of these symbols are internal array type code numbers for the corresponding type.

sys:array-types *index* *Function*

Returns the symbolic name of the array type. The *index* is the internal numeric code stored in **sys:*array-type-codes***.

zl:as-1 *value array index* *Function*

This is an obsolete version of **zl:aset** that only works for one-dimensional arrays. There is no reason ever to use it.

zl:as-2 *value array index1 index2* *Function*

This is an obsolete version of **zl:aset** that only works for two-dimensional arrays. There is no reason ever to use it.

zl:ascii *x* *Function*

zl:ascii returns a symbol whose printname is the character *x*.

x can be an integer (a character code), a character, a string, or a symbol.

Examples:

```
(zl:ascii 2) => α
(zl:ascii #\y) => |y|
(zl:ascii "Y") => Y
(zl:ascii 'a) => A
```

The symbol returned is interned in the current package.

This function is provided for Maclisp compatibility only.

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts*.

ascii-code *spec* *Function*

Returns an integer that is the ASCII code named by *spec*. If *spec* is a character, **char-to-ascii** is called. Otherwise, *spec* can be a string or keyword that names one of the ASCII special characters.

ascii-code returns an integer, for example **(ascii-code #\cr) => #o15**. **ascii-code** also recognizes strings and looks up the names of the ASCII

"control" characters. Thus **(ascii-code "soh")** and **(ascii-code #\↓)** return **1**. **(ascii-code #\c-A)** returns **#o101**, not **1**; there is no mapping between Symbolics character set control characters and ASCII control characters.

Valid ASCII special character names are listed below. All numbers are in octal.

NUL 000	HT 011	DC1 021	SUB 032
SOH 001	LF 012	DC2 022	ESC 033
STX 002	NL 012	DC3 023	ALT 033
ETX 003	VT 013	DC4 024	FS 034
EOT 004	FF 014	NAK 025	GS 035
ENQ 005	CR 015	SYN 026	RS 036
ACK 006	SO 016	ETB 027	US 037
BEL 007	SI 017	CAN 030	SP 040
BS 010	DLE 020	EM 031	DEL 177
TAB 011			

ascii-to-char *code* *Function*

Converts *code* (an ASCII code) to the corresponding character. The caller must ignore LF after CR if desired. See the section "ASCII String Functions" in *Symbolics Common Lisp: Language Concepts.*

The functions **char-to-ascii** and **ascii-to-char** provide the primitive conversions needed by ASCII-translating streams. They do not translate the Return character into a CR-LF pair; the caller must handle that. They just translate **#\return** into CR and **#\line** into LF. Except for CR-LF, **char-to-ascii** and **ascii-to-char** are wholly compatible with the ASCII-translating streams.

They ignore Symbolics Lisp Machine control characters; the translation of **#\c-g** is the ASCII code for **G**, not the ASCII code to ring the bell, also known as "control G." **(ascii-to-char (ascii-code "BEL"))** is **#/π**, not **#\c-G**. The translation from ASCII to character never produces a Lisp Machine control character.

ascii-to-string *ascii-array* *Function*

Converts *ascii-array*, an **sys:art-8b** array representing ASCII characters, into a Lisp string. Note that the length of the string can vary depending on whether *ascii-array* contained a newline character or Carriage Return Line Feed characters. See the section "ASCII Characters" in *Symbolics Common Lisp: Language Concepts.*

Example:

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```
(setq a-string-array
  (zl:make-array 5 :type zl:art-8b :initial-value (ascii-code #\x)))
 => #(120 120 120 120 120)
(ascii-to-string a-string-array)  => "xxxxx"
```

For a table of related items: See the section "ASCII String Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:aset *element array* &rest *subscripts* *Function*

Stores *element* into the element of *array* selected by the *subscripts*. The *subscripts* must be integers and their number must match the dimensionality of *array*. The returned value is *element*.

Current style suggests using **setf** and **aref** instead of **zl:aset**. For example:

```
(setf (aref array subscripts...) new-value)
```

ash *number count* *Function*

Shifts *number* arithmetically left *count* bits if *count* is positive, or right *-count* bits if *count* is negative. Unused positions are filled by zeroes from the right, and by copies of the sign bit from the left. Thus, unlike **lsh**, the sign of the result is always the same as the sign of *number*. If *number* is an integer, this is a shifting operation. If *number* is a floating-point number, this does scaling (multiplication by a power of two), rather than actually shifting any bits.
Examples:

```
(ash 1 3) => 8
(ash 10 3) => 80
(ash 10 -3) => 1
(ash 1 -3) => 0
(ash 1.5 3) => 12.0
(ash -1 3) => -8
(ash -1 -3) => -1
```

See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

asin *number* *Function*

Computes and returns the arc sine of *number*. The result is in radians.

The argument can be any noncomplex or complex number. Note that if the absolute value of *number* is greater than one, the result is complex, even if the argument is not complex.

The arc sine being a mathematically multiple-valued function, **asin** returns a principal value whose range is that strip of the complex plane containing numbers with real parts between -π/2 and π/2. Any number with a real part equal to -π/2 and a negative imaginary part is excluded from the range. Also excluded from the range is any number with real part equal to π/2 and a positive imaginary part.

Examples:

```
(asin 1) => 1.5707964   ;π/2 radians
(asin 0) => 0.0
(asin -1)  => -1.5707964   ;-π/2 radians
(asin 2)  => #c(1.5707964 -1.316958)
(asin -2)  => #c(-1.5707964 1.3169578)
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

asinh *number* *Function*

Computes and returns the hyperbolic arc sine of *number.* The result is in radians. The argument can be any noncomplex or complex number.

The hyperbolic arc sine being mathematically multiple-valued in the complex plane, **asinh** returns a principal value whose range is that strip of the complex plane containing numbers with imaginary parts between -π/2 and π/2. Any number with an imaginary part equal to -π/2 is not in the range if its real part is negative; any number with real part equal to π/2 is excluded from the range if its imaginary part is positive.

Example:

```
(asinh 0) => 0.0        ;(sinh 0) => 0.0
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:ass *predicate item alist* *Function*

(zl:ass *item alist***)** looks up *item* in the association list (list of conses) *alist.* The value is the first cons whose *car* matches *x* according to *predicate,* or **nil** if there is none such. **(zl:ass** *'eq a b***)** is the same as **(zl:assq** *a b***)**. See the function **zl:mem,** page 345. As with **zl:mem,** you may use noncommutative predicates; the first argument to the predicate is *item* and the second is the key of the element of *alist.*

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

A

assert *test-form* &optional *references format-string* &rest *format-args* *Macro*

assert signals an error if the value of *test-form* is **nil**. It is possible to proceed from this error; the function lets you change the values of some variables, and starts over, evaluating *test-form* again.

assert returns **nil**.

test-form is any form.

references is a list, each item of which must be a generalized variable reference that is acceptable to the macro **setf**. These should be variables on which *test-form* depends, whose values can sensibly be changed by the user in attempting to correct the error. Subforms of each of *references* are only evaluated if an error is signalled, and can be re-evaluated if the error is re-signalled (after continuing without actually fixing the problem).

format-string is an error message string.

format-args are additional arguments; these are evaluated only if an error is signalled, and re-evaluated if the error is signalled again.

The function **format** is applied in the usual way to *format-string* and and *format-args* to produce the actual error message.

If *format-string* (and therefore also *format-args*) are omitted, a default error message is used.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

assoc *item a-list* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

assoc searches the association list *a-list*. The value returned is the first pair in *a-list* such that the *car* of the pair satisfies the predicate specified by **:test**, or **nil** if there is no such pair in *a-list*. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(assoc 'loon '((eagle . raptor) (loon . diver))) =>
(LOON . DIVER)

(assoc 'diver '((eagle . raptor) (loon . diver))) => NIL

(assoc '2 '((1 a b c) (2 b c d) (-7 x y z))) => (2 B C D)
```

It is possible to **rplacd** the result of **assoc** (provided that it is non-**nil**) in order to update *a-list*. However, it is often better to update an alist by adding new pairs to the front, rather than altering old pairs. For example:

```
(setq values '((x . 100) (y . 200) (z . 50))) =>
((X . 100) (Y . 200) (Z . 50))

(assoc 'y values) => (Y . 200)

(rplacd (assoc 'y values) 201) => (Y . 201)

(assoc 'y values) => (Y . 201)
```

The two expressions

```
(assoc item alist :test pred)
```

and

```
(find item alist :test pred :key #'car)
```

are almost equivalent in meaning. The difference occurs when **nil** appears in *a-list* in place of a pair, and the item being searched for is **nil**. In these cases, **find** computes the *car* of the **nil** in *a-list*, finds that it is equal to *item*, and returns **nil**, while **assoc** ignores the **nil** in *a-list* and continues to search for an actual cons whose *car* is **nil**. See also, **find position**.

zl:assoc *item alist* *Function*

(zl:assoc *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose *car* is **zl:equal** to *x*, or **nil** if there is none such. Example:

```
(zl:assoc '(a b) '((x . y) ((a b) . 7) ((c . d) .e)))
        => ((a b) . 7)
```

zl:assoc could have been defined by:

```
(defun assoc (item list)
    (cond ((null list) nil)
          ((equal item (caar list)) (car list))
          ((assoc item (cdr list))) ))
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

A

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

assoc-if *predicate a-list* &key *key* *Function*

assoc-if searches the association list *a-list.* The value returned is the first pair in *a-list* such that the *car* of the pair satisfies *predicate,* or **nil** if there is no such pair in *a-list.* The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(assoc-if #'integerp '((eagle . raptor) (1 . 2))) =>
(1 . 2)

(assoc-if #'symbolp '((eagle . raptor) (1 . 2))) =>
(EAGLE . RAPTOR)

(assoc-if #'floatp '((eagle . raptor) (1 . 2))) =>
NIL
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

assoc-if-not *predicate a-list* &key *key* *Function*

assoc-if-not searches the association list *a-list.* The value returned is the first pair in *a-list* such that the *car* of the pair does not satisfy *predicate,* or **nil** if there is no such pair in *a-list.* The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(assoc-if-not #'integerp '((eagle . raptor) (1 . 2))) =>
(EAGLE . RAPTOR)

(assoc-if-not #'symbolp '((eagle . raptor) (1 . 2))) =>
(1 . 2)

(assoc-if-not #'symbolp '((eagle . raptor) (loon . diver))) =>
NIL
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:assq *item alist* *Function*

(zl:assq *item alist*) looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose *car* is **eq** to *x*, or **nil** if there is none such. Examples:

```
(zl:assq 'r '((a . b) (c . d) (r . x) (s . y) (r . z)))
       =>  (r . x)

(zl:assq 'fooo '((foo . bar) (zoo . goo))) => nil

(zl:assq 'b '((a b c) (b c d) (x y z))) => (b c d)
```

You can **rplacd** the result of **zl:assq** as long as it is not **nil**, if your intention is to "update" the "table" that was **zl:assq**'s second argument. Example:

```
(setq values '((x . 100) (y . 200) (z . 50)))
(zl:assq 'y values) => (y . 200)
(rplacd (zl:assq 'y values) 201)
(zl:assq 'y values) => (y . 201) now
```

A typical trick is to say **(cdr (zl:assq** *x y*)). Since the *cdr* of **nil** is guaranteed to be **nil**, this yields **nil** if no pair is found (or if a pair is found whose cdr is **nil**.)

zl:assq could have been defined by:

```
(defun zl:assq (item list)
    (cond ((null list) nil)
          ((eq item (caar list)) (car list))
          ((assq item (cdr list))) ))
```

zl:assq is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

atan *y* &optional *x* *Function*

With two arguments, *y* and *x*, **atan** computes and returns the arc tangent of the quantity *y*/*x*. If either argument is a double-float, the result is also a double-float. In the two argument case neither argument can be complex. The returned value is in radians and is always between -π (exclusive) and π (inclusive). The signs of *y* and *x* determine the quadrant of the result angle.

Note that either *y* or *x* (but not both simultaneously) can be zero. The examples illustrate a few special cases.

With only one argument *y*, **atan** computes and returns the arc tangent of

A

y. The argument can be any noncomplex or complex number. The result is in radians and its range is as follows: for a noncomplex *y* the result is noncomplex and lies between -π/2 and π/2 (both exclusive); for a complex *y* the range is that strip of the complex plane containing numbers with a real part between -π/2 and π/2. A number with real part equal to -π/2 is not in the range if it has a non-positive imaginary part. Similarly, a number with real part equal to π/2 is not in the range if its imaginary part is non-negative.

Examples:

```
(atan 0) => 0.0
(atan 0 673) => 0.0                ;(atan (/ y x))
(atan 1 1) => 0.7853982            ;first quadrant
(atan 1 -1) => 2.3561945           ;second quadrant
(atan -1 -1) => -2.3561945         ;third quadrant
(atan -1 1) => -0.7853982          ;fourth quadrant
(atan 1 0)  => 1.5707964
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:atan *y x* *Function*

Returns the angle, in radians, whose tangent is *y*/*x*. **zl:atan** always returns a number between zero and 2π.

Examples:

```
(zl:atan 1 1) => 0.7853982
(zl:atan -1 -1) => 3.926991
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:atan2 *y x* *Function*

Similar to **atan**, except that it accepts only noncomplex arguments.

Returns the angle, in radians, whose tangent is *y*/*x*. **zl:atan2** always returns a number between -π and π.

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

atanh *number* *Function*

Computes and returns the hyperbolic arc tangent of *number*. The result is in radians. The argument can be any noncomplex or complex number. Note that if the absolute value of the argument is greater than one, the result is complex even if the argument is not complex.

The hyperbolic arc tangent being mathematically multiple-valued in the complex plane, **atanh** returns a principal value whose range is that strip of the complex plane containing numbers with imaginary parts between $-\pi/2$ and $\pi/2$. Any number with an imaginary part equal to $-\pi/2$ is not in the range if its real part is non-negative; any number with imaginary part equal to $\pi/2$ is excluded from the range if its real part is non-positive.

Example:

```
(atanh 0) => 0.0
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts.*

atom *Type Specifier*

atom is the type specifier symbol for the predefined Lisp object, atom.

`atom ≡ (not cons).`

Examples:

```
(typep 'a 'atom) => T

(zl:typep 'a) => :SYMBOL

(subtypep 'atom 'common) => NIL and NIL

(atom 'a) => T

(sys:type-arglist 'atom) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Symbols and Keywords" in *Symbolics Common Lisp: Language Concepts.*

atom *object* *Function*

The predicate **atom** returns **t** if its argument is not a cons, otherwise **nil**.

Note that

```
(atom '())
```

is true because () is equivalent to **nil**.

```
(atom x)
```

is equivalent to

```
(type x 'atom)
```

is equivalent to

```
(not (typep x 'cons))
```

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

&aux *Lambda List Keyword*

&aux separates the arguments of a function from the auxiliary variables. If it is present, all specifiers after it are entries of the form:

(*variable initial-value-form*)

zl:base *Variable*

The value of **zl:base** is a number that is the radix in which integers and ratios are printed in, or a symbol with a **si:princ-function** property. The initial value of **zl:base** is 10. **zl:base** should not be greater than 36 or less than 2.

The printing of trailing decimal points for integers in base ten is controlled by the value of variable ***print-radix***. See the section "Printed Representation of Rational Numbers" in *Symbolics Common Lisp: Language* Concepts.

The following variable is a synonym for **zl:base**:

print-base

bignum *Type Specifier*

bignum is the type specifier symbol for the predefined primitive Lisp object, bignum.

The types **bignum** and **fixnum** are an *exhaustive partition* of the type integer, since `integer ≡ (or bignum fixnum)`. These two types are internal representations of integers used by the system for efficiency depending on integer size; in general, bignums and fixnums are transparent to the programmer.

Examples:

```
(typep 10000000000000000000000000000000 'bignum) => T

(typep '1 'bignum) => NIL

(zl:typep '10000000000000000000000000000000) => :BIGNUM

(subtypep 'bignum 'integer) => T and T  ; subtype and certain

(typep 565682366398848747848463539404874 'common) => T

(zl:bigp 444444444455555555555555555556666666666666) => T

(sys:type-arglist 'bignum) => NIL and T

(type-of 0988937489733837368948494949437363948409987 6) => BIGNUM
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

zl:bigp *object* *Function*

zl:bigp returns **t** if *object* is a bignum, otherwise **nil**.

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

bit *array* &rest *subscripts* *Function*

Returns the element of *array* selected by the *subscripts*. The *subscripts* must be integers and their number must match the dimensionality of *array*. The array must be an array of bits.

bit *Type Specifier*

bit is the type specifier symbol for the predefined Lisp bit data type.

The type **bit** is a *subtype* of the types **unsigned-byte** and **fixnum**.

bit is the special name for the type `(integer 0 1)` and the type `(mod 2)`.

Examples:

```
(typep 2 'bit) => NIL
(typep 0 'bit) => T

(subtypep 'bit 'unsigned-byte) => T and T ;subtype and certain

(equal-typep 'bit '(unsigned-byte 1)) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

bit-and *first second* &optional *third* *Function*

Performs logical *and* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-andc1 *first second* &optional *third* *Function*

Performs logical *and* operations on the complement of *first* with *second* on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-andc2 *first second* &optional *third* *Function*

Performs logical *and* operations on *first* with the complement of *second* on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bitblt *alu width height from-raster from-x from-y to-raster to-x to-y* *Function*

bitblt copies a rectangular portion of *from-raster* into a rectangular portion of *to-raster*. *from-raster* and *to-raster* must be two-dimensional arrays of bits or bytes (**sys:art-1b**, **sys:art-2b**, **sys:art-4b**, **sys:art-8b**, **sys:art-16b**, or **sys:art-fixnum**). The value stored can be a Boolean function of the new

value and the value already there, under the control of *alu*. This function is most commonly used in connection with raster images for TV displays.

The top-left corner of the source rectangle is:

(raster-aref *from-raster from-x from-y*)

The top-left corner of the destination rectangle is:

(raster-aref *to-raster to-x to-y*)

width and *height* are the dimensions of both rectangles. If *width* or *height* is zero, **bitblt** does nothing.

from-raster and *to-raster* are allowed to be the same array. **bitblt** normally traverses the arrays in increasing order of *x* and *y* subscripts. If *width* is negative, then **(abs** *width*) is used as the width, but the processing of the *x* direction is done backwards, starting with the highest value of *x* and working down. If *height* is negative it is treated analogously. When **bitblt**ing an array to itself, when the two rectangles overlap, it might be necessary to work backwards to achieve the desired effect, such as shifting the entire array upwards by a certain number of rows. Note that negativity of *width* or *height* does not affect the *(x,y)* coordinates specified by the arguments, which are still the top-left corner even if **bitblt** starts at some other corner.

If the two arrays are of different types, **bitblt** works bit-wise and not element-wise. That is, if you **bitblt** from an **sys:art-2b** raster into an **sys:art-4b** raster, then two elements of the *from-raster* correspond to one element of the *to-raster*. *width* is in units of elements of the *to-raster*.

If **bitblt** goes outside the bounds of the source array, it wraps around. This allows such operations as the replication of a small stipple pattern through a large array. If **bitblt** goes outside the bounds of the destination array, it signals an error.

If *src* is an element of the source rectangle, and *dst* is the corresponding element of the destination rectangle, then **bitblt** changes the value of *dst* to **(boole** *alu src dst*). The following are the symbolic names for some of the most useful *alu* functions:

tv:alu-seta	plain copy
tv:alu-setz	set destination to 0
tv:alu-ior	inclusive or
tv:alu-xor	exclusive or
tv:alu-andca	and with complement of source

For a chart of more *alu* possibilities: See the function **boole**, page 54.

bitblt is written in highly optimized microcode and goes very much faster than the same thing written with ordinary raster operations would. Unfor-

tunately this causes **bitblt** to have a couple of strange restrictions. Wraparound does not work correctly if *from-raster* is an indirect array with an index offset. **bitblt** signals an error if the *width*s of *from-raster* and *to-raster* are not both integral multiples of the machine word length. For **sys:art-1b** arrays, *width* must be a multiple of 32., for **sys:art-2b** arrays it must be a multiple of 16., and so on.

bit-eqv *first second* &optional *third* *Function*

Performs logical *exclusive nor* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-ior *first second* &optional *third* *Function*

Performs logical *inclusive or* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-nand *first second* &optional *third* *Function*

Performs logical *not and* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-nor *first second* &optional *third* *Function*

Performs logical *not or* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-not *source* &optional *destination* *Function*

source must be a bit-array. **bit-not** returns a bit-array of the same rank and dimensions that contains a copy of the argument with all the bits inverted. If *destination* is **nil** or omitted, a new array is created to contain the result. If *destination* is **t**, the result is destructively placed in the *source* array.

bit-orc1 *first second* &optional *third* *Function*

Performs logical *or* operations on the complement of *first* with *second* on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

bit-orc2 *first second* &optional *third* *Function*

Performs logical *or* operations on *first* with the complement of *second* on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

zl:bit-test *x y* *Function*

zl:bit-test is a predicate that returns **t** if any of the bits designated by the 1's in *x* are 1's in *y*.

The following function is a synonym of **zl:bit-test**:

logtest

For a table of related items: See the section "Predicates for Testing Bits in Integers" in *Symbolics Common Lisp: Language Concepts.*

bit-vector &optional (*size* '*) *Type Specifier*

bit-vector is the type specifier symbol for the Lisp data structure of that name.

The type **bit-vector** is a *subtype* of the type **vector**; `(bit-vector)` means `(vector bit)`.

The type **bit-vector** is a *supertype* of the type **simple-bit-vector**.

The types `(vector t)`, **string**, and **bit-vector** are *disjoint.*

This type specifier can be used in either symbol or list form. Used in list form, **bit-vector** allows the declaration and creation of specialized types of bit vectors whose size is restricted to the specified *size.* `(bit-vector size)` means the same as `(array bit (size))`: the set of bit-vectors of the indicated size.

Examples:

```
(setq array-bit-vector
      (make-array '(3) :element-type 'bit :fill-pointer 2))
   => #<ART-1B-3 43015121>

(typep #*10110 'bit-vector) => T

(typep #*101 '(bit-vector 3)) => T

(typep array-bit-vector 'bit-vector) => T

(subtypep 'bit-vector 'vector) => T and T
```

```
(bit-vector-p #*) => T ;empty bit vector

(sys:type-arglist 'bit-vector) => (&OPTIONAL (SIZE '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Arrays" in *Symbolics Common Lisp: Language Concepts.*

bit-vector-p *object* *Function*

Tests whether the given *object* is a bit vector. A bit vector is a one-dimensional array whose elements are required to be bits. See the type specifier **bit-vector**, page 51.

```
(bit-vector-p (make-array 3 :element-type 'bit :fill-pointer 2))
 => T

(bit-vector-p (make-array 5 :element-type 'string-char))
 => NIL
```

bit-xor *first second* &optional *third* *Function*

Performs logical *exclusive or* operations on bit arrays. The arguments must be bit arrays of the same rank and dimensions. A new array is created to contain the result if the third argument is **nil** or omitted. If the third argument is **t**, the first array is used to hold the result.

block *name* &body *body* *Special Form*

Evaluates each *form* in sequence and normally returns the (possibly multiple) values of the last *form*. However, (**return-from** *name value*) or (**return** or (**return (values-list** *list*)) form) might be evaluated during the evaluation of some *form*. In that case, the (possibly multiple) values that result from evaluating *value* are immediately returned from the innermost block that has the same name and that lexically contains the **return-from** form. Any remaining forms in that block are not evaluated.

name is not evaluated. It must be a symbol.

The scope of *name* is lexical. That is, the **return-from** form must be inside the block itself (or inside a block that that block lexically contains), not inside a function called from the block.

do, **prog**, and their variants establish implicit blocks around their bodies; you can use **return-from** to exit from them. These blocks are named **nil** unless you specify a name explicitly.

Examples:

```
(block nil
  (print "clear")
  (return)
  (print "open")) => "clear" NIL

(let ((x 2400))
  (block time-x
    (when (= x 2400)
      (return-from time-x "time to go"))
    ("time time time"))) => "time to go"

(defun bar ()
  (princ "zero ")
  (block a
    (princ "one ") (return-from a "two ")
    (princ "three "))
  (princ "four ")
  t) => BAR
(bar) => zero one four T

(block negative
  (mapcar (function (lambda (x)
                      (cond ((minusp x)
                             (return-from negative  x))
                            (t (f x))) ))
          y))
```

The following two forms are equivalent:

```
(cond ((predicate x)
       (do-one-thing))
      (t
       (format t "The value of X is ~S~%" x)
       (do-the-other-thing)
       (do-something-else-too)))

(block deal-with-x
  (when (predicate x)
    (return-from deal-with-x (do-one-thing)))
  (format t "The value of X is ~S~%" x)
  (do-the-other-thing)
  (do-something-else-too))
```

The interpreter and compiler generate implicit blocks for functions whose name is a list (such as methods) just as they do for functions whose name

is a symbol. You can use **return-from** for methods. The name of a method's implicit block is the name of the generic function it implements. If the name of the generic function is a list, the block name is the second symbol in that list.

For a table of related items: See the section "Blocks and Exits Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

B
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&body *Lambda List Keyword*

This keyword is used with macros only. It is identical in function to **&rest**, but it informs output-formatting and editing functions that the remainder of the form is treated as a body, and should be indented accordingly.

Note that either **&body** or **&rest**, but not both, should be used in any definition.

boole *op integer1* &rest *more-integers* *Function*

boole is the generalization of logical functions such as **logand**, **logior** and **logxor**. It performs bit-wise logical operations on integer arguments returning an integer which is the result of the operation.

The argument *op* specifies the logical operation to be performed; sixteen operations are possible. These are listed and described in the table below which also shows the truth tables for each value of *op*.

op can be specified by writing the name of one of the constants listed below which represents the desired operation, or by using an integer between 0 and 15 inclusive which controls the function that is computed. If the binary representation of *op* is *abcd* (*a* is the most significant bit, *d* the least) then the truth table for the Boolean operation is as follows:

	integer2	
	0	1
integer1 0	a	c
1	b	d

Examples:

```
(boole 6 0 0) => 0      ; a=0
(boole 11 1 0) => -2    ; a=1 and b=0
(boole 2 6 9) => 9      ; a=b=d=0 c=1 therefore 1's appear only
                        ; when integer1 is 0 and integer2 is 1
```

With two arguments, the result of **boole** is simply its second argument. At least two arguments are required.

If **boole** has more than three arguments, it is associated left to right; thus,

```
(boole op x y z) = (boole op (boole op x y) z)
(boole boole-and 0 1 1) => 0
```

For the basic case of three arguments, the results of **boole** are shown in the table below. This table also shows the value of bits *abcd* in the binary representation of *op* for each of the sixteen operations. (For example, **boole-clr** corresponds to #b0000, **boole-and** to #b0001, and so on.)

		a	*b*	*c*	*d*	
	Integer1	0	1	0	1	
op	*Integer2*	0	0	1	1	*Operation Name*
boole-clr		0	0	0	0	*clear*, always 0
boole-and		0	0	0	1	*and*
boole-andc1		0	0	1	0	*and* complement of *integer1* with *integer2*
boole-2		0	0	1	1	last of *more-integers*
boole-andc2		0	1	0	0	*and integer1* with complement of *integer2*
boole-1		0	1	0	1	*integer1*
boole-xor		0	1	1	0	*exclusive or*
boole-ior		0	1	1	1	*inclusive or*
boole-nor		1	0	0	0	*nor* (complement of *inclusive or*)
boole-eqv		1	0	0	1	*equivalence* (*exclusive nor*)
boole-c1		1	0	1	0	complement of *integer1*
boole-orc1		1	0	1	1	*or* complement of *integer1* with *integer2*
boole-c2		1	1	0	0	complement of *integer2*
boole-orc2		1	1	0	1	*or integer1* with complement of *integer2*
boole-nand		1	1	1	0	*nand* (complement of *and*)
boole-set		1	1	1	1	*set*, always 1

Examples:

```
(boole boole-clr 3) => 3  ;with two arguments always returns
                          ;integer1
(boole boole-set 7) => 7

(boole boole-1 1 0) => 1
(boole boole-2 1 0) => 0
```

As a matter of style the explicit logical functions such as **logand, logior,** and **logxor** are usually preferred over the equivalent forms of **boole. boole** is useful, however, when you want to generalize a procedure so that it can use one of several logical operations.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

boole-1 *Constant*

This constant can be used as the first argument to the function **boole;** it specifies a bit-wise logical operation that returns the first integer argument of **boole.**

boole-2 *Constant*

This constant can be used as the first argument to the function **boole;** it specifies a bit-wise logical operation that returns the last integer argument of **boole.**

boole-and *Constant*

This constant can be used as the first argument to the function **boole;** it specifies a bit-wise logical *and* operation to be performed on the integer arguments of **boole.**

boole-andc1 *Constant*

This constant can be used as the first argument to the function **boole;** it specifies a logical operation to be performed on the integer arguments of **boole,** namely, a bit-wise logical *and* of the complement of the first integer argument with the next integer argument.

boole-andc2 *Constant*

This constant can be used as the first argument to the function **boole;** it specifies a logical operation to be performed on the integer arguments of **boole,** namely, a bit-wise logical *and* of the first integer argument with the complement of the next integer argument.

boole-c1 *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical operation that returns the complement of the first integer argument of **boole**.

boole-c2 *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical operation that returns the complement of the last integer argument of **boole**.

boole-clr *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *clear* operation to be performed on the integer arguments of **boole**.

boole-eqv *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *equivalence* operation to be performed on the integer arguments of **boole**.

boole-ior *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *inclusive or* operation to be performed on the integer arguments of **boole**.

boole-nand *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *not-and* operation to be performed on the integer arguments of **boole**.

boole-nor *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *not-or* operation to be performed on the integer arguments of **boole**.

boole-orc1 *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical operation to be performed on the integer arguments of **boole**, namely, the logical *or* of the complement of the first integer argument with the next integer argument.

boole-orc2 *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical operation to be performed on the integer arguments of **boole**, namely, the logical *or* of the first integer argument with the complement of the next integer argument.

boole-set *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *set* operation to be performed on the integer arguments of **boole**.

boole-xor *Constant*

This constant can be used as the first argument to the function **boole**; it specifies a bit-wise logical *exclusive or* operation to be performed on the integer arguments of **boole**.

both-case-p *char* *Function*

Returns **t** if *char* is a letter that exists in another case.

```
(both-case-p #\M) => T
(both-case-p #\m) => T
```

boundp *symbol* *Function*

Returns **t** if the dynamic (special) variable *symbol* is bound; otherwise, it returns **nil**.

boundp-in-closure *closure symbol* *Function*

Returns **t** if *symbol* is bound in the environment of *closure*; that is, it does what **boundp** would do if you restored the value cells known about by *closure*. If *symbol* is not closed over by *closure*, this is just like **boundp**. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

boundp-in-instance *instance symbol* *Function*

Returns **t** if the instance variable *symbol* is bound in the given *instance*.

breakon &optional *function* (*condition* **t**) *Function*

With no arguments, **breakon** returns a list of all functions with breakpoints set by **breakon**.

breakon sets a **trace**-style breakpoint for the *function-spec*. Whenever the function named by *function-spec* is called, the condition **dbg:breakon-trap** is signalled, and the Debugger assumes control. At this point, you can inspect the state of the Lisp environment and the stack. Proceeding from the condition then causes the program to continue to run.

The first argument can be any function spec, so that you can trace methods and other functions not named by symbols. See the section "Function Specs" in *Symbolics Common Lisp: Language Concepts*.

condition-form can be used for making a conditional breakpoint. *condition-form* should be a Lisp form. It is evaluated when the function is called. If it returns **nil**, the function call proceeds without signalling any-

thing. *condition-form* arguments from multiple calls to **breakon** accumulate and are treated as an **or** condition. Thus, when any of the forms becomes true, the breakpoint "goes off". *condition-form* is evaluated in the dynamic environment of the function call. You can inspect the arguments of *function-spec* by looking at the variable **arglist**.

For a table of related items: See the section "Breakpoint Functions" in *Symbolics Common Lisp: Language Concepts*.

break-on-warnings *Variable*

This variable controls the action of the function **warn**. If ***break-on-warnings*** is **nil**, **warn** prints a warning message without signalling.

If ***break-on-warnings*** is not **nil**, **warn** enters the Debugger and prints the warning message. The default value is **nil**.

This flag is intended primarily for use when you are debugging programs that issue warnings.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts*.

dbg:bug-report-description *condition stream nframes* *Generic Function*

This generic function is called by the :Mail Bug Report (c-M) command in the Debugger to print out the text that is the initial contents of the mail-sending buffer. The handler should simply print whatever information it considers appropriate onto *stream*. *nframes* is the numeric argument given to c-M. The Debugger interprets *nframes* as the number of frames from the backtrace to include in the initial mail buffer. A *nframes* of **nil** means all frames.

The compatible message for **dbg:bug-report-description** is:

:bug-report-description

For a table of related items: See the section "Debugger Bug Report Functions" in *Symbolics Common Lisp: Language Concepts*.

dbg:bug-report-recipient-system *condition* *Generic Function*

This generic function is called by the :Mail Bug Report (c-M) command in the Debugger to find the mailing list to which to send the bug report mail. The mailing list is returned as a string.

The default method (the one in the **condition** flavor) returns **"lispm"**, and this is passed as the first argument to the **zl:bug** function.

The compatible message for **dbg:bug-report-recipient-system** is:

:bug-report-recipient-system

For a table of related items: See the section "Debugger Bug Report Functions" in *Symbolics Common Lisp: Language Concepts.*

butlast *list* *Function*

This creates and returns a list with the same elements as *list*, excepting the last element. Examples:

```
(butlast '(a b c d)) => (a b c)
(butlast '((a b) (c d))) => ((a b))
(butlast '(a)) => nil
(butlast nil) => nil
```

The name is from the phrase "all elements but the last".

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

byte *size position* *Function*

Creates a byte specifier for a byte *size* bits wide, *position* bits from the right-hand (least-significant) end of the word. The arguments *size* and *position* must be integers greater than or equal to zero.

The byte specifier so created serves as an argument to various byte manipulation functions.

Examples:

```
(ldb (byte 2 1) 9) => 0
(ldb (byte 3 4) #o12345) => 6
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

byte-position *bytespec* *Function*

Extracts the position field of *bytespec.*

bytespec is built using function **byte** with bit *size* and *position* arguments.

Example:

```
(byte-position (byte 3 4)) => 4
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

byte-size *bytespec* *Function*

Extracts the size field of *bytespec*.

bytespec is built using function **byte** with bit *size* and *position* arguments.

Example:

```
(byte-size (byte 3 4)) => 3
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts*.

caaaar *x* *Function*

`(caaaar x)` is the same as `(car (car (car (car x))))`

caaadr *x* *Function*

`(caaadr x)` is the same as `(car (car (car (cdr x))))`

caaar *x* *Function*

`(caaar x)` is the same as `(car (car (car x)))`

caadar *x* *Function*

`(caadar x)` is the same as `(car (car (cdr (car x))))`

caaddr *x* *Function*

`(caaddr x)` is the same as `(car (car (cdr (cdr x))))`

caadr *x* *Function*

`(caadr x)` is the same as `(car (car (cdr x)))`

caar *x* *Function*

`(caar x)` is the same as `(car (car x))`

cadaar *x* *Function*

`(cadaar x)` is the same as `(car (cdr (car (car x))))`

cadadr *x* *Function*

`(cadadr x)` is the same as `(car (cdr (car (cdr x))))`

cadar *x* *Function*

(cadar x) is the same as (car (cdr (car x)))

caddar *x* *Function*

(caddar x) is the same as (car (cdr (cdr (car x))))

cadddr *x* *Function*

(cadddr x) is the same as (car (cdr (cdr (cdr x))))

caddr *x* *Function*

(caddr x) is the same as (car (cdr (cdr x)))

cadr *x* *Function*

(cadr x) is the same as (car (cdr x))

flavor:call-component-method *function-spec* &key *apply arglist* *Function*

Produces a form that calls *function-spec*, which must be the function-spec for a component method. If no keyword arguments are given to **flavor:call-component-method**, the method receives the same arguments that the generic function received. That is, the first argument to the generic function is bound to **self** inside the method, and succeeding arguments are bound to the argument list specified with **defmethod**. Additional internal arguments are passed to the method, but the user never needs to be concerned about these.

arglist is a list of forms to be evaluated to supply the arguments to the method, instead of simply passing through the arguments to the generic function.

When *arglist* and *apply* are both supplied, **:apply** should be followed by **t** or **nil**. If **:apply t** is supplied, the method is called with **apply** instead of funcall. **:apply nil** causes the method to be called with **funcall**.

When *arglist* is not supplied, the value following **:apply** is the argument that should be given to **apply** when the method is called. (Certain internal arguments are also included in the **apply** form.) For example:

```
(flavor:call-component-method function-spec :apply list)
```

Results in:

```
(apply #'function-spec :apply list)
```

In other words, the following two forms have the same effect:

```
(flavor:call-component-method function-spec :apply list)
(flavor:call-component-method function-spec :arglist (list list)
                                            :apply t)
```

If *function-spec* is **nil**, **flavor:call-component-method** produces a form that returns **nil** when evaluated.

For examples: See the section "Examples Of **define-method-combination**" in *Symbolics Common Lisp: Language Concepts.*

flavor:call-component-methods *function-spec-list* &key (*operator* **'progn**) *Function*

Produces a form that invokes the function or special form named *operator.* Each argument or subform is a call to one of the methods in *function-spec-list. operator* defaults to **progn.**

car *x* *Function*

Returns the head (*car*) of list or cons *x*. Example:

```
(car '(a b c)) => a
```

Officially **car** is applicable only to conses and locatives. However, as a matter of convenience, **car** of **nil** returns **nil.**

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:car-location *cons* *Function*

zl:car-location returns a locative pointer to the cell containing the *car* of *cons.*

Note: there is no cdr-location function; the cdr-coding scheme precludes it.

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

case *test-object* &body *clauses* *Special Form*

case is a conditional that chooses one of its clauses to execute by comparing a value to various constants. The constants can be any object.

Its form is as follows:

```
(case key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

Structurally **case** is much like **cond**, and it behaves like **cond** in selecting

one clause and then executing all consequents of that clause. However, **case** differs in the mechanism of clause selection.

The first thing **case** does is to evaluate *test-object*, to produce an object called the *key object*. Then **case** considers each of the clauses in turn. If *key* is **eql** to any item in the clause, **case** evaluates the consequents of that clause as an implicit **progn**.

If no clause is satisfied, **case** returns **nil**.

case returns the value of the last consequent of the clause evaluated, or **nil** if there are no consequents to that clause.

The keys in the clauses are *not* evaluated; they must be literal key values. It is an error for the same key to appear in more than one clause. The order of the clauses does not affect the behavior of the **case** construct.

Instead of a *test*, one can write one of the symbols **t** and **otherwise**. A clause with such a symbol always succeeds and must be the last clause; this is an exception to the order-independence of clauses.

If there is only one key for a clause, that key can be written in place of a list of that key, provided that no ambiguity results. Such a "singleton key" can *not* be **nil** (which is confusable with (), a list of no keys), **t**, **otherwise**, or a cons.

Examples:

```
(let ((num 69))
  (case num
    ((1 2) "math...ack")
    ((3 4) "great now we can count"))) => NIL

(let ((num 3))
  (case num
    ((1 2) "one two")
    ((3 4 5 6) (princ "numbers") (princ " three") (fresh-line) )
    (t "not today"))) => numbers three
T

(let ((object-one 'candy))
  (case object-one
    (apple (setq class 'health) "weekdays")
    (candy (setq class 'junk) "weekends")
    (otherwise (setq class 'unknown) "all week long")))  => "weekends"
class => JUNK
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:caseq *test-object* &body *clauses* *Special Form*

Provided for Maclisp compatibility; it is exactly the same as **zl:selectq**. This is not perfectly compatible with Maclisp, because **zl:selectq** accepts **otherwise** as well as **t** where **zl:caseq** would not accept **otherwise**, and because Maclisp accepts a more limited set of keys then **zl:selectq** does. Maclisp programs that use **zl:caseq** work correctly as long as they do not use the symbol **otherwise** as the key.

Examples:

```
(let (( a 'big-bang))
  (caseq a
         (light "day")
         (dark  "night"))) => NIL

(setq a 3) => 3
(caseq a
       (1 "one")
       (2 "two")
       (t "not one or two")) => "not one or two"

(let (( a 'big-bang))
  (caseq a
         (light "day")
         (dark  "night")
         (otherwise "night and day"))) => "night and day"
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

catch *tag* &body *body* *Special Form*

Used with **throw** for nonlocal exits. **catch** first evaluates *tag* to obtain an object that is the "tag" of the catch. Then the *body* forms are evaluated in sequence, and **catch** returns the (possibly multiple) values of the last form in the body.

However, a **throw** (or **zl:*throw**) form might be evaluated during the evaluation of one of the forms in *body*. In that case, if the throw "tag" is **eq** to the catch "tag" and if this **catch** is the innermost **catch** with that tag, the evaluation of the body is immediately aborted, and **catch** returns values specified by the **throw** or **zl:*throw** form.

If the **catch** exits abnormally because of a **throw** form, it returns the (possibly multiple) values that result from evaluating **throw**'s second subform. If the **catch** exits abnormally because of a **zl:*throw** form, it returns two values: the first is the result of evaluating **zl:*throw**'s second subform, and the second is the result of evaluating **zl:*throw**'s first subform (the tag thrown to).

(catch 'foo *form*) catches a **(throw 'foo** *form*) but not a **(throw 'bar** *form*). It is an error if **throw** is done when no suitable **catch** exists.

The scope of the *tags* is dynamic. That is, the **throw** does not have to be lexically within the **catch** form; it is possible to throw out of a function that is called from inside a **catch** form.

For example:

```
(catch 'done
  (ask-database <pattern>
                #'(lambda (x) (when (nice-p x)
                                    (throw 'done x)))))
```

The **throw** to **'done** returns **x**, the pattern searched for in the database.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:*catch *tag* &body *body* *Special Form*

An obsolete version of **catch** that is supported for compatibility with Maclisp. It is equivalent to **catch** except that if **zl:*catch** exits normally, it returns only two values: the first is the result of evaluating the last form in the body, and the second is **nil**. If **zl:*catch** exits abnormally, it returns the same values as **catch** when **catch** exits abnormally: that is, the returned values depend on whether the exit results from a **throw** or a **zl:*throw**. See the special form **catch**, page 65.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

catch-error *form* &optional (*printflag* **t**) *Function*

catch-error evaluates *form*, trapping all errors.

form can be any Lisp expression.

printflag controls the printing or suppression of an error message by **catch-error.**

If an error occurs during the evaluation of *form*, **catch-error** prints an error message if the value of *printflag* is not **nil**. The default value of *printflag* is **t**.

catch-error returns two values: if *form* evaluated without error, the value of *form* and **nil** are returned. If an error did occur during the evaluation of *form*, **t** is returned.

Only the first value of *form* is returned if it was successfully evaluated.

catch-error-restart *(condition-flavor format-string . format-args)* *Special Form*

catch-error-restart establishes a restart handler for *condition-flavor* and then evaluates the body. If the handler is not invoked, **catch-error-restart** returns the values produced by the last form in the body, and the restart handler disappears. If a condition is signalled during the execution of the body and the restart handler is invoked, control is thrown back to the dynamic environment of the **catch-error-restart** form. In this case, **catch-error-restart** also returns **nil** as its first value and something other than **nil** as its second value. Its format is:

```
(catch-error-restart (condition-flavor format-string . format-args)
 form-1
 form-2
 ...)
```

condition-flavor is either a condition or a list of conditions that can be handled. *format-string* and *format-args* are a control string and a list of arguments (respectively) to be passed to **format** to construct a meaningful description of what would happen if the user were to invoke the handler. The Debugger uses these values to create a message explaining the intent of the restart handler.

The conditional variant of **catch-error-restart** is the form:

catch-error-restart-if

For a table of related items: See the section "Restart Functions" in *Symbolics Common Lisp: Language Concepts.*

catch-error-restart-if *cond-form (condition-flavor format-string . format-args)* *Special Form*

catch-error-restart-if establishes its restart handler conditionally. In all other respects, it is the same as **catch-error-restart**. Its format is:

```
(catch-error-restart-if cond-form
    (condition-flavor format-string . format-args)
  form-1
  form-2
  ...)
```

catch-error-restart-if first evaluates *cond-form*. If the result is **nil**, it evaluates the body as if it were a **progn** but does not establish any handlers. If the result is not **nil**, it continues just like **catch-error-restart**, establishing the handlers and executing the body.

For a table of related items: See the section "Restart Functions" in *Symbolics Common Lisp: Language Concepts.*

ccase *object* &body *body* *Special Form*

The name of this function stands for "continuable exhaustive case".

Structurally **ccase** is much like **case**, and it behaves like **case** in selecting one clause and then executing all consequents of that clause. However, **ccase** does not permit an explicit **otherwise** or **t** clause. The form of **ccase** is as follows:

```
(ccase key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

object must be a generalized variable reference acceptable to **setf**.

The first thing **ccase** does is to evaluate *object*, to produce an object called the *key object*.

Then **ccase** considers each of the clauses in turn. If *key* is **eql** to any item in the clause, **ccase** evaluates the consequents of that clause as an implicit **progn**.

ccase returns the value of the last consequent of the clause evaluated, or **nil** if there are no consequents to that clause.

The keys in the clauses are *not* evaluated; literal key values must appear in the clauses. It is an error for the same key to appear in more than one clause. The order of the clauses does not affect the behavior of the **ccase** construct.

If there is only one key for a clause, that key can be written in place of a list of that key, provided that no ambiguity results. Such a "singleton key" can *not* be **nil** (which is confusable with (), a list of no keys), **t**, **otherwise**, or a cons.

If no clause is satisfied, **ccase** uses an implicit **otherwise** clause to signal an error with a message constructed from the clauses. To continue from this error supply a new value for *object*, causing **ccase** to store that value and restart the clause tests. Subforms of *object* can be evaluated multiple times.

Examples:

```
(let ((num 24))
  (ccase num
    ((1 2 3) "integer less then 4")
    ((4 5 6) "integer greater than 3"))) =>
Error: The value of NUM is SI:*EVAL, 24, was of the wrong type.
       The function expected one of 1, 2, 3, 4, 5, or 6.
```

```
SI:*EVAL:
   Arg 0 (SYS:FORM): (DBG:CHECK-TYPE-1 'NUM NUM '#)
   Arg 1 (SI:ENV): ((# #) NIL (#) (#) ...)
   --defaulted args:--
   Arg 2 (SI:HOOK): NIL
s-A, <RESUME>:  Supply a replacement value to be stored into NUM
s-B, <ABORT>:   Return to Lisp Top Level in dynamic Lisp Listener 1
→ Supply a replacement value to be stored into NUM:
4
"integer greater than 3"


(let ((num 3))
  (ccase num
    ((1 2) "one two")
    ((3 4 5 6) (princ "numbers") (princ " three") (terpri) )
    (t "not today"))) => numbers three
T

(let ((Dwarf 'Sleepy))
  (ccase Dwarf
    ((Grumpy Dopey) (setq class "confused"))
    ((Bilbo Frodo) (setq class "Hobbits not Dwarfs"))
    (otherwise (setq class 'unknown) "talk to Snow White")))
=> "talk to Snow White"
class => UNKNOWN
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

cdaaar *x* *Function*

`(cdaaar x)` is the same as `(cdr (car (car (car x))))`

cdaadr *x* *Function*

`(cdaadr x)` is the same as `(cdr (car (car (cdr x))))`

cdaar *x* *Function*

(cdaar x) is the same as (cdr (car (car x)))

cdadar *x* *Function*

(cdadar x) is the same as (cdr (car (cdr (car x))))

cdaddr *x* *Function*

(cdaddr x) is the same as (cdr (car (cdr (cdr x))))

cdadr *x* *Function*

(cdadr x) is the same as (cdr (car (cdr x)))

cdar *x* *Function*

(cdar x) is the same as (cdr (car x))

cddaar *x* *Function*

(cddaar x) is the same as (cdr (cdr (car (car x))))

cddadr *x* *Function*

(cddadr x) is the same as (cdr (cdr (car (cdr x))))

cddar *x* *Function*

(cddar x) is the same as (cdr (cdr (car x)))

cdddar *x* *Function*

(cdddar x) is the same as (cdr (cdr (cdr (car x))))

cddddr *x* *Function*

(cddddr x) is the same as (cdr (cdr (cdr (cdr x))))

cdddr *x* *Function*

(cdddr x) is the same as (cdr (cdr (cdr x)))

cddr *x* *Function*

(cddr x) is the same as (cdr (cdr x))

cdr *x* *Function*

Returns the tail (*cdr*) of list or cons *x*. Example:

```
(cdr '(a b c)) => (b c)
```

Officially **cdr** is applicable only to conses and locatives. However, as a matter of convenience, **cdr** of **nil** returns **nil**.

Note that **cdr** is not the right way to read hardware registers, since **cdr** will in some cases start a block-read and the second read could easily read some register you did not want it to. Therefore, you should use **car** or **sys:%p-ldb** as appropriate for these operations.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

ceiling *number* &optional (*divisor* **1**) *Function*

Divides *number* by *divisor*, and truncates the result toward positive infinity. The truncated result and the remainder are the returned values.

number and *divisor* must each be a noncomplex number. Not specifying a divisor is exactly the same as specifying a divisor of 1.

If the two returned values are Q and R, then (+ (* Q *divisor*) R) equals *number*. If *divisor* is 1, then Q and R add up to *number*. If *divisor* is 1 and *number* is an integer, then the returned values are *number* and 0.

The first returned value is always an integer. The second returned value is integral if both arguments are integers, is rational if both arguments are rational, and is floating-point if either argument is floating-point. If only one argument is specified, then the second returned value is always a number of the same type as the argument.

Examples:

```
(ceiling 5) => 5 and 0
(ceiling -5) => -5 and 0
(ceiling 5.2) => 6 and -0.8000002
(ceiling -5.2) => -5 and -0.19999981
(ceiling 5.8) => 6 and -0.19999981
(ceiling -5.8) => -5 and -0.8000002
(ceiling 5 3) => 2 and -1
(ceiling -5 3) => -1 and -2
(ceiling 5 4) => 2 and -3
(ceiling -5 4) => -1 and -1
(ceiling 5.2 3) => 2 and -0.8000002
(ceiling -5.2 3) => -1 and -2.1999998
(ceiling 5.2 4) => 2 and -2.8000002
(ceiling -5.2 4) => -1 and -1.1999998
(ceiling 5.8 3) => 2 and -0.19999981
(ceiling -5.8 3) => -1 and -2.8000002
(ceiling 5.8 4) => 2 and -2.1999998
(ceiling -5.8 4) => -1 and -1.8000002
```

For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

cerror *continue-format-string error-format-string* &rest *args* *Function*

cerror is used to signal proceedable (continuable) errors. Like **error** it signals an error and enters the debugger. However, **cerror** allows the user to continue program execution from the debugger after resolving the error.

If the program is continued after encountering the error, **cerror** returns **nil**. The code following the call to **cerror** is then executed. This code should correct the problem, perhaps by accepting a new value from the user if a variable was invalid.

If the code that corrects the problem interacts with the program's use and might possibly be misleading it should make sure the error has really been corrected before continuing. One way to do this is to put the call to cerror and the correction code in a loop, checking each time to see if the error has been corrected before terminating the loop.

The *continue-format-string* argument, like the *error-format-string* argument, is given as a control string to **format** along with *args* to construct a mes-

sage string. The error message string is used in the same way that **error** uses it. The continue message string should describe the effect of continuing. The message is displayed as an aid to the user in deciding whether and how to continue. For example, it might be used by an interactive debugger as part of the documentation of its "continue" command.

The content of the continue message should adhere to the rules of style for error messages.

In complex cases where the *error-format-string* uses some of the *args* and the *continue-format-string* uses others, it may be necessary to use the **format** directives ~* and ~@* to skip over unwanted arguments in one or both of the format control strings.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts*.

change-instance-flavor *instance new-flavor* *Function*

Changes the flavor of an instance to another flavor.

For those instance variables in common (contained in the definition of the old flavor and the new flavor), the values of the instance variables remain the same when the instance is changed to the new format. New instance variables (defined by the new flavor but not the old flavor) are initialized according to any defaults contained in the definition of the new flavor.

Instance variables contained by the old flavor but not the new flavor are no longer part of the instance, and cannot be accessed once the instance is changed to the new format.

Instance variables are compared with **eq** of their names; if they have the same name and are defined by both the old flavor (or any of its component flavors) and the new flavor (or any of its component flavors), they are considered to be "in common".

If you need to specify a different treatment of instance variables when the instance is changed to the new flavor, you can write code to be executed at the time that the instance is changed. See the generic function **flavor:transform-instance**, page 591.

Note: There are two possible problems that might occur if you use **change-instance-flavor** while a process (either the current process or some other process) is executing inside of a method. The first problem is that the method continues to execute until completion even if it is now the "wrong" method. That is, the new flavor of the instance might require a different method to be executed to handle the generic function. The Flavors system cannot undo the effects of executing the wrong method and cause the right method to be executed instead.

The second problem is due to the fact that **change-instance-flavor** might change the order of storage of the instance variables. A method usually commits itself to a particular order at the time the generic function is called. If the order is changed after the generic function is called, the method might access the wrong memory location when trying to access an instance variable. The usual symptom is an access to a different instance variable of the same instance or an error "Trap: The word #<DTP-HEADER-I nnnn> was read from location nnnn". If the garbage collector has moved objects around in memory, it is possible to access an arbitrary location outside of the instance.

When a flavor is redefined, the implicit **change-instance-flavor** that happens never causes accesses to the wrong instance variable or to arbitrary locations outside the instance. But redefining a flavor while methods are executing might leave those methods as no longer valid for the flavor.

We recommend that you do not use **change-instance-flavor** of **self** inside a

method. If you cannot avoid it, then make sure that the old and new flavors have the same instance variables and inherit them from the same components. You can do this by using mixins that do not define any instance variables of their own, and using **change-instance-flavor** only to change which of these mixins are included. This prevents the problem of accessing the wrong location for an instance variable, but it cannot prevent a running method from continuing to execute even if it is now the wrong method.

A more complex solution is to make sure that all instance variables accessed after the **change-instance-flavor** by methods that were called before the **change-instance-flavor** are ordered (by using the **:ordered-instance-variables** option to **defflavor**), or are inherited from common components by both the old and new flavors. The old and new flavors should differ only in components more specific than the flavors providing the variables.

char *array* &rest *subscripts* *Function*

The function **char** returns the character at position *subscripts* of *array*. The count is from zero. The character is returned as a character object; it will necessarily satisfy the predicate **string-char-p**.

array must be a string array.

subscripts must be a non-negative integer less than the length of *array*.

Note that the array-specific function **aref**, and the general sequence function **elt** also work on strings.

To destructively replace a character within a string, use **char** in conjunction with the function **setf**.

Examples:

```
(char "a string" 1) => #\Space
(string-char-p (char "a string" 3)) => T

(char (make-array 4 :element-type 'character
                    :initial-element #\y) 3) => #\y
(string-char-p (char (make-array 4 :element-type 'character
                                   :initial-element #\.) 2)) => T

(char (make-array 4 :element-type 'character
                    :initial-element #\.
                    :fill-pointer 2) 1) => #\.
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

char≠ *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If all of the arguments are equal, **nil** is returned; otherwise **t**.

```
(char/= #\A #\A #\A) => NIL
(char/= #\A #\B #\C) => T
```

char≠ can be used in place of **char/=**.

char≤ *char* &rest *chars* *Function*

This predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If each of the arguments is equal to or less than the next, **t** is returned; otherwise **nil**.

```
(char<= #\A #\B #\C)  => T
(char<= #\C #\B #\A) => NIL
(char<= #\A #\A) => T
```

char≤ can be used instead of **char<=**.

char≥ *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If each of the arguments is equal to or greater than the next, **t** is returned; otherwise **nil**.

```
(char>= #\C #\B #\A) => T
(char>= #\A #\A) => T
(char>= #\A #\B #\C)  => NIL
```

char≥ can be used instead of **char>=**. n

char/= *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If all of the arguments are equal, **nil** is returned; otherwise **t**.

```
(char/= #\A #\A #\A) => NIL
(char/= #\A #\B #\C) => T
```

char≠ can be used in place of **char/=**.

char< *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If all of the arguments are ordered from smallest to largest, **t** is returned; otherwise **nil**.

```
(char< #\A #\B #\C) => T
(char< #\A #\A) => NIL
(char< #\A #\C #\B) => NIL
```

char<= *char* &rest *chars* *Function*

This predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If each of the arguments is equal to or less than the next, **t** is returned; otherwise **nil.**

```
(char<= #\A #\B #\C)  => T
(char<= #\C #\B #\A) => NIL
(char<= #\A #\A) => T
```

char≤ can be used instead of **char<=.**

char= *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If all of the arguments are equal, **t** is returned; otherwise **nil.**

```
(char= #\A #\A #\A) => T
(char= #\A #\B #\C) => NIL
```

char> *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If all of the arguments are ordered from largest to smallest, [t] is returned; otherwise **nil.**

```
(char> #\C #\B #\A) => T
(char> #\A #\A) => NIL
(char> #\A #\B #\C) => NIL
```

char>= *char* &rest *chars* *Function*

This comparison predicate compares characters exactly, depending on all fields including code, bits, character style, and alphabetic case. If each of the arguments is equal to or greater than the next, **t** is returned; otherwise **nil.**

```
(char>= #\C #\B #\A) => T
(char>= #\A #\A) => T
(char>= #\A #\B #\C)  => NIL
```

char≥ can be used instead of **char>=.** n

character *Type Specifier*

character is the type specifier symbol for the the predefined Lisp character data type.

The types **character, cons, symbol,** and **array** are *pairwise disjoint.*

The type **character** is a *supertype* of the type **string-char.**

Examples:

```
(typep #\0 'character) => T
(zl:typep #\~) => :CHARACTER
(characterp #\A) => T
(characterp (character "1")) => T
(sys:type-arglist 'character) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Characters" in *Symbolics Common Lisp: Language Concepts.*

character *x* *Function*

character coerces *x* to a single character. If *x* is a character, it is returned. If *x* is a string or an array, an error is returned. If *x* is a symbol, the first character of its pname is returned. Otherwise, an error occurs. See the section "The Character Set" in *Reference Guide to Streams, Files, and I/O.* The way characters are represented as integers is explained in that section.

characterp *object* *Function*

Returns **t** if *object* is a character object. See the section "Type Specifiers and Type Hierarchy for Characters" in *Symbolics Common Lisp: Language Concepts.*

char-bit *char name* *Function*

Returns **t** if the bit specified by *name* is set in *char*, otherwise it returns **nil.** *name* can be **:control, :meta, :super,** or **:hyper.** You can use **setf** on **char-bit** *access-form name.*

```
(char-bit #\c-A :control) => T
(char-bit #\h-c-A :hyper) => T
(char-bit #\h-c-A :meta) => NIL
```

char-bits *char* *Function*

Returns the bits field of *char.* You can use **setf** on **(char-bits** *access-form*).

```
(char-bits #\c-A) => 1
(char-bits #\h-c-A) => 9
(char-bits #\m-c-A) => 3
```

char-bits-limit *Constant*

The value of **char-bits-limit** is a non-negative integer that is the upper limit for the value in the bits field. Its value is 16.

char-code *char* *Function*

Returns the code field of *char*.

```
(char-code #\A) => 65
(char-code #\&) => 38
```


char-code-limit *Constant*

The value of **char-code-limit** is a non-negative integer that is the upper limit for the number of character codes that can be used. Its value is 65536.

char-control-bit *Constant*

The value of **char-control-bit** is the weight of the control bit, which is 1.

char-downcase *char* *Function*

If *char* is an uppercase alphabetic character in the standard character set, **char-downcase** returns its lowercase form; otherwise, it returns *char*. If character style information is present it is preserved.

```
(char-downcase #\A) => #\a
(char-downcase #\A) => #\a
(char-downcase #\3) => #\3
```

char-equal *char* &rest *chars* *Function*

This is the primitive for comparing characters for equality; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. **char-equal** compares code and bits, ignores case and character style, and returns **t** if the characters are equal. Otherwise it returns **nil**.

```
(char-equal #\A #\A) => T
(char-equal #\A #\Control-A) => NIL
(char-equal #\A #\B #\A) => NIL
```

Note that Common Lisp specifies that **char-equal** should ignore bits. This difference is incompatible. However, it is likely that the Common Lisp specification might change in the future so that **char-equal** should not ignore bits.

char-fat-p *char* *Function*

Returns **t** if *char* is a fat character, otherwise **nil**. *char* must be a character object. A character that contains non-zero bits or style information is called a fat character. See the section "Type Specifiers and Type Hierarchy for Characters" in *Symbolics Common Lisp: Language Concepts.*

```
(char-fat-p #\A) => NIL
(char-fat-p #\c-A) => T
(char-fat-p (make-character #\A :style '(nil :bold nil))) => T
```


char-flipcase *char* *Function*

If *char* is a lowercase alphabetic character in the standard character set, **char-flipcase** returns its uppercase form. If *char* is an uppercase alphabetic character in the standard character set, **char-flipcase** returns its lowercase form. Otherwise, it returns *char*. If character style information is present it is preserved.

```
(char-flipcase #\X) => #\x
(char-flipcase #\b) => #\B
```

char-font *char* *Function*

The contract of **char-font** is to return the font field of the character object specified by *char*. Genera characters do not have a font field so **char-font** always returns zero for character objects.

Genera does not support the Common Lisp concept of fonts, but supports the character style system instead. See the section "Character Styles" in *Symbolics Common Lisp: Language Concepts.* To find out the character style of a character, use **si:char-style**: See the function **si:char-style**, page 83.

The only reason to use **char-font** would be when writing a program intended to be portable to other Common Lisp systems.

char-font-limit *Constant*

The value of **char-font-limit** is the upper exclusive limit for the value of values of the font bit. Genera characters do not have a font field so the value of **char-font-limit** is 1. Genera does not support the Common Lisp concept of fonts, but supports the y character style system instead. See the section "Character Styles" in *Symbolics Common Lisp: Language Concepts.*

char-greaterp *char* &rest *chars* *Function*

This primitive compares characters for order; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. The result is **t** if *char* comes after *chars* ignoring case and style, otherwise **nil**. See the section "The Character Set" in *Reference Guide to Streams, Files, and I/O.* Details of the ordering of characters are in that section.

This comparison predicate compares the code and bits fields and ignores character style and distinctions of alphabetic case.

```
(char-greaterp #\A #\B #\C) => NIL
(char-greaterp #\A #\B #\B) => T
```

char-hyper-bit *Constant*

The name for the hyper bit attribute. The value of **char-hyper-bit** is 8.

char-int *char* *Function*

Returns the character as an integer, including the fields that contain the character's code (which itself contains the character's set and subindex into that character set), bits, and style.

```
(char-int #\a) => 97
(char-int #\8) => 56
(char-int #\c-m-A) => 50331713
(char-int
   (make-character #\a :style '(nil :bold nil))) => 65633
```

char-lessp *char* &rest *chars* *Function*

This primitive compares characters for order; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. The result is **t** if *char* comes before *chars* ignoring case and style, otherwise **nil**. See the section "The Character Set" in *Reference Guide to Streams, Files, and I/O*. Details of the ordering of characters are in that section.

This comparison predicate compares the code and bits fields and ignores character style and distinctions of alphabetic case.

```
(char-lessp #\A #\B #\C) => T
(char-lessp #\A #\B #\B) => NIL
```

char-meta-bit *Constant*

The name for the meta bit attribute. The value of **char-meta-bit** is 2.

char-mouse-button *char* *Function*

Returns the number corresponding to the mouse button that would have to be pushed to generate *char*. 0, 1, and 2 correspond to the left, middle, and right mouse buttons, respectively.

Example:

```
(char-mouse-button #\m-mouse-m) ==>
1
```

The complementary function is **make-mouse-char**.

char-mouse-equal *char1 char2* *Function*

Returns **t** if the mouse characters *char1* and *char2* are equal, **nil** otherwise.

char-name *char* *Function*

char must be a character object. **char-name** returns the name of the object (a string) if it has one. If the character has no name, or if it has non-zero bits or a character style other than NIL.NIL.NIL, **nil** is returned.

```
(char-name #\Tab) => "Tab"
```


char-not-equal *char* &rest *chars* *Function*

This primitive compares characters for non-equality; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. **char-equal** compares code and bits, ignores case and character style, and returns **t** if the characters are not equal. Otherwise it returns **nil**.

```
(char-not-equal #\A #\B) => T
(char-not-equal #\A #\c-A) => T
(char-not-equal #\A #\A) => NIL
(char-not-equal #\a #\A) => NIL
```

char-not-greaterp *char* &rest *chars* *Function*

This primitive compares characters for order; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. The result is **t** if *char* does not come after *chars* ignoring case and style, otherwise **nil**. See the section "The Character Set" in *Reference Guide to Streams, Files, and I/O*. Details of the ordering of characters are in that section.

This comparison predicate compares the code and bits fields and ignores character style and distinctions of alphabetic case.

```
(char-not-greaterp #\A #\B) => T
(char-not-greaterp #\a #\A) => T
(char-not-greaterp #\A #\a) => T
(char-not-greaterp #\A #\A) => T
```

char-not-lessp *char* &rest *chars* *Function*

This primitive compares characters for order; many of the string functions call it. *char* and *chars* must be characters; they cannot be integers. The result is **t** if *char* does not come before *chars* ignoring case and style, otherwise **nil**. See the section "The Character Set" in *Reference Guide to Streams, Files, and I/O*. Details of the ordering of characters are in that section.

This comparison predicate compares the code and bits fields and ignores character style and distinctions of alphabetic case.

```
(char-not-lessp #\A #\B) => NIL
(char-not-lessp #\B #\b) => T
(char-not-lessp #\A #\A) => T
```

si:char-style *char* *Function*

Returns the character style of the character object specified by *char*. The returned value is a character style object.

```
(si:char-style #\a)
=> #<CHARACTER-STYLE NIL.NIL.NIL 204004146>

(si:char-style (make-character #\a :style '(:swiss :bold nil)))
=> #<CHARACTER-STYLE SWISS.BOLD.NIL 116035602>
```

sys:char-subindex *char* *Function*

Returns the subindex field of *char* as an integer.

char-super-bit *Constant*

The name for the super bit attribute. The value of **char-super-bit** is 4.

char-to-ascii *ch* *Function*

Converts the character object *ch* to the corresponding ASCII code. This function works only for characters with neither bits nor style. See the section "ASCII String Functions" in *Symbolics Common Lisp: Language* Concepts.

It is an error to give **char-to-ascii** anything other than one of the 95 standard ASCII printing characters. To get the ASCII code of one of the other characters, use **ascii-code**, and give it the correct ASCII name.

The functions **char-to-ascii** and **ascii-to-char** provide the primitive conversions needed by ASCII-translating streams. They do not translate the Return character into a CR-LF pair; the caller must handle that. They just translate #**return** into CR and #**line** into LF. Except for CR-LF, **char-to-ascii** and **ascii-to-char** are wholly compatible with the ASCII-translating streams.

They ignore Symbolics Lisp Machine control characters; the translation of #**c-g** is the ASCII code for **G**, not the ASCII code to ring the bell, also known as "control G." **(ascii-to-char (ascii-code "BEL"))** is #/π, not #\c-G. The translation from ASCII to character never produces a Lisp Machine control character.

char-upcase *char* *Function*

If *char*, which must be a character, is a lowercase alphabetic character in the standard character set, **char-upcase** returns its uppercase form; otherwise, it returns *char*. If character style information is present it is preserved.

```
(char-upcase #\a) => #\A
(char-upcase #\a) => #\A
(char-upcase #\3) => #\3
```


zl:check-arg *arg-name predicate-or-form type-string* *Macro*

The **zl:check-arg** form is useful for checking arguments to make sure that they are valid. A simple example is:

```
(check-arg foo stringp "a string")
```

foo is the name of an argument whose value should be a string. **stringp** is a predicate of one argument, which returns **t** if the argument is a string. **"a string"** is an English description of the correct type for the variable.

The general form of **zl:check-arg** is

```
(check-arg var-name
           predicate
           description)
```

var-name is the name of the variable whose value is of the wrong type. If the error is proceeded this variable is **setq**'ed to a replacement value. *predicate* is a test for whether the variable is of the correct type. It can be either a symbol whose function definition takes one argument and returns non-**nil** if the type is correct, or it can be a nonatomic form which is evaluated to check the type, and presumably contains a reference to the variable *var-name*. *description* is a string which expresses *predicate* in English, to be used in error messages.

The *predicate* is usually a symbol such as **zl:fixp**, **stringp**, **zl:listp**, or **zl:closurep**, but when there isn't any convenient predefined predicate, or when the condition is complex, it can be a form. For example:

```
(defun test1 (a)
  (zl:check-arg a
                (and (numberp a) (≤ a 10.) (> a 0.))
                "a number from one to ten")
  ...)
```

If **test1** is called with an argument of 17, the following message is printed:

```
The argument A to TEST1, 17, was of the wrong type.
The function expected a number from one to ten.
```

In general, what constitutes a valid argument is specified in two ways in a **zl:check-arg**. *description* is human-understandable and *predicate* is executable. It is up to the user to ensure that these two specifications agree.

zl:check-arg uses *predicate* to determine whether the value of the variable is of the correct type. If it is not, **zl:check-arg** signals the **sys:wrong-type-argument** condition. See the flavor **sys:wrong-type-argument** in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:check-arg-type *arg-name type* &optional *type-string* *Macro*

This is a useful variant of the **zl:check-arg** form. A simple example is:

```
(zl:check-arg-type foo :number)
```

foo is the name of an argument whose value should be a number. **:number** is a value which is passed as a second argument to **zl:typep**; that is, it is a symbol that specifies a data type. The English form of the type name, which gets put into the error message, is found automatically.

The general form of **zl:check-arg-type** is:

```
(zl:check-arg-type var-name
                   type-name
                   description)
```

var-name is the name of the variable whose value is of the wrong type. If the error is proceeded this variable is **setq**'ed to a replacement value. *type-name* describes the type which the variable's value ought to have. It can be exactly those things acceptable as the second argument to **zl:typep**. *description* is a string which expresses *predicate* in English, to be used in error messages. It is optional. If it is omitted, and *type-name* is one of the keywords accepted by **zl:typep**, which describes a basic Lisp data type, then the right *description* is provided correctly. If it is omitted and *type-name* describes some other data type, then the description is the word "a" followed by the printed representation of *type-name* in lowercase.

The Common Lisp equivalent of **zl:check-arg-type** is the macro:

check-type

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

check-type *place type* &optional (*type-string* **'nil**) *Macro*

check-type signals an error if the contents of *place* are not of the desired *type*. If you continue from this error, you will be asked for a new value; **check-type** stores the new value in *place* and starts over, checking the type of the new value and signalling another error if it is still not of the desired type. Subforms of *place* can be evaluated multiple times because of the implicit loop generated. **check-type** returns **nil**.

place must be a generalized variable reference acceptable to the macro **setf**.

type must be a type specifier; it is not evaluated. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

type-string should be an English description of the type, starting with an indefinite article ("a" or "an"); it is evaluated. If *type-string* is not supplied, it is computed automatically from *type*. This optional argument is allowed because some applications of **check-type** may require a more specific description of what is wanted than can be generated automatically from the type specifier.

The error message mentions *place*, its contents, and the desired *type*.

Examples:

```
(setq bees '(bumble wasp jacket)) => (BUMBLE WASP JACKET)
(check-type bees (vector integer ))
=> Error : The value of BEES in SI:*EVAL, (BUMBLE WASP JACKET),
             was of the wrong type.
           The function expected a vector whose typical element
             is an integer.
(setq naards 'foo) => FOO
(check-type naards (integer 0 *) "a positive integer")
=> Error : The value of NAARDS in SI:*EVAL, FOO, was of the wrong
             type.
           The function expected a positive integer.
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

circular-list &rest *args* *Function*

circular-list constructs a circular list whose elements are *args*, repeated infinitely. **circular-list** is the same as **list** except that the list itself is used as the last *cdr*, instead of **nil**. **circular-list** is especially useful with mapcar, as in the expression:

```
(mapcar (function +) foo (circular-list 5))
```

which adds each element of **foo** to 5. **circular-list** could have been defined by:

```
(defun circular-list (&rest elements)
  (setq elements (copylist* elements))
  (rplacd (last elements) elements)
  elements)
```

circular-list is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

cis *radians* *Function*

radians must be a noncomplex number. **cis** could have been defined by:

```
(defun cis (radians)
  (complex (cos radians) (sin radians)))
```

Mathematically, this is equivalent to $e^{i * radians}$

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

:clear-hash *Message*

Removes all of the entries from the hash table. This message will be removed in the future – use **clrhash** instead.

:clear of **si:heap** *Method*

Remove all of the entries from the heap.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

zl:closure *symbol-list function* *Function*

This creates and returns a dynamic closure of *function* over the variables in *symbol-list.* Note that all variables on *symbol-list* must be declared special.

To test whether an object is a dynamic closure, use the **zl:closurep** predicate. See the section "Predicates" in *Symbolics Common Lisp: Language Concepts.* The **typep** function returns the symbol **zl:closure** if given a dynamic closure. **(typep** *x* **:closure)** is equivalent to **(zl:closurep** *x***)**.

The Symbolics Common Lisp equivalent of this function is **make-dynamic-closure.**

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:closure-alist *closure* *Function*

Returns an alist of (*symbol* . *value*) pairs describing the bindings which the dynamic closure performs when it is called. This list is not the same one that is actually stored in the closure; that one contains pointers to value cells rather than symbols, and **zl:closure-alist** translates them back to symbols so you can understand them. As a result, clobbering part of this list does not change the closure.

If any variable in the closure is unbound, this function signals an error.

The Symbolics Common Lisp equivalent of this function is **dynamic-closure-alist**.

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

closure-function *closure* *Function*

Returns the closed function from the dynamic closure *closure*. This is the function that was the second argument to **zl:closure** when the dynamic closure was created. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:closurep *arg* *Function*

zl:closurep returns **t** if its argument is a closure, otherwise **nil**.

zl:closure-variables *closure* *Function*

Creates and returns a list of all of the variables in the dynamic closure *closure*. It returns a copy of the list that was passed as the first argument to **zl:closure** when *closure* was created.

The Symbolics Common Lisp equivalent of this function is **dynamic-closure-variables**

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

clrhash *table* *Function*

Removes all of the entries from *table*.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:clrhash-equal *hash-table* *Function*

Removes all of the entries from *hash-table*. This function will be removed in the future – use **clrhash** instead.

sys:cl-structure-printer *structure-name object stream depth* *Macro*

This macro expands into an efficient function that prints a given structure *object* of type *structure-name* to the specified *stream* in #S format. It depends on the information calculated by **defstruct**, and so is only useful after the **defstruct** form has been compiled. This macro enables a structure print function to respect the variable ***print-escape***.

```
(defstruct (foo
             (:print-function foo-printer))
  a b c)

(defun foo-printer (object stream depth)
  (if *print-escape*
      (sys:cl-structure-printer foo object stream depth)
      other-printing-strategy))
```

code-char *code* &optional (*bits* **0**) (*font* **0**) *Function*

Constructs a character given its *code* field. *code*, *bits*, and *font* must be non-negative integers. If **code-char** cannot construct a character given its arguments, it returns **nil**.

To set the bits of a character, supply one of the character bits constants as the *bits* argument. See the section "Character Bit Constants" in *Symbolics Common Lisp: Language Concepts*.

For example:

```
(code-char 65 char-control-bit) => #\c-A
```

Since the value of **char-font-limit** is **1**, the only valid value of *font* is **0**. The only reason to use the *font* option would be when writing a program intended to be portable to other Common Lisp systems.

If you want to construct a new character that has character style other than NIL.NIL.NIL, use **make-character**: See the function **make-character**, page 323.

coerce *object result-type* *Function*

Converts an object to an equivalent object of another type.

object is a Lisp object.

result-type must be a type-specifier; *object* is converted to an equivalent object of the specified type. If *object* is already of the specified type, as determined by **typep**, it is returned.

If the coercion cannot be performed, an error is signalled. In particular, (**coerce** *x* **nil**) always signals an error.

Example:

```
(coerce 'x nil)
  => Error: I don't know how to coerce an object to nothing
```

It is not generally possible to convert any object to be of any type whatsoever; only certain conversions are allowed:

Any sequence type can be converted to any other sequence type, provided the new sequence can contain all actual elements of the old sequence (it is an error if it cannot). If the *result-type* is specified as simply **array**, for example, then **array t** is assumed. A specialized type such as **string** or (**vector (complex short-float)**) can be specified;

Examples:

```
(coerce '(a b c) 'vector) => #(A B C)
(coerce '(a b c) 'array) => #(A B C)
(coerce #*101 '(vector (complex short-float))) => #(1 0 1)
(coerce #(4 4) 'number)
 => Error: I don't know how to coerce an object to a number
```

Elements of the new sequence will be **eql** to corresponding elements of the old sequence. Note that elements are not coerced recursively. If you specify *sequence* as the *result-type*, the argument can simply be returned without copying it, if it already is a sequence.

Examples:

```
(coerce #(8 9) 'sequence) => #(8 9)
(eql (coerce #(1 2) 'sequence) #(1 2)) => NIL
(equalp (coerce #(1 2) 'sequence) #(1 2)) => T
```

In this respect, (**coerce** *sequence type*) differs from (**concatenate** *type sequence*), since the latter is required to copy the argument *sequence*.

Some strings, symbols, and integers can be converted to characters. If object is a string of length 1, then the sole element of the string is returned. If *object* is a symbol whose print name is of length 1, then the sole element of the print name is returned. If *object* is an integer *n*, then (**int-char** *n*) is returned.

Examples:

```
(coerce "b" 'character)  => #\b
(coerce "ab" 'character)
=> Error: "AB" is not one character long.
(coerce 'a 'character) => #\A
(coerce 'ab 'character)
 => Error: "AB" is not one character long.
(coerce 65 'character) => #\A
(coerce 150 'character) => #\Circle
```

Any non-complex number can be converted to a **short-float, single-float double-float,** or **long-float.** If simply **float** is specified as the *result-type* and if *object* is not already a floating-point number of some kind, then object is converted to a **single-float.**

Examples:

```
(coerce 0 'short-float) => 0.0
(coerce 3.5L0 'float) => 3.5d0
(coerce 7/2 'float) => 3.5
```

Any number can be converted to a complex number. If the number is not already complex, then a zero imaginary part is provided by coercing the integer zero to the type of the given real part. If the given real part is rational, however, then the rule of canonicalization for complex rational numbers results in the immediate re-conversion of the the result type from type **complex** back to type **rational.**

Examples:

```
(coerce 4.5s0 'complex) => #C(4.5 0.0)
(coerce 7/2 'complex) => 7/2
(coerce #C(7/2 0) '(complex double-float))
 => #C(3.5d0 0.0d0)
```

Any object can be coerced to type **t.**

Example:

```
(coerce 'house 't) => HOUSE
```

is equivalent to

```
(identity 'house) => HOUSE
```

Coercions from floating-point numbers to rational numbers, and of ratios to integers are not supported because of rounding problems. Use one of the specialized functions such as **rational, rationalize, floor,** and **ceiling** instead. See the section "Numeric Type Conversions" in *Symbolics Common Lisp: Language Concepts.*

Similarly, **coerce** does not convert characters to integers; use the specialized functions **char-code** or **char-int** instead.

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

collect Keyword For loop

collect *expr* {**into** *var*}

Causes the values of *expr* on each iteration to be collected into a list. When the

epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

The forms **collect** and **collecting** are synonymous.

Examples:

```
(defun loop1 (start end)
  (loop for x from start to end
        collect x)) => LOOP1
(loop1 0 4) => (0 1 2 3 4)

(defun loop2 (small-list)
  (loop for x from 0
        for item in small-list
        collect (list x item))) => LOOP2
(loop2 '("one" "two" "three" "four"))
  => ((0 "one") (1 "two") (2 "three") (3 "four"))
```

The following examples are equivalent.

```
(defun loop3 (small-list)
  (loop for x from 0
        for item in small-list
        collect x into result-1
        collect item into result-2
        finally (print (list result-1 result-2)))) => LOOP3
(loop3 '(a b c d e f))  =>
((0 1 2 3 4 5) (A B C D E F)) NIL

(defun loop3 (small-list)
  (loop for x from 0
        for item in small-list
        collecting x into result-1
        collecting item into result-2
        finally (print (list result-1 result-2)))) => LOOP3
(loop3 '(a b c d e f))  =>
((0 1 2 3 4 5) (A B C D E F)) NIL
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **collect, nconc,** and **append** are compatible.

See the section "**loop** Clauses", page 310.

zl:comment *Special Form*

Ignores its form and returns the symbol **zl:comment**. Example:

```
(defun foo (x)
    (cond ((null x) 0)
          (t (comment x has something in it)
             (1+ (foo (cdr x))))))
```

Usually it is preferable to comment code using the semicolon-macro feature of the standard input syntax. This allows you to add comments to your code that are ignored by the Lisp reader. Example:

```
(defun foo (x)
    (cond ((null x) 0)
          (t (1+ (foo (cdr x))))     ;x has something in it
      ))
```

A problem with such comments is that they are discarded when the form is read into Lisp. If the function is read into Lisp, modified, and printed out again, the comment is lost. However, this style of operation is hardly ever used; usually the source of a function is kept in an editor buffer and any changes are made to the buffer, rather than the actual list structure of the function. Thus, this is not a real problem.

See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts*.

common *Type Specifier*

common is the type specifier symbol denoting an *exhaustive union* of the following Common Lisp data types:

cons, symbol
(**array** *x*), where *x* is either **t** or a subtype of **common**
string, fixnum, bignum, ratio, short-float,
single-float, double-float long-float
(**complex** *x*) where *x* is a subtype of **common**
standard-char, hash-table, readtable, package,
pathname, stream, random-state
and all types created by the user with **defstruct**, or **defflavor.**

The type **common**, is a *subtype* of type **t**.

Examples:

```
(typep '#c(3 4) 'common)  => T

(subtypep 'common t) => T and T

(commonp 'cons) => T

(sys:type-arglist 'common) => NIL and T

(setq four
    (let ((x 4))
      (closure '(x) 'zerop))) => #<DTP-CLOSURE 1510647>

(typep four 'sys:dynamic-closure) => T

(subtypep 'sys:dynamic-closure 'common) => NIL and NIL
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

commonp *object* *Function*

The predicate **commonp** is true if its argument is any standard Common Lisp data type; it is false otherwise.

```
(commonp x) ≡ (typep x 'common)
```

Examples:

```
(commonp 1.5d9) => T
(commonp 1.0) => T
(commonp -12.) => T
(commonp '3kd) => T
(commonp 'symbol) => T
(commonp #c(3 4)) => T
(commonp 4) => T  is equivalent to  (typep 4 'common) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Predicates" in *Symbolics Common Lisp: Language Concepts.*

compiled-function *Type Specifier*

compiled-function is the type specifier symbol for the predefined Lisp data type of that name.

Examples:

```
(typep (compile nil '(lambda (a b) (+ a b))) 'compiled-function)
 => T

(zl:typep (compile nil '(lambda (a b) (+ a b))))
 => :COMPILED-FUNCTION

(sys:type-arglist 'compiled-function) => NIL and T

(compiled-function-p (compile nil '(lambda (a) (+ a a)))) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Functions" in *Symbolics Common Lisp: Language Concepts.*

compiled-function-p *object* *Function*

compiled-function-p returns **t** if its argument is any compiled code object.

compile-flavor-methods *flavor1 flavor2...* *Macro*

You can use **compile-flavor-methods** to cause the combined methods of a program to be compiled at compile-time, and the data structures to be generated at load-time, rather than both happening at run-time. **compile-flavor-methods** is thus a very good thing to use, since the need to invoke the compiler at run-time slows down a program using flavors the first time it is run. (The compiler is still called if incompatible changes have been made, such as addition or deletion of methods that must be called by a combined method.)

It is necessary to use **compile-flavor-methods** when you use the **:constructor** option for **defflavor**, to ensure that the constructor function is defined.

You use **compile-flavor-methods** by including the forms in a file to be compiled. This causes the compiler to include the automatically generated combined methods for the named flavors in the resulting .bin file, provided that all of the necessary flavor definitions have been made. Furthermore, when the .bin file is loaded, internal data structures (such as the list of all methods of a flavor) are generated.

You should use **compile-flavor-methods** only for flavors that will be instantiated. For a flavor that will never be instantiated (that is, one that only serves to be a component of other flavors that actually do get instantiated), it is almost always useless. The one exception is the unusual case where the other flavors can all inherit the combined methods of this flavor instead of each having its own copy of a combined method that happens to be identical to the others.

The **compile-flavor-methods** forms should be compiled after all of the information needed to create the combined methods is available. You should

put these forms after all of the definitions of all relevant flavors, wrappers, and methods of all components of the flavors mentioned.

In general, Flavors cannot guarantee that **defmethod** macro-expands correctly unless the flavor (and all of its component flavors) have been compiled. Therefore, the compiler gives a warning when you try to compile a method before the flavor and its components have been compiled.

If you see this warning and no other warnings, it is usually the case that the flavor system did compile the method correctly.

In complicated cases, such as a regular function and an internal flavor function (defined by **defun-in-flavor** or the related functions) having the same name, the flavor system cannot compile the method correctly. In those cases it is advisable to compile all the flavors first, and then compile the method.

See the function **flavor:print-flavor-compile-trace**, page 403.

compiler-let *bindlist body...* *Special Form*

When interpreted, a **compiler-let** form is equivalent to **let** with all variable bindings declared special. When the compiler encounters a **compiler-let,** however, it performs the bindings specified by the form (no compiled code is generated for the bindings) and then compiles the body of the **compiler-let** with all those bindings in effect. In particular, macros within the body of the **compiler-let** form are expanded in an environment with the indicated bindings. See the section "Nesting Macros" in *Symbolics Common Lisp: Language Concepts.*

compiler-let allows compiler switches to be bound locally at compile time, during the processing of the *body* forms. Value forms are evaluated at compile time. See the section "Compiler Switches" in *Program Development Utilities.* In the following example the use of **compiler-let** prevents the compiler from open-coding the **zl:map**.

```
(compiler-let ((open-code-map-switch nil))
  (zl:map (function (lambda (x) ...)) foo))
```

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts.*

complex &optional (*type* '*) *Type Specifier*

complex is the type specifier symbol for the predefined Lisp complex number type.

The types **complex**, **rational**, and **float** are *pairwise disjoint subtypes* of the type **number**.

This type specifier can be used in either symbol or list form. Used in list

form, **complex** allows the declaration and creation of complex numbers, whose real part and imaginary part are each of type *type*.

Examples:

```
(typep #c(3 4) 'complex) => T

(zl:typep #c(1.2 3.3)) => :COMPLEX

(subtypep 'complex 'number) => T and T ;subtype and certain

(typep '(complex 3 4) 'common) => T
```

The expression

```
(complexp #c(4/5 7.0)) => T
```

Is equivalent to

```
(typep #c(4/5 7.0) 'complex) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

complex *realpart* &optional *imagpart* *Function*

Constructs a complex number from real and imaginary noncomplex parts, applying complex canonicalization.

If the types of the real and imaginary parts are different, the coercion rules are applied to make them the same. If *imagpart* is not specified, a zero of the same type as *realpart* is used. If *realpart* is an integer or a ratio, and *imagpart* is 0, the result is *realpart*.
Examples:

```
(complex 7) => 7
(complex 4.3 0) => #C(4.3 0.0)
(complex 2 0) => 2
(complex 3 4) => #C(3 4)
(complex 3 4.0) => #C(3.0 4.0)
(complex 3.0d0 4) => #C(3.0d0 4.0d0)
(complex 5/2 4.0d0) => #C(2.5d0 4.0d0)
```

Related Functions:

realpart
imagpart

For a table of related items: See the section "Functions That Decompose and Construct Complex Numbers" in *Symbolics Common Lisp: Language Concepts*.

complexp *object* *Function*

Returns **t** if *object* is a complex number, otherwise **nil**.

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

flavor:compose-handler *generic flavor-name* &key *env* *Function*

Finds the methods that handle the specified generic operation on instances of the specified flavor. Four values are returned:

handler-function-spec
: The name of the handler, which can be a combined method, a single method, or an instance-variable accessor.

combined-method-list
: A list of function specs of all the methods called, in order of execution; the order is approximate because of wrappers.

method-combination
: A list of the method combination type and parameters to it.

error
: **nil** normally, otherwise a string describing an error that occurred.

For example, to use **flavor:compose-handler** on the generic function **change-status** for the flavor **box-with-cell**:

```
(flavor:compose-handler 'change-status 'box-with-cell)
-->(FLAVOR:COMBINED CHANGE-STATUS BOX-WITH-CELL)
   ((FLAVOR:METHOD CHANGE-STATUS CELL)
    (FLAVOR:METHOD CHANGE-STATUS BOX-WITH-CELL))
   (:AND :MOST-SPECIFIC-LAST)
   NIL
```

The generic function **change-status** and the methods for the flavors **box-with-cell** and **cell** are defined elsewhere: See the section "Example of Programming with Flavors: Life" in *Symbolics Common Lisp: Language Concepts.*

In the second return value of sample output here, we put each method on one line, for readability. This is not done by **flavor:compose-handler**.

The *env* parameter is described elsewhere: See the function **flavor:compose-handler-source**, page 99.

flavor:compose-handler-source *generic flavor-name* &key *env* *Function*

Finds the methods that handle the specified *generic* operation on instances of the flavor specified by *flavor-name*, and finds the source code of the combined method (if any). Seven values are returned:

form A Lisp form which is the body of the combined method. If there isn't actually a combined method, this is **nil**.

handler-function-spec
The name of the handler, which can be a combined method, a single method, or an instance-variable accessor.

combined-method-list
A list of function specs of all the methods called, in order of execution; the order is approximate because of wrappers.

wrapper-sources Information that the combined method requires so that Flavors knows when it needs to be recompiled.

lambda-list A list describing what the arguments of the combined method should be (not including the three interal arguments automatically given to all methods).

method-combination
A list of the method combination type and parameters to it.

error **nil** normally, otherwise a string describing an error that occurred.

flavor:compose-handler-source is generally slower than **flavor:compose-handler**, since the latter function can usually take advantage of pre-computed information present in virtual memory.

The *env* parameter to **flavor:compose-handler** and **flavor:compose-handler-source** can be used to insert hypotheses into their computations. If *env* is **nil**, the generics, flavors, and methods in the running world are used. *env* can be an alist of modifications to the running world; each element takes the form:

(*name flavor-structure generic-structure* (*method definition*)...)

Everything except *name* can be **nil**. *name* is the name of a generic, or a flavor, or both. *flavor-structure* is **nil** or the internal structure that describes the flavor. *generic-structure* is **nil** or the internal structure that describes the generic function. The remaining elements of an alist element refer to methods of the flavor named *name*; *method* is a function spec and *definition* is **nil** if that method is to be ignored, **t** if the method is to be assumed to exist, or the actual definition (expander function) in the case of a wrapper.

env can also be the symbol **compile**, which is used internally to access the compile-time environment.

concatenate *result-type* &rest *sequences* *Function*

concatenate returns a new sequence that contains all of the elements of all of the sequences in order.

The result does not share any structure with any of the argument sequences. The type of the result is specified by *result-type*, which must be a subtype of type sequence. It must be possible for every element of the argument sequences to be an element of a sequence of type *result-type*.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(concatenate 'vector "abc" #(ab) "gh") => #(#\a #\b #\c AB #\g #\h)

(setq vector (vector 'a 'b '1 '2)) => #(A B 1 2)

(setq list (make-list 3 :initial-element 'blah))
 => (BLAH BLAH BLAH)

(concatenate 'list vector list)
 => (A B 1 2 BLAH BLAH BLAH)

(concatenate 'vector list vector)  => #(BLAH BLAH BLAH A B 1 2)
```

If only one sequence argument is provided and it has the type specified by *result-type*, **concatenate** is required to to copy the argument rather than simply returning it. If a copy is not required, but only possible type-conversion, then the function **coerce** may be appropriate.

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts*.

cond &rest *clauses* *Special Form*

Consists of the symbol **cond** followed by several *clauses*. Each clause consists of a predicate form, called the *antecedent*, followed by zero or more *consequent* forms.

```
(cond (antecedent consequent consequent...)
      (antecedent)
      (antecedent consequent ...)
      ... )
```

Each clause represents a case that is selected if its antecedent is satisfied and the antecedents of all preceding clauses were not satisfied. When a clause is selected, its consequent forms are evaluated.

cond processes its clauses in order from left to right. First, the antecedent of the current clause is evaluated. If the result is **nil**, **cond** advances to the next clause. Otherwise, the **cdr** of the clause is treated as a list of consequent forms that are evaluated in order from left to right. After evaluating the consequents, **cond** returns without inspecting any remaining clauses. The value of the **cond** special form is the value of the last consequent evaluated, or the value of the antecedent if there were no consequents in the clause. If **cond** runs out of clauses, that is, if every antecedent evaluates to **nil**, and thus no case is selected, the value of the **cond** is **nil**.

Examples:

```
(cond) => NIL

(cond ((= 2 3) (print "2 equals 3, new math"))
      ((< 3 3) (print "3 < 3, not yet !"))) => NIL

(cond ((equal 'Becky 'Becky) "Girl")
      ((equal 'Tom 'Tom)     "Boy")) => "Girl"

(cond ((equal 'Rover 'Red) "dog")
      ((equal 'Pumpkin 'Pickles)   "cat")
      (t     "rat")) => "rat"


(cond ((zerop x)      ;First clause:
       (+ y 3))       ;(zerop x) is the antecedent.
                      ;(+ y 3) is the consequent.
      ((null y)       ;A clause with 2 consequents:
       (setq y 4)     ;this
       (cons x z))    ;and this.
      (z)             ;A clause with no consequents: the antecedent
                      ;is just z.  If z is non-nil, it is returned.
      (t              ;An antecedent of t
       105)           ;is always satisfied.
      )               ;This is the end of the cond.
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

cond-every &body *clauses* *Special Form*

Has the same syntax as **cond**, but executes every clause whose predicate is satisfied, not just the first. If a predicate is the symbol **otherwise**, it is satisfied if and only if no preceding predicate is satisfied. The value returned is the value of the last consequent form in the last clause whose predicate is satisfied. Multiple values are not returned.

Examples:

```
(cond-every) => NIL

(cond-every ((> 2 3) (print "sister"))
            ((= 2 3) (print "brother"))) => NIL

(cond-every ((equal 'mom 'mom) (princ "mother "))
            ((equal 'dog 'cat) (princ "pet dog"))
            ((equal 'dad 'dad) (princ "father")))
=> mother father"father"

(cond-every ((= 1 1) t) ((= 2 2) "yes!")
            (otherwise "no")) => "yes!"
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

condition-bind *list* &body *body* *Special Form*

condition-bind binds handlers for conditions and then evaluates its body with those handlers bound. One of the handlers might be invoked if a condition is signalled while the body is being evaluated. The handlers bound have dynamic scope.

The following simple example sets up application-specific handlers for two standard error conditions, **fs:file-not-found** and **fs:delete-failure**.

```
(condition-bind ((fs:file-not-found 'my-fnf-handler)
                 (fs:delete-failure 'my-delete-handler))
  (deletef pathname))
```

The format for **condition-bind** is:

```
(condition-bind ((condition-flavor-1 handler-1)
                 (condition-flavor-2 handler-2)
                 ...
                 (condition-flavor-m handler-m))
  form-1
  form-2
  ...
  form-n)
```

condition-flavor-j The name of a condition flavor or a list of names of condition flavors. The *condition-flavor-j* need not be unique or mutually exclusive. (See the section "Finding a Handler" in *Symbolics Common Lisp: Language Concepts.* Search order is explained in that section.)

handler-j A form that is evaluated to produce a handler function. One handler is bound for each condition flavor clause in the list. The forms for binding handlers are evaluated in order from *handler-1* to *handler-m*. All the *handler-j* forms are evaluated and then all handlers are bound. When *handler* is a lambda-expression, it is compiled. The handler function is a lexical closure, capable of referring to the lexical variables of the containing block.

form-i A body, constituting an implicit **progn**. The forms are evaluated sequentially. The **condition-bind** form returns whatever values *form-n* returns (**nil** when the body contains no forms). The handlers that are bound disappear when the **condition-bind** form is exited.

If a condition signal occurs for one of the *condition-flavor-j* during evaluation of the body, the signalling mechanism examines the bound handlers in the order in which they appear in the **condition-bind** form, invoking the first appropriate handler. You can think of the mechanism as being analogous to **typecase** or **zl-user:case**. It invokes the handler function with one argument, the condition object. The handler runs in the dynamic environment in which the error occurred; no **throw** is performed.

Any handler function can take one of three actions:

- It can return **nil** to indicate that it does not want to handle the condition after all. The handler is free to decide not to handle the condition, even though the *condition-flavor-j* matched. (In this case the signalling mechanism continues to search for a condition handler.)
- It can throw to some outer catch-form, using **throw**.
- If the condition has any proceed types, it can proceed from the condition by sending a **sys:proceed** method to the condition object and returning the resulting values. In this case, **signal** returns all of the values returned by the handler function. (Proceed types are not available for conditions signalled with **error**. See the section "Proceeding" in *Symbolics Common Lisp: Language Concepts*.)

The conditional variant of **condition-bind** is the form:

condition-bind-if

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts*.

condition-bind-default *list* &body *body* *Special Form*

This form binds its handlers on the default handler list instead of the bound handler list. See the section "Finding a Handler" in *Symbolics Common Lisp: Language Concepts*. In other respects **condition-bind-default** is

just like **condition-bind**. The default handlers are examined by the signalling mechanism only after all of the bound handlers have been examined. Thus, a **condition-bind-default** can be overridden by a **condition-bind** outside of it. This advanced feature is described in more detail in another section. See the section "Default Handlers and Complex Modularity" in *Symbolics Common Lisp: Language Concepts.*

The conditional variant of **condition-bind-default** is the form:

condition-bind-default-if

For a table of related items: See the section "Basic Forms for Default Handlers" in *Symbolics Common Lisp: Language Concepts.*

condition-bind-default-if *cond-form list* &body *body* *Special Form*

This form binds its handlers on the default handler list instead of the bound handler list. (See the section "Finding a Handler" in *Symbolics Common Lisp: Language Concepts.*) In other respects **condition-bind-default-if** is just like **condition-bind-if**. The default handlers are examined by the signalling mechanism only after all of the bound handlers have been examined. Thus, a **condition-bind-default-if** can be overridden by a **condition-bind** outside of it. This advanced feature is described in more detail in another section. See the section "Default Handlers and Complex Modularity" in *Symbolics Common Lisp: Language* Concepts.

For a table of related items: See the section "Basic Forms for Default Handlers" in *Symbolics Common Lisp: Language Concepts.*

condition-bind-if *cond-form list* &body *body* *Special Form*

condition-bind-if binds its handlers conditionally. In all other respects, it is just like **condition-bind**. It has an extra subform called *cond-form*, for the conditional. Its format is:

```
(condition-bind-if cond-form
                   ((condition-flavor-1 handler-1)
                    (condition-flavor-2 handler-2)
                    ...
                    (condition-flavor-m handler-m))
  form-1
  form-2
  ...
  form-n)
```

condition-bind-if first evaluates *cond-form*. If the result is **nil**, it evaluates the handler forms but does not bind any handlers. It then executes the body as if it were a **progn**. If the result is not **nil**, it continues just like **condition-bind** binding the handlers and executing the body.

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts.*

condition-call (&rest *varlist*) *form* &body *clauses* *Special Form*

condition-call binds handlers for conditions, expressing the handlers as clauses of a case-like construct instead of as functions. These handlers have dynamic scope.

condition-call and **condition-case** have similar applications. The major distinction is that **condition-call** provides the mechanism for using a complex conditional criterion to determine whether or not to use a handler. **condition-call** clauses have the ability to decline to handle a condition because the clause is selected on the basis of the predicate, rather than on the basis of the type of a condition.

The format is:

```
(condition-call (var)
    form
  (predicate-1 form-1-1 form-1-2 ... form-1-n)
  (predicate-2 form-2-1 form-2-2 ... form-2-n)
  ...
  (predicate-m form-m-1 form-m-2 ... form-m-n))
```

Each *predicate-j* must be a function of one argument. The predicates are called, rather than evaluated. The *form-j-i* are a body, a list of forms constituting an implicit **progn**. The handler clauses are bound simultaneously.

When a condition is signalled, each predicate in turn (in the order in which they appear in the definition) is applied to the condition object. The corresponding handler clause is executed for the first predicate that returns a value other than **nil**. The predicates are called in the dynamic environment of the signaller.

condition-call takes the following actions when it finds the right predicate:

1. It automatically performs a **throw** to unwind the dynamic environment back to the point of the **condition-call**. This discards the handlers bound by the **condition-call**.
2. It executes the body of the corresponding clause.
3. It makes **condition-call** return the values produced by the last form in the clause.

During the execution of the clause, the variable *var* is bound to the condition object that was signalled. If none of the clauses needs to examine the condition object, you can omit *var:*

```
(condition-call () ...)
```

condition-call And :no-error

As a special case, *predicate-m* (the last one) can be the special symbol **:no-error**. If *form* is evaluated and no error is signalled during the evaluation, **condition-case** executes the **:no-error** clause instead of returning the values returned by *form*. The variables *vars* are bound to the values produced by *form*, in the style of **multiple-value-bind**, so that they can be accessed by the body of the **:no-error** case. Any extra variables are bound to **nil**.

Some limitations on predicates:

- Predicates must not have side effects. The number of times that the signalling mechanism chooses to invoke the predicates and the order in which it invokes them are not defined. For side effects in the dynamic environment of the signal, use **condition-bind**.
- The predicates are not lexical closures and therefore cannot access variables of the lexically containing form, unless those variables are declared **special**.
- Lambda-expression predicates are not compiled.

The conditional variant of **condition-call** is the form:

condition-call-if

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts*.

condition-call-if *cond-form* (&rest *varlist*) *form* &body *clauses* *Special Form*

condition-call-if binds its handlers conditionally. In all other respects, it is just like **condition-call**. Its format includes *cond-form*, the subform that controls binding handlers:

```
(condition-call-if cond-form (var)
  form
  (predicate-1 form-1-1 form-1-2 ... form-1-n)
  (predicate-2 form-2-1 form-2-2 ... form-2-n)
  ...
  (predicate-m form-m-1 form-m-2 ... form-m-n))
```

condition-call-if first evaluates *cond-form*. If the result is **nil**, it does not set up any handlers; it just evaluates the form. If the result is not **nil**, it continues just like **condition-call**, binding the handlers and evaluating the form.

The **:no-error** clause applies whether or not *cond-form* is **nil**.

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts.*

condition-case (&rest *varlist*) *form* &rest *clauses* *Special Form*

condition-case binds handlers for conditions, expressing the handlers as clauses of a **case**-like construct instead of as functions. The handlers bound have dynamic scope.

Examples:

```
(condition-case ()
    (time:parse string)
  (time:parse-error *default-time*))

(condition-case (e)
    (time:parse string)
  (time:parse-error
   (format error-output "~A, using default time instead." e)
   *default-time*))

(do () (nil)
  (condition-case (e)
      (return (time:parse string))
    (time:parse-error
      (setq string
            (prompt-and-read
              :string
              "~A~%Use what time instead? " e)))))
```

The format is:

```
(condition-case (var1 var2 ...)
    form
  (condition-flavor-1 form-1-1 form-1-2 ... form-1-n)
  (condition-flavor-2 form-2-1 form-2-2 ... form-2-n)
  ...
  (condition-flavor-m form-m-1 form-m-2 ... form-m-n))
```

Each *condition-flavor-j* is either a condition flavor, a list of condition flavors, or **:no-error**. If **:no-error** is used, it must be the last of the handler clauses. The remainder of each clause is a body, a list of forms constituting an implicit **progn**.

condition-case binds one handler for each clause. The handlers are bound simultaneously.

If a condition is signalled during the evaluation of *form*, the signalling

mechanism examines the bound handlers in the order in which they appear in the definition, invoking the first appropriate handler.

condition-case normally returns the values returned by *form*. If a condition is signalled during the evaluation of *form*, the signalling mechanism determines whether the condition is one of the *condition-flavor-j*. If so, the following actions occur:

1. It automatically performs a **throw** to unwind the dynamic environment back to the point of the **condition-case**. This discards the handlers bound by the **condition-case**.
2. It executes the body of the corresponding clause.
3. It makes **condition-case** return the values produced by the last form in the handler clause.

While the clause is executing, *var1* is bound to the condition object that was signalled and the rest of the variables (*var2*, ...) are bound to **nil**. If none of the clauses needs to examine the condition object, you can omit *var1*.

```
(condition-case () ...)
```

As a special case, *condition-flavor-m* (the last one) can be the special symbol **:no-error**. If *form* is evaluated and no error is signalled during the evaluation, **condition-case** executes the **:no-error** clause instead of returning the values returned by *form*. The variables *var1*, *var2*, and so on are bound to the values produced by *form*, in the style of **multiple-value-bind**, so that they can be accessed by the body of the **:no-error** case. Any extra variables are bound to **nil**.

When an event occurs that none of the cases handles, the signalling mechanism continues to search the dynamic environment for a handler. You can provide a case that handles any **error** condition by using **error** as one *condition-flavor-j*.

The conditional variant of **condition-case** is the form:

condition-case-if

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts*.

condition-case-if *cond-form* (&rest *varlist*) *form* &rest *clauses* *Special Form*

condition-case-if binds its handlers conditionally. In all other respects, it is just like **condition-case**. Its syntax includes *cond-form*, a subform that controls binding handlers:

```
(condition-case-if cond-form (var)
    form
  (condition-flavor-1 form-1-1 form-1-2 ... form-1-n)
  (condition-flavor-2 form-2-1 form-2-2 ... form-2-n)
  ...
  (condition-flavor-m form-m-1 form-m-2 ... form-m-n))
```

condition-case-if first evaluates *cond-form*. If the result is **nil**, it does not set up any handlers; it just evaluates the form. If the result is not **nil**, it continues just like **condition-case**, binding the handlers and evaluating the form.

The **:no-error** clause applies whether or not *cond-form* is **nil**.

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts*.

dbg:condition-handled-p *condition* *Function*

dbg:condition-handled-p searches the bound handler list and the default handler list to see whether a handler exists for the condition object, condition. This function should be called only from a **condition-bind** handler function. It starts looking from the point in the lists from which the current handler was invoked and proceeds to look outwards through the bound handler list and the default handler list. It returns a value to indicate what it found:

Value	*Meaning*
:maybe	**condition-bind** handlers for the flavor exist. These handlers are permitted to decline to handle the condition. You cannot determine what would happen without actually running the handler.
nil	No handler exists.
t	A handler exists.

conjugate *number* *Function*

Returns the complex conjugate of *number*. The conjugate of a noncomplex number is itself. **conjugate** could have been defined by:

```
(defun conjugate (number)
  (complex (realpart number) (- (imagpart number))))
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts*.

cons *Type Specifier*

cons is the type specifier symbol for the predefined Lisp object of that name.

The types **cons** and **null** form an *exhaustive partition* of the type **list.**

The types **cons, symbol, array, number,** and **character** are *pairwise* disjoint.

Examples:

```
(typep '(a.b) 'cons) => T

(typep '(a b c) 'cons) => T

(zl:listp '(a b c)) => T

(subtypep 'cons 'list) => T and T

(subtypep 'list 'cons) => NIL and T

(sys:type-arglist 'cons) => NIL and T

(consp '(a b c)) => T

(type-of '(signed-byte 3)) => CONS
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "List Data Types".

cons *x y* *Function*

cons is the primitive function to create a new cons, whose *car* is *x* and whose *cdr* is *y*. Examples:

```
(cons 'a 'b) => (a . b)
(cons 'a (cons 'b (cons 'c nil))) => (a b c)
(cons 'a '(b c d)) => (a b c d)
```

cons may be thought of as creating a cons, or as adding a new element to the front of a list.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

cons-in-area *x y area-number* *Function*

cons-in-area creates a cons, whose *car* is *x* and whose *cdr* is *y*, in the specified *area.* (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

Example:

```
(cons-in-area 'a 'b my-area) => (a . b)
```

cons-in-area is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

constantp *object* *Function*

This predicate is **t** if *object*, when considered as a form to be evaluated, always evaluates to the same thing. This includes self-evaluating objects such as numbers, characters, strings, bit-vectors and keywords, as well as all constant symbols declared by **defconstant**, such as **nil**, t, and pi. In addition, a list whose **car** is **quote**, such as **(quote rhumba)** also returns **t** when it is given as *object* to **constantp**.

This predicate is **nil** if **user::object**, considered as a form, may or may not always evaluate to the same thing.

continue-whopper &rest *args* *Special Form*

Calls the combined method for the generic function that was intercepted by the whopper. Returns the values returned by the combined method.

args is the list of arguments passed to those methods. This function must be called from inside the body of a whopper. Normally the whopper passes down the same arguments that it was given. However, some whoppers might want to change the values of the arguments and pass new values; this is valid.

For more information on whoppers, including examples: See the section "Wrappers and Whoppers" in *Symbolics Common Lisp: Language Concepts.*

copy-alist *al* &optional *area* *Function*

This function returns an association list that is **equal** to *al*, but not **eq**. See the section "Association Lists" in *Symbolics Common Lisp: Language Concepts.* Only the top level of list structure is copied; that is, **copy-alist** copies in the *cdr* direction, but not in the *car* direction. Each element of *al* that is a cons is replaced in the copy by a new cons with the same *car* and *cdr*. See the function **copy-seq**, page 116. See the function **copy-tree**, page 117.

The optional *area* argument is the number of the area in which to create the new alist. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:copyalist *list* &optional *area* *Function*

zl:copyalist is for copying association lists. See the section "Lists" in *Symbolics Common Lisp: Language Concepts*. The *list* is copied, as in **zl:copylist**. In addition, each element of *list* that is a cons is replaced in the copy by a new cons with the same **car** and **cdr**. You can optionally specify the area in which to create the new copy. The default is to copy the new list into the area occupied by the old list.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts*.

copy-array-contents *from-array to-array* *Function*

Copies the contents of *from-array* into the contents of *to-array*, element by element. *from-array* and *to-array* must be arrays. If *to-array* is shorter than *from-array*, the rest of *from-array* is ignored. If *from-array* is shorter than *to-array*, the rest of *to-array* is filled with **nil** if it is a general array, or 0 if it is a numeric array or **(code-char 0)** for strings. This function always returns **t**.

Note that even if *from-array* or *to-array* has a leader, the whole array is used; the convention that leader element 0 is the "active" length of the array is not used by this function. The leader itself is not copied.

copy-array-contents works on multidimensional arrays. *from-array* and *to-array* are "linearized" and row-major order is used. See the section "Row-major Storage of Arrays" in *Converting to Genera 7.0*.

copy-array-contents does not work on conformally displaced arrays.

copy-array-contents-and-leader *from-array to-array* *Function*

Copies the contents and leader of *from-array* into the contents of *to-array*, element by element. **copy-array-contents** copies only the main part of the array.

copy-array-contents-and-leader does not work on conformally displaced arrays.

copy-array-portion *from-array from-start from-end to-array to-start to-end* *Function*

The portion of the array *from-array* with indices greater than or equal to *from-start* and less than *from-end* is copied into the portion of the array *to-array* with indices greater than or equal to *to-start* and less than *to-end*, element by element. If there are more elements in the selected portion of *to-array* than in the selected portion of *from-array*, the extra elements are filled with the default value as by **copy-array-contents**. If there are more elements in the selected portion of *from-array*, the extra ones are ignored. Multidimensional arrays are treated the same way as **copy-array-contents** treats them. This function always returns **t**.

copy-array-portion does not work on conformally displaced arrays.

Currently, **copy-array-portion** (as well as **copy-array-contents** and **copy-array-contents-and-leader**) copies one element at a time in increasing order of subscripts (this behavior might change in the future). This means that when copying from and to the same array, the results might be unexpected if *from-start* is less than *to-start*. You can safely copy from and to the same array as long as *from-start* >= *to-start*.

zl:copy-closure *closure* *Function*

Creates and returns a new closure by copying the dynamic closure *closure*. **zl:copy-closure** generates new external value cells for each variable in the closure and initializes their contents from the external value cells of *closure*.

The Symbolics Common Lisp equivalent of this function is **copy-dynamic-closure**.

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See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

copy-dynamic-closure *closure* *Function*

Creates and returns a new closure by copying the dynamic closure *closure*. **copy-dynamic-closure** generates new external value cells for each variable in the closure and initializes their contents from the external value cells of *closure*.

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

sys:copy-if-necessary *thing* &optional (*default-cons-area* **sys:working-storage-area**) *Function*

sys:copy-if-necessary moves *thing* from a temporary storage area or stack list to a permanent area. *thing* may be a string, symbol, list, tree, or **&rest** argument. **sys:copy-if-necessary** checks whether *thing* is in a temporary area of some kind, and moves it if it is. If *thing* is not in a temporary area, it is simply returned.

This function is used especially for **&rest** arguments, which are not guaranteed to be in permanent storage. Sometimes the rest-argument list is stored in the function-calling stack, and loses its validity when the function returns. If you wish to return a rest-argument or make it part of a permanent list structure, you must copy it first, as you must always assume that it is one of these special lists. See the section "Lambda-List Keywords" in *Symbolics Common Lisp: Language Concepts*.

sys:copy-if-necessary is a Symbolics extension to Common Lisp.

For more information on stack lists: See the section "Consing Lists on the Control Stack" in *Internals, Processes, and Storage Management.* See the special form **with-stack-list** in *Internals, Processes, and Storage* Management.

For more information on temporary storage areas see the **:gc** keyword of **make-area.** See the function **make-area** in *Internals, Processes, and Storage Management.*

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

copy-list *list* &optional *area force-dotted* *Function*

This function returns a list that is **equal** to *list*, but not **eq**. Only the top level of list structure is copied; that is, **copy-list** copies in the *cdr* direction, but not in the *car* direction. Each element of *list* that is a cons is replaced in the copy by a new cons with the same *car* and *cdr*. See also, **copy-alist copy-seq copy-tree copy-tree-share.**

The optional *area* argument is the number of the area in which to create the new list. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

If *list* is a dotted list, this will be true of the returned list also. This can be forced with the *force-dotted* argument. If the value of *force-dotted* is **t**, **copy-list** will always return a dotted list.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:copylist *list* &optional *area force-dotted* *Function*

Returns a list that is **zl:equal** to *list*, but not **eq**. **zl:copylist** does not copy any elements of the list: only the conses of the list itself. The returned list is fully cdr-coded to minimize storage. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts.* If the list is "dotted", that is, **(cdr (last** *list*)) is a non-**nil** atom, this is true of the returned list also. You can optionally specify the area in which to create the new copy. The default is to copy the new list into the area occupied by the old list.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

copy-list* *list* &optional *area* *Function*

This function is the same as **copy-list** except that the last cons of the resulting list is never cdr-coded. See the function **copy-list**, page 115. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts.* This makes for increased efficiency if you **nconc** something onto the list later.

The optional *area* argument is the number of the area in which to create the new list. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

copy-list* is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:copylist* *list* &optional *area* *Function*

This is the same as **zl:copylist** except that the last cons of the resulting list is never cdr-coded. See the function **zl:copylist**, page 115. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts.* This makes for increased efficiency if you **nconc** something onto the list later.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

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copy-seq *sequence* &optional *area* *Function*

A copy is made of the argument *sequence*, and the result is **equalp** to the argument, but not **eq**. The function **copy-seq** returns the same result as the function **subseq**, when the value of the **start** argument of **subseq** is 0.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(setq name "Bill") => "Bill"

(setq a-copy (copy-seq name)) => "Bill"

a-copy => "Bill"

name => "Bill"

(equalp a-copy name) => T

(eq a-copy name) => NIL
```

The optional *area* argument is the number of the area in which to create the new alist. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

copy-symbol *symbol* &optional *copyprops* *Function*

Returns a new uninterned symbol with the same print-name as *symbol*. If *copyprops* is non-**nil**, then the value and function-definition of the new symbol are the same as those of *sym*, and the property list of the new symbol is a copy of *symbol*'s. If *copyprops* is **nil** (the default), then the new symbol is unbound and undefined, and its property list is empty. See the section "Functions for Creating Symbols" in *Symbolics Common Lisp: Language Concepts*.

zl:copysymbol *symbol* &optional *copyprops* *Function*

Returns a new uninterned symbol with the same print-name as *symbol*. If *copyprops* is non-**nil**, then the value and function-definition of the new symbol are the same as those of *sym*, and the property list of the new symbol is a copy of *symbol*'s. If *copyprops* is **nil** (the default), then the new symbol is unbound and undefined, and its property list is empty. See the section "Functions for Creating Symbols" in *Symbolics Common Lisp: Language Concepts*.

copy-tree *tree* &optional *area* *Function*

copy-tree is useful for copying trees of conses. The argument *tree* may be any Lisp object. If it is not a cons, it is returned; otherwise the result is a new cons made from the results of calling **copy-tree** on the *car* and *cdr* of the argument. In other words, all conses in the tree are copied recursively, stopping only when non-conses are encountered. Circularities and the sharing of substructure are not preserved.

The optional *area* argument is the number of the area in which to create the new tree. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management*.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:copytree *tree* &optional *area* *Function*

zl:copytree copies all the conses of a tree and makes a new tree with the same fringe. You can optionally specify the area in which to create the new copy. The default is to copy the new list into the area occupied by the old list.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts*.

copy-tree-share *tree* &optional *area* (*hash* **(zl:make-equal-hash-table)**) *cdr-code* *Function*

copy-tree-share is similar to **copy-tree**; it makes a copy of an arbitrary structure of conses, copying at all levels, and optimally cdr-coding.

However, it also assures that all lists or tails of lists are optimally shared when **equal**.

copy-tree-share takes as arguments the tree to be copied, and optionally a storage area, an externally created hash table to be used for the equality testing and a *cdr-code*. The default storage area for the new list is the area occupied by the old list. If *cdr-code* is **t**, then lists will never be "forked" to enable sharing a tail. This wastes space but improves locality.

Note: **copy-tree-share** might be very slow in the general case, for long lists. However, applying it at the appropriate level of a specific structure-copying routine (furnishing a common externally created hash table) is likely to yield all the sharing possible, at a much lower computational cost. For example, **copy-tree-share** could be applied only to the branches of a long alist.

Example:

```
(copy-tree-share '((1 2 3) (1 2 3) (0 1 2 3) (0 2 3)))
```

If `x = '(1 2 3)`, the above returns (roughly):

```
`(,x ,x (0 . ,x) (0 . ,(cdr x)))
```

copy-tree-share is a Symbolics extension to Common Lisp.

zl:copytree-share *tree* &optional *area* (*hash* **(zl:make-equal-hash-table)**) *cdr-code* *Function*

zl:copytree-share is similar to **zl:copytree**; it makes a copy of an arbitrary structure of conses, copying at all levels, and optimally cdr-coding. However, it also assures that all lists or tails of lists are optimally shared when **zl:equal**.

zl:copytree-share takes as arguments the tree to be copied, and optionally a storage area, an externally created hash table to be used for the equality testing and a *cdr-code*. The default storage area for the new list is the area occupied by the old list. If *cdr-code* is **t**, then lists will never be "forked" to enable sharing a tail. This wastes space but improves locality.

Note: **zl:copytree-share** might be very slow in the general case, for long lists. However, applying it at the appropriate level of a specific structure-copying routine (furnishing a common externally created hash table) is likely to yield all the sharing possible, at a much lower computational cost. For example, **zl:copytree-share** could be applied only to the branches of a long alist.

Example:

```
(zl:copytree-share '((1 2 3) (1 2 3) (0 1 2 3) (0 2 3)))
```

If x = '(1 2 3), the above returns (roughly):

```
`(,x ,x (0 . ,x) (0 . ,(cdr x)))
```

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

cos *radians* *Function*

Returns the cosine of *radians*. *radians* can be of any numeric type.

Examples:

```
(cos 0) => 1.0
(cos (/ pi 2)) => -0.0d0
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

cosd *degrees* *Function*

Returns the cosine of *degrees*. *degrees* can be of any numeric type.

Examples:

```
(cosd 90) => -0.0
(cosd 45) => 0.7071068
(cosd 36.2) => 0.80696034
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

cosh *radians* *Function*

Returns the hyperbolic cosine of *radians*.

Example:

```
(cosh 0) => 1.0
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts.*

count *item sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*
from-end (*start* **0**) *end*

Counts the number of elements in a subsequence of *sequence* satisfying the predicate specified by the **:test** keyword. **count** returns a non-negative integer, which represents the number of elements in the specified subsequence of *sequence*.

item is matched against the elements specified by the *test* keyword. *item* can be any Symbolics Common Lisp object.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true, where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(count 'a '(a b c d) :test-not #'eql)  => 3
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element. For example:

```
(count 'a '((a b) (a b)  (b c)) :key #'car) => 2

(count 1 #(1 2 3 1 4 1) :key #'(lambda (x) (- x 1))) => 1
```

The **:from-end** argument does not affect the result returned; it is accepted purely for compatibility with other sequence functions. For example:

```
(count 'a '(a a a b c d) :from-end t :start 3) => 0

(count 'a '(a a a b c d) :from-end nil :start 3) => 0
```

For the sake of efficiency, you can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(count 'a '(a b a)) => 2

(count 'heron '(heron loon heron pelican heron stork)) => 3

(count 'a '(a a b b a a)  :start 1 :end 5) => 2
```

```
(count 'a '(a a b b a a)  :start 1 :end 6) => 3

(count 'a #(a b b b a) ) => 2
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

count Keyword For loop

count *expr* {**into** *var*} {*data-type*}

If *expr* evaluates non-**nil**, a counter is incremented. The *data-type* defaults to **fixnum**. When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

The forms **count** and **counting** are synonymous.

Examples:

```
(defun num-entry (small-list)
  (loop for x in small-list
        count t into num
        finally (return num))) => NUM-ENTRY
(num-entry '(a  b c  d)) => 4
```

Is equivalent to

```
(defun num-entry (small-list)
  (loop for x in small-list
        counting t into num
        finally (return num))) => NUM-ENTRY
(num-entry '(a  b c  d)) => 4
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **count** and **sum** are compatible.

See the section "**loop** Clauses", page 310.

count-if *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

count-if returns a non-negative integer, which represents the number of elements in the specified subsequence of *sequence* satisfying the predicate.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(count-if #'atom '((a b) ((a) b) (nil nil)) :key #'car) => 2

(count-if #'zerop #(1 2 1) :key #'(lambda (x) (- x 1))) => 2
```

The **:from-end** argument does not affect the result returned; it is accepted purely for compatibility with other sequence functions.

For example:

```
(count-if #'oddp '(1 1 2 2) :start 2 :from-end t)  => 0

(count-if #'oddp '(1 1 2 2) :start 2 :from-end nil) => 0
```

For the sake of efficiency, you can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(count-if #'oddp '(1 2 1 2)) => 2

(count-if #'oddp '(1 1 1 2 2 2) :start 2 :end 4) => 1

(count-if #'numberp '(heron 1.0 a 2 #\Space)) => 2
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

count-if-not *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

count-if-not returns a non-negative integer, which represents the number of elements in the specified subsequence of *sequence* that do not satisfy the predicate.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(count-if-not #'atom '((a b) ((a) b) (nil nil)) :key #'car) => 1

(count-if-not #'zerop #(1 2 1) :key #'(lambda (x) (- x 1))) => 1
```

The **:from-end** argument does not affect the result returned; it is accepted purely for compatibility with other sequence functions.

For example:

```
(count-if-not #'oddp '(1 1 2 2) :start 2 :from-end t) => 2

(count-if-not #'oddp '(1 1 2 2) :start 2 :from-end nil) => 2
```

For the sake of efficiency, you can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(count-if-not #'numberp '(heron 1.0 a 2 #\Space)) => 3

(count-if-not #'oddp '(3 4 3 4)) => 2
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts*.

ctypecase *object* &body *body* *Special Form*

The name of this function stands for "continuable exhaustive case". **ctypecase** is similar to **typecase**, except that it does not allow an explicit **otherwise** or **t** clause, and if no clause is satisfied it signals a proceedable error instead of returning **nil**.

ctypecase is a conditional that chooses one of its clauses by examining the type of an object. Its form is as follows:

```
(typecase form
   (types consequent consequent ...)
   (types consequent consequent ...)
   ...
   )
```

First **ctypecase** evaluates *form*, producing an object. **ctypecase** then examines each clause in sequence. *types* in each clause is a type specifier in either symbol or list form, or a list of type specifiers. The type specifier is not evaluated. If the object is of that type, or of one of those types, then the consequents are evaluated and the result of the last one is returned (or **nil** if there are no consequents in that clause). Otherwise, **ctypecase** moves on to the next clause.

If no clause is satisfied, **ctypecase** signals an error with a message constructed from the clauses. To continue from this error, supply a new value for *object*, causing **ctypecase** to store that value and restart the type tests. Subforms of *object* can be evaluated multiple times.

For an object to be of a given type means that if **typep** is applied to the object and the type, it returns **t**. That is, a type is something meaningful as a second argument to **typep**. A chart of supported data types appears elsewhere. See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

It is permissible for more than one clause to specify a given type, particularly if one is a subtype of another; the earliest applicable clause is chosen. Thus, for **ctypecase**, the order of the clauses can affect the behavior of the construct.

Examples:

```
(defun tell-about-car (x)
  (ctypecase (car x)
    (string "string")))=> TELL-ABOUT-CAR
(tell-about-car '("word" "more"))  => "string"
(tell-about-car '(a 1)) => proceedable error is signalled
```

```
(defun tell-about-car (x)                          ; see typecase
  (ctypecase (car x)
    (fixnum  "number.")
    ((or string symbol) "string or symbol.")
    (otherwise "I don't know.")))  => TELL-ABOUT-CAR
(tell-about-car '(1 a))  => "number."
(tell-about-car '(a 1))  => "string or symbol."
(tell-about-car '("word" "more"))  => "string or symbol."
(tell-about-car '(1.0))   => "I don't know."
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

debugging-info *function* *Function*

This returns the debugging info alist of *function*. Most of the elements of this alist are an internal interface between the compiler and the Debugger.

sys:debug-instance *instance* *Function*

Enters the debugger in the lexical environment of *instance*. This is useful in debugging. You can examine and alter instance variables, and run functions that use the instance variables.

decf *access-form* &optional *amount* *Macro*

Decrements the value of a generalized variable. **(decf** *ref***)** decrements the value of *ref* by 1. **(decf** *ref amount***)** subtracts *amount* from *ref* and stores the difference back into *ref*.

decf expands into a **setf** form, so *ref* can be anything that **setf** understands as its *access-form*. This also means that you should not depend on the returned value of a **decf** form.

You must take great care with **decf** because it might evaluate parts of *ref* more than once. (**decf** does not evaluate any part of *ref* more than once.)

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts*.

declare &rest *ignore* *Special Form*

The **declare** special form can be used in two ways: at top level or within function bodies. For information on top-level **declare** forms: See the section "How the Stream Compiler Handles Top-level Forms" in *Program Development Utilities*.

declare forms that appear within function bodies provide information to the Lisp system (for example, the interpreter and the compiler) about this particular function. Expressions appearing within the function-body **declare** are declarations; they are not evaluated. **declare** forms must appear at the front of the body of certain special forms, such as **let** and **defun**. Some declarations apply to function definitions and must appear as the first forms in the body of that function; otherwise they are ignored.

Function-body **declare** forms understand the following declarations. The first group of declarations can be used only at the beginning of a function body, for example, **defun**, **defmacro**, **defmethod**, **lambda**, or **flet**.

(arglist . *arglist***)**

This declaration saves *arglist* as the argument list of the function, to be used instead of its lambda-list if `c-sh-A` or the **arglist** function need to determine the function's arguments. The **arglist** declaration is used purely for documentation purposes.

Example:

```
(defun example (&rest options)
  (declare (arglist &key x y z))
  (lexpr-funcall #'example-2 "Print" options))
```

(values . *values*)

This declaration saves *values* as the return values list of the function, to be used if c-sh-A or the **arglist** function asks what values it returns. The **values** declaration is used purely for documentation purposes.

(sys:function-parent *name type*)

Helps the editor and source-finding tools (like m-.) locate symbol definitions produced as a result of macro expansion. (The accessor, constructor, and alterant macros produced by a **zl:defstruct** are an example.)

The **sys:function-parent** declaration should be inserted in the source definition to record the name of the outer definition of which it is a part. *name* is the name of the outer definition. *type* is its type, which defaults to **defun**. See the section "Using The **sys:function-parent** Declaration" in *Symbolics Common Lisp: Language Concepts*.

(sys:downward-function)

The declaration **sys:downward-function**, in the body of an internal lambda, guarantees to the system that lexical closures of the lambda in which it appears are only used as downward funargs, and never survive the calls to the procedure that produced them. This allows the system to allocate these closures on the stack.

```
(defun special-search-table (item)
  (block search
    (send *hash-table* :map-hash
          #'(lambda (key object)
              (declare (sys:downward-function))
              (when (magic-function key object item)
                (return-from search object))))))
```

Here, the **:map-hash** message to the hash table calls the closure of the internal lambda many times, but does not store it into permanent variables or data structure, or return it "around" **special-search-table**. Therefore, it is guaranteed that the closure does not survive the call to **special-search-table**. It is thus safe to allow the system to allocate that closure on the stack.

Stack-allocated closures have the same lifetime (*extent*) as **&rest** ar-

guments and lists created by **with-stack-list** and **with-stack-list***, and require the same precautions. See the variable **lambda-list-keywords**, page 282.

(sys:downward-funarg *var1 var2 ...***)** or **(sys:downward-funarg *)**
The **sys:downward-funarg** declaration (not to be confused with **sys:downward-function**) permits a procedure to declare its intent to use one or more of its arguments in a downward manner. For instance, **zl:sort**'s second argument is a funarg, which is only used in a downward manner, and is declared this way. The second argument to **process-run-function** is a good example of a funarg that is not downward. Here is an example of a function that uses and declares its argument as a downward funarg.

```
(defun search-alist-by-predicate (alist predicate)
  (declare (sys:downward-funarg predicate))
  ;; Traditional "recursive" style, for variety.
  (if (null alist)
      nil
      (let ((element (car list))
            (rest (cdr list))
        (if (funcall predicate (car element))
            (cdr element)
            (search-alist-by-predicate rest predicate))))))
```

This function only calls the funarg passed as the value of **predicate**. It does not store it into permanent structure, return it, or throw it around **search-alist-by-predicate**'s activation.

The reason you so declare the use of an argument is to allow the system to deduce guaranteed downward use of a funarg without need for the **sys:downward-function** declaration. For instance, if **search-alist-by-predicate** were coded as above, we could write

```
(defun look-for-element-in-tolerance (alist required-value tolerance)
  (search-alist-by-predicate alist
    #'(lambda (key)
        (< (abs (- key required-value)) tolerance))))
```

to search the keys of the list for a number within a certain tolerance of a required value. The lexical closure of the internal lambda is automatically allocated by the system on the stack because the system has been told that any funarg used as the first argument to **search-alist-by-predicate** is used only in a downward manner. No declaration in the body of the lambda is required.

All appropriate parameters to system functions have been declared in this way.

There are two possible forms of the **sys:downward-funarg** declaration:

(declare (sys:downward-funarg *var1 var2* **...)**
Declares the named variables, which must be parameters (formal arguments) of the function in which this declaration appears, to have their values used only in a downward fashion. This affects the generation of closures as functional arguments to the function in which this declaration appears: it does not directly affect the function itself. Due to an implementation restriction, *var-i* cannot be a keyword argument.

(declare (sys:downward-funarg *))
Declares guaranteed downward use of all functional arguments to this function. This is to cover closures of functions passed as elements of **&rest** arguments and keyword arguments.

The following group of declarations can be used at the beginning of any body, for example, a **let** body.

(special *sym1 sym2* ...**)**
The symbols *sym1*, *sym2*, and so on, are treated as special variables within the form containing the **declare**; the Lisp system (both the compiler and the interpreter) implements the variables using the value cells of the symbols.

(zl:unspecial *sym1 sym2* ...**)**
The symbols *sym1*, *sym2*, and so on, are treated as local variables within the form containing the **declare**.

Example:

```
(defun print-integer (number base)
  (declare (unspecial base))
  (when (≥ number base)
    (print-integer (floor number base) base))
  (tyo (digit-char (mod number base) base)))
```

(sys:array-register *variable1 variable2* ...**)**
Indicates to the compiler that *variable1*, *variable2*, and so on, are holding single-dimensional arrays as their values. Henceforth, each of these variables must *always* hold a single-dimensional array. The

compiler can then use special faster array element referencing and setting instructions for the **aref** and **zl:aset** functions. Whether or not this declaration is worthwhile depends on the type of array and the number of times that referencing and setting instructions are executed. For example, if the number of referencing instructions is more than ten, this declaration makes your program run faster; for one or two references, it actually slows execution.

(sys:array-register-1d *variable1 variable2 ...***)**

Indicates to the compiler that *variable1*, *variable2*, and so on, are holding single- or multidimensional arrays as their values, and that the array is going to be referenced as a one-dimensional array. Henceforth, each of these variables must *always* hold an array. The compiler can then use special faster array element referencing and setting instructions for the **sys:%1d-aref** and **sys:%1d-aset** functions. Whether or not this declaration is worthwhile depends on the type of array and the number of times that referencing and setting instructions are executed. For example, if the number of referencing instructions is more than ten, this declaration makes your program run faster; for one or two references, it actually slows execution.

The compiler also recognizes any number of **declare** forms as the first forms in the bodies of the following special forms. This means that you can have **special** declarations that are local to any of these blocks. In addition, declarations can appear at the front of the body of a function definition, like **defun, defmacro, defsubst**, and so on.

zl:destructuring-bind	**multiple-value-bind**
let	**let***
do	**do***
zl:do-named	**zl:do*-named**
prog	**prog***
lambda	

decode-float *float* *Function*

Determines and returns the significand, the exponent, and the sign corresponding to the floating-point argument *float*.

The significand is returned as a floating-point number of the same format as *float*. It is obtained by dividing the argument by an integral power of 2, the radix of the floating-point representation, so as to bring its value between 1/2 (inclusive) and 1 (exclusive). The quotient is then returned as the significand.

The second result of **decode-float** is the integer exponent *e* to which 2 must be raised to produce the appropriate power for the division.

The third result is a floating-point number, of the same format as the argument, whose absolute value is one and whose sign matches that of the argument.

Examples:

```
(decode-float 2.0) => 0.5 and 2 and 1.0
(decode-float -2.0) => 0.5 and 2 and -1.0
(decode-float 4.0) => 0.5 and 3 and 1.0
(decode-float 8.0) => 0.5 and 4 and 1.0
(decode-float 3.0) => 0.75 and 2 and 1.0
(decode-float 0.0) => 0.0 and 0 and 1.0
(decode-float -0.0) => 0.0 and 0 and -1.0

;;;; a possible use of decode-float
;;;; (log-abs float)≡(log (abs float))

(defun log-abs (float)
  (multiple-value-bind (significand exponent)
      (decode-float float)
    (+ (log significand)        ;log ab= log a + log b
       (* exponent (log 2)))))  ;log (expt x y)= ylogx

(log-abs 2.0) => 0.6931472              ;(log 2) => 0.6931472
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

decode-raster-array *raster* *Function*

Returns the following attributes of the raster as values: width, height, and spanning width. In a row-major implementation, width and height are the second and first dimensions, respectively. The spanning width is the number of linear array elements needed to go from (x,y) to (x,y+1). For nonconformal arrays, this is the same as the width. For conformal arrays, this is the width of the underlying array that provides the storage adjusted for possibly differing numbers of bits per element.

decode-raster-array should be used rather than **array-dimensions**, **zl:array-dimension-n**, or **sys:array-row-span** for the following reasons.

- **decode-raster-array** does error checking by ensuring that the array is two-dimensional.
- A single call to **decode-raster-array** is faster than any non-null combination of the alternatives.
- **decode-raster-array** always returns the *width* and *height*, which are

not the first and second dimensions as returned by **array-dimensions** or **zl:array-dimension-n**.

math:decompose *a* &optional *lu ps ignore* *Function*

Computes the LU decomposition of matrix *a*. If *lu* is non-**nil**, stores the result into it and returns it; otherwise it creates an array to hold the result, and returns that. The lower triangle of *lu*, with ones added along the diagonal, is L, and the upper triangle of *lu* is U, such that the product of L and U is *a*. Gaussian elimination with partial pivoting is used. The *lu* array is permuted by rows according to the permutation array *ps*, which is also produced by this function. If the argument *ps* is supplied, the permutation array is stored into it; otherwise, an array is created to hold it. This function returns two values: the LU decomposition and the permutation array.

def *function* &rest *defining-forms* *Special Form*

If a function is created in some strange way, wrapping a **def** special form around the code that creates it informs the editor of the connection. The form:

```
(def function-spec
  form1 form2...)
```

simply evaluates the forms *form1*, *form2*, and so on. It is assumed that these forms create or obtain a function somehow, and make it the definition of *function-spec*.

Alternatively, you could put **(def** *function-spec***)** in front of or anywhere near the forms that define the function. The editor only uses it to tell which line to put the cursor on.

zl:defconst *variable initial-value* &optional *documentation* *Special Form*

The same as **defvar**, except that *variable* is always set to *initial-value* regardless of whether *variable* is already bound. The rationale for this is that **defvar** declares a global variable, whose value is initialized to something but is then changed by the functions that use it to maintain some state. On the other hand, **zl:defconst** declares a constant, whose value is never changed by the normal operation of the program, only by changes to the program. **zl:defconst** always sets the variable to the specified value so that if, while developing or debugging the program, you change your mind about what the constant value should be, and you then evaluate the **zl:defconst** form again, the variable gets the new value. It is not the intent of **zl:defconst** to declare that the value of *variable* never changes; for example, **zl:defconst** is not license to the compiler to build assumptions about the value of *variable* into programs being compiled. See **defconstant** for that.

See the section "Special Forms for Defining Special Variables" in *Symbolics Common Lisp: Language Concepts.*

defconstant *variable initial-value* &optional *documentation* *Special Form*

Declares the use of a named constant in a program. *initial-value* is evaluated and *variable* set to the result. The value of *variable* is then fixed. It is an error if *variable* has any special bindings at the time the **defconstant** form is executed. Once a special variable has been declared constant by **defconstant**, any further assignment to or binding of that variable is an error.

The compiler is free to build assumptions about the value of the variable into programs being compiled. If the compiler does replace references to the name of the constant by the value of the constant in code to be compiled, the compiler takes care that such "copies" appear to be **eql** to the object that is the actual value of the constant. For example, the compiler can freely make copies of numbers, but it exercises care when the value is a list.

In Symbolics Common Lisp, **defconstant** and **zl:defconst** are essentially the same if the value is other than a number, a character, or an interned symbol. However, if the variable being declared already has a value, **zl:defconst** freely changes the value, whereas **defconstant** queries before changing the value. **defconstant**'s query offers three choices: Y, N, and P.

- The Y option changes the value.
- The N option does not change the value.
- The P option changes the value and when you change any future value, it prints a warning rather than a query.

The P option sets **sys:inhibit-fdefine-warnings** to **:just-warn**. **defconstant** obeys that variable, just as **query-about-redefinition** does. Use **(setq sys:inhibit-fdefine-warnings nil)** to revert to the querying mode.

When the value of a constant is changed by a patch file, a warning is printed.

defconstant assumes that changing the value is dangerous because the old value might have been incorporated into compiled code, which is out of date if the value changed.

In general, you should use **defconstant** to declare constants whose value is a number, character, or interned symbol and is guaranteed not to change. An example is π. The compiler can optimize expressions that contain references to these constants. If the value is another type of Lisp object or if it might change, you should use **zl:defconst** instead.

documentation, if provided, should be a string. It is accessible to the **documentation** function.

See the section "Special Forms for Defining Special Variables" in *Symbolics Common Lisp: Language Concepts.*

deff *function definition* *Special Form*

deff is a simplified version of **def**. It evaluates the form *definition-creator*, which should produce a function, and makes that function the definition of *function-spec*, which is not evaluated. **deff** is used for giving a function spec a definition that is not obtainable with the specific defining forms such as **defun** and **macro**. For example:

```
(deff foo 'bar)
```

makes **foo** equivalent to **bar**, with an indirection so that if **bar** changes, **foo** likewise changes;

```
(deff foo (function bar))
```

copies the definition of **bar** into **foo** with no indirection, so that further changes to **bar** have no effect on **foo**.

defflavor *name instance-variables component-flavors* &rest *options* *Special Form*

name is a symbol that is the name of this flavor. **defflavor** defines the name of the flavor as a type name in both the Common Lisp and Zetalisp type systems: See the section "Flavor Instances and Types" in *Symbolics Common Lisp: Language Concepts.*

instance-variables is a list of the names of the instance variables containing the local state of this flavor. Each element of this list can be written in two ways: either the name of the instance variable by itself, or a list containing the name of the instance variable and a default initial value for it. Any default initial values given here are forms that are evaluated by **make-instance** if they are not overridden by explicit arguments to **make-instance**.

If you do not supply an initial value for an instance variable as an argument to **make-instance**, and there is no default initial value provided in the **defflavor** form, the value of an instance variable remains unbound. (Another way to provide a default is by using the **:default-init-plist** option to **defflavor**.)

component-flavors is a list of names of the component flavors from which this flavor is built.

Each *option* can be either a keyword symbol or a list of a keyword symbol and its arguments. The options to **defflavor** are described elsewhere:

> See the section "Summary of **defflavor** Options" in *Symbolics Common Lisp: Language Concepts.*
> See the section "Complete Options for **defflavor**" in *Symbolics Common Lisp: Language Concepts.*

Several of these options affect instance variables. These options can be given in two ways:

keyword The keyword appearing by itself indicates that the option applies to all instance variables listed at the top of this **defflavor** form.

(*keyword var1 var2 ...*)
A list containing the keyword and one or more instance variables indicates that this option refers only to the instance variables listed here.

The following form defines a flavor **wink** to represent tiddly-winks. The instance variables **x** and **y** store the location of the wink. The default initial value of both **x** and **y** is **0**. The instance variable **color** has no default initial value. The options specify that all instance variables are **:initable-instance-variables**; **x** and **y** are **:writable-instance-variables**; and **color** is a **:readable-instance-variable**.

```
(defflavor wink ((x 0) (y 0) color)     ;x and y represent location
          ()                            ;no component flavors
  :initable-instance-variables
  (:writable-instance-variables x y)    ;this implies readable
  (:readable-instance-variables color))
```

You can specify that an option should alter the behavior of instance variables inherited from a component flavor. To do so, include those instance variables explicitly in the list of instance variables at the top of the defflavor form. In the following example, the variables **x** and **y** are explicitly included in this **defflavor** form, even though they are inherited from the component flavor, **wink**. These variables are made initable in the defflavor form for **big-wink**; they are made writable in the **defflavor** form for **wink**.

```
(defflavor big-wink (x y size)
          (wink)                        ;wink is a component
  (:initable-instance-variables x y))
```

If you specify a **defflavor** option for an instance variable that is not included in this **defflavor** form, an error is signalled. Flavors assumes you misspelled the name of the instance variable.

deffunction *function-spec lambda-macro-name lambda-list body...* *Special Form*
deffunction defines a function using an arbitrary lambda macro in place of **lambda**. A **deffunction** form is like a **defun** form, except that the function spec is immediately followed by the name of the lambda macro to be used. **deffunction** expands the lambda macro immediately, so the lambda macro must already be defined before **deffunction** is used. For example, suppose the **ilisp** lambda macro were defined as follows:

```
(lambda-macro ilisp (x)
  '(lambda (&optional ,@(second x) &rest ignore) . ,(cddr x)))
```

Then the following example would define a function called **new-list** that would use the lambda macro called **ilisp**:

```
(deffunction new-list ilisp (x y z)
  (list x y z))
```

new-list's arguments are optional, and any extra arguments are ignored. Examples:

```
(new-list 1 2) => (1 2 nil)
(new-list 1 2 3 4) -> (1 2 3)
```

defgeneric *generic-function-name (arg1 arg2...) options...* *Special Form*

Defines a generic function named *generic-function-name* that accepts arguments defined by *(arg1 arg2...)*, a lambda-list. The first argument, *arg1*, is required, unless the **:function** option is used to indicate otherwise. *arg1* represents the object that is supplied as the first argument to the generic function. The flavor of *arg1* determines which method is appropriate to perform this generic function on the object. Any additional arguments (*arg2*, and so on) are passed to the methods.

The arguments to **defgeneric** are displayed when you give the Arglist (m-X) command or press c-sh-A while this generic function is current.

For example, to define a generic function **total-fuel-supply** that works on instances of **army** and **navy**, and takes one argument (*fuel-type*) in addition to the object itself, we might supply military-group as *arg1*:

```
(defgeneric total-fuel-supply (military-group fuel-type)
  "Returns today's total supply
    of the given type of fuel
    available to the given military group."
  (:method-combination :sum))
```

The generic function is called as follows:

```
(total-fuel-supply blue-army ':gas)
```

The argument **blue-army** is known to be of flavor **army**. Therefore, Flavors chooses the method that implements the **total-fuel-supply** generic function on instances of the **army** flavor. That method takes only one argument, *fuel-type*:

```
(defmethod (total-fuel-supply army) (fuel-type)
   body of method)
```

The set of *options* for **defgeneric** are described elsewhere: See the section "Options For **defgeneric**" in *Symbolics Common Lisp: Language Concepts.*

It is not necessary to use **defgeneric** to set up a generic function. For further discussion: See the section "Use Of **defgeneric**" in *Symbolics Common Lisp: Language Concepts.*

The function spec of a generic function is described elsewhere: See the section "Function Specs for Flavor Functions" in *Symbolics Common Lisp: Language Concepts.*

si:define-character-style-families *device character-set* &rest *plists* *Function*

This function is the mechanism for defining new character styles, and for defining which font should be used for displaying characters from *character-set* on the specified *device*. *plists* contain the actual mapping between character styles and fonts.

It is necessary that a character style be defined in the world before you access a file that uses the character style. You should be careful not to put any characters from a style you define into a file that is shared by other users, such as sys.translations.

It is possible for *plists* to map from a character style into another character style; this usage is called *logical character styles*. It is expected that the logical style used has its own mapping, in this **si:define-character-style-families** form or another such form, that eventually is resolved into an actual font.

plists is a nested structure whose elements are of the form:

```
(:family family
         (:size size
                (:face face target-font
                 :face face target-font
                 :face face target-font)
          :size size
                (:face face target-font
                 :face face target-font)))
```

Each *target-font* is one of:

- A symbol such as **fonts:cptfont**, which represents a font for a black and white Symbolics console.
- A string such as "**furrier7**", which represents a font for an LGP2 printer.
- A list whose **car** is **:font** and whose **cadr** is an expression representing a font, such as `(:font ("Furrier" "B" 9 1.17))`. This is also a font for an LGP2 printer.
- A list whose **car** is **:style** and whose **cdr** is a character style, such as: `(:style` *family face size*`)`. This is an example of using a logical character style (see ahead for more details).

Each *size* is either a symbol representing a size, such as **:normal**, or an asterisk * used as a wildcard to match any size. The wildcard syntax is supported for the **:size** element only. When you use a wildcard for size the *target-font* must be a character style. The size element of *target-font* can be **:same** to match whatever the size of the character style is, or **:smaller** or **:larger**.

If you define a new size, that size cannot participate in the merging of relative sizes against absolute sizes. The ordered hierarchy of sizes is predefined. See the section "Merging Character Styles" in *Symbolics Common Lisp: Language Concepts*.

The elements can be nested in a different order, if desired. For example:

```
(:size size
       (:face face
              (:family target-font)))
```

The first example simply maps the character style BOX.ROMAN.NORMAL into the font **fonts:boxfont** for the character set **si:*standard-character-set*** and the device **si:*b&w-screen***. The face ROMAN and the size NORMAL are already valid faces and sizes, but BOX is a new family; this form makes BOX one of the valid families.

```
;;; -*- Package:SYSTEM-INTERNALS; Mode:LISP; Base: 10 -*-

(define-character-style-families *b&w-screen* *standard-character-set*
 '(:family :box
 (:size :normal (:face :roman fonts:boxfont))))
```

Once you have compiled this form, you can use the Zmacs command Change Style Region (invoked by c-X c-J) and enter BOX.ROMAN.NORMAL. This form does not make any other faces or sizes valid for the BOX family.

The following example uses the wildcard syntax for the **:size**, and associates the faces **:italic**, **:bold**, and **:bold-italic** all to the same character style of BOX.ROMAN.NORMAL. This is an example of using logical character styles. This form has the effect of making several more character styles valid; however, all styles that use the BOX family are associated with the same logical character style, which uses the same font.

```
;;; -*- Package:SYSTEM-INTERNALS; Mode:LISP; Base: 10 -*-

(define-character-style-families *b&w-screen* *standard-character-set*
 '(:family :box
 (:size * (:face :italic (:style :box :roman :normal)
 :bold (:style :box :roman :normal)
```

```
:bold-italic (:style :box :roman :normal)))))
```

For lengthier examples: See the section "Examples Of **si:define-character-style-families**" in *Symbolics Common Lisp: Language Concepts*.

define-global-handler *name conditions arglist* &body *body* *Macro*

name is a symbol, and a handler function by that name is defined.

conditions is a condition name, or a list of condition names.

arglist is a list of one element, the name of the argument (a symbol) which is bound to the condition object.

A global handler is like a bound handler with an important exception: unlike a bound handler which is of dynamic extent, a global handler is of indefinite extent. Once defined, a global handler must therefore be specifically removed with **undefine-global-handler**.

Similarly, since a global handler could be called in any process by any program, it cannot use a **throw** the way a bound handler can. Instead it should return **nil** (keep searching for another handler), or return multiple values where the first one is the name of a proceed-type, as with bound handlers.

A note of caution: The global handler functions do not maintain the order of the global handler list in any way. If there are two handlers whose conditions overlap each other in such a way that some instantiable condition could be handled by either, then either handler might run, depending on the order in which they were defined. When there is more experience with use of global handlers we will try to develop a good approach to this problem.

Example:

```
(define-global-handler infinity-is-three sys:divide-by-zero
    (error)
  (values :return-values '(3)))

(/ 1 0) ==> 3
```

For a table of related items: See the section "Basic Forms for Global Handlers" in *Symbolics Common Lisp: Language Concepts*.

define-method-combination *name parameters method-patterns options... body..* *Special Form*

Provides a rich declarative syntax for defining new types of method combination. This is more flexible and powerful than **define-simple-method-combination**.

name is a symbol that is the name of the new method combination type. *parameters* resembles the parameter list of a **defmacro**; it is matched against the parameters specified in the **:method-combination** option to defgeneric or **defflavor**.

method-patterns is a list of method pattern specifications. Each method pattern selects some subset of the available methods and binds a variable to a list of the function specs for these methods. Two of the method patterns select only a single method and bind the variable to the chosen method's function spec if a method is found and otherwise to **nil**. The variables bound by method patterns are lexically available while executing the *body* forms. See the section "*Method-patterns* Option To **define-method-combination**" in *Symbolics Common Lisp: Language* Concepts.

Each *option* is a list whose **car** is a keyword. These can be inserted in front of the body forms to select special options. See the section "Options Available In **define-method-combination**" in *Symbolics Common Lisp: Language Concepts.*

The *body* forms are evaluated to produce the body of a combined method. Thus the body forms of **define-method-combination** resemble the body forms of **defmacro**. Backquote is used in the same way. The *body* forms of **define-method-combination** usually produce a form that includes invocations of **flavor:call-component-method** and/or **flavor:call-component-methods**. These functions hide the implementation-dependent details of the calling of component methods by the combined method.

Flavors performs some optimizations on the combined method body. This makes it possible to write the body forms in a simple and easy-to-understand style, without being concerned about the efficiency of the generated code. For example, if a combined method chooses a single method and calls it and does nothing else, Flavors implements the called method as the handler rather than constructing a combined method. Flavors removes redundant invocations of **progn** and **multiple-value-prog1** and performs similar optimizations.

The variables **flavor:generic** and **flavor:flavor** are lexically available to the body forms. The values of both variables are symbols:

flavor:generic value is the name of the generic operation whose handler is being computed.

flavor:flavor value is the name of the flavor.

The *body* forms are permitted to **setq** the variables defined by the *method-patterns*, if further filtering of the available methods is required, beyond the filtering provided by the built-in filters of the *method-patterns*

mechanism. It is rarely necessary to resort to this. Flavors assumes that the values of the variables defined by the method patterns (after evaluating the body forms) reflect the actual methods that will be called by the combined method body.

body forms must not signal errors. Signalling an error (such as a complaint about one of the available methods) would interfere with the use of flavor examining tools, which call the user-supplied method combination routine to study the structure of the erroneous flavor. If it is absolutely necessary to signal an error, the variable **flavor:error-p** is lexically available to the body forms; its value must be obeyed. If **nil**, errors should be ignored.

define-modify-macro *name args function* &rest *documentation-and-declarations* *Macro*

This macro defines a read-modify-write macro named *name*. An example of such a macro is **incf**. The first subform of the macro will be a generalized-variable reference. The *function* is literally the function to apply to the old contents of the generalized-variable to get the new contents; it is not evaluated. *lambda-list* describes the remaining arguments for the *function*; these arguments come from the remaining subforms of the macro after the generalized-variable reference. *lambda-list* may contain *&optional* and *&rest* markers. (The *&key* marker is not permitted here; *&rest* suffices for the purposes of **define-modify-macro**.) *doc-string* is documentation for the macro *name* being defined.

The expansion of a **define-modify-macro** is equivalent to the following, except that it generates code that follows the semantic rules outlined above.

```
(defmacro name (reference . lambda-list)
  doc-string
  `(setf ,reference
         (function ,reference ,arg1 ,arg2 ...)))
```

where arg1, arg2, ..., are the parameters appearing in *lambda-list*; appropriate provision is made for a *&rest* parameter.

As an example, **incf** could have been defined by:

```
(define-modify-macro incf (&optional (delta 1)) +)
```

define-setf-method *access-function subforms* &body *body* *Macro*

In this context, the word "method" has nothing to do with flavors.

This macro defines how to **setf** a generalized-variable reference that is of the form (*access-fn* . . .). The value of the generalized-variable reference can always be obtained by evaluating it, so *access-fn* should be the name of a function or a macro.

subforms is a lambda list that describes the subforms of the generalized-variable reference, as with **defmacro**. The result of evaluating *body* must be five values representing the **setf** method. (The five values are described in detail at the end of this discussion.) Note that **define-setf-method** differs from the complex form of **defsetf** in that while the body is being executed the variables in *subforms* are bound to parts of the generalized-variable reference, not to temporary variables that will be bound to the values of such parts. In addition, **define-setf-method** does not have the **defsetf** restriction that *access-fn* must be a function or a function-like macro. An arbitrary **defmacro** destructuring pattern is permitted in subforms.

By definition, there are no good small examples of **define-setf-method** because the easy cases can all be handled by **defsetf**. A typical use is to define the **setf** method for **ldb**.

```
;;; SETF method for the form (LDB bytespec int).
;;; Recall that the int form must itself be suitable for SETF.

(define-setf-method ldb (bytespec int)
  (multiple-value-bind (temps vals stores
                        store-form accessform)
      (get-setf-method int)             ;Get SETF method for int.
    (let ((btemp (gensym))              ;Temp var for byte specifier.
          (store (gensym))              ;Temp var for byte to store.
          (stemp (first stores)))       ;Temp var for int to store.
      ;; Return the SETF method for LDB as five values.
      (values (cons btemp temps)        ;Temporary variables.
              (cons bytespec vals)      ;Value forms.
              (list store)              ;Store variables.
              `(let ((,stemp (dpb ,store ,btemp ,access-form)))
                 ,store-form
                 ,store)                ;Storing form.
              `(ldb ,btemp ,access-form);Accessing form.
        ))))
```

Here are the five values that express a **setf** method for a given access form.

- A list of *temporary variables.*
- A list of *value forms* (subforms of the given form) to whose values the teporary variables are to be bound.
- A second list of temporary variable, called *store variables.*
- A *storing form.*
- An *accessing form.*

The temporary variables are bound to the value forms as if by **let***; that is, the value forms are evaluated in the order given and may refer to the values of earlier value forms by using the corresponding variable.

The store variables are to be bound to the values of the *newvalue* form, that is, the values to be stored into the generalized variable. In almost all cases, only a single value is stored, and there is only one store variable.

The storing form and the accessing form may contain references to the temporary variables (and also, in the case of the storing form, to the store variables). The accessing form returns the value of the generalized variable. The storing form modifies the value of the generalized variable and guarantees to return the values of the store variables as its values. These are the correct values for **setf** to return. (Again, in most cases there is a single store variable and thus a single value to be returned.) The value returned by the accessing form is, of course, affected by execution of the storing form, but either of these forms may be evaluated any number of times, and therefore should be free of side effects (other than the storing action of the storing form).

The temporary variables and the store variables are generated names, as if by **gensym** or **gentemp**, so that there is never any problem of name clashes among them, or between them and other variables in the program. This is necessary to make the special forms that do more than one **setf** in parallel work properly. These are **psetf**, **shiftf** and **rotatef**.

Here are some examples of **setf** methods for particular forms:

- For a variable `x`:

```
()
()
(g0001)
(setq x g0001)
x
```

- For (`car` *exp*):

```
(g0002)
(exp)
(g0003)
(progn (rplaca g0002 g0003) g0003)
(car g0002)
```

- For (`supseq` *seq s e*):

```
(g0004 g0005 g0006)
(seq s e)
(g0007)
(progn (replace g0004 g0007 :start1 g0005 :end1 g0006)
       g0007)
(subseq g0004 g0005 g0006)
```

define-simple-method-combination *name operator* &optional *single-arg-is-value pretty-name* *Special Form*

Defines a new type of method combination that simply calls all the methods, passing the values they return to the function named *operator*.

It is also legal for *operator* to be the name of a special form. In this case, each subform is a call to a method. It is legal to use a lambda expression as *operator*.

name is the name of the method-combination type to be defined. It takes one optional parameter, the order of methods. The order can be either **:most-specific-first** (the default) or **:most-specific-last**.

When you use a new type of method combination defined by **define-simple-method-combination**, you can give the argument **:most-specific-first** or **:most-specific-last** to override the order that this type of method combination uses by default.

If *single-arg-is-value* is specified and not **nil**, and if there is exactly one method, it is called directly and *operator* is not called. For example, *single-arg-is-value* makes sense when *operator* is +.

pretty-name is a string that describes how to print method names concisely. It defaults to (**string-downcase** *name*).

Most of the simple types of built-in method combination are defined with **define-simple-method-combination**. For example:

```
(define-simple-method-combination :and and t)
(define-simple-method-combination :or or t)
(define-simple-method-combination :list list)
(define-simple-method-combination :progn progn t)
(define-simple-method-combination :append append t)
```

define-symbol-macro *name form* *Special Form*

define-symbol-macro *name form* defines a symbol macro. *name* is a symbol to be defined as a symbol macro. *form* is a Lisp form to be substituted for the symbol when the symbol is evaluated. A symbol macro is more like an inline function than a macro: *form* is the form to be substituted for the symbol, not a form whose evaluation results in the substitute form.

Example:

```
(define-symbol-macro foo (+ 3 bar))
(setq bar 2)
foo => 5
```

A symbol defined as a symbol macro cannot be used in the context of a variable. You cannot use **setq** on it, and you cannot bind it. You can use **setf** on it: **setf** substitutes the replacement form, which should access something, and expands into the appropriate update function.

For example, suppose you want to define some new instance variables and methods for a flavor. You want to test the methods using existing instances of the flavor. For testing purposes, you might use hash tables to simulate the instance variables, using one hash table per instance variable with the instance as the key. You could then implement an instance variable **x** as a symbol macro:

```
(defvar x-hash-table (make-hash-table))
(define-symbol-macro x (send x-hash-table :get-hash self))
```

To simulate setting a new value for **x**, you could use **(setf x** *value*), which would expand into **(send x-hash-table :put-hash self** *value*).

deflambda-macro *name pattern* &body *body* *Special Form*

Like **defmacro**, but defines a lambda macro instead of a normal macro.

zl:deflambda-macro-displace *name pattern* &body *body* *Special Form*

Like **zl:defmacro-displace**, but defines a displacing lambda macro instead of a displacing normal macro.

deflocf *access-function locate-function-or-subforms* &body *body* *Function*

defmacro *name pattern* &body *body* *Macro*

defmacro is a general-purpose macro-defining macro. A **defmacro** form looks like:

```
(defmacro name pattern . body)
```

The *pattern* can be anything made up out of symbols and conses. It is matched against the body of the macro form; both *pattern* and the form are **car**'ed and **cdr**'ed identically, and whenever a non-**nil** symbol occurs in pattern, the symbol is bound to the corresponding part of the form. If the corresponding part of the form is **nil**, it goes off the end of the form. **&optional**, **&rest**, **&key**, and **&body** can be used to indicate where optional pattern elements are allowed.

All of the symbols in *pattern* can be used as variables within *body*. *name* is the name of the macro to be defined; it can be any function spec. See the section "Function Specs" in *Symbolics Common Lisp: Language Concepts*.

body is evaluated with these bindings in effect, and its result is returned to the evaluator as the expansion of the macro.

defmacro could have been defined in terms of **destructuring-bind** as follows, except that the following is a simplified example of **defmacro** showing no error-checking and omitting the **&environment** and **&whole** features.

&whole is followed by *variable*, which is bound to the entire macro-call form or subform. *variable* is the value that the macro-expander function receives as its first argument. **&whole** is allowed only in the top-level pattern, not in inside patters.

&environment is followed by *variable*, which is bound to an object representing the lexical environment where the macro call is to be interpered. This environment might not be the complete lexical environment.

```
(defmacro defmacro (name pattern &body body)
  `(macro ,name (form env)
     (destructuring-bind ,pattern (cdr form)
       . ,body)))
```

See the section "&-Keywords Accepted By **defmacro**" in *Symbolics Common Lisp: Language Concepts.*

See the special form **destructuring-bind**, page 177.

zl:defmacro-displace *name pattern* &body *body* *Macro*

zl:defmacro-displace is just like **defmacro** except that it defines a displacing macro, using the **zl:displace** function.

defmacro-in-flavor *(function-name flavor-name) arglist body...)* *Special Form*

Defines a macro inside a flavor. Functions inside the flavor can use this macro, but the macro is not accessible in the global environment.

See the section "Defining Functions Internal to Flavors" in *Symbolics Common Lisp: Language Concepts.*

defmethod *Special Form*

A method is the code that performs a generic function on an instance of a particular flavor. It is defined by a form such as:

(defmethod *(generic-function flavor options...) (arg1 arg2...) body...*)

The method defined by such a form performs the generic function named by *generic-function*, when that generic function is applied to an instance of the given *flavor*. (The name of the generic function should not be a keyword, unless you want to define a message to be used with the old **send**

syntax.) You can include a documentation string and **declare** forms after the argument list and before the body.

A generic function is called as follows:

(*generic-function g-f-arg1 g-f-arg2...*)

Usually the flavor of *g-f-arg1* determines which method is called to perform the function. When the appropriate method is called, **self** is bound to the object itself (which was the first argument to the generic function). The arguments of the method are bound to any additional arguments given to the generic function. A method's argument list has the same syntax as in **defun**.

The *body* of a **defmethod** form behaves like the body of a **defun**, except that the lexical environment enables you to access instance variables by their names, and the instance by **self**.

For example, we can define a method for the generic function **list-position** that works on the flavor **wink**. **list-position** prints the representation of the object and returns a list of its x and y position.

```
(defmethod (list-position wink) () ; no args other than object
  "Returns a list of x and y position."
  (print self)                     ; self is bound to the instance
  (list x y))                      ; instance vars are accessible
```

The generic function **list-position** is now defined, with a method that implements it on instances of **wink**. We can use it as follows:

```
(list-position my-wink)
-->#<WINK 61311676>
   (4 0)
```

If no *options* are supplied, you are defining a primary method. Any *options* given are interpreted by the type of method combination declared with the **:method-combination** argument to either **defgeneric** or **defflavor**. See the section "Defining Special-Purpose Methods" in *Symbolics Common Lisp: Language Concepts*. For example, **:before** or **:after** can be supplied to indicate that this is a before-daemon or an after-daemon. For more information: See the section "Writing Before and After-Daemons" in *Symbolics Common Lisp: Language Concepts*.

If the generic function has not already been defined by **defgeneric**, defmethod sets up a generic function with no special options. If you call defgeneric for the name *generic-function* later, the generic function is updated to include any new options specified in the **defgeneric** form.

Several other sections of the documentation contain information related to **defmethod**:

See the section "**defmethod** Declarations" in *Symbolics Common Lisp: Language Concepts*. See the section "Writing Methods for **make-instance**" in *Symbolics Common Lisp: Language Concepts*. See the section "Function Specs for Flavor Functions" in *Symbolics Common Lisp: Language Concepts*. See the section "Setter and Locator Function Specs" in *Symbolics Common Lisp: Language Concepts*. See the function **block**, page 52. See the section "Variant Syntax of **defmethod**" in *Symbolics Common Lisp: Language Concepts*. See the section "Defining Methods to be Called by Message-Passing" in *Symbolics Common Lisp: Language Concepts*.

defpackage *name options...* *Special Form*

Define a package named *name*; the name must be a symbol so that the source file name of the package can be recorded and the editor can correctly sectionize the definition. If no package by that name already exists, a new package is created according to the specified options. If a package by that name already exists, its characteristics are altered according to the options specified. If any characteristic cannot be altered, an error is signalled. If the existing package was defined by a different file, you are queried before it is changed, as with any other type of definition.

Each *option* is a keyword or a list of a keyword and arguments. A keyword by itself is equivalent to a list of that keyword and one argument, **t**; this syntax really only makes sense for the **:external-only** and **:hash-inherited-symbols** keywords.

Wherever an argument is said to be a name or a package, it can be either a symbol or a string. Usually symbols are preferred, because the reader standardizes their alphabetic case and because readability is increased by not cluttering up the **defpackage** form with string quote (") characters.

None of the arguments are evaluated. The keywords arguments, most of which are identical to **make-package**'s, are:

(:nicknames *name name...***)**
: The package is given these nicknames, in addition to its primary name.

(:prefix-name *name***)**
: This name is used when printing a qualified name for a symbol in this package. The specified name should be one of the nicknames of the package or its primary name. If **:prefix-name** is not specified, it defaults to the shortest of the package's names (the primary name plus the nicknames).

(:use *package package...***)**
: External symbols and relative name mappings of the specified packages are inherited. If this option is not specified, it defaults to **(:use global)**. To inherit nothing, specify **(:use)**.

(:shadow *name name...***)**
: Symbols with the specified names are created in this package and declared to be shadowing.

(:export *name name...***)**
Symbols with the specified names are created in this package, or inherited from the packages it uses, and declared to be external.

(:import *symbol symbol...***)**
The specified symbols are imported into the package. Note that unlike **:export**, **:import** requires symbols, not names; it matters in which package this argument is read.

(:shadowing-import *symbol symbol...***)**
The same as **:import** but no name conflicts are possible; the symbols are declared to be shadowing.

(:import-from *package name name...***)**
The specified symbols are imported into the package. The symbols to be imported are obtained by looking up each *name* in *package*. (**defpackage** only) This option exists primarily for system bootstrapping, since the same thing can normally be done by **:import**. The difference between **:import** and **:import-from** can be visible if the file containing a **defpackage** is compiled; when **:import** is used the symbols are looked up at compile time, but when **:import-from** is used the symbols are looked up at load time. If the package structure has been changed between the time the file was compiled and the time it is loaded, there might be a difference.

(:relative-names (*name package*) (*name package*)**...)**
Declare relative names by which this package can refer to other packages. The package being created cannot be one of the *packages*, since it has not been created yet. For example, to be able to refer to symbols in the **common-lisp** package print with the prefix **lisp:** instead of **cl:** when they need a package prefix (for instance, when they are shadowed), you would use **:relative-names** like this:

```
(defpackage my-package (:use cl)
                       (:shadow error)
                       (:relative-names (lisp common-lisp)))

(let ((*package* (find-package 'my-package)))
  (print (list 'my-package::error 'cl:error)))
```

(:relative-names-for-me (*package name*) (*package name*)**...)**
Declare relative names by which other packages can refer to this package.
(**defpackage** only) It is valid to use the name of the package being created as a *package* here; this is useful when a package has a relative name for itself.

(:size *number*)
The number of symbols expected to be present in the package. This

controls the initial size of the package's hash table. The **:size** specification can be an underestimate; the hash table is expanded as necessary.

(:hash-inherited-symbols *boolean***)**
If true, inherited symbols are entered into the package's hash table to speed up symbol lookup. If false (the default), looking up a symbol in this package searches the hash table of each package it uses.

(:external-only *boolean***)**
If true, all symbols in this package are external and the package is locked. This feature is only used to simulate the old package system that was used before Release 5.0. See the section "External-only Packages and Locking" in *Symbolics Common Lisp: Language Concepts.*

(:include *package package...***)**
Any package that uses this package also uses the specified packages. Note that if the **:include** list is changed, the change is not propagated to users of this package. This feature is used only to simulate the old package system that was used before Release 5.0.

(:new-symbol-function *function***)**
function is called when a new symbol is to be made present in the package. The default is **si:pkg-new-symbol** unless **:external-only** is specified. Do not specify this option unless you understand the internal details of the package system.

(:colon-mode *mode***)**
If *mode* is **:external**, qualified names mentioning this package behave differently depending on whether ":" or "::" is used, as in Common Lisp. ":" names access only external symbols. If *mode* is **:internal**, ":" names access all symbols. **:internal** is the default currently. See the section "Specifying Internal and External Symbols in Packages" in *Symbolics Common Lisp: Language Concepts.*

(:prefix-intern-function *function***)**
The function to call to convert a qualified name referencing this package with ":" (rather than "::") to a symbol. The default is intern unless **(:colon-mode :external)** is specified. Do not specify this option unless you understand the internal details of the package system.

defparameter *variable initial-value* &optional *documentation* *Special Form*
The same as **defvar**, except that *variable* is always set to *initial-value* regardless of whether *variable* is already bound. The rationale for this is that **defvar** declares a global variable, whose value is initialized to something but is then changed by the functions that use it to maintain some state. On the other hand, **defparameter** declares a constant, whose value

is never changed by the normal operation of the program, only by changes to the program. **defparameter** always sets the variable to the specified value so that if, while developing or debugging the program, you change your mind about what the constant value should be, and you then evaluate the **defparameter** form again, the variable gets the new value. It is not the intent of **defparameter** to declare that the value of *variable* never changes; for example, **defparameter** is not a license to the compiler to build assumptions about the value of *variable* into programs being compiled. See **defconstant** for that.

See the section "Special Forms for Defining Special Variables" in *Symbolics Common Lisp: Language Concepts.*

defprop *symbol x indicator* *Special Form*

This gives *symbol*'s property list an *indicator*-property of *x*. After this is done, **(zl:get** *plist indicator*) returns *x*. If *plist* is a symbol, the symbol's associated property list is used. **zl:putprop** returns its second argument. See the section "Property Lists" in *Symbolics Common Lisp: Language* Concepts.

defprop is a form of **zl:putprop** with "unevaluated arguments," which is sometimes more convenient for typing. Normally it does not make sense to use a property list rather than a symbol as the first (or *plist*) argument. Example:

```
(defprop foo bar next-to)
```

is the same as:

```
(zl:putprop 'foo 'bar 'next-to)
```

defprop is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts.*

defselect *fspec* &body *methods* *Special Form*

defselect defines a function that is a select-method. This function contains a table of subfunctions; when it is called, the first argument, a symbol on the keyword package called the *message name*, is looked up in the table to determine which subfunction to call. Each subfunction can take a different number of arguments, and have a different pattern of **&optional** and **&rest** arguments. **defselect** is useful for a variety of "dispatching" jobs. By analogy with the more general message passing facilities in flavors, the subfunctions are sometimes called *methods* and the first argument is sometimes called a *message.*

The special form looks like:

```
(defselect (function-spec default-handler no-which-operations)
  (message-name (args...)
   body...)
  (message-name (args...)
   body...)
  ...)
```

function-spec is the name of the function to be defined. *default-handler* is optional; it must be a symbol and is a function that gets called if the select-method is called with an unknown message. If *default-handler* is unsupplied or **nil**, then an error occurs if an unknown message is sent. If *no-which-operations* is non-**nil**, the **:which-operations** method that would normally be supplied automatically is suppressed. The **:which-operations** method takes no arguments and returns a list of all the message names in the **defselect**.

The **:operation-handled-p** and **:send-if-handles** methods are automatically supplied. See the message **:operation-handled-p**, page 388. See the message **:send-if-handles**, page 473.

If *function-spec* is a symbol, and *default-handler* and *no-which-operations* are not supplied, then the first subform of the **defselect** can be just *function-spec* by itself, not enclosed in a list.

The remaining subforms in a **defselect** define methods. *message-name* is the message name, or a list of several message names if several messages are to be handled by the same subfunction. *args* is a lambda-list; it should not include the first argument, which is the message name. *body* is the body of the function.

A method subform can instead look like:

(*message-name* . *symbol*)

In this case, *symbol* is the name of a function that is called when the *message-name* message is received. It is called with the same arguments as the select-method, including the message symbol itself.

defsetf *access-function storing-function-or-args* &optional *store-variables* &body *body* *Macro*

This macro defines how to **setf** a generalized-variable reference of the form *(access-fn . . .)*. The value of a generalized-variable reference can always be obtained by evaluating it, so **user::access-fn** should be the name of a function or macro that evaluates its arguments, behaving like a function.

The user of **defsetf** provides a description of how to store into the generalized-variable reference and return the value that was stored (because **setf** is defined to return this value). Subforms of the reference are evaluated exactly once and in the proper left-to-right order. A **setf** of a

call on *access-fn* will also evaluate all of *access-fn*'s arguments; it cannot treat any of the specially. This means that *defsetf* cannot be used to describe how to store into a generalized variable that is a byte, such as `(ldb field reference)`. To handle situations that do not fit the restrictions of **defsetf**, use **user::define-set-method**, which gives the user additional control at the cost of additional complexity.

A **defsetf** function can take two forms, simple and complex. In the simple case, *storing-function-or-args* is the name of a function or macro. In the complex case, *storing-function-or-args* is a lambda list of arguments.

The simple form of **defsetf** is

```
(defsetf access-fn storing-function-or-args)
```

storing-function-or-args names a function or macro that takes one more argument than *access-fn* takes. When **setf** is given a *place* that is a acall on *access-fn*, it expands into a call on *storing-function-or-args* that is given all the arguments to *access-fn* and also, as its last argument, the new value (which must be returned by *storing-function-or-args* as its value).

For example, the effect of

```
(defsetf symbol-value set)
```

is built into the Common Lisp system. This causes the form `(setf (symbol-value foo) fu)` to expand into `(set foo fu)`. Note that

```
(defsetf car rplaca)
```

would be incorrect because **rplaca** does not return its last argument.

The complex form of **defsetf** looks like

```
(defsetf access-fn storing-function-or-args
(store-variables) . body)
```

and resembles **defmacro**. The *body* must compute the expansion of a **setf** of a call on *access-fn*. *storing-function-or-args* is a lambda list that describes the arguments of *access-fn* and may include **&optional**, **&rest**, and **&key** markers. Optional arguments can have defaults and "supplied-p" flags. *store-variables* describes the value to be stored into the generalized-variable reference.

The *body* forms can be written as if the variables in *storing-function-or-args* were bound to subforms of the call on *access-fn* and the *store-variables* were bound to the second subform of **setf**. However, this is not actually the case. During the evaluation of the *body* forms, these variables are bound to names of temporary variables, generated as if by **gensym** or **gentemp**, that will be bound by the expansion of **setf** to the values of those subforms. This binding permits the *body* forms to be writeen without regard for order of evaluation. *defsetf* arranges for the temporary variables to be optimized out of the final results in cases where that is possible. In other words, an attempt is made by **defsetf** to generate the best code possible.

Note that the code generated by the *body* forms must include provision for returning the correct value (the value of *store-variables*). This is handled by the *body* forms rather than by **defsetf** because in many cases this value can be returned at no extra cost, by calling a function that simultaneously stores into the generalized variable and returns the correct value.

Here is an example of the complex form of **defsetf**.

```
(defsetf subseq (sequence start &optional end) (new-sequence)
        '(progn (replace ,sequence ,new-sequence
                         :start1 ,start :end1 ,end)
                ,new-sequence))
```

For even more complex operations on **setf**: See the macro **define-setf-method**, page 141.

defstruct *options* &body *items* *Macro*

defstruct defines a record-structure data type. A call to **defstruct** looks like:

```
(defstruct (name option-1 option-2 ...)
           slot-description-1
           slot-description-2
           ...)
```

name must be a symbol; it is the name of the structure. It is given a **si:defstruct-description** property that describes the attributes and elements of the structure; this is intended to be used by programs that examine other Lisp programs and that want to display the contents of structures in a helpful way. *name* is used for other things; for more information: See the section "Named Structures" in *Symbolics Common Lisp: Language* Concepts.

Because evaluation of a **defstruct** form causes many functions and macros to be defined, you must take care not to define the same name with two

different **defstruct** forms. A name can only have one function definition at a time. If a name is redefined, the later definition is the one that takes effect, destroying the earlier definition. (This is the same as the requirement that each **defun** that is intended to define a distinct function must have a distinct name.)

Each *option* can be either a symbol, which should be one of the recognized option names, or a list containing an option name followed by the arguments to the option. Some options have arguments that default; others require that arguments be given explicitly. For more information about options: See the section "Options For **defstruct** And **zl:defstruct**" in *Symbolics Common Lisp: Language Concepts.*

Each *slot-description* can be in any of three forms:

1: *slot-name*
2: *(slot-name default-init)*
3: *((slot-name-1 byte-spec-1 default-init-1)*
(slot-name-2 byte-spec-2 default-init-2)
...)

Each *slot-description* allocates one element of the physical structure, even though in form 3 several slots are defined.

Each *slot-name* must always be a symbol; an accessor function is defined for each slot.

In form 1, *slot-name* simply defines a slot with the given name. An accessor function is defined with the name *slot-name.* The **:conc-name** option allows you to specify a prefix and have it concatenated onto the front of all the slot names to make the names of the accessor functions. Form 2 is similar, but allows a default initialization for the slot. Form 3 lets you pack several slots into a single element of the physical underlying structure, using the byte field feature of **defstruct.**

zl:defstruct *Macro*

zl:defstruct defines a record-structure data type. With Genera 7.0, the **defstruct** macro is available and preferred over **zl:defstruct. defstruct** accepts all standard Common Lisp options, and accepts several additional options. **zl:defstruct** is supported for compatibility with previous releases. See the section "Differences Between **defstruct** And **zl:defstruct**" in *Symbolics Common Lisp: Language Concepts.*

The basic syntax of **zl:defstruct** is the same as **defstruct**: See the macro **defstruct**, page 154.

For information on the options that can be given to **zl:defstruct** as well as **defstruct**: See the section "Options For **defstruct** And **zl:defstruct**" in *Symbolics Common Lisp: Language Concepts.*

The **:export** opton is accepted by **zl:defstruct** but not by **defstruct**. Stylistically, it is preferable to export any external interfaces in the package declarations instead of scattering **:export** options throughout a program's source files.

:export The **:export** option exports the specified symbols from the package in which the structure is defined. This option accepts the following as arguments: the names of slots and the following options: **:alterant**, **:constructor**, **:copier**, **:predicate**, **:size-macro**, and **:size-symbol**. The following example shows the use of **:export**.

```
(zl:defstruct (2d-moving-object
                (:type :array)
                :conc-name
                ;; export all accessors and the
                ;; make-2d-moving-object constructor
                (:export :accessors :constructor))
  mass
  x-pos
  y-pos
  x-velocity
  y-velocity)
```

See the section "Importing and Exporting Symbols" in *Symbolics Common Lisp: Language Concepts*.

defstruct-define-type *type* &body *options* *Macro*

Teaches **defstruct** and **zl:defstruct** about new types that it can use to implement structures.

The body of this function is shown in the following example:

```
(defstruct-define-type type
        option-1
        option-2
        ...)
```

where each *option* is either the symbolic name of an option or a list of the form (*option-name . rest*). See the section "Options To **defstruct-define-type**" in *Symbolics Common Lisp: Language Concepts*.

Different options interpret *rest* in different ways. The symbol *type* is given an **si:defstruct-type-description** property of a structure that describes the type completely.

defsubst *function lambda-list* &body *body* *Special Form*

defsubst is an easier way to define inline functions. It is used just like **defun** and does almost the same thing.

```
(defsubst name lambda-list . body)
```

defsubst defines a function that executes identically to the one that a similar call to **defun** would define. The difference comes when a function that *calls* this one is compiled. Then, the call is open-coded by substituting the inline function's definition into the code being compiled. Such a function is called an **inline** function. For example, if we define:

```
(defsubst square (x) (* x x))

(defun foo (a b) (square (+ a b)))
```

then if **foo** is used interpreted, **square** works just as if it had been defined by **defun**. If **foo** is compiled, however, the squaring is substituted into it and it compiles just like:

```
(defun foo (a b) (* (+ a b) (+ a b)))
```

square could have been defined as:

```
(proclaim ((inline square (x) (* x x))

(defun foo ...)
```

See the declaration **inline**, page 272.

A similar **square** could be defined as a macro, with:

```
(defmacro square (x) `(* ,x ,x))
```

When the compiler open-codes an **inline** function, it binds the argument variables to the argument values with **let**, so they get evaluated only once and in the right order. Then, when possible, the compiler optimizes out the variables. In general, anything that is implemented as an **inline** function can be reimplemented as a macro, just by changing the **defsubst** to a **defmacro** and putting in the appropriate backquote and commas, except that this does not get the simultaneous guarantee of argument evaluation order and generation of optimal code with no unnecessary temporary variables. The disadvantage of macros is that they are not functions, and so cannot be applied to arguments. Their advantage is that they can do much more powerful things than **inline** functions can. This is also a disadvantage since macros provide more ways to get into trouble. If something can be implemented either as a macro or as an **inline** function, it is generally better to make it an **inline** function.

As with **defun**, *name* can be any function spec, but you get the "**subst**" effect only when *name* is a symbol.

The difference between an **inline** function and one not declared inline is the way the calls to them are handled by the compiler. A call to a normal function is compiled as a *closed subroutine*; the compiler generates code to compute the values of the arguments and then apply the function to those values. A call to an **inline** function is compiled as an *open subroutine*; the compiler incorporates the body forms of the **inline** function into the function being compiled, substituting the argument forms for references to the variables in the function's *lambda-list*.

defsubst-in-flavor *(function-name flavor-name) arglist body...)* *Special Form*
Defines a function inside a flavor to be inline-coded in its callers. There is no analogous form for methods, since the caller cannot know at compile-time which method is going to be selected by the generic function mechanism.

See the section "Defining Functions Internal to Flavors" in *Symbolics Common Lisp: Language Concepts.*

defun *Special Form*
defun is the usual way of defining a function that is part of a program. A **defun** form looks like:

```
(defun name lambda-list
  body...)
```

name is the function spec you wish to define as a function. The *lambda-list* is a list of the names to give to the arguments of the function. Actually, it is a little more general than that; it can contain *lambda-list keywords* such as **&optional** and **&rest**. (Keywords are explained in other sections. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts.* See the section "Lambda-List Keywords" in *Symbolics Common Lisp: Language Concepts.*) Additional syntactic features of **defun** are explained in another section. See the section "Function-Defining Special Forms" in *Symbolics Common Lisp: Language Concepts.*

defun creates a list which looks like:

```
(si:digested-lambda...)
```

and puts it in the function cell of *name*. *name* is now defined as a function and can be called by other forms.

Examples:

```
(defun addone (x)
  (1+ x))

(defun add-a-number (x &optional (inc 1))
  (+ x inc))
```

```
(defun average (&rest numbers &aux (total 0))
  (loop for n in numbers
        do (setq total (+ total n)))
  (// total (length numbers)))
```

addone is a function that expects a number as an argument, and returns a number one larger. **add-a-number** takes one required argument and one optional argument. **average** takes any number of additional arguments that are given to the function as a list named **numbers**.

A declaration (a list starting with **declare**) can appear as the first element of the body. It is equivalent to a **zl:local-declare** surrounding the entire **defun** form. For example:

```
(defun foo (x)
  (declare (special x))
  (bar))              ;bar uses x free.
```

is equivalent to and preferable to:

```
(local-declare ((special x))
  (defun foo (x)
    (bar)))
```

(It is preferable because the editor expects the open parenthesis of a top-level function definition to be the first character on a line, which isn't possible in the second form without incorrect indentation.)

A documentation string can also appear as the first element of the body (following the declaration, if there is one). (It shouldn't be the only thing in the body; otherwise it is the value returned by the function and so is not interpreted as documentation. A string as an element of a body other than the last element is only evaluated for side effect, and since evaluation of strings has no side effects, they are not useful in this position to do any computation, so they are interpreted as documentation.) This documentation string becomes part of the function's debugging info and can be obtained with the function **documentation**. The first line of the string should be a complete sentence that makes sense read by itself, since there are two editor commands to get at the documentation, one of which is "brief" and prints only the first line.

Examples:

```
(defun my-append (&rest lists)
  "Like append but copies all the lists.
This is like the Lisp function append, except that
append copies all lists except the last, whereas
this function copies all of its arguments
including the last one."
  ...)
```

defun-in-flavor *(function-name flavor-name) arglist body...)* *Special Form*

Defines an internal function of a flavor. The syntax of **defun-in-flavor** is similar to the syntax of **defmethod**; the difference is the way the function is called and the scoping of *function-name.*

See the section "Defining Functions Internal to Flavors" in *Symbolics Common Lisp: Language Concepts.*

zl:defunp *Macro*

Usually when a function uses **prog**, the **prog** form is the entire body of the function; the definition of such a function looks like **(defun** *name arglist* **(prog** *varlist* ...)). Although the use of **prog** is generally discouraged, **prog** fans might want to use this special form. For convenience, the **zl:defunp** macro can be used to produce such definitions. A **zl:defunp** form such as:

```
(defunp fctn (args)
  form1
  form2
  ...
  formn)
```

expands into:

```
(defun fctn (args)
  (prog ()
     form1
     form2
     ...
        (return formn)))
```

You can think of **zl:defunp** as being like **defun** except that you can **return** out of the middle of the function's body.

defvar *name* &optional *initial-value documentation* *Special Form*

Declares *variable* special and records its location for the sake of the editor so that you can ask to see where the variable is defined. This is the recommended way to declare the use of a global variable in a program. If a second subform is supplied,

(defvar *variable initial-value*)

variable is initialized to the result of evaluating the form *initial-value* unless it already has a value, in which case it keeps that value. *initial-value* is not evaluated unless it is used; this is useful if it does something expensive like creating a large data structure. See the special form **sys:defvar-resettable**, page 161. See the special form **sys:defvar-standard**, page 161.

defvar should be used only at top level, never in function definitions, and only for global variables (those used by more than one function). **(defvar foo 'bar)** is roughly equivalent to:

```
(declare (special foo))
(if (not (boundp 'foo))
    (setq foo 'bar))
```

(defvar *variable initial-value documentation*)

allows you to include a documentation string that describes what the variable is for or how it is to be used. Using such a documentation string is even better than commenting the use of the variable, because the documentation string is accessible to system programs that can show the documentation to you while you are using the machine.

If **defvar** is used in a patch file or is a single form (not a region) evaluated with the editor's compile/evaluate from buffer commands, if there is an initial-value the variable is always set to it regardless of whether it is already bound. See the section "Patch Facility" in *Program Development Utilities*. See the section "Special Forms for Defining Special Variables" in *Symbolics Common Lisp: Language Concepts*.

sys:defvar-resettable *name initial-value* &optional (*warm-boot-value* **nil** *wbv-p*) *documentation* *Special Form*

sys:defvar-resettable is like **defvar**, except that it also maintains a *warm-boot value*. During a warm-boot, the system sets the variable to its warm-boot value. If you want a variable to be reset at warm boot time, define it with **sys:defvar-resettable**.

sys:defvar-standard *name initial-value* &optional (*warm-boot-value* **nil** *wbv-p*) (*standard-value* **nil** *sv-p*) *validation-predicate documentation* *Special Form*

sys:defvar-standard is like **sys:defvar-resettable**, except that it also defines a *standard value* that the variable should be bound to in command and breakpoint loops. For example, the standard values of **zl:base** and **zl:ibase** are 10. The *validation-predicate* is used to ensure that the value of the variable is valid when it is bound in command loops.

For example, **zl:base** is defined like this:

```
(defvar-standard zl:base 10. 10. 10. validate-base)
(defun validate-base (b)
   (and (fixnump b) (< 1 b 37.)))
```

See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts*.

defwhopper *Special Form*

The following form defines a whopper for a given *generic-function* when applied to the specified *flavor*:

```
(defwhopper (generic-function flavor) (arg1 arg2..)
        body)
```

The arguments should be the same as the arguments for any method performing the generic function.

When a generic function is called on an object of some flavor, and a whopper is defined for that function, the arguments are passed to the whopper, and the code of the whopper is executed.

Most whoppers run the methods for the generic function. To make this happen, the body of the whopper calls one of the following two functions: **continue-whopper** or **lexpr-continue-whopper**. At that point, the before daemons, primary methods, and after daemons are executed. Both **continue-whopper** and **lexpr-continue-whopper** return the values returned by the combined method, so the rest of the body of the whopper can use those values.

If the whopper does not use **continue-whopper** or **lexpr-continue-whopper**, the methods themselves are never executed, and the result of the whopper is returned as the result of calling the generic function.

Whoppers return their own values. If a generic function is called for value rather than effect, the whopper itself takes responsibility for getting the value back to the caller.

For more information on whoppers, including examples: See the section "Wrappers and Whoppers" in *Symbolics Common Lisp: Language Concepts*.

defwhopper-subst (*flavor generic-function*) *lambda-list* &body *body* *Macro*

Defines a wrapper for the *generic-function* when applied to the given *flavor* by combining the use of **defwhopper** with the efficiency of **defwrapper**.

The following example shows the use of **defwhopper-subst**.

```
(defwhopper-subst (xns add-checksum-to-packet)
                  (checksum &optional (bias 0))
  (when (= checksum #o177777)
   (setq checksum 0))
  (continue-whopper checksum bias))
```

The body is expanded in-line in the combined method, providing improved time efficiency but decreased space efficiency, unless the body is small.

See the section "Wrappers and Whoppers" in *Symbolics Common Lisp: Language Concepts.*

defwrapper *Macro*

Offers an alternative to the daemon system of method combination, for cases in which **:before** and **:after** daemons are not powerful enough.

defwrapper defines a macro that expands into code that is *wrapped around* the invocation of the methods. **defwrapper** is used in forms such as:

(defwrapper (*generic-function flavor*) ((*arg1 arg2*) *form*)
  body...)

The wrapper created by this form is wrapped around the method that performs *generic-function* for the given *flavor*. *body* is the code of the wrapper; it is analogous to the body of a **defmacro**. During the evaluation of *body*, the variable *form* is bound to a form that invokes the enclosed method. The result returned by *body* should be a replacement form that contains *form* as a subform. During the evaluation of this replacement form, the variables *arg1*, *arg2*, and so on are bound to the arguments given to the generic function when it is called. As with methods, **self** is implied as the first argument.

The symbol **ignore** can be used in place of the list **(arg1 arg2)** if the arguments to the generic function do not matter. This usage is common.

For more information on wrappers, including examples: See the section "Wrappers and Whoppers" in *Symbolics Common Lisp: Language Concepts.*

zl:del *predicate item list* &optional *n* *Function*

(**zl:del** *item list*) returns the *list* with all occurrences of *item* removed. *predicate* is used for the comparison. The argument *list* is actually modified (**rplacd**ed) when instances of *item* are spliced out. **zl:del** should be used for value, not for effect.

(**zl:del** *'eq a b*) is the same as (**zl:delq** *a b*). See the function **zl:mem**, page 345.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

delete *item sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*
from-end (*start* **0**) *end count*

delete returns a sequence of those items in the subsequence of *sequence* delimited by **:start** and **:end** which satisfy the predicate specified by the **:test** keyword argument. This is a destructive operation.* The argument *sequence* may be destroyed and used to construct the result; however, the returned form may or may not be **eq** to *sequence*. The elements that are not deleted occur in the same order in the result that they did in the argument.

For example:

```
(setq nums '(1 2 3)) => (1 2 3)
(delete 1 nums) => (2 3)
nums => (1 2 3)
```

However,

```
nums => (1 2 3)
(delete 2 nums) => (1 3)
nums => (1 3)
```

item is matched against the elements specified by the *test* keyword. The *item* can be any Symbolics Common Lisp object.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

Del Dy

For example:

```
(delete 4 '(6 1 6 4) :test #'>) => (6 6 4)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

Example:

```
(delete 0 '((0 1) (0 1) (1 0)) :key #'second) => ((0 1) (0 1))

(delete 0 #(1 2 1) :key #'(lambda (x) (- x 1))) => #(2)
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result

* Bizarrerie : on delete toujours l'element du CAR de la liste !!

when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are deleted.

For example:

```
(delete 4 '(4 2 4 1) :count 1 )  => (2 4 1)

(delete 4 #(4 2 4 1) :count 1 :from-end t) => #(4 2 1)
```

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(delete 'a #(a b c a)) => #(B C)

(delete 4 '(4 4 1)) => (1)

(delete 4 '(4 1 4) :start 1 :end 2) => (4 1 4)

(delete 4 '(4 1 4) :start 0 :end 3) => (1)
```

The **:count** argument, if supplied, limits the number of elements deleted. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(delete 4 '(4 2 4 1) :count 1 )  => (2 4 1)
```

delete is the destructive version of **remove**.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

zl:delete *item list* &optional *n* *Function*

(zl:delete *item list*) returns the *list* with all occurrences of *item* removed. **zl:equal** is used for the comparison. The argument *list* is actually modified (**rplacd**'ed) when instances of *item* are spliced out. **zl:delete** should be used for value, not for effect. That is, use:

```
(setq a (delete 'b a))
```

rather than:

```
(delete 'b a)
```

i[n] instances of *item* are deleted. *n* is allowed to be zero. If *n* is greater than or equal to the number of occurrences of *item* in the list, all occurrences of *item* in the list are deleted.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

:delete-by-item *item* &optional (*equal-predicate* #'=) of **si:heap** *Method*

Finds the first item that satisfies *equal-predicate*, and deletes it, returning the item and key if it was found, otherwise it signals **si:heap-item-not-found**. *equal-predicate* should be a function that takes two arguments. The first argument to *equal-predicate* is the current item from the heap and the second argument is *item*.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

:delete-by-key *key* &optional (*equal-predicate* #'=) of **si:heap** *Method*

Finds the first item whose key satisfies *equal-predicate* and deletes it, returning the item and key if it was found; otherwise it signals **si:heap-item-not-found**. *equal-predicate* should be a function that takes two arguments. The first argument to *equal-predicate* is the current key from the heap and the second argument is *key*.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

delete-duplicates *sequence* &key (*test* #'**eql**) *test-not* (*start* **0**) *end* *from-end key replace* *Function*

delete-duplicates compares the elements of *sequence* pairwise, and if any two match, then the one occurring earlier in the sequence is discarded. The returned form is *sequence*, with enough elements removed such that no two of the remaining elements match. **delete-duplicates** is a destructive function.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(delete-duplicates '(1 1 1 2 2 2 3 3 3) :test #'>)  => (1 1 1 2 2 2 3 3 3)

(delete-duplicates '(1 1 1 2 2 2 3 3 3) :test #'=) => (1 2 3)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(delete-duplicates '(a a b b c c)) => (A B C)

(delete-duplicates #(1 1 1 1 1 1)) => #(1)

(delete-duplicates #(1 1 1 2 2 2) :start 3) => #(1 1 1 2)

(delete-duplicates #(1 1 1 2 2 2) :start 2 :end 4) => #(1 1 1 2 2 2)
```

The function normally processes the sequence in the forward direction, but if a non-**nil** value is specified for **:from-end**, processing starts from the reverse direction. If the **:from-end** argument is true, then the one later in the sequence is discarded.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(delete-duplicates '((Smith S) (Jones J) (Taylor T) (Smith S)) :key #'second)
 => ((JONES J) (TAYLOR T) (SMITH S))
```

When the **:replace** keyword is specified, elements that stay are moved up to the position of elements that are deleted. **:replace** is not meaningful if the value of **:from-end** is **t**.

For example:

```
(delete-duplicates '(1 2 3 1 4 3) :replace 'non-nil) => (1 2 3 4)
```

delete-duplicates is the destructive version of **remove-duplicates**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

delete-if *predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

delete-if returns a sequence of those items in the subsequence of *sequence* delimited by **:start** and **:end** which satisfy *predicate*. The elements that are not deleted occur in the same order in the result that they did in the argument. This is a destructive operation. The argument *sequence* may be destroyed and used to construct the result; however, the returned form may or may not be **eq** to *sequence*.

For example:

```
(setq a-list '(1 a b c)) => (1 A B C)
(delete-if #'numberp a-list) => (A B C)
a-list => (1 A B C)
```

However,

```
(setq my-list '(0 1 0)) => (0 1 0)
(delete-if #'zerop my-list)  => (1)
my-list => (0 1)
```

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(delete-if #'atom '((book 1) (math (room c)) (text 3)) :key #'second)
 => ((MATH (ROOM C)))

(delete-if #'zerop #(1 2 1) :key #'(lambda (x) (- x 1)))
 => #(2)
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are deleted.

For example:

```
(delete-if #'numberp '(4 2 4 1) :count 1 ) => (2 4 1)

(delete-if #'numberp '(4 2 4 1) :count 1 :from-end t)  => (4 2 4)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(delete-if #'atom '('a 1 "list")) => ('A)

(delete-if #'numberp '(4 1 4) :start 1 :end 2) => (4 4)

(delete-if #'evenp '(4 1 4) :start 0 :end 3)  => (1)
```

The **:count** argument, if supplied, limits the number of elements deleted. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(delete-if #'oddp '(1 1 2 2) :count 1 ) => (1 2 2)
```

delete-if is the destructive version of **remove-if**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

delete-if-not *predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

delete-if-not returns a sequence of those items in the subsequence of sequence delimited by **:start** and **:end** which do not satisfy *predicate*. The elements that are not deleted occur in the same order in the result that they did in the argument. This is a destructive operation. The argument

sequence may be destroyed and used to construct the result; however, the returned form may or may not be **eq** to *sequence.*

For example:

```
(setq a-list '('s a b c))  => ('S A B C)
(delete-if-not #'atom a-list) => (A B C)
a-list => ('S A B C)
```

However,

```
(setq my-list '(0 1 0)) => (0 1 0)
(delete-if-not #'zerop my-list)  => (0 0)
my-list => (0 1)
```

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(delete-if-not #'atom '((book 1) (math (room c)) (text 3)) :key #'second)
 => ((BOOK 1) (TEXT 3))

(deleteif-not #'zerop #(1 2 1) :key #'(lambda (x) (- x 1))) => #(1 1)
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are deleted.

For example:

```
(delete-if-not #'oddp '(4 2 4 1) :count 1 )  => (2 4 1)

(delete-if-not #'oddp '(4 2 4 1) :count 1 :from-end t)  => (4 2 1)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(delete-if-not #'atom '('a 1 "list"))  => (1 "list")

(delete-if-not #'numberp '(4 1 4) :start 1 :end 2) => (4 1 4)

(delete-if-not #'evenp '(4 1 4) :start 0 :end 3) => (4 4)
```

The **:count** argument, if supplied, limits the number of elements deleted. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(delete-if-not #'oddp '(1 1 2 2) :count 1 ) => (1 1 2)
```

delete-if-not is the destructive version of **remove-if-not.**

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

zl:del-if *predicate list* *Function*

zl:del-if means "remove if this condition is true." *predicate* should be a function of one argument. A modified list is made by applying *predicate* to all the elements of *list* and removing the ones for which the predicate returns non-**nil**. **zl:del-if** is the destructive version of **zl:rem-if**, without the *extra-lists* **&rest** argument.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:del-if-not *predicate list* *Function*

zl:del-if-not means "remove if this condition is not true"; that is, it keeps the elements for which *predicate* is true.

predicate should be a function of one argument. A modified list is made by applying *predicate* to all of the elements of *list* and removing the ones for which the predicate returns **nil**. **zl:del-if-not** is the destructive version **zl:rem-if-not**, without the *extra-lists* **&rest** argument.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:delq *item list* &optional *n* *Function*

(zl:delq *item list***)** returns the *list* with all occurrences of *item* removed. **eq** is used for the comparison. The argument *list* is actually modified (**rplacd**'ed) when instances of *item* are spliced out. **zl:delq** should be used for value, not for effect. That is, use:

```
(setq a (delq 'b a))
```

rather than:

```
(delq 'b a)
```

These two are *not* equivalent when the first element of the value of a is b.

(zl:delq *item list n***)** is like **(zl:delq** *item list***)** except only the first *n* instances of *item* are deleted. *n* is allowed to be zero. If *n* is greater than or equal to the number of occurrences of *item* in the list, all occurrences of *item* in the list are deleted. Example:

```
(delq 'a '(b a c (a b) d a e)) => (b c (a b) d e)
```

zl:delq could have been defined by:

```
(defun delq (item list &optional (n -1))
  (cond ((or (atom list) (zerop n)) list)
        ((eq item (car list))
         (delq item (cdr list) (1- n)))
        (t (rplacd list (delq item (cdr list) n)))))
```

If the third argument (*n*) is not supplied, it defaults to **-1**, which is effectively infinity, since it can be decremented any number of times without reaching zero.

zl:delq is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

denominator *rational* *Function*

If *rational* is a ratio, **denominator** returns the denominator of *rational.* If *rational* is an integer, **denominator** returns 1.
Examples:

```
(denominator 4/5) => 5
(denominator 3) => 1
(denominator 4/8) => 2
```

For a table of related items: See the section "Functions That Extract Components From a Rational Number" in *Symbolics Common Lisp: Language Concepts.*

deposit-byte *into-value position size byte-value* *Function*

This is like **dpb** except that instead of using a byte specifier, the bit position and *size* are passed as separate arguments. The argument order is not analogous to that of **dpb** so that **deposit-byte** can be compatible with older versions of Lisp.

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

deposit-field *newbyte bytespec integer* *Function*

Returns an integer that is the same as *integer* except for the bits specified by *bytespec* which are taken from *newbyte.*

This is like function **dpb** ("deposit byte"), except that *newbyte* is not taken to be right-justified; the *bytespec* bits of *newbyte* are used for the *bytespec* bits of the result, with the rest of the bits taken from *integer. integer* must be an integer.

bytespec is built using function **byte** with bit *size* and *position* arguments.

deposit-field could have been defined as follows:

```
(deposit-field newbyte bytespec integer) ==>
                        (dpb (ldb bytespec newbyte) bytespec integer)
```

Example:

```
(deposit-field #o230 (byte 6 3) #o4567) => #o4237
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

:describe *Message*

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Dy

The object that receives this message should describe itself, printing a description onto the ***standard-output*** stream. The **describe** function sends this message when it encounters an instance.

The **:describe** method of **flavor:vanilla** calls **flavor:describe-instance,** which prints the following information onto the ***standard-output*** stream: a description of the instance, the name of its flavor, and the names and values of its instance variables. It returns the instance. For example:

```
(send cell-object :describe)
-->#<CELL 1160762135>, an object of flavor CELL,
     has instance variable values:
      X:                        24
      Y:                        3
      STATUS:                   :ALIVE
      NEXT-STATUS:              unbound
      NEIGHBORS:                unbound
    #<CELL 1160762135>
```

describe-defstruct *instance* &optional *name* *Function*

Takes an *instance* of a structure and prints out a description of the instance, including the contents of each of its slots. *name* should be the name of the structure; you must provide this name so that **describe-defstruct** can know of what structure *instance* is an instance, and thus figure out the names of *instance*'s slots.

If *instance* is a named structure, you do not have to provide *name*, since it is just the named structure symbol of *instance*. Normally the **describe** function calls **describe-defstruct** if it is asked to describe a named structure; however, some named structures have their own idea of how to describe themselves. See the section "Named Structures" in *Symbolics Common Lisp: Language Concepts*.

dbg:describe-global-handlers *Function*

Names the conditions for which global handlers have been defined, and the handlers for these conditions. See the macro **define-global-handler**, page 139.

Example:

```
(define-global-handler infinity-is-three sys:divide-by-zero
    (error)
  (values :return-values '(3)))

(dbg:describe-global-handlers)
Global handler for SYS:DIVIDE-BY-ZERO --> INFINITY-IS-THREE
NIL
```

For a table of related items: See the section "Basic Forms for Global Handlers" in *Symbolics Common Lisp: Language Concepts*.

flavor:describe-instance *instance* *Function*

flavor:describe-instance prints the following information onto the ***standard-output*** stream: a description of the instance, the name of its flavor, and the names and values of its instance variables. It returns the instance. For example:

```
(flavor:describe-instance cell-object)
-->#<CELL 1160762135>, an object of flavor CELL,
     has instance variable values:
      X:                        24
      Y:                        3
      STATUS:                   :ALIVE
      NEXT-STATUS:              unbound
      NEIGHBORS:                unbound
    #<CELL 1160762135>
```

When you use **describe** on an instance, a default method (implemented for **flavor:vanilla**) performs the **flavor:describe-instance** function.

describe-package *package* *Function*

Print a description of *package*'s attributes and the size of its hash table of symbols on ***standard-output***. *package* can be a package object or the name of a package. The **describe** function calls **describe-package** when its argument is a package.

:describe &optional (*stream* **zl:standard-output**) of **si:heap** *Method*

Describes the heap, giving the predicate, number of elements, and optionally the contents. If *stream* is given, the output of **:describe** is printed on *stream*.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts*.

zl:desetq {*variable-pattern value-pattern*}... *Special Form*

Lets you assign values to variables through destructuring patterns. In place of a variable to be assigned, you can provide a tree of variables. The value to be assigned must be a tree of the same shape. The trees are destructured into their component parts, and each variable is assigned to the corresponding part of the value tree.

The first *value-pattern* is evaluated. If *variable-pattern* is a symbol, it is set to the result of evaluating *value-pattern*. If *variable-pattern* is a tree, the result of evaluating *value-pattern* should be a tree of the same shape. The trees are destructured, and each variable that is a component of *variable-pattern* is set to the value that is the corresponding element of the tree that results from evaluating *value-pattern*. This process is repeated for each pair of *variable-pattern* and *value-pattern*. **zl:desetq** returns the last value. Example:

```
(desetq (a b) '((x y) z) c b)
```

a is set to **(x y)**, **b** is set to **z**, and **c** is set to **z**. The form returns the value of the last form, which is the symbol **z**.

destructuring-bind *pattern datum* &body *body* *Special Form*

Binds variables to values, using **defmacro**'s destructuring facilities, and evaluates the body forms in the context of those bindings.

First *datum* is evaluated. If *pattern* is a symbol, it is bound to the result of evaluating *datum*. If *pattern* is a tree, the result of evaluating *data* should be a tree of the same shape. It signals an error if the trees do not match. The trees are disassembled, and each variable that is a component of *pattern* is bound to the value that is the corresponding element of the tree that results from evaluating *datum*. If not enough values are supplied, the remaining variables are bound to **nil**. If too many values are supplied, the excess values are ignored. Finally, the body forms are evaluated sequentially, the old values of the variables are restored, and the result of the last body form is returned.

As with the pattern in a **defmacro** form, *pattern* actually resembles the **lambda**-list of a function; it can have **&**-keywords. See the section "**&**-Keywords Accepted By **defmacro**" in *Symbolics Common Lisp: Language Concepts*.

Example:

```
(zl:destructuring-bind (a (b) &optional (c 'd))
                       '((x y) (z))
  (values a b c))
```

returns **(x y)**, **z**, and **d**.

zl:destructuring-bind also exists. It is the same as **destructuring-bind** except that it does not signal an error if the trees *data* and *variable-pattern* do not match.

math:determinant *matrix* *Function*

Returns the determinant of *matrix*. *matrix* must be a two-dimensional square matrix.

zl:dfloat *x* *Function*

Converts any noncomplex number to a double-precision floating-point number.

For a table of related items: See the section "Functions That Convert Numbers to Floating-point Numbers" in *Symbolics Common Lisp: Language* Concepts.

zl:difference *arg* &rest *args* *Function*

Returns its first argument minus the sum of the rest of its arguments. Arguments of different numeric types are converted to a common type, which is also the type of the result. See the section "Coercion Rules for Numbers" in *Symbolics Common Lisp: Language Concepts.*

zl:difference is similar to the function - used with more than one argument.

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

digit-char *weight* &optional (*radix* **10**) (*style-index* **0**) *Function*

Returns the character that represents a digit with a specified weight *weight*. Returns **nil** if *weight* is not between 0 and (**1-** *radix*) or *radix* is not between 2 and 36.

See the function **digit-char-p**, page 178.

digit-char-p *char* &optional (*radix* **10**) *Function*

char must be a character object. **digit-char-p** returns the weight of that digit character (a number from zero to one less than the radix) if it is a valid digit in the specified radix. It returns **nil** if *char* is not a valid digit in the specified radix; it cannot return **t**. See the function **digit-char**, page 178.

zl:dispatch *ppss word* &body *clauses* *Special Form*

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(**dispatch** *byte-specifier number clauses...*) is the same as **select** (not **zl:selectq**), but the key is obtained by evaluating (**ldb** *byte-specifier number*). *byte-specifier* and *number* are both evaluated. See the section "Byte Manipulation Functions" in *Symbolics Common Lisp: Language* Concepts. Byte specifiers and **ldb** are explained in that section. Example:

```
(princ (dispatch 0202 cat-type
                 (0 "Siamese.")
                 (1 "Persian.")
                 (2 "Alley.")
                 (3 (ferror nil
                            "~S is not a known cat type."
                            cat-type))))
```

It is not necessary to include all possible values of the byte that is dispatched on.

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:displace *form expansion* *Function*

Replaces the car and cdr of *form* so that it looks like:

```
(si:displaced original-form expansion)
```

form must be a list. *original-form* is equal to *form* but has a different top-level cons so that the replacing mentioned above does not affect it. **si:displaced** is a macro, which returns the caddr of its own macro form. So when the **si:displaced** form is given to the evaluator, it "expands" to expansion. **zl:displace** returns *expansion.*

zl:dlet *((variable-pattern value-pattern)...) body...* *Special Form*

Binds variables to values, using destructuring, and evaluates the body forms in the context of those bindings. In place of a variable to be assigned, you can provide a tree of variables. The value to be assigned must be a tree of the same shape. The trees are destructured into their component parts, and each variable is assigned to the corresponding part of the value tree.

First the *value-patterns* are evaluated. If a *variable-pattern* is a symbol, it is bound to the result of evaluating the corresponding *value-pattern.* If *variable-pattern* is a tree, the result of evaluating *value-pattern* should be a tree of the same shape. The trees are destructured, and each variable that is a component of *variable-pattern* is bound to the value that is the corresponding element of the tree that results from evaluating *value-pattern.* The bindings happen in parallel; all the *value-patterns* are evaluated before any variables are bound. Finally, the body forms are evaluated sequentially, the old values of the variables are restored, and the result of the last body form is returned. Example:

```
(zl:dlet (((a b) '((x y) z))
          (c 'd))
         (values a b c))
```

returns **(x y)**, **z**, and **d**.

zl:dlet* *((variable-pattern value-pattern)...) body...* *Special Form*

Binds variables to values, using destructuring, and evaluates the body forms in the context of those bindings. In place of a variable to be assigned, you can provide a tree of variables. The value to be assigned must be a tree of the same shape. The trees are destructured into their component parts, and each variable is assigned to the corresponding part of the value tree.

The first *value-pattern* is evaluated. If *variable-pattern* is a symbol, it is bound to the result of evaluating *value-pattern.* If *variable-pattern* is a tree, the result of evaluating *value-pattern* should be a tree of the same shape. The trees are destructured, and each variable that is a component of

variable-pattern is bound to the value that is the corresponding element of the tree that results from evaluating *value-pattern*. The process is repeated for each pair of *variable-pattern* and *value-pattern*. The bindings happen sequentially; the variables in each *variable-pattern* are bound before the next *value-pattern* is evaluated. Finally, the body forms are evaluated sequentially, the old values of the variables are restored, and the result of the last body form is returned. Example:

```
(zl:dlet* (((a b) '((x y) z)) (c b)) (values a b c))
```

returns **(x y)**, **z**, and **z**.

do *(varforms...) (end-test exit-forms ...)* &body *body* *Special Form*

Provides a simple generalized iteration facility, with an arbitrary number of "index variables" whose values are saved when the **do** is entered and restored when it is left, that is, they are bound by the **do**. The index variables are used in the iteration performed by **do**. At the beginning, they are initialized to specified values, and then at the end of each trip around the loop the values of the index variables are changed according to specified rules. **do** allows you to specify a predicate that determines when the iteration terminates. The value to be returned as the result of the form can, optionally, be specified.

do looks like this:

```
(do ((var init repeat) ...)
  (end-test exit-form ...)
  body...)
```

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The first item in the form is a list of zero or more index variable specifiers. Each index variable specifier is a list of the name of a variable *var*, an initial value form *init*, which defaults to **nil** if it is omitted, and a repeat value form *repeat*. If *repeat* is omitted, the *var* is not changed between repetitions. If *init* is omitted, the *var* is initialized to **nil**.

An index variable specifier can also be just the name of a variable, rather than a list. In this case, the variable has an initial value of **nil**, and is not changed between repetitions.

All assignment to the index variables is done in parallel. At the beginning of the first iteration, all the *init* forms are evaluated, then the *vars* are bound to the values of the *init* forms, their old values being saved in the usual way. The *init* forms are evaluated *before* the *vars* are bound, that is, lexically *outside* of the **do**. At the beginning of each succeeding iteration those *vars* that have *repeat* forms get set to the values of their respective *repeat* forms. All the *repeat* forms are evaluated before any of the *vars* is set.

The second element of the **do**-form is a list of an end-testing predicate

form *end-test*, and zero or more forms, called the *exit-forms*. This resembles a **cond** clause. At the beginning of each iteration, after processing of the variable specifiers, the *end-test* is evaluated. If the result is **nil**, execution proceeds with the body of the **do**. If the result is not **nil**, the *exit-forms* are evaluated from left to right and then **do** returns. The value of the **do** is the value of the last *exit-form*, or **nil** if there were no *exit-forms* (*not* the value of the *end-test* as you might expect by analogy with **cond**).

Note that the *end-test* gets evaluated before the first time the body is evaluated. **do** first initializes the variables from the *init* forms, then it checks the *end-test*, then it processes the body, then it deals with the *repeat* forms, then it tests the *end-test* again, and so on. If the **end-test** returns a non-**nil** value the first time, then the body is never processed.

If the second element of the form is **(nil)**, the *end-test* is never true and there are no *exit-forms*. The *body* of the **do** is executed over and over. The infinite loop can be terminated by use of **return** or **throw**.

Example:

```
(do ((count 1 (+ count 1)))
    (nil)                                          ; Do forever.
  (let ((item (read) ))
    (if (null item) (return) (princ item)))) => ABCDEFGNIL
   ;typed - abcdefg()
```

If a **return** special form is evaluated inside the body of a **do**, then the **do** immediately stops, unbinds its variables, and returns the values given to **return**. See the special form **return**, page 451. **return** and its variants are explained in more detail in that section. **go** special forms and **prog**-tags can also be used inside the body of a **do** and they mean the same thing that they do inside **prog** forms, but we discourage their use since they make your program complicated and hard to understand.

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Examples:

```
(setq foo-array (make-array '(2 2) :initial-element 'a))
 => #2A((A A) (A A))
(do ((x 0 (+ x 1))                                 ; prints out array
     (n (array-dimension foo-array 0) ))
    ((= x n))
  (do ((y 0 (+ y 1))
       (n (array-dimension foo-array 1) ))
      ((= y n))
    (princ (aref foo-array x y)))) => AAAA
NIL
```

```
(arglist 'cl:array-dimensions) => (ARRAY) and NIL and NIL
(setq a-vector #(1 2 3)) => #(1 2 3)
(do ((i 0 (+ i 1))                              ; changes every 2 in vector into a 0
     (n (length a-vector)))
    ((= i n))
  (if (= 2 (aref a-vector i))
      (setf (aref a-vector i) 0))) => NIL
A-VECTOR => #(1 0 3)

(do ((z list (cdr z))    ;z starts as list and is cdr'ed each time.
     (y other-list)      ;y starts as other-list, and is unchanged by the do.
     (x)                 ;x starts as nil and is not changed by the do.
     w)                  ;w starts as nil and is not changed by the do.
    (nil)                ;The end-test is nil, so this is an infinite loop.
  body)                ;Presumably the body uses return somewhere.
```

The following construction exploits parallel assignment to index variables:

```
(do ((x e (cdr x))
     (oldx x x))
    ((null x))
  body)
```

On the first iteration, the value of **oldx** is whatever value **x** had before the **do** was entered. On succeeding iterations, **oldx** contains the value that **x** had on the previous iteration.

body can contain no forms at all. Very often an iterative algorithm can be most clearly expressed entirely in the *repeats* and *exit-forms* of a new-style **do**, and the *body* is empty.

The following example is like `(maplist 'f x y)`. (See the section "Mapping" in *Symbolics Common Lisp: Language Concepts.*)

```
(do ((x x (cdr x))
     (y y (cdr y))
     (z nil (cons (f x y) z))) ;exploits parallel assignment.
    ((or (null x) (null y))
     (nreverse z))             ;typical use of nreverse.
    ))                         ;no do-body required.
```

For information about a general iteration facility based on a keyword syntax rather than a list-structure syntax:

See the section "The **loop** Iteration Macro" in *Symbolics Common Lisp: Language Concepts.*

Zetalisp note: Zetalisp supports another, "old-style" version of **do**. This form is incompatible with the language specification presented in Guy Steele's *Common Lisp: the Language.*

The older **do** looks like this:

(do *var init repeat end-test body...*)

The first time through the loop *var* gets the value of the *init* form; the remaining times through the loop it gets the value of the *repeat* form, which is reevaluated each time. Note that the *init* form is evaluated before *var* is bound, that is, lexically *outside* of the **do**. Each time around the loop, after *var* is set, *end-test* is evaluated. If it is non-**nil**, the **do** finishes and returns **nil**. If the *end-test* evaluated to **nil**, the *body* of the loop is executed.

If the second element of the form is **nil**, there is no *end-test* nor *exit-forms*, and the *body* of the **do** is executed only once. In this type of **do** it is an error to have *repeats*. This type of **do** is no more powerful than **let**; it is obsolete and provided only for Maclisp compatibility.

return and **go** can be used in the body. It is possible for *body* to contain no forms at all.

Examples:

```
(do ( (i 0 (+ 1 i))                                  ; searches list for Dan.
     (names '(Adam Brain Carla Dan Eric Fred) (cdr names)))
    ((null names))
  (if  (equal 'Dan (car names))
       (princ "Hey Danny Boooooy ")))  => Hey Danny Boooooy NIL

(do ((zz x (cdr zz)))
    ((or (null zz)
         (zerop (f (car zz))))))
                ;this applies f to each element of x
                ;continuously until f returns zero.
                ;Note that the do has no body.

(defun list-splice (a b)
  (do ((x a (cdr x))
       (y b (cdr y))
       (xy '() (append xy (list (car x) (car y)))) )
      ((endp x) (endp y)  (append xy x y) )))  => LIST-SPLICE
(list-splice '(1 2 3) '(a b c))  => (1 A 2 B 3 C)
(list-splice '(1 2 3) '(a b c d e)) => (1 A 2 B 3 C D E)
```

return forms are often useful to do simple searches:

```
(setq a-vector #(1 2 3)) => #(1 2 3)
(do ((i 0 (+ i 1)))                          ; Iterate over the length of vector
    ((and (= 3 (aref a-vector i))            ; If we find a element that = 3
          (return i))))                      ;then return its index.
  => 2  ;note (aref a-vector 2) => 3
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

do Keyword For loop

do *expression*

expression is evaluated each time through the loop, as shown in the following example:

```
(defun print-elements-of-list (list-of-elements)
  (loop for element in list-of-elements
        do (print element)))
 => PRINT-ELEMENTS-OF-LIST
```

print-elements-of-list prints each element in its argument, which should be a list. It returns **nil**.

The forms **do** and **doing** are synonymous. Examples

```
(defun print-list (small-list)
  (loop for element in small-list
        do
    (princ element)
    (princ " A "))) => PRINT-LIST
(print-list '(1 2 3)) => 1 A 2 A 3 A NIL
```

This is equivalent to

```
(defun print-list (small-list)
  (loop for element in small-list
        doing
    (princ element)
    (princ " A "))) => PRINT-LIST
(print-list '(1 2 3)) => 1 A 2 A 3 A NIL
```

See the macro **loop**, page 309.

do* *Special Form*

Just like **do**, except that the variable clauses are evaluated sequentially rather than in parallel. When a **do** starts, all the initialization forms are evaluated before any of the variables are set to the results; when a **do*** starts, the first initialization form is evaluated, then the first variable is set to the result, then the second initialization form is evaluated, and so on. The stepping forms work analogously.

Examples:

```
(do ( (i 0 (+ 1 i))
      (i 0 (+ 1 i)))
    ((= i 10))
  (princ i)) => 0123456789NIL

(do* ( (i 0 (+ 1 i))
       (i 0 (+ 1 i)))
     ((= i 10))
  (princ i)) => 02468NIL
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:do*-named &whole *form* &rest *ignore* &environment *env* *Special Form*

Just like **zl:do-named**, except that the variable clauses are evaluated sequentially, rather than in parallel. See the special form **do***, page 185.

Examples:

```
(zl:do-named who-do
             ( (i 0 (+ 1 i))
               (i 0 (+ 1 i)))
             ((= i 10))
  (princ i)) => 0123456789NIL

(zl:do*-named who-do
              ( (i 0 (+ 1 i))
                (i 0 (+ 1 i)))
              ((= i 10))
  (princ i)) => 0123456789NIL
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

do-all-symbols (*variable* &optional *result*) *body...* *Special Form*

Evaluate the *body* forms repeatedly with *variable* bound to each symbol present in any package (excluding invisible packages).

When the iteration terminates, *result* is evaluated and its values are returned. The value of *variable* is **nil** during the evaluation of *result*. If *result* is not specified, the value returned is **nil**.

The **return** special form can be used to cause a premature exit from the iteration.

documentation *name* &optional (*type* **'defun**) *Function*

Given a function or a function spec, this finds its documentation string, which is stored in various different places depending on the kind of function. If there is no documentation, **nil** is returned.

See the section "The Document Examiner" in *User's Guide to Symbolics Computers*.

dbg:document-proceed-type *condition proceed-type stream* *Generic Function*

Prints out a description of what it means to proceed, using the given *proceed-type*, from this condition, on *stream*. This is used mainly by the Debugger to create its prompt messages. Phrase such a message as an imperative sentence, without any leading or trailing #\return characters. This sentence is for the human users of the machine who read this when they have just been dumped unexpectedly into the Debugger. It should be composed so that it makes sense to a person to issue that sentence as a command to the system.

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The compatible message for **dbg:document-proceed-type** is:

:document-proceed-type

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts*.

dbg:document-special-command *condition special-command* *Generic Function*

dbg:document-special-command prints the documentation of *command-type* onto *stream*. If you don't provide your own method explicitly, the default handler uses the documentation string from the **dbg:special-command** method. You can, however, provide this method in order to print a prompt string that has to be computed at run-time. This is analogous to **dbg:document-proceed-type**. The syntax is:

```
(defmethod (dbg:document-special-command my-flavor :my-command-keyword)
           (stream)
  body...)
```

The compatible message for **dbg:document-special-command** is:

:document-special-command

For a table of related items: See the section "Debugger Special Command Functions" in *Symbolics Common Lisp: Language Concepts.*

do-external-symbols (*variable* &optional *package result*) *body...* *Special Form*

Evaluate the *body* forms repeatedly with *variable* bound to each external symbol exported by *package*. *package* can be a package object or a string or symbol that is the name of a package, or it can be omitted, in which case the value of ***package*** is used by default.

When the iteration terminates, *result* is evaluated and its values are returned. The value of *variable* is **nil** during the evaluation of *result*. If *result* is not specified, the value returned is **nil**.

The **return** special form can be used to cause a premature exit from the iteration.

dolist (*var listform* &optional *resultform*) &body *forms* *Special Form*

A convenient abbreviation for the most common list iteration.

dolist performs *forms* once for each element in the list that is the value of *listform*, with *var* bound to the successive elements.

You can use **return** and **go** and **prog**-tags inside the body, as with **do**.

dolist returns **nil**, or the value of *resultform*, if the latter is specified.

Examples:

```
(dolist (people '(mary ann claire cindy) 4) (print people ))  =>
MARY
ANN
CLAIRE
CINDY 4

(dolist (z '(1 2 3 4) "hi") (princ (+ z 2))) => 3456"hi"

(dolist (j '(1 2 3 4) t) (princ (- 1 j)) (if (= j 3)(return)))
=> 0-1-2NIL
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:dolist (*var form*) &body *body* *Special Form*

A convenient abbreviation for the most common list iteration. **zl:dolist** performs *body* once for each element in the list that is the value of *form*, with *var* bound to the successive elements.

Examples:

```
(zl:dolist (people '(mary ann claire cindy)) (print people )) =>
MARY
ANN
CLAIRE
CINDY NIL

(zl:dolist (z '(1 2 3 4)) (princ (+ z 2))) => 3456NIL

(zl:dolist (j '(1 2 3 4)) (princ (- 1 j)) (if (= j 3)(return)))
=> 0-1-2NIL
```

Where

```
(zl:dolist (item (frobs foo))
  (mung item))
```

is equivalent to:

```
(do ((lst (frobs foo) (cdr lst))
     (item))
    ((null lst))
  (setq item (car lst))
  (mung item))
```

except that the name **lst** is not used. You can use **return** and **go** and **prog**-tags inside the body, as with **do**. **zl:dolist** forms return **nil** unless returned from explicitly with **return**.

See the special form **dolist**, page 187.

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts*.

do-local-symbols (*variable* &optional *package result*) *body*... *Special Form*

Evaluate the *body* forms repeatedly with *variable* bound to each symbol present in *package*. *package* can be a package object or a string or symbol that is the name of a package, or it can be omitted, in which case the value of ***package*** is used by default.

When the iteration terminates, *result* is evaluated and its values are returned. The value of *variable* is **nil** during the evaluation of *result*. If *result* is not specified, the value returned is **nil**.

The **return** special form can be used to cause a premature exit from the iteration.

zl:do-named &whole *form* &rest *ignore* &environment *env* *Special Form*

Sometimes one **do** is contained inside the body of an outer **do**. The **return** function always returns from the innermost surrounding **do**, but sometimes you want to return from an outer **do** while within an inner **do**. You can do this by giving the outer **do** a name. You use **zl:do-named** instead of **do** for the outer **do**, and use **return-from**, specifying that name, to return from the **zl:do-named**.

The syntax of **zl:do-named** is like **do** except that the symbol **do** is immediately followed by the name, which should be a symbol. Example:

```
(zl:do-named out
             ((x 1 (+ x 1)))
             ((= x 4))
  (do ((y 1 (+ 1 y)))
      ((= y 4))
    (if (= y 2) (zl:return-from out (values x y))) )) => 1 and 2

(zl:do-named george ((a 1 (1+ a))
                     (d 'foo))
                    ((> a 4) 7)
  (do ((c b (cdr c)))
      ((null c))
    ...
    (return-from george (cons b d))
    ...))
```

If the symbol **t** is used as the name, it is made "invisible" to **returns**; that is, **returns** inside that **zl:do-named** return to the next outermost level whose name is not **t**. **(return-from t ...)** returns from a **zl:do-named** named **t**. You can also make a **zl:do-named** invisible to **returns** by including immediately inside it the form **(declare (si:invisible-block t))**. This feature is not intended to be used by user-written code; it is for macros to expand into.

If the symbol **nil** is used as the name, it is as if this were a regular **do**. Not having a name is the same as being named **nil**.

progs and **zl:loop**s can have names just as **do**s can. Since the same functions are used to return from all of these forms, all of these names are in the same namespace; a **return** returns from the innermost enclosing iteration form, no matter which of these it is, and so you need to use names if you nest any of them within any other and want to return to an outer one from inside an inner one.

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

do-symbols (*variable* &optional *package result*) *body...* *Special Form*

Evaluate the *body* forms repeatedly with *variable* bound to each symbol accessible in *package*. *package* can be a package object or a string or symbol that is the name of a package, or it can be omitted, in which case the value of ***package*** is used by default.

When the iteration terminates, *result* is evaluated and its values are returned. The value of *variable* is **nil** during the evaluation of *result*. If *result* is not specified, the value returned is **nil**.

The **return** special form can be used to cause a premature exit from the iteration.

dotimes (*var countform* &optional *resultform*) &body *forms* *Special Form*

A convenient abbreviation for the most common integer iteration.

dotimes performs *forms* the number of times given by the value of *countform*, with *var* bound to **0**, **1**, and so forth on successive iterations.

You can use **return** and **go** and **prog**-tags inside the body, as with **do**.

The function returns **nil**, or the value of *resultform* if the latter is specified.

Examples:

```
(dotimes (i 5 10)
  (princ i)(princ " ")) => 0 1 2 3 4 10

(dotimes (j 5 t)
  (princ j)(if (= j 3) (return))) => 0123NIL
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:dotimes (*var form*) &body *body* *Special Form*

A convenient abbreviation for the most common integer iteration.
zl:dotimes performs *body* the number of times given by the value of *count*, with *index* bound to **0**, **1**, and so forth on successive iterations.

Example:

```
(zl:dotimes (i 5)
  (princ i)(princ " ")) => 0 1 2 3 4 NIL

(zl:dotimes (j 5)
  (princ j)(if (= j 3) (return))) => 0123NIL
```

Where

```
(zl:dotimes (i (// m n))
  (frob i))
```

is equivalent to:

```
(do ((i 0 (1+ i))
     (count (// m n)))
    ((≥ i count))
  (frob i))
```

except that the name **count** is not used. Note that **i** takes on values starting at 0 rather than 1, and that it stops before taking the value **(zl:/ m n)** rather than after. You can use **return** and **go** and **prog**-tags inside the body, as with **do**. **zl:dotimes** forms return **nil** unless returned from explicitly with **return**. For example:

```
(zl:dotimes (i 5)
  (if (eq (aref a i) 'foo)
      (return i)))
```

This form searches the array that is the value of **a**, looking for the symbol **foo**. It returns the fixnum index of the first element of **a** that is **foo**, or else **nil** if none of the elements are **foo**.

See the special form **dotimes**, page 190.

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts*.

double-float *Type Specifier*

double-float is the type specifier symbol for the predefined Lisp double-precision floating-point number type.

The type **double-float** is a *subtype* of the type **float**. In Symbolics Common Lisp, the type **double-float** is equivalent to the type **long-float**.

The type **double-float** is *disjoint* with the types **short-float**, and **single-float**.

Examples:

```
(typep -13D2 'double-float) => T

(zl:typep -12D4) => :DOUBLE-FLOAT

(subtypep 'double-float 'float) => T and T ;subtype and certain
```

```
(commonp 0d0) => T

(sys:double-float-p 6.03e23) => NIL

(sys:double-float-p 1.5d9) => T

(equal-typep 'double-float 'long-float) => T

(sys:type-arglist 'double-float)  => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

double-float-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (+ (float 1 *e*) *e*)))

The current value of **double-float-epsilon** is: 1.1102230246251568d-16.

double-float-negative-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (- (float 1 *e*) *e*)))

The current value of **double-float-negative-epsilon** is: 5.551115123125784d-17

sys:double-float-p *object* *Function*

Returns **t** if *object* is a double-precision floating-point number, otherwise **nil**.

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

dpb *newbyte bytespec integer* *Function*

"Deposit byte."

Returns a number that is the same as *integer* except in the bits specified by *bytespec.*

bytespec is built using function **byte** with bit *size* and *position* arguments. Here *size* indicates the number of low bits of *newbyte* to be placed in the result.

newbyte is interpreted as being right-justified, as if it were the result of **ldb** ("load byte").

integer must be an integer.

Examples:

```
(dpb 1 (byte 1 2) 1) => 5
(dpb 0 (byte 1 31.) -1_31.) => -4294967296.      ;; a bignum (-1_32)
(dpb -1 (byte 40. 0) -1_32.) => -1.
(dpb #o230 (byte 6 3) #o4567) => #o4307
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

sys:dynamic-closure *Type Specifier*

sys:dynamic-closure is the type specifier symbol for the predefined Lisp object of that name.

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Scoping" in *Symbolics Common Lisp: Language Concepts.*

Examples:

```
(setq four
    (let ((x 4))
      (closure '(x) 'zerop))) => #<DTP-CLOSURE 1510647>

(typep four 'sys:dynamic-closure) => T

(subtypep 'sys:dynamic-closure 'common) => NIL and NIL
```

dynamic-closure-alist *closure* *Function*

Returns an alist of (*symbol* . *value*) pairs describing the bindings which the dynamic closure performs when it is called. This list is not the same one that is actually stored in the closure; that one contains pointers to value cells rather than symbols, and **dynamic-closure-alist** translates them back to symbols so you can understand them. As a result, clobbering part of this list does not change the closure.

If any variable in the closure is unbound, this function signals an error. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

dynamic-closure-variables *closure* *Function*

Creates and returns a list of all of the variables in the dynamic closure *closure.* It returns a copy of the list that was passed as the first argument to **make-dynamic-closure** when *closure* was created. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

ecase *object* &body *body* *Special Form*

The name of this function stands for "exhaustive case" or "error-checking case".

Structurally **ecase** is much like **case**, and it behaves like **case** in selecting one clause and then executing all consequents of that clause. However, **ecase** does not permit an explicit **otherwise** or **t** clause. The form of **ecase** is as follows:

```
(ecase key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

The first thing **ecase** does is to evaluate *object*, to produce an object called the *key object.*

Then **ecase** considers each of the clauses in turn. If *key* is **eql** to any item in the clause, **ecase** evaluates the consequents of that clause as an implicit **progn.**

ecase returns the value of the last consequent of the clause evaluated, or **nil** if there are no consequents to that clause.

The keys in the clauses are *not* evaluated; literal key values must appear in the clauses. It is an error for the same key to appear in more than one clause. The order of the clauses does not affect the behavior of the **ecase** construct.

If there is only one key for a clause, that key can be written in place of a list of that key, provided that no ambiguity results. Such a "singleton key" can *not* be **nil** (which is confusable with **()**, a list of no keys), **t**, **otherwise**, or a cons.

If no clause is satisfied, **ecase** uses an implicit **otherwise** clause to signal an error with a message constructed from the clauses. It is not permissible to continue from this error. To supply your own error message, use **case** with an **otherwise** clause containing a call to **error.**

Examples:

```
(let ((num 24))
  (ecase num
    ((1 2 3) "integer")
    ((4 5 6) "integer"))) => non-proceedable error is signalled
```

```
(let ((num 3))
  (ecase num
    ((1 2) "one two")
    ((3 4 5 6) (princ "numbers") (princ " three") (terpri) )
    (t "not today"))) => numbers three
T

(let ((Dwarf 'Sleepy))
  (ecase Dwarf
    ((Grumpy Dopey) (setq class "confused"))
    ((Bilbo Frodo) (setq class "Hobbits not Dwarfs"))
    (otherwise (setq class 'unknown) "talk to Snow White")))
 => "talk to Snow White"
class => UNKNOWN

(defun test-ecase (x)
   (ecase x
     (a 'a)
     (b 'b)
     (otherwise 'c))) => TEST-ECASE

(test-ecase 'd) => C
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

eighth *list* *Function*

eighth takes a list as an argument, and returns the eighth element of *list.* **eighth** is identical to

```
(nth 7 list)
```

This function is provided because it makes more sense than using **nth** when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

elt *sequence index* *Function*

elt returns the element of *sequence* specified by *index.*

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

index must be a non-negative integer less than the length of *sequence* as returned by **length.** The first element of a sequence has index 0.

For example:

```
(setq bird-list '(heron stork pelican turkey)) =>
(HERON STORK PELICAN TURKEY)

(elt bird-list 2) => PELICAN

(equalp (elt bird-list 2) (third bird-list)) => T
```

Note that **elt** observes the fill pointer in those vectors that have fill pointers. The array-specific function **aref** may be used to access vector elements that are beyond the vector's fill pointer.

setf can be used with **elt** to destructively replace a sequence element with a new value. For example:

```
(setf (elt bird-list 2) 'hawk) => HAWK

bird-list => (HERON STORK HAWK TURKEY)
```

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

:empty-p of **si:heap** *Method*

Returns **t** if the heap is empty, otherwise returns **nil.**

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

si:encapsulate *function outer-function type body* &optional *extra-debugging-info* *Macro*

A call to **si:encapsulate** looks like:

```
(si:encapsulate function-spec outer-function type
                body-form
                extra-debugging-info)
```

All the subforms of this macro are evaluated. In fact, the macro could almost be replaced with an ordinary function, except for the way *body-form* is handled.

function-spec evaluates to the function spec whose definition the new encapsulation should become. *outer-function* is another function spec, which should often be the same one. Its only purpose is to be used in any error messages from **si:encapsulate.**

type evaluates to a symbol that identifies the purpose of the encapsulation; it says what the application is. For example, it could be **advise** or **trace.** The list of possible types is defined by the system because encapsulations are supposed to be kept in an order according to their type. See the vari-

able **si:encapsulation-standard-order**, page 198. *type* should have an **si:encapsulation-grind-function** property that tells **grindef** what to do with an encapsulation of this type.

body-form is a form that evaluates to the body of the encapsulation-definition, the code to be executed when it is called. Backquote is typically used for this expression. See the section "Backquote" in *Symbolics Common Lisp: Language Concepts*. **si:encapsulate** is a macro because, while *body* is being evaluated, the variable **si:encapsulated-function** is bound to a list of the form **(function** *uninterned-symbol***)**, referring to the uninterned symbol used to hold the prior definition of *function-spec*. If **si:encapsulate** were a function, *body-form* would just get evaluated normally by the evaluator before **si:encapsulate** ever got invoked, and so there would be no opportunity to bind **si:encapsulated-function**. The form *body-form* should contain **(apply si:encapsulated-function** *arglist***)** somewhere if the encapsulation is to live up to its name and truly serve to encapsulate the original definition. (The variable *arglist* is bound by some of the code that the **si:encapsulate** macro produces automatically. When the body of the encapsulation is run, *arglist*'s value is the list of the arguments that the encapsulation received.)

extra-debugging-info evaluates to a list of extra items to put into the debugging info alist of the encapsulation function (besides the one starting with **si:encapsulated-definition** that every encapsulation must have). Some applications find this useful for recording information about the encapsulation for their own later use.

When a special function is encapsulated, the encapsulation is itself a special function with the same argument quoting pattern. (Not all quoting patterns can be handled; if a particular special form's quoting pattern cannot be handled, **si:encapsulate** signals an error.) Therefore, when the outermost encapsulation is started, each argument has been evaluated or not as appropriate. Because each encapsulation calls the prior definition with **apply**, no further evaluation takes place, and the basic definition of the special form also finds the arguments evaluated or not as appropriate. The basic definition can call **eval** on some of these arguments or parts of them; the encapsulations should not.

Macros cannot be encapsulated, but their expander functions can be; if the definition of *function-spec* is a macro, then **si:encapsulate** automatically encapsulates the expander function instead. In this case, the definition of the uninterned symbol is the original macro definition, not just the original expander function. It would not work for the encapsulation to apply the macro definition. So during the evaluation of *body-form*, **si:encapsulated-function** is bound to the form **(cdr (function** *uninterned-symbol***))**, which extracts the expander function from the prior definition of the macro.

Because only the expander function is actually encapsulated, the encapsulation does not see the evaluation or compilation of the expansion itself. The value returned by the encapsulation is the expansion of the macro call, not the value computed by the expansion.

si:encapsulation-standard-order *Variable*

The value of this variable is a list of the allowed encapsulation types, in the order that the encapsulations are supposed to be kept in (innermost encapsulations first). If you want to add new kinds of encapsulations, you should add another symbol to this list. Initially its value is:

```
(advise breakon trace si:rename-within)
```

advise encapsulations are used to hold advice. **breakon** and **trace** encapsulations are used for implementing tracing. **si:rename-within** encapsulations are used to record the fact that function specs of the form **(:within** *within-function altered-function***)** have been defined. The encapsulation goes on *within-function*. See the section "Rename-Within Encapsulations" in *Symbolics Common Lisp: Language Concepts*.

endp *object* *Function*

The predicate **endp** is the recommended way to test for the end of a list. **endp** returns **nil** when it is applied to a cons, and **t** when it is applied to **nil**. **endp** signals an error when it is used on any other object.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts*.

&environment *Lambda List Keyword*

This keyword is used with macros only. It should be followed by a single variable that is bound to an environment representing the lexical environment in which the macro call is to be interpreted. This environment is not required to be the complete lexical environment; it should be used only with the function **macroexpand** for the sake of any local macro definitions that the **macrolet** construct may have established within that lexical environment. **&environment** is useful primarily in the rare cases where a macro definition must explicitly expand any macros in a subform of the macro call before computing its own expansion.

eq *x y* *Function*

(eq *x y***)** => **t** if and only if *x* and *y* are the same object. It should be noted that things that print the same are not necessarily **eq** to each other. In particular, numbers with the same value need not be **eq**, and two similar lists are usually not **eq**. Examples:

```
(eq 'a 'b) => nil
(eq 'a 'a) => t
(eq (cons 'a 'b) (cons 'a 'b)) => nil
(setq x (cons 'a 'b)) (eq x x) => t
```

Note that in Symbolics Common Lisp equal integers are **eq**; this is not true in Maclisp. Equality does not imply **eq**ness for other types of numbers. To compare numbers, use =. See the section "Numeric Comparisons" in *Symbolics Common Lisp: Language Concepts.*

si:eq-hash-table *Flavor*

This flavor is used to create an old style Zetalisp hash table using the **eq** function for comparison of the hash keys. This flavor is superseeded by **table:basic-table**. It accepts the following init options:

:size Sets the initial size of the hash table in entries, as an integer. The default is 100 (decimal). The actual size is rounded up from the size you specify to the next size that is good for the hashing algorithm. An automatic rehash of the hash table might occur before this many entries are stored in the table depending upon the keys being stored.

:area Specifies the area in which the hash table should be created. This is just like the **:area** option to **zl:make-array**. See the function **zl:make-array**, page 322. The default is **sys:working-storage-area**.

:growth-factor Specifies how much to increase the size of the hash table when it becomes full. If it is an integer, the hash table is increased by that number. If it is a floating-point number greater than one, the new size of the hash table is the old size multiplied by that number.

:rehash-before-cold

Causes **zl:disk-save** to rehash this hash table if its hashing has been invalidated. (This is part of the before-cold initializations.) Thus every user of the saved band does not have to waste the overhead of rehashing the first time they use the hash table after cold booting.

For **eq** hash tables, the hashing is invalidated whenever garbage collection or band compression occurs because the hash function is sensitive to addresses of objects, and those operations move objects to different addresses. For **equal** hash tables, the hash function is not sensitive to addresses of objects that **sxhash** knows how to hash but it is sensitive to addresses of other objects. The hash table remembers whether it contains any such objects.

Normally a hash table is automatically rehashed "on demand" the first time it is used after the hashing has become invalidated. This first **:get-hash** operation is therefore much slower than normal.
The **:rehash-before-cold** option should be used on hash tables that are a permanent part of your world, likely to be saved in a band saved by **zl:disk-save**, and to be touched by users of that band. This applies both to hash tables in Genera and to hash tables in user-written subsystems that are saved on disk bands.

eql *x y* *Function*

eql returns **t** if its arguments are **eq**, or if they are numbers of the same type with the same value, or (in Common Lisp) if they are character objects that represent the same character. The predicate = compares the values of two numbers even if the numbers are of different types.

Examples:

```
(eql 'a 'a) => t
(eql 3 3)   => t
(eql 3 3.0) => nil
(eql 3.0 3.0) => t
(eql #/a #/a) => t
(eql (cons 'a 'b) (cons 'a 'b)) => nil
(eql "foo" "FOO") => nil
```

The following expressions might return either **t** or **nil**:

```
(eql '(a . b) '(a . b))
(eql "foo" "foo")
```

In Symbolics Common Lisp:

```
(eql 1.0s0 1.0d0) => nil
(eql 0.0 -0.0) => nil
```

equal *x y* *Function*

equal returns **t** if its arguments are structurally similar (isomorphic) objects. If the two objects are **eql**, then they are also **equal**. If the objects are of different data types, then they are not **equal**.

Objects of each data type are compared differently for **equal**. **equal** returns **t** in the following cases:

Conses	The two *cars* are **equal** and the two *cdrs* are **equal**.
Strings	The strings are of the same length, and corresponding characters of each string are **char=**.

Bit-vectors	The vectors are of the same length, and corresponding elements of each vector are =.
Numbers	The numbers are **eql**; that is, they must have the same type and the same value.
Characters	The characters are **eql**; that is, they must be character objects representing the same character. The code and bits information are taken into account for **equal**, but font information is not.
Symbols	The symbols are **eq**; that is, they must be addressing the same memory location.
Arrays	The arrays are **eq**; that is, they must be addressing the same array in memory.
Pathnames	The pathname objects are equivalent; that is, all of the corresponding components (host, device, directory name, and so on) are the same. The sensitivity of the case of the pathname object is dependent on the file naming conventions of the file system the pathname object resides in.

For example:

```
(equal 'a 'a) => T
(equal 'a 'b) => NIL
(equal 3.0 3.0) => T
(equal 3 3.0) => NIL
(equal #c(3 -4.0) #c(3 -4)) => NIL
(equal '(a . b) '(a . b)) => T
(equal (cons 'a 'b) (cons 'a 'c)) => NIL
(progn (setq x '(a . b)) (equal x x )) => T
(equal #\A #\a) => NIL
(equal #\A #\A) => T
(equal #\c-A #\A) => NIL
(equal "Foo" "Foo") => T
(equal "FOO" "foo") => NIL
```

An intuitive definition, which is not quite correct, is that two objects are **equal** if their printed representation is the same. For example:

```
(setq a '(1 2 3))
(setq b '(1 2 3))
(eq a b) => NIL
(equal a b) => T
```

```
(setq a 'a) => A
(setq b a) => A
(equal a b) => T
```

zl:equal *x y* *Function*

The **zl:equal** predicate returns **t** if its arguments are similar (isomorphic) objects. See the function **eq**, page 198. Two numbers are **zl:equal** if they have the same value and type (for example, a flonum is never **zl:equal** to an integer, even if = is true of them). For conses, **zl:equal** is defined recursively as the two **car**s being **zl:equal** and the two **cdr**s being equal. Two strings are **zl:equal** if they have the same length, and the characters composing them are the same. See the function **string-equal**, page 525. Alphabetic case is ignored. All other objects are **zl:equal** if and only if they are **eq**. Thus **zl:equal** could have been defined by:

```
(defun equal (x y)
  (cond ((eq x y) t)
        ((neq (typep x) (typep y)) nil)
        ((numberp x) (= x y))
        ((stringp x) (string-equal x y))
        ((listp x) (and (equal (car x) (car y))
                        (equal (cdr x) (cdr y))))))
```

As a consequence of the above definition, it can be seen that **zl:equal** may compute forever when applied to looped list structure. In addition, **eq** always implies **zl:equal**; that is, if **(eq a b)** then **(zl:equal a b)**. An intuitive definition of **zl:equal** (which is not quite correct) is that two objects are **zl:equal** if they look the same when printed out. For example:

```
(setq a '(1 2 3))
(setq b '(1 2 3))
(eq a b) => nil
(equal a b) => t
(equal "Foo" "foo") => t
```

si:equal-hash *x* *Function*

si:equal-hash computes a hash code of an object, and returns it as an integer. A property of **si:equal-hash** is that **(equal** *x y***)** always implies **(= (si:equal-hash** *x***) (si:equal-hash** *y***))**. The number returned by **si:equal-hash** is always a nonnegative integer, possibly a large one. **si:equal-hash** tries to compute its hash code in such a way that common permutations of an object, such as interchanging two elements of a list or changing one character in a string, always changes the hash code.

si:equal-hash uses **%pointer** to define the hash key for data types such as

arrays, stack groups, or closures. This means that some of the hash keys in **equal** hash tables are based on a virtual memory address. Hash tables that are at all dependent on memory addresses are rehashed when the garbage collector flips.

si:equal-hash returns a second value (**t**, **:dynamic** or **nil**), if it has used **%pointer** to define the hash key.

Value	*meaning*
nil	Returned if the hash does not depend on the virtual address of the object being hashed.
:dynamic	Returned if the hash depends on the virtual address, but none of the dependent addresses are ephemeral. That is, if **:dynamic** is returned, future calls to **si:equal-hash** for the same object might not return the same number if an intervening dynamic GC occurs.
t	Returned if the hash depends on the virtual address *and* at least one of the virtual addresses is ephemeral. That is, if **t** is returned, future calls to **si:equal-hash** for the same object might not return the same number if an intervening ephemeral GC occurs. The value **t** is the strongest and must be preserved when merging more than one result.

For example, if **running-flag** is the merged flag that will eventually be returned, the following form will efficiently do a hash/merge step:

```
(multiple-value-bind (hash flag) (si:equal-hash object)
        ;; t is strongest, :dynamic next, do it fast
        (setq running-flag (or (eq flag 't) running-flag flag))
        hash)
```

Here is an example of how to use **si:equal-hash** in maintaining hash tables of objects:

```
(defun knownp (x &aux i bkt) ;look up x in the table
    (setq i (remainder (si:equal-hash x) 176))
      ;The remainder should be reasonably randomized.
    (setq bkt (aref table i))
      ;bkt is thus a list of all those expressions that
      ;hash into the same number as does x.
    (memq x bkt))
```

To write an "intern" for objects, one could:

```
(defun sintern (x &aux bkt i tem)
    (setq i (remainder (si:equal-hash x) 2n-1))
        ;2n-1 stands for a power of 2 minus one.
        ;This is a good choice to randomize the
        ;result of the remainder operation.
    (setq bkt (aref table i))
    (cond ((setq tem (memq x bkt))
           (car tem))
          (t (aset (cons x bkt) table i)
             x)))
```

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

si:equal-hash-table *Flavor*

This flavor is used to create an old style Zetalisp hash table using the **zl:equal** function for comparison of the hash keys. This flavor is superseeded by **table:basic-table**. It accepts the following init option as well as those described for **eq** hash tables. See the flavor **si:eq-hash-table**, page 199.

:rehash-threshold Specifies how full the table can be before it must grow. This is typically a flonum. The default is 0.8, which represents 80 percent.

equalp *x y* *Function*

Two objects are **equalp** if they are **equal**. Objects that have components are **equalp** if they are of the same type and corresponding components are **equalp**.

equalp differs from **equal** when it compares characters, strings and arrays. **equalp** returns **t** for character objects when they satisfy **char-equal**. **char-equal** ignores case, as well as font information. For example:

```
(equalp #\A #\a) => T
(equalp #\A #\A) => T
(equalp #\c-A #\A) => NIL
```

equalp returns **t** for arrays when they have the same dimensions, the dimensions match, and the corresponding elements are **equalp**. A string and a general array that happens to contain some characters will be **equalp** even though it is not **equal**. If either argument has a fill pointer, the fill pointer limits the number of elements examined by **equalp**. Because **equalp** performs element-by-element comparisons of strings and ignores the alphabetic case of characters, case distinctions are also ignored when **equalp** compares strings. For example:

```
(setq string "Any Random String") => "Any Random String"
(setq array (make-array 17 :initial-contents "any random string"))
  => #<ART-Q-17 40102625>
(equalp string array) => T
```

equal-typep *type1 type2* *Function*

Returns **t** if *type1* and *type2* are equivalent and denote the same data type. For the standard type specifiers in Symbolics Common Lisp: See the section "Type Specifier Symbols" in *Symbolics Common Lisp: Language* Concepts.

Examples:

```
(equal-typep 'bit '(unsigned-byte 1)) => T
(equal-typep 'double-float 'long-float) => T
(equal-typep 'bit '(integer 0 1)) => T
(equal-typep 'short-float 'single-float) => T
(equal-typep 'pathname 'complex) => NIL
```

error *format-string* &rest *format-args* *Function*

error is the function for signalling a condition that is not proceedable.

error takes three possible argument lists, as follows:

error {*format-string* &rest *format-args*}
or
error {*condition* &rest *init-options*}
or
error {*condition-object*}

Case 1:

When **error** is called with *format-string* and *format-args*, it signals a **zl:ferror** condition.

format-string is given as a control string to **format** along with *format-args* to construct an error message string.

Case 2:

When called with the arguments *condition* and *init-options*, a condition of type *condition* with init options as specified by *init-options* is created and is signalled.

condition is the name of a condition flavor.

init-options are the init options specified when the error object is created; they are passed in the **:init** message.

Used this way, **error** is similar to **signal** but restricted as follows:

- **error** sets the proceed types of the error object to **nil** so that it cannot be proceeded.
- If no handler exists, the Debugger assumes control, whether or not the object is an error object.
- **error** never returns to its caller.

Case 3:

In the third and more advanced form of **error**, *condition-object* can be a condition object that has been created with **make-condition** but not yet signalled. In this case, *init-options* is ignored.

For compatibility with the old Maclisp **error** function, **error** tries to determine that it has been called with Maclisp-style arguments and turns into an **zl:fsignal** or **zl:ferror** as appropriate. If *condition* is a string or a symbol that is not the name of a flavor, and **error** has no more than three arguments, **error** assumes it was called with Maclisp-style arguments.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

error-message-hook *Variable*

This variable lets you customize the error message printed by the Debugger.

You can bind ***error-message-hook*** to a one-argument function. Before printing an error message the Debugger checks the value of ***error-message-hook***; if this variable is bound to a **non-nil** value, the Debugger evaluates it and displays the result at the end of the Debugger message.

Examples:


```
(defun my-error-hook ()
  (format t "This is the error hook"))
(setq dbg:*error-message-hook* 'dbg:my-error-hook)


(defun get-plists (list-of-objects)
  (let ((dbg:*error-message-hook*
          (lambda ()
            (format t "While getting properties of ~S" list-of-objects))))
    (symbol-plist list-of-objects))) => GET-PLISTS

(get-plists '(a b c))
```

```
Trap: The argument given to the SYS:PROPERTY-CELL-LOCATION instruction, (A B C),
 was not a symbol.
While getting properties of (A B C)


SYMBOL-PLIST:
   Arg 0 (SYMBOL): (A B C)
s-A, <RESUME>:   Supply replacement argument
s-B:             Return a value from the PROPERTY-CELL-LOCATION instruction
s-C:             Retry the PROPERTY-CELL-LOCATION instruction
s-D: <ABORT>:    Return to Lisp Top Level in Dynamic Lisp Listener 1
→ Resume Proceed
Supply replacement argument
Form to evaluate and use as replacement argument:
'integer
(ZWEI:ZMACS-BUFFERS ((:SAGE-TYPE-SPECIFIER-RECORD #<SECTION-NODE Sage Type
 Specifier Record INTEGER 254116776>))
.
.
.
```

errorp *thing* *Function*

errorp returns **t** if *object* is an error object, and **nil** otherwise. That is:

```
(errorp x) <=> (typep x 'error)
```

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

error-restart *(condition-flavor format-string . format-args)* *Special Form*

This form establishes a restart handler for *condition-flavor* and then evaluates the body. If the handler is not invoked, **error-restart** returns the values produced by the last form in the body and the restart handler disappears. When the restart handler is invoked, control is thrown back to the dynamic environment inside the **error-restart** form and execution of the body starts all over again. The format is:

```
(error-restart (condition-flavor format-string . format-args)
 form-1
 form-2
 ...)
```

condition-flavor is either a condition or a list of conditions that can be handled. *format-string* and *format-args* are a control string and a list of ar-

guments (respectively) to be passed to **format** to construct a meaningful description of what would happen if the user were to invoke the handler. *format-args* are evaluated when the handler is bound. The Debugger uses these values to create a message explaining the intent of the restart handler.

For a table of related items: See the section "Restart Functions" in *Symbolics Common Lisp: Language Concepts.*

error-restart-loop *(condition-flavor format-string . format-args)* *Special Form*

error-restart-loop establishes a restart handler for *condition-flavor* and then evaluates the body. If the handler is not invoked, **error-restart-loop** evaluates the body again and again, in an infinite loop. Use the **return** function to leave the loop. This mechanism is useful for interactive top levels.

If a condition is signalled during the execution of the body and the restart handler is invoked, control is thrown back to the dynamic environment inside the **error-restart-loop** form and execution of the body is started all over again. The format is:

```
(error-restart-loop (condition-flavor format-string . format-args)
 form-1
 form-2
 ...)
```

condition-flavor is either a condition or a list of conditions that can be handled. *format-string* and *format-args* are a control string and a list of arguments (respectively) to be passed to **format** to construct a meaningful description of what would happen if the user were to invoke the handler. The Debugger uses these values to create a message explaining the intent of the restart handler.

For a table of related items: See the section "Restart Functions" in *Symbolics Common Lisp: Language Concepts.*

etypecase *object* &body *body* *Special Form*

The name of this function stands for "exhaustive type case" or "error-checking type case". **etypecase** is similar to **typecase**, except that: it does not allow an explicit **otherwise** or **t** clause, and it signals a non-continuable error instead of returning **nil** if no clause is satisfied.

etypecase is a conditional that chooses one of its clauses by examining the type of an object. Its form is as follows:

```
(typecase form
   (types consequent consequent ...)
   (types consequent consequent ...)
   ...
   )
```

First **etypecase** evaluates *form*, producing an object. **etypecase** then examines each clause in sequence. *types* in each clause is a type specifier in either symbol or list form, or a list of type specifiers. The type specifier is not evaluated. If the object is of that type, or of one of those types, then the consequents are evaluated and the result of the last one is returned (or **nil** if there are no consequents in that clause). Otherwise, **etypecase** moves on to the next clause.

If no clause is satisfied, **etypecase** signals an error with a message constructed from the clauses. It is not permissible to continue from this error. To supply your own error message, use **typecase** with an **otherwise** clause containing a call to **error**.

For an object to be of a given type means that if **typep** is applied to the object and the type, it returns **t**. That is, a type is something meaningful as a second argument to **typep**. A chart of supported data types appears elsewhere. See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

It is permissible for more than one clause to specify a given type, particularly if one is a subtype of another; the earliest applicable clause is chosen. Thus, for **etypecase**, the order of the clauses can affect the behavior of the construct.

Examples:

```
(defun tell-about-car (x)
  (etypecase (car x)
    (string "string")))  => TELL-ABOUT-CAR
(tell-about-car '("word" "more"))  => "string"
(tell-about-car '(a 1)) => non-proceedable error is signalled

(defun tell-about-car (x)
  (etypecase (car x)
    (fixnum "The car is a number.")
    ((or string symbol) "symbol or string")
    (otherwise "I don't know.")))  => TELL-ABOUT-CAR
(tell-about-car '(1 a)) => "The car is a number."
(tell-about-car '(a 1)) => "symbol or string"
(tell-about-car '("word" "more"))  => "symbol or string"
(tell-about-car '(1.0)) => "I don't know."
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

eval *form* &optional *env* *Function*

Evaluates *form*, and returns the result. Example:

```
(setq x 43 foo 'bar)
(eval (list 'cons x 'foo))
    => (43 . bar)
```

It is unusual to explicitly call **eval**, since usually evaluation is done implicitly. If you are writing a simple Lisp program and explicitly calling **eval**, you are probably doing something wrong. **eval** is primarily useful in programs that deal with Lisp itself.

Also, if you are only interested in getting at the value of a symbol (that is, the contents of the symbol's value cell), then you should use the primitive function **symbol-value**.

The actual name of the compiled code for **eval** is "**si:*eval**" because use of the **evalhook** feature binds the function cell of **eval**.

env defaults to the null lexical environment.

sys:eval-in-instance *instance form* *Function*

Evaluates *form* in the lexical environment of *instance*. The following form returns the sum of the instance variables **x** and **y** of the instance **this-box-with-cell**:

```
(sys:eval-in-instance this-box-with-cell '(+ x y))
--> 6
```

You can use **setq** to modify an instance variable; this is often useful in debugging. If you need to evaluate more than one form in the lexical environment of the instance, you can use **sys:debug-instance**: See the function **sys:debug-instance**, page 126.

evenp *integer* *Function*

Returns **t** if *integer* is even, otherwise **nil**. If *integer* is not an integer, **evenp** signals an error.

See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

every *predicate* &rest *sequences* *Function*

every is a predicate which returns **nil** as soon as any invocation of predicate returns **nil**. *predicate* must take as many arguments as there are sequences provided. *predicate* is first applied to the elements of the sequences with an index of 0, then with an index of 1, and so on, until a termination criterion is reached or the end of the shortest of the sequences is reached. If the end of a sequence is reached, **every** returns a non-**nil** value. Thus considered as a predicate, it is true if every invocation of *predicate* is true.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(every #'oddp '(1 3 5)) => T

(every #'equal '(1 2 3) '(3 2 1)) => NIL
```

If *predicate* has side effects, it can count on being called first on all those elements with an index of 0, then all those with an index of 1, and so on.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:every *list predicate* &optional *step-function* *Function*

zl:every returns **t** if *predicate* returns non-**nil** when applied to every element of *list*, or **nil** if *predicate* returns **nil** for some element. If *step-function* is present, it replaces **#'cdr** as the function used to get to the next element of the list; **#'cddr** is a typical function to use here. For example:

```
(zl:every '(1 3 5) #'oddp) => T

(zl:every '(1 2 3 4 5) #'oddp) => NIL

(zl:every '(1 2 3 4 5) #'oddp #'cddr) => T
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts.*

exp *number* *Function*

Returns *e* raised to the *number*th power, where *e* is the base of natural logarithms. If *number* is an integer or a single-float, the result is converted to a single-float; if it is a double-float, the result is double-float.

Examples:

```
(exp 1) => 2.7182817
(exp #c(0 -3)) => #C(-0.9899925 -0.14112002)
```

For a table of related items: See the section "Powers Of **e** and Log Functions" in *Symbolics Common Lisp: Language Concepts.*

export *symbols* &optional *package* *Function*

The *symbols* argument should be a list of symbols or a single symbol. If *symbols* is **nil**, it is treated like an empty list. These symbols become available as external symbols in *package*. *package* can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t**. The **:export** option to defpackage and **make-package** is equivalent.

expt *base-number power-number* *Function*

Computes and returns *base-number* raised to the power *power-number*. If the *base-number* is of type rational and the *power-number* is an integer, the calculation is exact (using the rule of rational canonicalization where applicable), and the result is of type rational; otherwise, a floating-point approximation may result.

If *power-number* is zero of type integer, the result is the value one in the type of *base-number*. This is true even if *base-number* is zero of any type. If *power-number* is a zero of any other data type, the result is the value one, in the type of the arguments after the application of the coercion rules, except as follows. An error results if the *base-number* is zero and the *power-number* is a zero not of type integer.

If *base-number* is negative and *power-number* is not an integer, the result of **expt** can be complex, even though neither argument is complex. **expt** always returns the principal complex value.

Complex canonicalization is applied to complex results.

Examples:

```
(expt 2 3) => 8
(expt .5 3) => 0.125
(expt -49 1/2) => #c(0 7)       ;the principal value
(expt 1/2 -2) => 4
(expt 2. 0) => 1
(expt 0 56) => 0
(expt 0 3/2) => 0
(expt 0.0 5) => 0.0
(expt 0.0 #c(3 4)) => 0.0
(expt #c(0 7) 2) => -49
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:expt *num expt* *Function*

Returns *num* raised to the *expt*th power. The result is an integer if both arguments are integers (even if *expt* is negative!) and floating-point if either *num* or *expt* or both is floating-point. If the exponent is an integer a repeated-squaring algorithm is used, while if the exponent is floating the result is (**exp** (* *expt* (**log** *num*))).

The following functions are synonyms of **zl:expt**:

zl:^
zl:^$

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

sys:external-symbol-not-found *Flavor*

A ":" qualified name referenced a name that had not been exported from the specified package.

The **:string** message returns the name being referenced (no symbol by this name exists yet). The **:package** message returns the package.

The **:export** proceed type exports a symbol by that name and uses it.

false &rest *ignore* *Function*

Takes no arguments and returns **nil**. See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts*.

fboundp *symbol* *Function*

Returns **t** if *symbol*'s function cell contains a function definition, or if symbol names a special form or a macro. Otherwise it returns **nil**. Since **fboundp** returns **t** for special forms and macros, if you want to check for these cases use **special-form-p** or **macro-function**.

fceiling *number* &optional (*divisor* **1**) *Function*

This is just like **ceiling**, except that the first returned value is always a floating-point number instead of an integer. The second returned value is the remainder. If *number* is a floating-point number and *divisor* is not a floating-point number of longer format, then the first returned value is a floating-point number of the same type as *number*.

Examples:

```
(fceiling 5) => 5.0 and 0
(fceiling -5) => -5.0 and 0
(fceiling 5.2) => 6.0 and -0.8000002
(fceiling -5.2) => -5.0 and -0.19999981
(fceiling 5 3) => 2.0 and -1
(fceiling -5 3) => -1.0 and -2
(fceiling 5.2 4) => 2.0 and -2.8000002
(fceiling -5.2 4) => -1.0 and -1.1999998
(fceiling 4.2d0) => 5.0d0 and -0.7999999999999998d0
(fceiling -4.2d0) => -4.0d0 and -0.20000000000000018d0
```

F

For a table of related items: See the section "Functions That Divide and Return Quotient as Floating-point Number" in *Symbolics Common Lisp: Language Concepts*.

fdefine *function-spec definition* &optional *carefully-flag* *Function*
no-query-flag

This is the primitive that **defun** and everything else in the system use to change the definition of a function spec. If *carefully* is non-**nil**, which it usually should be, then only the basic definition is changed, the previous basic definition is saved if possible (see **undefun**), and any encapsulations

of the function such as tracing and advice are carried over from the old definition to the new definition. *carefully* also causes the user to be queried if the function spec is being redefined by a file different from the one that defined it originally. However, this warnings is suppressed if either the argument *no-query* is non-**nil**, or if the global variable **sys:inhibit-fdefine-warnings** is **t**.

If **fdefine** is called while a file is being loaded, it records what file the function definition came from so that the editor can find the source code.

If *function-spec* was already defined as a function, and *carefully* is non-**nil**, the function-spec's **:previous-definition** property is used to save the previous definition. If the previous definition is an interpreted function, it is also saved on the **:previous-expr-definition** property. These properties are used by the **undefun** function, which restores the previous definition, and the **uncompile** function, which restores the previous interpreted definition. The properties for different kinds of function specs are stored in different places; when a function spec is a symbol its properties are stored on the symbol's property list.

defun and the other function-defining special forms all supply **t** for carefully and **nil** or nothing for *no-query*. Operations that construct encapsulations, such as **trace**, are the only ones that use **nil** for *carefully*.

fdefinedp *function-spec* *Function*
This returns **t** if *function-spec* has a definition, or **nil** if it does not.

sys:fdefine-file-pathname *Variable*
While loading a file, this is the generic-pathname for the file. The rest of the time it is **nil**. **fdefine** uses this to remember what file defines each function.

fdefinition *function-spec* *Function*
This returns *function-spec*'s definition. If it has none, an error occurs.

sys:fdefinition-location *function-spec* &optional *for-compiler* *Function*
This returns a locative pointing at the cell that contains *function-spec*'s definition. For some kinds of function specs, though not for symbols, this can cause data structure to be created to hold a definition. For example, if *function-spec* is of the **:property** kind, then an entry might have to be added to the property list if it isn't already there. In practice, you should write (**locf** (**fdefinition** *function-spec*)) instead of calling this function explicitly.

zl:ferror *format-string* &rest *format-args* *Function*

zl:ferror is a simple function for signalling when you do not care what the condition is. **zl:ferror** signals the condition **zl:ferror.** (See the flavor **zl:ferror** in *Symbolics Common Lisp: Language Concepts.*) The arguments are passed as the **:format-string** and **:format-args** init keywords to the error object.

The old **(zl:ferror nil ...)** syntax continues to be accepted for compatibility reasons indefinitely; the **nil** is ignored. An error is signalled if the first argument is a symbol other than **nil**; the first argument must be **nil** or a string.

Note: zl:ferror is an obsolete function. Use **error** instead in your new programs.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

ffloor *number* &optional (*divisor* **1**) *Function*

This is just like **floor,** except that the first returned value is always a floating-point number instead of an integer. The second returned value is the remainder. If *number* is a floating-point number and *divisor* is not a floating-point number of longer format, then the first returned value is a floating-point number of the same type as *number.*

Examples:

```
(ffloor 5) => 5.0 and 0
(ffloor -5) => -5.0 and 0
(ffloor 5.2) => 5.0 and 0.19999981
(ffloor -5.2) => -6.0 and 0.8000002
(ffloor 5 3) => 1.0 and 2
(ffloor -5 3) => -2.0 and 1
(ffloor 5.2 4) => 1.0 and 1.1999998
(ffloor -5.2 4) => -2.0 and 2.8000002
(ffloor 4.2d0) => 4.0d0 and 0.20000000000000018d0
(ffloor -4.2d0) => -5.0d0 and 0.7999999999999998d0
```

F

For a table of related items: See the section "Functions That Divide and Return Quotient as Floating-point Number" in *Symbolics Common Lisp: Language Concepts.*

fifth *list* *Function*

This function takes a list as an argument, and returns the fifth element of the list. **fifth** is identical to

```
(nth 4 list)
```

The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

fill *sequence item* &key (*start* **0**) *end* *Function*

fill destructively modifies *sequence* by replacing each element of the subsequence specified by the **:start** (which defaults to zero) and **:end** (which defaults to the length of the sequence) arguments with *item*.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

item can be any be any Lisp object, but must be a suitable element for sequence.

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence, up to but not including the one specified by the **:end** index (defaults to length of *sequence*).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(setq a-vector (vector 'a 'b 'c 'd 'e)) => #(A B C D E)

(fill a-vector 'z :start 1 :end 3) => #(A Z Z D E)

a-vector => #(A Z Z D E)

(fill a-vector 'rah) => #(RAH RAH RAH RAH RAH)

a-vector => #(RAH RAH RAH RAH RAH)
```

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

math:fill-2d-array *array list* *Function*

This is the opposite of **math:list-2d-array**. *list* should be a list of lists, with each element being a list corresponding to a row. *array*'s elements are stored from the list. Unlike **zl:fillarray**, if *list* is not long enough, **math:fill-2d-array** "wraps around", starting over at the beginning. The lists that are elements of *list* also work this way.

zl:fillarray *array source* *Function*

Fills up *array* with the elements of *source*. *array* can be any type of array or a symbol whose function cell contains an array. Two forms of this function exist, depending on whether the type of *source* is a list or an array.

If *source* is a list, then **zl:fillarray** fills up *array* with the elements of *list*. If *source* is too short to fill up all of *array*, then the last element of *source* is used to fill the remaining elements of *array*. If *source* is too long, the extra elements are ignored. If *source* is **nil** (the empty list), *array* is filled with the default initial value for its array type (**nil** or **0**).

If *source* is an array (or a symbol whose function cell contains an array), then the elements of *array* are filled up from the elements of *source*. If *source* is too small, then the extra elements of *array* are not affected. **zl:fillarray** returns *array*.

If *array* is multidimensional, the elements are accessed in row-major order: the last subscript varies the most quickly. The same is true of *source* if it is an array.

:filled-elements *Message*

Returns the number of entries in the hash table that have an associated value. This message will be removed in the future – use **zl-user:hash-table-count** instead.

fill-pointer *array* *Function*

Returns the value of the fill pointer. *array* must have a fill pointer. **setf** can be used on a **fill-pointer** form to set the value of the fill pointer.

finally Keyword For loop

F

finally *expression*

Puts *expression* into the *epilogue* of the loop, which is evaluated when the iteration terminates (other than by an explicit **return**). For stylistic reasons, then, this clause should appear last in the loop body. Note that certain clauses can generate code that terminates the iteration without running the epilogue code; this behavior is noted with those clauses. See the section "**loop** Clauses", page 310. This clause can be used to cause the loop to return values in a nonstandard way:

```
(loop for n in l                                    ; l is a list
      sum n into the-sum
      count t into the-count
      finally (return (quotient the-sum the-count)))

(defun sum-series (limit)
  (loop for num from 0 to limit
        with sum-of-series = 0
        initially (print "The sum of this series is :")
        do
    (setq sum-of-series (+ sum-of-series num))
        finally (prin1 sum-of-series))) => SUM-SERIES
(sum-series 9)  =>
"The sum of this series is :" 45
NIL

(defun over-the-top (num)
  (loop for i from 1 to 10
        when (= i num) return i
        finally (print "Finally triggered"))) => OVER-THE-TOP
(over-the-top 5) => 5
(over-the-top 20) =>
"Finally triggered" NIL
```

See the macro **loop**, page 309.

find *item sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*
from-end (*start* **0**) *end*

If *sequence* contains an element satisfying the predicate specified by the **:test** keyword argument, then the leftmost such element is returned; otherwise **nil** is returned.

item is matched against the elements specified by the *test* keyword. The *item* can be any Symbolics Common Lisp object.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

For example:

```
(find 'a '(a b c d) :test-not #'eql) => B
```

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(find 'a '((a b) (a d)  (b c)) :key #'car) => (A B)

(find 'a #((a b) (a d) (b a)) :key #'cadr) => (B A)
```

If the value of the **:from-end** keyword is non-**nil**, then the result is the rightmost element satisfying the test.

For example:

```
(find 3 '((right 3) (west 2) (south 3)) :key #'cadr :from-end t) => (SOUTH 3)
```

You can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(find 'A '(b c a)) => A

(find 'a '(a b b)  :start 1 :end 3)  => NIL

(find 'a '(a b b )  :start 0 :end 3) => A

(find 1 #(2 3 4 1) :end 4) => 1

(find 1 #(2 3 4 1) :end 3) => NIL
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts*.

F

find-all-symbols *string* *Function*

Searches all packages for symbols named *string* and returns a list of them. Duplicates are removed from the list; if a symbol is present in more than one package, it only appears once in the list. The **global** package is searched first, and so global symbols appear earlier in the list than symbols that shadow them. In general packages are searched in the order that they were created.

string can be a symbol, in which case its name is used. This is primarily for user convenience when calling **find-all-symbols** directly from the read-eval-print loop.

Invisible packages are not searched.

The **where-is** function is a more user-oriented version of **find-all-symbols**; it returns information about *string*, rather than just a list.

For more information: See the section "Mapping Names to Symbols" in *Symbolics Common Lisp: Language Concepts.*

:find-by-item *item* &optional (*equal-predicate* #'=) of **si:heap** *Method*

Finds the first item that satisfies *equal-predicate* and returns the item and key if it was found; otherwise it signals **si:heap-item-not-found**. *equal-predicate* should be a function that takes two arguments. The first argument to *equal-predicate* is the current item from the heap and the second argument is *item.*

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

:find-by-key *key* &optional (*equal-predicate* #'=) of **si:heap** *Method*

Finds the first item whose key satisfies *equal-predicate* and returns the item and key if it was found; otherwise it signals **si:heap-item-not-found**. *equal-predicate* should be a function that takes two arguments. The first argument to *equal-predicate* is the current key from the heap and the second argument is *key.*

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

flavor:find-flavor *flavor-name* &optional (*error-p* **t**) *Function*

This is useful for determining whether a flavor is defined in the world. Returns non-**nil** if the flavor is defined.

If the flavor is not defined and *error-p* is non-**nil** (or not supplied), **flavor:find-flavor** returns **nil**. However, if the flavor is not defined and *error-p* is **nil**, **flavor:find-flavor** signals an error.

find-if *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

If *sequence* contains an element satisfying *predicate*, then the leftmost such element is returned; otherwise **nil** is returned.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(find-if #'atom '((a (b)) ((a) b) (nil nil)) :key #'second)
=> ((A) B)
```

If the value of the **:from-end** keyword is non-**nil**, then the result is the rightmost element satisfying the test.

For example:

```
(find-if #'numberp '(1 1 2 2) :from-end t)  => 2

(find-if #'numberp '(1 1 2 2) :from-end nil) => 1
```

You can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(find-if #'oddp '(1 2 1 2))  => 1

(find-if #'oddp '(1 1 1 2 2 2) :start 3 :end 4)  => NIL
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts*.

find-if-not *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

If *sequence* contains an element that does not satisfy *predicate*, then the leftmost such element is returned; otherwise **nil** is returned.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(find-if-not #'atom '((a (b)) ((a) b) (nil nil)) :key #'second)
 => (A (B))
```

If the value of the **:from-end** keyword is non-**nil**, then the result is the rightmost element satisfying the test.

For example:

```
(find-if-not #'evenp '(3 2 1) :from-end t) => 1

(find-if-not #'evenp '(3 2 1) :from-end nil)  => 3
```

For the sake of efficiency, you can delimit the portion of the sequence to be operated on by the keyword arguments **:start** and **:end**.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(find-if-not #'oddp '(3 5 4 3 5)) => 4

(find-if-not #'oddp '(3 5 4 3 5) :start 3 :end 4)  => NIL

(find-if-not #'evenp '(3 5 4 3 5) :start 3 :end 4) => 3
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts*.

find-package *name* *Function*

Returns the package object whose name is *name*. This allows you to locate the actual package object for use with those functions that take a package (not the name of the package) as an argument, such as **package-name** and **package-nicknames**.

```
(find-package 'cl-user) =>
                #<Package USER (really COMMON-LISP-USER) 35715022>
(find-package 'sys) => #<Package SYSTEM 35532204>
```

See the section "Mapping Between Names and Packages" in *Symbolics Common Lisp: Language Concepts*.

zl:find-position-in-list *item list* *Function*

zl:find-position-in-list looks down *list* for an element that is **eq** to *item*, like **zl:memq**. However, it returns the numeric index in the list at which it found the first occurrence of *item*, or **nil** if it did not find it at all. This function is sort of the complement of **nth**; like **nth**, it is zero-based. See the function **nth**, page 382. Examples:

```
(zl:find-position-in-list 'a '(a b c)) => 0
(zl:find-position-in-list 'c '(a b c)) => 2
(zl:find-position-in-list 'e '(a b c)) => nil
```

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

zl:find-position-in-list-equal *item list* *Function*

zl:find-position-in-list-equal is exactly the same as **zl:find-position-in-list**, except that the comparison is done with **zl:equal** instead of **eq**.

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

find-symbol *string* &optional (*pkg* **zl:package**) *Function*

F

first *list* *Function*

This function takes a list as an argument and returns its first element. **first** is identical to **car**. The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:firstn *n list* *Function*

zl:firstn returns a list of length *n*, whose elements are the first *n* elements of **list**. If *list* is fewer than *n* elements long, the remaining elements of the returned list are **nil**. Example:

```
(zl:firstn 2 '(a b c d)) => (a b)
(zl:firstn 0 '(a b c d)) => nil
(zl:firstn 6 '(a b c d)) => (a b c d nil nil)
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:fix *x* *Function*

Converts *x* from a floating-point number to an integer, truncating towards negative infinity. If *x* is already an integer, it is returned unchanged.

zl:fix is similar to **floor**, except that it returns only the first value of **floor**.

See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

fixnum *Type Specifier*

fixnum is the type specifier symbol for the predefined primitive Lisp object, fixnum.

The types **fixnum** and **bignum** are an *exhaustive partition* of the type integer, since `integer ≡ (or bignum fixnum)`. These are internal representations of integers used by the system for efficiency depending on integer size; in general, fixnums and bignums are transparent to the programmer.

Examples:

```
(typep 4 'fixnum) => T

(zl:typep '1 )  => :FIXNUM

(subtypep 'fixnum 'number) => T and T ; subtype and certain

(commonp most-positive-fixnum) => T

(zl:fixnump 90) => T

(type-of 8654) => FIXNUM
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

zl:fixnump *object* *Function*

zl:fixnump returns **t** if its argument is a fixnum, otherwise **nil.**

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:fixp *object* *Function*

zl:fixp returns **t** if its argument is an integer, otherwise **nil.**

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:fixr *x* *Function*

Converts *x* from a floating-point number to an integer, rounding to the nearest integer. **zl:fixr** is similar to **round**, except when *x* is exactly halfway between two integers. In this case, **zl:fixr** rounds up (towards positive infinity), while **round** rounds to an even integer.

zl:fixr could have been defined by:

```
(defun zl:fixr (x)
  (if (zl:fixp x) x (zl:fix (+ x 0.5))))
```

For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

flavor:flavor-allowed-init-keywords *flavor-name* *Function*

Returns an alphabetically sorted list of all symbols that are valid init options for the flavor named *flavor-name.* Valid init options are allowed keyword arguments to **make-instance.**

This function is primarily useful for people, rather than programs, to call to get information. You can use this to help remember the name of an init option or to help write documentation about a particular flavor.

flavor-allows-init-keyword-p *flavor-name keyword* *Function*

Returns non-**nil** if the *keyword* is a valid init option for the flavor named *flavor-name*, or **nil** if it does not. Valid init options are allowed keyword arguments to **make-instance.** The non-**nil** value is the name of the component flavor that contributes the support of that keyword.

This function is primarily useful for people, rather than programs, to call to get information.

flavor:*flavor-compile-trace-list* *Variable*

Value is a list of structures, each of which describes the compilation of a combined method into the run-time (not the compile-time) environment, in newest-first order. The function **flavor:print-flavor-compile-trace** lets you selectively access the information saved in this variable. See the function **flavor:print-flavor-compile-trace**, page 403.

flavor:flavor-default-init-get *flavor property* *Function*

flavor:flavor-default-init-get is like **get** except that its first argument is either a flavor structure or the name of a flavor. It retrieves the property from the default init-plist of the specified flavor. You can use **setf**:

```
(setf (flavor:flavor-default-init-get f p) x)
```

flavor:flavor-default-init-putprop *flavor value property* *Function*

flavor:flavor-default-init-putprop is like **putprop** except that its first argument is either a flavor structure or the name of a flavor. It puts the property on the default-init-plist of the specified flavor.

flavor:flavor-default-init-remprop *flavor property* *Function*

flavor:flavor-default-init-remprop is like **remprop** except that its first argument is either a flavor structure or the name of a flavor. It removes the property from the default init-plist of the specified flavor.

float *number* &optional *other* *Function*

Converts any noncomplex number to a floating-point number. With no second argument, if *number* is already a floating-point, *number* is returned. If *number* is not of floating-point type, a single-float is produced and returned.

If the second argument *other* is provided, it must be of floating-point type, and *number* is converted to the same format as *other*.

Examples:

```
(float 3) => 3.0
(float 3 1.0d0) => 3.0d0
```

For a table of related items: See the section "Functions That Convert Numbers to Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts*.

float &optional (*low* '*) (*high* '*) *Type Specifier*

float is the type specifier symbol for the predefined Lisp floating-point number type.

The types **float**, **rational**, and **complex** are *pairwise disjoint subtypes* of **number**.

The **float** data type is a *supertype* of the types:

short-float
single-float
long-float
double-float

This type specifier can be used in either symbol or list form. Used in list form, **float** allows the declaration and creation of specialized floating-point numbers, whose range is restricted to *low* and *high*.

low and *high* must each be a floating-point number, a list of floating-point number, or unspecified; in floating-point number form the limits are inclusive; in list form they are *exclusive*, and * means that a limit does not exist and so effectively denotes minus or plus infinity, respectively.

Examples:

```
(typep 20.4e-2 'float) => T
(typep (/ (float 14) (float 4)) 'float) => T
 ;note the use of float the function and float the type
(subtypep 'float 'number) => T and T ;subtype and certain
(subtypep 'single-float 'float) => T and T
(commonp (float 3)) => T
(floatp 989.e-3) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

zl:float *x* *Function*

Converts any noncomplex number to a single-precision floating-point number. Note that **zl:float** reduces a double-precision argument to single precision.

Examples:

```
(zl:float 3) => 3.0
(zl:float 6.02d23) => 6.02e23
```

See the section "Functions That Convert Numbers to Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Functions That Convert Numbers to Floating-point Numbers" in *Symbolics Common Lisp: Language* Concepts.

float-digits *float* *Function*

Returns, as a non-negative integer, the number of binary digits used in the binary representation of its floating-point argument (including the implicit "hidden bit" used in IEEE standard floating-point representation).

Examples:

```
(float-digits 0.0) => 24
(float-digits 3.0s5) => 24
(float-digits pi) => 53          ;pi is a long float
(float-digits 1.0s-40) => 24
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

floatp *object* *Function*

floatp returns **t** if its argument is a (single- or double-precision) floating-point number. Otherwise it returns **nil.**

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

float-precision *float* *Function*

Returns, as a non-negative integer, the number of significant binary digits present in the binary representation of the floating-point argument. Note that if the argument is (a floating-point) zero, the result is an (integer) zero. For normalized floating-point numbers, **float-digits** and **float-precision** return identical results. For a denormalized or zero number, the precision is smaller than the number of representation digits (that is, **float-precision** returns a smaller number).

Examples:

```
(float-precision 0.0) => 0
(float-precision 1.6s-19) => 24
(float-precision 1.6l-19) => 53
(float-precision 1.0s-40) => 17
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

float-radix *float* *Function*

Returns the integer 2 denoting the radix of the internal IEEE floating-point representation in Symbolics Common Lisp.

Examples:

```
(float-radix pi) => 2
(float-radix 5.010) => 2
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

float-sign *float1* &optional *float2* *Function*

Returns a floating-point number *z* which has the same sign as *float1* and the same absolute value and format as *float2*. The second argument defaults to the value of (**float** 1 *float1*), that is, it is a floating-point 1 of the same type as *float1*. Both arguments must be floating-point numbers.

Examples:

```
(float-sign 3.0) => 1.0
(float-sign -7.9) => -1.0
(float-sign -2.0 pi) => -3.141592653589793d0
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

zl:flonump *object* *Function*

zl:flonump returns **t** if *object* is a single-precision floating-point number, otherwise it returns **nil**.

The following function is a synonym of **flonump**:

sys:single-float-p

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

floor *number* &optional (*divisor* **1**) *Function*

Divides *number* by *divisor*, and truncates the result toward negative infinity. The truncated result and the remainder are the returned values.

number and *divisor* must each be a noncomplex number. Not specifying a divisor is exactly the same as specifying a divisor of 1.

If the two returned values are Q and R, then (+ (* Q *divisor*) R) equals *number*. If *divisor* is 1, then Q and R add up to *number*. If *divisor* is 1 and *number* is an integer, then the returned values are *number* and 0.

The first returned value is always an integer. The second returned value is integral if both arguments are integers, is rational if both arguments are rational, and is floating-point if either argument is floating-point. If only one argument is specified, then the second returned value is always a number of the same type as the argument.

Examples:

```
(floor 5)  => 5 and 0
(floor -5) => -5 and 0
(floor 5.2) => 5 and 0.19999981
(floor -5.2) => -6 and 0.8000002
(floor 5.8) => 5 and 0.8000002
(floor -5.8) => -6 and 0.19999981
(floor 5 3) => 1 and 2
(floor -5 3) => -2 and 1
(floor 5 4) => 1 and 1
(floor -5 4) => -2 and 3
(floor 5.2 3) => 1 and 2.1999998
(floor -5.2 3) => -2 and 0.8000002
(floor 5.2 4) => 1 and 1.1999998
(floor -5.2 4) => -2 and 2.8000002
(floor 5.8 3) => 1 and 2.8000002
(floor -5.8 3) => -2 and 0.19999981
(floor 5.8 4) => 1 and 1.8000002
(floor -5.8 4) => -2 and 2.1999998
```

Using **floor** with one argument is the same as the **zl:fix** function, except that **zl:fix** returns only the first value of **floor**.

See the section "Comparison Of **floor**, **ceiling**, **truncate** And **round**" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

fmakunbound *sym* *Function*

Causes *sym* to be undefined, that is, its function cell to be empty. It returns *sym*.

for Keyword For loop

for is one of the iteration driving clauses for **loop**. As described below, there are numerous variants for this keyword.

The optional argument, *data-type* is reserved for data type declarations. It is currently ignored.

for *var* {*data-type*} **from** *expr1* {**to** *expr2*} {**by** *expr3*}

To iterate *upward*. Performs numeric iteration.

var is initialized to *expr1*, and on each succeeding iteration is incremented by *expr3* (default 1). If the **to** phrase is given, the iteration terminates when

F

var becomes greater than *expr2*. Each of the expressions is evaluated only once, and the **to** and **by** phrases can be written in either order.

Note that the **to** variant appropriate for the direction of stepping must be used for the endtest to be formed correctly; that is, the code does not work if *expr3* is negative or 0.

data-type defaults to **fixnum**. The keyword **as** is equivalent to the keyword **for**.

Examples:

```
(defun loop1 ()
  (loop for i from 1 to 10
        collect i)) => LOOP1
(loop1) => (1 2 3 4 5 6 7 8 9 10)

(defun loop2 ()
  (loop for i from 0 to 5 by 1
        do
    (princ i))) => LOOP2
(loop2) => 012345NIL

(defun loop3(inc)
  (loop as x from 0 by inc to (+ inc 4)
        do
    (princ x)
    (setq x (+ x 1))))  => LOOP3
(loop3 1) => 024NIL
```

for *var* {*data-type*} **from** *expr1* **downto** *expr2* {**by** *expr3*}

To iterate *downward*. Performs numeric iteration. *var* is initialized to *expr1*, and on each succeeding iteration is decremented by *expr3*, and the endtest is adjusted accordingly.

Examples:

```
(defun loop3 ()
  (loop for my-number from 7 by 2 downto -2
        do
    (princ my-number)(princ " "))) => LOOP3
(loop3) => 7 5 3 1 -1 NIL
```

for *var* {*data-type*} **from** *expr1* {**below** *expr2*} {**by** *expr3*}

Loop will terminate when the variable of iteration, *expr1*, is *greater than or equal* to some terminal value, *expr2*.

Examples:

```
(defun loop1 ()
  (loop for i from 0 below 10
        do
    (princ i))) => LOOP1
(loop1) => 0123456789NIL

(defun loop2 ()
  (loop for my-number from 7.5 by .5 below 12
        do
    (princ my-number)(princ " "))) => LOOP2
(loop2) => 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 NIL
```

for *var* {*data-type*} **from** *expr1* {**above** *expr2*} {**by** *expr3*}

Loop will terminate when the variable of iteration is *less than* or *equal* to some terminal value.

Examples:

```
(defun loop1 ()
  (loop for my-number from 12 by .5 above 7.5
        do
    (print my-number)))  => LOOP1
(loop1) =>
12
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0 NIL
```

for *var* {*data-type*} **downfrom** *expr1* {**by** *expr2*}

Used to iterate *downward* with no limit.

Examples:

```
(defun loop-downfrom (num)
  (loop for x downfrom 8 by num
        do
    (print x))) => LOOP-DOWNFROM
(loop-downfrom 1)
8
7
6
5... ;infinite
```

for *var* {*data-type*} **upfrom** *expr1* {**by** *expr2*}

Used to iterate *upward* with no limit.

Examples:

```
(defun loop-upfrom ()
  (loop for x upfrom -2 by 2
        do
    (print x))) => LOOP-UPFROM
(loop-upfrom)
-2
0
2
4... ;infinite
```

for *var* {*data-type*} **in** *expr1* {**by** *expr2*}

Iterates over each of the elements in the list *expr1*. If the **by** subclause is present, *expr2* is evaluated once on entry to the loop to supply the function to be used to fetch successive sublists, instead of **cdr**.

Examples:

```
(defun loop1 (input-list)
  (loop for x in input-list
        for i from 0
        do
    (princ (list i x)))) => LOOP1
(loop1 '(a b (c d) e)) => (0 A)(1 B)(2 (C D))(3 E)NIL
```

for *var* {*data-type*} **on** *expr1* {**by** *expr2*}

Like the previous **for** format, except that *var* is set to successive sublists of the list instead of successive elements. Note that since *var* is always a list, it is not meaningful to specify a *data-type* unless *var* is a *destructuring* pattern, as described in the section on *destructuring*. Note also that **loop** uses a **null** rather than an **atom** test to implement both this and the preceding clause.

Example:

```
(defun loop1 (input-list)
  (loop for sub1 on input-list
        do
    (print sub1))) => LOOP1
(loop1 '(a b c (k c) d)) =>
(A B C (K C) D)
(B C (K C) D)
(C (K C) D)
((K C) D)
(D) NIL
```

In contrast to what **in** would do

```
(defun loop1 (input-list)
  (loop for sub1 in input-list
        do
    (print sub1))) => LOOP1
(loop1 '(a b c (k c) d)) =>
A
B
C
(K C)
D NIL
```

for *var* {*data-type*} = *expr*

On each iteration, *expr* is evaluated and *var* is set to the result.

for *var* {*data-type*} = *expr1* **then** *expr2*

var is bound to *expr1* when the loop is entered, and set to *expr2* (reevaluated) at all but the first iteration. Since *expr1* is evaluated during the binding phase, it cannot reference other iteration variables set before it; for that, use the following:

Examples:

```
(defun loop1 (x)
  (loop for stepper = x then (* stepper x)
        do
    (print stepper))) => LOOP1
(loop1 3)
3
9
27
81... ; infinite loop
```

F

for *var* {*data-type*} **first** *expr1* **then** *expr2*

Sets *var* to *expr1* on the first iteration, and to *expr2* (reevaluated) on each succeeding iteration. The evaluation of both expressions is performed inside of the **loop** binding environment, before the **loop** body. This allows the first value of *var* to come from the first value of some other iteration variable, allowing such constructs as:

```
(loop for term in poly
      for ans first (car term) then (gcd ans (car term))
      finally (return ans))
```

for *var* {*data-type*} **being** *expr* **and its** *path* **...**
for *var* {*data-type*} **being** {**each**|**the**} *path* **...**

This provides a user-definable iteration facility. *path* names the manner in which the iteration is to be performed. The ellipsis indicates where various path-dependent preposition/expression pairs can appear.

See the section "Iteration Paths" in *Symbolics Common Lisp: Language Concepts.*
Examples:

```
(define-loop-sequence-path ascii-char
                           (lambda (string i)
                             (ascii-code (aref string i)))
  length) => NIL

(loop for x being the ascii-char of "ABC"
      doing
  (print x)) =>
65
66
67 NIL ; 65 is the ascii equivalent of "A"

(loop for a being the array-elements of q using (index ai)
      collecting (lambda (x)
                   when (> x a)
                   (aset x q ai))))
```

See the section "**loop** Clauses", page 310.

fourth *list* *Function*

This function takes a list as an argument, and returns the fourth element of the list. **fourth** is identical to

```
(nth 3 list)
```

The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

dbg:frame-active-p *frame* *Function*

dbg:frame-active-p indicates whether *frame* is an active frame.

Value	*Meaning*
nil	Frame is not active
not **nil**	Frame is active

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

dbg:frame-arg-value *frame arg-name-or-number* &optional *callee-context no-error-p* *Function*

dbg:frame-arg-value returns the value of the *n*th argument to *frame*. It returns a second value, which is a locative pointer to the word in the stack that holds the argument. If *n* is out of range, then it takes action based on *no-error-p*: if *no-error-p* is **nil**, it signals an error, otherwise it returns **nil**. *n* can also be the name of the argument (a symbol, but it need not be in the right package). Each argument passed for an **&rest** parameter counts as a separate argument when *n* is a number. **dbg:frame-arg-value** controls whether you get the caller or callee copy of the argument (original or possibly modified.)

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

dbg:frame-local-value *frame local-name-or-number* &optional *no-error-p* *Function*

dbg:frame-local-value returns the value of the *n*th local variable in *frame*. *n* can also be the name of the local variable (a symbol, but it need not be in the right package). It returns a second value, which is a locative pointer to the word in the stack that holds the local variable. If *n* is out of range, then the action is based on *no-error-p*: if *no-error-p* is **nil**, it signals an error, otherwise it returns **nil**.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-active-frame *frame* *Function*

dbg:frame-next-active-frame returns a frame pointer to the next active frame following *frame.* If *frame* is the last active frame on the stack, it returns **nil.**

"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-interesting-active-frame *frame* *Function*

dbg:frame-next-interesting-active-frame returns a frame pointer to the next interesting active frame following *frame.* If *frame* is the last interesting active frame on the stack, it returns **nil.**

"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

"Interesting active frames" include all of the active frames except those that are parts of the internals of the Lisp interpreter, such as the frames for **eval, apply, funcall, let,** and other basic Lisp special forms. The list of such functions is the value of the system constant, **dbg:*uninteresting-functions*.**

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-nth-active-frame *frame* &optional (*count* **1**) *Function*

dbg:frame-next-nth-active-frame goes up the stack by *count* active frames from *frame* and returns a frame pointer to that frame. It returns a second value that is not **nil.** When count is positive, this is like calling **dbg:frame-next-active-frame** *count* times; *count* can also be negative or zero. If either end of the stack is reached, it returns a frame pointer to the first or last active frame and **nil.**

"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-nth-interesting-active-frame *frame* &optional (*count* **1**) *Function*

dbg:frame-next-nth-interesting-active-frame goes up the stack by *count* interesting active frames from *frame* and returns a frame pointer to that frame. It returns a second value that is not **nil**. When count is positive, this is like calling **dbg:frame-next-interesting-active-frame** *count* times; *count* can also be negative or zero. If either end of the stack is reached, it returns a frame pointer to the first or last active frame and **nil**.

"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

"Interesting active frames" include all of the active frames except those that are parts of the internals of the Lisp interpreter, such as the frames for **eval, apply, funcall, let**, and other basic Lisp special forms. The list of such functions is the value of the system constant, **dbg:*uninteresting-functions***.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-nth-open-frame *frame* &optional (*count* **1**) *Function*

dbg:frame-next-nth-open-frame goes up the stack by *count* open frames from *frame* and returns a frame pointer to that frame. It returns a second value that is not **nil**. When count is positive, this is like calling **dbg:frame-next-open-frame** *count* times; *count* can also be negative or zero. If either end of the stack is reached, it returns a frame pointer to the first or last active frame and **nil**.

"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-next-open-frame *frame* *Function*

dbg:frame-next-open-frame returns a frame pointer to the next open frame following *frame-pointer.* If *frame* is the last open frame on the stack, it returns **nil**.

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"Next" means the frame of a procedure that was invoked more recently (the frame called by this one; toward the top of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-number-of-locals *frame* *Function*

dbg:frame-number-of-locals returns the number of local variables allocated for *frame.*

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-number-of-spread-args *frame* &optional (*type* **:supplied**) *Function*

dbg:frame-number-of-supplied-args returns the number of "spread" arguments that were passed in *frame.* (These are the arguments that are not part of a **&rest** parameter.) Sending a message to an instance results in two implicit arguments being passed internally along with the other arguments. These implicit arguments are included in the count.

type requests more specific definition of the number:

Value	*Meaning*
:supplied	Returns the number of arguments that were actually passed by the caller, except for arguments that were bound to a **&rest** parameter. This is the default.
:expected	Returns the number of arguments that were expected by the function being called.
:allocated	Returns the number of arguments for which stack locations have been allocated. In the absence of a **&rest** parameter, this is the same as **:expected** for compiled functions, and the same as **:supplied** for interpreted functions. If stack locations were allocated for arguments that were bound to a **&rest** parameter, they are included in the returned count.

These values would all be the same except in cases where a wrong-number-of-arguments error occurred, or where there are optional arguments (expected but not supplied).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

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For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-out-to-interesting-active-frame *frame* *Function*

dbg:frame-out-to-interesting-active-frame returns either *frame* (if it points to an interesting active frame) or the previous interesting active frame before *frame-pointer.* (This is what the :Previous Frame command `c-m-U` in the debugger does.)

"Interesting active frames" include all of the active frames except those that are parts of the internals of the Lisp interpreter, such as the frames for **eval, apply, funcall, let,** and other basic Lisp special forms. The list of such functions is the value of the system constant, **dbg:*uninteresting-functions*.**

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-previous-active-frame *frame* *Function*

dbg:frame-previous-active-frame returns a frame pointer to the previous active frame before *frame.* If *frame* is the first active frame on the stack, it returns **nil.**

"Previous" means the frame of a procedure that was invoked less recently (the caller of this frame; towards the base of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-previous-interesting-active-frame *frame* *Function*

dbg:frame-previous-interesting-active-frame returns a frame pointer to the previous interesting active frame before *frame.* If *frame* is the first interesting active frame on the stack, it returns **nil.**

"Previous" means the frame of a procedure that was invoked less recently (the caller of this frame; towards the base of the stack).

"Interesting active frames" include all of the active frames except those that are parts of the internals of the Lisp interpreter, such as the frames for **eval, apply, funcall, let,** and other basic Lisp special forms. The list of such functions is the value of the system constant, **dbg:*uninteresting-functions*.**

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-previous-open-frame *frame* *Function*

dbg:frame-previous-open-frame returns a frame pointer to the previous open frame before *frame.* If *frame* is the first open frame on the stack, it returns **nil.**

"Previous" means the frame of a procedure that was invoked less recently (the caller of this frame; towards the base of the stack).

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-real-function *frame* *Function*

dbg:frame-real-function returns either the function object associated with *frame* or **self** when the frame was the result of sending a message to an instance.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

dbg:frame-real-value-disposition *frame* *Function*

dbg:frame-real-value-disposition returns a symbol indicating how the calling function is going to handle the values to be returned by this frame. If the calling function just returns the values to its caller, then the symbol indicates how the final recipient of the values is going to handle them.

Value	*Meaning*
:ignore	The values would be ignored; the function was called for effect.
:single	The first value would be received and the rest would not; the function was called for value.
:multiple	All the values would be received; the function was called for multiple values. It returns a second value indicating the number of values expected. **nil** indicates an indeterminate number and is always returned.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

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dbg:frame-self-value *frame* &optional *instance-frame-only* *Function*

dbg:frame-self-value returns the value of **self** in *frame*, or **nil** if **self** does not have a value. If *instance-frame-only* is not **nil** then it returns **nil** unless this frame is actually a message-sending frame created by **send**.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

dbg:frame-total-number-of-args *frame* *Function*

dbg:frame-total-number-of-args returns the number of arguments that were passed in *frame*. For functions that take an **&rest** parameter, each argument is counted separately. Sending a message to an instance results in two implicit arguments being passed internally along with the other arguments. These implicit arguments are included in the count.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

fround *number* &optional (*divisor* **1**) *Function*

This is just like **round**, except that the first returned value is always a floating-point number instead of an integer. The second returned value is the remainder. If *number* is a floating-point number and *divisor* is not a floating-point number of longer format, then the first returned value is a floating-point number of the same type as *number*.

Examples:

```
(fround 5) => 5.0 and 0
(fround -5) => -5.0 and 0
(fround 5.2) => 5.0 and 0.19999981
(fround -5.2) => -5.0 and -0.19999981
(fround 5 3) => 2.0 and -1
(fround -5 3) => -2.0 and 1
(fround 5.2 4) => 1.0 and 1.1999998
(fround -5.2 4) => -1.0 and -1.1999998
(fround 4.2d0) => 4.0d0 and 0.20000000000000018d0
(fround -4.2d0) => -4.0d0 and -0.20000000000000018d0
```

For a table of related items: See the section "Functions That Divide and Return Quotient as Floating-point Number" in *Symbolics Common Lisp: Language Concepts.*

zl:fset *sym definition* *Function*

Stores *definition*, which can be any Lisp object, into *sym*'s function cell. It returns *definition.*

zl:fset-carefully *function-spec definition* &optional *no-query-flag* *Function*

This function is obsolete. It is equivalent to:

```
(fdefine symbol definition t force-flag)
```

zl:fsignal *format-string* &rest *format-args* *Function*

zl:fsignal is a simple function for signalling when you do not care to use a particular condition. **zl:fsignal** signals **dbg:proceedable-ferror.** (See the flavor **dbg:proceedable-ferror** in *Symbolics Common Lisp: Language Concepts.*) The arguments are passed as the **:format-string** and **:format-args** init keywords to the error object.

Note: zl:fsignal is now obsolete. Use **cerror** in your new programs instead.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:fsymeval *symbol* *Function*

Returns *symbol*'s definition, the contents of its function cell. If the function cell is empty, **zl:fsymeval** causes an error.

The Common Lisp equivalent for **zl:fsymeval** is **symbol-function.**

ftruncate *number* &optional (*divisor* **1**) *Function*

This is just like **truncate**, except that the first returned value is always a floating-point number instead of an integer. The second returned value is the remainder. If *number* is a floating-point number and *divisor* is not a floating-point number of longer format, then the first returned value is a floating-point number of the same type as *number.*

Examples:

```
(ftruncate 5) => 5.0 and 0
(ftruncate -5) => -5.0 and 0
(ftruncate 5.2) => 5.0 and 0.19999981
(ftruncate -5.2) => -5.0 and -0.19999981
(ftruncate 5 3) => 1.0 and 2
(ftruncate -5 3) => -1.0 and -2
(ftruncate 5.2 4) => 1.0 and 1.1999998
(ftruncate -5.2 4) => -1.0 and -1.1999998
(ftruncate 4.2d0) => 4.0d0 and 0.2000000000000018d0
(ftruncate -4.2d0) => -4.0d0 and -0.2000000000000018d0
```

For a table of related items: See the section "Functions That Divide and Return Quotient as Floating-point Number" in *Symbolics Common Lisp: Language Concepts.*

funcall *fn* &rest *args* *Function*

(funcall *fn a1 a2* **...** *an***)** applies the function *fn* to the arguments *a1*, *a2*, ..., *an*. *fn* cannot be a special form nor a macro; this would not be meaningful. Example:

```
(cons 1 2) => (1 . 2)
(setq cons 'plus)
(funcall cons 1 2) => 3
(cons 1 2) => (1 . 2)
```

This shows that the use of the symbol **cons** as the name of a variable and the use of that symbol as the name of a function do not interact. The funcall form evaluates the variable and gets the symbol **zl:plus**, which is the name of a different function. The **cons** form invokes the function named **cons**.

Note: The Maclisp functions **subrcall**, **lsubrcall**, and **zl:arraycall** are not needed in Symbolics Common Lisp; **funcall** is just as efficient. **zl:arraycall** is provided for compatibility; it ignores its first subform (the Maclisp array type) and is otherwise identical to **aref**. **subrcall** and **lsubrcall** are not provided.

See the section "Functions for Function Invocation" in *Symbolics Common Lisp: Language Concepts.*

function ((*arg1-type arg2-type ...*) *value-type*) *Type Specifier*

function is the type specifier for the predefined Lisp object of that name.

The list syntax is for declaration. Every element of this type is a function that accepts arguments at *least* of the types specified by the *argj-type* forms, and returns a value that is a member of the types specified by the *value-type* form.

Examples:

```
(defun fun-example (num) (+ num num)) => FUN-EXAMPLE
(typep 'fun-example 'function) => T
(sys:type-arglist 'function) => NIL and T
(functionp 'fun-example) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Functions" in *Symbolics Common Lisp: Language Concepts.*

function *function* *Special Form*

This means different things depending on whether *function* is a function or the name of a function. (Note that in neither case is *function* evaluated.) The name of a function is a symbol or a function-spec list. See the section "Function Specs" in *Symbolics Common Lisp: Language Concepts.* A function is typically a list whose car is the symbol **lambda**; however there are several other kinds of functions available. See the section "Kinds of Functions" in *Symbolics Common Lisp: Language Concepts.*

If you want to pass an anonymous function as an argument to a function, you could just use **quote**. For example:

```
(mapc (quote (lambda (x) (car x))) some-list)
```

The compiler and interpreter cannot tell that the first argument is going to be used as a function; for all they know, **mapc** treats its first argument as a piece of list structure, asking for its **car** and **cdr** and so forth. The compiler cannot compile the function; it must pass the lambda-expression unmodified. This means that the function does not get compiled, which makes it execute more slowly than it might otherwise. The interpreter cannot make references to free lexical variables work by making a lexical closure; it must pass the lambda-expression unmodified.

The **function** special form is the way to say that a lambda-expression represents a function rather than a piece of list structure. You just use the symbol **function** instead of **quote**:

F

```
(mapc (function (lambda (x) (car x))) some-list)
```

To ease typing, the reader converts *#'thing* into **(function** *thing*). So #' is similar to ' except that it produces a **function** form instead of a **quote** form. So the above form could be written as:

```
(mapc #'(lambda (x) (car x)) some-list)
```

If *function* is not a function but the name of a function (typically a symbol, but in general any kind of function spec), then **function** returns the definition of *function*; it is like **fdefinition** except that it is a special form instead of a function, and so

```
(function fred)
```

is like

```
(fdefinition 'fred)
```

which is like

```
(fsymeval 'fred)
```

since **fred** is a symbol.

If *function* is the name of a local function defined with **flet** or **labels**, then **(function** *function*) produces a lexical closure of *function*, just like **(function (lambda...))**.

Another way of explaining **function** is that it causes *function* to be treated the same way as it would as the car of a form. Evaluating the form *(function arg1 arg2...)* uses the function definition of *function* if it is a symbol, and otherwise expects *function* to be a list that is a lambda-expression. Note that the car of a form cannot be a nonsymbol function spec, to avoid difficult-to-read code. This can be written as:

```
(funcall (function spec) args...)
```

You should be careful about whether you use #' or '. Suppose you have a program with a variable **x** whose value is assumed to contain a function that gets called on some arguments. If you want that variable to be the **car** function, there are two things you could say:

```
(setq x 'car)
or
(setq x #'car)
```

The former causes the value of **x** to be the symbol **car**, whereas the latter causes the value of **x** to be the function object found in the function cell of **car**. When the time comes to call the function (the program does **(funcall x ...)**), either of these two work because if you use a symbol as a function, the contents of the symbol's function cell is used as the function. The

former case is a bit slower, because the function call has to indirect through the symbol, but it allows the function to be redefined, traced, or advised. (See the special form **trace** in *Program Development Utilities*. See the special form **advise** in *Program Development Utilities*.) The latter case, while faster, picks up the function definition out of the symbol **car** and does not see any later changes to it.

sys:function-cell-location *sym* *Function*

Returns a locative pointer to *sym*'s function cell. See the section "Cells and Locatives". It is preferable to write:

```
(locf (fsymeval sym))
```

rather than calling this function explicitly.

si:function-encapsulated-p *function-spec* *Function*

si:function-encapsulated-p looks at the debugging info alist to check whether *function-spec* is an encapsulation.

functionp *arg* &optional *allow-special-forms* *Function*

functionp returns **t** if its argument is a function (essentially, something that is acceptable as the first argument to **apply**), otherwise it returns **nil**. In addition to interpreted, compiled, and built-in functions, **functionp** is true of closures, select-methods, and symbols whose function definition is **functionp**. See the section "Other Kinds of Functions" in *Symbolics Common Lisp: Language Concepts*. **functionp** is not true of objects that can be called as functions but are not normally thought of as functions: arrays, stack groups, entities, and instances. If *allow-special-forms* is specified and non-**nil**, then **functionp** is true of macros and special-form functions (those with quoted arguments). Normally **functionp** returns **nil** for these since they do not behave like functions. As a special case, **functionp** of a symbol whose function definition is an array returns **t**, because in this case the array is being used as a function rather than as an object.

sys:function-parent *function-spec* &optional *definition-type* *Function*

When a symbol's definition is produced as the result of macro expansion of a source definition, so that the symbol's definition does not appear textually in the source, the editor cannot find it. The accessor, constructor, and alterant macros produced by a **zl:defstruct** are an example of this. The **sys:function-parent** declaration can be inserted in the source definition to record the name of the outer definition of which it is a part.

The declaration consists of the following:

(**sys:function-parent** *name type*)

name is the name of the outer definition. *type* is its type, which defaults to

defun. See the section "Using The **sys:function-parent** Declaration" in *Symbolics Common Lisp: Language Concepts.* Declarations are explained in another section. See the section "Declarations" in *Symbolics Common Lisp: Language Concepts.*

sys:function-parent is a function related to the declaration. It takes a function spec and returns **nil** or another function spec. The first function spec's definition is contained inside the second function spec's definition. The second value is the type of definition.

Two examples:

```
(defsubst foo (x y)
  (declare (sys:function-parent bar))
  ...)

(defmacro defxxx (name ...)
  `(local-declare ((sys:function-parent ,name defxxx))
        (defmacro ...)
        (defmacro ...)
        ))
```

si:function-spec-get *function-spec indicator* *Function*

Returns the value of the *indicator* property of *function-spec*, or **nil** if it doesn't have such a property.

si:function-spec-putprop *function-spec value indicator* *Function*

Gives *function-spec* an *indicator* property whose value is *value.*

fundefine *function-spec* *Function*

Removes the definition of *function-spec.* For symbols this is equivalent to **fmakunbound.** If the function is encapsulated, **fundefine** removes both the basic definition and the encapsulations. Some types of function specs (**:location** for example) do not implement **fundefine.** **fundefine** on a **:within** function spec removes the replacement of *function-to-affect*, putting the definition of *within-function* back to its normal state. **fundefine** on a method's function spec removes the method completely, so that future messages or generic functions will be handled by some other method.

Regarding **fundefine** and generic functions: The first time you define a method for a previously undefined generic function, the name of the generic function is given the generic function as its function definition, so you can call it. Additional method definitions do not do this, even if you **fundefine** the name of the generic function. Thus, if you **fundefine** a generic function, and then compile a **defmethod** form, the generic function remains undefined until you do an explicit **defgeneric.** While the generic function is undefined, any callers to it will malfunction.

gcd &rest *integers* *Function*

Computes and returns an integer representing the greatest common divisor of all the arguments, which must be integers. The result is always non-negative.

If one argument is given, the absolute value is returned. If there are no arguments, the returned value is 0.

Examples:

```
(gcd) => 0
(gcd -9) => 9
(gcd 36 48) => 12
(gcd 16 72 40 24) => 8
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:gcd *integer1 integer2* &rest *more-integers* *Function*

Returns the greatest common divisor of all its arguments. The arguments must be integers.

The following function is a synonym of **zl:gcd**:

zl:

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

flavor:generic *generic-function-name* *Special Form*

Evaluates to the generic function named *generic-function-name* (which is not evaluated). This is used when there is a prologue function so that the function definition of *generic-function-name* is not itself the generic function. This is used in conjunction with the **:function** option to **defgeneric**. For example:

```
(apply (flavor:generic make-instance) new-instance init-options)
```

sys:generic-function *Type Specifier*

sys:generic-function is the type specifier symbol for the predefined Lisp object of that name.

Examples:

```
(defflavor ship
  (name x-velocity y-velocity z-velocity mass)
   ()    ; no component flavors
  :readable-instance-variables
  :writable-instance-variables
  :initable-instance-variables) => SHIP

(setq my-ship
  (make-instance 'ship :name "Enterprise"
                       :mass 4534
                       :x-velocity 24
                       :y-velocity 2
                       :z-velocity 45)) => #<SHIP 43062426>

(ship-name my-ship) => "Enterprise"

(typep #'ship-name 'sys:generic-function) => T

(defmethod (speed ship) ()
   (sqrt (+ (expt x-velocity 3)
            (expt y-velocity 4)
            (expt z-velocity 1)))) => (FLAVOR:METHOD SPEED SHIP)

(typep #'speed 'sys:generic-function) => T
(type-of my-ship) => SHIP
(sys:type-arglist 'sys:generic-function) => NIL
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Flavors" in *Symbolics Common Lisp: Language Concepts.*

gensym &optional *arg* *Function*

Invents a print-name, and creates a new symbol with that print-name. It returns the new, uninterned symbol.

The invented print-name is a character prefix (the value of **si:*gensym-prefix**) followed by the decimal representation of a number (the value of **si:*gensym-counter**), for example, "G0001". The number is increased by 1 every time **gensym** is called.

If the argument *arg* is present and is a fixnum, then **si:*gensym-counter** is set to *arg*. If *arg* is a string or a symbol, then **si:*gensym-prefix** is set to the string or the symbol's print-name. After handling the argument, gensym creates a symbol as it would with no argument. Examples:

```
if      (gensym) =>#:G3310
then    (gensym "foo") => #:|foo3311|
        (gensym 32) => #:|foo32|
        (gensym) => #:|foo33|
```

gensym is usually used to create a symbol that should not normally be seen by the user, and whose print-name is unimportant, except to allow easy distinction by eye between two such symbols. The optional argument is rarely supplied. The name comes from "generate symbol", and the symbols produced by it are often called "gensyms".

zl:gensym &optional *x* *Function*

Invents a print-name, and creates a new symbol with that print-name. It returns the new, uninterned symbol.

If the argument *x* is present and is a fixnum, then **si:*gensym-counter** is set to *x* and incremented. If *x* is a string or a symbol, then **si:*gensym-prefix** is set to the first character of the string or of the symbol's print-name. After handling the argument, **zl:gensym** creates a symbol as it would with no argument. Examples:

```
if      (zl:gensym) =>#:G3310
then    (zl:gensym "foo") => #:F3311
        (zl:gensym 32) => #:F0033
        (zl:gensym) => #:F0034
```

Note that the number is in decimal and always has four digits, and the prefix is always one character.

See the function **gensym**, page 251.

gentemp &optional (*prefix* "**t**") *package* *Function*

Creates and returns a new symbol as **gensym** does, but **gentemp** interns the symbol in **package**. **package** defaults to the current package, that is, the value of ***package***. **gentemp** guarantees that the generated symbol is a new one not already existing in *package*. There is no provision for resetting the **gentemp** counter and the prefix is not remembered from one call to the next. If *prefix* is omitted, T is used. See the section "Functions for Creating Symbols" in *Symbolics Common Lisp: Language Concepts*.

get *symbol indicator* &optional *default* *Function*

get searches the property list of *symbol* for an indicator that is **eq** to indicator. See the section "Property Lists" in *Symbolics Common Lisp: Language Concepts*. The first argument must be a symbol. If a matching indicator is found, then the corresponding value is returned; otherwise *default* is returned. If *default* is not specified, then **nil** is used as the default.

Note that there is no way to distinguish an absent property from one whose value is *default*.

Suppose that the property list of **eagle** is

```
(color (brown white) food snakes seed-eater nil)
```

Then, for example:

```
(get 'eagle 'color) => (BROWN WHITE)

(get 'eagle 'food) => SNAKES

(get 'eagle 'seed-eater) => NIL

(get 'eagle 'beak "No such indicator") => "No such indicator"
```

setf may be used with **get** to create a new property-value pair, possibly replacing an old pair with the same name. For example:

```
(setf (get 'eagle 'food) '(mice snakes)) => (MICE SNAKES)
```

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:get *plist indicator* *Function*

zl:get looks up *plist*'s *indicator* property. See the section "Property Lists" in *Symbolics Common Lisp: Language Concepts*. If it finds such a property, it returns the value; otherwise, it returns **nil**. If *plist* is a symbol, the symbol's associated property list is used. For example, if the property list of **foo** is **(baz 3)**, then:

```
(zl:get 'foo 'baz) => 3
(zl:get 'foo 'zoo) => nil
```

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts*.

flavor:get-all-flavor-components *flavor-name* &optional *env* *Function*

Returns a list of the components of the flavor *flavor-name*, in the sorted ordering of flavor components. Any duplicate flavors are eliminated from this list by the flavor ordering mechanism. See the section "Ordering Flavor Components" in *Symbolics Common Lisp: Language Concepts*.

For example:

```
(flavor:get-all-flavor-components 'tv:minimum-window)
-->(TV:MINIMUM-WINDOW TV:ESSENTIAL-EXPOSE TV:ESSENTIAL-ACTIVATE
   TV:ESSENTIAL-SET-EDGES TV:ESSENTIAL-MOUSE TV:ESSENTIAL-WINDOW
   TV:SHEET SI:OUTPUT-STREAM SI:STREAM FLAVOR:VANILLA)
```

zl:getchar *string index* *Function*

Returns the *index*th character of *string* as a symbol. Note that 1-origin indexing is used. This function is mainly for Maclisp compatibility; **aref** should be used to index into strings (however, **aref** does not coerce symbols into strings).
Examples:

```
(zl:getchar "string" 1) => |s|
(zl:getchar 'symbol 2) => Y
(zl:getchar "STRING" 1) => S
(zl:getchar "ORANGE" 0) => NIL  ;1-origin indexing is used
```

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:getcharn *string index* *Function*

Returns the *index*th character of *string* as a character. Note that 1-origin indexing is used. This function is mainly for Maclisp compatibility; **aref** should be used to index into strings (however, **aref** does not coerce symbols or numbers into strings).
Examples:

```
(zl:getcharn "string" 1) => #\s
(zl:getcharn 'symbol 2) => #\Y
(zl:getcharn "STRING" 1) => #\S
(zl:getcharn "ORANGE" 0) => 0   ;1-origin indexing is used
```

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts.*

getf *plist indicator* &optional *default* *Function*

Searches the property list *plist* for *indicator*. If *indicator* is found, the corresponding value is returned. If **getf** cannot find *indicator*, *default* is returned. If *default* is not specified, **nil** is used. Note that there is no way to distinguish between a property whose value is *default* and a missing property. See the section "Functions Relating to the Property List of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

zl:get-flavor-handler-for *flavor-name operation* *Function*

Given a *flavor-name* and an *operation* (a function spec that names a generic function or a message), **zl:get-flavor-handler-for** returns the flavor's method for the operation or **nil** if it has none.

For example:

```
(zl:get-flavor-handler-for 'box-with-cell 'find-neighbors)
-->#<DTP-COMPILED-FUNCTION
    (FLAVOR:METHOD FIND-NEIGHBORS CELL) 20740320>

(zl:get-flavor-handler-for 'cell ':print-self)
-->#<DTP-COMPILED-FUNCTION
    (FLAVOR:METHOD SYS:PRINT-SELF FLAVOR:VANILLA DEFAULT) 42456350>
```

Although *operation* is usually a symbol (naming a generic function) or a keyword (naming a message), it is occasionally a list. For example, names of some generic functions are lists, such as **(setf function)**.

si:get-font *device character-set style* &optional (*error-p* **t**) *inquiry-only* *Function*

Given a *device*, *character-set* and *style*, **si:get-font** returns a font object that would be used to display characters from that character set in that style on the device. This is useful for determining whether there is such font mapping for a given device/set/style combination.

If *error-p* is non-**nil**, this function signals an error if no font is found. If *error-p* is **nil** and no font isfound, **si:get-font** returns **nil**.

If *inquiry-only* is provided, the returned value is not a font object, but some other representation of a font, such as a symbol in the **fonts** package (for screen fonts) or a string (for printer fonts).

```
(si:get-font si:*b&w-screen* si:*standard-character-set*
             '(:jess :roman :normal))

=> #<FONT JESS13 154102066>

(si:get-font lgp:*lgp2-printer* si:*standard-character-set*
             '(:swiss :roman :normal) nil t)

=> "Helvetica10"
```

dbg:get-frame-function-and-args *frame* *Function*

dbg:get-frame-function-and-args returns a list containing the name of the function for *frame-pointer* and the values of the arguments.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

get-handler-for *object operation* *Generic Function*

Given an *object* and an *operation* (a function spec that names a generic function or a message), **get-handler-for** returns that object's method for the operation, or **nil** if it has none. When *object* is an instance of a flavor, this function can be useful to find which of that flavor's components supplies the method. If a combined method is returned, you can use the Zmacs command List Combined Methods (m-X) to find out what it does.

For example:

```
(get-handler-for this-box-with-cell 'count-live-neighbors)
-->#<DTP-COMPILED-FUNCTION
    (FLAVOR:METHOD 'COUNT-LIVE-NEIGHBORS CELL) 42456350>

(get-handler-for this-box-with-cell ':print-self)
-->#<DTP-COMPILED-FUNCTION
    (FLAVOR:METHOD SYS:PRINT-SELF FLAVOR:VANILLA DEFAULT) 42456350>
```

Because it is a generic function, you can define methods for **get-handler-for**. The syntax of this is:

```
(defmethod (get-handler-for flavor) (operation)
  body)
```

In most cases you should use **:or** method combination (by supplying the **:method-combination** option for **defflavor**) so your method need not know what the **flavor:vanilla** method does.

Although *operation* is usually a symbol (naming a generic function) or a keyword (naming a message), it is occasionally a list. For example, names of some generic functions are lists, such as **(setf function)**.

Note that **get-handler-for** does not work on named-structures or non-instance streams. You might consider using **:operation-handled-p** instead.

gethash *key table* &optional *default* *Function*

This function finds the entry in *table* whose key is *key* and returns the associated value. If there is no such entry, **gethash** returns *default* which is **nil** if not specified. It returns three values; the value associated with *key*, whether or not the key was found (**t** or **nil**), and the found key if one exists, or **nil** if not.

setf is used with **gethash** to make new entries in the table. If an entry with the specified *key* exists, it is removed before the new entry is added.

```
(setf (gethash a-key my-table) a-value)
```

The *default* argument to **gethash** can be specified in a very useful way with related functions like **incf**.

```
(incf (gethash b-key my-table 0) b-value)
is a shorthand for
(setf (gethash b-key my-table) (+ (gethash b-key my-table 0) 1))
```

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

:get-hash *key* *Message*

Find the entry in the hash table whose key is *key*, and return three values. The first returned value is the associated value of *key*, or **nil** if there is no such entry. The second value is **t** if an entry was found or **nil** if there is no entry for *key* in this table. The third value is *key*, or **nil** if there was no such key. This message will be removed in the future – use **zl:gethash** instead.

zl:gethash *key hash-table* *Function*

Finds the entry in *table* whose key is *key* and returns the associated value. This function will be removed in the future – use **gethash** instead.

zl:gethash-equal *key hash-table* *Function*

Finds the entry in *table* whose key is *key* and returns the associated value. This function will be removed in the future – use **gethash** instead.

zl:getl *plist indicator-list* *Function*

zl:getl is like **zl:get**, except that the second argument is a list of indicators. **zl:getl** searches down *plist* for any of the indicators in *indicator-list* until it finds a property whose indicator is one of the elements of *indicator-list*. If *plist* is a symbol, the symbol's associated property list is used. See the section "Property Lists" in *Symbolics Common Lisp: Language Concepts.* **zl:getl** returns the portion of the list inside *plist* beginning with the first such property that it found. So the **car** of the returned list is an indicator, and the **cadr** is the property value. If none of the indicators on *indicator-list* are on the property list, **zl:getl** returns **nil**. For example, if the property list of **foo** were:

```
(bar (1 2 3) baz (3 2 1) color blue height six-two)
```

then:

```
(zl:getl 'foo '(baz height))
  => (baz (3 2 1) color blue height six-two)
```

When more than one of the indicators in *indicator-list* is present in *plist*, which one **zl:getl** returns depends on the order of the properties. This is the only thing that depends on that order. The order maintained by **zl:putprop** and **defprop** is not defined (their behavior with respect to order is not guaranteed and can be changed without notice).

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:get-pname *sym* *Function*

Returns the print-name of the symbol *sym.* Example:

```
(zl:get-pname 'xyz) => "xyz"
```

get-properties *plist indicator-list* *Function*

Searches the property list stored in *plist* for any of the indicators in *indicator-list.*

get-properties returns three values. If none of the indicators is found, all three values are **nil**. If the search is successful, the first two values are the property found and its value and the third value is the tail of the property list whose **car** is the property found. Thus the third value serves to indicate success or failure and also allows you to restart the search after the property found, if you so desire.

See the section "Functions Relating to the Property List of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

get-setf-method *reference* &optional *for-effect* *Function*

In this context, the word "method" has nothing to do with flavors.

get-setf-method returns five values constituting the **setf** method for reference, which is a generalized-variable reference. (The five values are described in detail at the end of this discussion.) **get-setf-method** takes care of error-checking and macro expansion and guarantees to return exactly one store-variable.

If *for-effect* is **t**, you are indicating that you don't care about the evaluation of *store-forms* (one of the five values), which allows the possibility of more efficient code. In other words, *for-effect* is an optimization.

As an example, an extremely simplified version of **setf**, allowing no more and no fewer than two subforms, containing no optimization to remove uncessary variables, an not allowing storing of multiple values, could be defined by:

```
(defmacro setf (reference value)
   (multiple-value-bind (vars vals stores store-form access-form)
       (get-setf-method reference)
     (declare (ignore access-form))
     `(let* ,(mapcar #'list
                     (append vars stores)
                     (append vals (list value)))
        ,store form)))
```

Here are the five values that express a **setf** method for a given access form.

- A list of *temporary variables.*
- A list of *value forms* (subforms of the given form) to whose values the teporary variables are to be bound.
- A second list of temporary variable, called *store variables.*
- A *storing form.*
- An *accessing form.*

The temporary variables are bound to the value forms as if by **let***; that is, the value forms are evaluated in the order given and may refer to the values of earlier value forms by using the corresponding variable.

The store variables are to be bound to the values of the *newvalue* form, that is, the values to be stored into the generalized variable. In almost all cases, only a single value is stored, and there is only one store variable.

The storing form and the accessing form may contain references to the temporary variables (and also, in the case of the storing form, to the store variables). The accessing form returns the value of the generalized variable. The storing form modifies the value of the generalized variable and guarantees to return the values of the store variables as its values. These are the correct values for **setf** to return. (Again, in most cases there is a single store variable and thus a single value to be returned.) The value returned by the accessing form is, of course, affected by execution of the storing form, but either of these forms may be evaluated any number of times, and therefore should be free of side effects (other than the storing action of the storing form).

The temporary variables and the store variables are generated names, as if by **gensym** or **gentemp**, so that there is never any problem of name clashes among them, or between them and other variables in the program. This is necessary to make the special forms that do more than one **setf** in parallel work properly. These are **psetf**, **shiftf** and **rotatef**.

Here are some examples of **setf** methods for particular forms:

- For a variable `x`:

```
()
()
(g0001)
(setq x g0001)
x
```

- For `(car` *exp*`)`:

```
(g0002)
(exp)
(g0003)
(progn (rplaca g0002 g0003) g0003)
(car g0002)
```

- For (supseq *seq s e*):

```
(g0004 g0005 g0006)
(seq s e)
(g0007)
(progn (replace g0004 g0007 :start1 g0005 :end1 g0006)
       g0007)
(subseq g0004 g0005 g0006)
```

get-setf-method-multiple-value *reference* &optional *for-effect* *Function*

user::get-setf-multiple-value returns five values constituting the **setf** method for **user::reference**, which is a generalized-variable reference. (The five values are described in detail at the end of this discussion.) This is the same as **define-setf-method**, except that it does not check the number of store-variables (one of the five values). Use **user::get-setf-multiple-value** in cases that allow storing multiple values into a generalized variable. This is not a common need.

Here are the five values that express a **setf** method for a given access form.

- A list of *temporary variables.*
- A list of *value forms* (subforms of the given form) to whose values the teporary variables are to be bound.
- A second list of temporary variable, called *store variables.*
- A *storing form.*
- An *accessing form.*

The temporary variables are bound to the value forms as if by **let***; that is, the value forms are evaluated in the order given and may refer to the values of earlier value forms by using the corresponding variable.

The store variables are to be bound to the values of the *newvalue* form, that is, the values to be stored into the generalized variable. In almost all cases, only a single value is stored, and there is only one store variable.

The storing form and the accessing form may contain references to the temporary variables (and also, in the case of the storing form, to the store variables). The accessing form returns the value of the generalized variable. The storing form modifies the value of the generalized variable and guarantees to return the values of the store variables as its values. These are the correct values for **setf** to return. (Again, in most cases there is a

single store variable and thus a single value to be returned.) The value returned by the accessing form is, of course, affected by execution of the storing form, but either of these forms may be evaluated any number of times, and therefore should be free of side effects (other than the storing action of the storing form).

The temporary variables and the store variables are generated names, as if by **gensym** or **gentemp**, so that there is never any problem of name clashes among them, or between them and other variables in the program. This is necessary to make the special forms that do more than one **setf** in parallel work properly. These are **psetf**, **shiftf** and **rotatef**.

Here are some examples of **setf** methods for particular forms:

- For a variable x:

```
()
()
(g0001)
(setq x g0001)
x
```

- For (car *exp*):

```
(g0002)
(exp)
(g0003)
(progn (rplaca g0002 g0003) g0003)
(car g0002)
```

- For (supseq *seq s e*):

```
(g0004 g0005 g0006)
(seq s e)
(g0007)
(progn (replace g0004 g0007 :start1 g0005 :end1 g0006)
       g0007)
(subseq g0004 g0005 g0006)
```

globalize *name* &optional *package* *Function*

Establish a symbol named *name* in *package* and export it. If this causes any name conflicts with symbols with the same name in packages that use *package*, instead of signalling an error make an attempt to resolve the name conflict automatically. Print an explanation of what is being done on **zl:error-output**.

globalize is useful for patching up an existing package structure. For example, if a new function is added to the Lisp language **globalize** can be used to add its name to the **global** package and hence make it accessible to

all packages. Symbols with the desired name might already exist, either by coincidence or because the function was already ed or already called. **globalize** makes all such symbols have the new function as their definition.

package can be a package or the name of a package, as a symbol or a string. It defaults to the **global** package. **globalize** is the only function that does not care whether *package* is locked.

name can be a symbol or a string. If *package* already contains a symbol by that name, that symbol is chosen. Otherwise, if *name* is a symbol, it is chosen. If *name* is a string and any of the packages that use *package* contains a nonshadowing symbol by that name, one such symbol is chosen. Otherwise, a new symbol named *name* is created. Whichever symbol is chosen this way is made present in *package* and exported from it. If the home package of the chosen symbol is a package that uses *package*, then the home package is set to *package*; in other words, the symbol is "promoted" to a "higher" package. If the home package of the chosen symbol is some other package, it is not changed. This case typically occurs when the chosen symbol is inherited by *package* from some package it uses.

The above rules for choosing a symbol to export ensure that no name conflict occurs if at all possible. If any nonshadowing symbols exist named *name* but that are distinct from the chosen symbol present in the packages that use *package*, then a name conflict occurs. **globalize** does its best to resolve the name conflict by merging together the values, function definitions, and properties of all the symbols involved. After merging, all the symbols have the same value, the same function definition, and the same properties. The value cells, function cells, and property list cells of all the symbols are forwarded to the corresponding cells of the chosen symbol, using **sys:dtp-one-q-forward**. This ensures that any future change to one of the symbols is reflected by all of the symbols.

The merging operation simply consists of making sure that there are no conflicts. If more than one of the symbols has a value (is **boundp**), all the values must be **eql** or an error is signalled. Similarly, all the function definitions of symbols that are **fboundp** must be **eql** and all the properties with any particular indicator must be **eql**. If an error occurs you must manually resolve it by removing the unwanted value, definition, or property (using **makunbound**, **fmakunbound**, or **zl:remprop**) then try again.

Note that if *name* is a symbol, **globalize** attempts to use that symbol, but there is no guarantee that it will not use some other symbol. If *name* is in a package that does not use *package*, and **globalize** does not use *name* as the symbol (because another symbol by that name already exists in *package* or in some package that uses *package*), then *name* is not merged with the chosen symbol. It is generally more predictable to use a string, rather than a symbol, for *name*.

Of course, **globalize** cannot cause two distinct symbols to become **eq**. Its conflict resolution techniques are useful only for symbols that are used as names for things like functions and variables, not for symbols that are used for their own sake. You can sometimes get the desired effect by using one of the conflicting symbols as the first argument to **globalize**, rather than using a string.

For example, suppose a program in the **color** package deals with colors by symbolic names, perhaps using **zl:selectq** to test for such symbols as **red**, **green**, and **yellow**. Suppose there is also a function named **red** in the **math** package and someone decides that this function is generally useful and should be made global. Doing **(globalize 'color:red)** ensures that the exported symbol is the one that the color program is looking for; this means that every package except the **math** package sees the right symbol to use if it wants to call the color program. Programs that call the **red** function do not care which of the two symbols they use as the name of the function, since both symbols have the same definition. Usually the situation described in this example would not arise, because standard programming style dictates that the color program should have been using keywords for this application.

globalize returns two values. The first is the chosen symbol and the second is a (possibly empty) list of all the symbols whose value, function, and property cells were forwarded to the cells of the chosen symbol.

To disable the messages printed by **globalize**, bind **zl:error-output** to a null stream (one that throws away all output). For example:

```
(let ((zl:error-output 'si:null-stream))
  (globalize 'rumpelstiltskin))
```

g-l-p *array* *Function*

If *array* has a fill pointer, **g-l-p** returns a list that stops at the fill pointer, if you never modify the fill-pointer except with **zl:array-push**, **zl:array-pop** and so on. *array* must be a general (**sys:art-q-list**) array. Example:

```
(setq a (zl:make-array 4 :type 'art-q-list))
(aref a 0) => nil
(setq b (g-l-p a)) => (nil nil nil nil)
(setf (car b) t)
b => (t nil nil nil)
(aref a 0) => t
(setf (aref a 2) 30)
b => (t nil 30 nil)
```

go *tag* *Special Form*

Transfers control within a **tagbody** form or a construct like **do** or **prog** that uses an implicit **tagbody**.

The *tag* can be a symbol or an integer. It is not evaluated. **go** transfers control to the tag in the body of the **tagbody** that is **eql** to the *tag* in the **go** form. If the body has no such tag, the bodies of any lexically containing **tagbody** forms are examined as well. If no tag is found, an error is signalled.

The scope of *tag* is lexical. That is, the **go** form must be inside the tagbody construct itself (or inside a **tagbody** form that that **tagbody** lexically contains), not inside a function called from the **tagbody**, but defined outside the **tagbody**.

Examples:

```
(tagbody
  (let ((z 5))
    (unwind-protect
        (if (= 5 z) (go out))
      (print z)))
  out
   (princ "4 3 and then there were none")(terpri)) =>
5 4 3 and then there were none
NIL

(prog (x y z)
  (setq x some frob)
loop
  do something
  (if some predicate (go endtag))
  do something more
  (if (minusp x) (go loop))
endtag
  (return z))
```

For a table of related items: See the section "Transfer of Control Functions" in *Symbolics Common Lisp: Language Concepts.*

graphic-char-p *char* *Function*

Returns **t** if *char* does not have any control bits set and is not a format effector.

```
(graphic-char-p #\A) => T
(graphic-char-p #\c-A) => NIL
(graphic-char-p #\Space) => T
```

zl:greaterp *number* &rest *more-numbers* *Function*

zl:greaterp compares its arguments from left to right. If any argument is not greater than the next, **zl:greaterp** returns **nil**. But if the arguments are monotonically strictly decreasing, the result is **t**. Examples:

```
(zl:greaterp 4 3) => t
(zl:greaterp 4 3 2 1 0) => t
(zl:greaterp 4 3 1 2 0) => nil
```

The following function is a synonym of **zl:greaterp**:

```
>
```

zl:haipart *x n* *Function*

Returns the high *n* bits of the binary representation of |*x*|, or the low *-n* bits if *n* is negative. *x* must be an integer; its sign is ignored. **zl:haipart** could have been defined by:

```
(defun zl:haipart (x n)
  (setq x (abs x))
  (if (minusp n)
      (logand x (1- (ash 1 (- n))))
      (ash x (min (- n (zl:haulong x)) 0))))
```

For a table of related items: See the section "Functions Returning Components or Characteristics of Argument" in *Symbolics Common Lisp: Language Concepts*.

:handle-condition *cond ignore* *Message*

:handle-condition is an interactive handler message to instances of **dbg:basic-handler**.

cond is a condition object. You should handle this condition, ignoring the second argument. **:handle-condition** can return values or throw in the same way that **condition-bind** handlers can.

For a table of related items: See the section "Interactive Handler Messages".

:handle-condition-p *cond* *Message*

:handle-condition-p is an interactive handler message to instances of **dbg:basic-handler**. This message examines *cond* which is a condition object. It returns **nil** it if declines to handle the condition and something other than **nil** when it is prepared to handle the condition.

For a table of related items: See the section "Interactive Handler Messages".

hash-table *Type Specifier*

hash-table is the type specifier symbol for the predefined Lisp data structure, hash table.

The types **hash-table, readtable, package, pathname, stream** and **random-state** are *pairwise disjoint.*

Examples:

```
(setq a-hash-table (make-hash-table))
=> #<EQL-BLOCK-ARRAY-PROCESS-LOCKING-DUMMY
        -GC-LOCKING-ASSOCIATION-MUTATING-TABLE 16126776>
(setf (gethash 'color a-hash-table) 'red) => RED
(setf (gethash 'name a-hash-table) 'Ron) => RON
(typep 'hash-table 'common) => T
(subtypep 'hash-table 't) => T and T
(sys:type-arglist 'hash-table) => NIL and T
(hash-table-p a-hash-table) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Table Management" in *Symbolics Common Lisp: Language Concepts.*

hash-table-count *table* *Function*

This function returns the number of entries in *table.* When a table is first created or has been cleared, the number of entries is zero.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

hash-table-p *object* *Function*

hash-table-p returns **t** if its argument is an old Zetalisp hash-table or new generic table object, and **nil** otherwise.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:haulong *x* *Function*

This returns the number of significant bits in |x|. *x* must be an integer. Its sign is ignored. The result is the least integer strictly greater than the base-2 logarithm of |x|.

zl:haulong is similar to **integer-length.**

Examples:

```
(zl:haulong 0) => 0
(zl:haulong 3) => 2
(zl:haulong -7) => 3
```

For a table of related items: See the section "Functions Returning Components or Characteristics of Argument" in *Symbolics Common Lisp: Language Concepts.*

zl:ibase *Variable*

The value of **zl:ibase** is a number that is the radix in which integers and ratios are read. The initial value of **zl:ibase** is 10. **zl:ibase** should not be greater than 36.

When **zl:ibase** is set to a value greater than ten, the reader interprets the token as a symbol, unless control variable **si:*read-extended-ibase-signed-number*** or **si:*read-extended-ibase-unsigned-number*** is set to t.

identity *x* *Function*

identity always returns *x* as its value. Sometimes functions require a second function as an argument, and **identity** is useful in those situations.

if *condition true* &rest *false* *Special Form*

The simplest conditional form. The "if-then" form looks like:

(if *predicate-form then-form*)

predicate-form is evaluated, and if the result is non-**nil**, the *then-form* is evaluated and its result is returned. Otherwise, **nil** is returned.

Examples:

```
(if (numberp 'a) "never reaches this point") => NIL

(if (not nil) "A Word") => "A Word"

(if 'not-nil "reaches this point") => "reaches this point"
```

In the "if-then-else" form, it looks like:

(if *predicate-form then-form else-form*)

predicate-form is evaluated, and if the result is non-**nil**, the *then-form* is evaluated and its result is returned. Otherwise, the *else-form* is evaluated and its result is returned.

Examples:

```
(if (equal 'boy 'girl)  "same" "different") => "different"

(if (not nil) 'A 'B) => A

(if 'word "reaches this point" "never reaches this point")
=> "reaches this point"
```

Zetalisp Note: Zetalisp supports multiple *else* clauses: if there are more than three subforms, **if** assumes you want more than one *else-form*; these are evaluated sequentially and the result of the last one is returned, if the predicate returns **nil**.

Multiple *else* clauses are incompatible with the language specification presented in Guy Steele's *Common Lisp: the Language.*

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

if Keyword For loop

if *expr*

If *expr* evaluates to **nil**, the following clause is skipped, otherwise not.

Examples

```
(defun print-odd (list-of-nums)
  (loop for num in list-of-nums
        if (oddp num)
          collect num and do (print num)))  => PRINT-ODD
(print-odd '(2 3 49 2 3 4))  =>
3
49
3 (3 49 3)
```

if-then-else conditionals can be written using the **else** keyword, as in:

```
(defun print-odd-else (list-of-nums)
  (loop for num in list-of-nums
        if (oddp num)
          collect num and do (print num)
        else
          do (print "An even number !"))) => PRINT-ODD-ELSE
(print-odd-else '(4 3 2 9 7)) =>
"An even number !"
3
"An even number !"
9
7 (3 9 7)
```

Multiple clauses can appear in an **else**-phrase using **and** to join them.

In the typical format of a conditionalized clause such as

when *expr1 keyword expr2*

expr2 can be the keyword **it**. If that is the case, then a variable is generated to hold the value of *expr1*, and that variable gets substituted for *expr2*. Thus, the composition:

when *expr* **return it**

is equivalent to the clause:

thereis *expr*

and one can collect all non-**null** values in an iteration by saying:

when *expression* **collect it**

If multiple clauses are joined with **and**, the **it** keyword can only be used in the first. If multiple **when**s, **unless**es, and/or **if**s occur in sequence, the value substituted for **it** is that of the last test performed. The **it** keyword is not recognized in an **else**-phrase.

Conditionals can be nested.

See the section "**loop** Clauses", page 310.

ignore &rest *ignore* *Function*

Takes any number of arguments and returns **nil**. This is often useful as a "dummy" function; if you are calling a function that takes a function as an argument, and you want to pass one that does not do anything and does not mind being called with any argument pattern, use this.

ignore is also used to suppress compiler warnings for ignored arguments. For example:

```
(defun foo (x y)
  (ignore y)
  (sin x))
```

See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts.*

ignore-errors &body *body* *Special Form*

ignore-errors sets up a very simple handler on the bound handlers list that handles all error conditions. Normally, it executes *body* and returns the first value of the last form in *body* as its first value and **nil** as its second value. If an error signal occurs while *body* is executing, **ignore-errors** immediately returns with **nil** as its first value and something not **nil** as its second value.

ignore-errors replaces **zl:errset** and **catch-error**.

For a table of related items: See the section "Basic Forms for Bound Handlers" in *Symbolics Common Lisp: Language Concepts*.

imagpart *number* *Function*

If *number* is a complex number, **imagpart** returns the imaginary part of *number*. If *number* is a noncomplex number, **imagpart** returns a zero of the same type as *number*.
Examples:

```
(imagpart #c(3 4)) => 4
(imagpart 4) => 0
```

Related Functions:

complex
realpart

For a table of related items: See the section "Functions That Decompose and Construct Complex Numbers" in *Symbolics Common Lisp: Language Concepts*.

zl:implode *char-list* *Function*

zl:implode is like **zl:maknam** except that the returned symbol is interned in the current package. This function is provided mainly for Maclisp compatibility.

Example:

```
(zl:implode '(a #\b "C" #\4 5)) => |AbC4¬|
```

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts*.

import *symbols* &optional *package* *Function*

The *symbols* argument should be a list of symbols or a single symbol. If *symbols* is **nil**, it is treated like an empty list. These symbols become internal symbols in *package*, and can therefore be referred to without a colon qualifier. **import** signals a correctable error if any of the imported symbols has the same name as some distinct symbol already available in the package.

package can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***.
Returns **t**.

incf *access-form* &optional *amount* *Macro*

Increments the value of a generalized variable. **(incf** *ref***)** increments the value of *ref* by 1. **(incf** *ref amount***)** adds *amount* to *ref* and stores the sum back into *ref*.

incf expands into a **setf** form, so *ref* can be anything that **setf** understands as its *access-form*. This also means that you should not depend on the returned value of an **incf** form.

You must take great care with **incf** because it might evaluate parts of *ref* more than once. (**incf** does not evaluate any part of *ref* more than once.)

Example:

```
(incf (car (mumble))) ==>
(setf (car (mumble)) (1+ (car (mumble)))) ==>
(rplaca (mumble) (1+ (car (mumble))))
```

The **mumble** function is called more than once, which can be significantly inefficient if **mumble** is expensive, and which can be downright wrong if **mumble** has side effects. The same problem can come up with the **decf**, **zl:swapf**, **push**, and **pop** macros.

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts*.

dbg:initialize-special-commands *condition* *Generic Function*

The Debugger calls **dbg:initialize-special-commands** after it prints the error message. The methods are combined with **:progn** combination, so that each one can do some initialization. In particular, the methods for this generic function can remove items from the list **dbg:special-commands** in order to decide not to offer these special commands.

The compatible message for **dbg:initialize-special-commands** is:

:initialize-special-commands

For a table of related items: See the section "Debugger Special Command Functions" in *Symbolics Common Lisp: Language Concepts*.

initially Keyword For loop

initially *expression*

Puts *expression* into the *prologue* of the iteration. It is evaluated before any other initialization code other than the initial bindings. For the sake of good style, the **initially** clause should therefore be placed after any **with** clauses but before the main body of the loop.

Examples

```
(defun sum-it (limit)
  (loop with sum-of-series = 0
        initially (print "The sum of this series is :")
        for num from 0 to limit
        do
    (setq sum-of-series (+ sum-of-series num))
        finally (prin1 sum-of-series))) => SUM-IT
(sum-it 9)  =>
"The sum of this series is :" 45
NIL
```

See the macro **loop**, page 309.

inline *Declaration*

(**inline** *function1 function2 ...*) specifies that it is desirable for the compiler to open-code calls to the specified functions; that is, the code for a specified function should be integrated into the calling routine, appearing "in line" in place of a procedure call. This may achieve extra speed at the expense of debuggability (calls to functions compiled in-line cannot be traced, for example). This declaration is pervasive, that is it affects all code in the body of the form. The compiler is free to ignore this declaration.

Note that rules of lexical scoping are observed; if one of the functions mentioned has a lexically apparent local definition (as made by **flet** or **labels**), then the declaration applies to that local definition and not to the global function definition.

in-package *package-name* &rest *make-package-keywords* *Function*

:insert *item key* of **si:heap** *Method*

Inserts *item* into the heap based on *key*, and returns *item* and *key*.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts*.

instance &optional *(flavor '*)* *Type Specifier*

instance is a type specifier symbol denoting flavor instances. When a new flavor is defined with **defflavor**, the name of the flavor becomes a valid type symbol, and individual instances of that flavor become valid types of **instance** that can be tested with **typep**.

instance is a subtype of **t**.

Examples:

```
(defflavor ship
  (name x-velocity y-velocity z-velocity mass)
   ()    ; no component flavors
  :readable-instance-variables
  :writable-instance-variables
  :initable-instance-variables) => SHIP

(setq my-ship
  (make-instance 'ship :name "Enterprise"
                       :mass 4534
                       :x-velocity 24
                       :y-velocity 2
                       :z-velocity 45)) => #<SHIP 43100701>

(ship-name my-ship) => "Enterprise"

(typep my-ship 'instance) => T

(typep my-ship '(instance ship)) => T

(zl:typep my-ship) => SHIP

(type-of my-ship) => SHIP

(type-of 'ship) => SYMBOL

(sys:type-arglist 'instance) => (&OPTIONAL (FLAVOR '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

For a discussion of flavors: See the section "Flavors" in *Symbolics Common Lisp: Language Concepts.*

instancep *x* *Function*

Returns **t** if the object *x* is a flavor instance, otherwise **nil.**

int-char *integer* *Function*

Converts *integer* to a character.

```
(int-char 97) => #\A
```

integer &optional (*low* '*) (*high* '*) *Type Specifier*

integer is the type specifier symbol for the predefined Lisp integer number type.

The types **integer** and **ratio** are an *exhaustive partition* of the type rational, since `rational ≡ (or integer ratio)`.

This type specifier can be used in either symbol or list form. Used in list form, **integer** allows the declaration and creation of specialized integer numbers, whose range is restricted to *low* and *high*.

low and *high* must each be an integer, a list of an integer, or unspecified. If these limits are expressed as integers, they are *inclusive*; if they are expressed as a list of an integer, they are *exclusive*; * means that a limit does not exist, and so effectively denotes minus or plus infinity, respectively.

The type **fixnum** is simply a name for `(integer smallest largest)` for the values of **most-negative-fixnum** and **most-positive-fixnum**. The type `(integer 0 1)` is so useful that it has the special name **bit**.

Examples:

```
(typep 4 'integer) => T
(subtypep 'integer 'rational) => T and T ;subtype and certain
(subtypep '(integer *) 'rational) => T and T
(subtypep 'signed-byte 'integer) => T and T
(subtypep 'fixnum 'integer) => T and T
(subtypep 'bignum 'integer) => T and T
(commonp 23.) => T
(integerp 23.) => T
(integerp -3_78) => T
(integerp most-positive-fixnum) => T
(integerp most-negative-fixnum) => T
(integerp -2147483648) => T
(equal-typep 'bit '(integer 0 1)) => T
(equal-typep '(integer  -2147483648 2147483647) 'fixnum) => T
(sys:type-arglist 'integer) => (&OPTIONAL (LOW '*) (HIGH '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

integer-decode-float *float* *Function*

Returns three values, representing: the significand (scaled so as to be an integer), the exponent, and the sign of the floating-point argument, *float*, as described below.

For an argument *f*, the first result is an integer which is strictly less than

(**expt** 2 (**float-precision** *f*)), but no less than (**expt** 2 (-(**float-precision** *f*) 1)) except that if *f* is zero, the returned integer value is zero.

The second value returned is an integer *e* such that the first result (the significand) times 2 raised to the power e is equal to the absolute value of the argument *float*.

The final value of **integer-decode-float** represents the sign of *float* and is 1 or -1.

Examples:

```
(integer-decode-float 2.0) => 8388608 and -22 and 1
(integer-decode-float -2.0) => 8388608 and -22 and -1
(integer-decode-float 4.0) => 8388608 and -21 and 1
(integer-decode-float 8.0) => 8388608 and -20 and 1
(integer-decode-float 3.0) => 12582912 and -22 and 1
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts*.

integer-length *integer* *Function*

Returns the result of the following computation:

(values (ceiling (log (if (minusp *integer*)(- *integer*)(1+ *integer*)) 2))))

If *integer* is non-negative, the result represents the number of significant bits in the unsigned binary representation of *integer*. More generally, regardless of the sign of *integer*, the result denotes the number of significant bits needed to represent *integer* in unsigned binary two's-complement form. (To get the number of bits needed for a signed binary two's complement representation, add 1 bit to the result of **integer-length**).

Examples:

```
(integer-length 0) => 0          (integer-length -0) => 0
(integer-length 1) => 1          (integer-length -1) => 0
(integer-length 2) => 2          (integer-length -2) => 1
(integer-length 8) => 4          (integer-length -8) => 3
(integer-length 15) => 4         (integer-length -15) => 4

;;; A possible use of integer-length
;;; The function trailing-zeros returns the number of
;;; consecutive zeros starting at the least significant
;;; bit of the binary representation of an integer
```

```
(defun trailing-zeros (integer)
  (1- (integer-length (logand integer (- integer)))))

(trailing-zeros 0) => -1
;;; An adequate result since there are an undefined amount
;;; of trailing zeros in 0
(trailing-zeros 1) => 0
(trailing-zeros 4) => 2          ; 4 is #b100
(trailing-zeros 9) => 0          ; 9 is #b1001
```

For a table of related items: See the section "Functions Returning Components or Characteristics of Argument" in *Symbolics Common Lisp: Language Concepts.*

integerp *object* *Function*

The predicate **integerp** is true if its argument is an integer; it is false, otherwise.

Examples:

```
(integerp 7) => T
(integerp 4.0) => NIL
(integerp #c(2 0)) => T          ;#c(2 0) is coerced to an integer
(integerp "not a number") => NIL
```

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

intern *string* &optional (*pkg* **zl:package**) *Function*

Finds or creates a symbol named *string* in *pkg*. Inherited symbols in *pkg* are included in the search for a symbol named *string*. If a symbol named *string* is found, it is returned. If no such symbol is found, one is created and installed in *pkg* as an internal symbol (if *pkg* is the **keyword** package, the symbol is installed as an external symbol).

intern returns two values. The first is the symbol that was found or created. The second value is **nil** for newly created symbols. If the symbol returned is a pre-existing symbol, this second value is one of the following:

:internal	The symbol is present in *pkg* as an internal symbol.
:external	The symbol is present in *pkg* as an external symbol.
:inherited	The symbol is an internal symbol in *pkg* inherited by way of **use-package**.

For more information: See the section "Mapping Names to Symbols" in *Symbolics Common Lisp: Language Concepts.*

zl:intern *sym* &optional *pkg* *Function*

Finds or creates a symbol named *string* accessible to *pkg*, either directly present in *pkg* or inherited from a package it uses.

If *string* is not a string but a symbol, **zl:intern** searches for a symbol with the same name. If it does not find one, it interns *string* – rather than a newly created symbol – in *pkg* (even if it is also interned in some other package) and returns it.

See the function **intern**, page 276.

intern-local *string* &optional *pkg* *Function*

Finds or creates a symbol named *string* directly present in *pkg*. Symbols inherited by *pkg* from packages it uses are not considered, thus **intern-local** can cause a name conflict. **intern-local** is considered to be a low-level primitive and indiscriminate use of it can cause undetected name conflicts. Use **import**, **shadow**, or **shadowing-import** for normal purposes.

If *string* is not a string but a symbol, and no symbol with that print name is already interned in *pkg*, **intern-local** interns *string* – rather than a newly created symbol – in *pkg* (even if it is also interned in some other package) and returns it.

For more information: See the section "Mapping Names to Symbols" in *Symbolics Common Lisp: Language Concepts*.

intern-local-soft *string* &optional *pkg* *Function*

Find a symbol named *string* directly present in *pkg*. Symbols inherited by *pkg* from packages it uses are not considered. If no symbol is found, the two values **nil** **nil** are returned.

intern-local-soft is a good low-level primitive for when you want complete control of what packages to search and when to add new symbols.

For more information: See the section "Mapping Names to Symbols" in *Symbolics Common Lisp: Language Concepts*.

intern-soft *string* &optional *pkg* *Function*

Finds a symbol named *string* accessible to *pkg*, either directly present in *pkg* or inherited from a package it uses. If no symbol is found, the two values **nil** **nil** are returned.

intersection *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

intersection takes two lists and returns a new list containing everything that is an element of both lists, as checked by the **:test** and **:test-not** keywords. If either list has duplicate entries, the redundant entries may or may not appear in the result. For example:

```
(intersection '(a b c) '(f a d)) => (A)

(intersection '(a b c a d) '(f a d)) => (A A D)

(intersection '(a b c) '(a f a d)) => (A)
```

There is no guarantee that the order of elements in the result will reflect the ordering of the arguments in any particular way.

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For all possible ordered pairs consisting of one element from *list1* and one element from *list2*, the test is used to determine whether they match. For every matching pair, the element from *list1* will be put in the result.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:intersection &rest *lists* *Function*

Takes any number of lists that represent sets and creates and returns a new list that represents the intersection of all the sets it is given. **zl:intersection** uses **eq** for its comparisons. You cannot change the function used for the comparison. **(zl:intersection)** returns **nil**.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

math:invert-matrix *matrix* &optional *into-matrix* *Function*

Computes the inverse of *matrix*. If *into-matrix* is supplied, stores the result into it and returns it; otherwise it creates an array to hold the result, and returns that. *matrix* must be two-dimensional and square. The Gauss-Jordan algorithm with partial pivoting is used. Note: if you want to solve a set of simultaneous equations, you should not use this function; use **math:decompose** and **math:solve**.

math:invert-matrix does not work on conformally displaced arrays.

dbg:invoke-restart-handlers *condition* &key (*flavors* **nil** *flavors-specified*) *Function*

dbg:invoke-restart-handlers searches the list of restart handlers to find a restart handler for *condition*. The *flavors* argument controls which restart handlers are examined. *flavors* is a list of condition names. When *flavors* is omitted, the function examines every restart handler. When *flavors* is provided, the function examines only those restart handlers that handle at least one of the conditions on the list.

The first restart handler that it finds to handle the condition is invoked and given *condition*. It returns **nil** if no appropriate restart handler is found.

isqrt *integer* *Function*

Integer square root. *integer* must be a non-negative integer; the result is the greatest integer less than or equal to the exact square root of *integer*. Examples:

```
(isqrt 4) => 2
(isqrt 5) => 2
(isqrt 8) => 2
(isqrt 9) => 3
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts*.

K
L

&key *Lambda List Keyword*

If the lambda-list keyword **&key** is present, all specifiers up to the next lambda-list keyword, or the end of the list, are keyword parameter specifiers. The keyword parameter specifiers can be followed by the lambda-list keyword **&allow-other-keys**, if desired.

keyword *Type Specifier*

keyword is the type specifier symbol for the predefined Lisp object of that name.

Examples:

```
(typep ':list 'keyword) => T
(subtypep 'keyword 't) => T and T
(subtypep 'keyword 'common) => NIL and NIL
(sys:type-arglist 'keyword) => NIL and T
(keywordp ':fixnum) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Symbols and Keywords" in *Symbolics Common Lisp: Language Concepts.*

zl:keyword-extract *keylist keyvar keywords* &optional *flags* &body *otherwise* *Special Form*

Aids in writing functions that take keyword arguments in the standard fashion. You can also use the **&key** lambda-list keyword to create functions that take keyword arguments. **&key** is preferred and is substantially more efficient; **zl:keyword-extract** is obsolete. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts.*

The form:

```
(zl:keyword-extract key-list iteration-var
        keywords flags other-clauses...)
```

parses the keywords out into local variables of the function. *key-list* is a form that evaluates to the list of keyword arguments; it is generally the function's **&rest** argument. *iteration-var* is a variable used to iterate over the list; sometimes *other-clauses* uses the form:

```
(car (setq iteration-var (cdr iteration-var)))
```

to extract the next element of the list. (Note that this is not the same as **pop**, because it does the **car** after the **cdr**, not before.)

keywords defines the symbols that are keywords to be followed by an argument. Each element of *keywords* is either the name of a local variable

that receives the argument and is also the keyword, or a list of the keyword and the variable, for use when they are different or the keyword is not to go in the keyword package. Thus, if *keywords* is **(a (b c) d)** then the keywords recognized are **:a**, **b**, and **:d**. If **:a** is specified its argument is stored into **a**. If **:d** is specified its argument is stored into **d**. If **b** is specified, its argument is stored into **c**.

Note that **zl:keyword-extract** does not bind these local variables; it assumes you have done that somewhere else in the code that contains the **zl:keyword-extract** form.

flags defines the symbols that are keywords not followed by an argument. If a flag is seen its corresponding variable is set to **t**. (You are assumed to have initialized it to **nil** when you bound it with **let** or **&aux**.) As in *keywords*, an element of *flags* can be either a variable from which the keyword is deduced, or a list of the keyword and the variable.

If there are any *other-clauses*, they are **zl:selectq** clauses selecting on the keyword being processed. These clauses are for handling any keywords that are not handled by the *keywords* and *flags* elements. These can be used to do special processing of certain keywords for which simply storing the argument into a variable is not good enough. Unless the *other-clauses* include an **otherwise** (or **t** clause, after them there is an **otherwise** clause to complain about any unhandled keywords found in *key-list*. If you write your own **otherwise** clause, it is up to you to take care of any unhandled keywords.

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts*.

keywordp *object* *Function*

A predicate that is true if *object* is a symbol and its home package is the keyword package, and false otherwise.

lambda *lambda-list body...* *Special Form*

Provided, as a convenience, to obviate the need for using the **function** special form when the latter is used to name an anonymous (lambda) function. When **lambda** is used as a special form, it is treated by the evaluator and compiler identically to the way it would have been treated if it appeared as the operand of a **function** special form. For example, the following two forms are equivalent:

```
(my-mapping-function (lambda (x) (+ x 2)) list)

(my-mapping-function (function (lambda (x) (+ x 2))) list)
```

Note that the form immediately above is usually written as:

```
(my-mapping-function #'(lambda (x) (+ x 2)) list)
```

The first form uses **lambda** as a special form; the latter two do not use the **lambda** special form, but rather, use **lambda** to name an anonymous function.

See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts.*

Using **lambda** as a special form is incompatible with Common Lisp.

lambda-list-keywords *Variable*

The value of this variable is a list of all of the allowed "&" keywords. Some of these are obsolete and do not do anything; the remaining ones (some of which are also obsolete) are listed below. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language* Concepts. Example functions which use each of these keywords are provided in that section.

&optional
Declares the following arguments to be optional. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts.*

&rest Declares the following argument to be a rest argument. There can be only one **&rest** argument.
It is important to realize that the list of arguments to which a rest-parameter is bound is set up in whatever way is most efficiently implemented, rather than in the way that is most convenient for the function receiving the arguments. It is not guaranteed to be a "real" list. Sometimes the rest-args list is stored in the function-calling stack, and loses its validity when the function returns. If a rest-argument is to be returned or made part of permanent list-structure, it must first be copied, as you must always assume that it is one of these special lists. See the function **sys:copy-if-necessary**, page 114.
The system does not detect the error of omitting to copy a rest-argument; you simply find that you have a value that seems to change behind your back. At other times the rest-args list is an argument that was given to **zl:apply**; therefore it is not safe to **rplaca** this list as you might modify permanent data structure. An attempt to **rplacd** a rest-args list is unsafe in this case, while in the first case it causes an error, since lists in the stack are impossible to **rplacd**.

&key Separates the positional parameters and rest parameter from the keyword parameters. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts.*

&allow-other-keys
In a lambda-list that accepts keyword arguments, **&allow-other-keys** says that keywords that are not specifically listed after **&key** are allowed. They and the corresponding values are ignored, as far as keyword arguments are concerned, but they do become part of the rest argument, if there is one.

&aux It separates the arguments of a function from the auxiliary variables. Following **&aux** you can put entries of the form:

(*variable initial-value-form*)

or just *variable* if you want it initialized to **nil** or do not care what the initial value is.

zl:&special
Declares the following arguments and/or auxiliary variables to be special within the scope of this function. **zl:&special** can appear anywhere any number of times.

zl:&local
Turns off a preceding **zl:&special** for the variables that follow. **zl:&local** can appear anywhere any number of times.

zl:&quote
Using **zl:&quote** is an obsolete way to define special functions. **zl:&quote** declares that the following arguments are not to be evaluated. You should implement language extensions as macros rather than through special functions, because macros directly define a Lisp-to-Lisp translation and therefore can be understood by both the interpreter and the compiler.
Special functions, on the other hand, only extend the interpreter. The compiler has to be modified to understand each new special function so that code using it can be compiled. Since all real programs are eventually compiled, writing your own special functions is strongly discouraged.

zl:&eval
This is obsolete. Use macros instead to define special functions. **zl:&eval** turns off a preceding **zl:&quote** for the arguments which follow.

zl:&list-of
This is not supported. Use **zl:loop** or **mapcar** instead of **zl:&list-of**.

&body This is for macros defined by **defmacro** or **macrolet** only. It is similar to **&rest**, but declares to **grindef** and the code-formatting module of the editor that the body forms of a special form follow and should be indented accordingly.
See the section "**&**-Keywords Accepted By **defmacro**" in *Symbolics Common Lisp: Language Concepts*.

K
L

&whole

This is for macros defined by **defmacro** or **macrolet** only. **&whole** is followed by *variable*, which is bound to the entire macro-call form or subform. *variable* is the value that the macro-expander function receives as its first argument. **&whole** is allowed only in the top-level pattern, not in inside patterns.
See the section "**&**-Keywords Accepted By **defmacro**" in *Symbolics Common Lisp: Language Concepts.*

&environment

This is for macros defined by **defmacro** or **macrolet** only.**&environment** is followed by *variable*, which is bound to an object representing the lexical environment where the macro call is to be interpreted. This environment might not be the complete lexical environment. It should be used only with the **macroexpand** function for any local macro definitions that the **macrolet** construct might have established within that lexical environment. **&environment** is allowed only in the top-level pattern, not in inside patterns. See the section "Lexical Environment Objects and Arguments" in *Symbolics Common Lisp: Language Concepts.*
See the section "**&**-Keywords Accepted By **defmacro**" in *Symbolics Common Lisp: Language Concepts.*

lambda-macro *name lambda-list body...* *Special Form*

Like **macro**, defines a lambda macro to be called *name. lambda-list* should be a list of one variable, which is bound to the function being expanded. The lambda macro must return a function. Example:

```
(lambda-macro ilisp (x)
  '(lambda (&optional ,@(second x) &rest ignore) . ,(cddr x)))
```

This defines a lambda macro called **ilisp**. After it has been defined, the following list is a valid Lisp function:

```
(ilisp (x y z) (list x y z))
```

The above function takes three arguments and returns a list of them, but all of the arguments are optional and any extra arguments are ignored. (This shows how to make functions that imitate Interlisp functions, in which all arguments are always optional and extra arguments are always ignored.) So, for example:

```
(funcall #'(ilisp (x y z) (list x y z)) 1 2)  =>  (1 2 nil)
```

lambda-parameters-limit *Constant*

The value of **lambda-parameters-limit** is a positive integer that is the upper exclusive bound on the number of distinct parameter names that can appear in a single lambda-list. The value is currently 128.

last *list* *Function*

last returns the last cons of *list*. If *list* is **nil**, it returns **nil**. Note that **last** is unfortunately *not* analogous to **first** (**first** returns the first element of a list, but **last** does not return the last element of a list); this is a historical artifact. Example:

```
(setq x '(a b c d))
(last x) => (d)
(rplacd (last x) '(e f))
x => '(a b c d e f)
```

last could have been defined by:

```
(defun last (x)
    (cond ((atom x) x)
          ((atom (cdr x)) x)
          ((last (cdr x))) ))
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

lcm &rest *integers* *Function*

Computes and returns the least common multiple of the absolute values of its arguments. All the arguments must be integers, and the result is always a non-negative integer.

For one argument, **lcm** returns the absolute value of that argument. If one or more of the arguments is zero, **lcm** returns zero. If there are no arguments, the returned value is 1.

Examples:

```
(lcm) => 1
(lcm -6) => 6           ;absolute value of only one argument
(lcm 6 15) => 30
(lcm 0 6) => 0
(lcm 2 3 4 5) => 60
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts*.

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ldb *bytespec integer* *Function*

"Load byte."

Returns a byte extracted from *integer* as specified by *bytespec.*

bytespec is built using function **byte** with bit *size* and *position* arguments.

ldb extracts from *integer size* contiguous bits starting at *position* and returns this value. *integer* must be an integer.

The result is right-justified: the *size* bits are the lowest bits in the returned value and the rest of the returned bits are zero. **ldb** always returns a nonnegative integer.

Examples:

```
(ldb (byte 1 2) 5) => 1
(ldb (byte 32. 0) -1) => (1- 1_32.)  ;;a positive bignum
(ldb (byte 16. 24.) -1_31.) => #o177600
(ldb (byte 6 3) #o4567) => #o56
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

ldb-test *bytespec integer* *Function*

ldb-test is a predicate that returns **t** if any of the bits designated by the byte specifier *bytespec* are 1's in *integer.* That is, it returns **t** if the designated field is nonzero. **ldb-test** could have been defined as follows:

```
(ldb-test bytespec integer) ==> (not (zerop (ldb bytespec integer)))
```

Examples:

```
(ldb-test (byte 2 1) 6) => T
(ldb-test (byte 2 3) #o542) => NIL
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

ldiff *list sublist* *Function*

list should be a list, and *sublist* should be one of the conses that make up *list.* **ldiff** (meaning "list difference") returns a new list, whose elements are those elements of *list* that appear before *sublist.* Examples:

```
(setq x '(a b c d e))
(setq y (cdddr x)) => (d e)
(ldiff x y) => (a b c)
```

but:

```
(ldiff '(a b c d) '(c d)) => (a b c d)
```

since the sublist was not **eq** to any part of the list.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

least-negative-double-float *Constant*

The value of **least-negative-double-float** is that negative floating-point number in double-float format which is closest in value (but not equal to) zero.

least-negative-long-float *Constant*

The value of **least-negative-long-float** is that negative floating-point number in long-float format closest in value (but not equal to) zero. In Symbolics Common Lisp this constant has the same value as **least-negative-double-float.**

least-negative-short-float *Constant*

The value fo **least-negative-short-float** is that negative floating-point number in short-float format closest in value (but not equal to) zero. In Symbolics Common Lisp this constant has the same value as **least-negative-single-float.**

least-negative-single-float *Constant*

The value of **least-negative-single-float** is that negative floating-point number in single-float format that is closest in value (but not equal to) zero.

least-positive-double-float *Constant*

The value of **least-positive-double-float** is that positive floating-point number in double-float format closest in value (but not equal to) zero.

least-positive-long-float *Constant*

The value of **least-positive-long-float** is that positive floating-point number in single- float format closest in value (but not equal to) zero. In Symbolics Common Lisp this constant has the same value as **least-positive-double-float.**

least-positive-short-float *Constant*

The value of **least-positive-short-float** is that positive floating-point number in short- float format closest in value (but not equal to) zero. In Symbolics Common Lisp this constant has the same value as **least-positive-single-float.**

least-positive-single-float *Constant*

The value of **least-positive-single-float** is that positive floating-point number in single- float format closest in value (but not equal to) zero.

length *sequence* *Function*

length returns the number of elements in *sequence* as a non-negative integer. If the sequence is a vector with a fill pointer, the "active length" as specified by the fill pointer is returned.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(length '()) => 0

(length '(a b c)) => 3

(length '(a (b c) d e)) => 4

(length (vector 'a 'b 'c 'd 'e)) => 5
```

See the section "Array Leaders" in *Symbolics Common Lisp: Language* Concepts.

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

zl:length *list* *Function*

zl:length returns the length of *list.* The length of a list is the number of elements in it. Examples:

```
(zl:length nil) => 0
(zl:length '(a b c d)) => 4
(zl:length '(a (b c) d)) => 3
```

zl:length could have been defined by:

```
(defun length (x)
    (cond ((atom x) 0)
          ((1+ (zl:length (cdr x)))) ))
```

or by:

```
(defun length (x)
    (do ((n 0 (1+ n))
         (y x (cdr y)))
        ((atom y) n) ))
```

except that it is an error to take **zl:length** of a non-**nil** atom.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

zl:lessp *number* &rest *more-numbers* *Function*

zl:lessp compares its arguments from left to right. If any argument is not less than the next, **zl:lessp** returns **nil**. But if the arguments are monotonically strictly increasing, the result is **t**.

Arguments must be noncomplex numbers, but they need not be of the same type.

Examples:

```
(zl:lessp 3 4) => t
(zl:lessp 1 1) => nil
(zl:lessp 0 1 2 3 4) => t
(zl:lessp 0 1.0 5/2 3 2 4) => nil
```

The following function is a synonym of **zl:lessp**:

<

let *((var value)...) body...* *Special Form*

Used to bind some variables to some objects, and evaluate some forms (the "body") in the context of those bindings. A **let** form looks like this:

```
(let ((var1 vform1)
      (var2 vform2)
      ...)
  bform1
  bform2
  ...)
```

When this form is evaluated, first the *vforms* (the values) are evaluated. Then the *vars* are bound to the values returned by the corresponding

vforms. Thus the bindings happen in parallel; all the *vforms* are evaluated before any of the *vars* are bound. Finally, the *bforms* (the body) are evaluated sequentially, the old values of the variables are restored, and the result of the last *bform* is returned.

You can omit the *vform* from a **let** clause, in which case it is as if the *vform* were **nil**: the variable is bound to **nil**. Furthermore, you can replace the entire clause (the list of the variable and form) with just the variable, which also means that the variable gets bound to **nil**. It is customary to write just a variable, rather than a clause, to indicate that the value to which the variable is bound does not matter, because the variable is **setq**'ed before its first use. Example:

```
(let ((a (+ 3 3))
      (b 'foo)
      (c)
      d)
  ...)
```

Within the body, **a** is bound to **6**, **b** is bound to **foo**, **c** is bound to **nil**, and **d** is bound to **nil**.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts*.

let* *((var value)...) body...* *Special Form*

The same as **let**, except that the binding is sequential. Each *var* is bound to the value of its *vform* before the next *vform* is evaluated. This is useful when the computation of a *vform* depends on the value of a variable bound in an earlier *vform*. Example:

```
(let* ((a (+ 1 2))
       (b (+ a a)))
 ...)
```

Within the body, **a** is bound to **3** and **b** is bound to **6**.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts*.

let-and-make-dynamic-closure *vars* &body *body* *Function*

When using dynamic closures, it is very common to bind a set of variables with initial values, and then make a closure over those variables. Furthermore, the variables must be declared as "special".
let-and-make-dynamic-closure is a special form that does all of this. It is best described by example:

```
(let-and-make-dynamic-closure ((a 5) b (c 'x))
   (function (lambda () ...)))
```

macro-expands into

```
(let ((a 5) b (c 'x))
  (declare (special a b c ))
  (make-dynamic-closure '(a b c)
          (function (lambda () ...)))))
```

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:let-closed *((variable value)...) function* *Special Form*

When using dynamic closures, it is very common to bind a set of variables with initial values, and then make a closure over those variables. Furthermore, the variables must be declared as "special". **zl:let-closed** is a special form that does all of this. It is best described by example:

```
(let-closed ((a 5) b (c 'x))
   (function (lambda () ...)))
```

macro-expands into

```
(let ((a 5) b (c 'x))
  (declare (special a b c ))
  (closure '(a b c)
          (function (lambda () ...)))))
```

The Symbolics Common Lisp equivalent of this function is **let-and-make-dynamic-closure**. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

letf *places-and-values body...* *Special Form*

Just like **let**, except that it can bind any storage cells rather than just variables. The cell to be bound is specified by an access form that must be acceptable to **locf**. For example, **letf** can be used to bind slots in a structure. **letf** does parallel binding.

Given the following structure, **letf** calls **do-something-to** with **ship**'s x position bound to zero.

```
(defstruct ship position-x position-y) => SHIP
(setq QE2 (make-ship)) => #S(SHIP :POSITION-X NIL :POSITION-Y NIL)

(letf (((ship-position-x QE2) 0))
  (do-something-to QE2))
```

It is preferable to use **letf** instead of the **zl:bind** subprimitive.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts.*

letf* *places-and-values body...* *Special Form*

Just like **let***, except that it can bind any storage cells rather than just variables. The cell to be bound is specified by an access form that must be acceptable to **locf**. For example, **letf*** can be used to bind slots in a structure. **letf*** does sequential binding.

Given the following structure, **letf*** calls **do-something-to** with **ship**'s x position bound to 0 and y position bound to 5.

```
(defstruct ship position-x position-y) => SHIP
(setq QE2 (make-ship)) => #S(SHIP :POSITION-X NIL :POSITION-Y NIL)

(letf* (((ship-position-x QE2) 0)
        ((ship-position-y QE2) (+ (ship-position-x QE2) 5)))
  (do-something-to QE2))
```

It is preferable to use **letf*** instead of the **zl:bind** subprimitive.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts.*

let-globally *((var value)...) body...* *Special Form*

Similar in form to **let**. The difference is that **let-globally** does not *bind* the variables; instead, it saves the old values and *sets* the variables, and sets up an **unwind-protect** to set them back. The important difference between **let-globally** and **let** is that when the current stack group calls some other stack group, the old values of the variables are *not* restored. Thus, **let-globally** makes the new values visible in all stack groups and processes that do not bind the variables themselves, not just the current stack group.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts.*

let-globally-if *predicate varlist body...* *Special Form*

let-globally-if is like **let-globally**. It takes a predicate form as its first argument. It binds the variables only if *predicate* evaluates to something other than **nil**. *body* is evaluated in either case.

let-if *condition ((var value)...) body...* *Special Form*

A variant of **let** in which the binding of variables is conditional. The variables must all be special variables. The **let-if** special form, typically written as:

```
(let-if cond
        ((var-1 val-1) (var-2 val-2)...)
  body-form1 body-form2...)
```

first evaluates the predicate form *cond*. If the result is non-**nil**, the value forms *val-1*, *val-2*, and so on, are evaluated and then the variables *var-1*, *var-2*, and so on, are bound to them. If the result is **nil**, the *vars* and *vals* are ignored. Finally the body forms are evaluated.

See the section "Special Forms for Binding Variables" in *Symbolics Common Lisp: Language Concepts*.

sys:lexical-closure *Type Specifier*

sys:lexical-closure is the type specifier symbol for the predefined Lisp object of that name.

Examples:

```
(typep *standard-output* 'sys:lexical-closure) => T
(zl:typep *standard-output*) => :LEXICAL-CLOSURE
(sys:type-arglist 'sys:lexical-closure) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

See the section "Scoping" in *Symbolics Common Lisp: Language Concepts*.

lexpr-continue-whopper &rest *args* *Special Form*

Calls the methods for the generic function that was intercepted by the whopper in the same way that **continue-whopper** does, but the last element of *args* is a list of arguments to be passed. This is useful when the arguments to the intercepted generic function include an **&rest** argument. Returns the values returned by the combined method.

For more information on whoppers, including examples: See the section "Wrappers and Whoppers" in *Symbolics Common Lisp: Language Concepts*.

lexpr-send *object message-name* &rest *arguments* *Function*

Sends the message named *message-name* to the *object*. *arguments* are the arguments passed, except that the last element of *arguments* should be a list, and all the elements of that list are passed as arguments. Example:

```
(send some-window :set-edges 10 10 40 40)
```

does the same thing as

```
(setq new-edges '(10 10 40 40))
(lexpr-send some-window :set-edges new-edges)
```

lexpr-send is to **send** as **zl:lexpr-funcall** is to **funcall**.

lexpr-send is supported for compatibility with previous versions of the flavor system. When writing new programs, it is good practice to use generic functions instead of message-passing.

lexpr-send-if-handles *object message* &rest *arguments* *Function*

Sends the message named *message* to *object* if the flavor associated with object has a method defined for *message*. *message* is a message name and arguments is a list of arguments for that message. If *object* does not have a method defined, **nil** is returned.

The difference between **lexpr-send-if-handles** and **send-if-handles** is that for **lexpr-send-if-handles**, the last element of arguments should be a list; all the elements of that list are passed as arguments.
lexpr-send-if-handles is to **send-if-handles** as **lexpr-send** is to **send**.

list *Type Specifier*

list is the type specifier symbol for the predefined Lisp data structure, list.

The types **list** and **vector** are an *exhaustive partition* of the type **sequence**, since `sequence ≡ (or list vector)`.

Examples:

```
(typep '(a b c) 'list) => T
(zl:typep '(a b (d c) e)) => :LIST
(subtypep 'list 'sequence) => T and T
(sys:type-arglist 'list) => NIL and T
(listp ()) => T
(listp '(2.0s0 (a 1) #\*)) => T
(listp '(\A|b|)) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Lists" in *Symbolics Common Lisp: Language Concepts*.

list &rest *args* *Function*

list constructs and returns a list of its arguments. Example:

```
(list 3 4 'a (car '(b . c)) (+ 6 -2)) => (3 4 a b 4)
```

list could have been defined by:

```
(defun list (&rest args)
    (let ((list (make-list (length args))))
      (do ((l list (cdr l))
           (a args (cdr a)))
          ((null a) list)
        (rplaca l (car a)))))
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

list* &rest *args* *Function*

list* is like **list** except that the last cons of the constructed list is "dotted." It must be given at least one argument. Example:

```
(list* 'a 'b 'c 'd) => (a b c . d)
```

This is like

```
(cons 'a (cons 'b (cons 'c 'd)))
```

More examples:

```
(list* 'a 'b) => (a . b)
(list* 'a) => a
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

list*-in-area *area-number* &rest *args* *Function*

list*-in-area is exactly the same as **list*** except that it takes an extra argument, an area number, and creates the list in that area. See the section "Areas" in *Internals, Processes, and Storage Management.*

list*-in-area is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

math:list-2d-array *array* *Function*

Returns a list of lists containing the values in *array*, which must be a two-dimensional array. There is one element for each row; each element is a list of the values in that row.

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list-all-packages *Function*

Returns a list of all the packages that exist in Genera.

zl:listarray *array* &optional *limit* *Function*

zl:listarray creates and returns a list whose elements are those of *array*. *array* can be any type of array or a symbol whose function cell contains an array.

If *limit* is present, it should be an integer, and only the first *limit* (if there are more than that many) elements of *array* are used, and so the maximum length of the returned list is *limit*.

If *array* is multidimensional, the elements are accessed in row-major order: the last subscript varies the most quickly.

list-array-leader *array* &optional *limit* *Function*

list-array-leader creates and returns a list whose elements are those of *array*'s leader. *array* can be any type of array or a symbol whose function cell contains an array.

If *limit* is present, it should be an integer, and only the first *limit* (if there are more than that many) elements of *array*'s leader are used, and so the maximum length of the returned list is *limit*. If *array* has no leader, **nil** is returned.

zl:listify *n* *Function*

Manufactures a list of *n* of the arguments of a lexpr. With a positive argument *n*, it returns a list of the first *n* arguments of the lexpr. With a negative argument *n*, it returns a list of the last **(abs** *n***)** arguments of the lexpr. Basically, it works as if defined as follows:

```
(defun listify (n)
     (cond ((minusp n)
            (listify1 (arg nil) (+ (arg nil) n 1)))
           (t
            (listify1 n 1)) ))

(defun listify1 (n m)       ; auxiliary function.
     (do ((i n (1- i))
          (result nil (cons (arg i) result)))
         ((< i m) result) ))
```

zl:listify exists only for compatibility with Maclisp lexprs. To write functions that can accept variable numbers of arguments, use the **&optional** and **&rest** keywords. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts*.

list-in-area *area-number* &rest *args* *Function*

list-in-area is exactly the same as **list** except that it takes an extra argument, an area number, and creates the list in that area. See the section "Areas" in *Internals, Processes, and Storage Management.*

list-in-area is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

list-length *list* *Function*

list-length returns, as an integer, the length of *list.* **list-length** differs from length when *list* is circular. In these cases, **length** may fail to return, whereas **list-length** will return **nil.** For example:

```
(list-length '()) => 0

(list-length '(a b c d)) => 4

(list-length '(a (b c) d))  => 3

(let ((x (list 'a 'b 'c)))
   (rplacd (last x) x)
   (list-length x)) => NIL
```

See the function **length,** page 288.

For a table of related items: See the section "Functions for Finding Information About Lists and Conses" in *Symbolics Common Lisp: Language* Concepts.

listp *object* *Function*

listp returns **t** if its argument is a list, otherwise **nil.** This means **(listp nil)** is **t.** Note this distinction between **listp** and **zl:listp.** **(zl:listp nil)** is **nil,** since **zl:listp** returns **t** if its argument is a cons.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:listp *arg* *Function*

zl:listp returns **t** if its argument is a cons, otherwise **nil.** Note that this means **(zl:listp nil)** is **nil** even though **nil** is the empty list.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

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load-byte *from-value position size* *Function*

This is like **ldb** except that instead of using a byte specifier, the bit position and *size* are passed as separate arguments. The argument order is not analogous to that of **ldb** so that **load-byte** can be compatible with older versions of Lisp.

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts*.

sys:local-declarations *Variable*

sys:local-declarations is a list of local declarations. Each declaration is itself a list whose car is an atom which indicates the type of declaration. The meaning of the rest of the list depends on the type of declaration. For example, in the case of **special** and **zl:unspecial** the cdr of the list contains the symbols being declared.

The compiler is interested only in **special**, **zl:unspecial**, **macro**, and **arglist** declarations.

Local declarations are added to **sys:local-declarations** in two ways:

- Inside a **zl:local-declare**, the specified declarations are bound onto the front.
- If **sys:undo-declarations-flag** is **t**, some kinds of declarations in a file that is being compiled are consed onto the front of the list; they are not popped until **sys:local-declarations** is unbound at the end of the file.

zl:local-declare *declarations* &body *body* *Special Form*

zl:local-declare, while available in Release 6, should *not* be used for new code. See the section "Lexical Scoping" in *Symbolics Common Lisp: Language Concepts*.

A **zl:local-declare** form looks like this:

```
(local-declare (declaration declaration ...)
  form1
  form2
  ...)
```

Example:

```
(local-declare ((special foo1 foo2))
(defun larry ()
    )
(defun george ()
    )
 ); end of local-declare
```

zl:local-declare understands the same declarations as **declare**.

Each local declaration is consed onto the list **sys:local-declarations** while the *forms* are being evaluated (in the interpreter) or compiled (in the compiler). This list has two uses. First, it can be used to pass information from outer macros to inner macros. Secondly, the compiler specially interprets certain declarations as local declarations, which apply only to the compilation of the *forms*.

sys:localize-list *list* &optional *area* *Function*

sys:localize-list is a function that improves locality of incrementally-constructed lists and alists. **sys:localize-list** returns either *list* or a copy of *list*, depending on how sparsely it is stored in virtual memory.

The optional *area* argument is the number of the area in which to create the new list. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

sys:localize-list is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

sys:localize-tree *tree* &optional (*n-levels* **100**) *area* *Function*

sys:localize-tree is a function that improves locality of incrementally-constructed lists and trees. **sys:localize-tree** returns either *tree* or a copy of *tree*, depending on how sparsely it is stored in virtual memory.

The optional argument *n-levels* is the number of levels of list structure to localize. This is especially useful for alists, where the value of *n-levels* is set to 2.

The optional *area* argument is the number of the area in which to create the new tree. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

L[sys:localize-tree] is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Copying Lists" in *Symbolics Common Lisp: Language Concepts.*

locally &body *body* *Macro*

The **locally** macro is a special form that you can use to declare local pervasive declarations wherever you need them. **locally** does not bind variables and cannot be used to declare variable bindings. You can use the special declaration to pervasively affect referenes to, rather than bindings of, variables. For example:

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```
(locally (declare (inline floor) (notinline car cdr))
         (declare (optimize space))
  (floor (car x) (cdr y)))
```

zl:locate-in-closure *closure symbol* *Function*

This returns the location of the place in the dynamic closure *closure* where the saved value of *symbol* is stored. An equivalent form is **(locf (symeval-in-closure** *closure symbol*)). See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:locate-in-instance *instance symbol* *Function*

Returns a locative pointer to the cell inside *instance* that holds the value of the instance variable named *symbol*, regardless of whether the instance variable was declared a **:locatable-instance-variable.**

In Symbolics Common Lisp, this operation is performed by:

```
(locf (scl:symbol-value-in-instance instance symbol))
```

location-boundp *location* *Function*

location-boundp is a version of **boundp** that can be used on any cell in the Symbolics Lisp Machine. It takes a locative pointer to designate the cell rather than a symbol. It returns **t** if the cell at *location* is bound to a value, and otherwise it returns **nil.** The following two calls are equivalent:

```
(location-boundp (locf a))
(variable-boundp a)
```

The following two calls are also equivalent. When **a** is a special variable, they are also the same as the two calls in the preceding example.

```
(location-boundp (value-cell-location 'a))
(boundp 'a)
```

location-contents *locative* *Function*

Returns the contents of the cell at which *locative* points. For example:

```
(location-contents (value-cell-location x))
```

is the same as:

```
(symeval x)
```

To store objects into the cell at which a locative points, you should use **(setf (location-contents x) y)** as shown in the following example:

```
(setf (location-contents (value-cell-location x)) y)
```

This is the same as:

```
(set x y)
```

Note that **location-contents** is not the right way to read hardware registers, since **cdr** (which is called by **location-contents**) will in some cases start a block-read and the second read could easily read some register you didn't want it to. Therefore, you should use **car** or **sys:%p-ldb** as appropriate for these operations.

location-makunbound *loc* &optional *variable-name* *Function*

location-makunbound is a version of **makunbound** that can be used on any cell in the Symbolics Lisp Machine. It takes a locative pointer to . designate the cell rather than a symbol. (**makunbound** is restricted to use with symbols.)

location-makunbound takes a symbol as an optional second argument: *variable-name* of the location that is being made unbound. It uses *variable-name* to label the null pointer it stores so that the Debugger knows the name of the unbound location if it is referenced. This is particularly appropriate when the location being made unbound is really a variable value cell of one sort or another, for example, closure or instance.

locative *Type Specifier*

locative is the type specifier symbol for the predefined Lisp object, locative.

Examples:

```
(typep (locf x) 'locative) => T
(zl:typep (locf x)) => :LOCATIVE
(subtypep 'locative 'common) => NIL and NIL
(subtypep 'locative 't) => T and T
(sys:type-arglist 'locative) => NIL and T
(zl:locativep (locf xyz)) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

locativep *arg* *Function*

locativep returns **t** if its argument is a locative, otherwise **nil.**

locf *access-form* *Macro*

Takes a form that *accesses* some cell and produces a corresponding form to create a locative pointer to that cell. Examples:

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```
(locf (array-leader foo 3)) ==> (ap-leader foo 3)
(locf a) ==> (variable-location 'a)
(locf (plist 'a)) ==> (property-cell-location 'a)
(locf (aref q 2)) ==> (aloc q 2)
```

If *access-form* invokes a macro or a substitutable function, **locf** expands the *access-form* and starts over again. This lets you use **locf** together with **defstruct** accessors.

If *access-form* is **(cdr** *list***)**, **locf** returns the list itself instead of a locative.

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts.*

log *number* &optional *base* *Function*

Computes and returns the logarithm of *number* in the base *base*, which defaults to *e*, the base of the natural logarithms. Note that the result can be a complex number even when the argument is noncomplex. This occurs if the argument is negative.

The range of the one-argument **log** function is that strip of the complex plane containing numbers with imaginary parts between -π (exclusive) and π (inclusive).

The range of the two-argument **log** function is the entire complex plane. It is an error if *number* or *base* is zero. Both arguments can be numbers of any type.

The result is always in complex or noncomplex floating-point format. Numeric type coercion is applied to the arguments where proper.

Examples:

```
(log 2) => 0.6931472
(log 16 2) => 4.0
(log -1.0)  => #C(0.0 3.1415927)
(log -1 #C(0 1)) => #C(2.0 0.0)
```

For a table of related items: See the section "Powers Of e and Log Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:log *n* *Function*

Returns the natural logarithm of *n*. *n* must be positive, and can be of any numeric data type.

Example:

```
(zl:log 2) => 0.6931472
```

For a table of related items: See the section "Powers Of e and Log Functions" in *Symbolics Common Lisp: Language Concepts.*

logand &rest *integers* *Function*

Returns the bit-wise logical *and* of its arguments. If no argument is given the result is -1, which is an identity for this operation.

Examples:

```
(logand) => -1
(logand 8) => 8
(logand 9 15) => 9
(logand 9 15 12) => 8
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

zl:logand *number* &rest *more-numbers* *Function*

Returns the bit-wise logical *and* of its arguments. At least one argument is required. Examples:

```
(zl:logand #o3456 #o707) => #o406
(zl:logand #o3456 #o-100) => #o3400
```

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logandc1 *integer1 integer2* *Function*

logandc1 is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the bit-wise logical *and* of the complement of *integer1* with *integer2.*

Examples:

```
(logandc1 15 8) => 0
(logandc1 8 15) => 7
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

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logandc2 *integer1 integer2* *Function*

logandc2 is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the bit-wise logical *and* of *integer1* with the complement of *integer2*.

Examples:

```
(logandc2 15 8) => 7
(logandc2 8 15) => 0
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logbitp *index integer* *Function*

If *index* is a non-negative integer j, the predicate **logbitp** is true if bit j in *integer* (that bit whose weight is 2^j) is a one-bit; otherwise it is false.

Examples:

```
(logbitp 1 8) => NIL
(logbitp 1 10) => T
```

For a table of related items: See the section "Predicates for Testing Bits in Integers" in *Symbolics Common Lisp: Language Concepts.*

logcount *integer* *Function*

If *integer* is positive, **logcount** determines and returns the number of one-bits in the binary representation of *integer*. If *integer* is negative, **logcount** determines and returns the number of 0 bits in the two's-complement binary representation of *integer*. The result is always a non-negative integer.

Examples:

```
(logcount 0) => 0
(logcount 6) => 2
(logcount -1) => 0
(logcount -5) => 1              ;-5 is #b ...11011
```

For a table of related items: See the section "Functions Returning Components or Characteristics of Argument" in *Symbolics Common Lisp: Language Concepts.*

sys:%logdpb *newbyte bytespec integer* *Function*

sys:%logdpb is like **dpb** except that it only returns fixnums, while **dpb** would produce a bignum result for arithmetic correctness. If the sign-bit (bit-32) changes, the result reflects the changed sign.

sys:%logdpb is good for manipulating fixnum bit-masks such as are used in some internal system tables and data structures.

The behavior of **sys:%logdpb** depends on the size of fixnums, so functions using it might not work the same way on future implementations of Symbolics Common Lisp. Its name starts with "%" because it is more like machine-level subprimitives than other byte manipulation functions.

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts*.

logeqv &rest *integers* *Function*

Returns the bit-wise logical *equivalence* (also known as *exclusive nor*) of its arguments. If no argument is given, the result is -1, which is an identity for this operation.

Examples:

```
(logeqv) => -1
(logeqv 5) => 5
(logeqv -3 4) => 6              ;-3 is #b11101 and 4 is #b00100
(logeqv 9 2) => -12
(logeqv -3 4 9 2) => 13 ;(logeqv 6 -12) => 13
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logior &rest *integers* *Function*

Returns the bit-wise logical *inclusive or* of its arguments.

If no argument is given, the result is zero. This is an identity for this operation.

Examples:

```
(logior) => 0
(logior -5) => -5
(logior 3 10) => 11
(logior 4 8 2) => 14
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

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zl:logior *number* &rest *more-numbers* *Function*

Returns the bit-wise logical *inclusive or* of its arguments. At least one argument is required. Example:

```
(zl:logior #o4002 #o67) => #o4067
```

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

sys:%logldb *bytespec integer* *Function*

sys:%logldb is like **ldb** except that it only loads out of fixnums and allows a byte size of 32 bits of the fixnum including the sign bit. The result of **sys:%logldb** can be negative when the size of the byte specified by *bytespec* is 32.

The behavior of **sys:%logldb** depends on the size of fixnums, so functions using it might not work the same way on future implementations of Symbolics Common Lisp. Its name starts with "%" because it is more like machine-level subprimitives than other byte manipulation functions.

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

lognand *integer1 integer2* *Function*

lognand is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the logical *not-and* of its two arguments.

Example:

```
(lognand 6 12) => -5                    ;(lognot 4) => -5
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

lognor *integer1 integer2* *Function*

lognor is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the logical *not-or* of its two arguments.

Example:

```
(lognor 3 10) => -12
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

lognot *integer* *Function*

Returns the logical complement of *integer*. This is the same as **zl:logxoring** *integer* with -1.
Example:

```
(lognot 3456) => -3457
(lognot 0) => -1
(lognot 1) => -2
```

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logorc1 *integer1 integer2* *Function*

logorc1 is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the logical *or* of the complement of *integer1* with *integer2*.

Examples:

```
(logorc1 -1 11) => 11
(logorc1 11 -1) => -1
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logorc2 *integer1 integer2* *Function*

logorc2 is a non-associative bit-wise logical operation and takes exactly two arguments. It returns the logical *or* of *integer1* with the complement of *integer2*.

Examples:

```
(logorc2 -1 11) => -1
(logorc2 11 -1) => 11
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

logtest *integer1 integer2* *Function*

The predicate **logtest** is true if any of the bits designated by the 1's in *integer1* are 1's in *integer2* (that is, if there exists at least one non-negative integer j, such that bit j in *integer1* and bit j in *integer2* are both 1's).

Examples:

```
(logtest 10 4) => NIL
(logtest 9 1) => T
(logtest 11 3) => T
```

For a table of related items: See the section "Predicates for Testing Bits in Integers" in *Symbolics Common Lisp: Language Concepts.*

logxor &rest *integers* *Function*

logxor returns the bit-wise logical *exclusive or* of its arguments. If no argument is given, the result is zero. This is an identity for this operation.

Examples:

```
(logxor) => 0
(logxor 5) => 5
(logxor 3 4) => 7
(logxor 9 2) => 11
(logxor 3 4 9 2) => 12          ;(logxor 7 11) => 12
```

See the function **boole**, page 54.

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

zl:logxor *integer* &rest *more-integers* *Function*

Returns the bit-wise logical *exclusive or* of its arguments. At least one argument is required. Example:

```
(zl:logxor #o2531 #o7777) => #o5246
```

For a table of related items: See the section "Functions Returning Result of Bit-wise Logical Operations" in *Symbolics Common Lisp: Language* Concepts.

long-float *Type Specifier*

long-float is the type specifier symbol for the predefined Lisp double-precision floating-point number type.

The type **long-float** is a *subtype* of the type **float**. In Symbolics Common Lisp, the type **long-float** is identical to the type **double-float**.

The type **long-float** is *disjoint* with the types **short-float**, and **single-float**.

Examples:

```
(typep 0d0 'long-float) => T

(subtypep 'long-float 'double-float)
=> T and T ;subtype and certain

(commonp 1.5d9) => T

(equal-typep 'long-float 'double-float) => T

(sys:double-float-p 1.5d9) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

long-float-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (+ (float 1 *e*) *e*)))

In Symbolics Common Lisp **long-float-epsilon** has the same value as **double-float-epsilon**, namely: 1.1102230246251568d-16.

long-float-negative-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (- (float 1 *e*) *e*)))

In Symbolics Common Lisp the value of **long-float-negative-epsilon** is the same as that of **double-float-negative-epsilon**, namely: 5.551115123125784d-17.

loop &rest *forms* *Macro*

loop is a Lisp macro that provides a programmable iteration facility. The Symbolics Common Lisp implementation of **loop** is an extension of the Common Lisp specification for this macro in Guy L. Steele's *Common Lisp: the Language.* **loop** works identically in Symbolics Common Lisp and in Zetalisp.

The general approach is that a form introduced by the word **loop** generates a single program loop, into which a large variety of features can be incorporated. The loop consists of some initialization (*prologue*) code, a body that can be executed several times, and some exit (*epilogue*) code. Variables can be declared local to the loop. The features are concerned with loop variables, deciding when to end the iteration, putting user-written code into the loop, returning a value from the construct, and iterating a variable through various real or virtual sets of values.

The **loop** form consists of a series of clauses, each introduced by a keyword symbol. Forms appearing in or implied by the clauses of a **loop** form are classed as those to be executed as initialization code, body code, and/or exit code; within each part of the template that **loop** fills in, they are executed strictly in the order implied by the original composition. Thus, just as in ordinary Lisp code, side effects can be used, and one piece of code might depend on following another for its proper operation.

Note that **loop** forms are intended to look like stylized English rather than Lisp code. There is a notably low density of parentheses, and many of the keywords are accepted in several synonymous forms to allow writing of more euphonious and grammatical English.

loop Clauses

Internally, **loop** constructs a **prog** that includes variable bindings, preiteration (initialization) code, postiteration (exit) code, the body of the iteration, and stepping of variables of iteration to their next values (which happens on every iteration after executing the body).

A *clause* consists of the keyword symbol and any Lisp forms and keywords with which it deals. For example:

```
(loop for x in l
      do (print x))
```

contains two clauses, "`for x in l`" and "`do (print x)`". Certain parts of the clause are described as being *expressions*, such as **(print** *x* **)** in the example above. An expression can be a single Lisp form, or a series of forms implicitly collected with **progn**. An expression is terminated by the next following atom, which is taken to be a keyword. This syntax allows only the first form in an expression to be atomic, but makes misspelled keywords more easily detectable.

loop uses print-name equality to compare keywords so that **loop** forms can be written without package prefixes; in Lisp implementations that do not have packages, **eq** is used for comparison.

Bindings and iteration variable steppings can be performed either sequentially or in parallel, which affects how the stepping of one iteration variable can depend on the value of another. The syntax for distinguishing the two is described with the corresponding clauses. When a set of things is "in parallel", all of the bindings produced are performed in parallel by a single lambda binding. Subsequent bindings are performed inside that binding environment.

These are the main **loop** clauses and their keywords.

Clause	*Keywords*
Iteration-driving	**repeat, for, as**
Initialization bindings	**with, nodeclare**
Entrance and Exit	**initially, finally**
Side Effects	**do, doing**
Accumulating Return Values	**collect[ing], nconc[ing]** **append[ing], count[ing]** **summ[ing], maximize** **minimize**
End Tests	**until, while, loop-finish** **always, never, thereis**
Conditionalization	**when, if, unless**
Miscellaneous	**named, return**

The dictionary entry for each individual keyword covers it in detail.

Iteration-Driving Clauses

These clauses all create a *variable of iteration*, which is bound locally to the loop and takes on a new value on each successive iteration. Note that if more than one iteration-driving clause is used in the same loop, several variables are created that all step together through their values; when any of the iterations terminates, the entire loop terminates. Nested iterations are not generated; for those, you need a second **loop** form in the body of the loop. In order to not produce strange interactions, iteration-driving clauses are required to precede any clauses that produce "body" code: that is, all except those that produce prologue or epilogue code (**initially** and **finally**), bindings (**with**), the **named** clause, and the iteration termination clauses (**while** and **until**).

The following kinds of iteration are possible:

- Iteration in series and in parallel
- Joining iteration clauses with **and**
- Iterating with **repeat**
- Iterating with **for** and **as**

See the section "**loop** Clauses", page 310.

Accumulating Return Values for **loop**

Several clauses accumulate a return value for the iteration in some manner. The general form is:

type-of-collection expr {*data-type*} {**into** *var*}

where *type-of-collection* is a **loop** keyword, and *expr* is the thing being "accumulated" somehow. (The optional argument, *data-type*, is currently ignored.)

If no **into** is specified, then the accumulation is returned when the **loop** terminates. If there is an **into**, then when the epilogue of the **loop** is reached, *var* (a variable automatically bound locally in the loop) has been set to the accumulated result and can be used by the epilogue code. In this way, a user can accumulate and somehow pass back multiple values from a single **loop**, or use them during the loop. It is safe to reference these variables during the loop, but they should not be modified until the epilogue code of the loop is reached.

For example:

```
(loop for x in list
      collect (foo x) into foo-list
      collect (bar x) into bar-list
      collect (baz x) into baz-list
      finally (return (list foo-list bar-list baz-list)))
```

has the same effect as:

```
(do ((g0001 list (cdr g0001))
     (x) (foo-list) (bar-list) (baz-list))
    ((null g0001)
     (list (nreverse foo-list)
           (nreverse bar-list)
           (nreverse baz-list)))
  (setq x (car g0001))
  (setq foo-list (cons (foo x) foo-list))
  (setq bar-list (cons (bar x) bar-list))
  (setq baz-list (cons (baz x) baz-list)))
```

except that **loop** arranges to form the lists in the correct order, obviating the **nreverse**s at the end, and allowing the lists to be examined during the computation.

Not only can there be multiple *accumulations* in a **loop**, but a single accumulation can come from multiple places *within the same* **loop** *form*. Ob-

viously, the types of the collection must be compatible. **collect, nconc,** and **append** can all be mixed, as can **sum** and **count,** and **maximize** and minimize.

For example:

```
(loop for x in '(a b c) for y in '((1 2) (3 4) (5 6))
      collect x
      append y)
  => (a 1 2 b 3 4 c 5 6)
```

The following computes the average of the entries in the list *list-of-frobs*:

```
(loop for x in list-of-frobs
      count t into count-var
      sum x into sum-var
      finally (return (quotient sum-var count-var)))
```

End Tests for **loop**

Several clauses can be used to provide additional control over when the iteration gets terminated, possibly causing exit code (due to **finally**) to be performed and possibly returning a value (for example, from **collect**).

until might be needed, for example, to step through a strange data structure, as in:

```
(loop until (top-of-concept-tree? concept)
      for concept = expr then (superior-concept concept)
          ...)
```

Note that the placement of the **until** clause before the **for** clause is valid in this case because of the definition of this particular variant of **for,** which *binds* **concept** to its first value rather than setting it from inside the **loop**.

loop-finish can also be of use in terminating the iteration.

loop *Conditionalization*

The keywords **when, if-then-else,** and **unless** can be used to "conditionalize" the following clause. Conditionalization clauses can precede any of the side-effecting or value-producing clauses, such as **do, collect, always,** or **return.**

Multiple conditionalization clauses can appear in sequence. If one test fails, then any following tests in the immediate sequence, and the clause being conditionalized, are skipped.

The format of a conditionalized clause is typically something like:

when *expr1 keyword expr2*

For example:

keyword can be ..

If *expr2* is the keyword **it**, a variable is generated to hold the value of *expr1* and that variable is substituted for *expr2*. See the section "**loop** Conditionalization " in *Symbolics Common Lisp: Language Concepts*.

Multiple clauses can be conditionalized under the same test by joining them with **and**, as in:

```
(loop for i from a to b
      when (zerop (remainder i 3))
        collect i and do (print i))
```

which returns a list of all multiples of **3** from **a** to **b** (inclusive) and prints them as they are being collected.

If-then-else conditionals can be written using the **else** keyword, as in:

```
(loop for i from 1 to 9
      if (oddp i)
        collect i into odd-numbers
      else collect i into even-numbers
      finally (return even-numbers)) => (2 4 6 8)
```

Multiple clauses can appear in an **else**-phrase, using **and** to join them in the same way as above.

Conditionals can be nested. For example:

```
(loop for i from a to b
      when (zerop (remainder i 3))
        do (print i)
        and when (zerop (remainder i 2))
              collect i)
```

returns a list of all multiples of **6** from **a** to **b**, and prints all multiples of **3** from **a** to **b**.

When **else** is used with nested conditionals, the "dangling else" ambiguity is resolved by matching the **else** with the innermost **when** not already matched with an **else**. Here is a complicated example.

```
(loop for x in l
      when (atom x)
        when (memq x *distinguished-symbols*)
          do (process1 x)
      else do (process2 x)
      else when (memq (car x) *special-prefixes*)
             collect (process3 (car x) (cdr x))
             and do (memorize x)
      else do (process4 x))
```

Useful with the conditionalization clauses is the **return** clause, which causes an explicit return of its "argument" as the value of the iteration, bypassing any epilogue code. That is:

when *expr1* **return** *expr2*

is equivalent to:

when *expr1* **do (return** *expr2***)**

Conditionalization of one of the "aggregated boolean value" clauses simply causes the test that would cause the iteration to terminate early not to be performed unless the condition succeeds. For example:

```
(loop for x in l
      when (significant-p x)
        do (print x) (princ "is significant.")
        and thereis (extra-special-significant-p x))
```

does not make the **extra-special-significant-p** check unless the **significant-p** check succeeds.

In the typical format of a conditionalized clause such as

when *expr1 keyword expr2*

expr2 can be the keyword **it**. If that is the case, then a variable is generated to hold the value of *expr1*, and that variable gets substituted for *expr2*. Thus, the composition:

when *expr* **return it**

is equivalent to the clause:

thereis *expr*

and one can collect all non-**null** values in an iteration by saying:

when *expression* **collect it**

If multiple clauses are joined with **and**, the **it** keyword can only be used in the first. If multiple **whens**, **unlesses**, and/or **ifs** occur in sequence, the

value substituted for **it** is that of the last test performed. The **it** keyword is not recognized in an **else**-phrase.

Destructuring

Destructuring provides you with the ability to "simultaneously" assign or bind multiple variables to components of some data structure. Typically this is used with list structure. For example:

```
(loop with (foo . bar) = '(a b c) ...)
```

has the effect of binding **foo** to **a** and **bar** to **(b c)**.

Here's how this might work:

```
(defun ex-destructuring ()
  (loop for x from 1 to 4
        with (one . rest) = '(1 2 3)
        do
    (princ x)(princ " ")
        finally (print one)(print rest)))  => EX-DESTRUCTURING

(ex-destructuring) => 1 2 3 4
1
(2 3) NIL
```

Iteration Paths For loop

Iteration paths provide a mechanism for user extension of iteration-driving clauses. The interface is constrained so that the definition of a path need not depend on much of the internals of **loop**. The typical form of an iteration path is

`for` *var* {*data-type*} `being {each|the}` *pathname* {*preposition1 expr1*}...

pathname is an atomic symbol that is defined as a **loop** path function. The usage and defaulting of *data-type* is up to the path function. Any number of preposition/expression pairs can be present; the prepositions allowable for any particular path are defined by that path. For example:

```
(loop for x being the array-elements of my-array from 1 to 10
          ...)
```

To enhance readability, pathnames are usually defined in both the singular and plural forms; this particular example could have been written as:

```
(loop for x being each array-element of my-array from 1 to 10
      ...)
```

See the section "Iteration Paths" in *Symbolics Common Lisp: Language Concepts.*

zl:loop *x* &optional *ignore* *Macro*

A Lisp macro that provides a programmable iteration facility.

The general approach is that a form introduced by the word **zl:loop** generates a single program loop, into which a large variety of features can be incorporated. The loop consists of some initialization (*prologue*) code, a body that can be executed several times, and some exit (*epilogue*) code. Variables can be declared local to the loop. The features are concerned with loop variables, deciding when to end the iteration, putting user-written code into the loop, returning a value from the construct, and iterating a variable through various real or virtual sets of values.

The **zl:loop** form consists of a series of clauses, each introduced by a keyword symbol. Forms appearing in or implied by the clauses of a **zl:loop** form are classed as those to be executed as initialization code, body code, and/or exit code; within each part of the template that **zl:loop** fills in, they are executed strictly in the order implied by the original composition. Thus, just as in ordinary Lisp code, side effects can be used, and one piece of code might depend on following another for its proper operation.

Note that **zl:loop** forms are intended to look like stylized English rather than Lisp code. There is a notably low density of parentheses, and many of the keywords are accepted in several synonymous forms to allow writing of more euphonious and grammatical English.

Here are some examples to illustrate the use of **zl:loop**. The dictionary entry for **loop**, and the chapter discussion cover this topic in more detail. See the macro **loop**, page 309. See the section "The **loop** Iteration Macro" in *Symbolics Common Lisp: Language Concepts.*

print-elements-of-list prints each element in its argument, which should be a list. It returns **nil**.

```
(defun print-elements-of-list (list-of-elements)
  (loop for element in list-of-elements
        do (print element))) => PRINT-ELEMENTS-OF-LIST
```

gather-alist-entries takes an association list and returns a list of the "keys"; that is, **(gather-alist-entries '((foo 1 2) (bar 259) (baz)))** returns **(foo bar baz)**.

```
(defun gather-alist-entries (list-of-pairs)
  (loop for pair in list-of-pairs
        collect (car pair))) => GATHER-ALIST-ENTRIES
```

extract-interesting-numbers takes two arguments, which should be integers, and returns a list of all the numbers in that range (inclusive) that satisfy the predicate **interesting-p**.

```
(defun extract-interesting-numbers (start-value end-value)
  (loop for number from start-value to end-value
        when (interesting-p number) collect number))
 => EXTRACT-INTERESTING-NUMBERS
```

find-maximum-element returns the maximum of the elements of its argument, a one-dimensional array. For Maclisp, **aref** could be a macro that turns into either **funcall** or **zl:arraycall** depending on what is known about the type of the array.

```
(defun find-maximum-element (an-array)
  (loop for i from 0 below (array-dimension-n 1 an-array)
        maximize (aref an-array i)))
 => FIND-MAXIMUM-ELEMENT
```

my-remove is like the Lisp function **zl:delete**, except that it copies the list rather than destructively splicing out elements. This is similar, although not identical, to the **zl:remove** function.

```
(defun my-remove (object list)
  (loop for element in list
        unless (equal object element) collect element))
 => MY-REMOVE
```

find-frob returns the first element of its list argument that satisfies the predicate **frobp**. If none is found, an error is generated.

```
(defun find-frob (list)
  (loop for element in list
        when (frobp element) return element
        finally (ferror nil "No frob found in the list ~S" list)))
 => FIND-FROB
```

Data Types Recognized By zl:loop

In many of the clause descriptions, an optional *data-type* is shown. This is a slot reserved for data type declarations; it is currently ignored.

loop-finish *Macro*

(loop-finish) causes the iteration to terminate "normally", the same as implicit termination by an iteration-driving clause, or by the use of **while** or **until** – the epilogue code (if any) is run, and any implicitly collected result is returned as the value of the **loop**. For example:

```
(loop for x in '(1 2 3 4 5 6)
      collect x
      do (cond ((= x 4) (loop-finish))))
 => (1 2 3 4)
```

This particular example would be better written as **until (= x 4)** in place of the **do** clause.

See the section "**loop** Clauses", page 310.

lower-case-p *char* *Function*

Returns **t** if *char* is a lower-case letter.

```
(lower-case-p #\a) => T
(lower-case-p #\A) => NIL
```

lsh *number count* *Function*

Returns *number* shifted left *count* bits if *count* is positive or zero, or number shifted right |*count*| bits if *count* is negative. Zero bits are shifted in (at either end) to fill unused positions. *number* and *count* must be fixnums. Since the result is also a fixnum, bits shifted off either end are lost. (In some applications you might find **ash** useful for shifting bignums.)

Note that like the Zetalisp functions whose name begins with the percent-sign (%), **lsh** is machine-dependent.

Examples:

```
(lsh 4 1) => #o10
(lsh #o14 -2) => #o3
(lsh -1 1) => #o-2
(lsh -100 27) => -536870912 ;(ash -100 27) => -13421772800
```

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

M

macro *name lambda-list* &body *body* *Special Form*

The primitive special form for defining macros is **macro**. A macro definition looks like this:

```
(macro name (form env)
    body)
```

name can be any function spec. *form* and *env* must be variables. *body* is a sequence of Lisp forms that expand the macro; the last form should return the expansion. **defmacro** is usually preferred in practice.

macroexpand *form* &optional *env dont-expand-special-forms* *Function*

If *form* is a macro form, **macroexpand** expands it repeatedly until it is not a macro form and returns two values: the final expansion and **t**. Otherwise, it returns *form* and **nil**. *env* is a lexical environment that can be supplied to specify the lexical environment of the expansions. See the section "Lexical Environment Objects and Arguments" in *Symbolics Common Lisp: Language Concepts*. *dont-expand-special-forms* prevents macro expansion of forms that are both special forms and macros.

macroexpand-1 *form* &optional *env dont-expand-special-forms* *Function*

If *form* is a macro form, **macroexpand-1** expands it (once) and returns the expanded form and **t**. Otherwise it returns *form* and **nil**. *env* is a lexical environment that can be supplied to specify the lexical environment of the expansions. See the section "Lexical Environment Objects and Arguments" in *Symbolics Common Lisp: Language Concepts*. *dont-expand-special-forms* prevents macro expansion of forms that are both special forms and macros. See the variable ***macroexpand-hook***, page 320.

macroexpand-hook *Variable*

The value of this variable is used as the expansion interface hook by **macroexpand-1**. When **macroexpand-1** determines that a symbol names a macro, it obtains the expansion function for that macro. The value of ***macroexpand-hook*** is called as a function of three arguments: the expansion function, *form*, and *env*. The value returned from this call is the expansion of the macro call.

The initial value of ***macroexpand-hook*** is **funcall**, and the net effect is to invoke the expansion function, giving it *form* and *env* as its two arguments.

macro-function *function* *Function*

macro-function tests whether its argument is the name of a macro. function should be a symbol. If *function* has a global function definition that is a macro definition, then the expansion function (a function of two arguments, the macro-call form and an environment) is returned. The function **macroexpand** is the best way to invoke the expansion function.

If *function* has no global function definition, or has a definition as an ordinary function or as a special form but not as a macro, then **nil** is returned.

It is possible for *both* **macro-function** and **special-form-p** to be true of a symbol. This is so because it is permitted to implement any macro also as a special form for speed.

macro-function cannot be used to determine whether a symbol names a locally defined macro established by **macrolet**; **macro-function** can examine only global definitions.

setf can be used with **macro-function** to install a macro as a symbol's global function definition:

For example:

(**setf** (**macro-function** *symbol*) *fn*)

The value installed must be a function that accepts two arguments, an entire macro call and an environment, and computes the expansion for that call. Performing this operation causes the symbol to have *only* that macro definition as a global function definition; any previous definition, whether as a macro or as a function, is lost.

make-array *dimensions* &key (*element-type* **t**) *initial-element* *Function*
initial-contents adjustable fill-pointer
displaced-to displaced-index-offset
displaced-conformally area leader-list
leader-length named-structure-symbol

make-array creates and returns a new array. *dimensions* is the only required argument. *dimensions* is a list of integers that are the dimensions of the array; the length of the list is the dimensionality, or rank of the array.

```
;; Create a two-dimensional array
(make-array '(3 4) :element-type 'string-char)
```

For convenience when making a one-dimensional array, the single dimension can be provided as an integer rather than a list of one integer.

```
;; Create a one-dimensional array of five elements.
(make-array 5)
```

The initialization of the elements of the array depends on the element type. By default the array is a general array, the elements can be any type of Lisp object, and each element of the array is initially **nil**. However, if the **:element-type** option is supplied, and it constrains the array elements to being integers or characters, the elements of the array are initially 0 or characters whose character code is 0 and style is **[nil.nil.nil]**. You can

M

specify initial values for the elements by using the **:initial-contents** or **:initial-element** options.

Several of the keyword options are enhancements to Common Lisp. These include: **:displaced-conformally**, **:area**, **:leader-list**, **:leader-length**, and **:named-structure-symbol**.

See the section "Keyword Options For **make-array**" in *Symbolics Common Lisp: Language Concepts*.

See the section "Examples Of **make-array**" in *Symbolics Common Lisp: Language Concepts*.

zl:make-array *dimensions* &key *area type displaced-to displaced-index-offset displaced-conformally adjustable leader-list leader-length named-structure-symbol initial-value fill-pointer* *Function*

Genera offers both **zl:make-array** and **make-array**. See the function **make-array**, page 321.

dimensions is the only required argument. *dimensions* is a list of integers that are the dimensions of the array; the length of the list is the dimensionality, or rank of the array. For the one-dimensional case you can just give the integer.

zl:make-array returns two values: the newly created array, and the number of words allocated in the process of creating the array. The second value is the **sys:%structure-total-size** of the array. Note that **make-array** returns only one value, the newly created array.

Most of the keyword options to **zl:make-array** have the same meaning as the keyword options with the same name that can be given to **make-array**. See the section "Keyword Options For **make-array**" in *Symbolics Common Lisp: Language Concepts*.

:initial-value The **:initial-value** keyword for **zl:make-array** has the same meaning as the **:initial-element** keyword for **make-array**.

:type The **:type** option for **zl:make-array** is used for the same purpose as is the **:element-type** option for **make-array**; that is, to specify that the elements of the array should be of a certain type. The value of the **:type** option is the symbolic name of one of the Zetalisp array types, which include:

sys:art-q
sys:art-q-list
sys:art-*n*b
sys:art-string
sys:art-fat-string
sys:art-boolean
sys:art-fixnum

The default type of array is **sys:art-q**, a general array. See the section "Zetalisp Array Types" in *Symbolics Common Lisp: Language Concepts.*

The initialization of the elements of the array depends on the type of array. If the array is of a type whose elements can only be integers or characters, element of the array are initially 0 or character code 0. Otherwise, each element is initially **nil**.

zl:make-array-into-named-structure *array* *Function*

array is made to be a named structure, and is returned.

make-char *char* &optional (*bits* **0**) (*font* **0**) *Function*

Takes the argument *char*, which must be a character object. *bits* and *font* must be non-negative integers. **make-char** sets the bits field to *bits* and returns the new character. If **make-char** cannot construct a character given its arguments, it returns **nil**.

To set the bits of the character, supply one of the character bits constants as the *bits* argument. See the section "Character Bit Constants" in *Symbolics Common Lisp: Language Concepts.*

```
(make-char #\A char-meta-bit) => #\m-A
```

Since the value of **char-font-limit** is **1**, the only valid value of *font* is **0**. The only reason to use the *font* option would be when writing a program intended to be portable to other Common Lisp systems.

If you want to construct a new character that has character style other than NIL.NIL.NIL, use **make-character**: See the function **make-character**, page 323.

make-character *char* &key (*bits* **0**) (*style* **nil**) *Function*

Takes an argument *char*, which must be a character object, and returns a new character with the same code, but having the specified bits and style.

To set the bits of the character, supply one of the character bits constants as the value of the **:bits** keyword. See the section "Character Bit Constants" in *Symbolics Common Lisp: Language Concepts.* For example:

M

```
(make-character #\1 :bits char-control-bit) => #\c-1
```

To set the character style of the character, use the **:style** keyword and supply a list of the form (*:family :face :size*). Any of the elements of this list can be **nil**. For example:

```
(make-character #\A :style '(nil :italic nil)) => #\A
```

make-condition *condition-name* &rest *init-options* *Function*

make-condition creates a condition object of the specified *condition-name* with the specified *init-options*. This object can then be signalled by passing it to **signal** or **error**. Note that you are not supposed to design functions that indicate errors by *returning* error objects; functions should always indicate errors by *signalling* error objects. This function makes it possible to build complex systems that use subroutines to generate condition objects so that their callers can signal them.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts*.

make-dynamic-closure *symbol-list function* *Function*

Creates and returns a dynamic closure of *function* over the variables in *symbol-list*. Note that all variables on *symbol-list* must be declared special.

To test whether an object is a dynamic closure, use **(typep** *x* **:closure)**. **(typep** *x* **:closure)** is equivalent to **(zl:closurep** *x***)**. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:make-equal-hash-table &rest *options* *Function*

This creates a new hash table using the **equal** function for comparison of the keys. This function calls **make-instance** using the **si:equal-hash-table** flavor, passing *options* to **make-instance** as init options. See the flavor **si:equal-hash-table**, page 204. This function will be removed in the future – use **zl:make-hash-table** with the **:test** keyword.

make-hash-table &key (*test* **'eql**) (*size* **cli:*default-table-size***) (*area* **sys:default-cons-area**) *hash-function rehash-before-cold rehash-after-full-gc* (*entry-size* **2**) (*mutating* **t**) *initial-contents optimizations* (*locking* **:process**) *ignore-gc growth-factor growth-threshold rehash-size rehash-threshold* &rest *options* *Function*

This function creates and returns a new table object. This function calls **make-instance** using a basic table flavor and mixins for the necessary additional flavors as specified by the options.

make-hash-table takes the following keyword arguments:

:test One of the values #'**eq**, #'**eql**, or #'**equal**; one of the predicates **eq**, **eql**, **equal**; or some arbitrary predicate that you specify. It determines how keys are compared.

:size An integer representing the initial size of the table.

:area If **:area** is **nil** (the default), the **sys:default-cons-area** is used. Otherwise, the number of the area that you wish to use. This keyword is a Symbolics extension to Common Lisp.

:hash-function Specifies a replacement hashing function. The default is based on the **:test** predicate. This keyword is a Symbolics extension to Common Lisp.

:rehash-before-cold

Causes a rehash whenever the hashing algorithm has been invalidated. (This is part of the before-cold initializations.) Thus every user of the saved band does not have to waste the overhead of rehashing the first time they use the table after cold booting.

For **eq** tables, hashing is invalidated whenever garbage collection or band compression occurs because the hash function is sensitive to addresses of objects, and those operations move objects to different addresses. For **equal** tables, the hash function is not sensitive to addresses of objects that **sxhash** knows how to hash but it is sensitive to addresses of other objects. The table remembers whether it contains any such objects.

Normally a table is automatically rehashed "on demand" the first time it is used after hashing has become invalidated. This first **gethash** operation is therefore much slower than normal.

The **:rehash-before-cold** keyword should be used on tables that are a permanent part of your world, likely to be saved in a band saved by **zl:disk-save**, and to be touched by users of that band. This applies both to tables in Genera and to tables in user-written subsystems that are saved on disk bands.

This keyword is a Symbolics extension to Common Lisp.

:rehash-after-full-gc

Similar to **:rehash-before-cold**. Causes a rehash whenever the garbage collector performs a full gc. This keyword is a Symbolics extension to Common Lisp.

:entry-size An integer that determines how large each entry is. Especially useful for tables of type set. Currently the

only legal values are 1 and 2. This keyword is a Symbolics extension to Common Lisp.

:mutating Turns mutation on and off. This keyword is a Symbolics extension to Common Lisp.

:initial-contents A table object to copy the contents from, or a sequence of keys and values to fill the table with. This keyword is a Symbolics extension to Common Lisp.

:optimizations This keyword is reserved for use in a future release. It is a Symbolics extension to Common Lisp.

:locking One or more of the following locking strategies: **:process, :without-interrupts, nil,** or a cons consisting of a lock and an unlock function. The default is to lock against the garbage collector when necessary and to lock against other processes. This keyword is a Symbolics extension to Common Lisp.

:ignore-gc By default, if the hash function is sensitive to the garbage collector, then the table is protected against GC flip. This keyword is a Symbolics extension to Common Lisp.

:growth-factor A synonym for **:rehash-size.** If the keyword is an integer, it is the number of entries to add, and if it is a floating-point number, it is the ratio of the new size to the old size. If the value is neither an integer or a floating-point number, then an error is signalled. This keyword is a Symbolics extension to Common Lisp.

:growth-threshold
A synonym for **:rehash-threshold.** If it is an integer greater than zero and less than the **:size,** then it is related to the number of entries at which growth should occur. The threshold is the current size minus the **:growth-threshold.** If it is a floating-point number between zero and one, then it is the percentage of entries that can be filled before growth will occur. If the value is neither an integer or a floating-point number, then an error is signalled. This keyword is a Symbolics extension to Common Lisp.

:rehash-size The growth factor of the table when it becomes full. If the value of the keyword is an integer, it is the number of entries to add, and if it is a floating-point number, it is the ratio of the new size to the old size. If the value is neither an integer or a floating-point number, then an error is signalled.

:rehash-threshold How full the table can become before it must grow. If it

is an integer greater than zero and less than the **:size**, then it is related to the number of entries at which growth should occur. The threshold is the current size minus the **:growth-threshold**. If it is a floating point number between zero and one, then it is the percentage of entries that can be filled before growth will occur. If the value is neither an integer or a floating-point number, then an error is signalled.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:make-hash-table &rest *options* *Function*

This creates a new hash table using the **eq** function for comparison of the keys. This function calls **make-instance** using the **si:eq-hash-table** flavor, passing *options* to **make-instance** as init options. See the flavor **si:eq-hash-table**, page 199. This function will be removed in the future – use **zl:make-hash-table** with the **:test** keyword.

make-heap (&key (*size* **100**) (*predicate* #'<) (*growth-factor* **1.5**) *interlocking*) *Function*

make-heap creates a new heap. **:predicate**, **:size**, and **:growth-factor** are passed as init options to **make-instance** when the heap is created.

make-heap takes the following keyword arguments:

:size The default is **100**.

:predicate An ordering predicate that is applied to each key. The default is #'<.

:growth-factor A number or **nil**. If it is an integer, the heap is increased by that number. If it is a floating-point number greater than one, the new size of the heap is the old size multiplied by that number. If it is **nil**, the condition **si:heap-overflow** is signalled instead of growing the heap.

:interlocking

:without-interrupts
This causes **make-heap** to create a kind of heap that can be interlocked for use by multiple processes, using **without-interrupts** to perform the interlocking.

t This causes **make-heap** to create a kind of heap that can be interlocked for use by multiple processes, using

M

process-lock to perform the interlocking.

nil This causes **make-heap** to create a heap that uses no locking at all. This is the default.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

make-instance *flavor-name* &rest *init-options* *Generic Function*

Creates and returns a new instance of the flavor named *flavor-name*, initialized according to *init-options*, which are alternating keywords and arguments. All *init-options* are passed to any methods defined for **make-instance**.

If **compile-flavor-methods** has not been done in advance, **make-instance** causes the combined methods of a program to be compiled, and the data structures to be generated. This is sometimes called *composing* the flavor. **make-instance** also checks that the requirements of the flavor are met. Requirements of the flavor are set up with these **defflavor** options: **:required-flavors, :required-methods, :required-init-keywords**, and **:required-instance-variables**.

init-options can include:

:initable-instance-variable value
You can supply keyword arguments to **make-instance** that have the same name as any instance variables specified as **:initable-instance-variables** in the **defflavor** form. Each keyword must be followed by its initial value. This overrides any defaults given in **defflavor** forms.

:init-keyword value
You can supply keyword arguments to **make-instance** that have the same name as any keywords specified as **:init-keywords** in the **defflavor** form. Each keyword must be followed by a value. This overrides any defaults given in **defflavor** forms.

:allow-other-keys t
Specifies that unrecognized keyword arguments are to be ignored.

:allow-other-keys :return
Specifies that a list of unrecognized keyword arguments are to be the second return value of **make-instance**. Otherwise only one value is returned, the new instance.

:area *number* Specifies the area number in which the new instance is

to be created. Note that you can use the **:area-keyword** option to **defflavor** to change the **:area** keyword to **make-instance** to a keyword of your choice, such as **:area-for-instances**.
Note that any ancillary values constructed by **make-instance** (other than the instance itself) are constructed in whatever area you specify for them; this is not affected by using the **:area** keyword. For example, if you supply a variable initialization that causes consing, that allocation is done in whatever area you specify for it, not in this area. For example:

```
(defflavor foo ((foo-1 (make-array 100)))
               ())
```

In this example the array is consed in **sys:default-cons-area**.

:area nil Specifies that the new instance is to be created in the **sys:default-cons-area**. This is the default, unless the **:default-init-plist** option is used to specify a different default for **:area**.

If not supplied in the *init-options* argument to **make-instance**, the **:default-init-plist** option to the **defflavor** form is consulted for any default values for initable instance variables, init keywords, and the **:area** and **:allow-other-keys** options.

If you want to know what the allowed keyword arguments to **make-instance** are, use the Show Flavor Initializations command. See the section "Show Flavor Commands" in *Symbolics Common Lisp: Language Concepts*. `c-sh-A` works too, if the flavor name is constant.

You can define a method to run every time an instance of a certain flavor is created: See the section "Writing Methods For **make-instance**" in *Symbolics Common Lisp: Language Concepts*.

make-list *size* &key *initial-element area* *Function*

This function creates and returns a list containing *size* elements, each of which is initialized to the value of the **:initial-element**. The value of *size* should be a non-negative integer. For example:

```
(make-list 5) => (NIL NIL NIL NIL NIL)

(make-list 3 :initial-element 'rah) => (RAH RAH RAH)
```

:initial-element The value of the **:initial-element** argument. The default is **nil**).

area An optional argument that is the number of the area in

which to create the new list. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

zl:make-list *length* &rest *options* *Function*

This creates and returns a list containing *length* elements. *length* should be an integer. *options* are alternating keywords and values. The keywords can be either of the following:

:area The value specifies in which area the list should be created. See the section "Areas" in *Internals, Processes, and Storage Management.* It should be either an area number (an integer), or **nil** to mean the default area.

:initial-value
The elements of the list are all this value. It defaults to **nil**.

zl:make-list always creates a *cdr-coded* list. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts.* Examples:

```
(zl:make-list 3) => (nil nil nil)
(zl:make-list 4 :initial-value 7) => (7 7 7 7)
```

When **zl:make-list** was originally implemented, it took exactly two arguments: the area and the length. This obsolete form is still supported so that old programs will continue to work, but the new keyword-argument form is preferred.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

make-mouse-char *button* &optional (*bits* **0**) *Function*

Constructs a mouse character given a mouse button number. 0, 1, and 2 correspond to the left, middle, and right mouse buttons, respectively.

The optional *bits* argument is a number encoding the shift keys qualifying the root mouse character as follows:

Bits	Shift Key
0	None
1	CONTROL
2	META
4	SUPER
8	HYPER
16	SHIFT

The shift keys are additive with respect to the *bits* value, for example:

```
(make-mouse-char 0 31) ==>
#\h-s-m-c-sh-Mouse-L
```

make-package *name* &key ... *Function*

make-package is the primitive subroutine called by **defpackage**. **make-package** makes a new package and returns it. An error is signalled if the package name or nickname conflicts with an existing package. **make-package** takes the same arguments as **defpackage** except that standard **&key** syntax is used, and there is one additional keyword, **:invisible**.

When an argument is called a *name*, it can be either a symbol or a string. When an argument is called a *package*, it can be the name of the package as a symbol or a string, or the package itself.

The keyword arguments are:

:use '(*package package...*)
: External symbols and relative name mappings of the specified packages are inherited. If only a single package is to be used, the name rather than a list of the name can be passed. If no package is to be used, specify **nil**. The default value for **:use** is **global**.

:nicknames '(*name name...*)
: The package is given these nicknames, in addition to its primary name.

Symbolics Common Lisp provides additional functionality with these keywords:

:prefix-name *name*
: This name is used when printing a qualified name for a symbol in this package. The specified name should be one of the nicknames of the package or its primary name. If **:prefix-name** is not specified, it defaults to the shortest of the package's names (the primary name plus the nicknames).

:invisible *boolean*
: If true, the package is not entered into the system's table of packages, and therefore cannot be referenced via a qualified name. This is useful if you simply want a package to use as a data structure, rather than as the package in which to write a program.

:shadow '(*name name...*)
: Symbols with the specified names are created in this package and declared to be shadowing.

:export '(*name name...*)
: Symbols with the specified names are created in this package, or inherited from the packages it uses, and declared to be external.

:import '(*symbol symbol...*)

The specified symbols are imported into the package. Note that unlike **:export**, **:import** requires symbols, not names; it matters in which package this argument is read.

:shadowing-import '(*symbol symbol...*)

The same as **:import** but no name conflicts are possible; the symbols are declared to be shadowing.

:import-from '(*package name name...*)

The specified symbols are imported into the package. The symbols to be imported are obtained by looking up each *name* in *package*. (**defpackage** only) This option exists primarily for system bootstrapping, since the same thing can normally be done by **:import**. The difference between **:import** and **:import-from** can be visible if the file containing a **defpackage** is compiled; when **:import** is used the symbols are looked up at compile time, but when **:import-from** is used the symbols are looked up at load time. If the package structure has been changed between the time the file was compiled and the time it is loaded, there might be a difference.

:relative-names '((*name package*) (*name package*)...)

Declare relative names by which this package can refer to other packages. The package being created cannot be one of the *packages*, since it has not been created yet. For example, to be able to refer to symbols in the **common-lisp** package print with the prefix **lisp:** instead of **cl:** when they need a package prefix (for instance, when they are shadowed), you would use **:relative-names** like this:

```
(defpackage my-package (:use cl)
                       (:shadow error)
                       (:relative-names (lisp common-lisp)))

(let ((*package* (find-package 'my-package)))
  (print (list 'my-package::error 'cl:error)))
```

:relative-names-for-me '((*package name*) (*package name*)...)

Declare relative names by which other packages can refer to this package.

(**defpackage** only) It is valid to use the name of the package being created as a *package* here; this is useful when a package has a relative name for itself.

:size *number*

The number of symbols expected to be present in the package. This controls the initial size of the package's hash table. The **:size** specification can be an underestimate; the hash table is expanded as necessary.

:hash-inherited-symbols *boolean*

If true, inherited symbols are entered into the package's hash table to speed up symbol lookup. If false (the default), looking up a symbol in this package searches the hash table of each package it uses.

:external-only *boolean*

If true, all symbols in this package are external and the package is locked. This feature is only used to simulate the old package system that was used before Release 5.0. See the section "External-only Packages and Locking" in *Symbolics Common Lisp: Language Concepts*.

:include '(*package package...***)**

Any package that uses this package also uses the specified packages. Note that if the **:include** list is changed, the change is not propagated to users of this package. This feature is used only to simulate the old package system that was used before Release 5.0.

:new-symbol-function *function*

function is called when a new symbol is to be made present in the package. The default is **si:pkg-new-symbol** unless **:external-only** is specified. Do not specify this option unless you understand the internal details of the package system.

:colon-mode *mode*

If *mode* is **:external**, qualified names mentioning this package behave differently depending on whether ":" or "::" is used, as in Common Lisp. ":" names access only external symbols. If *mode* is **:internal**, ":" names access all symbols. **:internal** is the default currently. See the section "Specifying Internal and External Symbols in Packages" in *Symbolics Common Lisp: Language Concepts*.

:prefix-intern-function *function*

The function to call to convert a qualified name referencing this package with ":" (rather than "::") to a symbol. The default is intern unless **(:colon-mode :external)** is specified. Do not specify this option unless you understand the internal details of the package system.

make-plane *rank* &key (*type* **sys:art-q**) (*default-value* **nil** *default-value-supplied*) (*extension* **32**) (*initial-dimensions* **nil**) (*initial-origins* **nil**) *Function*

Creates and returns a plane. *rank* is the number of dimensions. *options* is a list of alternating keyword symbols and values. The allowed keywords are:

:type The array type symbol (for example, **sys:art-1b**) specifying the type of the array out of which the plane is made.

:default-value

The default component value.

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:extension
The amount by which to extend the plane. See the section "Planes" in *Symbolics Common Lisp: Language Concepts.*

:initial-dimensions
A list of dimensions for the initial creation of the plane. You might want to use this option to create a plane whose first dimension is a multiple of 32, so you can use **bitblt** on it. The default is 1 in each dimension.

:initial-origins
A list of origins for the initial creation of the plane. The default is all zero.

Example:

```
(make-plane 2 :type sys:art-4b :default-value 3)
```

creates a two-dimensional plane of type **sys:art-4b**, with default value **3.**

make-random-state &optional *state* *Function*

Returns a new object of type **random-state** which the function **random** can use as its *state* argument.

If *state* is **nil** or omitted, **make-random-state** returns a copy of the current random-number state object (the value of variable ***random-state***).

If *state* is a state object, a copy of that state object is returned.

If *state* is **t**, the function returns a new state object that has been "randomly" initialized.

Examples:

```
(setq x (make-random-state)) => #.(RANDOM-STATE 71 1695406379...)
;;; the value of x is now a random state
(setq copy-x (make-random-state x)) => #.(RANDOM-STATE 71...)
;;; this makes a copy of random state x
;;; a way to get reproducibly random numbers
```

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts.*

make-raster-array *width height* &key *make-array-options* *Function*

Makes rasters; this should be used instead of **make-array** when making arrays that are rasters. **make-raster-array** is similar to **make-array**, but **make-raster-array** takes *width* and *height* as separate arguments instead of taking a single *dimensions* argument. If the raster is to be used with **bitblt**, the width times the number of bits per array element must be a multiple of 32.

The *make-array-options* are the options that can be given to **make-array**. For information on those options: See the section "Keyword Options For **make-array**" in *Symbolics Common Lisp: Language Concepts.*

When you cannot use **make-raster-array**, for example from the **:make-array** option to **defstruct** contructors, you should use **raster-width-and-height-to-make-array-dimensions** instead.

zl:make-raster-array *width height* &rest *zl:make-array-options* *Function*

This function is provided for compatibility with previous releases. **make-raster-array** offers the same functionality. For information on this function: See the function **make-raster-array**, page 334.

The only difference between **zl:make-raster-array** and **make-raster-array** is the list of keyword options they accept. **zl:make-raster-array** accepts the keyword options that can be given to **zl:make-array**. **make-raster-array** accepts the keyword options that can be given to **make-array**.

For information on the argument *zl:make-array-options*: See the function **zl:make-array**, page 322.

make-sequence *type size* &key *initial-element area* *Function*

make-sequence returns a sequence of type *type* and of length *size*, each of whose elements has been initialized to the value of the **:initial-element** argument (or **nil** if none is specified). If **:initial-element** is specified, the value must be an object that can be an element of a sequence of type *type*. For example:

```
(make-sequence '(vector double-float) 5 :initial-element 1d0)
 => #(1.0d0 1.0d0 1.0d0 1.0d0 1.0d0)
```

The optional *area* argument is the number of the area in which to create the new alist. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

You can also create sequences using the **vector** and **make-list** functions. See the function **vector**, page 610. See the function **make-list**, page 329.

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

make-string *size* &key *initial-element element-type area* *Function*

The function **make-string** returns a simple string of length *size*. It constructs a one-dimensional array without fill pointer or displacement, to hold elements of type **character**, or any of its subtypes, that is, **string-char**, or **standard-char**. Depending on their character type, strings created with **make-string** can therefore be either fat or thin.

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The ability to create fat as well as thin strings represents an extension of the **make-string** function as presented in Guy L. Steele's *Common Lisp: the Language.*

The optional keywords are as follows:

:initial-element Each element of the new array is initialized to the character specified by this keyword; this character must correspond to the type specified by **:element-type**, if any. If no initial element is specified, array elements are initialized to characters with a **char-code** of 0, whose type corresponds to the type specified by **:element-type**; if **:element-type** is also unspecified, **make-string** builds a thin string.

:element-type Specifies the type of characters in the string and must be of type **character,** or any of its subtypes. If this keyword is left unspecified, the string type corresponds to the type of the character specified in **:initial-element.** If both keywords are omitted, **make-string** builds a thin string.

:area Specifies the area in which to create the array. **:area** should be an integer or **nil** to mean the default area.

The examples below show the interaction of the keywords **:initial-element** and **:element-type.**

Since **make-string** only lets you build simple character arrays, you must use the array-specific function **make-array** to build more complex character arrays.

Examples:

```
; :initial-element and :element-type are omitted. String is thin.
(string-char-p (char (make-string 5) 1)) => T

; :initial-element and :element-type specify a thin string.
(string-char-p (char (make-string 5 :initial-element #\C
                                    :element-type 'string-char) 0)) => T

; :initial-element and :element-type specify a fat string.
(string-fat-p (make-string 5 :initial-element #\hyper-C
                             :element-type 'character)) => T

; :element-type is omitted, and :initial-element
; is a standard character. String is thin.
(string-char-p (char (make-string 5 :initial-element #\a) 2)) => T
```

```
; :element-type is omitted, and  :initial-element
; is a fat character.  String is fat.
(string-fat-p (make-string 3 :initial-element #\hyper-super-a)) => T

; :initial-element is omitted and
; :element-type is a subtype of character. String is thin.
(string-fat-p (make-string 4 :element-type 'string-char)) => NIL

; :initial-element is omitted and
; :element-type is of type character. String is fat.
(string-fat-p (make-string 4 :element-type 'character)) => T


(make-array 5 :element-type 'string-char) => "·····"
          ;returns a simple, thin string

(make-array 3 :element-type 'character :initial-element #\hyper-super-q)
=> "<H-S-Q><H-S-Q-><H-S-Q>"    ;returns a fat, simple string

(make-string 4 :area working-storage-area)  => "····"
```

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts.*

make-symbol *pname* &optional *permanent-p* *Function*

Creates a new uninterned symbol whose print-name is the string *pname.* The value and function bindings are unbound and the property list is empty. If *permanent-p* is specified, it is assumed that the symbol is going to be interned and probably kept around forever; in this case it and its pname are put in the proper areas. If *permanent-p* is **nil** (the default), the symbol goes in the default area and *pname* is not copied. *permanent-p* is mostly for the use of **intern** itself.

Examples:

```
(make-symbol "FOO") => FOO
(make-symbol "Foo") => |Foo|
```

Note that the symbol is *not* interned; it is simply created and returned.

If a symbol has lowercase characters in its print-name, the printer quotes the name using slashes or vertical bars. The vertical bars inhibit the Lisp reader's normal action, which is to convert a symbol to uppercase upon reading it. See the section "What the Printer Produces" in *Reference Guide to Streams, Files, and I/O.*

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Example:

```
(setq a (make-symbol "Hello"))     ; => |Hello|
(princ a)                          ; prints out Hello
```

zl:maknam *char-list* *Function*

zl:maknam returns an uninterned symbol whose print-name is a string made up of the characters in *char-list*. This function is provided mainly for Maclisp compatibility.

Examples:

```
(zl:maknam '(a b #\0 d)) => #:AB0D
(zl:maknam '(1 2 #\h "b")) => #:|↓αhb|
```

For a table of related items: See the section "Maclisp-Compatible String Functions" in *Symbolics Common Lisp: Language Concepts.*

makunbound *symbol* *Function*

makunbound causes *symbol* to become unbound. Example:

```
(setq a 1)
a => 1
(makunbound 'a)
a => causes an error.
```

makunbound returns its argument.

makunbound-globally *var* *Function*

Works like **makunbound** but sets the global value regardless of any bindings currently in effect.

makunbound-globally operates on the *global value* of a special variable; it bypasses any bindings of the variable in the current stack group. It resides in the global package.

makunbound-globally does not work on local variables.

makunbound-in-closure *closure symbol* *Function*

Makes *symbol* be unbound in the environment of *closure*; that is, it does what **makunbound** would do if you restored the value cells known about by *closure*. If *symbol* is not closed over by *closure*, this is just like makunbound. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts.*

map *result-type function* &rest *sequences* *Function*

map applies *function* to *sequences*, and returns a new sequence such that element *j* of the new sequence is the result of applying *function* to element *j* of each of the argument sequences. The returned sequence is as long as

the shortest of the input sequences. *function* must take at least as many arguments as there are sequences provided, and at least one sequence must be provided.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(map 'list #'- '(4 3 2 1) '(3 2 1 0)) => (1 1 1 1)

(map 'string #'(lambda (x) (if (oddp x) #\1 #\0)) '(1 2 3 4)) =>
"1010"
```

If *function* has side effects, it can count on being called first on all of the elements with index 0, then on all of those numbered 1, and so on.

The type of the result sequence is specified by the argument *result-type* (which must be a subtype of the type sequence), as for the function **coerce**. In addition, you may specify **nil** for the result type, meaning that no result sequence is to be produced. In this case *function* is invoked only for effect, and **map** returns **nil**. This gives an effect similar to **mapc**.

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Mapping Sequences" in *Symbolics Common Lisp: Language Concepts*.

zl:map *fcn list* &rest *more-lists* *Function*

The mapping function **zl:map** applies *fcn* to *list* and to successive sublists of that list. If all the lists are not of the same length, the iteration terminates when the shortest list runs out, and excess sublists of it are ignored.

zl:map works like **maplist** except that it does not construct a list to return. Use **zl:map** when the *fcn* is being called merely for its side effects, rather than its returned values.

zl:map is the same as **mapl**.

Examples:

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```
(zl:map #'equal '(2 3 4) '(2 3 4)) => (2 3 4)
(zl:map #'(lambda (x y) (if (equal x y)(princ "equal ")))
        '(2 3 4) '(2 3 4))
 => equal equal equal
(2 3 4)
(zl:map #'(lambda (x) (if (member (car x) (cdr x)) nil
                          (princ (car x)) (princ " ")))
        '(a b a c b)) => A C B (A B A C B)
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Mapping Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:mapatoms *function* &optional (*pkg* **zl:package**) (*inherited-p* **t**) *Function*

function should be a function of one argument. **zl:mapatoms** applies function to each of the symbols in *package*. If *inherited-p* is **t**, this is all symbols accessible to *package*, including symbols it inherits from other packages. If *inherited-p* is **nil**, *function* only sees the symbols that are directly present in *package*.

Note that when *inherited-p* is **t** symbols that are shadowed but otherwise would have been inherited are seen; this slight blemish is for the sake of efficiency. If this is a problem, *function* can try **zl:intern** in *package* on each symbol it gets, and ignore the symbol if it is not **eq** to the result of **zl:intern**; this measure is rarely needed.

zl:mapatoms-all *function* *Function*

function should be a function of one argument. **zl:mapatoms-all** applies *function* to all of the symbols in all of the packages in existence, except for invisible packages. Note that symbols that are present in more than one package are seen more than once.

Example:

```
(mapatoms-all
  (function
    (lambda (x)
      (and (alphalessp 'z x)
           (print x)))))
```

mapc *fcn list* &rest *more-lists* *Function*

mapc is like **mapcar**, except that it does not return any useful value.

mapc applies *fcn* to successive elements of the argument lists. If the lists are not of the same length, the iteration terminates when the shortest list runs out.

fcn must take take as many arguments as there are lists.

mapc is used when *fcn* is being called merely for its side effects, rather than its returned values.

Examples:

```
(mapc #'+ '(2 1 0) '(2 3 4)) => (2 1 0)
(mapc #'(lambda (x y) (if (= (+ x y) 3) (princ "three ")))
      '(1 2 3) '(2 1 3))
 => three three (1 2 3)
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

mapcan *fcn list* &rest *more-lists* *Function*

The mapping function **mapcan** is like **mapcar**, except that it combines the results of the function using **nconc** instead of **list**.

mapcan applies *fcn* to *list* and to successive elements of that list.

fcn must take as many arguments as there are lists.

Examples:

```
(mapcan #'(lambda (x) (if (equal x 3) nil (princ x))) '(1 2 3 4))
 => 124NIL

(mapcan #'(lambda (x) (and (integerp x) (list x)))
        '(1 2.3 3. 4 'd 0))
 => (1 3 4 0)
```

If **mapcar** were used for the above example, the result would be as follows:

```
(mapcar #'(lambda (x) (if (equal x 3) nil (princ x))) '(1 2 3 4))
 => 124(1 2 NIL 4)

(mapcar #'(lambda (x) (and (integerp x) (list x)))
        '(1 2.3 3. 4 'd 0)) => ((1) NIL (3) (4) NIL (0))
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

mapcar *fcn list* &rest *more-lists* *Function*

fcn is a function that takes as many arguments as there are lists in the call to **mapcar**. For example, since **expt** takes two arguments the following use of **mapcar** is incorrect:

Wrong:

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```
(mapcar #'expt '(1 2 3 4 5) '(43 2 1 4 2) '(2 3 2 3 2))
```

Right:

```
(mapcar #'expt '(1 2 3 4 5) '(43 2 1 4 2))
```

In the correct example, **mapcar** calls **expt** repeatedly, each time using successive elements of the first list as its first argument and successive elements of the second list as its second argument. Thus, **mapcar** calls **expt** with the arguments 1 and 43, 2 and 2, 3 and 1, 4 and 4, and 5 and 2 and returns a list of the five results.

Examples:

```
(mapcar #'- '(3 4 2 5) '(1 1 2 3)) => (2 3 0 2)

(mapcar #'= '(1 2 3 4) '(1 2 3 8)) => (T T T NIL)

(mapcar #'(lambda (x) (if (numberp x) 0 1)) '(1 2 3 'k "hi" 'fly))
=> (0 0 0 1 1 1)

(mapcar #'list '('hot 'cat 'sam 'new) '('dog 'hat 'man 'york))
=> (('HOT 'DOG) ('CAT 'HAT) ('SAM 'MAN) ('NEW 'YORK))

(mapcar #'+ '(1 2 3 4) (circular-list 1)) => (2 3 4 5)

(mapcar #'= '(1 2 3 3 45) '(2 2)) => (NIL T)
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

mapcon *fcn list* &rest *more-lists* *Function*

The mapping function **mapcon** is like **maplist**, except that it combines the results of the function using **nconc** instead of **list**.

mapcon applies *fcn* to *list* and to successive sublists of that list rather than to successive elements.

fcn must take as many arguments as there are lists.

mapcon could have been defined by:

```
(defun mapcon (f x y)
  (apply 'nconc (maplist f x y)))
```

Of course, this definition is less general than the real one.

Examples:

```
(mapcon #'(lambda (x y) (and (equal y x)(list x)) )
        '('yo 'ho 'woo 'wa) '('hi 'ho 'woo 'wa))
=> (('HO 'WOO 'WA) ('WOO 'WA) ('WA))
```

If **maplist** were used for the above example the result would look as follows:

```
(maplist #'(lambda (x y) (and (equal y x)(list x)) )
         '('yo 'ho 'woo 'wa) '('hi 'ho 'woo 'wa))
=> (NIL (('HO 'WOO 'WA)) (('WOO 'WA)) (('WA)))
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

:map-hash *function* &rest *args* *Message*

For each entry in the hash table, call *function* on the key of the entry and the value of the entry. If *args* are supplied, they are passed along to function following the value of the entry argument. This message will be removed in the future – use **maphash** instead.

maphash *function table* *Function*

For each entry in *table*, call *function* on the key of the entry and the value of the entry.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:maphash-equal *function hash-table* &rest *args* *Function*

For each entry in *hash-table*, call *function* on the key of the entry and the value of the entry. If *args* are supplied, they are passed along to function following the value of the entry. This message will be removed in the future – use **maphash** instead.

mapl *fcn list* &rest *more-lists* *Function*

The mapping function **mapl** applies *fcn* to *list* and to successive sublists of that list. If all the lists are not of the same length the iteration terminates when the shortest list runs out and excess sublists of it are ignored.

mapl works like **maplist**, except that it does not accumulate the results of calling *fcn*. Use **mapl** when *fcn* is being called merely for its side effects, rather than its returned value.

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

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maplist *fcn list* &rest *more-lists* *Function*

maplist applies *fcn* to *list* and to successive sublists of that list rather than to successive elements as does **mapcar**.

fcn must take as many arguments as there are lists.

maplist returns a list that accumulates the results of the successive calls to *fcn*.

Examples:

```
(maplist #'append '(a b c d) '(1 2 3 4))
=> ((A B C D 1 2 3 4) (B C D 2 3 4) (C D 3 4) (D 4))

(maplist #'(lambda (a-list) (cons 'twiddle a-list))
         '(blank dee dumb))
  => ((TWIDDLE BLANK DEE DUMB) (TWIDDLE DEE DUMB) (TWIDDLE DUMB))

(maplist #'equal '("car" "house" "door" "barn")
         '('cat 'hat "door" "barn"))
 => (NIL NIL T T)
```

For a table of related items: See the section "Mapping Functions" in *Symbolics Common Lisp: Language Concepts.*

mask-field *bytespec integer* *Function*

This is similar to **ldb** ("load byte"); however, the specified byte of *integer* is returned as a number in the position specified by *bytespec* in the returned word, instead of in position 0 as with **ldb**. *integer* must be an integer.

bytespec is built using function **byte** with bit *size* and *position* arguments.

Example:

```
(mask-field (byte 6 3) #o4567) => #o560
```

For a table of related items: See the section "Summary of Byte Manipulation Functions" in *Symbolics Common Lisp: Language Concepts.*

max *number* &rest *more-numbers* *Function*

max returns the largest of its arguments. At least one argument is required. The arguments can be of any noncomplex numeric type. The result type is the type of the largest argument.

Example:

```
(max 1 3 2) => 3
```

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

maximize Keyword For loop

maximize *expr* {*data-type*} {**into** *var*}

Computes the maximum of *expr* over all iterations. *data-type* defaults to **number**. Note that if the loop iterates zero times, or if conditionalization prevents the code of this clause from being executed, the result is meaningless. If **loop** can determine that the arithmetic being performed is not contagious (by virtue of *data-type* being **fixnum** or **flonum**), it can choose to code this by doing an arithmetic comparison rather than calling **max**. As with the **sum** clause, specifying *data-type* implies that both the result of the **max** operation and the value being maximized is of that type. When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

Examples:

```
(defun maxi (my-list)
  (loop for x from 0
        for item in my-list
        maximize item into result1
        finally (return result1))) => MAXI
(maxi '(1 2 4 5 8 7 6)) => 8
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **maximize** and **minimize** are compatible.

See the section "**loop** Clauses", page 310.

zl:mem *predicate item list* *Function*

(zl:mem *item list***)** returns **nil** if *item* is not one of the elements of *list*. Otherwise, it returns the sublist of *list* beginning with the first occurrence of *item*; that is, it returns the first cons of the list whose *car* is *item*. The comparison is made by *predicate*. Because **zl:mem** returns **nil** if it does not find anything, and something non-**nil** if it finds something, it is often used as a predicate.

zl:mem is the same as **zl:memq** except that it takes an extra argument that should be a predicate of two arguments, which is used for the com-

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parison instead of **eq**. **(zl:mem** *'eq a b***)** is the same as **(zl:memq** *a b***)**. **(zl:mem** *'equal a b***)** is the same as **(zl:member** *a b***)**.

zl:mem is usually used with equality predicates other than **eq** and **zl:equal**, such as **=**, **char-equal** or **zl:string-equal**. It can also be used with noncommutative predicates. The predicate is called with *item* as its first argument and the element of *list* as its second argument, so:

```
(zl:mem #'< 4 list)
```

finds the first element in *list* for which **(< 4** *x***)** is true; that is, it finds the first element greater than **4**.

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:memass *predicate item alist* *Function*

(zl:memass *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value returned is the portion of the list beginning with the pair containing the first element that matches *item*, according to *predicate*, or **nil** if there is none such.

(car (zl:memass *x y z***))** = **(zl:ass** *x y z***)**.

See the function **zl:mem**, page 345. As with **zl:mem**, you can use noncommutative predicates; the first argument to the predicate is *item* and the second is the key of the element of *alist*.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts*.

member *item list* &key *(test* **#'eql)** *test-not (key* **#'identity)** *Function*

member searches *list* for an element that satisfies the predicate specified by the **:test** keyword with respect to *item*. If no element is found that matches *item*, **nil** is returned; otherwise the tail of *list* beginning with the first element that satisfied the predicate is returned. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

list is searched on the top level only. For example:

```
(member 'item '(a b c)) => NIL

(member 'item '(a #\Space item 5/3)) => (ITEM 5/3)
```

member can be used as a predicate, since the value returned by **member** is **eq** to the portion of the list it matches. This implies that **rplaca** or **rplacd** can be used to alter the found list element, as long as a check is made first that **member** did not return **nil**. For example:

```
(setq list '(loon eagle heron)) => (LOON EAGLE HERON)

(if (member 'eagle list)
    (rplaca (member 'eagle list) 'hawk)) => (HAWK HERON)

list => (LOON HAWK HERON)
```

See also, **find position**.

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts*.

member &rest *list* *Type Specifier*

member allows the definition of a data type consisting of objects that are elements of *list*. An object is of this type if it is **eql** to one of the objects specified in *list*. As a type specifier, **member** can only be used in list form.

Examples:

```
(typep 3 '(member 1 2 3)) => T
(typep 'a '(member a b c)) => T
(subtypep '(member one two three) '(member one two three four))
 => T and T
(sys:type-arglist 'member) => (&REST LIST) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:member *item list* *Function*

(zl:member *item list*) returns **nil** if *item* is not one of the elements of *list*. Otherwise, it returns the sublist of *list* beginning with the first occurrence of *item*; that is, it returns the first cons of the list whose *car* is *item*. The comparison is made by **zl:equal**.

zl:member could have been defined by:

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```
(defun member (item list)
  (cond ((null list) nil)
        ((equal item (car list)) list)
        (t (member item (cdr list))) ))
```

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts.*

member-if *predicate list* &key *key* *Function*

member-if is very similar to **member**. **member-if** searches for an element in *list* which satisfies *predicate*. If none is found, **member-if** returns **nil**; otherwise the tail of *list* beginning with the first element that satisfied the predicate is returned. *list* is searched on the top level only. For example:

```
(member-if #'numberp '(a #\Space 5/3 item)) => (5/3 ITEM)
```

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts.*

member-if-not *predicate list* &key *key* *Function*

member-if-not is very similar to **member**. **member-if-not** searches for the first element in *list* which does not satisfy *predicate*. If every element satisfies the predicate, **member-if-not** returns **nil**; otherwise it returns the tail of *list* beginning with the first element that did not satisfy the predicate. *list* is searched on the top level only. For example:

```
(member-if-not #'numberp '(4.0 #\Space 5/3 item)) =>
(#\Space 5/3 ITEM)

(member-if-not #'numberp '(5/3 4.0)) => NIL
```

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:memq *item list* *Function*

(zl:memq *item list*) returns **nil** if *item* is not one of the elements of *list*. Otherwise, it returns the sublist of *list* beginning with the first occurrence of *item*; that is, it returns the first cons of the list whose *car* is *item*. The comparison is made by **eq**. Because **zl:memq** returns **nil** if it does not find anything, and something non-**nil** if it finds something, it is often used as a predicate. Examples:

```
(zl:memq 'a '(1 2 3 4)) => nil
(zl:memq 'a '(g (x a y) c a d e a f)) => (a d e a f)
```

Note that the value returned by **zl:memq** is **eq** to the portion of the list beginning with **a**. Thus **rplaca** on the result of **zl:memq** can be used, if you first check to make sure **zl:memq** did not return **nil**. Example:

```
(let ((sublist (zl:memq x z)))      ;search for x in the list z.
  (if (not (null sublist))          ;if it is found,
      (rplaca sublist y)))          ;replace it with y.
```

zl:memq could have been defined by:

```
(defun memq (item list)
    (cond ((null list) nil)
          ((eq item (car list)) list)
          (t (memq item (cdr list))) ))
```

zl:memq is hand-coded in microcode and therefore especially fast.

For a table of related items: See the section "Functions for Searching Lists" in *Symbolics Common Lisp: Language Concepts.*

merge *result-type sequence1 sequence2 predicate* &key *key* *Function*

merge destructively merges the sequences according to an order determined by *predicate*. The result is a sequence of type *result-type*, which must be a subtype of sequence, as for the function **coerce**.

Sequence1 and *sequence2* can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

predicate should take two arguments and return a non-**nil** value if and only if the first argument is strictly less than the second (in some appropriate sense). If the first argument is greater than or equal to the second (the the appropriate sense), then *predicate* should return **nil**.

The **merge** function determines the relationship between two elements by giving keys extracted from the elements to *predicate*. The **:key** function, when applied to an element, should return the key for that element. The **:key** function defaults to the identity function, thereby making the element itself be the key.

The **:key** function should not have any side effects. A useful example of a **:key** function would be a component selector function for a **defstruct** structure, used to merge a sequence of structures.

If the **:key** and *predicate* functions always return, then the merging function will always terminate. The result of merging two sequences x and y is a new sequence z, such that the length of z is the sum of the lengths of x and y, and z contains all of the elements of x and y. If *x1* and *x2* are two

elements of *x*, and *x1* precedes *x2* in *x*, then *x1* precedes *x2* in *z*, and similarly for the elements of *y*. In short, *z* is an *interleaving* of *x* and *y*.

Moreover, if *x* and *y* were correctly sorted according to *predicate*, then *z* will also be correctly sorted. For example:

```
(merge 'list '(1 3 4 6 7) '(2 5 8) #'<) => (1 2 3 4 5 6 7 8)
```

If *x* or *y* is not so sorted, then *z* will not be sorted, but will nevertheless be an interleaving of *x* and *y*. For example:

```
(merge 'list '(3 6 4 1 7) '(2 5 8) #'<) => (2 3 5 6 4 1 7 8)
```

The merging operation is guaranteed to be *stable*, that is, if two or more elements are considered equal by *predicate*, then the elements from *sequence1* will precede those from *sequence2* in the result. The predicate is assumed to consider two elements from *x* and *y* to be equal if **(funcall** *predicate x y***)** and **(funcall** *predicate y x***)** are both false. For example:

```
(merge 'string "BOY" "nosy" #'char-lessp) => "BnOosYy"
```

The result can *not* be "BnoOsYy", "BnOosyY", or "BnoOsyY", because the function **char-lessp** ignores case, and so considers the characters **Y** and **y** to be equal. Since **Y** and **y** are equal, the stability property then guarantees that the character from the first argument (**Y**) must precede the one from the second argument (**y**).

For a table of related items: See the section "Sorting and Merging Sequences" in *Symbolics Common Lisp: Language Concepts.*

flavor:method-options *function-spec* *Function*

flavor:method-options returns the (*options...*) portion of the *function-spec*. *options* is the *options* argument that was given in the **defmethod** form for this method, such as **:before** or **:progn**. See the section "Function Specs for Flavor Functions" in *Symbolics Common Lisp: Language Concepts.*

The (*options...* portion is the **cdddr** of the *function-spec*. Functions specs for methods are in the form:

(*type generic flavor options...*)

type is typically **flavor:method**.

This is useful in the bodies of **define-method-combination** forms. The definition of the **:case** method combination type provides a good example of the use of **flavor:method-options**. See the section "Examples Of **define-method-combination**" in *Symbolics Common Lisp: Language* Concepts.

mexp *(repeat nil) (compile nil) (do-style-checking nil) (do-macro-expansion t) (do-named-constants nil) (do-inline-forms t) (do-optimizers nil) (do-constant-folding nil) (do-function-args nil)* *Special Form*

The function **mexp** goes into a loop in which it reads forms and sequentially expands them, printing out the result of each expansion (using the grinder to improve readability). See the section "Formatting Lisp Code" in *Reference Guide to Streams, Files, and I/O*. It terminates when you press the END key. If you type in a form that is not a macro form, there are no expansions and so it does not type anything out, but just prompts you for another form. This allows you to see what your macros are expanding into, without actually evaluating the result of the expansion.

For example:

```
(mexp)
Type End to stop expanding forms

Macro form → (loop named t until nil return 5)
(ZL:LOOP NAMED T UNTIL NI RETURN 5) →
(PROG T NIL
SI:NEXT-LOOP AND NIL
                  (GO SI:END-LOOP))
      (RETURN 5)
      (GO SI:NEXT-LOOP)
SI:END-LOOP)

Macro form → (defparameter foo bar) →
(PROGN (EVAL-WHEN (COMPILE)
         (COMPILER:SPECIAL-2 'FOO))
       (EVAL-WHEN (LOAD EVAL)
         (SI:DEFCONST-1 FOO BAR NIL)))
```

See the section "Expanding Lisp Expressions in Zmacs" in *Text Editing and Processing*. That section describes two editor commands that allow you to expand macros – c-sh-M and m-sh-M. There is also the Command Processor command, Show Expanded Lisp Code. See the document *User's Guide to Symbolics Computers*.

min *number* &rest *more-numbers* *Function*

min returns the smallest of its arguments. At least one argument is required. The arguments can be of any noncomplex numeric type. The result type is the type of the smallest argument.

Example:

```
(min 1 3 2) => 1
```

For a table of related items: See the section "Numeric Comparison Functions" in *Symbolics Common Lisp: Language Concepts.*

minimize Keyword For loop

minimize *expr* {*data-type*} {**into** *var*}

Computes the minimum of *expr* over all iterations. *data-type* defaults to **number.** Note that if the loop iterates zero times, or if conditionalization prevents the code of this clause from being executed, the result is meaningless. If **loop** can determine that the arithmetic being performed is not contagious (by virtue of *data-type* being **fixnum** or **flonum**), it can choose to code this by doing an arithmetic comparison rather than calling **min.** As with the **sum** clause, specifying *data-type* implies that both the result of the **min** operation and the value being minimized is of that type. When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, they should not be modified until the epilogue code for the loop is reached.

Examples:

```
(defun mini (my-list)
  (loop for x from 0
        for item in my-list
        minimize item into result1
        finally (return result1)))  => MINI
(mini '(3 4 5 6 0 8 7)) => 0
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **minimize** and **maximize** are compatible.

See the section "**loop** Clauses", page 310.

zl:minus *x* *Function*

Returns the negative of *x.* **zl:minus** is similar to - used with one argument.

Examples:

```
(zl:minus 1) => -1
(zl:minus -3.0) => 3.0
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

minusp *number* *Function*

Returns **t** if its argument is a negative number, strictly less than zero. Otherwise it returns **nil**. If *number* is not a noncomplex number, **minusp** signals an error.

Examples:

```
(minusp -5)  => T
(minusp 0)  => NIL
(minusp 0.0d0)  => NIL
(minusp -0.0)  => NIL
```

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

mismatch *sequence1 sequence2* &key *from-end* (*test* #'**eql**) *test-not* *Function*
key (*start1* **0**) (*start2* **0**) *end1 end2*

mismatch compares the specified subsequences of *sequence1* and *sequence2* element-wise. If they are of equal length and match in every element, the result is **nil**. Otherwise, the result is a non-negative integer representing the index within *sequence1* of the leftmost position at which the two subsequences fail to match, or, if one subsequence is shorter than and a matching prefix of the other, the result is the index relative to *sequence1* beyond the last position tested.

For example:

```
(mismatch '(loon heron stork) '(loon heron stork)) => NIL

(mismatch '(hawk loon owl pelican) '(hawk loon eagle pelican)) => 2

(mismatch '(1 2 3) '(1 2 3 4 5)) => 3
```

If the value of the **:from-end** keyword is non-**nil**, then *one plus* the index of the rightmost position in which the sequences differ is returned. In effect, the (sub)sequences are aligned at their right-hand ends and the last elements are compared, then the ones before, and so on. The index returned is again an index relative to *sequence1*. For example:

```
(mismatch '(hawk loon owl pelican) '(hawk loon eagle pelican)
          :from-end t) => 3
```

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by *:test*, *keyfn* is the function specified by *:key* and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(mismatch  '(2 3 4) '(1 2 3) :test #'>) => NIL
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(mismatch '((north 1)(south 2)) '((right 1)(left 2)) :key #'second)
 => NIL
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

mod *number divisor* *Function*

Divides *number* by *divisor* converting the quotient into an integer and truncating the result toward negative infinity. Returns the remainder. This is the same as the second value of (**floor** *number divisor*).

When there is no remainder, the returned value is **0**.

The arguments can be integers or floating-point numbers.

Examples:

```
(mod 3 2) => 1
(mod -3 2)  => 1
(mod 3 -2)  => -1
(mod -3 -2) => -1
(mod 4 -2)  => 0
(mod 3.8 2) => 1.8
(mod -3.8 2) => 0.20000005
```

Related Functions:

floor
rem

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

mod *n* *Type Specifier*

mod defines the set of non-negative integers less than *n*. This is equivalent to `(integer 0 n-1)`, or to `(integer 0 (n))`.

As a type specifier, **mod** can only be used in list form.

Examples:

```
(typep 3 '(mod 4)) => T
(typep 5 '(mod 4)) => NIL
(typep 4 '(mod 4)) => NIL
(subtypep 'bit '(mod 2)) => T and T
(sys:type-arglist 'mod) => (N) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. For a discussion of the function **mod**: See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

modify-hash *table key function* *Function*

modify-hash combines the action of **setf** of **gethash** into one call to **modify-hash**. It lets you both examine the value of *key* and change it. It is more efficient because it does the lookup once instead of twice.

Finds the value associated with *key* in *table*, then calls *function* with *key*, this value, a flag indicating whether or not the value was found. Puts whatever is returned by this call to *function* into *table*, associating it with *key*. Returns the new value and the key of the entry.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts*.

:modify-hash *key function* &rest *args* *Message*

This message combines the actions of **:get-hash** and **:put-hash**. It lets you both examine the value for a particular key and change it. It is more efficient because it does the hash lookup once instead of twice.

It finds *value*, the value associated with *key*, and *key-exists-p*, which indicates whether the key was in the table. It then calls *function* with *key*, *value*, *key-exists-p*, and *other-args*. If no value was associated with the key, then *value* is **nil** and *key-exists-p* is **nil**. It puts whatever value *function* returns into the hash table, associating it with *key*.

```
(send new-coms ':modify-hash k foo a b c) =>
(funcall foo k val key-exists-p a b c)
```

This function will be removed in the future – use **modify-hash** instead.

modules *Variable*

most-negative-double-float *Constant*

The value of **most-negative-double-float** is that floating-point number in double-float format closest in value (but not equal to) negative infinity.

most-negative-fixnum *Constant*

The value of **most-negative-fixnum** is that fixnum closest in value to negative infinity.

most-negative-long-float *Constant*

The value of **most-negative-long-float** is that floating-point number in long-float format closest in value (but not equal to) negative infinity. In Symbolics Common Lisp this constant has the same value as **most-negative-double-float**.

most-negative-short-float *Constant*

The value of **most-negative-short-float** is that floating-point number in short-float format closest in value (but not equal to) negative infinity. In Symbolics Common Lisp this constant has the same value as **most-negative-single-float**.

most-negative-single-float *Constant*

The value of **most-negative-single-float** is that floating-point number in single-float format closest in value (but not equal to) negative infinity.

most-positive-double-float *Constant*

The value of **most-positive-double-float** is that floating-point number in double-float format which is closest in value (but not equal to) positive infinity.

most-positive-fixnum *Constant*

The value of **most-positive-fixnum** is that fixnum closest in value to positive infinity.

most-positive-long-float *Constant*

The value of **most-positive-long-float** is that floating-point number in long-float format which is closest in value (but not equal to) positive infinity. In Symbolics Common Lisp this constant has the same value as **most-positive-double-float**.

most-positive-short-float *Constant*

The value of **most-positive-short-float** is that floating-point number in short-float format which is closest in value (but not equal to) positive infinity. In Symbolics Common Lisp this constant has the same value as **most-positive-single-float**.

most-positive-single-float *Constant*

The value of **most-positive-single-float** is that floating-point number in single-float format which is closest in value (but not equal to) positive infinity.

mouse-char-p *char* *Function*

Returns **t** if *char* is a mouse character, **nil** otherwise.

zl:multiple-value *(variable...) form* *Special Form*

Used for calling a function that is expected to return more than one value. *form* is evaluated, and the *variables* are *set* (not lambda-bound) to the values returned by *form*. If more values are returned than there are variables, then the extra values are ignored. If there are more variables than values returned, extra values of **nil** are supplied. If **nil** appears in the *var-list*, then the corresponding value is ignored (you can't use **nil** as a variable.) Example:

```
(zl:multiple-value (symbol already-there-p)
        (intern "goo"))
```

In addition to its first value (the symbol), **zl:intern** returns a second value, which is **t** if the symbol returned as the first value was already interned, or else **nil** if **zl:intern** had to create it. So if the symbol **goo** was already known, the variable **already-there-p** is set to **t**, otherwise it is set to **nil**.

zl:multiple-value is usually used for effect rather than for value; however, its value is defined to be the first of the values returned by *form*.

multiple-value-bind *(variable...) form body...* *Special Form*

Similar to **zl:multiple-value**, but locally binds the variables that receive the values, rather than setting them, and has a body – a set of forms that are evaluated with these local bindings in effect. First *form* is evaluated. Then the *variables* are bound to the values returned by *form*. Then the *body* forms are evaluated sequentially, the bindings are undone, and the result of the last *body* form is returned.

multiple-value-call *function body...* *Special Form*

First evaluates *function* to obtain a function. It then evaluates all the forms in *body*, gathering together all the values of the forms (not just one value from each). It gives these values as arguments to the function and returns whatever the function returns.

For example, suppose the function **frob** returns the first two elements of a list of numbers:

```
(multiple-value-call #'+ (frob '(1 2 3)) (frob '(4 5 6)))
  <=> (+ 1 2 4 5) => 12.
```

multiple-value-list *form* *Special Form*

Evaluates *form* and returns a list of the values it returned. This is useful for when you do not know how many values to expect. Example:

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```
(setq a (multiple-value-list (intern "goo")))
a => (goo nil)
```

This is similar to the example of **zl:multiple-value**; **a** is set to a list of two elements, the two values returned by **zl:intern**.

multiple-value-prog1 *first-form body...* *Special Form*

Like **prog1**, except that if its first form returns multiple values, **multiple-value-prog1** returns those values. In certain cases, **prog1** is more efficient than **multiple-value-prog1**, which is why both special forms exist.

flavor:multiple-value-prog2 *forms...* *Macro*

Evaluates the *forms* and returns all the values of the second form. This is similar to **multiple-value-prog1**.

math:multiply-matrices *matrix-1 matrix-2* &optional *matrix-3* *Function*

Multiplies *matrix-1* by *matrix-2*. If *matrix-3* is supplied, **math:multiply-matrices** stores the results into *matrix-3* and returns *matrix-3*; otherwise it creates an array to contain the answer and returns that. All matrices must be two-dimensional arrays, and the first dimension of *matrix-2* must equal the second dimension of *matrix-1*.

name-char *name* *Function*

If *name* is the same as the name of a character object, that object is returned; otherwise **nil** is returned. **name-char** does not recognize names with modifier bit prefixes such as "hyper-space".

```
(name-char "Tab") => #\Tab
```

sys:name-conflict *Flavor*

Any sort of name conflict occurred (there are specific flavors, built on **sys:name-conflict**, for each possible type of name conflict.) The following proceed types might be available, depending on the particular error:

The **:skip** proceed type skips the operation that would cause a name conflict.

The **:shadow** proceed type prefers the symbols already present in a package to conflicting symbols that would be inherited. The preferred symbols are added to the package's shadowing-symbols list.

The **:export** proceed type prefers the symbols being exported (or being inherited due to a **use-package**) to other symbols. The conflicting symbols are removed if they are directly present, or shadowed if they are inherited.

The **:unintern** proceed type removes the conflicting symbol.

The **:shadowing-import** proceed type imports one of the conflicting symbols and makes it shadow the others. The symbol to be imported is an optional argument.

The **:share** proceed type causes the conflicting symbols to share value, function, and property cells. It as if **globalize** were called.

The **:choose** proceed type pops up a window in which the user can choose between the above proceed types individually for each conflict.

named Keyword For loop

named *name*

Gives the **prog** that **loop** generates a name of *name*, so that you can use the **return-from** form to return explicity out of that particular **loop**:

```
(loop named sue
      ...
     do (loop  ... do (return-from sue value) .... )
      ...)
```

The **return-from** form shown causes *value* to be immediately returned as the value of the outer **loop**. Only one name can be given to any particular **loop** construct. This feature does not exist in the Maclisp version of **zl:loop**, since Maclisp does not support "named progs".

See the section "**loop** Clauses", page 310.

named-structure-invoke *operation structure* &rest *args* *Function*

operation should be a keyword symbol, and *structure* should be a named structure. The handler function of the named structure symbol, found as the value of the **named-structure-invoke** property of the symbol, is called with appropriate arguments.

N

named-structure-p *x* *Function*

This semi-predicate returns **nil** if *x* is not a named structure; otherwise it returns *x*'s named structure symbol.

named-structure-symbol *x* *Function*

x should be a named structure. This returns *x*'s named structure symbol: if *x* has an array leader, element 1 of the leader is returned, otherwise element 0 of the array is returned.

nbutlast *list* *Function*

This is the destructive version of **butlast**; it changes the *cdr* of the second-to-last cons of the list to **zl-user:nil.** If there is no second-to-last cons (that is, if the list has fewer than two elements) it returns **nil.** Examples:

```
(setq foo '(a b c d))
(nbutlast foo) => (a b c)
foo => (a b c)
(nbutlast '(a)) => nil
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

nconc &rest *lists* *Function*

nconc takes lists as arguments. It returns a list that is the arguments concatenated together. The arguments are changed, rather than copied. See the function **append**, page 21. Example:

```
(setq x '(a b c))
(setq y '(d e f))
(nconc x y) => (a b c d e f)
x => (a b c d e f)
```

Note that the value of **x** is now different, since its last cons has been **rplacd**'ed to the value of **y**. If

```
(nconc x y)
```

evaluated again, it would yield a piece of "circular" list structure, whose printed representation would be **(a b c d e f d e f d e f ...)**, repeating forever.

nconc could have been defined by:

```
(defun nconc (x y)                ;for simplicity, this definition
    (cond ((null x) y)            ;only works for 2 arguments.
          (t (rplacd (last x) y) ;hook y onto x
             x)))                 ;and return the modified x.
```


nconc Keyword For loop

nconc *expr* {**into** *var*}

Causes the values of *expr* on each iteration to be **nconc**ed together, for example:

```
(loop for i from 1 to 3
      nconc (list i (* i i)))
=> (1 1 2 4 3 9)
```

When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

The forms **nconc** and **nconcing** are synonymous.

Examples:

```
(defun indexing (small-list)
  (loop for x from 0
        for item in small-list
        nconc (list x item))) => INDEXING
(indexing '(a b c d )) => (0 A 1 B 2 C 3 D)
```

Is equivalent to

```
(defun indexing (small-list)
  (loop for x from 0
        for item in small-list
        nconcing (list x item)))  => INDEXING
(indexing '(a b c d )) => (0 A 1 B 2 C 3 D)
```

Not only can there be multiple accumulations in a **loop,** but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **nconc, collect,** and **append** are compatible.

See the section "**loop** Clauses", page 310.

ncons *x* *Function*

(ncons *x*) is the same as **(cons *x* nil)**. In other words, it creates a new cons, whose *car* is *x* and whose *cdr* is **nil**. The name of the function is from "nil-cons".

ncons is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts*.

ncons-in-area *x area-number* *Function*

ncons-in-area creates a cons, whose *car* is *x* and whose *cdr* is **nil**, in the specified *area*. (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management*.

ncons-in-area is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts*.

neq *x y* *Function*

(neq *x y*) = **(not (eq *x y*))**. This is provided simply as an abbreviation for typing convenience.

never Keyword For loop

never *expr*

Causes the loop to return **t** if *expr* **never** evaluates non-**null**. This is equivalent to **always (not** *expr*). If the loop terminates before *expr* is ever evaluated, the epilogue code is run and the loop returns **t**.

never *expr* is like **(and (not** *expr1*) **(not** *expr2*) ...). If the loop terminates before *expr* is ever evaluated, **never** is like **(and)**.

If you want a similar test, except that you want the epilogue code to run if *expr* evaluates non-**null**, use **until**.

Examples:

```
(defun loop-never(my-list)
  (loop for x in my-list
        finally (print  "what you going to do next ?")
        do
    (princ x) (princ " ")
        do
        and never (equal x 'a))) => LOOP-NEVER
```

```
(loop-never '(b c a e) => (B C A E)

(loop-never '(a a)) => A NIL
```

See the section "**loop** Clauses", page 310.

nintersection *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nintersection is the destructive version of **intersection**. **intersection** takes *list1* and *list2* and returns a new list containing everything that is an element of both lists. **nintersection** performs the same operation, but uses the cells of *list1* to construct the result. The value of *list2* is not altered. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

See the function **intersection**, page 277. For example:

```
(setq a-list '(a b c)) => (A B C)

(setq b-list '(f a d)) => (F A D)

(nintersection a-list b-list) => (A)

a-list => (A)

b-list => (F A D)
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:nintersection &rest *lists* *Function*

Takes any number of lists that represent sets and returns a new list that represents the intersection of all the sets it is given, by destroying any of the lists passed as arguments and reusing the conses. **zl:nintersection** uses **eq** for its comparisons. You cannot change the function used for the comparison. **(zl:nintersection)** returns **nil**.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

ninth *list* *Function*

ninth takes a list as an argument, and returns the ninth element of *list.* **ninth** is identical to

```
(nth 8 list)
```

This function is provided because it makes more sense than using **nth** when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

nleft *n list* &optional *tail* *Function*

Returns a "tail" of *list*, that is, one of the conses that makes up *list*, or **nil**. **(nleft** *n list***)** returns the last *n* elements of *list.* If *n* is too large, **nleft** returns *list.*

(nleft *n list tail***)** takes cdr of *list* enough times that taking *n* more cdrs would yield *tail*, and returns that. You can see that when *tail* is **nil** this is the same as the two-argument case. If *tail* is not **eq** to any tail of *list*, **nleft** returns **nil**.

nleft is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

nlistp *x* *Function*

nlistp returns **t** if its argument is not a list, otherwise **nil**. This means **(nlistp nil)** is **nil**. Note this distinction between **nlistp** and **zl:nlistp**. **(zl:nlistp nil)** is **t**, since **zl:nlistp** returns **nil** if its argument is a cons.

nlistp is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:nlistp *arg* *Function*

zl:nlistp returns **t** if its argument is anything besides a cons, otherwise **nil**. **zl:nlistp** is identical to **atom**, and so **(zl:nlistp nil)** returns **t**.

nodeclare Keyword For loop

nodeclare *variable-list*

The variables in *variable-list* are noted by **loop** as not requiring local type declarations. Consider the following:

```
(declare (special k) (fixnum k))
(defun foo (l)
  (loop for x in l as k fixnum = (f x) ...))
```

If **k** did not have the **fixnum** data-type keyword given for it, then **loop** would bind it to **nil**, and some compilers would complain. On the other hand, the **fixnum** keyword also produces a local **fixnum** declaration for **k**; since **k** is special, some compilers complain (or error out). The solution is to do:

```
(defun foo (l)
  (loop nodeclare (k)
        for x in l as k fixnum = (f x) ...))
```

which tells **loop** not to make that local declaration. The **nodeclare** clause must come *before* any reference to the variables so noted. Positioning it incorrectly causes this clause to not take effect, and cannot be diagnosed.
See the macro **loop**, page 309.
This exists for compatibility with other implementations of **loop**.

not *x* *Function*

not returns **t** if *x* is **nil**, else **nil**. **null** is the same as **not**; both functions are included for the sake of clarity. Use **null** to check whether something is **nil**; use **not** to invert the sense of a logical value. Even though Lisp uses the symbol **nil** to represent falseness, you should not make understanding of your program depend on this. For example, one often writes:

```
(cond ((not (null lst)) ... )
      ( ... ))
```

rather than

```
(cond (lst ... )
      ( ... ))
```

There is no loss of efficiency, since these compile into exactly the same instructions.

See the function **null**, page 383.

not *type* *Type Specifier*

The type specifier **not** defines the set of objects that are *not* of the specified *type*. As a type specifier, **not** can only be used in list form.

Examples:

```
(typep "music" '(not integer)) => T
(subtypep 'nil '(not t)) => T and T
(subtypep 'nil '(not integer)) => T and T
(subtypep 'bit (not nil)) => T and T
(equal-typep t (not nil)) => T
(sys:type-arglist 'not) => (TYPE) and T
```


See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Predicates" in *Symbolics Common Lisp: Language Concepts*.

notany *predicate* &rest *sequences* *Function*

notany is a predicate which returns **nil** as soon as any invocation of predicate returns a non-**nil** value. *predicate* must take as many arguments as there are sequences provided. *predicate* is first applied to the elements of the sequences with an index of 0, then with an index of 1, and so on, until a termination criterion is reached or the end of the shortest of the sequences is reached. If the end of a sequence is reached, **notany** returns a non-**nil** value. Thus considered as a predicate, it is true if no invocation of *predicate* is true.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(notany #'oddp '(1 2 5)) => NIL

(notany #'equal '(0 1 2 3) '(3 2 1 0)) => T
```

If *predicate* has side effects, it can count on being called first on all those elements with an index of 0, then all those with an index of 1, and so on.

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts*.

notevery *predicate* &rest *sequences* *Function*

notevery is a predicate which returns a non-**nil** value as soon as any invocation of *predicate* returns **nil**. *predicate* must take as many arguments as there are sequences provided. *predicate* is first applied to the elements of the sequences with an index of 0, then with an index of 1, and so on, until a termination criterion is reached or the end of the shortest of the sequences is reached. If the end of a sequence is reached, **notevery** returns **nil**. Thus considered as a predicate, it is true if not every invocation of *predicate* is true.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(notevery #'oddp '(1 2 5)) => T

(notevery #'equal '(1 2 3) '(1 2 3)) => NIL
```

If *predicate* has side effects, it can count on being called first on all those elements with an index of 0, then all those with an index of 1, and so on.

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts.*

notinline *Declaration*

(notinline *function1 function2* ... **)** specifies that it is *undesirable* to compile the specified functions in-line. This declaration is pervasive, that is it affects all code in the body of the form.

Note that rules of lexical scoping are observed; if one of the functions mentioned has a lexically apparent local definition (as made by **flet** or **labels**), then the declaration applies to that local definition and not to the global function definition.

nreconc *l tail* *Function*

This returns a list that is the first argument reversed concatenated concatenated together with the second argument. **(nreconc** *l tail***)** is exactly the same as **(nconc (nreverse** *l***)** *tail***)** except that it is more efficient. Both *l* and *tail* should be lists. Example:

```
(setq x '(a b c))
(setq y '(d e f))
(nreconc x y) => (c b a d e f)
x => (a d e f)
```

nreconc could have been defined by:

```
(defun nreconc (l tail)
    (cond ((null l) tail)
          ((nreverse1 l tail)) ))

defun nreverse1 (l tail)                ; auxiliary function
    (cond ((null (cdr l)) (rplacd l tail))
          ((nreverse1 (cdr l) (rplacd l tail)))))
          ;; this last call depends on order of argument evaluation.
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

nreverse *sequence* *Function*

nreverse returns a sequence containing the same elements as *sequence*, but in reverse order. The result may or may not be **eq** to the argument, so it is usually wise to say something like **(setq** *x* **(nreverse** *x***))**, because **(nreverse** *x***)** is not guaranteed to leave the reversed value in *x*.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(setq item-list '(heron stork loon owl)) => (HERON STORK LOON OWL)

(nreverse item-list) => (OWL LOON STORK HERON)

item-list => (HERON)
```

nreverse is the destructive version of **reverse**.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

zl:nreverse *list* *Function*

zl:nreverse reverses its argument, which should be a list. The argument is destroyed by **rplacd**s all through the list (see **zl:reverse**). Example:

```
(zl:nreverse '(a b c)) => (c b a)
```

zl:nreverse could have been defined by:

```
(defun nreverse  (x)
    (cond ((null x) nil)
          ((nreverse1 x nil))))

(defun nreverse1 (x y)          ; auxiliary function
    (cond ((null (cdr x)) (rplacd x y))
          ((nreverse1 (cdr x) (rplacd x y)))))
          ;; this last call depends on order of argument evaluation.
```

zl:nreverse does something inefficient with cdr-coded lists, because it just uses **rplacd** in the straightforward way. See the section "Cdr-Coding" in *Symbolics Common Lisp: Language Concepts*. Using **zl:reverse** might be preferable in some cases.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

nset-difference *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nset-difference is the destructive version of **set-difference**. **set-difference** returns a new list of elements of *list1* that do not appear in *list2*. **nset-difference** performs the same operation, but uses the cells of *list1* to construct the result. The value of *list2* is not altered. The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

See the function **set-difference**, page 474. For example:

```
(setq a-list '(eagle hawk loon pelican)) =>
(EAGLE HAWK LOON PELICAN)

(setq b-list '(owl hawk stork)) => (OWL HAWK STORK)

(nset-difference a-list b-list) => (EAGLE LOON PELICAN)

a-list => (EAGLE LOON PELICAN)

b-list => (OWL HAWK STORK)
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

nset-exclusive-or *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nset-exclusive-or is the destructive version of **set-exclusive-or**. **set-exclusive-or** returns a list of elements that appear in exactly one of *list1* and *list2*. **nset-exclusive-or** performs the same operation, but alters the values of the list arguments during the operation. The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

See the function **set-exclusive-or**, page 475. For example:

```
(setq a-list '(eagle hawk loon pelican)) =>
(EAGLE HAWK LOON PELICAN)

(setq b-list '(owl hawk stork)) => (OWL HAWK STORK)

(nset-exclusive-or a-list b-list) =>
(EAGLE LOON PELICAN OWL STORK)

a-list => (EAGLE HAWK LOON PELICAN)

b-list => (OWL STORK)
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

nstring-capitalize *string* &key (*start* **0**) (*end* **nil**) *Function*

The function **nstring-capitalize** is the destructive version of **string-capitalize**. **nstring-capitalize** returns *string* modified such that for every word in *string*, the initial character, if case-modifiable, is uppercased. All other case-modifiable characters in the word are lowercased.

For the purposes of **string-capitalize**, a word is defined as a consecutive subsequence of alphanumeric characters or digits, delimited at each end either by a non-alphanumeric character, or by an end of string.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The entire argument, *string*, is returned, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the operation. Default is **nil**, that is, the operation continues to the end of the string.

Examples:

```
(nstring-capitalize " a bUNch of WOrDs" :start 0 :end 3)
=> " A bUNch of WOrDs"

(nstring-capitalize " a bUNch of WOrDs" :start 8)
=> " a bUNch Of Words"

(nstring-capitalize " 1234567 a bunch of numbers" :start 1 :end 5)
 => " 1234567 a bunch of numbers"
```

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

nstring-capitalize-words *string* &key (*start* **0**) (*end* **nil**) *Function*

The function **nstring-capitalize-words** is the destructive version of **string-capitalize-words**.

nstring-capitalize-words returns *string*, modified such that hyphens are changed to spaces and initial characters of each word are capitalized if they are case-modifiable.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The entire argument, *string*, is returned, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

Examples:

```
(nstring-capitalize-words "three-hyphenated-words")
 => "Three Hyphenated Words"

(nstring-capitalize-words  "three-hyphenated-words" :end 5)
 => "Three-hyphenated-words"

(nstring-capitalize-words  "three-hyphenated-words" :start 6)
 => "three-Hyphenated Words"
```

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

nstring-downcase *string* &key (*start* **0**) (*end* **nil**) *Function*

The function **nstring-downcase** is the destructive version of the function **string-downcase**. **nstring-downcase** returns *string*, modified to replace its uppercase alphabetic characters by the corresponding lowercase characters.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for lowercasing. These keyword arguments must be non-negative integer indices into the string array. The entire argument, *string*, is returned, however.

:start Specifies the position within *string* from which to begin lowercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the lowercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

Examples:

```
(nstring-downcase "WHAT TIME IS IT !!!!") => "what time is it !!!!"
(nstring-downcase "A BUNCH OF WORDS" :start 2 :end 7) => "A bunch OF WORDS"
(nstring-downcase "A BUNCH OF WORDS" :start 11)  => "A BUNCH OF words"
(setq string "THREE UPPERCASE WORDS") => "THREE UPPERCASE WORDS"
(nstring-downcase string :start 0 :end 5 )  => "three UPPERCASE WORDS"
(nstring-downcase string :start 16 :end nil) => "three UPPERCASE words"
string => "three UPPERCASE words"
```

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

nstring-upcase *string* &key (*start* **0**) (*end* **nil**) *Function*

The function **nstring-upcase** is the destructive version of the function **string-upcase**. **nstring-upcase** returns *string*, modified by replacing its lowercase alphabetic characters by the corresponding uppercase characters.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The entire string argument is returned, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

Characters not in the standard character set are unchanged.

Examples:

```
(nstring-upcase "a four word string" :start 2 :end 6)
  => "a FOUR word string"
(nstring-upcase "a four word string" :start 12)
  => "a four word STRING"
```

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

nsublis *alist tree* &rest *args* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nsublis is the destructive version of **sublis**. **sublis** makes substitutions for objects in a tree. **nsublis** performs the same operation, but alters the relevant parts of *tree*. See the function **sublis**, page 568. The keywords are

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(setq exp '((* x y) (+ x y))) => ((* X Y) (+ X Y))

(nsublis '((x . 100)) exp) => ((* 100 Y) (+ 100 Y))

exp => ((* 100 Y) (+ 100 Y))
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:nsublis *alist tree* *Function*

zl:nsublis is like **zl:sublis** but changes the original tree instead of creating new.

zl:nsublis could have been defined by:

```
(defun nsublis (alist tree)
  (cond ((atom tree)
         (let ((tem (assq tree alist)))
           (if tem (cdr tem) tree)))
        (t (rplaca tree (nsublis alist (car tree)))
           (rplacd tree (nsublis alist (cdr tree)))
           tree)))
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

nsubst *new old tree* &rest *args* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nsubst is the destructive version of **subst**. **nsubst** changes *tree* by destructively replacing *new* for every subtree or leaf of *tree* such that *old* and the subtree or leaf satisfy **:test**. See the function **subst**, page 571. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For example:

```
(setq bird-list '(waders (flamingo stork) raptors (eagle hawk))) =>
(WADERS (FLAMINGO STORK) RAPTORS (EAGLE HAWK))

(nsubst 'heron 'stork bird-list) =>
(WADERS (FLAMINGO HERON) RAPTORS (EAGLE HAWK))
```

```
bird-list => (WADERS (FLAMINGO HERON) RAPTORS (EAGLE HAWK))
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:nsubst *new old tree* *Function*

zl:nsubst is a destructive version of **zl:subst**. The list structure of *tree* is altered by replacing each occurrence of *old* with *new*. **zl:nsubst** could have been defined as

```
(defun nsubst (new old tree)
    (cond ((eq tree old) new)      ;if item eq to old, replace.
          ((atom tree) tree)       ;if no substructure, return arg.
          (t                       ;otherwise, recurse.
             (rplaca tree (nsubst new old (car tree)))
             (rplacd tree (nsubst new old (cdr tree)))
             tree)))
```

nsubst-if *new predicate tree* &rest *args* &key *key* *Function*

nsubst-if is the destructive version of **subst-if**. **nsubst-if** changes *tree* by destructively replacing *new* for every subtree or leaf of *tree* such that the subtree or leaf satisfy *predicate*. See the function **subst-if**, page 573. The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For example:

```
(setq item-list '(numbers (1.0 2 5/3) symbols (foo bar)))
  => (NUMBERS (1.0 2 5/3) SYMBOLS (FOO BAR))

(nsubst-if '3.1415 #'numberp item-list)
  => (NUMBERS (3.1415 3.1415 3.1415) SYMBOLS (FOO BAR))

item-list => (NUMBERS (3.1415 3.1415 3.1415) SYMBOLS (FOO BAR))
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

nsubst-if-not *new predicate tree* &rest *args* &key *key* *Function*

nsubst-if-not is the destructive version of **subst-if-not**. **nsubst-if-not** changes *tree* by destructively replacing *new* for every subtree or leaf of *tree* such that the subtree or leaf do not satisfy *predicate*. See the function **subst-if-not**, page 573. The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For example:

```
(setq item-list '(numbers 1.0 2 5/3 symbols foo bar))
 => (NUMBERS 1.0 2 5/3 SYMBOLS FOO BAR)

(nsubst-if-not '3.1415 #' '(numbers 1.0 2 5/3 symbols foo bar))

item-list
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

nsubstitute *newitem olditem sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *from-end* (*start* **0**) *end count* *Function*

nsubstitute returns a sequence of the same type as the argument *sequence* which has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying the predicate specified by the **:test** keyword have been replaced by *newitem.* The argument *sequence* is destroyed during construction of the result, but the result may or may not be **eq** to *sequence.*

For example:

```
(setq letters '(a b c)) => (A B C)
(nsubstitute 'a 'b '(a b c)) => (A A C)
letters => (A B C)
```

However,

```
letters => (A B C)
(nsubstitute 'b 'c letters) => (A B B)
letters => (A B B)
```

newitem and *olditem* can be any Symbolics Common Lisp object but *newitem* must be a suitable element for *sequence.*

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql.**

For example:

```
(nsubstitute 0 3 '(1 1 4 4 2) :test #'<) => (1 1 0 0 2)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(nsubstitute 1 2 '((1 1) (1 2) (4 3)) :key #'second) => ((1 1) 1 (4 3))

(nsubstitute 'a 'b '((a b) (b c) (b b)) :key #'second) => (A (B C) A)
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(nsubstitute 'hi 'b '(b a b) :from-end t :count 1 )
 => (B A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(nsubstitute 'a 'B '(b a b) :start 1 :end 3)  => (B A A)

(nsubstitute 'a 'b '(b a b) :end 2) => (A A B)

(nsubstitute 'a 'b '(b a b) :end 3) => (A A A)
```

A non-**nil** **:count**, if supplied, limits the number of elements altered; if more than **:count** elements satisfy the test, then of these elements only the leftmost are replaced, as many as specified by **:count**

For example:

```
(nsubstitute 'a 'b '(b b a b b) :count 3) => (A A A A B)
```

To perform destructive substitutions throughout a tree: See the function **nsubst**, page 374.

nsubstitute is case-insensitive.

nsubstitute is the destructive version of **substitute**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

nsubstitute-if *newitem predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

nsubstitute-if returns a sequence of the same type as the argument sequence which has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying *predicate* have been replaced by *newitem*. The argument *sequence* is destroyed during construction of the result, but the result may or may not be **eq** to *sequence*.

For example:

```
(setq numbers '(a b)) => (A B)
(nsubstitute-if 3 #'numberp numbers) => (A B)
numbers => (A B)
```

However,

```
numbers => (1 1 19)
(nsubstitute-if 2 #'numberp numbers) => (2 2 2)
numbers => (2 2 2)
```

newitem can be any Symbolics Common Lisp object but must be a suitable element for the *sequence*.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(nsubstitute-if 1 #'oddp '((1 1) (1 2) (4 3)) :key #'second)
 => (1 (1 2) 1)
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(nsubstitute-if 'hi #'atom '(b 'a b) :from-end t :count 1 )
 => (B 'A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(nsubstitute-if 1 #'zerop '(0 1 0) :start 1 :end 3) => (0 1 1)

(nsubstitute-if 1 #'zerop '(0 1 0) :start 0 :end 2)  => (1 1 0)

(nsubstitute-if 1 #'zerop '(0 1 0)  :end 1)  => (1 1 0)
```

A non-**nil** **:count**, if supplied, limits the number of elements altered; if more than **:count** elements satisfy the test, then of these elements only the leftmost are replaced, as many as specified by **:count**

For example:

```
(nsubstitute-if 'see 'atom  '(b b a b b) :count 3)
 => (SEE SEE SEE B B)
```

nsubstitute-if is the destructive version of **substitute-if**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

nsubstitute-if-not *newitem predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

nsubstitute-if-not returns a sequence of the same type as the argument sequence which has the same elements, except that those in the subsequence delimited by **:start** and **:end** which do not satisfy *predicate* have been replaced by *newitem*. The argument *sequence* is destroyed during construction of the result, but the result may or may not be **eq** to *sequence*.

For example:

```
(setq numbers '(0 0 0)) => (0 0 0)
(nsubstitute-if-not 1 #'numberp numbers) => (0 0 0)
numbers => (0 0 0)
```

However,

```
numbers => (1 0 0)
(nsubstitute-if-not 2 #'consp numbers)  => (2 2 2)
numbers => (2 2 2)
```

newitem can be any Symbolics Common Lisp object but must be a suitable element for the *sequence*.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(nsubstitute-if-not 1 #'oddp '((1 1) (1 2) (4 3)) :key #'second)
 => ((1 1) 1 (4 3))
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(nsubstitute-if-not 'hi #'atom '('b a 'b) :from-end t :count 1 )
 => ('B A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(nsubstitute-if-not 1 #'zerop '(3 0 2) :start 1 :end 3) => (3 0 1)

(nsubstitute-if-not 1 #'zerop '(3 0 2) :start 0 :end 2)  => (1 0 2)

(nsubstitute-if-not 1 #'zerop '(3 0 2)  :end 1) => (1 0 2)
```

A non-**nil** **:count**, if supplied, limits the number of elements altered; if more than **:count** elements satisfy the test, then of these elements only the leftmost are replaced, as many as specified by **:count**

For example:

```
(nsubstitute-if-not 'see 'consp  '(b b a b b) :count 3)
=> (SEE SEE SEE B B)
```

nsubstitute-if-not is the destructive version of **substitute-if-not.**

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

nsubstring *string from* &optional *to* (*area* **nil**) *Function*

nsubstring is the destructive form of the function **substring.** Instead of copying the substring, the system creates an indirect array that shares part of the argument *string.* See the section "Indirect Arrays" in *Symbolics Common Lisp: Language Concepts.* Modifying one string modifies the other.

string is a string or an object that can be coerced to a string. Since **nsubstring** is destructive, coercion should be used with care since a string internal to the object might be modified. See the function **string**, page 502.

Note that **nsubstring** does not necessarily use less storage than **substring**; an **nsubstring** of any length uses at least as much storage as a **substring** four characters long. So you should not use this just "for efficiency"; it is intended for uses in which it is important to have a substring that, if modified, causes the original string to be modified too.

Examples:

```
(setq a "Aloysius") => "Aloysius"
a => "Aloysius"
(setq b (nsubstring a 2 4)) => "oy"
(nstring-upcase b) => "OY"
a => "AlOYsius"
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

nsymbolp *arg* *Function*

nsymbolp returns **nil** if its argument is a symbol, otherwise **t**.

nth *n list* *Function*

(**nth** *n list*) returns the *n*th element of *list*, where the zeroth element is the car of the list. Examples:

```
(nth 1 '(foo bar gack)) => bar
(nth 3 '(foo bar gack)) => nil
```

If *n* is greater than the length of the list, **nil** is returned.

Note: this is not the same as the Interlisp function called **nth**, which is similar to but not exactly the same as the Symbolics Common Lisp function **nthcdr**. Also, some people have used their own macros and functions called **nth** in their Maclisp programs.

nth could have been defined by:

```
(defun nth (n list)
  (do ((i n (1- i))
       (l list (cdr l)))
      ((zerop i) (car l))))
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

nthcdr *n list* *Function*

(**nthcdr** *n list*) performs the **cdr** operation on *list n* times, and returns the result. Examples:

```
(nthcdr 0 '(a b c)) => (a b c)
(nthcdr 2 '(a b c)) => (c)
```

In other words, it returns the *n*th *cdr* of the list. If *n* is greater than the length of the list, **nil** is returned.

This is similar to Interlisp's function **nth**, except that the Interlisp function is one-based instead of zero-based; see the Interlisp manual for details. **nthcdr** could have been defined by:

```
(defun nthcdr (n list)
    (do ((i 0 (1+ i))
         (list list (cdr list)))
        ((= i n) list)))
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

null *x* *Function*

not returns **t** if *x* is **nil**, else **nil**. **null** is the same as **not**; both functions are included for the sake of clarity. Use **null** to check whether something is **nil**; use **not** to invert the sense of a logical value. Even though Lisp uses the symbol **nil** to represent falseness, you should not make understanding of your program depend on this. For example, one often writes:

```
(cond ((not (null lst)) ... )
      ( ... ))
```

rather than

```
(cond (lst ... )
      ( ... ))
```

There is no loss of efficiency, since these compile into exactly the same instructions.

null *Type Specifier*

null is the type specifier symbol for the predefined Lisp null data type.

The type null is a *subtype* of the type **symbol**; the only object of type **null** is **nil**.

The types **null** and **cons** form an *exhaustive partition* of the type **list**.

Examples:

```
(typep nil 'null) => T
(null ()) => T
(subtypep 'null 't) => T and T
(subtypep 'null 'symbol) => T and T
(equal-typep (null ()) (not ())) => T
(sys:type-arglist 'null) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Predicates" in *Symbolics Common Lisp: Language Concepts*.

number &optional *(low-limit '*) (high-limit '*)* *Type Specifier*

number is the type specifier symbol for the predefined Lisp data type, number.

The type **number** is a *supertype* of the following types, which are themselves pairwise disjoint:

rational
float
complex

The types **number, cons, symbol, array,** and **character** are *pairwise* disjoint.

This type specifier can be used in either symbol or list form. Used in list form, **number** allows the declaration and creation of specialized numbers whose range is restricted to the limits specified in the arguments *low-limit* and *high-limit.* The list form is a Symbolics Common Lisp extension to Common Lisp.

low-limit and *high-limit* must each be an integer, a list of an integer, or unspecified. If these limits are expressed as integers, they are *inclusive*; if they are expressed as a list of an integer, they are *exclusive*; * means that a limit does not exist, and so effectively denotes minus or plus infinity, respectively.

Examples:

```
(typep '1 'number) => T
(typep 1 '(number 1 3)) => T
(typep 0 '(number 1 3)) => NIL
(typep 4 '(number 5 *)) => NIL
(typep 5 '(number 5 *)) => T
(subtypep 'bit '(number 0 4))  => T and T
(commonp 3.14) => T
(numberp '16) => T
(numberp most-positive-long-float) => T
(subtypep 'rational 'number) => T and T
(subtypep 'float 'number) => T and T
(subtypep 'complex 'number) => T and T
(sys:type-arglist 'number)
=> (&OPTIONAL (LOW-LIMIT '*) (HIGH-LIMIT '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

sys:number-into-array *array n* &optional (*radix* **zl:base**) (*at-index* **0**) (*min-columns* **0**) *Function*

Deposits the printed representation of *number* into *array*, which must be a string. **sys:number-into-array** is the inverse of **zl:parse-number.** It has three optional arguments:

radix	The radix to use when converting the number into its printed representation. It defaults to **zl:base.**
at-index	The character position in the array to start putting the number.
min-columns	The minimum number of characters required for the

printed representation of the number. If the number contains fewer characters than *min-columns*, the number is right-justified within the array. If the number contains more characters than *min-columns*, *min-columns* is ignored. An error is signalled if the number contains more characters than the length of the array minus *at-index*. The default is the first position, position 0.

The following example puts 23453243 into *string* starting at character position 5. Since *min-columns* is 10, the number is preceded by two spaces.

```
(let ((string (make-array 20. :type 'art-string :initial-value #\X)))
  (zl:number-into-array string 23453243. 10. 5. 10.)
    string)

=>  "XXXXX  23453243XXXXX"
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

numberp *object* *Function*

numberp returns **t** if its argument is any kind of number, otherwise **nil.**

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

numerator *rational* *Function*

If *rational* is a ratio, **numerator** returns the numerator of *rational.* If rational is an integer, **numerator** returns *rational.*
Examples:

```
(numerator 4/5) => 4
(numerator 3) => 3
(numerator 4/8) => 1
```

Related Functions:

denominator

For a table of related items: See the section "Functions That Extract Components From a Rational Number" in *Symbolics Common Lisp: Language Concepts.*

nunion *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

nunion is the destructive version of **union.** **union** takes two lists and returns a new list containing everything that is an element of either of the lists. **nunion** performs the same operation, but it destroys the values of the list arguments. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

See the function **union**, page 602. For example:

```
(setq a-list '(a b c)) => (A B C)

(setq b-list '(f a d)) => (F A D)

(nunion a-list b-list) => (A B C F D)

a-list => (A B C F D)

b-list => (F D)
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:nunion &rest *lists* *Function*

Takes any number of lists that represent sets and returns a new list that represents the union of all the sets it is given, by destroying any of the lists passed as arguments and reusing the conses. **zl:nunion** uses **eq** for its comparisons. You cannot change the function used for the comparison. **(zl:nunion)** returns **nil**.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

oddp *integer* *Function*

Returns **t** if *integer* is odd, otherwise **nil**. If *integer* is not an integer, **oddp** signals an error.

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

once-only *variable-list* &body *body* *Macro*

A **once-only** form looks like:

```
(once-only var-list
  form1
  form2
  ...)
```

var-list is a list of variables. **once-only** is usually used in macros where these variables are Lisp forms. The *forms* are a Lisp program that presumably uses the values of those variables. When the form resulting from the expansion of the **once-only** is evaluated, it first inspects the values of each of the variables in *var-list*; these values are assumed to be Lisp forms. It binds each variable either to its current value, if the current value is a trivial form, or to a generated symbol. Next, **once-only** evaluates the *forms*, in this new binding environment, and when they have been evaluated it undoes the bindings. The result of the evaluation of the last *form* is presumed to be a Lisp form, typically the expansion of a macro. If all of the variables had been bound to trivial forms, then *once-only* just returns that result. Otherwise, **once-only** returns the result wrapped in a lambda-combination that binds the generated symbols to the result of evaluating the respective nontrivial forms.

The effect is that the program produced by evaluating the **once-only** form is coded in such a way that it only evaluates each form once, unless evaluation of the form has no side effects, for each of the forms that were the values of variables in *var-list.* At the same time, no unnecessary lambda-binding appears in this program, but the body of the **once-only** is not cluttered up with extraneous code to decide whether or not to introduce lambda-binding in the program it constructs.

Note well: while **once-only** attempts to prevent multiple evaluation, it does *not* necessarily preserve the *order* of evaluation of the forms! Since it generates the new bindings, the evaluation of complex forms (for which a new variable needs to be created) may be moved ahead of the evaluation of simple forms (such as variable references). **once-only** does not solve all of the problems mentioned in this section.

:operation-handled-p *operation* *Message*

operation is a generic function or message name. The object should return **t** if it has a handler for the specified operation, **nil** if it does not.

flavor:vanilla provides a method for **:operation-handled-p**.

Instead of sending this message, you can use the **operation-handled-p** function. See the function **operation-handled-p**, page 388.

operation-handled-p *object message-name* *Function*

Returns **t** if the flavor associated with *object* has a method defined for *message-name* and **nil** if a method is not defined for *message-name.*

&optional *Lambda List Keyword*

If the lambda-list keyword **&optional** is present, all specifiers up to the next lambda-list keyword, or the end of the list, are optional parameter specifiers.

or &rest *body* *Special Form*

Evaluates each form one by one, from left to right. If a form evaluates to **nil**, **or** proceeds to evaluate the next form. If there is no other form, **or** returns **nil**. But if a form evaluates to a non-**nil** value, **or** immediately returns that value without evaluating any other form.

As with **and**, **or** can be used either as a logical **or** function, or as a conditional. Examples:

```
(or) => NIL

(or 'start 'finish 'middle) => START

(or (> 3 4))  => NIL

(or (numberp 'arg) "not a number")  => "not a number"

(or it-is-fish
    it-is-fowl
    (print "It is neither fish nor fowl."))
```

Note: **(or) => nil** , the identity for this operation.

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

or &rest *types* *Type Specifier*

The type specifier **or** allows the definition of data types as the union of other data types specified by *types.* As a type specifier, **or** can only be used in list form.

Examples:

```
(typep 33 '(or ratio number)) => T
(typep '33s '(or number atom)) => T
(subtypep '(bit-vector 2) '(or (bit-vector 1) (bit-vector 2)))
 => T and T
(sys:type-arglist 'or) => (&REST TYPES) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. For a discussion of the function **or**: See the section "Flow of Control" in *Symbolics Common Lisp: Language Concepts*.

package *Type Specifier*

package is the type specifier symbol for the predefined Lisp data type, package.

The types **package**, **hash-table**, **readtable**, **pathname**, **stream**, and **random-state** are *pairwise disjoint*.

Examples:

```
(typep *package* 'package) => T
(typep (in-package 'example) 'package) => T
(typep (in-package 'cl-user) 'package) => T
(typep (find-package 'cl-user) 'package) => T
(zl:typep *package*) => ZL:PACKAGE
(sys:type-arglist 'package) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Packages" in *Symbolics Common Lisp: Language Concepts*.

zl:package *Variable*

See ***package***.

package *Variable*

The value of ***package*** is the current package; many functions that take packages as optional arguments default to the value of ***package***, including **intern** and related functions. The reader and the printer deal with printed representations that depend on the value of ***package***. Hence the current package is part of the user interface and is displayed in the status line at the bottom of the screen.

It is often useful to bind ***package*** to a package around some code that deals with that package. The operations of loading, compiling, and editing a file all bind ***package*** to the package associated with the file.

sys:package-cell-location *symbol* *Function*

Returns a locative pointer to *symbol*'s package cell. It is preferable to write the following, rather than calling this function explicitly.

```
(locf (symbol-package symbol))
```

sys:package-error *Flavor*

All package-related error conditions are built on **sys:package-error**.

package-external-symbols *package* *Function*

A list of all the external symbols exported by *package*. *package* can be a package object or the name of a package (a symbol or a string).

sys:package-locked *Flavor*

There was an attempt to intern a symbol in a locked package.

The **:symbol** message returns the symbol. The **:package** message returns the package.

The **:no-action** proceed type interns the symbol just as if the package had not been locked. Other proceed types are also available when interning the symbol would cause a name conflict.

package-name *pkg* *Function*

Returns the name of *pkg* as a string. *pkg* must be a package object.

```
(find-package 'global) => #<Package ZL (really GLOBAL) 35736740>
(package-name *) => "ZL"
```

See the section "Mapping Between Names and Packages" in *Symbolics Common Lisp: Language Concepts*.

package-nicknames *pkg* *Function*

Returns the acceptable nickname strings for *pkg*. *pkg* must be a package object.

```
(find-package "common-lisp") => #<Package COMMON-LISP 35553744>
(package-nicknames *) => ("COMMON-LISP-GLOBAL" "CL" "LISP")
```

sys:package-not-found *Flavor*

A package-name lookup did not find any package by the specified name.

The **:name** message returns the name. The **:relative-to** message returns **nil** if only absolute names are being searched, or else the package whose relative names are also searched.

The **:no-action** proceed type can be used to try again. The **:new-name** proceed type can be used to specify a different name or package. The **:create-package** proceed type creates the package with default characteristics.

packagep *object* *Function*

package-shadowing-symbols *package* *Function*
The list of symbols that have been declared as shadowing symbols in this package by **shadow** or **shadowing-import**. All symbols on this list are present in the specified package. *package* can be a package object or the name of a package (a symbol or a string).

package-used-by-list *package* *Function*
The list of other packages that use the argument package. *package* can be a package object or the name of a package (a symbol or a string). The elements of the list returned are package objects.

package-use-list *pkg* *Function*
The list of other packages used by the argument package. *pkg* must be a package object. The elements of the list returned are package objects.

sys:page-in-raster-array *raster* &optional *from-x from-y to-x to-y* *Function*
(*hang-p* **si:*default-page-in-hang-p***)
(*normalize-p* **t**)
Ensures that the storage that represents *raster* is in main memory. *from-x* and *from-y* can be specified as **nil**, meaning the lower limit for that item. *to-x* and *to-y* can be specified as **nil**, meaning the upper limit for that item.

This, rather than **sys:page-in-array**, should be used on rasters.

sys:page-out-raster-array *array* &optional *from-x from-y to-x to-y* *Function*
(*hang-p* **si:*default-page-in-hang-p***)
Take the pages that represent *raster* out of main memory. *from-x* and *from-y* can be specified as **nil**, meaning the lower value for that item. *to-x* and *to-y* can be specified as **nil**, meaning the upper limit for that item.

This, rather than **sys:page-out-array**, should be used on rasters.

pairlis *keys data* &optional *a-list* *Function*
pairlis takes two lists and makes an association list that associates elements of the first list to corresponding elements of the second list. **pairlis** signals an error if the two lists, *keys* and *data*, are not of the same length. If the optional argument *a-list* is provided, then the new pairs are added to the front of *a-list*.

The new pairs may appear in the resulting alist in any order; in particular, either forward or backward order is permitted. Therefore, the result of the following call might be either of the two results.

```
(pairlis '(one two) '(1 2) '((three . 3) (four . 4))) =>
((TWO . 2) (ONE . 1) (THREE . 3) (FOUR . 4))
or
((ONE . 1) (TWO . 2) (THREE . 3) (FOUR . 4))
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:pairlis *cars cdrs* *Function*

zl:pairlis takes two lists and makes an association list which associates elements of the first list with corresponding elements of the second list. Example:

```
(zl:pairlis '(beef clams chicken) '(roast fried yu-shing))
  => ((beef . roast) (clams . fried) (chicken . yu-shing))
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:parse-ferror *format-string* &rest *format-args* *Function*

Signals an error of flavor **zl:parse-ferror**. *format-string* and *format-args* are passed as the **:format-string** and **:format-args** init options to the error object.

See the flavor **zl:parse-ferror** in *Symbolics Common Lisp: Language* Concepts.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:parse-number *string* &optional (*from* **0**) (*to nil*) (*radix nil*) *Function*
(*fail-if-not-whole-string nil*)

zl:parse-number takes a string and "reads" a number from it. The function currently does not handle anything but integers.

string must be a string. It returns two values: the number found (or **nil**) and the character position of the next unparsed character in the string. It returns **nil** when the first character that it looks at cannot be part of a number. (**read-from-string** is a more general function that uses the Lisp reader; **prompt-and-read** reads a number from the keyboard.) Four optional arguments:

from	The character position in the string to start parsing. The default is the first one, position 0.
to	The character position past the last one to consider. The default, **nil**, means the end of the string.

radix The radix to read the string in. The default, **nil**, means base 10.

fail-if-not-whole-string
The default is **nil**. **nil** means to read up to the first character that is not a digit and stop there, returning the result of the parse so far. **t** means to stop at the first nondigit and to return **nil** and 0 length if that is not the end of the string.

Examples:

```
(zl:parse-number "123    ") => 123 and 3
(zl:parse-number "   123") => NIL and 0
(zl:parse-number "-123") => -123 and 4
(zl:parse-number "25.3") => 25 and 2
(zl:parse-number "$$$123" 3 4) => 1 and 4
(zl:parse-number "123$$$" 0 nil nil nil) => 123 and 3
(zl:parse-number "123$$$" 0 nil nil t) => NIL and 0
```

The Common Lisp equivalent to **zl:parse-number** is the function **parse-integer**.

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

pathname *Type Specifier*

pathname is the type specifier symbol for the predefined Lisp data type, pathname.

The types **pathname**, **hash-table**, **readtable**, **package**, **stream**, and **random-state** are *pairwise disjoint.*

Examples:

```
(typep (pathname "apple") 'pathname) => T
(type-of (pathname "bubbles")) => FS:LMFS-PATHNAME
(sys:type-arglist 'pathname) => NIL
(pathnamep *default-pathname-defaults*) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Files" in *Reference Guide to Streams, Files, and I/O.*

phase *number* *Function*

The phase of a number is the angle part of its polar representation as a complex number. The phase of zero is arbitrarily defined to be zero. **phase** returns a single-precision result, unless *number* is a double-precision complex number.

phase could have been defined as:

```
(defun phase (number)
  (atan (imagpart number) (realpart number)))
```

See the function **abs**, page 13.

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

pi *Constant*

The value of constant **pi** is the best possible approximation to π in double floating-point format.

To obtain an approximation to π in some other precision, write `(float pi x)` where *x* is a floating-point number of the desired precision; or write `(coerce pi` *type*`)` where *type* is the name of a valid floating-point precision type.

Examples:

```
pi => 3.141592653589793d0

(float pi 1.0) => 3.1415927
(float pi 1.0L0)  => 3.141592653589793d0
(coerce pi 'single-float) => 3.1415927
```

pkg-add-relative-name *from-package name to-package* *Function*

Add a relative name named *name*, a string or a symbol, that refers to *to-package*. From now on, qualified names using *name* as a prefix, when the current package is *from-package* or a package that uses *from-package*, refer to *to-package*.

from-package and *to-package* can be packages or names of packages.

It is an error if *from-package* already defines *name* as a relative name for a package different from *to-package*.

zl:pkg-bind *pkg body...* *Macro*

pkg can be a package or a package name. The forms of the *body* are evaluated with the variable ***package*** bound to the package named by *pkg*. The values of the last form are returned.

Example:

```
(zl:pkg-bind "zwei"
  (read-from-string function-name))
```

The difference between **zl:pkg-bind** and a simple **let** of the variable ***package*** is that **zl:pkg-bind** ensures that the new value for ***package*** is actually a package; it coerces package names (strings or symbols) into actual package objects.

pkg-delete-relative-name *from-package name* *Function*

If *from-package* defines *name* as a relative name, it is removed. *from-package* can be a package or the name of a package. *name* can be a symbol or a string. It is not an error if *from-package* does not define *name* as a relative name.

pkg-find-package *x* &optional *(create-p* **:error***) (relative-to* **nil***)* *Function*

pkg-find-package tries to interpret *x* as a package. Most of the functions whose descriptions say "... can be either a package or the name of a package" call **pkg-find-package** to interpret their package argument.

If *x* is a package, **pkg-find-package** returns it.

If *x* is a symbol or a string, it is interpreted as the name of a package. If *relative-to* is specified and non-**nil**, then it must be a package or the name of a package. If *relative-to* or one of the packages it uses has a relative name of *x*, the package named by that relative name is used. If the relative name search fails, or if no relative name search is called for (that is, *relative-to* is **nil**, which is the default), then if a package with a primary name or nickname of *x* exists it is returned.

If *x* is a list, it is presumed to have come from a file attribute line. **pkg-find-package** is done on the car of the list. If that fails, a new package is created with that name, according to the specifications in the rest of the list. See the section "Specifying Packages in Programs" in *Symbolics Common Lisp: Language Concepts*.

If no package is found, the *create-p* argument controls what happens. Note that this can only happen if *x* is a symbol or a string. The possible values for *create-p* are:

:error or **nil**	An error is signalled. The error can be continued by defining the package manually, creating it automatically with default attributes, or using a different package name instead. **:error** is the default. **nil** is accepted as a synonym for **:error** for backwards compatibility.
:find	Just return **nil**.
:ask	Ask the user whether to create it.
t	Create a package with the specified name with default attributes. It does inherit from **global** but not from any other packages.

The package name search is independent of alphabetic case. However, this might be changed in the future for Common Lisp compatibility and should not be depended upon. In any event it is not considered good style to have two distinct packages whose names differ only in alphabetic case.

zl:pkg-global-package *Variable*

The **global** package.

zl:pkg-goto &optional *pkg globally* *Function*

pkg can be a package or the name of a package. *pkg* is made the current package; in other words, the variable ***package*** is set to the package named by *pkg*. **zl:pkg-goto** can be useful to "put the keyboard inside" a package when you are debugging.

pkg defaults to the **user** package.

If *globally* is specified non-**nil**, then ***package*** is set with **zl:setq-globally** instead of **setq**. This is useful mainly in an init file, where you want to change the default package for user interaction, and a simple **setq** of ***package*** does not work because it is bound by **zl:load** when it loads the init file.

sys:pkg-keyword-package *Variable*

The **keyword** package.

pkg-kill *package* *Function*

Kill *package* by removing it from all package system data structures. The name and nicknames of *package* cease to be recognized package names. If *package* is used by other packages, it is un-used, causing its external symbols to stop being accessible to those packages. If other packages have relative names for *package*, the names are deleted.

Any symbols in *package* still exist and their home package is not changed. If this is undesirable, evaluate **(zl:mapatoms #'remob** *package* **nil)** first.

package can be a package or the name of a package.

zl:pkg-name *package* *Function*

Get the (primary) name of a package. The name is a string.

It is an error if *package* is not a package object. (The phrase "it is an error" has special significance in Common Lisp. See the function **package-name**, page 390.) Note that **zl:pkg-name** is a structure-accessing function and does not check that its argument is a package object, only that it is some kind of an array with a leader.

zl:pkg-system-package *Variable*

The **system** package.

plane-aref *plane* &rest *point* *Function*

Returns the contents of a specified element of a plane. **plane-aref** takes the subscripts as arguments. **setf** of **plane-aref** is allowed.

zl:plane-aset *datum plane* &rest *point* *Function*

Stores *datum* into the specified element of a plane, extending it if necessary, and returns *datum*. **zl:plane-aset** differs from **zl:plane-store** in the way it takes its arguments; **zl:plane-aset** takes the subscripts as arguments, while **zl:plane-store** takes a list of subscripts.

setf of **plane-aref** is preferred.

plane-default *plane* *Function*

Returns the contents of the infinite number of plane elements that are not actually stored.

plane-extension *plane* *Function*

Returns the amount to extend the plane by in any direction when **zl:plane-store** is done outside of the currently stored portion.

zl:plane-origin *plane* *Function*

Returns a list of numbers, giving the lowest coordinate values actually stored.

zl:plane-ref *plane point* *Function*

Returns the contents of a specified element of a plane. It differs from **plane-aref** in the way that it takes its arguments; **plane-aref** takes the subscripts as arguments, while **zl:plane-ref** takes a list of subscripts.

zl:plane-store *datum plane point* *Function*

Stores *datum* into the specified element of a plane, extending it if necessary, and returns *datum*. **zl:plane-store** differs from **zl:plane-aset** in the way it takes its arguments; **zl:plane-aset** takes the subscripts as arguments, while **zl:plane-store** takes a list of subscripts.

zl:plist *symbol* *Function*

Returns the list that represents the property list of *symbol*. Note that this is not the property list itself; you cannot do **zl:get** on it.

The Common Lisp equivalent of this function is **symbol-plist**.

zl:plus &rest *args* *Function*

Returns the sum of its arguments. If there are no arguments, it returns **0**, which is the identity for this operation.

The following functions are synonyms of **zl:plus**:

+
zl:+$

plusp *number* *Function*

Returns **t** if its argument is a positive number, strictly greater than zero. Otherwise it returns **nil**. If *number* is not a noncomplex number, **plusp** causes an error.

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

pop *list* *Function*

The result returned by **pop** is the *car* of the contents of *list*, and as a side effect, the *cdr* of contents is stored back into *list*. The form *list* may be any form acceptable as a generalized variable to **setf**. If *list* is viewed as a push-down stack, then **pop** pops an element from the top of the stack and returns it. For example:

```
(setq stack '(a b c)) => (A B C)

(pop stack) => A

stack => (B C)
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:pop *access-form* *Macro*

Removes an element from the front of a list which is stored in a generalized variable. **(zl:pop** *ref***)** finds the cons in *ref*, stores the *cdr* of the cons back into *ref*, and returns the *car* of the cons. Example:

```
(setq x '(a b c))
(zl:pop x) => a
x => (b c)
```

All the caveats that apply to **incf** apply to **zl:pop** as well: forms within *ref* might be evaluated more than once. (**zl:pop** does not evaluate any part of *ref* more than once.)

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

position *item sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*
from-end (*start* **0**) *end*

If *sequence* contains an element satisfying the predicate specified by the **:test** keyword, then **position** returns the index within the sequence of the leftmost such element as a non-negative integer; otherwise **nil** is returned.

item is matched against the elements specified by the *test* keyword. The *item* can be any Symbolics Common Lisp object but must be a suitable element for the *sequence.*

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(position 1 #(3 2 1 2) :test #'eq) => 2
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(position 'c #((1 a) (2 b) (3 c)) :key #'second) => 2
```

If the value of the **:from-end** argument is non-**nil**, then the result is the index of the rightmost element that satisfies the predicate, however, the index is still computed from the left-hand end of the sequence.

For example:

```
(position 3 #(2 2 3 4 4 3) :from-end 'non-nil) => 5

(position 3 #(2 2 3 4 4 3) :from-end nil) => 2
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(position 'a #(b b a b b)) => 2

(position 'a #(b b a b b)) => 2

(position 2 #(2 3 3 2 3) :start 2) => 3

(position 3 #(2 1 1 1 2) :start 1 :end 4) => NIL
```

position is case-insensitive.

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

position-if *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

If *sequence* contains an element satisfying *predicate*, then **position** returns the index within the sequence of the leftmost such element as a non-negative integer; otherwise **nil** is returned.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(position-if #'zerop #((1 a)(0 b)(3 c)) :key #'car)
 => 1
```

If the value of the **:from-end** argument is non-**nil**, then the result is the index of the rightmost element that satisfies the predicate, however, the index is still computed from the left-hand end of the sequence.

For example:

```
(position-if #'numberp #(1 a b c 3) :from-end 'non-nil) => 4

(position-if #'numberp #(a 1 b c 3) :from-end nil) => 1
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(position-if #'numberp  #(2 a b c 3) :start 2) => 4

(position-if #'numberp #(2 a b c 2) :start 1 :end 4) => NIL
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

position-if-not *predicate sequence* &key *key from-end* (*start* **0**) *end* *Function*

If *sequence* contains an element that does not satisfy *predicate*, then position returns the index within the sequence of the leftmost such element as a non-negative integer; otherwise **nil** is returned.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(position-if-not #'zerop #((1 a)(0 b)(3 c)) :key #'car)
 => 0
```

If the value of the **:from-end** argument is non-**nil**, then the result is the index of the rightmost element that satisfies the predicate, however, the index is still computed from the left-hand end of the sequence.

For example:

```
(position-if-not #'numberp #(1 a b c 3) :from-end 'non-nil)  => 3

(position-if-not #'numberp #(a 1 b c 3) :from-end nil) => 0
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(position-if-not #'numberp  #(2 a b c 3) :start 2) => 2

(position-if-not #'numberp #(a 1 2 3 a) :start 1 :end 4) => NIL
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

zl:prinlength *Variable*

zl:prinlength can be set to the maximum number of elements of a list that is printed before the printer gives up and print a "...". If it is **nil**, which it is initially, any length list can be printed. Otherwise, the value of **zl:prinlength** must be an integer. This variable has been superseded by ***print-length***.

zl:prinlevel *Variable*

zl:prinlevel can be set to the maximum number of nested lists that can be printed before the printer gives up and just prints a "**". If it is **nil**, which it is initially, any number of nested lists can be printed. Otherwise, the value of **zl:prinlevel** must be an integer. This variable has been superseded by ***print-level***.

print-base *Variable*

The value of this variable determines the radix in which the printer prints rational numbers (integers and ratios).

print-base can have any integer value from 2 to 36, inclusive; its default value is 10 (decimal radix). For values above 10, letters of the alphabet are used to represent digits above 9.

If no radix specifier is set (see ***print-radix***) integers in base ten are printed without a trailing decimal point.

If the value of ***print-base*** is a symbol that has a **si:princ-function** property (such as **:roman** or **:english**), the value of the property is applied to two arguments

- - of the number to be printed
- the stream to which to print it

This allows output in roman numerals and the like.

Examples:

```
(setq *print-base* ':roman)
(* 5 5) ==> XXV

(setq *print-base* ':english)
(* 5 5) ==> twenty-five
```


sys:print-cl-structure *object stream depth* *Function*

This function is intended for use in a **defstruct :print-function** option. It prints the structure *object* to the specified *stream* using the standard #S syntax. It enables a print function to respect the variable ***print-escape***.

```
(defstruct (foo :print-function
                (lambda (object stream depth)
                  (if *print-escape*
                      (sys:print-cl-structure object stream depth)
                      other-printing-strategy)))
  a b c)
```

flavor:print-flavor-compile-trace &key *flavor generic newest oldest newest-first* *Function*

Enables you to view information on the compilation of combined methods that have been compiled into the run-time environment. You can supply keywords to filter the output and control the order of the combined methods displayed:

flavor	Argument is a symbol that names a flavor of interest; all compilations of combined methods for that flavor are displayed. If the argument to *flavor* is **nil**, all flavors are displayed.
generic	Argument is a generic function or message of interest; all compilations of combined methods for that generic functin are displayed. If the argument to *generic* is **nil**, all generic functions are displayed.

newest Argument is an integer greater than or equal to 1, or **nil**. If an integer is given, it selects the number of compilations to display, starting from the most recent. If **nil** is given, all compilations are displayed. The order of combined methods displayed depends on the keyword *newest-first*.

oldest Argument is an integer greater than or equal to 1, or **nil**. If an integer is given, it selects the number of compilations to display, starting from the oldest. If **nil** is given, all compilations are displayed. The order of combined methods displayed depends on the keyword *newest-first*.

newest-first Argument is either non-**nil** or **nil**. **nil** causes the display to be ordered from oldest compilation to newest. A non-**nil** value causes the order to be from newest to oldest. By default, combined methods are displayed in oldest-first order.

The output of this function is mouse-sensitive. When you position the mouse over the name of a method or flavor, the menu offers several options that enable you to request more information. Pathnames are also mouse-sensitive.

dbg:print-frame-locals *frame local-start* &optional (*indent* **0**) *Function*

dbg:print-frame-locals prints the names and values of the local variables of *frame*. *local-start* is the first local slot number to print; the value returned by **dbg:print-function-and-args** is often suitable for this. *indent* is the number of spaces to indent each line; the default is no indentation.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts*.

dbg:print-function-and-args *frame* &optional *show-pc-p show-source-file-p show-local-if-different present-as-function* *Function*

dbg:print-function-and-args prints the name of the function executing in *frame* and the names and values of its arguments, in the same format as the Debugger uses. If *show-pc-p* is true, the program counter value of the frame, relative to the beginning of the function, is printed in octal. **dbg:print-function-and-args** returns the number of local slots occupied by arguments.

Caution: Use this function only within the context of the **dbg:with-erring-frame** macro.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

print-radix *Variable*

If this variable is set to **t**, rational numbers are printed with a radix specifier indicating what radix the printer is using. (The current radix is controlled by the value of variable ***print-base***).

The default value of ***print-radix*** is **nil**.

The radix specifier has the general format

#nnrddddd

where *n* is an unsigned decimal integer in the range 2 - 36 (inclusive) representing the radix, and *ddddd* denotes the number in radix *n*.

When the value of ***print-base*** is 2, 8, or 16 (that is, binary, octal, or hexadecimal) the radix specifier is printed in the abbreviated form, #b, #o, #x, using lower case letters.

For printing integers, base ten is indicated by a trailing decimal instead of a leading radix specifier; for ratios, however, the specifier #10r is printed.

sys:print-self *object stream print-depth slashify-p* *Generic Function*

The *object* should output its printed representation to the *stream*. *print-depth* is the current depth in list-structure (for comparison with ***print-level***). *slashify-p* indicates whether slashification is enabled (**prin1** versus **princ**). The printer calls this generic function when it encounters an instance.

The **sys:print-self** method of **flavor:vanilla** ignores the last two arguments and prints something like *#<flavor-name octal-address>*. The *flavor-name* tells you the type of object, and *octal-address* lets you tell different objects apart (provided the garbage collector does not move them). For example:

```
#<CELL 1160762135>
```

The compatible message for **sys:print-self** is **:print-self**.

sys:proceed *condition proceed-type* &rest *args* *Generic Function*

Causes a program to continue execution after an error condition has been signalled.

To proceed from a condition, a handler function calls the **sys:proceed** generic function with one or more arguments. The first argument is the *condition* object. The second argument is the proceed type, and any remaining arguments are the arguments for that proceed type.

The condition flavor defined by the program signalling the error defines the proceed types that are available to **sys:proceed** for a particular condition. You can also define a method that creates a new proceed type.

The way to define a method that creates a new proceed type is somewhat unusual in that it uses a style of method combination called **:case** combination. Here's an example from the system:

```
(defmethod (sys:proceed sys:subscript-out-of-bounds :new-subscript)
           (&optional (sub (prompt-and-read :number
                                            "Subscript to use instead: ")))
  "Supply a different subscript."
  (values :new-subscript sub))
```


This code fragment creates a proceed type called **:new-subscript** for the condition flavor **sys:subscript-out-of-bounds**. New proceed types are always defined by adding a **sys:proceed** method to the condition flavor, which is defined (in the **defflavor** for **condition**) to be combined using the **:case** method combination. The method must always return values rather than throwing.

In **:case** method combination, the first argument to the **sys:proceed** function is like a subsidiary message name, causing a further dispatch just as the original message name caused a primary dispatch. The method from the example is invoked whenever you call the **sys:proceed** generic function with a condition object:

```
(sys:proceed  obj :new-subscript new-sub)
```

The variables in the lambda list for the method come from the rest of the arguments of the **send**.

All of the arguments to a **sys:proceed** method must be optional arguments. The **sys:proceed** method should provide default values for all its arguments. One useful way of doing this is to prompt a user for the arguments using the ***query-io*** stream. The example uses **prompt-and-read**. If all the optional arguments were supplied, the **sys:proceed** method must not do any input or output using ***query-io***.

This facility has been defined assuming that **condition-bind** handlers would supply all the arguments for the method themselves. The Debugger runs this method and does not supply arguments, relying on the method to prompt the user for the arguments.

As in the example, the method should have a documentation string as the first form in its body. The **dbg:document-proceed-type** generic function to a proceedable condition object displays the string. This string is used by the Debugger as a prompt to describe the proceed type. For example, the subscript example might result in the following Debugger prompt:

```
s-A: Supply a different subscript
```

The string should be phrased as a one-line description of the effects of proceeding from the condition. It should not have any leading or trailing newlines. (You can use the messages that the Debugger prints out to describe the effects of the s- commands as models if you are interested in stylistic consistency.)

Sometimes a simple fixed string is not adequate. You can provide a piece of Lisp code to compute the documentation text at run time by providing your own method for **sys:document-proceed-type**. This method definition takes the following form:

```
(defmethod (dbg:document-proceed-type condition-flavor proceed-type)
           (stream)
  body...)
```

The body of the method should print documentation for *proceed-type* of *condition-flavor* onto *stream*.

The body of the **sys:proceed** method can do anything it wants. In general, it tries to repair the state of things so that execution can proceed past the point at which the condition was signalled. It can have side-effects on the state of the environment, it can return values so that the function that called **signal** can try to fix things up, or it can do both. Its operation is invisible to the handler; the signaller is free to divide the work between the function that calls **signal** and the **sys:proceed** method as it sees fit. When the **sys:proceed** method returns, **signal** returns all of those values to its caller. That caller can examine them and take action accordingly.

The meaning of these returned values is strictly a matter of convention between the **sys:proceed** method and the function calling **signal**. It is completely internal to the signaller and invisible to the handler. By convention, the first value is often the name of a proceed type. See the section "Signallers" in *Symbolics Common Lisp: Language Concepts*.

A **sys:proceed** method can return a first value of **nil** if it declines to proceed from the condition. If a **nil** returned by a **sys:proceed** method becomes the return value for a **condition-bind** handler, this signifies that the handler has declined to handle the condition, and the condition continues to be signalled. When the **sys:proceed** function is called by the Debugger, the Debugger prints a message saying that the condition was not proceeded, and it returns to its command level. This might be used by an interactive **sys:proceed** method that gives the user the opportunity either to proceed or to abort; if the user aborts, the method returns **nil**. Returning **nil** from a **sys:proceed** method should not be used as a substitute for detecting earlier (such as when the condition object is created) that the proceed type is inappropriate for that condition.

Condition objects created with **error** instead of **signal** do not have any proceed types.

See the section "Proceeding" in *Symbolics Common Lisp: Language* Concepts.

The compatible message for **sys:proceed** is:

:proceed

dbg:proceed-type-p *condition proceed-type* *Generic Function*

Returns **t** if *proceed-type* is one of the valid proceed types of this condition object. Otherwise, returns **nil**.

The compatible message for **dbg:proceed-type-p** is:

:proceed-type-p

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

dbg:proceed-types *condition* *Generic Function*

Returns a list of all the valid proceed types for this condition.

The compatible message for **dbg:proceed-types** is:

:proceed-types

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

:proceed-types (for **condition**) *Init Option*

Defines the set of proceed types to be handled by this instance. *proceed-types* is a list of proceed types (symbols); it must be a subset of the set of proceed types understood by this flavor. If this option is omitted, the instance is able to handle all of the proceed types understood by this flavor in general, but by passing this option explicitly, a subset of acceptable proceed types can be established. This is used by **signal-proceed-case**.

If only one way to proceed exists, *proceed-types* can be a single symbol instead of a list.

If you pass a symbol that is not an understood proceed type, it is ignored. It does not signal an error because the proceed type might become understood later when a new **defmethod** is evaluated; if not, the problem is caught later.

The order in which the proceed types occur in the list controls the order in which the Debugger displays them in its list. Sometimes you might want to select an order that makes more sense for the user, although usually this is not important. The most important thing is that the RESUME command in the Debugger is assigned to the first proceed type in the list.

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

dbg:*proceed-type-special-keys* *Variable*

The value of this variable should be an alist associating proceed types with characters. When an error supplies any of these proceed types, the Debugger assigns that proceed type to the specified key. For example, this is the mechanism by which the **:store-new-value** proceed type is offered on the `s-sh-C` keystroke.

For a table of related items: See the section "Debugger Special Key Variables" in *Symbolics Common Lisp: Language Concepts.*

prog &whole *form* &rest *l* &environment *env* *Special Form*

Provides temporary variables, sequential evaluation of forms, and a "goto" facility. A typical **prog** looks like:

```
(prog (var1 var2 (var3 init3) var4 (var5 init5))
 tag1
     statement1
     statement2
 tag2
     statement3
     . . .
   )
```

The first subform of a **prog** is a list of variables, each of which can optionally have an initialization form. The first thing evaluation of a **prog** form does is to evaluate all of the *init* forms. Then each variable that had an *init* form is bound to its value, and the variables that did not have an *init* form are bound to **nil**. Example:

```
(prog ((a t)  b  (c 5)  (d (car '(zz . pp))))
  <body>
  )
```

The initial value of **a** is **t**, that of **b** is **nil**, that of **c** is the integer 5, and that of **d** is the symbol **zz**. The binding and initialization of the variables is done in *parallel*; that is, all the initial values are computed before any of the variables are changed. **prog*** is the same as **prog** except that this initialization is sequential rather than parallel.

The part of a **prog** after the variable list is called the *body*. Each element of the body is either a symbol or an integer, in which case it is called a *tag*, or anything else (almost always a list), in which case it is called a *statement.*

After **prog** binds the variables, it processes each form in its body sequen-

tially. Anything that is a *tag* are skipped over. *statements* are evaluated, and their returned values discarded. If the end of the body is reached, the **prog** returns **nil**. However, two special forms can be used in **prog** bodies to alter the flow of control. If **(return** *x***)** is evaluated, **prog** stops processing its body, evaluates *x*, and returns the result. If **(go** *tag***)** is evaluated, **prog** jumps to the part of the body labelled with the *tag*, where processing of the body is continued. *tag* is not evaluated.

The compiler requires that **go** and **return** forms be *lexically* within the scope of the **prog**; it is not possible for a function called from inside a **prog** body to **return** to the **prog**. That is, the **return** or **go** must be inside the **prog** itself, not inside a function called by the **prog**.

See the special form **do**, page 180. That uses a body similar to **prog**. The **do**, **catch**, and **throw** special forms are included as an attempt to encourage goto-less programming style, which often leads to more readable, more easily maintained code. You should use these forms instead of **prog** wherever reasonable. Moreover, since **prog** is a combination of **block**, tagbody, and **let**, it is often better to use these constructs as needed. This is especially true in the case of macros with bodies where the unintended inclusion of a **block** might overshadow the user's use of **block**.

If the first subform of a **prog** is a non-**nil** symbol (rather than a variable list), it is the name of the **prog**, and **return-from** can be used to return from it. In Zetalisp: See the special form **zl:do-named**, page 189.

Examples:

```
(defun t-test (choice)
  (prog classic (pep coca)      ; Initialize  pep, coca to nil.
        (if (equal choice "left") (go left) )
     right
        (princ  "pep is it")
        (terpri)
        (return t)
     left
        (princ "coca is it")
        (terpri)
        (return))) => T-TEST
(t-test "left")  => coca is it
NIL
(t-test "right") => pep is it
T
```

```
(prog (x y z) ;x, y, z are prog variables  - temporaries.
      (setq y (car w) z (cdr w))  ;w is a free variable.
   loop
   (cond ((null y) (return x))
         ((null z) (go err)))
rejoin
   (setq x (cons (cons (car y) (car z))
                 x))
   (setq y (cdr y)
         z (cdr z))
   (go loop)
err
   (break "are-you-sure?")
   (setq z y)
   (go rejoin))
```

prog, do, and their variants are effectively constructed out of **let, block,** and **tagbody** forms. **prog** could have been defined as the following macro (except for processing of local **declare,** which has been omitted for clarity):

```
(defmacro prog (&rest x)
  (let ((block-name (and (symbolp (car x))
                         (neq (car x) nil)
                         (pop x)))
        (variables (car x))
        (tagbody (cdr x)))
    (if block-name
        `(block ,block-name
           (block nil
             (let ,variables
               (tagbody ,@tagbody))))
        `(block nil
           (let ,variables
             (tagbody ,@tagbody))))))
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

prog* &whole *form* &rest *l* &environment *env* *Special Form*

The **prog*** special form is almost the same as **prog.** The only difference is that the binding and initialization of the temporary variables is done sequentially, so each one can depend on the previous ones.

For example:

```
(prog* ((y z) (x (car y)))
       (return x))
```

returns the car of the value of **z**.

Examples:

```
(prog ( (x 1) (y (+ x 1)) z)
      (princ x)(princ " ")
      (princ y)(princ " ")
      (princ z)(princ " ")
      (terpri)) => Error: The variable X is unbound.

(prog* ( (x 1) (y (+ x 1)) z)
       (princ x)(princ " ")
       (princ y)(princ " ")
       (princ z)(princ " ")
       (terpri)) => 1 2 NIL
NIL
```

For a table of related items: See the section "Iteration Functions" in *Symbolics Common Lisp: Language Concepts.*

prog1 *value* &rest *ignore* *Special Form*

Similar to **progn**, but it returns *value* (its *first* form) rather than its last. It is most commonly used to evaluate an expression with side effects, and return a value that must be computed *before* the side effects happen. Example:

```
(setq x (prog1 y (setq y x)))
```

interchanges the values of the variables **x** and **y**.

prog1 never returns multiple values. See the special form **multiple-value-prog1**, page 358. See the section "Special Forms for Sequencing" in *Symbolics Common Lisp: Language Concepts.*

prog2 *ignore value* &rest *ignore* *Special Form*

prog2 is similar to **progn** and **prog1**, but it returns its *second* form. It is included largely for compatibility with old programs. See the section "Special Forms for Sequencing" in *Symbolics Common Lisp: Language* Concepts.

progn &body *body* *Special Form*

The *body* forms are evaluated in order from left to right and the value of the last one is returned. **progn** is the primitive control structure construct for "compound statements". Although lambda-expressions, **cond** forms, **do** forms, and many other control structure forms use **progn** implicitly, that

is, they allow multiple forms in their bodies, there are occasions when one needs to evaluate a number of forms for their side effects and make them appear to be a single form. Example:

```
(foo (cdr a)
     (progn (setq b (extract frob))
            (car b))
     (cadr b))
```

See the section "Special Forms for Sequencing" in *Symbolics Common Lisp: Language Concepts*.

zl:progv *vars vals* &body *body* *Special Form*

Provides the user with extra control over binding. It binds a list of special variables to a list of values, and then evaluates some forms. The lists of special variables and values are computed quantities; this is what makes **zl:progv** different from **let**, **prog**, and **do**.

zl:progv first evaluates *vars* and *vals*, and then binds each symbol to the corresponding value. If too few values are supplied, the remaining symbols are bound to **nil**. If too many values are supplied, the excess values are ignored.

After the symbols have been bound to the values, the *body* forms are evaluated, and finally the symbols' bindings are undone. The result returned is the value of the last form in the body. Example:

```
(setq a 'foo b 'bar)

(zl:progv (list a b 'b) (list b)
  (list a b foo bar))
    => (foo nil bar nil)
```

During the evaluation of the body of this **zl:progv**, **foo** is bound to **bar**, **bar** is bound to **nil**, **b** is bound to **nil**, and **a** retains its top-level value **foo**.

progw *vars-and-vals* &body *body* *Special Form*

A somewhat modified kind of **zl:progv**; like **zl:progv**, it only works for special variables. First, *vars-and-vals-form* is evaluated. Its value should be a list that looks like the first subform of a **let***:

```
((var1 val-form-1)
 (var2 val-form-2)
 ...)
```

Each element of this list is processed in turn, by evaluating the *val-form*, and binding the *var* to the resulting value. Finally, the *body* forms are evaluated sequentially, the bindings are undone, and the result of the last form is returned. Note that the bindings are sequential, not parallel.

This is a very unusual special form because of the way the evaluator is called on the result of an evaluation. Thus, **progw** is mainly useful for implementing special forms and for functions part of whose contract is that they call the interpreter. For an example of the latter, see **sys:*break-bindings***; **zl:break** implements this by using **progw**.

sys:property-cell-location *sym* *Function*

Returns a locative pointer to the location of *sym*'s property-list cell. This locative pointer is as valid as *sym* itself as a handle on *sym*'s property list.

sys:property-list-mixin *Flavor*

This mixin flavor provides methods that perform the generic functions on property lists. **sys:property-list-mixin** provides methods for the following generic functions:

:get *indicator* *Message*

The **:get** message looks up the object's *indicator* property. If it finds such a property, it returns the value; otherwise it returns **nil**.

:getl *indicator-list* *Message*

The **:getl** message is like the **:get** message, except that the argument is a list of indicators. The **:getl** message searches down the property list for any of the indicators in *indicator-list* until it finds a property whose indicator is one of those elements. It returns the portion of the property list beginning with the first such property that it found. If it does not find any, it returns **nil**.

:putprop *property indicator* *Message*

Gives the object an *indicator*-property of *property*.

:remprop *indicator* *Message*

Removes the object's *indicator* property by splicing it out of the property list. It returns that portion of the list inside the object of which the former *indicator*-property was the **car**.

:push-property *value indicator* *Message*

The *indicator*-property of the object should be a list (note that **nil** is a list and an absent property is **nil**). This message sets the *indicator*-property of the object to a list whose **car** is *value* and whose **cdr** is the former *indicator*-property of the list. This is analogous to doing:

```
(zl:push value (get object indicator))
```

See the macro **zl:push**, page 417.

:property-list *Message*
Returns the list of alternating indicators and values that implements the property list.

:set-property-list *list* *Message*
Sets the list of alternating indicators and values that implements the property list to *list*.

:property-list *list* (for **sys:property-list-mixin**) *Init Option*
Initializes the list of alternating indicators and values that implements the property list to *list*.

provide *module-name* *Function*

psetf &rest *pairs* *Macro*
The **psetf** macro is similar to **setf**, except that **psetf** performs all the assignments in *parallel*, that is, simultaneously, instead of from left to right. The **&rest** argument indicates that **psetf** expects 0 or more *pairs* on which to perform assignment operations. In each pair, a *new value* is assigned to a *place*. Evaluations are still performed from left to right, but assignments are parallel. **psetf** always returns the value **nil**.

psetq &rest *rest* *Macro*
The **psetq** macro is similar to **setq**, except that **psetq** performs all the assignments in *parallel*, that is, simultaneously, instead of from left to right. The **&rest** argument indicates that **psetq** expects 0 or more pairs which to perform assignment operations. In the arglist, these pairs are represented by *rest*. In each pair, a *form* is assigned to a *variable*. Evaluations are still performed from left to right, but assignments are parallel. **psetq** always returns the value **nil**.

zl:psetq {*variable value*}... *Special Form*
Just like a **setq** form, except that the variables are set "in parallel"; first all the *value* forms are evaluated, and then the *variables* are set to the resulting values. Example:

```
(setq a 1)
(setq b 2)
(psetq a b b a)
a => 2
b => 1
```

push *item reference* &key *area localize* *Function*

If the list held in *reference* is viewed as a push-down stack, then **push** pushes an element onto the top of the stack. The value of the argument *item* can be any lisp object. The value of the argument *reference* can be the name of any generalized variable containing a list. *item* is consed onto the front of the list, and the augmented list is stored back into *reference* and returned. The value of *reference* can be any form acceptable as a generalized variable to **setf**.

The effect of **(push** *item place***)** is the same as **(setf** *place* **(cons** *item place***)**, except that the **setf** form evaluates any subforms of *place* twice, while **push** evaluates them only once. Moreover, for certain *place* forms, **push** can be significantly more efficient than the **setf** form.

The optional keyword arguments **:area** and **:localize** are Symbolics extensions to Common Lisp.

:area An integer that specifies the area in which to store the augmented list. See the section "Areas" in *Internals, Processes, and Storage Management.*

:localize Can be **nil**, **t**, or a positive integer, which behave as follows:

nil	Do not change the behavior of **push**.
t	Localize the top level of list structure by calling **sys:localize-list** or **sys:localize-tree** on the list before returning it.
integer	Localize *integer* levels of list structure by calling **sys:localize-list** or **sys:localize-tree** on the list before returning it.

Examples:

```
(setq alist '((a . b) (c . d))) => ((A . B) (C . D))

(push '(1 . 2) (cdr alist)) => ((1 . 2) (C . D))

alist => ((A . B) (1 . 2) (C . D))

(push '(3 . 4) alist :localize 2) =>
((3 . 4) (A . B) (1 . 2) (C . D))

alist => ((3 . 4) (A . B) (1 . 2) (C . D))
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

zl:push *item access-form* *Macro*

Adds an item to the front of a list that is stored in a generalized variable. **(zl:push** *item ref***)** creates a new cons whose **car** is the result of evaluating *item* and whose **cdr** is the contents of *ref*, and stores the new cons into *ref*.

The form:

```
(zl:push (hairy-function x y z) variable)
```

replaces the commonly used construct:

```
(setq variable (cons (hairy-function x y z) variable))
```

and is intended to be more explicit and esthetic.

All the caveats that apply to **incf** apply to **zl:push** as well: forms within *ref* might be evaluated more than once. **(zl:push** does not evaluate any part of *ref* more than once.) The returned value of **zl:push** is not defined.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

zl:push-in-area *item access-form area* *Macro*

Adds an item to the front of a list that is stored in a generalized variable. **(zl:push-in-area** *item ref area***)** creates a new cons in *area* whose *car* is the result of evaluating *item* and whose *cdr* is the contents of *ref*, and stores the new cons into *ref*. See the section "Areas" in *Internals, Processes, and Storage Management.*

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

pushnew *item reference* &key *test test-not key area localize* *Function*

If the list held in *reference* is viewed as a push-down stack, then **pushnew** pushes *item* onto the top of the stack, unless it is already a member of the list. The value of the argument *item* can be any lisp object. The value of the argument *reference* can be the name of any generalized variable containing a list.

item is checked for membership in the list, as determined by the **:test** predicate, which defaults to **eql**. If *item* is not a member of the list, then it is consed onto the front of the list, and the augmented list is stored back into *reference* and returned. If *item* is member of the list, then the unaugmented list is returned. The value of *reference* can be any form acceptable as a generalized variable to **setf**.

The optional keyword arguments **:area** and **:localize** are Symbolics extensions to Common Lisp.

:area An integer that specifies the area in which to store the augmented list. See the section "Areas" in *Internals, Processes, and Storage Management.*

:localize Can be **nil**, **t**, or a positive integer, which behave as follows:

nil	Do not change the behavior of **push**.
t	Localize the top level of list structure by calling **sys:localize-list** or **sys:localize-tree** on the list before returning it.
integer	Localize *integer* levels of list structure by calling **sys:localize-list** or **sys:localize-tree** on the list before returning it.

Examples:

```
(setq alist '((a . b) (c . d))) => ((A . B) (C . D))

(pushnew '(1 . 2) (cdr alist) :localize nil) => ((1 . 2) (C . D))

alist => ((A . B) (1 . 2) (C . D))

(pushnew '(C . D) (cdr alist) :test #'equal :localize 2) =>
((1 . 2) (C . D))

alist => ((A . B) (1 . 2) (C . D))
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

:put-hash *key value* *Message*

Create an entry in the hash table associating *key* to *value*. If there is an existing entry for *key* then replace the value of that entry with *value* and return *value*. The hash table automatically grows if necessary. This message will be removed in the future – use **setf** in conjunction with the **gethash** function.

zl:puthash *key value hash-table* *Function*

Create an entry in *hash-table* associating *key* to *value*. If there is an existing entry for *key*, then replace the value of that entry with *value* and return *value*. *hash-table* grows automatically if necessary. This function will be removed in the future – use **setf** in conjunction with the **gethash** function.

zl:puthash-equal *key value hash-table* *Function*

Create an entry in *hash-table* associating *key* to *value*. If there is an existing entry for *key*, then replace the value of that entry with *value* and return *value*. *hash-table* grows automatically if necessary. This function will be removed in the future – use **setf** in conjunction with the **gethash** function.

zl:putprop *plist x indicator* *Function*

This gives *plist* an *indicator*-property of *x*. After this is done, **(zl:get** *plist indicator***)** returns *x*. If *plist* is a symbol, the symbol's associated property list is used. **zl:putprop** returns its second argument. See the section "Property Lists" in *Symbolics Common Lisp: Language Concepts*.

Example:

```
(zl:putprop 'Nixon 'not 'crook) => NOT
```

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts*.

quote *object* *Special Form*

Returns *object*. It is useful specifically because *object* is not evaluated; the **quote** is how you make a form that returns an arbitrary Lisp object. **quote** is used to include constants in a form. Examples:

```
(quote x) => x
(setq x (quote (some list)))   x => (some list)
```

Since **quote** is so useful but somewhat cumbersome to type, the reader normally converts any form preceded by a single quote (') character into a **quote** form. Example:

```
(setq x '(some list))
```

is converted by **read** into

```
(setq x (quote (some list)))
```

See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts*.

zl:quotient *number* &rest *more-numbers* *Function*

Returns the first argument divided by all of the rest of its arguments.

With more than one argument, **zl:quotient** is the same as **zl:/**;

With integer arguments, **zl:quotient** acts like **truncate**, except that it returns only a single value, the quotient.

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts*.

random *number* &optional (*state* ***random-state***) *Function*

random generates and returns a pseudorandom number between zero (inclusive) and *number* (exclusive) of the same type as *number*. This argument must be positive and can either be an integer or a floating-point number. The pseudorandom numbers generated are nearly uniformly distributed.

If *number* is an integer, each of the possible results occurs with probability very close to *1/number*.

The optional argument *state* must be an object of type **random-state**. It defaults to the current value of the variable ***random-state*** which is used to maintain the state of the pseudorandom number generator between calls. The value of ***random-state*** changes as a side effect of the **random** operation.

Examples:

```
(random 2) => 0
(random 2) => 1
(random 25) => 14
(setq x (make-random-state)) => #.(RANDOM-STATE 71 1695406379...)
(setq copy-x (make-random-state x)) => #.(RANDOM-STATE 71...)
;;; this makes a copy of random state x
;;; a great way to get reproducibly random numbers
(random 10 copy-x) => 8
(random 10 copy-x) => 7
(random 10 copy-x) => 4
(setq new-copy-x (make-random-state x)) => #.(RANDOM-STATE 71...)
(random 10 new-copy-x) => 8
(random 10 new-copy-x) => 7
(random 10 new-copy-x) => 4
```

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:random &optional *arg random-array* *Function*

(zl:random) returns a random integer, positive or negative. If *arg* is present, an integer between 0 and *arg* minus 1 inclusive is returned. If *random-array* is present, the given array is used instead of the default one. Otherwise, the default random-array is used (and is created if it does not already exist). The algorithm is executed inside a **without-interrupts** so two processes can use the same random-array without colliding.

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts*.

si:random-create-array *length offset seed* &optional *(area* **nil***)* *Function*

Creates, initializes, and returns a random-array. *length* is the length of the array. *offset* is the distance between the pointers and should be an integer less than *length*. *seed* is the initial value of the seed, and should be an integer. This calls **si:random-initialize** on the random array before returning it.

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts*.

si:random-initialize *array* &optional *new-seed* *Function*

array must be a random-array, such as is created by **si:random-create-array**. If *new-seed* is provided, it should be an integer, and the seed is set to it. **si:random-initialize** reinitializes the contents of the array from the seed (calling **zl:random** changes the contents of the array and the pointers, but not the seed).

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts*.

R

random-state *Type Specifier*

random-state is the type specifier symbol for the predefined Lisp object, random-state. An object of type **random-state** is used to encapsulate state information used by the pseudo-random number generator.

The types **random-state**, **readtable**, **hash-table**, **package**, **pathname**, and **stream** are *pairwise disjoint*.

Examples:

```
(typep (make-random-state) 'random-state) => T

(zl:typep (make-random-state) 'random-state) => T

(random-state-p *random-state*) => T

(commonp *random-state*) => RANDOM-STATE
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

random-state *Variable*

This variable holds a data structure, an object of type **random-state** which the function **random** uses by default to encode the internal state of the random-number generator.

This data structure can be printed and successfully read back in. Each call to **random** performs a side effect on ***random-state***. ***random-state*** can be lambda-bound to a different random-number state object to save and restore the old state object.

random-state-p *object* *Function*

This predicate is true if the argument is an object of type **random-state**; it is false otherwise.

Examples:

```
(setq x (make-random-state)) => #.(RANDOM-STATE 71 1695406379...)
(setq copy-x (make-random-state x)) => #.(RANDOM-STATE 71...)
(random-state-p x) => T
(random-state-p copy-x) => T
(random-state-p *random-state*) => T     ;always true
(random-state-p (random 10))  => NIL
```

For a table of related items: See the section "Random Number Functions" in *Symbolics Common Lisp: Language Concepts.*

R

zl:rass *predicate item alist* *Function*

(zl:rass *item alist*) looks up *item* in the association list (list of conses) *alist.* The value is the first cons whose *cdr* matches *x* according to *predicate,* or **nil** if there is none such. See the function **zl:mem**, page 345. As with **zl:mem**, you can use noncommutative predicates; the first argument to the predicate is *item* and the second is the **cdr** of the element of *alist.*

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

rassoc *item a-list* &key (*test* **#'eql**) *test-not* (*key* **#'identity**) *Function*

rassoc searches the association list *a-list.* The value returned is the first pair in *a-list* such that the *cdr* of the pair satisfies the predicate specified by **:test**, or **nil** if there is no such pair in *a-list.* **rassoc** is the reverse form of **assoc.** The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t.** If **:test** is not supplied the default operation is **eql.**
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil.**
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

If *a-list* is considered to be a mapping, then **rassoc** treats the *a-list* as representing the inverse mapping. For example:

```
(rassoc 'diver '((eagle . raptor) (loon . diver))) =>
(LOON . DIVER)

(rassoc 'loon '((eagle . raptor) (loon . diver))) => NIL
```

The two expressions

```
(rassoc item alist :test pred)
```

and

```
(find item alist :test pred :key #'cdr)
```

are almost equivalent in meaning. The difference occurs when **nil** appears in *alist* in place of a pair, and the item being searched for is **nil**. In these cases, **find** computes the *cdr* of the **nil** in *alist*, finds that it is equal to *item*, and returns **nil**, while **assoc** ignores the **nil** in *alist* and continues to search for an actual cons whose *cdr* is **nil**. See the function **assoc**, page 40.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:rassoc *item alist* *Function*

(zl:rassoc *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose **cdr** is **zl:equal** to *x*, or **nil** if there is none such.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

rassoc-if *predicate a-list* &key *key* *Function*

rassoc-if searches the association list *a-list*. The value returned is the first pair in *a-list* such that the *cdr* of the pair satisfies *predicate*, or **nil** if there is no such pair in *a-list*. The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(rassoc-if #'integerp '((eagle . raptor) (1 . 2))) => (1 . 2)

(rassoc-if #'symbolp '((eagle . raptor) (1 . 2))) =>
(EAGLE . RAPTOR)

(rassoc-if #'floatp '((eagle . raptor) (1 . 2))) => NIL
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts.*

rassoc-if-not *predicate a-list* &key *key* *Function*

rassoc-if-not searches the association list *a-list*. The value returned is the first pair in *a-list* such that the *cdr* of the pair does not satisfy *predicate*, or **nil** if there is no such pair in *a-list*. The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

Example:

```
(rassoc-if-not #'integerp '((eagle . raptor) (1 . 2))) =>
(EAGLE . RAPTOR)

(rassoc-if-not #'symbolp '((eagle . raptor) (1 . 2))) => (1 . 2)

(rassoc-if-not #'symbolp '((eagle . raptor) (loon . diver))) => NIL
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:rassq *item alist* *Function*

(zl:rassq *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose **cdr** is **eq** to *x*, or **nil** if there is none such. **zl:rassq** means "reverse assq." **zl:rassq** could have been defined by:

```
(defun rassq (item in-list)
    (do l in-list (cdr l) (null l)
      (and (eq item (cdar l))
           (return (car l)))))
```

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts*.

raster-aref *raster x y* *Function*

Accesses the (*x*,*y*) graphics coordinate of *raster*. Use this instead of **aref** when accessing rasters.

raster-index-offset *raster x y* *Function*

Returns a linear index of the array element referenced by the (x,y) coordinate of the raster. This can be used as the index to **sys:%1d-aref** or as the **:displaced-index-offset** argument to **make-array**.

raster-index-offset is preferred over manual computation and over **array-row-major-index** when the array is conceptually a raster.

raster-width-and-height-to-make-array-dimensions *width height* *Function*

Creates an argument that can be used to call **make-array**. You would use this in circumstances in which it is not possible to call **zl:make-raster-array**, for example from the **:make-array** option to **defstruct** contructors.

ratio &optional *(low '*) (high '*)* *Type Specifier*

ratio is the type specifier symbol for the predefined Lisp ratio number type.

The types **ratio** and **integer** are *disjoint subtypes* of the type **rational**.

This type specifier can be used in either symbol or list form. Used in list form, **ratio** allows the declaration and creation of a specialized set of ratios whose range is restricted to the limits specified in the arguments *low* and *high*. The list form is a Symbolics Common Lisp extension to Common Lisp.

low and *high* must each be an integer, a list of an integer, or unspecified. If these limits are expressed as integers, they are *inclusive*; if they are expressed as a list of an integer, they are *exclusive*; * means that a limit does not exist, and so effectively denotes minus or plus infinity, respectively.

Examples:

```
(typep -5/2 'ratio) => T
(typep 4/5 '(ratio 0 1)) => T
(typep 2/1 '(ratio 0 1)) => NIL
(typep 2 '(ratio 3 *)) => NIL
(subtypep 'ratio 'rational) => T and T ; subtype and certain
(subtypep '(ratio 2 9) 'rational) => T and T
(subtypep '(ratio 3.2/3 *) 'rational) => T and T
(commonp 15/5) => T
(zl:rationalp #3r120/21) => T
(sys:type-arglist 'ratio) => (&OPTIONAL (LOW '*) (HIGH '*)) and T
(subtypep '(ratio 0 9) '(rational 0 9)) => T and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

rational *number* *Function*

rational accepts any non-complex *number* and converts it to a rational number in canonical form. If the argument is already rational, it is returned. If *number* is in floating-point form, it is assumed to be completely accurate, and **rational** returns a rational number mathematically equal to the precise value of the floating-point number. Note that:

(float (rational *x*) *x*) ≡ *x*

Examples:

```
(rational 0.2) => 13421773/67108864
(rational 3.95) => 16567501/4194304
(rational 6/2) => 3
```

For a table of related items: See the section "Functions That Convert Noncomplex to Rational Numbers" in *Symbolics Common Lisp: Language* Concepts.

rational &optional (*low* '*) (*high* '*) *Type Specifier*

rational is the type specifier symbol for the predefined Lisp rational number type.

The types **rational**, **float**, and **complex** are *pairwise disjoint subtypes* of the type **number**.

The type **rational** is a *supertype* of the following types which are an exhaustive partition of it:

integer
ratio

This type specifier can be used in either symbol or list form. Used in list form, **rational** allows the declaration and creation of specialized rational numbers, whose range is restricted to *low* and *high*.

low and *high* must each be a rational, a list of rational numbers, or unspecified. If these limits are expressed as rationals, they are *inclusive*; if they are expressed as a list of rationals, they are *exclusive*; * means that a limit does not exist, and so effectively denotes minus or plus infinity, respectively.

Examples:

```
(typep #3r102/21 'rational) => T
(typep 4 '(rational 3 4)) => T
(typep 5 '(rational 3 4)) => NIL
(typep 2354 '(rational *)) => T
(zl:typep 2/3 ) => :RATIONAL
(subtypep 'rational 'number) => T and T  ;subtype and certain
(subtypep 'integer 'rational) => T and T
(subtypep 'ratio 'rational) => T and T
(subtypep '(rational -4 98) '(rational *)) => T and T
(typep 17/89 'common) => T
(rationalp 6/3) => T
(rationalp (+ #2r101 #2r11)) => T
(sys:type-arglist ':rational) => NIL
(sys:type-arglist 'rational)
=> (&OPTIONAL (LOW '*) (HIGH '*)) and T
(subtypep '(rational 0 9) 'rational) => T and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

zl:rational *number* *Function*

Converts any noncomplex number to an equivalent rational number. If *number* is a floating-point number, **zl:rational** returns the rational number of least denominator, which when converted back to the same floating-point precision, is equal to *number*.

The following function is a synonym of **zl:rational**:

rationalize

For a table of related items: See the section "Functions That Convert Noncomplex to Rational Numbers" in *Symbolics Common Lisp: Language* Concepts.

rationalize *number* *Function*

rationalize accepts any non-complex *number* and converts it to a rational number in canonical form. If the argument is already rational, it is returned. If *number* is in floating-point form, **rationalize** assumes that it is accurate only to the precision of the floating-point representation. Hence the returned value can be any rational number for which the floating-point argument is the best available approximation. The aim is to keep both numerator and denominator as small as possible. **rationalize** is guaranteed to return the number with the smallest denominator, such that the following expression is true:

(float (rationalize *x***)** *x***)** ≡ *x*

Examples:

```
(rationalize 0.2) => 1/5
(rationalize 3.95) => 79/20
```

For a table of related items: See the section "Functions That Convert Non-complex to Rational Numbers" in *Symbolics Common Lisp: Language* Concepts.

rationalp *object* *Function*

This predicate is true if *object* is a rational number (a ratio or an integer) after conversion to canonical form; it is false otherwise.

Examples:

```
(rationalp 3.0) => NIL
(rationalp 2) => T
(rationalp #c(3 4)) => NIL
(rationalp (/ 22 7)) => T
(rationalp #c(4 0)) => T  ;complex canonicalization
```

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:rationalp *object* *Function*

Returns **t** if *object* is a ratio. Returns **nil** if *object* is an integer or other type of object.

Examples:

```
(zl:rationalp (/ 8 7)) => T
(zl:rationalp 9/16) => T
(zl:rationalp 4) => NIL
(zl:rationalp (/ 9 3)) => NIL
(zl:rationalp 16/4) => NIL
```

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

read-base *Variable*

The value of ***read-base*** is a number controlling the radix in which integers and ratios are read. Valid values are between 2 and 36, inclusive; the default is 10 (decimal radix).

The value of ***read-base*** does not affect rational numbers whose radix is explicitly indicated by a radix specifier, or by a trailing decimal point. See the section "Radix Specifier Format" in *Symbolics Common Lisp: Language Concepts.*

The reader uses letters to represent digits greater than 10. Thus, when ***read-base*** is greater than 10 and no radix specifier is present, some tokens could be read as either integers, floating-point numbers, or symbols. The reader's action on such tokens is determined by the value of **si:*read-extended-ibase-unsigned-number*** and **si:*read-extended-ibase-signed-number***. Setting these variables to **t** causes the tokens to be always interpreted as numbers.

Note: This is an incompatible difference from the language specification in Steele's *Common Lisp* manual.

Related Variables: See the section "Control Variables for Reading Numbers" in *Symbolics Common Lisp: Language Concepts.*

read-default-float-format *Variable*

Controls the printing and reading of floating-point numbers. This variable takes on one of four possible values, namely **short-float, single-float, long-float,** or **double-float.**

For *printing* floating-point numbers:

The printer checks the value of ***read-default-float-format*** and applies the following rules to decide whether to print an exponent character with the number, and if so, which character.

Notation used	*Does number's format match current value of* **cl:*read-default-float-format***?	*Exponent marker*
Ordinary	Yes	Don't print marker
	No	Print marker and zero
Exponential	Yes	Print e
	No	Print marker

See the section "Printed Representation of Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

For *reading* floating-point numbers:

read-default-float-format controls how floating-point numbers with no exponent or an exponent preceded by "E" or "e" are read. Following is a summary of the way possible values cause these numbers to be read.

Value	*Floating-point precision*
single-float	single-precision
short-float	single-precision
double-float	double-precision
long-float	double-precision

The default value is **single-float.**

See the section "How the Reader Recognizes Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

R

si:*read-extended-ibase-signed-number* *Variable*

Controls how a token that could be an integer, floating-point number, or symbol and starts with a + or - sign, is interpreted when ***read-base*** (or **zl:ibase**) is greater than ten. Here are the possible values of this variable and their effect on the token read.

nil	It is never an integer.
t	It is always an integer.
:sharpsign	It is a symbol or floating-point number at top level, but an integer after **#x** or #*n***R**.
:single	It is a symbol or floating-point number except immediately after **#x** or #*n***R**.

The default value is **:sharpsign.**

In the table below, the token FACE for each case could be a symbol or a hexadecimal number. **:single** makes it an integer on the second line, but a symbol on the first and third lines. **:sharpsign** makes it an integer on both the second and third lines.

	nil	**t**	**:single**	**:sharpsign**
+FACE	symbol	integer	symbol	symbol
#x+FACE	symbol	integer	integer	integer
#x(+FACE +FF 1234 +5C00)	symbol	integer	symbol	integer

+1d0	float	integer	float	float

Related Topics:

si:*read-extended-ibase-unsigned-number*

si:*read-extended-ibase-unsigned-number* *Variable*

Controls how a token that could be an integer, floating-point number, or symbol and does not start with a + or - sign, is interpreted when ***read-base*** (or **zl:ibase**) is greater than ten. Here are the possible values of this variable and the their effect on the token read.

nil	It is never an integer.
t	It is always an integer.
:sharpsign	It is a symbol or floating-point number at top level, but an integer after #**X** or #*n***R**.
:single	It is a symbol or floating-point number except immediately after #**X** or #*n***R**.

The default value is **:single**.

In the table below, the token FACE for each case could be a symbol or a hexadecimal number. **:single** makes it an integer on the second line, but a symbol on the first and third lines. **:sharpsign** makes it an integer on both the second and third lines.

	nil	**t**	**:single**	**:sharpsign**
FACE	symbol	integer	symbol	symbol
#xFACE	symbol	integer	integer	integer
#x(FACE FF 1234 5C00)	symbol	integer	symbol	integer
1d0	float	integer	float	float

Related Topics:

si:*read-extended-ibase-signed-number*

si:*read-multi-dot-tokens-as-symbols* *Variable*

When **t**, for Zetalisp, tokens containing more than one dot, but no other characters, are read as symbols. When **nil**, for Common Lisp, tokens containing more than one dot but no other characters signal an error when read. Default: **t**.

readtable *Type Specifier*

readtable is the type specifier symbol for the predefined Lisp data structure, hash table.

The types **readtable, hash-table, package, pathname, stream** and **random-state** are *pairwise disjoint.*

Examples:

```
(typep *readtable* 'readtable) => T
(zl:typep *readtable*) => ZL:READTABLE
(subtypep 'readtable 'common) => T and T
(sys:type-arglist 'readtable) => NIL and T
(readtablep *readtable*) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "The Readtable" in *Reference Guide to Streams, Files, and I/O.*

R

realpart *number* *Function*

If *number* is a complex number, **realpart** returns the real part of *number.* If *number* is a noncomplex number, **realpart** returns *number.*

Examples:

```
(realpart #c(3 4)) => 3
(realpart 4) => 4
```

Related Functions:

complex
imagpart

For a table of related items: See the section "Functions That Decompose and Construct Complex Numbers" in *Symbolics Common Lisp: Language Concepts.*

recompile-flavor *flavor* &key *generic ignore-existing-methods* *Function*
(*do-dependents* **t**)

recompile-flavor updates the internal data of *flavor* and any flavors that depend on it, such as regenerating inherited information about methods. Normally the Flavors system does the equivalent of **recompile-flavor** whenever it is needed.

recompile-flavor is provided so you can recover from unusual situations where the Flavors system does not automatically update the inherited information. These situations include: redefining a function called as part of expanding a wrapper, and recovering from a bug in a method combination routine. If for any reason you suspect that the inherited methods have not been calculated and combined properly, you can use **recompile-flavor.**

If you supply a non-**nil** value to *generic*, only the methods for that generic function are changed. The system does this when you define a new method or redefine a wrapper (when the new definition is not **equal** to the old). Otherwise, all generic functions are updated.

If you supply a non-**nil** value to *ignore-existing-methods*, all combined methods are regenerated. Otherwise, new combined methods are generated only if the set of methods to be called has changed. This is the default.

do-dependents controls whether flavors that depend on the given flavor are also recompiled. By default, all flavors that depend on it are recompiled. You can specify **nil** for *do-dependents* to prevent the dependent flavors from being recompiled.

recompile-flavor affects only flavors that have already been compiled. Typically this means it affects flavors that have been instantiated, and does not affect mixins.

record-source-file-name *function-spec* &optional (*type* **'defun**) (*no-query* **(eq sys:inhibit-fdefine-warnings t)**) *Function*

record-source-file-name associates the definition of a function with its source files, so that tools such as Edit Definition (m-.) can find the source file of a function. It also detects when two different files both try to define the same function, and warns the user.

record-source-file-name is called automatically by **defun**, **defmacro**, **defstruct**, **defflavor**, and other such defining special forms. Normally you do not invoke it explicitly. If you have your own defining macro, however, that does not expand into one of the above, then you can make its expansion include a **record-source-file-name** form.

Normally, **record-source-file-name** returns **t**. If a definition of the same name and type was already made by another file, the user is asked whether the definition should be performed. If the user answers "no", **record-source-file-name** returns **nil**. When **nil** is returned the caller should not perform the definition.

function-spec The function spec for the entity being defined.

type The type of entity being defined, with **defun** as the default. *type* can be any symbol, typically the name of the corresponding special form for defining the entity. Some standard examples:

defun
defvar
defflavor
defstruct

Both macros and substs are subsumed under the type

defun, because you cannot have a function named **x** in one file and a macro named **x** in another file.

no-query Controls queries about redefinitions. **t** means to suppress queries about redefining. The default value of *no-query* depends on the value of **sys:inhibit-fdefine-warnings**. When **sys:inhibit-fdefine-warnings** is **t**, *no-query* is **t**; otherwise it is **nil**. Regardless of the value for *no-query*, queries are suppressed when the definition is happening in a patch file.

You cannot specify the source file name with this function. The function is always associated with the pathname for the file being loaded (**sys:fdefine-file-pathname**).

When redefining functions, some users try to avoid redefinition warnings and queries by using the form **(zl:remprop** *symbol* **:source-file-name)**. The preferred way to do this is to use the form **(record-source-file-name** *function-spec* **'defun t)**. The former method causes the system to forget both the original definition and other definitions for the same symbol (as a variable, flavor, structure, and so forth). **record-source-file-name** lets the system know that the function is defined in two places, and it avoids redefinition warnings and queries.

Of course, if you are redefining something other than a function, use the appropriate definition type symbol instead of **defun** as the second argument to **record-source-file-name**. For example, if you are redefining a flavor, use **defflavor** as the second argument. See the section "Using The **sys:function-parent** Declaration" in *Symbolics Common Lisp: Language Concepts*.

reduce *function sequence* &key *from-end* (*start* **0**) *end* (*initial-value* **nil** *initial-value-p*) *Function*

reduce combines all of the elements of a sequence using a binary operation, for example, using + to sum all of the elements.

sequence is combined or "reduced" using *function*, which must accept two arguments. The reduction is left-associative, unless the value of the **:from-end** keyword argument is **t**, in which case it is right-associative. If the **:initial-value** argument is specified, it is logically placed before sequence (or after, if the value of the **:from-end** argument is **t**) and it is included in the reduction operation.

If the specified subsequence contains exactly one element and no **:initial-value** argument is specified, then that element is returned and *function* is not called. If the **:start** and **:end** arguments are specified and the subsequence is empty, and the **:initial-value** argument is specified, then the **:initial-value** is returned and *function* is not called. If the subsequence

is empty and no **:initial-value** is specified, then *function* is called with zero arguments, and **reduce** returns whatever the function returns. (This is the only case where *function* is called with other than two arguments.)

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(reduce #'+ '(1 2 3 4)) => 10

(reduce #'- '(1 2 3 4) :from-end t) => -2

(reduce #'+ '()) => 0

(reduce #'+ #(1 1 1 1 1) :start 2 :end 5) => 3

(reduce #'list '(1 2 3 4)) => (((1 2) 3) 4)

(reduce #'list '(1 2 3 4) :initial-value 'foo :from-end t) =>
(1 (2 (3 (4 FOO))))
```

For a table of related items: See the section "Mapping Sequences" in *Symbolics Common Lisp: Language Concepts*.

rem *number divisor* *Function*

rem divides *number* by *divisor*, truncating the quotient toward zero, and returns the remainder. This is the same as the second value of (**truncate** *number divisor*). If q and r denote, respectively, the quotient and remainder, then: q * *divisor* + r = *number*.

The arguments can be rational or floating-point numbers. The returned value, r is rational if both arguments are rational; it is floating-point if either argument is floating-point.

Examples:

```
(rem 3 2) => 1
(rem 3 -2) => 1
(rem -3 2) => -1
(rem -3 -2) => -1
(rem 4 2) => 0
(rem 3.8 2) => 1.8
(rem -3.8 2) => -1.8
(rem 19/5 2) => 9/5
```

The following functions are synonyms of **rem**:

zl:
zl:remainder

Related Functions:

truncate
mod

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:rem *predicate item list* &optional *n* *Function*

(zl:rem *item list*) returns a copy of *list* with all occurrences of *item* removed. *predicate* is used for the comparison. **(zl:rem** *'eq a b*) is the same as **(zl:remq** *a b*). See the function **zl:mem**, page 345.

i[n] instances of *item* are deleted. *n* is allowed to be zero. If *n* is greater than or equal to the number of occurrences of *item* in the list, all occurrences of *item* in the list are deleted.

This Zetalisp function is shadowed by the Common Lisp function of the same name. Common Lisp **zl:rem** is the remainder function.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:remainder *x y* *Function*

Returns the remainder of *x* divided by *y*. *x* and *y* must be integers. The exact rules for the meaning of the quotient and remainder of two integers in Zetalisp are given in another section. See the section "Integer Division in Zetalisp" in *Symbolics Common Lisp: Language Concepts.*

Examples:

```
(zl:remainder 3 2) => 1
(zl:remainder -3 2) => -1
(zl:remainder 3 -2) => 1
(zl:remainder -3 -2) => -1
```

The following functions are synonyms of **zl:remainder**:

rem
zl:

remf *place indicator* *Macro*

Removes *indicator* from the property list stored in *place*. If it cannot find *indicator*, it returns **nil**. See the section "Functions Relating to the Property List of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

:rem-hash *key* *Message*

Remove any entry for *key* in the hash table. Returns **t** if there was an entry or **nil** if there was not. This message will be removed in the future – use **remhash** instead.

remhash *key table* *Function*

Remove any entry for *key* in *table*. Returns **t** if there was an entry or **nil** if there was not.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:remhash-equal *key hash-table* *Function*

Remove any entry for *key* in *hash-table*. Returns **t** if there was an entry or **nil** if there was not. This function will be removed in the future – use **remhash** instead.

zl:rem-if *predicate list* &rest *extra-lists* *Function*

zl:subset-not and **zl:rem-if** do the same thing, but they are used in different contexts. **zl:rem-if** means "remove if this condition is true". **zl:subset-not** refers to the function's action if *list* is considered to represent a mathematical set.

predicate should be a function of one argument, if there are no *extra-lists* arguments. A new list is made by applying *predicate* to all the elements of *list* and removing the ones for which the predicate returns non-nil.

If *extra-lists* is present, each element of *extra-lists* (that is, each further argument to **zl:subset-not** or **zl:rem-if**) is a list of objects to be passed to *predicate* as *predicate*'s second argument, third argument, and so on. The reason for this is that *predicate* might be a function of many arguments; *extra-lists* lets you control what values are passed as additional arguments to *predicate*. However, the list returned by **zl:subset-not** or **zl:rem-if** is still a "subset" of those values that were passed as the *first* argument in the various calls to *predicate*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:rem-if-not *predicate list* &rest *extra-lists* *Function*

zl:subset and **zl:rem-if-not** do the same thing, but they are used in different contexts. **zl:rem-if-not** means "remove if this condition is not true"; that is, it keeps the elements for which *predicate* is true. **zl:subset** refers to the function's action if *list* is considered to represent a mathematical set.

predicate should be a function of one argument, if there are no *extra-lists* arguments. A new list is made by applying *predicate* to all of the elements of *list* and removing the ones for which the predicate returns **nil**.

If *extra-lists* is present, each element of *extra-lists* (that is, each further argument to **zl:subset** or **zl:rem-if-not**) is a list of objects to be passed to *predicate* as *predicate*'s second argument, third argument, and so on. The reason for this is that *predicate* might be a function of many arguments; *extra-lists* lets you control what values are passed as additional arguments to *predicate*. However, the list returned by **zl:subset** or **zl:rem-if-not** is still a "subset" of those values that were passed as the *first* argument in the various calls to *predicate*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

R

zl:remob *symbol* &optional *package* *Function*

zl:remob removes *symbol* from *package* (the name is historical and means "REMove from OBlist"). *symbol* itself is unaffected, but **zl:intern** no longer finds it in *package*. Removing a symbol from its home package sets its home package to **nil**; removing a symbol from a package different from its home package leaves the symbol's home package unchanged.

zl:remob returns **t** if the symbol was found and removed, or **nil** if it was not found.

zl:remob is always "local", in that it removes only from the specified package and not from any other packages. Thus **zl:remob** has no effect unless the symbol is present in the specified package, even if it is accessible from that package via inheritance.

If *package* is unspecified it defaults to the symbol's home package. Note this exception well: the default value of **zl:remob**'s *package* argument is *not* the current package.

The equivalent function in Common Lisp is **unintern**.

remove *item sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*
from-end (*start* **0**) *end count*

remove returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying the predicate specified by the **:test** keyword have been removed. This is a non-destructive operation. The returned sequence is a copy of *sequence*, save that some elements are not copied. Elements that are not removed occur in the same order in the result as they did in sequence.

For example:

```
(setq nums '(1 2 3)) => (1 2 3)
(remove 1 nums) => (2 3)
nums => (1 2 3)

(remove 2 nums) => (1 3)
nums  => (1 2 3)
```

item is matched against the elements specified by the *test* keyword. The *item* can be any Symbolics Common Lisp object.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(remove 4 #(6 1 6 4) :test #'>) => #(6 6 4)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(remove 0 '((0 1) (0 1) (1 0)) :key #'second)
=> ((0 1) (0 1))
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are removed.

For example:

```
(remove 4 '(4 2 4 1) :count 1) => (2 4 1)

(remove 4 #(4 2 4 1) :count 1 :from-end t) => #(4 2 1)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(remove 'a #(b a a c)) => #(B C)

(remove 4 '(4 4 1)) => (1)

(remove 4 '(4 1 4) :start 1 :end 2) => (4 1 4)

(remove 4 '(4 1 4) :start 0 :end 3) => (1)
```


The **:count** argument, if supplied, limits the number of elements removed. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(remove 4 '(4 2 4 1) :count 1) => (2 4 1)
```

remove is the non-destructive version of **delete**.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

zl:remove *item list* &optional *n* *Function*

(zl:remove *item list***)** returns a copy of *list* with all occurrences of *item* removed. **zl:equal** is used for the comparison. **zl:remove** is the non-destructive version of **zl:delete**.

i[n] instances of *item* are deleted. *n* is allowed to be zero. If *n* is greater than or equal to the number of occurrences of *item* in the list, all occurrences of *item* in the list are deleted.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

remove-duplicates *sequence* &key *from-end* (*test* #'**eql**) *test-not* (*start* **0**) *end key* *Function*

remove-duplicates compares the elements of *sequence* pairwise, and if any two match, then the one occurring earlier in the sequence is discarded. The returned form is *sequence*, with enough elements removed such that no two of the remaining elements match. **remove-duplicates** is a non-destructive function.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The function normally processes the sequence in the forward direction, but if a non-**nil** value is specified for **:from-end**, processing starts from the reverse direction. If the **:from-end** argument is true, then the one later in the sequence is discarded.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(remove-duplicates '(1 1 1 2 2 2 3 3 3) :test #'>)  => (1 1 1 2 2 2 3 3 3)

(remove-duplicates '(1 1 1 2 2 2 3 3 3) :test #'=) => (1 2 3)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(remove-duplicates '(a a b b)) => (A B)

(remove-duplicates #(1 1 1 1 1 1)) => #(1)
```

```
(remove-duplicates #(1 1 1 2 2 2) :start 3) => #(1 1 1 2)

(remove-duplicates #(1 1 1 2 2 2) :start 2 :end 4) => #(1 1 1 2 2 2)
```

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(remove-duplicates '((Smith S) (Jones J) (Taylor T) (Smith S)) :key #'second)
 => ((JONES J) (TAYLOR T) (SMITH S))
```

The value returned by **remove-duplicates** can share elements with sequence. A list may share a tail with an input list, and the result can be **eq** to the input sequence if not elements are removed.

remove-duplicates is the non-destructive version of **delete-duplicates**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

flavor:remove-flavor *flavor-name* *Function*

Removes the definition of the flavor named by *flavor-name.* Any accessor functions are also removed from the world.

remove-if *predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

remove-if returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying *predicate* have been removed. This is a non-destructive operation. The returned sequence is a copy of *sequence*, save that some elements are not copied. Elements that are not removed occur in the same order in the result as they did in *sequence.*

For example:

```
(setq a-list '(1 a b c)) => (1 A B C)
(remove-if #'numberp a-list)  => (A B C)
a-list => (1 A B C)

(setq my-list '(0 1 0)) => (0 1 0)
(remove-if #'zerop my-list)  => (1)
my-list  => (0 1 0)
```

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(remove-if #'atom '((book 1) (math (room c)) (text 3)) :key #'second)
 => ((MATH (ROOM C)))
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are deleted.

For example:

```
(remove-if #'numberp '(4 2 4 1) :count 1 )  => (2 4 1)

(remove-if #'numberp '(4 2 4 1) :count 1 :from-end t) => (4 2 4)
```


Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(remove-if #'atom '('a 1 "list")) => ('A)

(remove-if #'numberp '(4 1 4) :start 1 :end 2)  => (4 4)

(remove-if #'evenp '(4 1 4) :start 0 :end 3)  => (1)
```

The **:count** argument, if supplied, limits the number of elements deleted. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(remove-if #'oddp '(1 1 2 2) :count 1 ) => (1 2 2)
```

remove-if is the non-destructive version of **delete-if**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

remove-if-not *predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

remove-if-not returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** which do not satisfy *predicate* have been removed. The returned sequence is a copy of *sequence*, save that some elements are not copied. Elements that are not removed occur in the same order in the result as they did in *sequence*. This is a non-destructive operation.

For example:

```
(setq a-list '(1 a b c)) => (1 A B C)
(remove-if-not #'numberp a-list) => (1)
a-list  => (1 A B C)

(setq my-list '(0 1 0)) => (0 1 0)
(remove-if-not #'zerop my-list) => (0 0)
my-list => (0 1 0)
```


predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(remove-if-not #'atom '((book 1) (math (room c)) (text 3)) :key #'second)
 => ((BOOK 1) (TEXT 3))
```

If the value of the **:from-end** argument is non-**nil**, it only affects the result when the **:count** argument is specified. In that case only the rightmost **:count** elements that satisfy the predicate are removed.

For example:

```
(remove-if-not #'numberp '(4 'a 'b 1) :count 1 )
 => (4 'B 1)

(remove-if-not #'numberp '('c 4 2 4 'a) :count 1 :from-end t)
 => ('C 4 2 4)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(remove-if-not #'atom '('a 1 "list"))  => (1 "list")

(remove-if-not #'numberp '('a 'b 'c) :start 1 :end 2) => ('A 'C)

(remove-if-not #'evenp '(1 2 3 5) :start 0 :end 3)  => (2 5)
```

The **:count** argument, if supplied, limits the number of elements deleted. If more than **:count** elements of *sequence* satisfy the predicate, then only the leftmost **:count** of those elements are deleted.

For example:

```
(remove-if-not #'oddp '(1 1 2 2) :count 1 ) => (1 1 2)
```

remove-if-not is the non-destructive version of **delete-if-not.**

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

:remove of **si:heap** *Method*

Removes the top item from the heap and returns it and its key as values. The third value is **nil** if the heap was empty; otherwise it is **t.**

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

remprop *symbol indicator* *Function*

The **remprop** function removes from the property list in *symbol* a property with an indicator **eq** to *indicator.* For example, if the property list of **foo** was:

```
(color blue height six-three near-to bar)
```

then:

```
(remprop 'foo 'height) => (six-three near-to bar)
```

and **foo**'s property list would be:

```
(color blue near-to bar)
```

If *plist* has no *indicator*-property, then **remprop** has no side-effect and returns **nil**.

zl:remprop *plist indicator* *Function*

This removes *plist*'s *indicator* property, by splicing it out of the property list. It returns that portion of the list inside *plist* of which the former *indicator*-property was the *car*. The *car* of what **zl:remprop** returns is what **zl:get** would have returned with the same arguments. If *plist* is a symbol, the symbol's associated property list is used. For example, if the property list of **foo** was:

```
(color blue height six-three near-to bar)
```

then:

```
(zl:remprop 'foo 'height) => (six-three near-to bar)
```

and **foo**'s property list would be:

```
(color blue near-to bar)
```

If *plist* has no *indicator*-property, then **zl:remprop** has no side-effect and returns **nil**.

For a table of related items: See the section "Functions That Operate on Property Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:remq *item list* &optional *n* *Function*

(**zl:remq** *item list*) returns a copy of *list* with all occurrences of *item* removed. **eq** is used for the comparison. **zl:remq** is the non-destructive version of **zl:delq**. Examples:

```
(setq x '(a b c d e f))
(zl:remq 'b x) => (a c d e f)
x => (a b c d e f)
(zl:remq 'b '(a b c b a b) 2) => (a c a b)
```

i[n] instances of *item* are deleted. *n* is allowed to be zero. If *n* is greater than or equal to the number of occurrences of *item* in the list, all occurrences of *item* in the list are deleted.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

flavor:rename-instance-variable *flavor-name old new* *Function*

Renames an instance variable *old* to a new name *new* for the given *flavor-name*. When this is done, the value of the old instance variable is carried over to the new instance variable. Any old instances are updated to

reflect the new name of the instance variable. Often you use **flavor:rename-instance-variable** first, which ensures that the value of the instance variable is carried over. You might then use **defflavor** to add options such as **:readable-instance-variables**, or change the default initial value.

```
(flavor:rename-instance-variable 'ship 'captain 'skipper)
```

rename-package *pkg new-name* &optional *new-nicknames* *Function*

Replaces the old name and all old nicknames of *pkg* with *new-name* and *new-nicknames*. *new-name* is a string or a symbol. *new-nicknames* is a list of strings or symbols. *new-nicknames* defaults to **nil**. See the section "Mapping Between Names and Packages" in *Symbolics Common Lisp: Language Concepts*.

si:rename-within-new-definition-maybe *function definition* *Function*

Given *new-structure* that is going to become a part of the definition of *function-spec*, perform on it the replacements described by the **si:rename-within** encapsulation in the definition of *function-spec*, if there is one. The altered (copied) list structure is returned.

It is not necessary to call this function yourself when you replace the basic definition because **fdefine** with *carefully* supplied as **t** does it for you. **si:encapsulate** does this to the body of the new encapsulation. So you only need to call **si:rename-within-new-definition-maybe** yourself if you are rplac'ing part of the definition.

For proper results, *function-spec* must be the outer-level function spec. That is, the value returned by **si:unencapsulate-function-spec** is *not* the right thing to use. It has had one or more encapsulations stripped off, including the **si:rename-within** encapsulation if any, and so no renamings are done.

repeat Keyword For loop

Repeat is one of the iteration-driving clauses for **loop**.

repeat *expression*

Evaluates *expression* (during the variable-binding phase), and causes the **loop** to iterate that many times. *expression* is expected to evaluate to an integer. If *expression* evaluates to a 0 or negative result, the body code is not executed.

Examples:

```
(defun loop1 (how-far)
  (loop repeat how-far
        for x from 1 to 1000 by 2
        do
    (princ x)(princ " ")))    => LOOP1
(loop1 5) => 1 3 5 7 9 NIL
(loop1 9) => 1 3 5 7 9 11 13 15 17 NIL
```

See the section "**loop** Clauses", page 310.

replace *sequence1 sequence2* &key (*start1* **0**) *end1* (*start2* **0**) *end2* *Function*

replace destructively modifies *sequence1* by copying into it successive elements from *sequence2*.

sequences can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero. The elements of *sequence2* must be of a type that can be stored into *sequence1*.

The keyword arguments **:start1**, **:end1**, **:start2**, and **:end2** are used to specify subsequences of *sequence1* and *sequence2*.

:start1 and **:end1** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end1**, else an error is signalled. It defaults to zero (the start of the sequence).

:start1 indicates the start position for the operation within the sequence. **:end1** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence). If both **:start1** and **:end1** are omitted, the entire sequence is processed by default.

:start2 and **:end2** operate the same as **:start1** and **:end1**.

If the subsequences delimited by **:start1**, **:start2**, **:end1** and **:end2** are not of the same length, then the shorter length determines how many elements are copied. The extra elements near the end of the longer subsequence are not involved in the operation. The number of elements copied can be expressed as:

```
(min (- end1 start1) (- end2 start2))
```

If *sequence1* and *sequence2* are the same (**eq**) object and the region being modified overlaps the region being copied from, then it is as if the entire source region were copied to another place, and only then copied back into the target region. However, if *sequence1* and *sequence2* are not the same, but the region begin modified overlaps the region being copied from, then after the **replace** operation the subsequence of *sequence1* being modified will have unpredictable contents.

For example:

```
(setq bird-list '(heron flamingo loon owl)) =>
(HERON FLAMINGO LOON OWL)

(replace bird-list bird-list :start2 2 :end2 3) =>
(LOON FLAMINGO LOON OWL)

bird-list => (LOON FLAMINGO LOON OWL)

(setq bird-list '(heron flamingo loon owl)) =>
(HERON FLAMINGO LOON OWL)

(replace bird-list '(hawk turkey) :start1 1 :end1 3) =>
(HERON HAWK TURKEY OWL)
```

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

dbg:report *condition stream* *Generic Function*

Prints the text message associated with this object onto *stream.* The condition flavor does not support this itself, but you must provide a handler, and any flavor built on **condition** that is instantiated must support this function.

The compatible message for **dbg:report** is:

:report

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

dbg:report-string *condition* *Generic Function*

Returns a string containing the report message associated with this object. It works by sending **:report** to the object.

The compatible message for **dbg:report-string** is:

:report-string

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

require *module-name* &optional *pathname* *Function*

&rest *Lambda List Keyword*

If the lambda-list keyword **&rest** is present, the following specifier is a single rest parameter specifier. There can only be one **&rest** argument.

It is important to realize that the list of arguments to which a rest-parameter is bound is set up in whatever way is most efficiently implemented, rather than in the way that is most convenient for the function receiving the arguments. It is not guaranteed to be a "real" list. Sometimes the rest-args list is stored in the function-calling stack, and loses its validity when the function returns. If a rest-argument is to be returned or made part of permanent list-structure, it must first be copied, as you must always assume that it is one of these special lists. See the function **sys:copy-if-necessary**, page 114.

The system does not detect the error of omitting to copy a rest-argument; you simply find that you have a value that seems to change behind your back. At other times the rest-args list is an argument that was given to **apply**; therefore it is not safe to **rplaca** this list as you might modify permanent data structure. An attempt to **rplacd** a rest-args list is unsafe in this case, while in the first case it causes an error, since lists in the stack are impossible to **rplacd**.

rest *x* *Function*

rest performs the same function as **cdr**, but it mnemonically complements the function **first**. **setf** can be used with **rest** to replace the *cdr* of a list with a new value. For example:

```
(setq item-list '(loon eagle)) => (LOON EAGLE)

(setf (rest item-list) 'heron) => HERON

item-list => (LOON . HERON)
```

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:rest1 *list* *Function*

zl:rest1 returns the rest of the elements of a list, starting with element 1 (counting the first element as the zeroth). Thus **zl:rest1** is identical to **cdr**. The reason these names are provided is that they make more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:rest2 *list* *Function*

zl:rest2 returns the rest of the elements of a list, starting with element 2 (counting the first element as the zeroth). Thus **zl:rest2** is identical to **cddr**. The reason these names are provided is that they make more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:rest3 *list* *Function*

zl:rest3 returns the rest of the elements of a list, starting with element 3 (counting the first element as the zeroth). The reason these names are provided is that they make more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:rest4 *list* *Function*

zl:rest4 returns the rest of the elements of a list, starting with element 4 (counting the first element as the zeroth). The reason these names are provided is that they make more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

return &optional *values* *Special Form*

Can be used to exit from a construct like **do** or an unnamed **prog** that establishes an implicit block around its body. In this case the name of the block is **nil**, and **(return** *value...***)** is the same as **(return-from nil** *value...***)**. See the special form **return-from**, page 454.

Examples:

```
(dolist (j '(1 2 3 4)) (princ (- 1 j)) (if (= j 3)(return)))
 => 0-1-2NIL

(dotimes (j 5 t)
  (princ j)(if (= j 3) (return)))  => 0123NIL
```

```
(do ((j 0 (+ 1)))
    (nil)                                          ; Do forever
  (format t "~%Input ~D: " j)
  (let ((item (read)))
    (if (null item)(return)                        ; Process items until nil seen.
        (format t "~&Output ~D: ~S" j (print item)))))
=> Input 0:
   ABCDEF
   Output 0: ABCDEF
   Input 1: NIL
```

The following are equivalent

```
(prog ((var1 1) var2 (end1 4))
      (return end1)) => 4

(prog ((var1 1) var2 (end1 4))
      (return-from nil end1)) => 4
```

In addition, **break** recognizes the typed-in form **(return** *value***)** specially. If this form is typed at a **break**, *value* is evaluated and returned as the value of **break**. Only the result of the first *value* form is returned, but if this form itself returns multiple values, they are all returned as the value of **break**. That is, **(return 'foo 'bar)** returns only **foo**, but **(return (values 'foo 'bar))** returns both **foo** and **bar**. See the function **break** in *Program Development Utilities*.

It is valid to write simply **(return)**, which exits from the block or from a break loop and returns **nil**.

Example:

```
(block nil
  (print "clear")
  (return)
  (print "open")) => "clear" NIL
```

If not specially recognized by **break** and not inside a block, **return** signals an error.

Zetalisp note: The form **(return** *form1 form2 form3...***)** is no longer legal and generates a compiler message to that effect. Use the form **(return** *(values form1 form2 form3...)***)** to have multiple values returned.

Similarly, if you omit *value*, **return** now defaults to **nil**, rather than returning with zero values as formerly; the compiler generates a message to that effect also. Use **return (values)** if you want zero values returned.

The variable **compiler:*return-style-checker-on*** controls compiler messages for these invalid formats of **return**. To disable the compiler messages specify **nil** for the value of **compiler:*return-style-checker-on***.

For a table of related items: See the section "Blocks and Exits Functions and Variables" in *Symbolics Common Lisp: Language Concepts*.

return Keyword For loop

return *expression*

Immediately returns the value of *expression* as the value of the loop, without running the epilogue code. This is most useful with some sort of conditionalization, as discussed in the previous section. Unlike most of the other clauses, **return** is not considered to "generate body code", so it is allowed to occur between iteration clauses, as in:

```
(loop for entry in list
      when (not (numberp entry))
        return (error...)
      as from = (times entry 2)
         ... )
```

If you instead want the loop to have some return value when it finishes normally, you can place a call to the **return** function in the epilogue (with the **finally** clause).

See the section "**loop** Clauses", page 310.

sys:return-array *array* *Function*

sys:return-array is a subtle and dangerous feature that should be avoided by most users. This function attempts to return *array* to free storage. If it is displaced, this returns the displaced array itself, not the data that the array points to. Because of the way storage allocation works, **sys:return-array** does nothing if the array is not at the end of its region, that is, if it was not the most recently allocated non-list object in its area. **sys:return-array** returns **t** if storage was really reclaimed, or **nil** if it was not.

It is the responsibility of any program that calls **sys:return-array** to ensure that there are no references to *array* anywhere in the Lisp world. This includes locative pointers to array elements, such as you might create with **zl:aloc**. The results of attempting to use such a reference to the returned array are unpredictable. Simply holding such a reference in a local variable, without attempting to access it or to print it out, is allowed, although it may thwart the garbage collector.

Other tools are available for manually allocating and freeing arrays. See the special form **sys:with-stack-array** in *Internals, Processes, and Storage Management*.

return-from *block-name values* *Special Form*

Exits from a **block** or a construct like **do** or **prog** that establishes an implicit block around its body.

The *value* subforms are optional. Any *value* forms are evaluated, and the resulting values (possibly multiple, possibly none) are returned from the innermost block that has the same name and that lexically contains the **return-from** form. The returned values depend on how many *value* subforms are provided and on the syntax used as shown below:

Value subforms	*Syntax*	*Values returned from block*
None	(**return-from** *name*)	**nil**
None	(**return-from** *name (values)*)	None
1	(**return-from** *name value*)	All values that result from evaluating the *value* subform
>1	(**return-from** *name (values value)*)	One value from each *value* subform

Zetalisp note: The form (**return** *form1 form2 form3...*) is no longer legal and generates a compiler message to that effect. Use the form (**return** (*values form1 form2 form3...*)) to have multiple values returned.

Similarly, if you omit *value*, **return** now defaults to **nil**, rather than returning with zero values as formerly; the compiler generates a message to that effect also. Use **return (values)** if you want zero values returned.

The variable **compiler:*return-style-checker-on*** controls compiler messages for these invalid formats of **return**. To disable the compiler messages specify a **nil** value for **compiler:*return-style-checker-on***.

block-name is not evaluated. It must be a symbol.

The scope of *name* is lexical. That is, the **return-from** form must be inside the block itself (or inside a block that that block lexically contains), not inside a function called from the block.

When a construct like **do** or an unnamed **prog** establishes an implicit block, its name is **nil**. You can use either (**return-from nil** *value...*) or the equivalent (**return** *value...*) to exit from such a construct.

The **return-from** form is unusual: It never returns a value itself, in the conventional sense. It is not useful to write **(setq a (return-from** *name* **3))**, because when the **return-from** form is evaluated, the containing block is immediately exited, and the **setq** never happens.

Examples:

```
(block foo
  (print "enter foo")
  (when (< 1 2)
    (return-from foo (values 1 2 3 4)))
  (print "leave foo")) => "enter foo" 1 and 2 and 3 and 4

(block state-of
  (princ "H-2-O ")
  (return-from state-of (values-list '(Ice Water Steam)))
  (princ "ice-cream")) => H-2-O ICE and WATER and STEAM

(setq stuff '(north east south west right left up down))
  => (NORTH EAST SOUTH WEST RIGHT LEFT UP DOWN)

(defun index-of-thing (thing stuff)
  (do ( (count 1 (+ count 1)) )
      ((= count (length stuff)))
    (if (eq thing (car stuff))
        (return-from index-of-thing count))
    (setq stuff (cdr stuff)))) => INDEX-OF-THING
(index-of-thing 'south stuff) => 3

(do ((j 0 (+ 1)))
    (nil)                                          ; Do forever
  (format t "~%Input ~D: " j)
  (let ((item (read)))
    (if (null item)(return-from nil)               ;Process items until nil see
        (format t "~&Output ~D: ~S" j (print item)))))
=> Input 0:
   ABCDEF
   Output 0: ABCDEF
   Input 1: NIL
```

For an explanation of named **dos** and **progs** in Zetalisp: See the special form **zl:do-named**, page 189.

Following is an example, returning a single value from an implicit block named **nil**:

Examples:

```
(do ((x x (cdr x))
     (n 0 (* n 2)))
    ((null x) n)
  (cond ((atom (car x))
         (setq n (1+ n)))
        ((memq (caar x) '(sys boom bleah))
         (return-from nil n))))
```

Or

```
(Block nil
  (print "rivers hills")
  (if (= 3 3.) (return-from nil "five"))
  (print "water trees")) => "rivers hills" "five"
```

Following is another example, returning multiple values. The function below is like **assoc**, but it returns an additional value, the index in the table of the entry it found:

```
(defun assocn (x table)
  (do ((l table (cdr l))
       (n 0 (1+ n)))
      ((null l) nil)
    (if (eql (caar l) x)
        (return-from nil (values (car l) n)))))
```

For a table of related items: See the section "Blocks and Exits Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:return-list *form* *Special Form*

An obsolete function supported for compatibility with earlier releases. It is like **return** except that the block returns all of the elements of *list* as multiple values. This means that the following two forms are equivalent:

(zl:return-list *list***)**

(return (values-list *list***))**

Examples:

```
(block nil
  (print "enter foo")
  (when (< 1 2)
    (zl:return-list '(1 2 3 4)))
  (print "leave foo")) => "enter foo"
1
2
3
4


(block nil
  (print "enter foo")
  (when (< 1 2)
    (return (values-list '(1 2 3 4)) ))
  (print "leave foo")) => "enter foo"
1
2
3
4
```

The latter form is the preferred way to return list elements as multiple values from a block named **nil**. To direct the returned values to a named block, use:

(return-from *name* **(values-list** *list*)).

Example:

```
(block state-of
  (princ "H-2-O ")
  (return-from state-of (values-list '(Ice Water Steam)))
  (princ "ice-cream")) => H-2-O
ICE
WATER
STEAM
```

For a table of related items: See the section "Blocks and Exits Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

compiler:*return-style-checker-on* *Variable*

This style-checker variable is associated with to functions **return** and **return-from** and controls the display of compiler messages for invalid formats of these functions. The documentation for **return** and **return-from** describes the specific formats activating the style-checker.

compiler:*return-style-checker-on* is set to **t** by default; set it to **nil** to disable the compiler messages.

For a table of related items: See the section "Blocks and Exits Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

revappend *x y* *Function*

(revappend *x y***)** is functionally the same as **(append (reverse** *x***)** *y***)**, except that it is potentially more efficient. The values of both *x* and *y* should be lists. The value of the *x* argument is copied, not destroyed. For example:

```
(setq a-list '(a b c)) => (A B C)

(setq b-list '(x y z)) => (X Y Z)

(revappend a-list b-list) => (C B A X Y Z)

a-list => (A B C)
```

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

reverse *sequence* *Function*

reverse returns a new sequence of the same type as *sequence*, containing the same elements in reverse order. This operation is non-destructive.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(reverse '(heron flamingo loon)) => (LOON FLAMINGO HERON)

(reverse #(1 2 3)) => #(3 2 1)
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

zl:reverse *list* *Function*

zl:reverse creates a new list whose elements are the elements of *list* taken in reverse order. **zl:reverse** does not modify its argument, unlike **zl:nreverse**, which is faster but does modify its argument. The list created by **zl:reverse** is not cdr-coded. Example:

```
(zl:reverse '(a b (c d) e)) => (e (c d) b a)
```

zl:reverse could have been defined by:

```
(defun reverse (x)
    (do ((l x (cdr l))          ; scan down argument,
         (r nil                 ; putting each element
            (cons (car l) r)))  ; into list, until
        ((null l) r)))          ; no more elements.
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

rot *x y* *Function*

Returns *x* rotated left *y* bits if *y* is positive or zero, or *x* rotated right |*y*| bits if *y* is negative. The rotation considers *x* as a 32-bit number. *x* and *y* must be fixnums. (There is no function for rotating bignums.) Examples:

```
(rot 1 2)  => #o4
(rot 1 -2) => #o10000000000
(rot -1 7) => #o-1
(rot #o15 32.) => #o15
```

For a table of related items: See the section "Machine-dependent Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

rotatef &rest *references* *Macro*

Each of the *references* can be any form acceptable as a generalized variable to **setf**. All the *references* form an end-around shift register that is rotated one place to the left, with the value of *reference1* being shifted around to *references*. **rotatef** always returns **nil**.

Here is an example as seen in a Lisp Listener:

```
(setq circus (list 'ringling-brothers 'barnum 'bailey))
(RINGLING-BROTHERS BARNUM BAILEY)
(rotatef (first circus) (second circus) (third circus)
NIL
circus
(BARNUM BAILEY RINGLING-BROTHERS)
```

Here is another example as seen in a Lisp Listener:

```
(setq alpha (list 'able 'baker 'charlie 'dog 'easy 'fox))
(ABLE BAKER CHARLIE DOG EASY FOX)
(rotatef (first alpha) (third alpha) (fifth alpha))
NIL
alpha
(CHARLIE BAKER EASY DOG ABLE FOX)
```

Finally:

```
(setq trio (list 'adam 'eve 'pinch-me-tight))
(ADAM EVE PINCH-ME-TIGHT)
(rotatef (first trio) (third trio))
NIL
trio
(PINCH-ME-TIGHT EVE ADAM)
```

That is, given two *references*, **rotatef** swaps them.

R

round *number* &optional (*divisor* **1**) *Function*

Divides *number* by *divisor*, and rounds the result toward the nearest integer. The rounded result and the remainder are the returned values.

Using **round** with one argument is similar to the **zl:fixr** function, except when the quotient is exactly halfway between two integers. In that case, **zl:fixr** chooses the larger one, while **round** chooses the even one.

number and *divisor* must each be a noncomplex number. Not specifying a divisor is exactly the same as specifying a divisor of 1.

If the two returned values are Q and R, then (+ (* Q *divisor*) R) equals *number*. If *divisor* is 1, then Q and R add up to *number*. If *divisor* is 1 and *number* is an integer, then the returned values are *number* and 0.

The first returned value is always an integer. The second returned value is integral if both arguments are integers, is rational if both arguments are rational, and is floating-point if either argument is floating-point. If only one argument is specified, then the second returned value is always a number of the same type as the argument.

Examples:

```
(round 5) => 5 and 0
(round -5) => -5 and 0
(round 5.2) => 5 and 0.19999981
(round -5.2) => -5 and -0.19999981
(round 5.8) => 6 and -0.19999981
(round -5.8) => -6 and 0.19999981
(round 5 3) => 2 and -1
(round -5 3) => -2 and 1
(round 5 4) => 1 and 1
(round -5 4) => -1 and -1
(round 5.2 3) => 2 and -0.8000002
(round -5.2 3) => -2 and 0.8000002
(round 5.2 4) => 1 and 1.1999998
(round -5.2 4) => -1 and -1.1999998
(round 5.8 3) => 2 and -0.19999981
(round -5.8 3) => -2 and 0.19999981
(round 5.8 4) => 1 and 1.8000002
(round -5.8 4) => -1 and -1.8000002
```


For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

rplaca *x y* *Function*

(rplaca *x y***)** changes the *car* of *x* to *y* and returns (the modified) *x*. *x* must be a cons or a locative. *y* can be any Lisp object. Example:

```
(setq g '(a b c))
(rplaca (cdr g) 'd) => (d c)
Now g => (a d c)
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

rplacd *x y* *Function*

(rplacd *x y***)** changes the *cdr* of *x* to *y* and returns (the modified) *x*. *x* must be a cons or a locative. *y* can be any Lisp object. Example:

```
(setq x '(a b c))
(rplacd x 'd) => (a . d)
Now x => (a . d)
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:samepnamep *sym1 sym2* *Function*

Returns **t** if the two symbols *sym1* and *sym2* have **string=** print-names, that is, if their printed representation is the same. If either or both of the arguments is a string instead of a symbol, then that string is used in place of the print-name. **zl:samepnamep** is useful for determining if two symbols would be the same except that for being in different packages. Examples:

```
(zl:samepnamep 'xyz (maknam '(x y z)) => t

(zl:samepnamep 'xyz (maknam '(w x y)) => nil

(zl:samepnamep 'xyz "xyz") => t
```

This is the same function as **string=**. **zl:samepnamep** is provided mainly for compatibility with older dialects of Lisp. In new programs, you just use **string=**.

zl:sassoc *item alist function* *Function*

(zl:sassoc *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose *car* is **zl:equal** to *x*, or, if there is none such, **zl:sassoc** calls the function *function* with no arguments. **zl:sassoc** could have been defined by:

```
(defun sassoc (item alist function)
    (or (assoc item alist)
        (apply function nil)))
```

zl:sassoc is of limited use. It is primarily a leftover from earlier implementations of Lisp.

For a table of related items: See the section "Functions That Operate on Association Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:sassq *item alist function* *Function*

(zl:assq *item alist***)** looks up *item* in the association list (list of conses) *alist*. The value is the first cons whose *car* is **eq** to *x*, or, if there is none such, **zl:sassq** calls the function *function* with no arguments. **zl:sassq** could have been defined by:

```
(defun sassq (item alist function)
    (or (assq item alist)
        (apply function nil)))
```

zl:sassq is of limited use. It is primarily a leftover from earlier implementations of Lisp.

satisfies *predicate* &rest *predicate-args* *Type Specifier*

A type specifier list of the form (**satisfies** *predicate*) denotes the set of all objects that satisfy the argument *predicate*. Thus **satisfies** makes it possible to extend the type hierarchy to objects that cannot be defined as composites of other types.

predicate can be a symbol whose global function definition is a one-argument predicate. In Symbolics Common Lisp *predicate* can also be a lambda-expression. This is an extension to Common Lisp.

For example, the type (**satisfies numberp**) is the same as the type number. The call

(**typep** *x* '(**satisfies** *p*))

results in applying *p* to *x* and returning **t** if the result is true and **nil** if the result is false.

When applying **satisfies** avoid using predicates that can cause side effects when invoked.

Examples:

```
(typep 3 '(satisfies numberp)) => T

(deftype odd-integer ()
     '(and integer (satisfies oddp))) => "a odd integer"

(typep 3 'odd-integer) => T
(typep 4 'odd-integer) => NIL

(sys:type-arglist 'satisfies)
=> (PREDICATE &REST PREDICATE-ARGS) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

sbit *array* &rest *subscripts* *Function*

Returns the element of *array* selected by the *subscripts*. The *subscripts* must be integers and their number must match the dimensionality of *array*. **sbit** is like **bit**, but for **sbit**, the array must be a simple array of bits.

scale-float *float integer* *Function*

scale-float computes and returns (* *float* $2^{integer}$).

Although the same result can be obtained by using exponentiation and multiplication, the use of **scale-float** can be much more efficient and avoids the intermediate overflow and underflow if the final result is representable.

Examples:

```
(scale-float .5 2) => 2.0
(scale-float .5 3) => 4.0
(scale-float .5 4) => 8.0
(scale-float .75 2) => 3.0
```

For a table of related items: See the section "Functions That Decompose and Construct Floating-point Numbers" in *Symbolics Common Lisp: Language Concepts.*

schar *array* &rest *subscripts* *Function*

The function **schar** returns the character at position *subscripts* of *array*. The count is from zero. The character is returned as a character object.

array must be a string array.

subscripts must be a non-negative integer less than the length of *array*.

Note that the array-specific function **aref** and the general sequence function **elt** also work on strings.

To destructively replace a character within a string, use **schar** in conjunction with the generic function **setf**.

```
(schar "a string" 0) => #\a
(string-char-p (schar "a string" 3)) => T

(schar "a string" 1) => #\Space

(schar (make-array 4 :element-type 'character
                     :initial-element #\y) 3) => #\y
(string-char-p (schar (make-array 4 :element-type 'character
                                    :initial-element #\.) 2))  => T

(string-char-p (schar (make-array 4 :element-type 'character
                      :initial-element #\.
                      :fill-pointer 2) 1)) => T
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

search *sequence1 sequence2* &key *from-end* (*test* #'**eql**) *test-not key* (*start1* **0**) (*start2* **0**) *end1 end2* *Function*

search looks for a subsequence of *sequence2* that element-wise matches *sequence1*. If no such subsequence exists, **search** returns **nil**. If such a subsequence exists, **search** returns the index into *sequence2* of the leftmost element of the leftmost such matching subsequence.

sequence1 and *sequence2* can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

If the value of the **:from-end** keyword is non-**nil**, the index of the leftmost element of the rightmost matching subsequence is returned. For example:

```
(search '(1 2) '(3 4 1 2 6 1 2 5)) => 2

(search '(1 2) '(3 4 1 2 6 1 2 5) :from-end t) => 5
```

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

For example:

```
(search '(2) '(1 2 2 3) :test-not #'>) => 1
```

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

The keyword arguments **:start1**, **:end1**, **:start2**, and **:end2** are used to specify subsequences for each separate sequence

:start1 and **:end1** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end1**, else an error is signalled. It defaults to zero (the start of the sequence).

:start1 indicates the start position for the operation within the sequence. **:end1** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence). If both **:start1** and **:end1** are omitted, the entire sequence is processed by default.

:start2 and **:end2** operate the same as **:start1** and **:end1**.

For example:

```
(search #(a b) #(a b c d a b) :start2 3)
 => 4

(search #(1 2 3) #(1 2 3 1 2 3 1 2 3) :start1 2 :start2 4)
 => 5
```

```
(search #(1 2 3) #(1 2 3 1 2 3 1 2 3) :start1 2 :end1 3 :start2 4 :end2 9)
 => 5
```

For a table of related items: See the section "Searching for Sequence Items" in *Symbolics Common Lisp: Language Concepts.*

second *list* *Function*

This function takes a list as an argument, and returns the second element of the list. **second** is identical to **cadr**. It is also identical to

```
(nth 1 list)
```

The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

select *test-object* &body *clauses* *Special Form*

A conditional that chooses one of its clauses to execute by comparing the value of a form against various constants, which are typically keyword symbols. Its form is as follows:

```
(select key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

The first thing **select** does is to evaluate *key-form*; call the resulting value *key*. Then **select** considers each of the clauses in turn. If *key* matches the clause's *test*, the consequents of this clause are evaluated, and **select** returns the value of the last consequent. If there are no matches, **select** returns **nil**.

A *test* can be any of the following:

A symbol	If the *key* is **eq** to the symbol, it matches.
A number	If the *key* is **eq** to the number, it matches. Only small numbers (*integers*) work.
A list	If the *key* is **eq** to one of the elements of the list, then it matches. The elements of the list should be symbols or integers.
t or **otherwise**	The symbols **t** and **otherwise** are special keywords that match anything. Either symbol can be used; **t** is mainly for compatibility with Maclisp's **zl:caseq** construct. To be useful, this should be the last clause in the **select**.

select is the same as **zl:selectq**, except that the test elements are evaluated before they are used.

This creates a syntactic ambiguity: if **(bar baz)** is seen the first element of a clause, is it a list of two forms, or is it one form? **select** interprets it as a list of two forms. If you want to have a clause whose test is a single form, and that form is a list, you have to write it as a list of one form.

Examples:

```
(select (+ 1 2)
  ("four"  "four")
  ((5 6 7) "five six seven")
  (3 "three")
  (t "drop out")) => "three"
```

Where

```
(select (frob x)
  (foo 1)
  ((bar baz) 2)
  (((current-frob)) 4)
  (otherwise 3))
```

is equivalent to:

```
(let ((var (frob x)))
  (cond ((eq var foo) 1)
        ((or (eq var bar) (eq var baz)) 2)
        ((eq var (current-frob)) 4)
        (t 3)))
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

selector *test-object test-function* &body *clauses* *Special Form*

A conditional that chooses one of its clauses to execute by comparing the value of a form against various constants, which are typically keyword symbols. Its form is as follows:

```
(selector key-form test-function
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

The first thing **selector** does is to evaluate *key-form*; call the resulting value *key*. Then **selector** considers each of the clauses in turn. If *test-function* applied to *key* satisfies the clause's *test*, the consequents of this

clause are evaluated, and **selector** returns the value of the last consequent. If no clause is satisfied, **selector** returns **nil**.

test can be a symbol, a number, or a list whose elements are symbols or numbers. In place of a *test* **selector** also accepts a **t** or **otherwise** clause. **t** is mainly for compatibility with Maclisp's **zl:caseq** construct. To be useful, this should be the last clause in the **selector**.

test-function can be any user-specified function.

selector is the same as **select**, except that you get to specify the function used for the comparison instead of **eq**.

Examples:

```
(let ((arg -14))
  (selector (abs arg) >
    (10 "greater than 10")
    (1 "greater than 1"))) => "greater than 10"
```

Where

```
(selector (frob x) equal
  (('(one . two)) (frob-one x))
  (('(three . four)) (frob-three x))
  (otherwise (frob-any x)))
```

is equivalent to:

```
(let ((var (frob x)))
  (cond ((equal var '(one . two)) (frob-one x))
        ((equal var '(three . four)) (frob-three x))
        (t (frob-any x))))
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:selectq *test-object* &body *clauses* *Special Form*

A conditional that chooses one of its clauses to execute by comparing the value of a form against various constants, which are typically keyword symbols. Its form is as follows:

```
(zl:selectq key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

The first thing **zl:selectq** does is to evaluate *key-form*; call the resulting value *key*. Then **zl:selectq** considers each of the clauses in turn. If *key*

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matches the clause's *test*, the consequents of this clause are evaluated, and **zl:selectq** returns the value of the last consequent. If there are no matches, **zl:selectq** returns **nil**.

A *test* can be any of the following:

A symbol	If the *key* is **eq** to the symbol, it matches.
A number	If the *key* is **eq** to the number, it matches. Only small numbers (*integers*) work.
A list	If the *key* is **eq** to one of the elements of the list, then it matches. The elements of the list should be symbols or integers.
t or **otherwise**	The symbols **t** and **otherwise** are special keywords that match anything. Either symbol can be used; **t** is mainly for compatibility with Maclisp's **zl:caseq** construct. To be useful, this should be the last clause in the **zl:selectq**.

Note that the *test* elements are *not* evaluated; if you want them to be evaluated, use **select** rather than **zl:selectq**.

Examples:

```
(let ((voice 'tenor))
  (zl:selectq voice
    (bass "Barber of Seville")
    (Mezzo "Carmen"))) => NIL

(setq a 2)  => 2
(zl:selectq a
  (1 "one")
  (2 "two")
  ((one two) "1 2")
  (otherwise "not one or two")) => "two"

(let (( a 'big-bang))
   (zl:selectq a
       (light "day")
       (dark  "night")
       (t "night and day"))) => "night and day"
```

Where

```
(let ((x 'Bird))
  (zl:selectq x
    (foo (do-this))
    (bar (do-that))
    ((baz quux mum) (do-the-other-thing))
    (otherwise (zl:ferror nil "Hey there, never heard of ~S" x))))
=> Error: Hey there, never heard of BIRD
```

is equivalent to:

```
(let ((x 'Bird))
  (cond ((eq x 'foo) (do-this))
        ((eq x 'bar) (do-that))
        ((zl:memq x '(baz quux mum)) (do-the-other-thing))
        (t (zl:ferror nil "Hey there, never heard of ~S" x))))
=> Error: Hey there, never heard of BIRD
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

selectq-every *obj* &body *clauses* *Special Form*

A conditional that chooses one of its clauses to execute by comparing the value of a form against various constants, which are typically keyword symbols. Its form is as follows:

```
(selectq-every key-form
  (test consequent consequent ...)
  (test consequent consequent ...)
  (test consequent consequent ...)
  ...)
```

The first thing **selectq-every** does is to evaluate *key-form*; call the resulting value *key*. Then **selectq-every** considers each of the clauses in turn. If *key* matches the clause's *test*, the consequents of this clause are evaluated, and **selectq-every** returns the value of the last consequent. If there are no matches, **selectq-every** returns **nil**.

A *test* can be any of the following:

A symbol	If the *key* is **eq** to the symbol, it matches.
A number	If the *key* is **eq** to the number, it matches. Only small numbers (*integers*) work.
A list	If the *key* is **eq** to one of the elements of the list, then it matches. The elements of the list should be symbols or integers.
t or **otherwise**	The symbols **t** and **otherwise** are special keywords that match anything. Either symbol can be used; **t** is mainly

for compatibility with Maclisp's **zl:caseq** construct. To be useful, this should be the last clause in the **zl:selectq**.

selectq-every is like **zl:selectq**, but like **cond-every**, **selectq-every** executes every selected clause, instead of just the first one. If an **otherwise** clause is present, it is selected if and only if no preceding clause is selected. The value returned is the value of the last form in the last selected clause. Multiple values are not returned.

Note that the *test* elements are *not* evaluated.

Examples:

```
(let ((book 'Lisp))
  (selectq-every book
    ((mystery fantasy science-fiction) (setq type 'fun))
    ((Lisp Pascal Fortran APL) (setq type 'Languages))
    ((Lisp History Math) (setq school 'homework))
    (otherwise (setq type 'unknown)))) => HOMEWORK
type => LANGUAGES

(selectq-every animal
  ((cat dog) (setq legs 4))
  ((bird man) (setq legs 2))
  ((cat bird) (put-in-oven animal))
  ((cat dog man) (beware-of animal)))
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts*.

self *Variable*

When a generic function is called on an object, the variable **self** is automatically bound to that object. This enables the methods to lexically manipulate the object itself (as opposed to its instance variables).

send *object message-name* &rest *arguments* *Function*

Sends the message named *message-name* to the *object*. *arguments* are the arguments passed. **send** does exactly the same thing as **funcall**. For stylistic reasons, it is preferable to use **send** instead of **funcall** when sending messages because **send** clarifies the programmer's intent.

send is supported for compatibility with previous versions of the flavor system. When writing new programs, it is good practice to use generic functions instead of message-passing.

send-if-handles *object message* &rest *arguments* *Function*

Sends the message named *message* to *object* if the flavor associated with object has a method defined for *message*. If it does not have a method defined, **nil** is returned. *message* is a message name and *arguments* is a list of arguments for that message.

:send-if-handles *operation* &rest *arguments* *Message*

operation is a generic function or message name and *arguments* is a list of arguments for the operation.

If a generic function is given, the object should perform the generic function if it has a method for it.

If a message is given, the object should send itself that message with those arguments if it handles the message.

If no method for the generic function or message is available, **nil** is returned.

flavor:vanilla provides a method for **:send-if-handles**.

Instead of sending this message, you can use the **send-if-handles** function. See the function **send-if-handles**, page 473.

sequence &optional *(type '*)* *Type Specifier*

sequence is the type specifier symbol for the predefined Lisp structure of that name.

The type **sequence** is a *supertype* of the types **vector** and **list**. These two types are an exhaustive partition of the type **sequence**.

The type specifier **sequence** can be used in either symbol or list form. Used in list form, **sequence** defines the set of sequences whose elements are of type *type*. *type* must be one of the standard data types. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

Examples:

```
(typep '(a b c d e) 'sequence) => T
(typep '(mom 25 dad 28) '(sequence list)) => T
(subtypep 'list 'sequence) => T and T
(subtypep 'vector 'sequence) => T and T
(sys:type-arglist 'sequence) => (&OPTIONAL (TYPE '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Sequences" in *Symbolics Common Lisp: Language Concepts*.

set *symbol value* *Function*

set is the primitive for assignment of a value to a dynamic (special) variable. The *symbol*'s value is changed to *value*; *value* can be any Lisp object. **set** only changes the value of the current dynamic binding. If *symbol* has no current binding in effect, its most global value is changed. **set** returns *value*. Example:

```
(set (cond ((eq a b) 'c)
           (t 'd))
     'foo)
```

either sets **c** to **foo** or sets **d** to **foo**.

set does not work on local (lexically bound) variables.

zl:setarg *i x* *Function*

Used only during the application of a lexpr. **(setarg** *i x***)** sets the lexpr's *i*'th argument to *x*. *i* must be greater than zero and not greater than the number of arguments passed to the lexpr. After **(setarg** *i x***)** has been done, **(arg** *i***)** returns *x*.

zl:setarg exists only for compatibility with Maclisp lexprs. To write functions that can accept variable numbers of arguments, use the **&optional** and **&rest** keywords. See the section "Evaluating a Function Form" in *Symbolics Common Lisp: Language Concepts*.

set-char-bit *char name value* *Function*

Changes the bit named *name* in *char* and returns the new character. *value* is **nil** to clear the bit or non-**nil** to set it.

```
(set-char-bit #\A :meta T) => #\m-A
(set-char-bit #\h-c-A :control NIL) => #\h-A
```

set-difference *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

set-difference is a non-destructive function which returns a list of elements of *list1* that do not appear in *list2*. Note that there is no guarantee that the order of elements in the result will reflect the ordering of the arguments in any particular way. The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For all possible ordered pairs consisting of one element from *list1* and one element from *list2*, the predicate is used to determine whether they match. An element of *list1* appears in the result if and only if it does not match any element of *list2*. For example:

```
(setq a-list '(eagle hawk loon pelican)) =>
(EAGLE HAWK LOON PELICAN)

(setq b-list '(owl hawk stork)) => (OWL HAWK STORK)

(set-difference a-list b-list) => (EAGLE LOON PELICAN)

(set-difference b-list a-list) => (OWL STORK)
```

It is also possible to perform applications such as removing from a list of strings all of those strings containing one of a given list of characters. In this example, we remove all flavor names that contain the characters "c" or "w".

```
(set-difference '("strawberry" "chocolate" "banana" "lemon"
                  "pistachio" "rhubarb") '(#\c #\w)
                :test #'(lambda (s c) (find c s))) =>
("banana" "lemon" "rhubarb")
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

set-exclusive-or *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

set-exclusive-or is a non-destructive function which returns a list of elements that appear in exactly one of *list1* and *list2*. Note that there is no guarantee that the order of elements in the result will reflect the ordering of the arguments in any particular way. The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For all possible ordered pairs consisting of one element from *list1* and one element from *list2*, the predicate is used to determine whether they match. The result contains precisely those elements of *list1* and *list2* which appear in no matching pair. For example:

```
(setq a-list '(eagle hawk loon pelican)) =>
(EAGLE HAWK LOON PELICAN)

(setq b-list '(owl hawk stork)) => (OWL HAWK STORK)

(set-exclusive-or a-list b-list) => (EAGLE LOON PELICAN OWL STORK)
```

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts*.

setf *reference value* &rest *more-pairs* *Macro*

Takes a form that *accesses* something, and "inverts" it to produce a corresponding form to *update* the thing. A **setf** expands into an update form, which stores the result of evaluating the form *value* into the place referenced by the *reference*. If you supply more than one *reference value* pair, the pairs are processed sequentially.

The form of *reference* can be any of the following:

- The name of a variable (either local or global).
- A function call to any of the following functions:

aref	**car**	**svref**	
nth	**cdr**	**get**	
elt	**caar**	**getf**	**symbol-value**
rest	**cadr**	**gethash**	**symbol-function**
first	**cdar**	**documentation**	**symbol-plist**
second	**cddr**	**fill-pointer**	**macro-function**
third	**caaar**	**caaaar**	**cdaaar**
fourth	**caadr**	**caaadr**	**cdaadr**
fifth	**cadar**	**caadar**	**cdadar**
sixth	**caddr**	**caaddr**	**cdaddr**
seventh	**cdaar**	**cadaar**	**cddaar**
eighth	**cdadr**	**cadadr**	**cddadr**
ninth	**cddar**	**caddar**	**cdddar**
tenth	**cdddr**	**cadddr**	**cddddr**

- A function call whose first element is the name of a selector function created by **defstruct**.
- A function call to one of the following functions paired with a *value* of the specified type so that it can be used to replace the specified "place":

Function name	*Required type*
char	**string-char**
schar	**string-char**
bit	**bit**
sbit	**bit**
subseq	**sequence**

In the case of **subseq**, the replacement value must be a sequence whose elements can be contained by the sequence argument to subseq. If the length of the replacement value does not equal the length of the subsequence to be replaced, then the shorter length determines the number of elements to be stored. See the function **replace**, page 448.

- A function call to any of the following functions with an argument to that function in turn being a "place" form. The result of applying the specified update function is then stored back into this new place.

Function name	*Argument that is a place*	*Update function used*
char-bit	**first**	**set-char-bit**
ldb	**second**	**dpb**
mask-field	**second**	**deposit-field**

- A **the** type declaration form, in which case the declaration is transferred to the *value* form and the resulting **setf** form is analyzed. For example,

```
(setf (the integer (cadr x)) (+ y 3))
```

is processed as if it were

```
(setf (cadr x) (the integer (+ y 3)))
```

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:setf *access-form value* *Macro*

Takes a form that *accesses* something, and "inverts" it to produce a corresponding form to *update* the thing. A **zl:setf** expands into an update form, which stores the result of evaluating the form *value* into the place referenced by the *access-form*. Examples:

```
(setf (array-leader foo 3) 'bar)
                ==> (store-array-leader 'bar foo 3)
(setf a 3) ==> (setq a 3)
(setf (plist 'a) '(foo bar)) ==> (setplist 'a '(foo bar))
(setf (aref q 2) 56) ==> (aset 56 q 2)
(setf (cadr w) x) ==> (rplaca (cdr w) x)
```

If *access-form* invokes a macro or a substitutable function, then **zl:setf** expands the *access-form* and starts over again. This lets you use **zl:setf** together with **defstruct** accessors.

For the sake of efficiency, the code produced by **zl:setf** does not preserve order of evaluation of the argument forms. This is only a problem if the argument forms have interacting side effects. For example, if you evaluate:

```
(setq x 3)
(setf (aref a x) (setq x 4))
```

the form might set element **3** or element **4** of the array. We do not guarantee which one it will do; do not just try it and see and then depend on it, because it is subject to change without notice.

Furthermore, the value produced by **zl:setf** depends on the structure type and is not guaranteed; **zl:setf** should be used for side effect only. If you want well-defined semantics, you can use **zl:setf** in your Symbolics Common Lisp programs.

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts*.

zl:set-globally *var value* *Function*

Works like **set** but sets the global value regardless of any bindings currently in effect.

zl:set-globally operates on the *global value* of a special variable; it bypasses any bindings of the variable in the current stack group. It resides in the global package.

zl:set-globally does not work on local variables.

zl:set-in-closure *closure symbol x* *Function*

This sets the binding of *symbol* in the environment of *closure* to *x*; that is, it does what would happen if you restored the value cells known about by *closure* and then set *symbol* to *x*. This allows you to change the contents of the value cells known about by a dynamic closure. If *symbol* is not closed over by *closure*, this is just like **set**. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:set-in-instance *instance symbol value* *Function*

Alters the value of an instance variable inside a particular instance, regardless of whether the instance variable was declared a **:writable-instance-variable** or a **:settable-instance-variable.** *instance* is the instance to be altered, *symbol* is the instance variable whose value should be set, and *value* is the new value. If there is no such instance variable, an error is signalled.

In Symbolics Common Lisp, this operation is performed by:

```
(setf (scl:symbol-value-in-instance instance symbol) value)
```

zl:setplist *symbol list* *Function*

Sets the list that represents the property list of *symbol* to *list.* Use **zl:setplist** with extreme caution, since property lists sometimes contain internal system properties, which are used by many useful system functions. Also, it is inadvisable to have the property lists of two different symbols be **eq**, since the shared list structure causes unexpected effects on one symbol if **zl:putprop** or **zl:remprop** is done to the other.

dbg:set-proceed-types *condition new-proceed-types* *Generic Function*

Sets the list of valid proceed types for this condition to *new-proceed-types.*

The compatible message for **dbg:set-proceed-types** is:

:set-proceed-types

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts.*

setq {*variable value*}... *Special Form*

Used to set the value of one or more variables. The first *value* is evaluated, and the first *variable* is set to the result. Then the second *value* is evaluated, the second *variable* is set to the result, and so on for all the variable/value pairs. **setq** returns the last value, that is, the result of the evaluation of its last subform. Example:

```
(setq x (+ 3 2 1) y (cons x nil))
```

x is set to **6**, **y** is set to **(6)**, and the **setq** form returns **(6)**. Note that the first variable was set before the second value form was evaluated, allowing that form to use the new value of **x**.

zl:setq-globally &rest *vars-and-vals* *Special Form*

zl:setq-globally has been superseded by **symbol-value-globally**. You use **setf** with **symbol-value-globally** to set global values in your init file.

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zl:setq-standard-value *name form* &optional (*setq-p* **t**) (*globally-p* **t**) (*error-p* **t**) *Special Form*

Sets the standard value of *name* to the value of *form*. If you want to change your default **zl:base** to 8 (octal), do this:

```
(setq-standard-value base 8)
(setq-standard-value ibase 8)
```

zl:setq-standard-value runs the validation function associated with the symbol and signals an error if the validation function fails. You can only use **zl:setq-standard-value** on symbols defined with **sys:defvar-standard**. **zl:setq-standard-value** and **zl:setq-globally** work with **login-forms** and are recommended for use in init files where you want your customizations to be undone when you log out.

For programs, **zl:setq-standard-value** has been superceded by **setf** of **sys:standard-value**.

seventh *list* *Function*

This function takes a list as an argument, and returns the seventh element of the list. **seventh** is identical to

```
(nth 6 list)
```

. The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

shadow *symbols* &optional *package* *Function*

The *symbols* argument should be a list of symbols or a single symbol. If *symbols* is **nil**, it is treated like an empty list. The name of each symbol is extracted, and *package* is searched for a symbol of that name. If no such symbol is present in this package (directly, not by inheritance), a new symbol is created with this name and inserted in *package* as an internal symbol. The symbol is also placed on the shadowing-symbols list of *package*.

package can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t**.

shadow should be used with caution. It changes the state of the package system in such a way that the consistency rules do not hold across the change.

shadowing-import *symbols* &optional *package* *Function*

This is like **import**, but it does not signal an error even if the importation of a symbol would shadow some symbol already available in the package. If a distinct symbol with the same name is already present in the package, it is removed (using **unintern**). The imported symbol is placed on the shadowing-symbols list of *package*.

The *symbols* argument should be a list of symbols or a single symbol. If *symbols* is **nil**, it is treated like an empty list. *package* can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t**.

shadowing-import should be used with caution. It changes the state of the package system in such a way that the consistency rules do not hold across the change.

shiftf &rest *references-and-values* *Macro*

Each *references-and-values* can be any form acceptable as a generalized variable to **setf**. All the forms are treated as a shift register; the last *references-and-values* is shifted in from the right, all values shift over to the left one place, and the value shifted out of the first *references-and-values* position is returned.

For example as seen in a Lisp Listener:

```
(setq forces (list army navy air-force marines))
(ARMY NAVY AIR-FORCE MARINES)
(shiftf (car forces) (cadr forces 'new-york-cops))
ARMY
forces
(NAVY NEW-YORK-COPS AIR-FORCE MARINES)
(shiftf (cadr forces) (cddr forces) 'monterey-lifeguards)
NEW-YORK-COPS
forces
(NAVY (AIR-FORCE MARINES) . MONTEREY-LIFEGUARDS)
```

short-float *Type Specifier*

short-float is the type specifier symbol for the predefined Lisp single-precision floating-point number type.

The type **short-float** is a *subtype* of the type **float**. In Symbolics Common Lisp **short-float** is identical with **single-float**.

The type **short-float** is *disjoint* with the types **long-float** and **double-float**.

Examples:

```
(typep 0.0 'short-float) => T

(subtypep 'short-float 'float) => T and T ;subtype and certain

(commonp 1.0) => T

(equal-typep 'short-float 'single-float) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

short-float-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (+ (float 1 *e*) *e*)))

In Symbolics Common Lisp **short-float-epsilon** has the same value as **single-float-epsilon**, namely: 5.960465e-8.

short-float-negative-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (- (float 1 *e*) *e*)))

In Symbolics Common Lisp the value of **short-float-negative-epsilon** is the same as that of **single-float-negative-epsilon**, namely: 2.9802326e-8.

signal *flavor* &rest *init-options* *Function*

signal is the primitive function for signalling a condition. The argument *flavor* is a condition flavor symbol. The *init-options* are the init options when the **condition-object** is created; they are passed in the **:init** message to the instance. (See the generic function **make-instance**, page 328.) signal creates a new condition object of the specified flavor, and signals it. If no handler handles the condition and the object is not an error object, signal returns **nil**. If no handler handles the condition and the object is an error object, the Debugger assumes control.

In a more advanced form of **signal**, *flavor* can be a condition object that has been created with **make-condition** but not yet signalled. In this case, *init-options* is ignored.

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts*.

signal-proceed-case *Special Form*

signal-proceed-case signals a proceedable condition. It has a clause to handle each proceed type of the condition. It has a slightly more complicated syntax than most special forms: you provide some variables, some argument forms, and some clauses:

```
(signal-proceed-case ((var1 var2 ...) arg1 arg2 ...)
   (proceed-type-1 body1...)
   (proceed-type-2 body2...)
   ...)
```

The first thing this form does is to call **signal**, evaluating each *arg* form to pass as an argument to **signal**. In addition to the arguments you supply, **signal-proceed-case** also specifies the **dbg:proceed-types** init option, which it builds based on the *proceed-type-i* clauses.

When **signal** returns, **signal-proceed-case** treats the first returned value as the symbol for a proceed type. It then picks a *proceed-type-i* clause to run, based on that value. It works in the style of **case**: each clause starts with a proceed type (a keyword symbol), or a list of proceed types, and the rest of the clause is a list of forms to be evaluated. **signal-proceed-case** returns the values produced by the last form.

var1, *var2*, and so on, are bound to successive values returned from **signal** for use in the body of the *proceed-type-i* clause selected.

One *proceed-type-i* can be **nil**. If **signal** returns **nil**, meaning that the condition was not handled, **signal-proceed-case** runs the **nil** clause if one exists, or simply returns **nil** itself if no **nil** clause exists. Unlike **case**, no otherwise clause is available for **signal-proceed-case**.

The value passed as the **dbg:proceed-types** option to **signal** lists the various proceed types in the same order as the clauses, so that the Debugger displays them in that order to the user and the RESUME command runs the first one.

signed-byte &optional (*s* '*) *Type Specifier*

signed-byte is the type specifier symbol for the predefined Lisp signed byte data type.

This type specifier can be used in either symbol or list form. Used in list form, **signed-byte** defines the set of integers that can be represented in two's-complement form in a byte of *s* bits. This is equivalent to

$$(\text{integer } -2^{s-1}\ 2^{s-1} - 1)$$

Simply **signed-byte** or **(signed-byte *)** is the same as **integer**.

Examples:

```
(typep 0 '(signed-byte 3)) => T

(subtypep 'signed-byte 'bit)
 => NIL and T  ;not a subtype and certain

(commonp 3) => T

(sys:type-arglist 'signed-byte) => (&OPTIONAL (S '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

zl:signp *test x* *Special Form*

signp is used to test the sign of a number. It is present only for compatibility with older versions of Lisp, and is not recommended for use in new programs. **zl:signp** returns **t** if *x* is a number that satisfies the *test*, **nil** if it is not a number or does not meet the test. *test* is not evaluated, but *x* is. *test* can be one of the following:

l	$x < 0$
le	$x \leq 0$
e	$x = 0$
n	$x \neq 0$
ge	$x \geq 0$
g	$x > 0$

Examples:

```
(zl:signp ge 12) => t
(zl:signp le 12) => nil
(zl:signp n 0) => nil
(zl:signp g 'foo) => nil
```

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts*.

signum *number* *Function*

signum is a function for determining the sign of its argument.

For a rational argument, **signum** returns -1, 0, or 1, depending on whether the argument is negative, zero, or positive.

If the argument is a floating-point number, the result is a floating-point number of the same format whose value is minus one, zero, or one.

For a non-zero complex argument *z*, (**signum** *z*) returns a complex number of the same phase as *z* but with unit magnitude. If *z* is a complex zero, **signum** returns zero.

Examples:

```
(signum -2.5)  =>  -1.0
(signum 3.9)  =>  1.0
(signum 0)  =>  0
(signum 59)  =>  1
(signum #C(3 4)) => #C(0.6 0.8)
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

simple-array &optional (*element-type '**) (*dimensions '**) *Type Specifier*

simple-array is the type specifier symbol for the Lisp data structure of that name.

The type **simple-array** is a *subtype* of the type **array.**

The types **simple-vector, simple-string,** and **simple-bit-vector** are *disjoint subtypes* of the type **simple-array**: **simple-vector** means `(simple-array t (*))`; **simple-string** means `(simple-array string-char)` or `(simple-array character)`; **simple-vector** means `(simple-array bit (*))`.

This type specifier can be used in either symbol or list form. Used in list form, **simple-array** allows the declaration and creation of specialized simple arrays whose members are all members of the type *element-type* and whose dimensions match *dimensions.* This is equivalent to

```
(array element-type dimensions)
```

except that it additionally specifies that objects of the type are *simple* arrays. (A simple array is an array that has no fill pointer, whose contents are not shared with another array, and whose size is not adjusted dynamically after creation.)

element-type must be a valid type specifier, or unspecified. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

dimensions can be a non-negative integer, which is the number of dimensions, or it can be a list of non-negative integers representing the length of each dimension (any of which can be unspecified). *dimensions* can also be unspecified.

Examples:

```
(setq example-array (make-array '(3) :fill-pointer 2))
=> #<ART-Q-3 1321277>
```

```
(setq example-simple-array (make-array '(3))) => #<ART-Q-3 1330466>

(typep example-simple-array 'simple-array) => T

(zl:typep example-simple-array) => :ARRAY

(subtypep 'simple-array 'array) => T and T

(sys:type-arglist 'simple-array)
=> (&OPTIONAL (ELEMENT-TYPE '*) (DIMENSIONS '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Arrays" in *Symbolics Common Lisp: Language Concepts*.

simple-bit-vector &optional (*size* '*) *Type Specifier*

simple-bit-vector is the type specifier symbol for the Lisp data structure of that name.

simple-vector, **simple-string**, and **simple-bit-vector** are *disjoint subtypes* of the type **simple-array**: **simple-vector** means `(simple-array t (*))`; **simple-string** means `(simple-array string-char)` or `(simple-array character)`; **simple-bit-vector** means `(simple-array bit (*))`.

This type specifier can be used in either symbol or list form. Used in list form, **simple-bit-vector** defines the set of bit-vectors of the indicated *size*. This means the same as (**simple-array bit** (*size*)).

Examples:

```
(setq array-bit-vector-not-simple
      (make-array '(3) :element-type 'bit :fill-pointer 2))
   => #<ART-1B-3 43035106>

(setq array-bit-vector-simple
      (make-array '(3) :element-type 'bit))
   => #<ART-1B-3 43054543>

(typep array-bit-vector-simple 'simple-array) => T

(typep array-bit-vector-not-simple 'simple-array) => NIL

(typep #*1 '(simple-bit-vector 1)) => T

(subtypep 'simple-bit-vector 'simple-array) => T and T

(subtypep 'simple-bit-vector 'bit-vector) => T and T

(simple-bit-vector-p array-bit-vector-simple) => T
```

```
(sys:type-arglist 'simple-bit-vector)
=> (&OPTIONAL (SIZE '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Arrays" in *Symbolics Common Lisp: Language Concepts*.

simple-bit-vector-p *object* *Function*

Tests whether the given *object* is a simple bit vector. A simple bit vector is a one-dimensional array whose elements are required to be bits; the array is not displaced to another array and has no fill pointer. See the type specifier **simple-bit-vector**, page 486.

```
(simple-bit-vector-p
 (make-array 3 :element-type 'bit))
 => T

(simple-bit-vector-p
  (make-array 5 :element-type 'bit :fill-pointer 2))
 => NIL
```

simple-string &optional (*size* '*) *Type Specifier*

simple-string is the type specifier symbol for the predefined Lisp data type, simple string.

The type **simple-string** is a *subtype* of the type **string**.

Note: Although **string** is a subtype of **vector**, **simple-string** is *not* a subtype of **simple-vector**.

The types **simple-vector**, **simple-string**, and **simple-bit-vector** are *disjoint subtypes* of the type **simple-array**: **simple-vector** means `(simple-array t (*))`; **simple-string** means `(simple-array string-char)` or `(simple-array character)`; **simple-bit-vector** means `(simple-array bit (*))`.

This type specifier can be used in either symbol or list form. Used in list form, **simple-string** defines the set of simple strings whose size is restricted to *size*. This means the same as `(simple-array string-char (`*size*`))`, or `(simple-array character (`*size*`))`.

Examples:

```
(setq string-one (make-string 5 :initial-element #\.))  => "....."
  ; a thin, simple string

(setq string-two (make-array 3 :element-type 'character
                               :initial-element #\x))  => "xxx"
  ; a fat, simple string
```

```
(typep string-one 'simple-string) => T
(typep string-two 'simple-string) => T

(simple-string-p string-one) => T
(simple-string-p string-two) => T

(subtypep 'simple-string 'string) => T and T
(subtypep 'simple-string 'vector) => T and T
(subtypep 'simple-string 'simple-array) => T and T

(commonp string-two) => T

(sys:type-arglist 'simple-string) => (&OPTIONAL (SIZE '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Strings" in *Symbolics Common Lisp: Language Concepts*.

simple-string-p *object* *Function*

The predicate **simple-string-p** is true if its argument is a simple string; it is false otherwise. A simple string is a one-dimensional array; its elements can be characters of type **string-char** or **character**, but the array must have no fill pointer or displacement.

simple-string is a subtype of type **string**. **simple-string-p** is always **t** for strings built with **make-string**.

Examples:

```
(simple-string-p "fred") => T

(simple-string-p (make-string 3 :initial-element #\z)) => T

(simple-string-p (make-string 4 :initial-element #\hyper-a)) => T

(simple-string-p (make-array 5 :element-type 'string-char
                               :fill-pointer t))  => NIL

(simple-string-p (make-array 2 :element-type 'character
                               :initial-element #\b)) => T
```

For a table of related items: See the section "String Type-Checking Predicates" in *Symbolics Common Lisp: Language Concepts*.

simple-vector &optional (*size* '*) *Type Specifier*

simple-vector is the type specifier symbol for the Lisp data structure of that name.

The type **simple-vector** is a *subtype* of the types:

vector
(vector t)

Note: Although **string** is a subtype of **vector, simple-string** is *not* a subtype of **simple-vector.**

The types **simple-vector, simple-string,** and **simple-bit-vector** are *disjoint subtypes* of the type **simple-array**: **simple-vector** means `(simple-array t (*))`; **simple-string** means `(simple-array string-char)` or `(simple-array character)`; **simple-bit-vector** means `(simple-array bit (*))`.

This type specifier can be used in either symbol or list form. Used in list form, **simple-vector** defines the set of specialized one-dimensional arrays of size *size*. This is the same as (**vector t** *size*), except that it additionally specifies that its elements are simple general vectors.

Examples:

```
(typep #(13 3 0) 'simple-vector) => T

(subtypep 'simple-vector 'vector) => T and T

(sys:type-arglist 'simple-vector) => (&OPTIONAL (SIZE '*)) and T

(simple-vector-p #(a b c)) => T

(typep #(1 1 2) '(simple-vector 3)) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Arrays" in *Symbolics Common Lisp: Language Concepts.*

simple-vector-p *object* *Function*

Tests whether the given *object* is a simple general vector. A simple general vector is a one-dimensional array whose elements have no type constraints; the array is not displaced to another array and has no fill pointer. See the type specifier **simple-vector,** page 489.

```
(simple-vector-p (make-array 3))
 => T

(simple-vector-p
 (make-array 5 :element-type 'bit :fill-pointer 2))
 => NIL
```

sin *radians* *Function*

Returns the sine of *radians*. Examples:

```
(sin 0) => 0.0
(sin (/ pi 2)) => 0.9999999999999999d0
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts*.

sind *degrees* *Function*

Returns the sine of *degrees*. *degrees* can be any numeric type.

Examples:

```
(sind #C(30 40))  => #C(0.62687695 0.65492296)
(sind 30.0)  => 0.5
(sind 30)  => 0.5
(sind #C(0.0 30.0))  => #C(0.0 0.5478535)
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts*.

single-float *Type Specifier*

single-float is the type specifier symbol for the predefined Lisp single-precision floating-point number type.

The type **single-float** is a *subtype* of the type **float**. In Symbolics Common Lisp **single-float** is equivalent to **short-float**.

The type **single-float** is *disjoint* with the types **long-float** and **double-float**.

Examples:

```
(typep .00700 'single-float) => T

(subtypep 'single-float 'float) => T and T ;subtype and certain

(zl:typep .123456 ) => :SINGLE-FLOAT

(typep -0.3 'common) => T

(sys:single-float-p 1.e3) => T

(equal-typep 'single-float 'short-float) => T

(sys:type-arglist 'single-float) => NIL and T

(type-of 63e8) => SINGLE-FLOAT
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Numbers" in *Symbolics Common Lisp: Language Concepts*.

single-float-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (+ (float 1 *e*) *e*)))

The current value of **single-float-epsilon** is: 5.960465e-8.

single-float-negative-epsilon *Constant*

The value of this constant is the smallest positive floating-point number *e* of a format such that it satisfies the expression:

(not (= (float 1 *e*) (- (float 1 *e*) *e*)))

The current value of **single-float-negative-epsilon** is: 2.9802326e-8

sys:single-float-p *object* *Function*

Returns **t** if *object* is a single-precision floating-point number, otherwise **nil**.

For a table of related items: See the section "Numeric Type-checking Predicates" in *Symbolics Common Lisp: Language Concepts*.

sinh *radians* *Function*

Returns the hyperbolic sine of *radians*. Example:

```
(sinh 0) => 0.0
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts*.

sixth *list* *Function*

This function takes a list as an argument, and returns the sixth element of the list. **sixth** is identical to

```
(nth 5 list)
```

. The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

math:solve *lu ps b* &optional *x* *Function*

This function takes the LU decomposition and associated permutation array produced by **math:decompose**, and solves the set of simultaneous equations defined by the original matrix *a* and the right-hand sides in the vector *b*. If *x* is supplied, the solutions are stored into it and it is returned; otherwise, an array is created to hold the solutions and that is returned. *b* must be a one-dimensional array.

some *predicate* &rest *sequences* *Function*

some is a predicate which returns a non-**nil** value as soon as any invocation of *predicate* returns a non-**nil** value. *predicate* must take as many arguments as there are sequences provided. *predicate* is first applied to the elements of the sequences with an index of 0, then with an index of 1, and so on, until a termination criterion is reached or the end of the shortest of the sequences is reached. If the end of a sequence is reached, **some** returns **nil**. Thus considered as a predicate, it is true if some invocation of *predicate* is true.

If *predicate* has side effects, it can count on being called first on all those elements with an index of 0, then all those with an index of 1, and so on.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(some #'oddp '(1 2 5)) => T

(some #'equal '(0 1 2 3) '(3 2 1 0)) => NIL
```

However since it returns whatever the predicate returns it does not have to be **t**.

For example:

```
(some #'(lambda (x) (if (oddp x) x)) '(2 4 3))  => 3
```

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:some *list predicate* &optional *step-function* *Function*

zl:some returns a tail of *list* such that the car of the tail is the first element that the *predicate* returns non-**nil** when applied to, or **nil** if *predicate* returns **nil** for every element. If *step-function* is present, it replaces **cdr** as the function used to get to the next element of the list; **cddr** is a typical function to use here. Example

```
(setq list '(a b 1 2)) => (A B 1 2)
(zl:some list #'numberp) => (1 2)
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Predicates That Operate on Sequences" in *Symbolics Common Lisp: Language Concepts.*

sort *sequence predicate* &key *key* *Function*

sort destructively modifies *sequence* by sorting it according to an order determined by *predicate*. *predicate* should take two arguments and return a non-**nil** value if and only if the first argument is strictly less than the second (in some appropriate sense). If the first argument is greater than or equal to the second (in the appropriate sense), then *predicate* should return **nil**.

The **sort** function determines the relationship between two elements by giving keys extracted from the elements to *predicate*. The **:key** argument, when applied to an element, should return the key for that element. It defaults to the identity function, thereby making the element itself the key.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The **:key** function should not have any side effects. A useful example of a **:key** function would be a component selector function for a **defstruct** structure, used in sorting a sequence of structures.

If the **:key** and *predicate* functions always return, then the sorting operation will always terminate, producing a sequence containing the same elements as the original sequence (that is, the result is a permutation of *sequence*). This is guaranteed even if *predicate* does not really consistently represent a total order (in which case the elements will be scrambled in some unpredictable way, but no element will be lost). If the **:key** function consistently returns meaningful keys, and the predicate does reflect some total ordering criterion on those keys, then the elements of the result sequence will be properly sorted according to that ordering.

For example:

```
(sort #(1 3 2 4 3 5) #'>) => #(5 4 3 3 2 1)

(sort '((up 2)(down 1)(west 4)(south 3)) #'< :key #'cadr)
 => ((DOWN 1) (UP 2) (SOUTH 3) (WEST 4))
```

The sorting operation performed by **sort** is not guaranteed *stable*. Elements considered equal by *predicate* may or may not be stay in their original order. *predicate* is assumed to consider two elements *x* and *y* to be equal if **(funcall** *predicate x y***)** and **(funcall** *predicate y x***)** are both false. The function **stable-sort** guarantees stability, but may be slower than **sort** in some situations.

The sorting operation is destructive, so in the cases where the argument should not be destroyed, you must sort a copy of the argument. When the

argument is an vector, the sort is accomplished by permuting the elements in place. When the argument is a list, the sort is accomplished by destructive reordering in the same manner as **nreverse**.

If the execution of either the **:key** or *predicate* functions causes an error, the state of the list or vector being sorted is undefined. However, if the error is corrected, the sort will proceed correctly.

Note that since sorting requires many comparisons, and thus many calls to *predicate*, sorting will be much faster if *predicate* is a compiled function rather than interpreted.

For example:

```
(setq bird-list '(heron stork loon owl flamingo turkey)) =>
(HERON STORK LOON OWL FLAMINGO TURKEY)

(sort bird-list #'string-lessp) =>
(FLAMINGO HERON LOON OWL STORK TURKEY)
```

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sorting and Merging Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:sort *x sort-lessp-predicate* *Function*

The first argument to **zl:sort** is an array or a list. The second is a predicate, which must be applicable to all the objects in the array or list. The predicate should take two arguments, and return non-**nil** if and only if the first argument is strictly less than the second (in some appropriate sense). The predicate should return **nil** if its arguments are equal. For example, to sort in the opposite direction from <, use >, not ≥. This is because the quicksort algorithm used to sort arrays and cdr-coded lists becomes very much slower when the predicate returns non-**nil** for equal elements while sorting many of them.

The **zl:sort** function proceeds to sort the contents of the array or list under the ordering imposed by the predicate, and returns the array or list modified into sorted order. Note that since sorting requires many comparisons, and thus many calls to the predicate, sorting is much faster if the predicate is a compiled function rather than interpreted. Example:

```
(defun mostcar (x)
    (cond ((symbolp x) x)
          ((mostcar (car x)))))
```

```
(zl:sort fooarray
      (function (lambda (x y)
          (alphalessp (mostcar x) (mostcar y)))))
```

If **fooarray** contained these items before the sort:

```
(Tokens (The lion sleeps tonight))
(Carpenters (Close to you))
((Rolling Stones) (Brown sugar))
((Beach Boys) (I get around))
(Beatles (I want to hold your hand))
```

then after the sort **fooarray** would contain:

```
((Beach Boys) (I get around))
(Beatles (I want to hold your hand))
(Carpenters (Close to you))
((Rolling Stones) (Brown sugar))
(Tokens (The lion sleeps tonight))
```

When **zl:sort** is given a list, it can change the order of the conses of the list (using **rplacd**), and so it cannot be used merely for side effect; only the *returned value* of **zl:sort** is the sorted list. This changes the original list; if you need both the original list and the sorted list, you must copy the original and sort the copy. See the function **zl:copylist**, page 115.

Sorting an array just moves the elements of the array into different places, and so sorting an array for side effect only is all right.

If the argument to **zl:sort** is an array with a fill pointer, note that, like most functions, **zl:sort** considers the active length of the array to be the length, and so only the active part of the array is sorted. See the function **zl:array-active-length**, page 29.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sorting and Merging Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:sortcar *x predicate* *Function*

zl:sortcar is the same as **zl:sort** except that the predicate is applied to the **cars** of the elements of *x*, instead of directly to the elements of *x*. Example:

```
(zl:sortcar '((3 . dog) (1 . cat) (2 . bird)) #'<)
                  =>  ((1 . cat) (2 . bird) (3 . dog))
```

Remember that **zl:sortcar**, when given a list, can change the order of the conses of the list (using **rplacd**), and so it cannot be used merely for side effect; only the *returned value* of **zl:sortcar** is the sorted list.

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

sort-grouped-array *array group-size predicate* *Function*

sort-grouped-array considers its array argument to be composed of records of *group-size* elements each. These records are considered as units, and are sorted with respect to one another. The *predicate* is applied to the first element of each record, so the first elements act as the keys on which the records are sorted.

sort-grouped-array is a Symbolics extension to Common Lisp.

sort-grouped-array-group-key *array group-size predicate* *Function*

This is like **sort-grouped-array** except that the *predicate* is applied to four arguments: an array, an index into that array, a second array, and an index into the second array. *predicate* should consider each index as the subscript of the first element of a record in the corresponding array, and compare the two records. This is more general than **sort-grouped-array** since the function can get at all of the elements of the relevant records, instead of only the first element.

sort-grouped-array-group-key is a Symbolics extension to Common Lisp.

dbg:special-command *condition* &rest *per-command-args* *Generic Function*

dbg:special-command is sent when the user invokes the special command. It uses **:case** method-combination and dispatches on the name of the special command. No arguments are passed. The syntax is:

```
(defmethod (dbg:special-command my-flavor :my-command-keyword) ()
  "documentation"
  body...)
```

Any communication with the user should take place over the ***query-io*** stream. The method can return **nil** to return control to the Debugger or it can return the same thing that any of the **sys:proceed** methods would have returned in order to proceed in that manner.

The compatible message for **dbg:special-command** is:

:special-command

For a table of related items: See the section "Debugger Special Command Functions" in *Symbolics Common Lisp: Language Concepts.*

dbg:special-command-p *condition special-command* *Generic Function*

Returns **t** if *command-type* is a valid Debugger special command for this condition object; otherwise, returns **nil**.

The compatible message for **dbg:special-command-p** is:

:special-command-p

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts*.

dbg:special-commands *condition* *Generic Function*

Returns a list of all Debugger special commands for this condition. See the section "Debugger Special Commands" in *Symbolics Common Lisp: Language Concepts*.

The compatible message for **dbg:special-commands** is:

:special-commands

For a table of related items: See the section "Basic Condition Methods and Init Options" in *Symbolics Common Lisp: Language Concepts*.

dbg:*special-command-special-keys* *Variable*

The value of this variable should be an alist associating names of special commands with characters. When an error supplies any of these special commands, the Debugger assigns that special command to the specified key. For example, this is the mechanism by which the **:package-dwim** special command is offered on the `c-sh-P` keystroke.

For a table of related items: See the section "Debugger Special Key Variables" in *Symbolics Common Lisp: Language Concepts*.

special-form-p *function* *Function*

If *function* globally names a special form, then a non-**nil** value is returned; otherwise **nil** is returned.

It is possible for both **special-form-p** and **macro-function** to be true for a given symbol. This is possible because implementors of Common Lisp dialects are permitted to implement any macro as a special form for speed.

sqrt *number* *Function*

sqrt computes and returns the principal square root of *number*. If *number* is not complex but is negative, the result will be a complex number.

Examples:

```
(sqrt 16) => 4
(sqrt -16) => #C(0 4)
(sqrt 2) => 1.4142135
(sqrt 2.0d0) => 1.4142135623730950d0
(sqrt #C(3 4))  => #C(2.0 1.0)
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:sqrt *n* *Function*

Returns the square root of *n*. *n* must be a non-negative number.

Example:

```
(zl:sqrt 4) => 2.0
```

For a table of related items: See the section "Arithmetic Functions" in *Symbolics Common Lisp: Language Concepts.*

stable-sort *sequence predicate* &key *key* *Function*

stable-sort destructively modifies *sequence* by sorting it according to an order determined by *predicate*. **stable-sort** is the stable version of **sort**. **stable-sort** guarantees that elements considered equal by *predicate* will remain in their original order. *predicate* is assumed to consider two elements *x* and *y* to be equal if **(funcall** *predicate x y***)** and **(funcall** *predicate y x***)** are both false. **stable-sort** may be slower than **sort** in some situations.

See the function **sort**, page 493.

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sorting and Merging Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:stable-sort *x predicate* *Function*

zl:stable-sort is like **zl:sort**, but if two elements of *x* are equal, that is, *predicate* returns **nil** when applied to them in either order, then those two elements remain in their original order.

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

For a table of related items: See the section "Sorting and Merging Sequences" in *Symbolics Common Lisp: Language Concepts.*

zl:stable-sortcar *x predicate* *Function*

zl:stable-sortcar is like **zl:sortcar**, but if two elements of *x* are equal, that is, *predicate* returns **nil** when applied to their cars in either order, then those two elements remain in their original order.

For a table of related items: See the section "Functions for Sorting Lists" in *Symbolics Common Lisp: Language Concepts.*

standard-char *Type Specifier*

standard-char is the type specifier symbol for the predefined Lisp standard character data type.

The type **standard-char** is a *subtype* of the type **string-char.**

Examples:

```
(setq a-string (make-array 4 :element-type 'standard-char
                             :initial-element #\∞)) => "∞∞∞∞"
(typep #\> 'standard-char) => T
(subtypep 'standard-char 'string-char) => T and T
(string-char-p (char a-string 1)) => T
(standard-char-p '#\!) => T
(sys:type-arglist 'standard-char) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Characters" in *Symbolics Common Lisp: Language Concepts.*

standard-char-p *char* *Function*

Returns **t** if *char* is one of the Common Lisp standard characters. *char* must be a character object.

The Common Lisp standard character set includes:

```
! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _
a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
```

See the section "Type Specifiers and Type Hierarchy for Characters" in *Symbolics Common Lisp: Language Concepts.*

sys:standard-value *symbol* &key (*listener* **nil**) (*global-p* **nil**) *Function*

Returns the standard value associated with *symbol* If *global-p* is **t,** then it returns the standard value independent of any standard value bindings made with **sys:standard-value-let** or **sys:standard-value-progv.** If *listener* is non-**nil,** it must be a flavor instance that supports the standard value binding environment protocol. The value returned will be the binding specific to that environment.

You change the standard value of *symbol* with **(setf (sys:standard-value** *symbol* &key (*listener* **nil**) (*global-p* **nil**) (*setq-p* **nil**))). Note that if there is a standard value binding for *symbol*, then only the bound value is changed. The usual constraints apply to the values of *listener*.

If *setq-p* is **t**, then the value cell of *symbol* is set to the same value as the standard value.

If *global-p* is **t**, then both the standard value setting and the value cell setting, if any, are set in the global environment rather than in any exisitng binding environment.

Ordinary Symbol	*Standard Value Symbol*
(setq foo t)	(setf (sys:standard-value foo :setq-p t) t)
(zl:set-globally 'foo t)	(setf (sys:standard-value foo :global-p t :setq-p t) t)

See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts*.

sys:standard-value-let *vars-and-vals* &body *body* *Macro*

Like **let** except that it also pushes the values in *vals* onto the **si:*interactive-bindings*** alist, causing them to become the new standard bindings. All the symbols in *vars* are then bound to *vals* (with a **let**) and *body* is executed in this context.

Example:

```
(defun octal-top-level ()
  (standard-value-let
    ((base 8)
     (ibase 8)
     (package (pkg-find-package 'new-command-loop)))
    (let ((standard-io 'terminal-io))
        (loop
             as form = (read)
             do (print (eval form))))))
```

See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts*.

sys:standard-value-let* *vars-and-vals* &body *body* *Macro*

Like **let*** except that it also pushes the values in *vals* onto the **si:*interactive-bindings*** alist, causing them to become the new standard bindings. All the symbols in *vars* are then bound to *vals* (with a **let***) and *body* is executed in this context. See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts*.

sys:standard-value-p *symbol* *Function*

Returns **t** if *symbol* has a standard value. See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts.*

sys:standard-value-progv *vars vals* &body *body* *Macro*

Causes all of the symbols in *vars* to have their corresponding value in *vals* pushed onto the **si:*interactive-bindings*** alist (that is, those values become the new standard bindings). All the symbols in *vars* are then bound to *vals* (with a **zl:progv**) and *body* is executed in this context. This is useful for writing Lisp style command loops. See the section "Standard Variables" in *Symbolics Common Lisp: Language Concepts.*

zl:store-array-leader *value array index* *Function*

Stores *value* in the *index*ed element of *array*'s leader. *array* should be an array with a leader, and *index* should be an integer. *value* can be any object. **zl:store-array-leader** returns *value.*

However, the preferred method is to use **setf** and **array-leader**, as shown in the following example:

```
(make-array '(2 3) :leader-list '(t nil))
(setf (array-leader array 1) 'x)
```

stream *Type Specifier*

stream is the type specifier symbol for the predefined Lisp object of that name.

The types **stream**, **hash-table**, **readtable**, **package**, **pathname**, and **random-state** are *pairwise disjoint.*

Examples:

```
(typep *standard-input* 'stream) => T
(streamp *standard-output*) => T
(input-stream-p *standard-input*) => T
(sys:type-arglist 'stream) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Streams" in *Reference Guide to Streams, Files, and I/O.*

string *x* *Function*

string coerces *x* into a string. Most of the string functions apply this to their string arguments.

If *x* is a string, it is returned.

If *x* is a symbol, its print name is returned.

If *x* is a character, a string containing that character is returned.

If *x* is a pathname, the "string for printing" is returned. See the section "Pathname Messages".

Str

If *x* is any instance that handles the **:string-for-printing** message, a "string for printing" is returned. See the section "Pathname Messages".

string does not convert a list or other sequence of characters to be a string. Use the function **coerce** for that purpose. (Unlike **string**, **coerce** does not work for symbols, though.)

If you want to get the string representation of a number or any other Lisp object, **string** is *not* what you should use. You can use **format**, passing a first argument of **nil**. You might also want to use **with-output-to-string**, **prin1-to-string**, or **princ-to-string**.

Examples:

```
(string "a string") => "a string"
(string 'symbol) => "SYMBOL"
(string #\c) => "c"
```

The following are equivalent:

```
(string (si:patch-system-pathname "LMFS" :system-directory))
=> "SYS:LMFS;PATCH;LMFS.SYSTEM-DIR.NEWEST"

(send
 (si:patch-system-pathname "LMFS" :system-directory ) :string-for-printing)
 => "SYS:LMFS;PATCH;LMFS.SYSTEM-DIR.NEWEST"
```

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts.*

string &optional (*size* '*) *Type Specifier*

string is the type specifier symbol for the predefined Lisp string data type.

This type specifier can be used in either symbol or list form. Used in list form, **string** allows the declaration and creation of specialized types of strings whose size is restricted to *size.*

The type **string** is a *subtype* of the type **vector**; **string** means `(vector string-char)` or `(vector character)`.

The types **string**, `(vector t)`, and **bit-vector** are *disjoint.*

The type **string** is a *supertype* of the type **simple-string.**

Note that for purposes of type-checking, **typep** and **subtypep** are currently inconsistent in the kinds of strings they recognize. **typep** returns **t** for both thin strings `(vector string-char)`, and fat strings `(vector character)`. For example:

```
(equal-typep 'string '(vector string-char)) => T

(typep (make-array 1 :element-type 'character
                     :initial-element #\control-a) 'string) => T
```

subtypep on the other hand, currently recognizes only `(vector string-char)` as a string.

```
(subtypep 'string '(vector string-char)) => T and T
(subtypep 'string '(vector character)) => NIL and NIL
```

The two functions will be made congruent in the next release.

Examples:

```
(typep "1;oi498f" 'string) => T
(typep "123" '(string 3)) => T
(typep "123" '(string 5)) => NIL
(zl:typep "U.S. Telephone Area Codes") => :STRING
(subtypep 'string 'vector) => T and T
(stringp "artificial intelligence") => T
(stringp (make-array 3 :element-type 'string-char
                       :initial-element #\s
                       :fill-pointer 2)) => T
(sys:type-arglist 'string) => (&OPTIONAL (SIZE '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Strings" in *Symbolics Common Lisp: Language Concepts*.

string≠ *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string≠ returns **nil** unless *string1* is not equal to *string2*. If the condition is satisfied, **string≠** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string≠** is the function **string-not-equal**.

Examples:

```
(string≠ "apple" "apple") => NIL
(string≠ "apple" 'apple) => 0
(string≠ "apple" "apply") => 4
(string≠ "apple" "apropos") => 2
(string≠ "banana" "anachronism" :start1 1 :end1 4) => 3
(string≠ "banana" "anachronism" :start1 1 :end1 4 :end2 3) => NIL
```

The following function is a synonym of **string≠**:

string/=

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string≠ *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string≠ "apple" "apple")  => NIL
(zl:string≠ "apple" 'apple) => T
(zl:string≠ "apple" "apply") => T
(zl:string≠ "apple" "apropos") => T
(zl:string≠ "banana" "anachronism"  1 0 4) => T
(zl:string≠ "banana" "anachronism" 1 0 4 3) => NIL
```

The following functions are synonyms of **zl:string≠**:

string≠
string/=

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string≤ *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string≤ returns **nil** unless *string1* is less than or equal to *string2*. If the condition is satisfied, **string≤** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string≤** is the predicate **string-not-greaterp**.

```
(string≤ "apple" "apple") => 5
(string≤ "apple" 'apple) => NIL
(string≤ "sneeze" "snow") => 2
(string≤ "elephant" "aardvark") => NIL
(string≤ "ZY" "ab") => 0
(string≤ "painting" "interest" :start1 2 :end1 5) => 5
```

The following function is a synonym of **string≤**:

string<=

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

zl:string≤ *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string≤ "apple" "apple") => T
(zl:string≤ "apple" 'apple) => NIL
(zl:string≤ "sneeze" "snow") => T
(zl:string≤ "elephant" "aardvark") => NIL
(zl:string≤ "ZY" "ab") => T
(zl:string≤ "painting" "interest" 2 0 5) => T
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

string≥ *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string≥ returns **nil** unless *string1* is greater than or equal to *string2*. If the condition is satisfied, **string≥** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.

:end1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

:start2 and **:end2** Work in analogous fashion for *string2*.

The case-insensitive version of **string≥** is the predicate **string-not-lessp**.

Examples:

```
(string≥ "apple" "apple") => 5
(string≥ "dog" "DOG") => 0
(string≥ "flat" "flush") => NIL
(string≥ "ab" "ZY") => 0
(string≥ "detonate" "unnatural" :start1 4 :start2 2 :end2 5) => 7
(string≥ "dog" "elephant" :start2 3) => NIL
```

The following function is a synonym of **string≥**:

string>=

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

zl:string≥ *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string≥ "apple" "apple") => T
(zl:string≥ "dog" "DOG") => T
(zl:string≥ "flat" "flush") => NIL
(zl:string≥ "ab" "ZY") => T
(zl:string≥ "detonate" "unnatural" 4 2 nil 5) => T
(zl:string≥ "dog" "elephant" 0 3) => NIL
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string/= *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string/= returns **nil** unless *string1* is not equal to *string2*. If the condition is satisfied, **string/=** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string/=** is the function **string-not-equal**.

Examples:

```
(string/= "apple" "apple") => NIL
(string/= "apple" 'apple) => 0
(string/= "apple" "apply") => 4
(string/= "apple" "apropos") => 2
(string/= "banana" "anachronism" :start1 1 :end1 4) => 3
(string/= "banana" "anachronism" :start1 1 :end1 4 :end2 3) => NIL
```

The following function is a synonym of **string/=**:

string≠

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string< *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string< returns **nil** unless *string1* is less than *string2*. If the condition is satisfied, **string<** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 is less than *string2* if the first characters that differ satisfy **char<**, or if *string1* is a proper subset of *string2* (of shorter length and matches in all characters of string1).

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

Str

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string<** is the function **string-lessp**.

Examples:

```
(string< "ostrich" "giraffe") => NIL
(string< "demo" "demonstrate") => 4
(string< "abcd" "bazy") => 0
(string< "fred" "Fred") => NIL
(string< "Chicken" "chicken") => 0
(string< "apple" "nap" :start2 1) => NIL
(string< "test" "overestimate" :start1 1 :start2 4) => 5
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string< *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string< "ostrich" "giraffe") => NIL
(zl:string< "demo" "demonstrate") => T
(zl:string< "abcd" "bazy") => T
(zl:string< "fred" "Fred") => NIL
(zl:string< "Chicken" "chicken") => T
(zl:string< "apple" "nap" 0 1) => NIL
(zl:string< "test" "overestimate" 1 4) => T
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string<= *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string<= returns **nil** unless *string1* is less than *string2*. If the condition is satisfied, **string<=** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string<=** is the predicate **string-not-greaterp**.

```
(string<= "apple" "apple") => 5
(string<= "apple" 'apple) => NIL
(string<= "sneeze" "snow") => 2
(string<= "elephant" "aardvark") => NIL
(string<= "ZY" "ab") => 0
(string<= "painting" "interest" :start1 2 :end1 5) => 5
```

The following function is a synonym of **string<=**:

string≤

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

string= *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly. **string=** returns **t** if corresponding characters in the two strings are identical in all character fields, including modifier bits, character set, character style, and alphabetic case; it is false otherwise.

If the (sub)strings compared are of unequal length, **string=** is false.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string=** is the function **string-equal**.

Example:

```
(string= 'symbol "SYMBOL") => T
(string= "apple" "orange") => NIL
(string= "apple" "please" :start1 2 :end2 3) => T
(string= "apple" "APPLE") => NIL
(string= "apple" "apply") => NIL
(string= "apple" "applesauce") => NIL
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

sys:%string= *string1 index1 string2 index2 count* *Function*

This is a low-level string comparison, possibly more efficient than the other comparisons. Its only current efficiency advantage is its simplified arguments and minimized type-checking.

The function compares two strings or substrings of them, exactly. **sys:%string=** returns **t** if corresponding characters in the two strings are identical in all character fields, including modifier bits, character set, character style, and alphabetic case; otherwise it returns **nil**.

If the (sub)strings compared are of unequal length, **sys:%string=** is false.

string1 and *string2* must be strings.

index1 and *index2* specify the starting position for the search within *string1* and *string2* respectively.

count specifies the number of characters to be compared in both strings.

Examples:

```
(sys:%string= "apple" 0 "apple" 0 nil) => T
(sys:%string= "apple" 0 "APPLE" 0 nil) => NIL
(sys:%string= "ccc" 0 "cccc" 0 nil)  => NIL
(sys:%string= "ccc" 0 "cccc" 0 3) => T
(sys:%string= "anything" 3 "third" 0 3) => T
(sys:%string= "anything" 3 "third" 1 3) => NIL
(sys:%string= "moooo" 3 (make-array 5
                                    :element-type 'character
                                    :initial-element #\o) 3 nil) => T
```

The case-insensitive version of **sys:%string=** is the function

sys:%string-equal

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

zl:string= *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string= 'symbol "SYMBOL") => T
(zl:string= "apple" "orange") => NIL
(zl:string= "apple" "please" 2 0 nil 3) => T
(zl:string= "apple" "APPLE") => NIL
(zl:string= "apple" "apply") => NIL
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

The Common Lisp equivalent to **zl:string=** is the function:

string=

string> *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string> returns **nil** unless *string1* is greater than *string2*. If the condition is satisfied, **string>** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-insensitive version of **string>** is the predicate **string-greaterp**.

Examples:

```
(string> "apple" "apple") => NIL
(string> "true" "TRUE") => 0
(string> "arm" "aim") => 1
(string> "puppet" "puzzle") => NIL
(string> "book" "ball" :start1 1 :start2 2 :end2 3) => 1
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

zl:string> *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including bits, style, and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string> "apple" "apple") => NIL
(zl:string> "true" "TRUE") => T
(zl:string> "arm" "aim") => T
(zl:string> "puppet" "puzzle") => NIL
(zl:string> "book" "ball" 1 2 nil 3) => T
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

string>= *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including modifier bits, character set, character style, and alphabetic case.

string>= returns **nil** unless *string1* is greater than or equal to *string2*. If the condition is satisfied, **string>=** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.

:end1 Specifies the position within *string1* of the first

character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

:start2 and **:end2** Work in analogous fashion for *string2*.

The case-insensitive version of **string>=** is the predicate **string-not-lessp**.

Examples:

```
(string>= "apple" "apple") => 5
(string>= "dog" "DOG") => 0
(string>= "flat" "flush") => NIL
(string>= "ab" "ZY") => 0
(string>= "detonate" "unnatural" :start1 4 :start2 2 :end2 5) => 7
(string>= "dog" "elephant" :start2 3) => NIL
```

The following function is a synonym of **string>=**:

string≥

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

string-append &rest *strings* *Function*

Copies and concatenates any number of strings into a single string.

strings are strings or objects that can be coerced to strings. See the function **string**, page 502.

With a single argument, **string-append** simply copies it.

string-append returns an array of the same type as the argument with the greatest number of bits per element. For example, if the arguments are arrays with elements of type **string-char** and of type **character**, an array with elements of type **character** is returned.

The destructive version of **string-append** is the function **string-nconc**.

Example:

```
(string-append "Hell" "o") => "Hello"
(string-append #\! "foo" #\!) => "!foo!"
(string-append #\! 'foo #\!) => "!FOO!"
(string-append #\1 "2") => "12"
(string-append) => ""

(setq string (make-array 5 :element-type 'string-char
       :initial-contents "hello" :fill-pointer t)) => "hello"
(string-append string " there") => "hello there"
(string-append string #\!) => "hello!"
```

```
(setq thin-string (make-string 3)) => ""
(setq fat-string (make-array 3 :element-type 'character
                               :initial-element #\A)) => "AAA"
(setq new (string-append thin-string fat-string)) => "AAA"
(string-fat-p new) => T
```

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts.*

string-capitalize *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns a copy of *string*; for every word in the copy, the initial character, if case-modifiable, is uppercased. All other case-modifiable characters in the word are lowercased.

For the purposes of **string-capitalize**, a word is defined as a consecutive subsequence of alphanumeric characters or digits, delimited at each end either by a non-alphanumeric character, or by an end of string.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The result is always the same length as *string*, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

The destructive version of **string-capitalize** is the function **nstring-capitalize.**

Examples:

```
(string-capitalize "lexington") => "Lexington"
(string-capitalize 'symbol) => "Symbol"
(string-capitalize "one two three" :start 5) => "one tWo Three"
(string-capitalize "a MIxeD-Up sTrinG" :start 2) => "a Mixed-Up String"
(string-capitalize "a MIxeD-Up sTrinG" :start 2 :end 10) => "a Mixed-Up sTrinG"
(string-capitalize "tom&jerry aren't in room 15d")
=> "Tom&Jerry Aren'T In Room 15d"
```

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

string-capitalize-words *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns a copy of *string*, such that hyphens are changed to spaces and initial characters of each word are capitalized if they are case-modifiable.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The result is always the same length as *string*, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

The destructive version of **string-capitalize-words** is the function **nstring-capitalize-words**.

Examples:

```
(string-capitalize-words "string-capitalize-words")
=> "String Capitalize Words"

(string-capitalize-words "three-hyphenated-words" :start 6 :end 8)
=> "three-Hyphenated-words"
```


For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

zl:string-capitalize-words *string* &optional (*copy-p* **t**) *keep-hyphen* *Function*

This function changes hyphens to spaces and capitalizes each word in the argument *string*. The effect on the original argument depends on the value of *copy-p*: if *copy-p* is not **nil**, a copy of *string* is returned; this is the default; if *copy-p* is **nil**, *string* itself is modified and returned.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

You can retain hyphens in *string* by setting *keep-hyphen* to a non-**nil** value.

Examples:

```
(zl:string-capitalize-words "Lisp-listener")
=> "Lisp Listener"

(zl:string-capitalize-words "LISP-LISTENER")
=> "Lisp Listener"

(zl:string-capitalize-words "lisp--listener")
=> "Lisp  Listener"

(zl:string-capitalize-words "symbol-processor-3" t t)
=> "Symbol-Processor-3"

(zl:string-capitalize-words "use--some-hyphens" nil)
=> "Use  Some Hyphens"

(zl:string-capitalize-words "use--some-hyphens" nil t)
=> "Use  Some Hyphens"
```

The Symbolics Common Lisp equivalent to **zl:string-capitalize-words** are the functions:

nstring-capitalize-words
string-capitalize-words

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

string-char *Type Specifier*

string-char is the type specifier symbol for the predefined Lisp string character data type.

The type **string-char** is a *subtype* of the type **character.**

The type **string-char** is a *supertype* of the type **standard-char.**

Examples:

```
(setq a-string (make-array 3 :element-type 'string-char
                     :initial-element #\,))  => ",,,"

(typep (char a-string 2) 'string-char) => T

(setq b-string (make-string 9 :initial-element #\.)) => "........."

(typep (char b-string 4) 'string-char) => T

(subtypep 'string-char 'character) => T and T
```

```
(subtypep 'standard-char 'string-char) => T and T

(sys:type-arglist 'string-char) => NIL and T

(string-char-p #\g) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. For a discussion of characters: See the section "Characters" in *Symbolics Common Lisp: Language Concepts*. For a discussion of strings: See the section "Strings" in *Symbolics Common Lisp: Language Concepts*.

string-char-p *char* *Function*

Returns **t** if *char* can be stored into a thin string. *char* must be a character object. Any character that is a standard character satisfies this test.

Examples:

```
(string-char-p "r")     ;signals an error; char must be a character
(string-char-p #\∞) => T
(string-char-p #\meta-m) => NIL
```

For a table of related items: See the section "String Type-Checking Predicates" in *Symbolics Common Lisp: Language Concepts*.

string-compare *string1 string2* &key (*start1* **0**) (*start2* **0**) (*end1* **nil**) (*end2* **nil**) *Function*

Compares two strings, or substrings of them. The comparison is case-insensitive, ignoring character style and alphabetic case.

string-compare returns:

- a positive number if *string1* > *string2*
- zero if *string1* = *string2*
- a negative number if *string1* < *string2*

If the strings are not equal, the absolute value of the number returned is one more than the index (in *string1*) at which the difference occurred.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.

:end1 Specifies the position within *string1* of the first

character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

:start2 and **:end2** Work in analogous fashion for *string2*.

Examples:

```
(string-compare "one" "one") => 0
(string-compare "puppet" "puppet" :start1 3 :start2 3) => 0
(string-compare "puppet" "PUPPET") => 0
(string-compare 'symbol 'foo) => 1
(string-compare "alabaster" "alas!") => -4
(string-compare "george" "forgery" :start1 2 :start2 1 :end2 5)
 => 0
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

The case-sensitive version of **string-compare** is the function:

string-exact-compare

sys:%string-compare *string1 index1 string2 index2 count* *Function*

This is a low-level, case-insensitive string comparison, possibly more efficient than the other comparisons. Its only current efficiency advantage is its simplified arguments and minimized type-checking.

index1 and *index2* specify the starting position for the search within *string1* and *string2* respectively.

count specifies the number of characters to be compared in both strings. If *count* is nil (unspecified), the entire length of the (sub)strings is compared.

sys:%string-compare returns:

- 0 if *string1* is equal to *string2*
- a positive number if *string1* > *string2*
- a negative number if *string1* < *string2*

If the strings are not equal, the absolute value of the number returned is one more than the index in *string1* at which the difference occurred.

Examples:

```
(sys:%string-compare "tom" 0 "toM" 0 nil) => 0
(sys:%string-compare "feeding" 3 "dinner" 0 3) => 0
(sys:%string-compare "b" 0 "a" 0 nil) => 1
(sys:%string-compare "a" 0 "b" 0 nil) => -1
(sys:%string-compare "word" 0 "words" 0 nil) => -5
(sys:%string-compare "words" 0 "word" 0 nil) => 5
(sys:%string-compare "...." 0 (make-array 4
                                :element-type 'character
                                :initial-element #\.) 0 nil)  => 0
```

The case-sensitive version of **sys:%string-compare** is **sys:%string-exact-compare.**

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-compare *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1* *lim2* *Function*

Compares the characters of *string1* starting at *idx1* and ending just below *lim1* with the characters of *string2* starting at *idx2* and ending just below *lim2*. The comparison is in alphabetical order. *string1* and *string2* are strings or objects that can be coerced to strings. See the function **string**, page 502. *lim1* and *lim2* default to the lengths of the strings. **string-compare** returns:

- a positive number if *string1* > *string2*
- zero if *string1* = *string2*
- a negative number if *string1* < *string2*

If the strings are not equal, the absolute value of the number returned is one more than the index (in *string1*) at which the difference occurred.

Examples:

```
(zl:string-compare "one" "one") => 0
(zl:string-compare "puppet" "puppet"  3  3)  => 0
(zl:string-compare "puppet" "PUPPET") => 0
(zl:string-compare 'symbol 'foo) => 1
(zl:string-compare "alabaster" "alas!") => -4
(zl:string-compare "abcd" "abce" 1 1) => -3
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

The Symbolics Common Lisp equivalent to **zl:string-compare** is the function:

string-compare

string-downcase *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns a copy of *string*, with uppercase alphabetic characters replaced by the corresponding lowercase characters. (**char-downcase** is applied to each character of *string*.)

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The result is always the same length as *string*, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

Examples:

```
(string-downcase "A TITLE") => "a title"
(string-downcase "A BUNCH OF WORDS" :start 10) => "A BUNCH OF words"
(string-downcase "A BUNCH OF WORDS" :start 0 :end 1)
=> "a BUNCH OF WORDS"
(setq string "THREE UPPERCASE WORDS") => "THREE UPPERCASE WORDS"
(string-downcase string :start 0 :end 5 ) => "three UPPERCASE WORDS"
(string-downcase string :start 16 :end nil) => "THREE UPPERCASE words"
string => "THREE UPPERCASE WORDS"
```

Str

The destructive version of **string-downcase** is the function **nstring-downcase**.

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts*.

zl:string-downcase *string* &optional (*from* **0**) *to* (*copy-p* **t**) *Function*

This function replaces uppercase alphabetic characters in argument *string* with the corresponding lowercase characters. The effect on the original argument depends on the value of *copy-p*: if *copy-p* is not **nil**, a copy of *string* is returned; if *copy-p* is **nil**, *string* itself is modified and returned.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

from is the index in *string* at which to begin lowercasing characters. If *to* is supplied, it is used in place of (**array-active-length** *string*) as the index one greater than the last character to be lowercased.

Examples:

```
(zl:string-downcase "A TITLE") => "a title"
(zl:string-downcase "A BUNCH OF WORDS" 10) => "A BUNCH OF words"
(zl:string-downcase "A BUNCH OF WORDS" 0 1) => "a BUNCH OF WORDS"
(setq string "THREE UPPERCASE WORDS") => "THREE UPPERCASE WORDS"
(zl:string-downcase string 0 5 nil) => "three UPPERCASE WORDS"
(zl:string-downcase string 16 nil nil)  => "three UPPERCASE words"
string => "three UPPERCASE words"
```

The Common Lisp equivalents to **zl:string-downcase** are the functions:

nstring-downcase
string-downcase

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

string-equal *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

string-equal compares two strings, or substrings of them. The comparison ignores the character fields for character style and alphabetic case. Two characters are considered to be the same if **char-equal** is true of them.

string-equal returns **t** if the strings are the same, and **nil** otherwise. If the (sub)strings compared are of unequal length, **string-equal** is false.

string1 and *string2* are strings or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-sensitive version of **string-equal** is the predicate **string=**.

Examples:

```
(string-equal 'symbol "SYMBOL") => T
(string-equal "apple" "orange") => NIL
(string-equal "apple" "please" :start1 2 :end2 3) => T
(string-equal "apple" "APPLE") => T
(string-equal "apple" "apply") => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

sys:%string-equal *string1 index1 string2 index2 count* *Function*

This is a low-level, case-insensitive string comparison, possibly more efficient than the other comparisons. Its only current efficiency advantage is its simplified arguments and minimized type-checking. **sys:%string-equal** returns **t** if the *count* characters of *string1* starting at *idx1* are **char-equal** to the *count* characters of *string2* starting at *idx2*, or **nil** if the characters are not equal or if *count* runs off the length of either array.

Instead of an integer, *count* can also be **nil**. In this case, **sys:%string-equal** compares the substring from *idx1* to **(string-length** *string1***)** against the substring from *idx2* to **(string-length** *string2***)**. If the lengths of these substrings differ, then they are not equal and **nil** is returned.

Note that *string1* and *string2* must really be strings; the usual coercion of symbols and characters to strings is not performed. This function is documented because certain programs that require high efficiency and are willing to pay the price of less generality might want to use **sys:%string-equal** in place of **string-equal**.

Str

Examples:

To compare the two strings "hat" and "hat":

```
(sys:%string-equal "hat" 0 "hat" 0 nil) => T
```

To see if the string "Dante" starts with the characters "dan":

```
(sys:%string-equal "Dante" 0 "dan" 0 3)  => T
```

```
(setq fat-string (make-array 4 :element-type 'character
                               :initial-element #\a)) => "aaaa"
(sys:%string-equal fat-string 0 "aaaa" 0 nil) => T
```

The case-sensitive version of **sys:%string-equal** is the function:

sys:%string=

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-equal *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

string-equal compares two strings, returning **t** if they are equal and **nil** if they are not. The comparison ignores character fields for character style and alphabetic case.

zl:equal calls **zl:string-equal** if applied to two strings. *string1* and *string2* are strings or objects that can be coerced to strings. See the function **string**, page 502.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-equal "Foo" "foo") => T
(zl:string-equal "foo" "bar") => NIL
(zl:string-equal "element" "select" 0 1 3 4) => T
(zl:string-equal 'symbol "SYMBOL") => T
(zl:string-equal "apple" "orange") => NIL
(zl:string-equal "apple" "please" 2 0 nil 3) => T
(zl:string-equal "apple" "APPLE") => T
(zl:string-equal "apple" "apply") => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

The Common Lisp equivalent to **zl:string-equal** is the function:

string-equal

string-exact-compare *string1 string2* &key (*start1* **0**) (*start2* **0**) (*end1* **nil**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly including the character fields for character style and alphabetic case.

string-exact-compare returns:

- a positive number if *string1* > *string2*
- zero if *string1* = *string2*
- a negative number if *string1* < *string2*

If the strings are not equal, the absolute value of the number returned is one more than the index (in *string1*) at which the difference occurred.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

Examples:

```
(string-exact-compare "aaa" "aaa") => 0

(string-exact-compare "yo" "YO") => 1

(string-exact-compare "this is it" "This Is it") => 1

(setq fat-string (make-string 3 :initial-element #\k
                               :element-type 'character)) => "kkk"
(string-exact-compare fat-string "kkk") => 0
(string-exact-compare fat-string "asdjf") => 1

(string-exact-compare #\d "mmmm..") => -1
```

The case-insensitive version of **string-exact-compare** is the predicate:

string-compare

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

sys:%string-exact-compare *string1 index1 string2 index2 count* *Function*

This is a low-level string comparison, possibly more efficient than the other comparisons. Its only current efficiency advantage is its simplified arguments and minimized type-checking.

sys:%string-exact-compare returns:

- a positive number if *string1* > *string2*
- zero if *string1* = *string2*
- a negative number if *string1* < *string2*

string1 and *string2* must be strings.

index1 and *index2* specify the starting position for the search within *string1* and *string2* respectively.

count specifies the number of characters to be compared in both strings.

Examples:

```
(sys:%string-exact-compare "apple" 0 "apple" 0 nil) => 0
(sys:%string-exact-compare "apple" 0 "APPLE" 0 nil) => 1
(sys:%string-exact-compare "orange" 0 "organ" 0 nil) => -3
(sys:%string-exact-compare "orange" 1 "organ" 0 3) => 1
(sys:%string-exact-compare "hello" 1 "yelp!" 1 2) => 0
(sys:%string-exact-compare "hello" 1 "yelp!" 1 3) => -3
(sys:%string-exact-compare "aaaa" 0 (make-array 4
                                      :element-type 'character
                                      :initial-element #\a) 0 nil) => 0
```

The case-insensitive version of **sys:%string-exact-compare** is the function **sys:%string-compare.**

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-exact-compare *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This is a comparison predicate that compares two strings or substrings of them, exactly, depending on all fields including character style and alphabetic case.

zl:string-exact-compare returns:

- a positive number if *string1* > *string2*
- zero if *string1* = *string2*
- a negative number if *string1* < *string2*

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-exact-compare "apple" "apple") => 0
(zl:string-exact-compare "APPLE" "apple") => -1
(zl:string-exact-compare "orange" "organ") => -3
(zl:string-exact-compare "airplane" "aardvark") => 2
(zl:string-exact-compare "baseball" "seven" 2) => -3
(zl:string-exact-compare "flight" "salient" 1 2 nil 5) => 3
```

For a table of related items: See the section "Case-Sensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-fat-p *string* *Function*

The predicate **string-fat-p** returns **t** if its argument is a string array whose elements are of type **character** rather than of type **string-char**. Array-elements of type **character** are wider characters with bits holding information about modifier bits, character set, and character style.

It is an error if the argument is not a string.

Examples:

```
(string-fat-p "string") => NIL

(string-fat-p "string") => T

(string-fat-p (string-append "fred" #\meta-q)) => T

(string-fat-p (make-string 3 :initial-element #\hyper-super-a)) => T

(string-fat-p (make-string 3 :element-type 'character)) => T

(string-fat-p (make-array 4 :element-type 'character
                            :initial-element #\a)) => T

(string-fat-p 4) => NIL
```

For a table of related items: See the section "String Type-Checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-flipcase *string* &key (*start* **0**) (*end* **nil**) *Function*

The function **string-flipcase** returns a copy of *string*, with uppercase alphabetic characters replaced by the corresponding lowercase characters, and with lowercase alphabetic characters replaced by the corresponding uppercase characters.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for case changing. These keyword arguments must be non-negative integer indices into the string array. The result is always the same length as *string*, however.

:start Specifies the position within *string* from which to begin case changing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the case changing operation. Default is **nil**, that is, the operation continues to the end of the string.

Examples:

```
(string-flipcase "a sTrANGe UsE OF CaPitalS")
=> "A StRangE uSe of cApITALs"

(string-flipcase 'symbol) => "symbol"
(string-flipcase 'symbol :start 2 :end 4) => "SYmbOL"
(string-flipcase "End" :start 2) => "EnD"
(string-flipcase "STRing") => "strING"
```

The destructive version of **string-flipcase** is the function:

nstring-flipcase

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

zl:string-flipcase *string* &optional (*from* **0**) *to* (*copy-p* **t**) *Function*

This function reverses the alphabetic case in its argument: it changes uppercase alphabetic characters to lowercase and lowercase characters to uppercase. The effect on the original argument depends on the value of *copy-p*: if *copy-p* is not **nil**, a copy of *string* is returned; this is the default; if *copy-p* is **nil**, *string* itself is modified and returned.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

from is the index in *string* at which to begin exchanging the case of

characters. If *to* is supplied, it is used in place of **(array-active-length** *string***)** as the index one greater than the last character whose case is to be exchanged.

Examples:

```
(zl:string-flipcase "small LARGE") => "SMALL large"
(zl:string-flipcase "small LARGE" 6) => "small large"
(zl:string-flipcase "small LARGE" 1 3) => "sMAll LARGE"
(setq string "STRing") => "STRing"
(zl:string-flipcase string 0 nil nil) => "strING"
(zl:string-flipcase string 0 nil nil) => "STRing"
```

The Symbolics Common Lisp equivalents to **zl:string-flipcase** are the functions:

string-flipcase
nstring-flipcase

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

string-greaterp *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

Str

string-greaterp returns **nil** unless *string1* is greater than *string2*. If the condition is satisfied, **string-greaterp** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.

:end1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

:start2 and **:end2** Work in analogous fashion for *string2*.

The case-sensitive version of **string-greaterp** is the predicate **string>**.

Examples:

```
(string-greaterp "apple" "apple") => NIL
(string-greaterp "true" "TRUE") => NIL
(string-greaterp "arm" "aim") => 1
(string-greaterp "puppet" "puzzle") => NIL
(string-greaterp "book" "ball" :start1 1 :start2 2 :end2 3) => 1
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-greaterp *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1* *lim2* *Function*

This compares two strings or substrings of them. The comparison ignores the character fields for character style and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-greaterp "apple" "apple") => NIL
(zl:string-greaterp "true" "TRUE") => NIL
(zl:string-greaterp "arm" "aim") => T
(zl:string-greaterp "puppet" "puzzle") => NIL
(zl:string-greaterp "book" "ball" 1 2 0 3) => T
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-left-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the beginning.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, an array of characters, or a string of characters.

Examples:

```
(string-left-trim '(#\p) "pop") => "op"
(string-left-trim #(#\sp) "  spaces   ") => "spaces   "
(string-left-trim "atn" "attack at dawn") => "ck at dawn"
```

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts*.

zl:string-left-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the beginning.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, or a string of characters.

Str

Examples:

```
(zl:string-left-trim '(#/p) "pop") => "op"
(zl:string-left-trim "atn" "attack at dawn") => "ck at dawn"
```

The Common Lisp equivalent to **zl:string-left-trim** is the function:

string-left-trim

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts*.

string-length *string* *Function*

string-length returns the number of characters in *string*.

string must be a string or an object that can be coerced into a string. See the function **string**, page 502.

string-length returns the **zl:array-active-length** if *string* is a string, or the **zl:array-active-length** of the print name if *string* is a symbol.

Examples:

```
(string-length "mississippi") => 11
(string-length 'alabama) => 7
(string-length
  (make-array 10 :element-type 'string-char :fill-pointer 7)) => 7
(string-length #\4) => 1
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts.*

string-lessp *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

string-lessp returns **nil** unless *string1* is less than *string2*. If the condition is satisfied, **string-lessp** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 is less than *string2* if the first characters that differ satisfy **char-lessp**, or if *string1* is a proper subset of *string2* (of shorter length and matches in all characters of string1).

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-sensitive version of **string-lessp** is the predicate **string<**.

Examples:

```
(string-lessp "ostrich" "giraffe") => NIL
(string-lessp "demo" "demonstrate") => 4
(string-lessp "abcd" "bazy") => 0
(string-lessp "fred" "Fred") => NIL
(string-lessp "Chicken" "chicken") => NIL
(string-lessp "apple" "nap" :start2 1) => NIL
(string-lessp "test" "overestimate" :start1 1 :start2 4) => 5
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-lessp *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This compares two strings using alphabetical order (as defined by **char-lessp**). The result is **t** if *string1* is the lesser, or **nil** if they are equal or *string2* is the lesser.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-lessp "ostrich" "giraffe") => NIL
(zl:string-lessp "demo" "demonstrate") => T
(zl:string-lessp "abcd" "bazy") => T
(zl:string-lessp "fred" "Fred") => NIL
(zl:string-lessp "Chicken" "chicken") => NIL
(zl:string-lessp "apple" "nap" 0 1) => NIL
(zl:string-lessp "test" "overestimate" 1 4) => T
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-nconc *modified-string* &rest *strings* *Function*

string-nconc is the destructive version of **string-append**. Instead of making a new string containing the concatenation of its arguments, **string-nconc** modifies its first argument.

modified-string must be a string with a fill-pointer so that additional characters can be tacked onto it.

The value of **string-nconc** is *modified-string* or a new, longer copy of it if the strings don't fit; in the latter case the original copy is forwarded to the new copy. See the function **adjust-array**, page 16.

Unlike **nconc**, **string-nconc** with more than two arguments modifies only its first argument, not every argument but the last.

Examples:

```
(setq string (make-array 5 :element-type 'string-char
       :initial-contents "hello" :fill-pointer 5)) => "hello"
(string-nconc string " there")  => "hello there"
(string-nconc string #\!) => "hello there!"
string => "hello there!"
```

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts*.

zl:string-nconc *to-string* &rest *strings* *Function*

zl:string-nconc is like **string-append** except that instead of making a new string containing the concatenation of its arguments, **zl:string-nconc** modifies its first argument.

to-string must be a string with a fill-pointer so that additional characters can be tacked onto it. See the function **zl:array-push-extend**, page 33.

The value of **zl:string-nconc** is *to-string* or a new, longer copy of it; in the latter case the original copy is forwarded to the new copy. See the function **zl:adjust-array-size**, page 16.

Unlike **nconc**, **zl:string-nconc** with more than two arguments modifies only its first argument, not every argument but the last.

The Symbolics Common Lisp equivalent to **zl:string-nconc** is the function:

string-nconc

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts*.

string-nconc-portion *to-string {from-string from to} ...* *Function*

Adds information onto a string without allocating intermediate substrings.

to-string must be a string with a fill-pointer so that additional characters can be added onto it. The remaining arguments can be any number of "string portion specs", which are string/from/to triples. *from* and *to* are required but can be **nil** and **nil**. Even though the arguments are called strings, they can be anything that can be coerced to a string with **string** (for example, symbols or characters).

The value of **string-nconc-portion** is *to-string* or a new, longer copy of it; in the latter case the original copy is forwarded to the new copy (see **zl:adjust-array-size**).

string-nconc-portion is like **string-nconc** except that it takes parts of strings without consing substrings.

Example:

```
(let ((a (make-array 10 :element-type 'string-char :fill-pointer 0)))
        (zl:string-nconc-portion a 'xxxfoobar 3 nil
                                  #\sp nil nil
                                  "tempstuff" 0 4)) => "FOOBAR temp"
```

string-nconc-portion uses **zl:array-push-portion-extend** internally, which uses **zl:adjust-array-size** to take care of growing the *to-string* if necessary.

For a table of related items: See the section "String Construction" in *Symbolics Common Lisp: Language Concepts*.

Str

string-not-equal *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

string-not-equal returns **nil** unless *string1* is not equal to *string2*. If the condition is satisfied, **string-not-equal** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1 Specifies the position within *string1* from which to

begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.

:end1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

:start2 and **:end2** Work in analogous fashion for *string2*.

The case-sensitive version of **string-not-equal** is the predicate **string≠**.

Examples:

```
(string-not-equal "apple" "apple") => NIL
(string-not-equal "apple" 'apple) => NIL
(string-not-equal "apple" "apply") => 4
(string-not-equal "apple" "apropos") => 2
(string-not-equal "banana" "anachronism" :start1 1 :end1 4) => 3
(string-not-equal "banana" "anachronism" :start1 1 :end1 4 :end2 3) => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

zl:string-not-equal *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1* *lim2* *Function*

This compares two strings or substrings of them. The comparison ignores character fields for character style and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-not-equal "apple" "apple") => NIL
(zl:string-not-equal "apple" 'apple) => NIL
(zl:string-not-equal "apple" "apply") => T
(zl:string-not-equal "apple" "apropos") => T
(zl:string-not-equal "banana" "anachronism" 1 0 4) => T
(zl:string-not-equal "banana" "anachronism" 1 0 4 3) => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-not-greaterp *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

string-not-greaterp returns **nil** unless *string1* is less than or equal to *string2*. If the condition is satisfied, **string-not-greaterp** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-sensitive version of **string-not-greaterp** is the predicate **string≤**.

Examples:

```
(string-not-greaterp "apple" "apple") => 5
(string-not-greaterp "apple" 'apple) => 5
(string-not-greaterp "sneeze" "snow") => 2
(string-not-greaterp "elephant" "aardvark") => NIL
(string-not-greaterp "ZY" "ab") => NIL
(string-not-greaterp "painting" "interest" :start1 2 :end1 5) => 5
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-not-greaterp *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1 lim2* *Function*

This compares two strings or substrings of them. The comparison ignores character fields for character style and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-not-greaterp "apple" "apple") => T
(zl:string-not-greaterp "apple" 'apple) => T
(zl:string-not-greaterp "sneeze" "snow") => T
(zl:string-not-greaterp "elephant" "aardvark") => NIL
(zl:string-not-greaterp "ZY" "ab") => NIL
(zl:string-not-greaterp "painting" "interest" 2 0 5) => T
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-not-lessp *string1 string2* &key (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

string-not-lessp returns **nil** unless *string1* is greater than or equal to *string2*. If the condition is satisfied, **string-not-lessp** returns the position within the strings of the first character at which the strings fail to match; this index is equivalent to the length of the longest common portion of the strings.

string1 and *string2* must be strings, or objects that can be coerced to strings. See the function **string**, page 502.

The keywords let you specify substrings of the two string arguments for comparison. These keyword arguments must be non-negative integer indices into the string array.

:start1	Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.
:start2 and **:end2**	Work in analogous fashion for *string2*.

The case-sensitive version of **string-not-lessp** is the predicate **string≥**.

Examples:

```
(string-not-lessp "apple" "apple") => 5
(string-not-lessp "dog" "DOG") => 3
(string-not-lessp "flat" "flush") => NIL
(string-not-lessp "ab" "ZY") => NIL
(string-not-lessp "detonate" "unnatural" :start1 4 :start2 2 :end2 5) => 7
(string-not-lessp "dog" "elephant" :start2 3) => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts.*

zl:string-not-lessp *string1 string2* &optional (*idx1* **0**) (*idx2* **0**) *lim1* *lim2* *Function*

This is a comparison predicate that compares two strings, or substrings of them. The comparison ignores character fields for character style and alphabetic case.

The optional arguments let you specify substrings of the two string arguments for comparison.

idx1 Specifies the position within *string1* from which to begin the comparison (counting from 0). Default is 0, the first character in the string.

idx2 Specifies the position within *string2* from which to begin the comparison. Default is 0.

lim1 Specifies the position within *string1* of the first character beyond the end of the comparison. Default is **nil**, that is, the operation continues to the end of the string.

lim2 Specifies the position within *string2* of the first character beyond the end of the comparison. Default is **nil**.

Examples:

```
(zl:string-not-lessp "apple" "apple") => T
(zl:string-not-lessp "dog" "DOG") => T
(zl:string-not-lessp "flat" "flush") => NIL
(zl:string-not-lessp "ab" "ZY") => NIL
(zl:string-not-lessp "detonate" "unnatural" 4 2 0 5) => NIL
(zl:string-not-lessp "dog" "elephant" 0 3) => NIL
```

For a table of related items: See the section "Case-Insensitive String Comparison Predicates" in *Symbolics Common Lisp: Language Concepts*.

string-nreverse *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns *string* with the order of characters reversed, modifying the original string, rather than creating a new one. This reverses a one-dimensional array of any type. If *string* is a character, it is simply returned.

If *string* is not a string or another one-dimensional array, it is coerced into a string. Since **string-nreverse** is destructive, coercion should be used with care since a string internal to the object might be modified. See the function **string**, page 502.

The keywords let you select portions of the string argument for reversing. These keyword arguments must be non-negative integer indices into the string array. The entire argument, *string*, is returned, however.

:start Specifies the position within *string* from which to begin reversing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the reversing operation. Default is **nil**, that is, the operation continues to the end of the string.

The nondestructive version of **string-nreverse** is the function **string-reverse**.

Examples:

```
(setq a "bloom") => "bloom"
(string-nreverse a) => "moolb"
a => "moolb"
(string-nreverse "mysbolics" :start 0 :end 3) => "symbolics"
```

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

zl:string-nreverse *string* *Function*

Returns *string* with the order of characters reversed, modifying the original string, rather than creating a new one. This reverses a one-dimensional array of any type. If *string* is a character, it is simply returned.

If *string* is not a string or another one-dimensional array, it is coerced into a string. Note that because of its destructive nature, zl:nreverse does not accept symbol arguments. Since **string-nreverse** is destructive, coercion should be used with care since a string internal to the object might be modified. See the function **string**, page 502.

Examples:

```
(zl:string-nreverse 'symbol)
        ;signals an error: "illegal to modify the pname of a symbol"
(zl:string-nreverse "word") => "drow"
(setq string "two words") => "two words"
(zl:string-nreverse string) => "sdrow owt"
string  => "sdrow owt"
```

Str

The Symbolics Common Lisp equivalent to **zl:string-nreverse** is the function:

string-nreverse

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

stringp *object* *Function*

stringp returns **t** if its argument is a string, otherwise **nil.**

A string is a one-dimensional array whose elements can be of type **string-char** or **character**; since **stringp** is a supertype of **simple-string-p**, it always returns **t** for any object of which **simple-string-p** is **t.**

Unlike arrays of type **simple-string**, an array of type **string** can have a fill pointer and displacement (that is, it can be extended, and its contents can be shared with other array objects).

The function **stringp** is an extension of its Common Lisp counterpart, since it returns **t** for arrays with elements of type **character** as well as for arrays of type **string-char.**

Examples:

```
(stringp "string") => T

(stringp 'symbol) => NIL

(stringp 123) => NIL

(stringp (make-string 3 :initial-element #\a)) => T

(stringp (make-string 3 :initial-element #\a
                        :element-type 'character)) => T

(stringp (make-array 5 :element-type 'string-char
                       :fill-pointer 8) => T

(stringp (make-array 4 :element-type 'character
                       :fill-pointer 3)) => T

(simple-string-p (make-array 5 :element-type 'string-char
                               :fill-pointer 8)) => NIL
```

For a table of related items: See the section "String Type-Checking Predicates" in *Symbolics Common Lisp: Language Concepts.*

string-pluralize *string* *Function*

string-pluralize returns a copy of its string argument containing the plural of the word in *string*. Any added characters go in the same case as the last character of *string*.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

Examples:

```
(string-pluralize "event") => "events"
(string-pluralize "Man") => "Men"
(string-pluralize "Can") => "Cans"
(string-pluralize "key") => "keys"
(string-pluralize "TRY") => "TRIES"
(string-pluralize 'part) => "PARTS"
```

For words with multiple plural forms depending on the meaning, **string-pluralize** cannot always do the right thing.

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

zl:string-pluralize *string* *Function*

zl:string-pluralize returns a copy of its string argument containing the plural of the word in *string*. Any added characters go in the same case as the last character of *string*.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

Examples:

```
(zl:string-pluralize "event") => "events"
(zl:string-pluralize "Man") => "Men"
(zl:string-pluralize "Can") => "Cans"
(zl:string-pluralize "key") => "keys"
(zl:string-pluralize "TRY") => "TRIES"
(zl:string-pluralize "child") => "children"
```

For words with multiple plural forms depending on the meaning, **zl:string-pluralize** cannot always do the right thing.

The Symbolics Common Lisp equivalent to **zl:string-pluralize** is the function:

string-pluralize

string-reverse *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns a copy of *string* with the order of characters reversed. This reverses a one-dimensional array of any type. If *string* is not a string or another one-dimensional array, it is coerced into a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for reversing. These keyword arguments must be non-negative integer indices into the string array. The entire argument, *string*, is returned, however.

:start Specifies the position within *string* from which to begin reversing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the reversing operation. Default is **nil**, that is, the operation continues to the end of the string.

The generic function **reverse** also works on strings.

The destructive version of **string-reverse** is **string-nreverse**.

Examples:

```
(string-reverse #\a) => "a"
(string-reverse 'symbol) => "LOBMYS"
(string-reverse "a string") => "gnirts a"
(string-reverse "end" :start 1) => "edn"
(string-reverse "start" :end 3) => "atsrt"
(string-reverse "middle" :start 1 :end 5) => "mlddie"
```

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse *string* *Function*

Returns a copy of *string* with the order of characters reversed. This reverses a one-dimensional array of any type. If *string* is not a string or another one-dimensional array, it is coerced into a string. See the function **string**, page 502.

Examples:

```
(zl:string-reverse #/a) => "a"
(zl:string-reverse 'symbol) => "LOBMYS"
(zl:string-reverse "a string") => "gnirts a"
(zl:string-reverse "end" 1)     ;signals an error
```

The Symbolics Common Lisp equivalent to **zl:string-reverse** is the function:

string-reverse

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search *key string* &optional *from* (*to* **0**) (*key-start* **0**) *key-end* *Function*

zl:string-reverse-search searches for the string *key* in the string *string*, using **string-equal** to do the comparison. The search proceeds in reverse order, starting from the index one less than *from*, which defaults to the length of *string*, and returns the index of the first (leftmost) character of the first instance found, or **nil** if none is found. Note that the index returned is from the beginning of the string, although the search starts from the end. The *from* condition, restated, is that the instance of *key* found is the rightmost one whose rightmost character is before the *from*'th character of *string*. If the *to* argument is supplied, it limits the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-reverse-search "na" "banana") => 4
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search-char *char string* &optional *from* (*to* **0**) *Function*

zl:string-reverse-search-char searches through *string* in reverse order, starting from the index one less than *from*, which defaults to the length of *string*, and returns the index of the first character that is **char-equal** to *char*, or **nil** if none is found. Note that the index returned is from the beginning of the string, although the search starts from the end. If the *to* argument is supplied, it limits the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-reverse-search-char #/n "banana") => 4
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts*.

zl:string-reverse-search-exact *key string* &optional *from* (*to* **0**) (*key-start* **0**) *key-end* *Function*

This searches one string for another, comparing characters exactly and depending on all fields including bits, style, and alphabetic case. Substrings of either argument can be specified.

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts*.

zl:string-reverse-search-exact-char *char string* &optional *from* (*to* **0**) *Function*

Searches a string or a substring for the specified character, starting from the end of the string. In other words, it searches the string for the last occurrence of the specified character. It compares all fields of the character, including bits, style, and alphabetic case. Use the optional *from* argument to end the search at the specified position.

zl:string-reverse-search-exact-char returns:

- The position of the last occurrence of the character if the character is found.
- **nil** if the character is not contained within the string.

For example:

```
(zl:string-reverse-search-exact-char #/a "bbab") => 2

(zl:string-reverse-search-exact-char #/a "bbaba") => 4

(zl:string-reverse-search-exact-char #/a "bbb") => NIL

(zl:string-reverse-search-exact-char #/a "bAcBA") => NIL
```

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search-not-char *char string* &optional *from* (*to* **0**) *Function*

zl:string-reverse-search-not-char searches through *string* in reverse order, starting from the index one less than *from*, which defaults to the length of *string*, and returns the index of the first character that is not **char-equal** to *char*, or **nil** if none is found. Note that the index returned is from the beginning of the string, although the search starts from the end. If the *to* argument is supplied, it limits the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-reverse-search-not-char #/a "banana") => 4
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search-not-exact-char *char string* &optional *from* (*to* **0**) *Function*

Searches a string or a substring for occurrences of any character other than the specified character, starting from the end of the string. It compares all fields of the character, including bits, style, and alphabetic case. Use the optional *from* argument to end the search at the specified position.

zl:string-reverse-search-not-exact-char returns:

- The position of the last occurrence of a character that does not match the specified character.
- **nil** if the string contains only the specified character.

For example:

```
(zl:string-reverse-search-not-exact-char #/a "aaa") => nil

(zl:string-reverse-search-not-exact-char #/a "bbab") => 3

(zl:string-reverse-search-not-exact-char #/a "bbaba") => 3

(zl:string-reverse-search-not-exact-char #/a "bbb") => 2

(zl:string-reverse-search-not-exact-char #/a "bAcBA") => 4
```

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search-not-set *char-set string* &optional *from* (*to* **0**) *Function*

zl:string-reverse-search-not-set searches through *string* in reverse order, starting from the index one less than *from*, which defaults to the length of *string*, and returns the index of the first character that is not **char-equal** to any element of *char-set*, or **nil** if none is found. Note that the index returned is from the beginning of the string, although the search starts from the end. If the *to* argument is supplied, it limits the extent of the search. *char-set* is a set of characters, which can be represented as a list of characters or a string of characters. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502.

```
(zl:string-reverse-search-not-set '(#/a #/n) "banana") => 0
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-reverse-search-set *char-set string* &optional *from* (*to* **0**) *Function*

zl:string-reverse-search-set searches through *string* in reverse order, starting from the index one less than *from*, which defaults to the length of *string*, and returns the index of the first character that is **char-equal** to some element of *char-set*, or **nil** if none is found. Note that the index returned is from the beginning of the string, although the search starts from the end. If the *to* argument is supplied, it limits the extent of the search. *char-set* is a set of characters, which can be represented as a list of characters or a string of characters. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502.

```
(zl:string-reverse-search-set "ab" "banana") => 5
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-right-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the end.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, an array of characters, or a string of characters.

Examples:

```
(string-right-trim '(#\4) "456454") => "45645"
(string-right-trim #(#\t #\h) "that tooth") => "that too"
(string-right-trim "o" "otto") => "ott"
```

Related Functions:

string-trim
string-left-trim

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

zl:string-right-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the end.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, or a string of characters.

Examples:

```
(zl:string-right-trim '(#/4) "456454") => "45645"
(zl:string-right-trim "o" "otto") => "ott"
```

The Common Lisp equivalent to **zl:string-right-trim** is the function:

string-right-trim

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

string-search *key string* &key *from-end* (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

Searches *string* looking for occurrences of *key*. The search uses **char-equal** which ignores character fields for character style and alphabetic case.

string-search returns **nil**, or the position of the first character of *key* occurring in the (sub)string. To reverse the search, returning the position of the last occurrence of the initial *key* character in the (sub)string searched, specify a non-**nil** value for **:from-end**.

key and *string* must be strings, or objects that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched, as well as the parts of *key* to search for. These keyword arguments must be non-negative integer indices into the string array.

:from-end If a non-**nil** value is specified, returns the position of the first character of the *last* occurrence of *key* in the string or the specified substring.

:start1	Specifies the position within *key* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *key* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *key* is used.
:start2 and **:end2**	Work analogously for *string*.

Examples:

```
(string-search "es" "witches") => 5
(string-search "es" "tresses") => 2
(string-search "es" "tresses" :from-end t) => 5
(string-search "er" "tresses") => NIL
(string-search "er" "tresses" :from-end t) => NIL
(string-search "es" "tresses" :start2 3) => 5

(string-search #\a "banana") => 1


(string-search 'symbol "abolish" :start1 3) => 1
(string-search 'symbol "abolish" :start1 3 :end2 3) => NIL
```

The case-sensitive version of **string-search** is the function:

string-search-exact

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts*.

zl:string-search *key string* &optional (*from* **0**) *to* (*key-start* **0**) *key-end* *Function*

zl:string-search searches for the string *key* in the string *string*, using **string-equal** to do the comparison. The search begins at *from*, which defaults to the beginning of *string*. The value returned is the index of the first character of the first instance of *key*, or **nil** if none is found. If the *to* argument is supplied, it is used in place of (**string-length** *string*) to limit the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-search "an" "banana") => 1
(zl:string-search "an" "banana" 2) => 3
(zl:string-search "es" "witches") => 5
(zl:string-search "es" "tresses")  => 2
(zl:string-search "er" "tresses")  => NIL
```

The Symbolics Common Lisp equivalent to **zl:string-search** is the function:

string-search

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-char *char string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for the character *char*. The search uses **char-equal**, which ignores the character fields for character style and alphabetic case.

string-search-char returns **nil** if it does not find *char*; if successful, it returns the position of the first occurrence of *char*. To reverse the search, returning the position of the last occurrence of *char* in the (sub)string searched, set **:from-end** to **t**.

char must be a character object.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end	If set to a non-**nil** value, returns the position of the *last* occurrence of *char* in the string or the specified substring.
:start	Specifies the position within *string* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.
:end	Specifies the position within *string* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *string* is searched.

Examples:

```
(string-search #\? "banana") => NIL
(string-search-char #\a "banana") => 1
(string-search-char #\a "banana" :from-end t) => 5
(string-search-char #\a "banana" :start 1 :end 3) => 1
(string-search-char #\a "banana" :start 1 :end 4 :from-end t) => 3
(string-search-char #\A "banana" ) => 1
```

The case-sensitive version of **string-search-char** is the function:

string-search-exact-char

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

sys:%string-search-char *char string start end* *Function*

This is a low-level string search, possibly more efficient than the other searching functions. Its only current efficiency advantage is its simplified arguments and minimized type-checking.

string must be an array;

char must be a character;

from, and *to* must be integers.

Except for this lack of type-coercion, and the fact that none of the arguments is optional, **sys:%string-search-char** is the same as **zl:string-search-char**. This function is documented for the benefit of those who require the maximum possible efficiency in string searching.

Examples:

```
(sys:%string-search-char #\a
    (make-array 4 :element-type 'character
                  :initial-element #\a) 2 4)  => 2
(sys:%string-search-char #\p "zippy" 0 90) => 2
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-char *char string* &optional (*from* **0**) *to* *Function*

zl:string-search-char searches through *string* starting at the index *from*, which defaults to the beginning, and returns the index of the first character that is **char-equal** to *char*, or **nil** if none is found. If the *to* argument is supplied, it is used in place of (**string-length** *string*) to limit the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502.

Example:

```
(zl:string-search #\? "banana") => NIL
(zl:string-search-char #\a "banana") => 1
(zl:string-search-char #\a "banana") => 1
(zl:string-search-char #\a "banana"  1  3) => 1
(zl:string-search-char #\a "banana" 1 4 ) => 1
```

The Symbolics Common Lisp equivalent to **zl:string-search-char** is the function:

string-search-char

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-exact *key string* &key *from-end* (*start1* **0**) (*end1* **nil**) (*start2* **0**) (*end2* **nil**) *Function*

Searches *string* looking for occurrences of *key*. The search compares all characters exactly, using all character fields including character style and alphabetic case.

string-search-exact returns **nil**, or the position of the first character of *key* occurring in the (sub)string. To reverse the search, returning the position of the last occurrence of the initial *key* character in the (sub)string searched, specify a non-**nil** value for **:from-end**.

key and *string* must be strings, or objects that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched, as well as the parts of *key* to search for. These keyword arguments must be non-negative integer indices into the string array.

:from-end	If a non-**nil** value is specified, returns the position of the first character of the *last* occurrence of *key* in the string or the specified substring.
:start1	Specifies the position within *key* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start1** must be ≤ **:end1**.
:end1	Specifies the position within *key* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *key* is used.
:start2 and **:end2**	Work analogously for *string*.

Examples:

```
(setq a-string (make-string 3 :initial-element #\a))  => "aaa"
(string-search-exact #\a a-string) => 0

(string-search-exact #\a "AAA") => NIL

(string-search-exact #\a "bbbabba") => 3

(string-search-exact #\a "aaabAcBA") => 0

(string-search-exact #\a "abbbacccbaddda" :from-end 2 )  => 13
```

The case-insensitive version of **string-search-exact** is the function:

string-search

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-exact *key string* &optional (*from* **0**) *to* (*key-start* **0**) *key-end* *Function*

This searches one string for another, comparing characters exactly and depending on all fields including bits, style, and alphabetic case. Substrings of either argument can be specified.

Examples:

```
(setq a-string (make-string 3 :initial-element #\a))  => "aaa"
(zl:string-search-exact #\a a-string) => 0

(zl:string-search-exact #\a "AAA") => NIL

(zl:string-search-exact #\a "bbbabba") => 3

(zl:string-search-exact #\a "aaabAcBA") => 0
```

The Symbolics Common Lisp equivalent to **zl:string-search-exact** is the function:

string-search-exact

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-exact-char *char string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for the character, *char*. The search compares all characters exactly, using all character fields including character style and alphabetic case.

string-search-exact-char returns **nil** if it does not find *char*; if successful, it returns the position of the first occurrence of *char* in the string or substring searched. To reverse the search returning the position of the *last* occurrence of *char* in the (sub)string searched, specify a non-**nil** value for the keyword **:from-end**.

char must be a character object.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end	If set to a non-**nil** value, returns the position of the *last* occurrence of *char* in the string or the specified substring.
:start	Specifies the position within *string* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end.**
:end	Specifies the position within *string* of the first character beyond the end of the search. Default is **nil,** that is the entire length of *string* is searched.

Examples:

```
(string-search-exact-char #\a "bbab") => 2

(string-search-exact-char #\a "abbaba") => 0

(string-search-exact-char #\a "bbAAaAAab") => 4

(string-search-exact-char #\a "bAcBA")  => NIL

(string-search-exact-char #\a "abbababba"
                          :from-end 2 :start 3 :end 9) => 8
```

The case-insensitive version of **string-search-exact-char** is the function:

string-search-char

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

sys:%string-search-exact-char *char string start end* *Function*

This is a low-level string search, possibly more efficient than the other searching functions. Its only current efficiency advantage is its simplified arguments and minimized type-checking.

The function returns **nil** if unsuccessful, or the position in the string of the character sought for. Count starts at zero.

Examples:

```
(sys:%string-search-exact-char #\a
  (make-array 4 :element-type 'character :initial-element #\a) 0 9)
 => 0

(sys:%string-search-exact-char #\i "Garfield" 0 6)  => 4
```

```
(sys:%string-search-exact-char #\I "Garfield" 0 6)  => NIL
```

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-exact-char *char string* &optional (*from* **0**) *to* *Function*

Searches a string or a substring for the specified character, comparing all fields of the character, including, style, and alphabetic case. Use the optional *to* argument to end the search at the specified position.

zl:string-search-exact-char returns:

- The position of the first occurrence of the character in the string.
- **nil** if the character is not contained within the string.

For example:

```
(zl:string-search-exact-char #\a "bbab") => 2
(zl:string-search-exact-char #\A "abattoir") => NIL

(zl:string-search-exact-char #\a "abbaba") => 0

(zl:string-search-exact-char #\a "bbAAaAAab") => 4

(zl:string-search-exact-char #\meta-A "bAcBA")  => NIL
```

Str

The Symbolics Common Lisp equivalent to **zl:string-search-exact-char** is the function:

string-search-exact-char

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-not-char *char string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for occurrences of any character other than *char*. The search uses **char-equal**, which ignores the character fields for character style and alphabetic case.

string-search-not-char returns **nil**, or the position of the first occurrence of any character that is not *char*. To reverse the search, returning the position of the last occurrence of a character other than *char* in the (sub)string searched, specify **t** for the keyword argument **:from-end**.

char must be a character object.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end If it has a non-**nil** value, returns the position of the *last* occurrence of a character that does not match *char* in the string or the specified substring.

:start Specifies the position within *string* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *string* is searched.

Examples:

```
(string-search-not-char #\E "eel") => 2
(string-search-not-char #\l "oscillate") => 0
(string-search-not-char #\l "oscillate" :start 5) => 6
(string-search-not-char #\l "oscillate" :start 5 :from-end t) => 8
(string-search-not-char #\l "oscillate" :start 2 :end 5 :from-end t) => 3
```

The case-sensitive version of **string-search-not-char** is the function:

string-search-not-exact-char

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts*.

zl:string-search-not-char *char string* &optional (*from* **0**) *to* *Function*

zl:string-search-not-char searches through *string* starting at the index *from*, which defaults to the beginning, and returns the index of the first character which is not **char-equal** to *char*, or **nil** if none is found. If the *to* argument is supplied, it is used in place of (**string-length** *string*) to limit the extent of the search. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-search-not-char #\b "banana") => 1
(zl:string-search-not-char #\n "banana" 2) => 3
(zl:string-search-not-char #\n "banana" 2 3) => NIL
(zl:string-search-not-char #\E "eel") => 2
(zl:string-search-not-char #\l "oscillate") => 0
(zl:string-search-not-char #\l "oscillate" 5) => 6
(zl:string-search-not-char #\l "oscillate" 2  5 ) => 2
```

The Symbolics Common Lisp equivalent to **zl:string-search-not-char** is the function:

string-search-not-char

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-not-exact-char *char string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for occurrences of any character other than *char*. The search compares all characters exactly, using all character fields including character style and alphabetic case.

string-search-not-exact-char returns **nil**, or the position of the first occurrence of any character that is not *char*. To reverse the search, returning the position of the last occurrence of a character other than *char* in the (sub)string searched, specify **t** for the keyword argument **:from-end**.

char must be a character object.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end	If it has a non-**nil** value, returns the position of the *last* occurrence of a character that does not match *char* in the string or the specified substring.
:start	Specifies the position within *string* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.
:end	Specifies the position within *string* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *string* is searched.

Examples:

```
(setq a-string (make-string 3 :initial-element #\a)) => "aaa"
(string-search-not-exact-char #\a a-string) => NIL

(string-search-not-exact-char #\a "AAA") => 0

(string-search-not-exact-char #\a "bbba") => 0

(string-search-not-exact-char #\a "aaabAcBA") => 3

(string-search-not-exact-char #\a
                "abbacccaccca" :from-end 3 :start 2 :end 9) => 8
```

The case-insensitive version of **string-search-not-exact-char** is the function:

string-search-not-char

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-not-exact-char *char string* &optional (*from* **0**) *to* *Function*

Searches a string or a substring for the first occurrence of any character other than the specified character. It compares all fields of the character, including bits, style, and alphabetic case. Use the optional *to* argument to end the search at the specified position.

zl:string-search-not-exact-char returns:

- The position of the first character in the string that does not match the specified character.
- **nil** if the string contains only the specified character.

For example:

```
(setq a-string (make-string 3 :initial-element #\a))  => "aaa"
(zl:string-search-not-exact-char #\a a-string) => NIL

(zl:string-search-not-exact-char #\a "AAA")  => 0

(zl:string-search-not-exact-char #\a "bbba") => 0

(zl:string-search-not-exact-char #\a "aaabAcBA") => 3
```

The Symbolics Common Lisp equivalent to **zl:string-search-not-exact-char** is the function:

string-search-not-exact-char

For a table of related items: See the section "Case-Sensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-search-not-set *char-set string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for a character that is not in *char-set.* The search uses **char-equal**, which ignores the character fields for character style and alphabetic case.

string-search-not-set returns **nil**, or the position of the first character that is not **char-equal** to some element of the *char-set.* To reverse the search, returning the position of the last occurrence of a character not in *char-set* in the (sub)string searched, specify **t** for the keyword argument **:from-end**.

char-set is a set of characters which can be represented as a list of characters, an array of characters, or a string of characters.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end	If a non-**nil** value is specified, returns the position of the *last* occurrence of a character not in *char-set* in the (sub)string searched.
:start	Specifies the position within *string* from which to begin the search (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end.**
:end	Specifies the position within *string* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *string* is searched.

Str

Examples:

```
(string-search-not-set #(#\a) "aaa") => NIL
(string-search-not-set '(#\h #\i) "hi") => NIL
(string-search-not-set '(#\a) "bcaa")  => 0
(string-search-not-set '(#\a #\b #\c) "abcdefabc") => 3
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-not-set *char-set string* &optional (*from* **0**) *to* *Function*

zl:string-search-not-set searches through *string* looking for a character that is not in *char-set*. The search begins at the index *from*, which defaults to the beginning. It returns the index of the first character that is not **char-equal** to any element of *char-set*, or **nil** if none is found. If the *to* argument is supplied, it is used in place of (**string-length** *string*) to limit the extent of the search. *char-set* is a set of characters, which can be represented as a list of characters or a string of characters. *string* is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-search-not-set '(#\a #\b) "banana") => 2
(zl:string-search-not-set '(#\h #\i) "hi")  => NIL
(zl:string-search-not-set '(#\a) "bcaa")  => 0
(zl:string-search-not-set '(#\a #\b #\c) "abcdefabc") => 3
```

The Symbolics Common Lisp equivalent to **zl:string-search-not-set** is the function:

string-search-not-set

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts*.

string-search-set *char-set string* &key *from-end* (*start* **0**) (*end* **nil**) *Function*

Searches *string* looking for a character that is in *char-set*. The search uses **char-equal**, which ignores the character fields for character style and alphabetic case.

string-search-set returns **nil**, or the position of the first character that is **char-equal** to some element of the *char-set*. To reverse the search, returning the position of the last occurrence of the initial character of *char-set* in the (sub)string searched, set **:from-end** to **t**.

char-set is a set of characters which can be represented as a list of characters, an array of characters, or a string of characters.

string must be a string, or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you specify the parts of *string* to be searched. These keyword arguments must be non-negative integer indices into the string array.

:from-end If set to a non-**nil** value, returns the position of the *last* occurrence of the first character of *char-set* in the string or the specified substring.

:start Specifies the position within *string* from which to begin the search (counting from 0). Default is 0,

the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the search. Default is **nil**, that is the entire length of *string* is searched.

Examples:

```
(string-search-set #(#\a) "aaa") => 0
(string-search-set '(#\h #\i) "hi") => 0
(string-search-set '(#\a) "bcaa") => 2
(string-search-set '(#\a #\b #\c) "abcdefabc") => 0
(string-search-set #(#\a #\. #\h) "ping...ahh...haaa") => 4
```

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

zl:string-search-set *char-set string* &optional (*from* **0**) *to* *Function*

zl:string-search-set searches through *string* looking for a character that is in *char-set.* The search begins at the index *from*, which defaults to the beginning. It returns the index of the first character that is **char-equal** to some element of *char-set*, or **nil** if none is found. If the *to* argument is supplied, it is used in place of **(string-length** *string***)** to limit the extent of the search.

char-set is a set of characters, which can be represented as a list of characters or a string of characters.

string is a string or an object that can be coerced to a string. See the function **string**, page 502. Example:

```
(zl:string-search-set '(#\h #\i) "hi") => 0
(zl:string-search-set '(#\a) "bcaa") => 2
(zl:string-search-set '(#\a #\b #\c) "abcdefabc") => 0
```

The Symbolics Common Lisp equivalent to **zl:string-search-set** is the function:

string-search-set

For a table of related items: See the section "Case-Insensitive String Searches" in *Symbolics Common Lisp: Language Concepts.*

string-to-ascii *lispm-string* *Function*

Converts *lispm-string* to an **sys:art-8b** array containing ASCII character codes. See the section "ASCII Characters" in *Symbolics Common Lisp: Language Concepts.*

Example:

```
(string-to-ascii "hello") => #<ART-8B-5 24443106>
```

For a table of related items: See the section "ASCII String Functions" in *Symbolics Common Lisp: Language Concepts.*

string-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the beginning and end. *string* itself is not modified.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, an array of characters, or a string of characters.

Examples:

```
(string-trim '(#\sp) "  Dr. No  ") => "Dr. No"
(string-trim #(#\a #\b) "abbafooabb") => "foo"
(string-trim "ab" "abbafooabb") => "foo"
```

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

zl:string-trim *char-set string* *Function*

This returns a substring of *string*, with all characters in *char-set* stripped off the beginning and end. *string* itself is not modified.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

char-set is a set of characters, that can be represented as a list of characters, or a string of characters.

Examples:

```
(zl:string-trim '(#\sp) "    blank    ") => "blank"
(zl:string-trim "ab" "abbafooabb") => "foo"
```

The Common Lisp equivalent to **zl:string-trim** is the function:

string-trim

For a table of related items: See the section "String Manipulation" in *Symbolics Common Lisp: Language Concepts.*

string-upcase *string* &key (*start* **0**) (*end* **nil**) *Function*

Returns a copy of *string*, with lowercase alphabetic characters replaced by the corresponding uppercase characters. (**char-upcase** is applied to each character of *string*.)

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

The keywords let you select portions of the string argument for uppercasing. These keyword arguments must be non-negative integer indices into the string array. The result is always the same length as *string*, however.

:start Specifies the position within *string* from which to begin uppercasing (counting from 0). Default is 0, the first character in the string. **:start** must be ≤ **:end**.

:end Specifies the position within *string* of the first character beyond the end of the uppercasing operation. Default is **nil**, that is, the operation continues to the end of the string.

The destructive version **string-upcase** is the function **nstring-upcase**.

Examples:

```
(string-upcase 'fred) => "FRED"
(string-upcase "window") => "WINDOW"
(string-upcase "miXEd-uP") => "MIXED-UP"
(string-upcase "") => ""
(string-upcase "17.'≤αh") => "17.'≤αH"
(string-upcase "end" :start 1) => "eND"
(string-upcase "middle" :start 2 :end 4) => "miDDle"
(zl:string-upcase a 2 4) => "a STring"
(zl:string-upcase a 5 7) => "a strINg"
(zl:string-upcase a 2 4 nil) => "a STring"
(zl:string-upcase a 5 7 nil) => "a STrINg"
(setq a "a string")  => "a string"
(string-upcase a :start 2 :end 4) => "a STring"
```

Str

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

zl:string-upcase *string* &optional (*from* **0**) *to* (*copy-p* **t**) *Function*

This function replaces lowercase alphabetic characters in argument *string* with the corresponding uppercase characters. The effect on the original argument depends on the value of *copy-p*: if *copy-p* is not **nil**, a copy of *string* is returned; if *copy-p* is **nil**, *string* itself is modified and returned.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

from is the index in *string* at which to begin uppercasing characters. If *to* is supplied, it is used in place of (**array-active-length** *string*) as the index one greater than the last character to be uppercased.

Examples:

```
(zl:string-upcase 'fred) => "FRED"
(zl:string-upcase "window") => "WINDOW"
(zl:string-upcase "miXEd-uP") => "MIXED-UP"
(zl:string-upcase "") => ""
(zl:string-upcase "17.'≤αh") => "17.'≤αH"
(zl:string-upcase "end" 1) => "eND"
(zl:string-upcase "middle" 2 4) => "miDDle"
(zl:string-upcase "mixed up fonts") => "MIXED UP FONTS"
(setq a "a string") => "a string"
(zl:string-upcase a 2 4) => "a STring"
(zl:string-upcase a 5 7) => "a strINg"
(zl:string-upcase a 2 4 nil) => "a STring"
(zl:string-upcase a 5 7 nil) => "a STrINg"
```

The Common Lisp equivalent to **zl:string-upcase** are the functions:

string-upcase
nstring-upcase

For a table of related items: See the section "String Conversion" in *Symbolics Common Lisp: Language Concepts.*

structure &optional *(name '*)* *Type Specifier*

structure is the type specifier symbol denoting instances of a structure. When a new structure is defined with **defstruct**, the name of the structure type becomes a valid type symbol, and individual instances of that structure become valid types of **structure** that can be tested with **typep**.

structure is a subtype of **t**.

Examples:

```
(defstruct ship
   x-position
   y-position) => SHIP
(setq my-boat (make-ship)) => #S(SHIP :X-POSITION NIL
                                      :Y-POSITION NIL)
(typep my-boat '(structure ship)) => T
(zl:typep my-boat) => SHIP
(type-of my-boat) => SHIP
(sys:type-arglist 'structure) => (&OPTIONAL (NAME '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Structure Macros" in *Symbolics Common Lisp: Language Concepts.*

zl:sub1 *x* *Function*

(zl:sub1 *x***)** is the same as **(-** *x* **1)**.

The following functions are synonyms of **zl:sub1**:

1-
zl:1-$

sublis *alist tree* &rest *args* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

sublis makes non-destructive substitutions for objects in a tree (a structure of conses). The first argument to **sublis** is an association list, or alist. The second argument is the tree in which the substitutions are to be made, as for **subst**. **sublis** looks at all the subtrees and leaves of the tree. If a subtree or leaf appears as a key in the association list (that is, the key and the subtree or leaf satisfy the predicate specified by the **:test** keyword), it is replaced by the datum it is associated with. The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

In effect, **sublis** can perform several **subst** operations simultaneously. For example:

```
(setq exp '((* x y) (+ x y))) => ((* X Y) (+ X Y))

(sublis '((x . 100)) exp) => ((* 100 Y) (+ 100 Y))
```

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

zl:sublis *alist tree* *Function*

zl:sublis makes substitutions for symbols in a tree. The first argument to **zl:sublis** is an association list. See the section "Association Lists" in *Symbolics Common Lisp: Language Concepts*. The second argument is the tree in which substitutions are to be made. **zl:sublis** looks at all symbols in the fringe of the tree; if a symbol appears in the association list, occurrences of it are replaced by the object with which it is associated. The argument is not modified; new conses are created where necessary and only where

necessary, so the newly created tree shares as much of its substructure as possible with the old. For example, if no substitutions are made, the result is just the old tree. Example:

```
(zl:sublis '((x . 100) (z . zprime))
           '(plus x (minus g z x p) 4))
  => (plus 100 (minus g zprime 100 p) 4)
```

zl:sublis could have been defined by:

```
(defun sublis (alist sexp)
  (cond ((symbolp sexp)
         (let ((tem (assq sexp alist)))
           (if tem (cdr tem) sexp)))
        ((listp sexp)
         (let ((car (sublis alist (car sexp)))
               (cdr (sublis alist (cdr sexp))))
           (if (and (eq (car sexp) car) (eq (cdr sexp) cdr))
               sexp
               (cons car cdr))))
        (t
         (sexp))))
```

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:subrp *arg* *Function*

zl:subrp returns **t** if its argument is any compiled code object, otherwise **nil**. The Symbolics Common Lisp does not use the term "subr"; the name of this function comes from Maclisp.

subseq *sequence start* &optional *end* *Function*

subseq returns the subsequence of *sequence* specified by **:start** and **:end**. **subseq** always allocates a new sequence for a result, and never shares storage with an old sequence. The result subsequence is always of the same type as *sequence.*

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

For example:

```
(subseq #(1 2 3 4 5) 3 5) => #(4 5)
```

Note *start* and *end* are not keywords.

setf can be used with **subseq** to destructively replace a subsequence with a sequence of new values. See the function **replace**, page 448. See the function **substitute**, page 574. For example:

```
(setq num-list '(1 2 3 4 5)) => (1 2 3 4 5)

(setf (subseq num-list 2 4) '(0 0)) => (0 0)

num-list => (1 2 0 0 5)
```

For a table of related items: See the section "Sequence Construction and Access" in *Symbolics Common Lisp: Language Concepts.*

zl:subset *predicate list* &rest *extra-lists* *Function*

zl:subset and **zl:rem-if-not** do the same thing, but they are used in different contexts. **zl:rem-if-not** means "remove if this condition is not true"; that is, it keeps the elements for which *predicate* is true. **zl:subset** refers to the function's action if *list* is considered to represent a mathematical set.

predicate should be a function of one argument, if there are no *extra-lists* arguments. A new list is made by applying *predicate* to all of the elements of *list* and removing the ones for which the predicate returns **nil**.

If *extra-lists* is present, each element of *extra-lists* (that is, each further argument to **zl:subset** or **zl:rem-if-not**) is a list of objects to be passed to *predicate* as *predicate*'s second argument, third argument, and so on. The reason for this is that *predicate* might be a function of many arguments; *extra-lists* lets you control what values are passed as additional arguments to *predicate*. However, the list returned by **zl:subset** or **zl:rem-if-not** is still a "subset" of those values that were passed as the *first* argument in the various calls to *predicate*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:subset-not *predicate list* &rest *extra-lists* *Function*

zl:subset-not and **zl:rem-if** do the same thing, but they are used in different contexts. **zl:rem-if** means "remove if this condition is true". **zl:subset-not** refers to the function's action if *list* is considered to represent a mathematical set.

predicate should be a function of one argument, if there are no *extra-lists* arguments. A new list is made by applying *predicate* to all the elements of *list* and removing the ones for which the predicate returns non-**nil**.

If *extra-lists* is present, each element of *extra-lists* (that is, each further argument to **zl:subset-not** or **zl:rem-if**) is a list of objects to be passed to *predicate* as *predicate*'s second argument, third argument, and so on. The reason for this is that *predicate* might be a function of many arguments; *extra-lists* lets you control what values are passed as additional arguments to *predicate*. However, the list returned by **zl:subset-not** or **zl:rem-if** is still a "subset" of those values that were passed as the *first* argument in the various calls to *predicate*.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts*.

subsetp *list1 list2* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

subsetp is a predicate that is true if every element of *list1* appears in *list2*, and false otherwise.

```
(setq a-list '(loon stork heron)) => (LOON STORK HERON)

(setq b-list '(loon owl stork eagle heron)) =>
(LOON OWL STORK EAGLE HERON)

(subsetp a-list b-list) => T

(subsetp b-list a-list) => NIL
```

The keywords are:

:test	Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.
:test-not	Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.
:key	If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts*.

subst *new old tree* &rest *args* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *Function*

subst makes a copy of *tree*, substituting *new* for every subtree or leaf of tree (whether the subtree or leaf is a *car* or *cdr* of its parent) such that *old* and the subtree or leaf satisfy the predicate specified by the **:test** keyword.

It returns the modified copy of *tree*, and the original tree is unchanged, although it may share with parts of the result tree. For example:

```
(setq bird-list '(waders (flamingo stork) raptors (eagle hawk))) =>
(WADERS (FLAMINGO STORK) RAPTORS (EAGLE HAWK))

(subst 'heron 'stork bird-list) =>
(WADERS (FLAMINGO HERON) RAPTORS (EAGLE HAWK))
```

The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:subst *new old tree* *Function*

(zl:subst *new old tree***)** substitutes *new* for all occurrences of *old* in *tree*, and returns the modified copy of *tree*. The original *tree* is unchanged, as **zl:subst** recursively copies all of *tree* replacing elements **zl:equal** to *old* as it goes. Example:

```
(zl:subst 'Tempest 'Hurricane
       '(Shakespeare wrote (The Hurricane)))
=> (Shakespeare wrote (The Tempest))
```

zl:subst could have been defined by:

```
(defun subst (new old tree)
    (cond ((equal tree old) new) ;if item equal to old, replace.
          ((atom tree) tree)     ;if no substructure, return arg.
          ((cons (subst new old (car tree))  ;otherwise recurse.
                 (subst new old (cdr tree))))))
```

Note that this function is not "destructive"; that is, it does not change the *car* or *cdr* of any existing list structure.

To copy a tree, use **zl:copytree**; the old practice of using **zl:subst** to copy trees is unclear and obsolete.

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

subst-if *new predicate tree* &rest *args* &key *key* *Function*

subst-if makes a copy of *tree*, substituting *new* for every subtree or leaf of *tree* such that *old* and the subtree or leaf satisfy the test specified by predicate. It returns the modified copy of tree, and the original tree is unchanged, although it may share with parts of the result tree. For example:

```
(setq item-list '(numbers (1.0 2 5/3) symbols (foo bar))) =>
(NUMBERS (1.0 2 5/3) SYMBOLS (FOO BAR))

(subst-if '3.1415 #'numberp item-list) =>
(NUMBERS (3.1415 3.1415 3.1415) SYMBOLS (FOO BAR))

item-list => (NUMBERS (1.0 2 5/3) SYMBOLS (FOO BAR))
```

The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

subst-if-not *new predicate tree* &rest *args* &key *key* *Function*

subst-if-not makes a copy of *tree*, substituting *new* for every subtree or leaf of *tree* such that *old* and the subtree or leaf do not satisfy the test specified by *predicate.* It returns the modified copy of tree, and the original tree is unchanged, although it may share with parts of the result tree. For example:

```
(setq item-list '(numbers (1.0 2 5/3) symbols (foo bar))) =>
(NUMBERS (1.0 2 5/3) SYMBOLS (FOO BAR))

(subst-if-not '3.1415 #'numberp item-list) =>
(3.1415 (1.0 2 5/3) 3.1415 (3.1415 3.1415))

item-list => (NUMBERS (1.0 2 5/3) SYMBOLS (FOO BAR))
```

The keyword is:

:key If not **nil**, should be a function of one argument that will extract from an element the part to be tested in place of the whole element.

For a table of related items: See the section "Functions for Modifying Lists" in *Symbolics Common Lisp: Language Concepts.*

substitute *newitem olditem sequence* &key (*test* #'**eql**) *test-not* (*key* #'**identity**) *from-end* (*start* **0**) *end count* *Function*

substitute returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying the predicate specified by the **:test** keyword are replaced by *newitem.* This is a non-destructive operation, and the result is a copy of *sequence* with some elements changed.

For example:

```
(setq letters '(a b c))  => (A B C)
(substitute 'a 'b '(a b c)) => (A A C)
letters => (A B C)

(substitute 'b 'c letters) => (A B B)
letters  => (A B C)
```

newitem and *olditem* can be any Symbolics Common Lisp object but must be a suitable element for the *sequence.*

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

:test specifies the test to be performed. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is true. Where *testfun* is the test function specified by **:test**, *keyfn* is the function specified by **:key** and *x* is an element of the sequence. The default test is **eql**.

For example:

```
(substitute 0 3 '(1 1 4 4 2) :test #'<)  => (1 1 0 0 2)
```

:test-not is similar to **:test**, except that the sense of the test is inverted. An element of *sequence* satisfies the test if (**funcall** *testfun item* (*keyfn x*)) is false.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(substitute 1 2 '((1 1) (1 2) (4 3)) :key #'second)  => ((1 1) 1 (4 3))

(substitute 'a 'b '((a b) (b c) (b b)) :key #'cadr)  => (A (B C) A)
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(substitute 'hi 'b '(b a b) :from-end t :count 1 )
 => (B A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(substitute 'a 'b '(b a b) :start 1 :end 3) => (B A A)

(substitute 'a 'b '(b a b) :end 2) => (A A B)

(substitute 'a 'b '(b a b) :end 3) => (A A A)
```

The :count argument, if specified, limits the number of elements altered. If more than **:count** elements satisfy the predicate, then only the leftmost **:count** elements are replaced.

For example:

```
(substitute 'a 'b '(b b a b b) :count 3)  => (A A A A B)
```

The result of the **substitute** function can share cells with the argument sequence. A list can share a tail with an input list, and the result can be **eq** to the input *sequence* if no elements need to be changed.

See the function **subst**, page 571.

substitute is the non-destructive version of **nsubstitute**.

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts*.

substitute-if *newitem predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

substitute-if returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** and satisfying *predicate* are replaced by *newitem*. This is a non-destructive operation, and the result is a copy of *sequence* with some elements changed.

For example:

```
(setq numbers '(0 1 19))  => (0 1 19)
(substitute-if 1 #'zerop numbers) => (1 1 19)
numbers  => (0 1 19)

(substitute-if 2 #'numberp numbers)  => (2 2 2)
numbers  => (0 1 19)
```

newitem can be any Symbolics Common Lisp object but must be a suitable element for the *sequence*.

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(substitute-if 1 #'oddp '((1 1) (1 2) (4 3)) :key #'second)
 => (1 (1 2) 1)
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(substitute-if 'hi #'atom '(b 'a b) :from-end t :count 1 )
 => (B 'A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(substitute-if 1 #'zerop '(0 1 0) :start 1 :end 3)
 => (0 1 1)

(substitute-if 1 #'zerop '(0 1 0) :start 0 :end 2)
=> (1 1 0)

(substitute-if 1 #'zerop '(0 1 0)  :end 1)
=> (1 1 0)
```

A non-**nil** **:count**, if supplied, limits the number of elements altered; if more than **:count** elements satisfy the test, then of these elements only the leftmost are replaced, as many as specified by **:count**

For example:

```
(substitute-if 'see 'atom  '(b b a b b) :count 3)
 => (SEE SEE SEE B B)
```

substitute-if is the non-destructive version of **nsubstitute-if.**

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

substitute-if-not *newitem predicate sequence* &key *key from-end* (*start* **0**) *end count* *Function*

substitute-if-not returns a sequence of the same type as *sequence* that has the same elements, except that those in the subsequence delimited by **:start** and **:end** that do not satisfy *predicate* are replaced by *newitem.* This is a non-destructive operation, and the result is a copy of *sequence* with some elements changed.

For example:

```
(setq numbers '(0 0 0))=> (0 0 0)
(substitute-if-not 1 #'numberp numbers) => (0 0 0)
numbers => (0 0 0)

(substitute-if-not 2 #'consp numbers)  => (2 2 2)
numbers => (0 0 0)
```

newitem can be any Symbolics Common Lisp object but must be a suitable element for the *sequence.*

predicate is the test to be performed on each element.

sequence can be either a list or a vector (one-dimensional array). Note that **nil** is considered to be a sequence, of length zero.

The value of the keyword argument **:key**, if non-**nil**, is a function that takes one argument. This function extracts from each element the part to be tested in place of the whole element.

For example:

```
(substitute-if-not 1 #'oddp '((1 1) (1 2) (4 3)) :key #'second)
 => ((1 1) 1 (4 3))
```

A non-**nil** **:from-end** specification matters only when the **:count** argument is provided; in that case only the rightmost **:count** elements satisfying the test are replaced.

For example:

```
(substitute-if-not 'hi #'atom '('b a 'b) :from-end t :count 1 )
=> ('B A HI)
```

Use the keyword arguments **:start** and **:end** to delimit the portion of the sequence to be operated on.

:start and **:end** must be non-negative integer indices into the sequence. **:start** must be less than or equal to **:end**, else an error is signalled. It defaults to zero (the start of the sequence).

:start indicates the start position for the operation within the sequence. **:end** indicates the position of the first element in the sequence *beyond* the end of the operation. It defaults to **nil** (the length of the sequence).

If both **:start** and **:end** are omitted, the entire sequence is processed by default.

For example:

```
(substitute-if-not 1 #'zerop '(3 0 2) :start 1 :end 3)
=> (3 0 1)

(substitute-if-not 1 #'zerop '(3 0 2) :start 0 :end 2)
=> (1 0 2)

(substitute-if-not 1 #'zerop '(3 0 2)  :end 1)
=> (1 0 2)
```

A non-**nil** **:count**, if supplied, limits the number of elements altered; if more than **:count** elements satisfy the test, then of these elements only the leftmost are replaced, as many as specified by **:count**

For example:

```
(substitute-if-not 'see 'consp  '(b b a b b) :count 3)
=> (SEE SEE SEE B B)
```

substitute-if-not is the non-destructive version of **nsubstitute-if-not.**

For a table of related items: See the section "Sequence Modification" in *Symbolics Common Lisp: Language Concepts.*

substring *string from* &optional *to* (*area* **nil**) *Function*

This extracts a substring of *string*, starting at the character specified by *from* and going up to but not including the character specified by *to*.

string is a string or an object that can be coerced to a string. See the function **string**, page 502.

from and *to* are 0-origin indices. The length of the returned string is *to* minus *from*. If *to* is not specified it defaults to the length of *string*. The area in which the result is to be consed can be optionally specified.

The destructive version of **substring** is the function **nsubstring**.

Examples:

```
(substring "Nebuchadnezzar" 4 8) => "chad"
(substring "Nebuchadnezzar" 4) => "chadnezzar"
(substring 'string 1 4) => "TRI"
(setq a "Aloysius") => "Aloysius"
(setq b (substring a 2 4)) => "oy"
(nstring-upcase b) => "OY"
(substring a 0) => "Aloysius"
```

For a table of related items: See the section "String Access and Information" in *Symbolics Common Lisp: Language Concepts*.

subtypep *type1 type2* *Function*

Compares the two type specifiers, *type1* and *type2*. **subtypep** is true if *type1* is definitely a subtype of *type2*. If the result is **nil**, however, *type1* may or may not be a subtype of *type2* (sometimes it is impossible to tell, especially when **satisfies** type specifiers are involved). A second returned value indicates the certainty of the result; if it is true, then the first value is an accurate indication of the subtype relationship. Thus, **subtypep** returns one of three possible result combinations:

t t	*type1* is definitely a subtype of *type2*.
nil t	*type1* is definitely not a subtype of *type2*.
nil nil	**subtypep** could not determine the relationship.

The arguments *type1* and *type2* must be type specifiers that are acceptable to **typep**. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

Examples:

```
(subtypep 'single-float 'float) => T and T ; subtype and certain
(subtypep 'bit '(number 0 4)) => T and T
(subtypep 'array t) => T and T
(subtypep 'common t) => T and T
(subtypep 'signed-byte 'bit) => NIL and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

sum Keyword For loop

sum *expr* {*data-type*} {**into** *var*}

Evaluates *expr* on each iteration, and accumulates the sum of all the values. *data-type* defaults to **number**, which for all practical purposes is **notype**. Note that specifying *data-type* implies that *both* the sum and the number being summed (the value of *expr*) is of that type. When the epilogue of the **loop** is reached, *var* has been set to the accumulated result and can be used by the epilogue code.

It is safe to reference the values in *var* during the loop, but they should not be modified until the epilogue code for the loop is reached.

The forms **sum** and **summing** are synonymous.

Examples:

```
(defun geometric-s (num)
  (loop for i from 1 to num
        sum i into sum-var
        finally (print sum-var)))  => GEOMETRIC-S
(geometric-s 5) =>
15 NIL
```

Is equivalent to

```
(defun geometric-s (num)
  (loop for i from 1 to num
        summing i into sum-var
        finally (print sum-var))) => GEOMETRIC-S
(geometric-s 5) =>
15 NIL
```

Not only can there be multiple accumulations in a **loop**, but a single accumulation can come from multiple places *within the same* **loop** form, if the types of the collections are compatible. **sum** and **count** are compatible.

See the section "**loop** Clauses", page 310.

svref *array* &rest *subscript* *Function*

Returns the element of the vector selected by *subscript*. The first argument must be a simple vector. The *subscript* must be an integer.

zl:swapf *a b* *Macro*

Exchanges the value of one generalized variable with that of another. *a* and *b* are access-forms suitable for **setf**. The returned value is not defined. All the caveats that apply to **incf** apply to **zl:swapf** as well: Forms within *a* and *b* can be evaluated more than once. (**rotatef** does not evaluate any form within *a* and *b* more than once.)

Examples:

```
(swapf a b)
   ==> (setf a (prog1 b (setf b a)))
   ==> (setq a (prog1 b (setq b a)))

(swapf (car (foo)) (car (bar)))
   ==> (setf (car (foo)) (prog1 (car (bar)) (setf (car (bar)) (car (foo)))))
   ==> (rplaca (foo) (prog1 (car (bar)) (rplaca (bar) (car (foo)))))
```

Note that in the second example the functions **foo** and **bar** are called twice.

See the section "Generalized Variables" in *Symbolics Common Lisp: Language Concepts.*

:swap-hash *key value* *Message*

This does the same thing as **zl:puthash**, but returns different values. If there was an existing entry in the hash table whose key was *key*, then it returns the old associated value as its first returned value, and **t** as its second returned value. Otherwise it returns two values, **nil** and **nil**. This message will be removed in the future – use **swaphash** instead.

swaphash *key value hash-table* *Function*

This does the same thing as **zl:puthash**, but returns different values. If there was an existing entry in *hash-table* whose key was *key*, then it returns the old associated value as its first returned value, and **t** as its second returned value. Otherwise it returns two values, **nil** and **nil**.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:swaphash-equal *key value hash-table* *Function*

This does the same thing as **zl:puthash**, but returns different values. If there was an existing entry in *hash-table* whose key was *key*, then it returns the old associated value as its first returned value, and **t** as its

second returned value. Otherwise it returns two values, **nil** and **nil**. This function will be removed in the future – use **swaphash** instead.

sxhash *x* *Function*

sxhash computes a hash code of an object, and returns it as a fixnum. A property of **sxhash** is that **(equal** *x y***)** always implies **(= (sxhash** *x***) (sxhash** *y***))**. The number returned by **sxhash** is always a nonnegative fixnum, possibly a large one. **sxhash** tries to compute its hash code in such a way that common permutations of an object, such as interchanging two elements of a list or changing one character in a string, always changes the hash code.

sxhash is the same as **si:equal-hash**, except that **sxhash** returns 0 as the hash value for objects with data types like arrays, stack groups, or closures. As a result, hashing such structures could degenerate to the case of linear search.

symbol *Type Specifier*

symbol is the type specifier symbol for the predefined Lisp symbol data type.

The types **symbol**, **cons**, **array**, **number**, and **character** are *pairwise* disjoint.

The type **symbol** is a *supertype* of the type **null**.

Examples:

```
(typep 'word 'symbol) => T
(zl:typep t) => :SYMBOL
(subtypep 'symbol 'common) => T and T
(sys:type-arglist 'symbol) => NIL and T
(symbolp 'time) => T
(nsymbolp 'it) => NIL
(symbol-package nil) => #<Package COMMON-LISP 35470675>
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*. See the section "Symbols and Keywords" in *Symbolics Common Lisp: Language Concepts*.

symbol-function *symbol* *Function*

Returns the current global function definition named by *symbol*. If *symbol* has no function definition, signals an error. The definition can be a function or an object representing a special form or macro. If the definition is an object representing special form or a macro, it is an error to try to invoke the object as a function. See the section "Functions Relating to the Function Cell of a Symbol" in *Symbolics Common Lisp: Language Concepts*.

symbol-name *symbol* *Function*

Returns the print name of *symbol.*

symbolp *arg* *Function*

symbolp returns **t** if its argument is a symbol, otherwise **nil.**

symbol-package *symbol* *Function*

Returns the contents of *symbol*'s package cell, which is the package that owns *symbol,* or **nil** if *symbol* is uninterned.

symbol-plist *symbol* *Function*

Returns the list that represents the property list of *symbol.* Note that this is not the property list itself; you cannot do **get** on it. You must give the symbol itself to **get** or use **getf.**

You can use **setf** to destructively replace the entire property list of a symbol; however, this is potentially dangerous since it may destroy information that the Lisp system has stored on the property list. You also must be careful to make the new property list a list of even length.

See the section "Functions Relating to the Property List of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

symbol-value *symbol* *Function*

Returns the current value of the dynamic (special) variable named *symbol.* This is the function called by **eval** when it is given a symbol to evaluate. If the symbol is unbound, then **symbol-value** causes an error. Constant symbols are really variables whose values cannot be changed. You can use **symbol-value** to get the value of such a constant. **symbol-value** of a keyword returns that keyword.

symbol-value works only on special variables. It cannot find the value of a lexical variable.

See the section "Functions Relating to the Value of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

symbol-value-globally *var* *Function*

Works like **symbol-value** but returns the global value of a special variable regardless of any bindings currently in effect (in the current stack group).

symbol-value-globally does not work on local (lexical) variables.

You can use **setf** with **symbol-value-globally** to bind the global value of a special variable. **(setf (symbol-value-globally** *function*)) ...) is the same as **zl:set-globally** and supersedes **zl:setq-globally.**

See the section "Functions Relating to the Value of a Symbol" in *Symbolics Common Lisp: Language Concepts.*

symbol-value-in-closure *closure ptr* *Function*

This returns the binding of *symbol* in the environment of *closure*; that is, it returns what you would get if you restored the value cells known about by *closure* and then evaluated *symbol*. This allows you to "look around inside" a dynamic closure. If *symbol* is not closed over by *closure*, this is just like **user::symvol-value**.

See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

symbol-value-in-instance *instance symbol* &optional *no-error-p* *Function*

You can use this function to read, alter, or locate an instance variable inside a particular instance, regardless of whether the instance variable was declared in the **defflavor** form to be a **:readable-instance-variable**, **:gettable-instance-variable**, **:writable-instance-variable**, **:settable-instance-variable**, or a **:locatable-instance-variable**.

instance is the instance to be examined, and *symbol* is the instance variable. If there is no such instance variable, an error is signalled, unless *no-error-p* is non-**nil**, in which case **nil** is returned.

To read the value of an instance variable:

```
(scl:symbol-value-in-instance instance symbol))
```

To alter the value of an instance variable:

```
(setf (scl:symbol-value-in-instance instance symbol) value)
```

To get a locative pointer to the cell inside an instance that holds the value of an instance variable:

```
(locf (scl:symbol-value-in-instance instance symbol))
```

zl:symeval *symbol* *Function*

zl:symeval is the basic primitive for retrieving a symbol's value. **(zl:symeval** *symbol***)** returns *symbol*'s current binding. This is the function called by **eval** when it is given a symbol to evaluate. If the symbol is unbound, then **zl:symeval** causes an error.

The Common Lisp equivalent of this function is **symbol-value**.

zl:symeval-globally *var* *Function*

Works like **zl:symeval** but returns the global value regardless of any bindings currently in effect.

zl:symeval-globally operates on the *global value* of a special variable; it bypasses any bindings of the variable in the current stack group. It resides in the global package.

zl:symeval-globally does not work on local variables.

The Symbolics Common Lisp equivalent of this function is **symbol-value-globally**.

zl:symeval-in-closure *closure symbol* *Function*

This returns the binding of *symbol* in the environment of *closure*; that is, it returns what you would get if you restored the value cells known about by *closure* and then evaluated *symbol*. This allows you to "look around inside" a dynamic closure. If *symbol* is not closed over by *closure*, this is just like **zl:symeval**. See the section "Dynamic Closure-Manipulating Functions" in *Symbolics Common Lisp: Language Concepts*.

zl:symeval-in-instance *instance symbol* &optional *no-error-p* *Function*

Finds the value of an instance variable inside a particular instance, regardless of whether the instance variable was declared a **:readable-instance-variable** or a **:gettable-instance-variable**. *instance* is the instance to be examined, and *symbol* is the instance variable whose value should be returned. If there is no such instance variable, an error is signalled, unless *no-error-p* is non-**nil**, in which case **nil** is returned.

The Symbolics Common Lisp function **symbol-value-in-instance** has the same syntax and functionality as the Zetalisp function **zl:symeval-in-instance**.

t *Type Specifier*

t is the type specifier symbol for the predefined Lisp data type, t.

The type **t** is a *supertype* of every type whatsoever. Every Lisp object belongs to type **t**.

Examples:

```
(typep nil 't) => T
(zl:typep t) => :SYMBOL
(type-of t) => SYMBOL
(constantp pi) => T
(constantp t) => T
(equal-typep (not nil) t) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

table-size *table* *Function*

Returns the total number of entries in *table.* Note that this does not include the number of entries that are deleted but not removed from the table.

For a table of related items: See the section "Table Functions" in *Symbolics Common Lisp: Language Concepts.*

tagbody *tag-or-statement...* *Special Form*

The body of a **tagbody** form is a series of *tags* or *statements.* A *tag* can be a symbol or an integer; a *statement* is a list. **tagbody** processes each element of the body in sequence. It ignores *tags* and evaluates *statements,* discarding the results. If it reaches the end of the body, it returns **nil**.

If a **(go** *tag***)** form is evaluated during evaluation of a *statement,* **tagbody** searches its body and the bodies of any **tagbody** forms that lexically contain it. Control is transferred to the innermost *tag* that is **eql** to the *tag* in the **go** form. Processing continues with the next *tag* or *statement* that follows the *tag* to which control is transferred.

The scope of the *tag* is lexical. That is, the **go** form must be inside the **tagbody** construct itself (or inside a **tagbody** form that that **tagbody** lexically contains), not inside a function called from the **tagbody**.

do, prog, and their variants use implicit **tagbody** constructs. You can provide *tags* within their bodies and use **go** forms to transfer control to the *tags.*

Examples:

```
(let ((x 'hello))
  (tagbody
    (catch 'stuff
      (if (numberp x)
          (princ "a number")
          (go trouble)))
    (return)
 trouble
    (princ "trouble trouble") (terpri))) => trouble trouble
NIL
```

The following two forms are equivalent:

```
(dotimes (i n) (print i))

(let ((i 0))
  (when (plusp n)
    (tagbody
      loop
      (print i)
      (setq i (1+ i))
      (when (< i n) (go loop)))))
```

For a table of related items: See the section "Transfer of Control Functions" in *Symbolics Common Lisp: Language Concepts.*

tailp *sublist list* *Function*

tailp returns **t** if *sublist* is an ending sublist of *list* (that is, a subset of the conses that make up *list*) and otherwise returns **nil**. Another way to look at this is that **tailp** returns **t** if (**nthcdr** *n list*) returns *sublist* for all *n*. For example:

```
(setq item-list '(a b c)) => (A B C)

(tailp (cdr item-list) item-list) => T

(tailp (car item-list) item-list) => NIL

(tailp (nthcdr 2 item-list) item-list) => T

(tailp nil item-list) => T
```

tailp could have been defined by:

```
(defun tailp (tail list)
  (do () ((eq tail list) t)
    (if (atom list)
        (return nil)
        (setf list (cdr list)))))
```

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts.*

tan *radians* *Function*

Returns the tangent of *radians.* Examples:

```
(tan 0) => 0.0
(tan (/ pi 4)) => 1.0d0
```

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

tand *degrees* *Function*

Returns the tangent of *degrees.*

For a table of related items: See the section "Trigonometric and Related Functions" in *Symbolics Common Lisp: Language Concepts.*

tanh *radians* *Function*

Returns the hyperbolic tangent of *radians.* Example:

```
(tanh 0) => 0.0
```

For a table of related items: See the section "Hyperbolic Functions" in *Symbolics Common Lisp: Language Concepts.*

tenth *list* *Function*

tenth takes a list as an argument, and returns the tenth element of *list.* **tenth** is identical to

```
(nth 9 list)
```

This function is provided because it makes more sense than using **nth** when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts.*

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thereis Keyword For loop

thereis *expr*

If *expr* evaluates non-**null**, the iteration is terminated and that value is returned,

without running the epilogue code. If the loop terminates before *expr* is ever evaluated, the epilogue code is run and the loop returns **nil**.

thereis *expr* is like **(or** *expr1 expr2* ...**)**. If the loop terminates before *expr* is ever evaluated, **thereis** is like **(or)**.

If you want a similar test, except that you want the epilogue code to run if *expr* evaluates non-**null**, use **until**.

Examples:

```
(defun loop-thereis (my-list)
  (loop for x in my-list
        finally (print  "what you going to do next ?")
        do
    (princ x) (princ " ")
        do
        and thereis (equal x 'a))) => LOOP-THEREIS

(loop-thereis '(b c a e)) => B C A T

(loop-thereis '(a a)) => A T
```

See the section "**loop** Clauses", page 310.

third *list* *Function*

This function takes a list as an argument, and returns the third element of the list. **third** is identical to

```
(nth 2 list)
```

The reason this name is provided is that it makes more sense when you are thinking of the argument as a list rather than just as a cons.

For a table of related items: See the section "Functions for Extracting From Lists" in *Symbolics Common Lisp: Language Concepts*.

throw *tag value* *Special Form*

Used with **catch** to make nonlocal exits. It first evaluates *tag* to obtain an object that is the "tag" of the throw. It next evaluates *form* and saves the (possibly multiple) values. It then finds the innermost **catch** (or **zl:*catch**) whose "tag" is **eq** to the "tag" that results from evaluating *tag*. It causes the **catch** (or **zl:*catch**) to abort the evaluation of its body forms and to return all values that result from evaluating *form*. In the process, dynamic variable bindings are undone back to the point of the **catch**, and any **unwind-protect** cleanup forms are executed. An error is signalled if no suitable **catch** is found.

The scope of the *tags* is dynamic. That is, the **throw** does not have to be lexically within the **catch** form; it is possible to throw out of a function that is called from inside a **catch** form.

The value of *tag* cannot be the symbol **sys:unwind-protect-tag**; that is reserved for internal use.

For example:

```
(catch 'done
  (ask-database <pattern>
                #'(lambda (x) (when (nice-p x)
                                (throw 'done x)))))
```

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:*throw *tag value* *Function*

An obsolete version of **throw** that is supported for compatibility with Maclisp. It is equivalent to **throw** except that it causes the **catch** or **zl:*catch** to return only two values: the first is the result of evaluating *form*, and the second is the result of evaluating *tag* (the tag thrown to). See the special form **throw**, page 589.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:times &rest *args* *Function*

Returns the product of its arguments. If there are no arguments, it returns **1**, which is the identity for this operation.

The following functions are synonyms of **zl:times**:

*****

zl:*$

:top of **si:heap** *Method*

Returns the value and key of the top item on the heap. The third value is **nil** if the heap was empty; otherwise it is **t**.

For a table of related items: See the section "Heap Functions and Methods" in *Symbolics Common Lisp: Language Concepts.*

sys:trace-conditions *Variable*

The value of this variable is a condition or a list of conditions. It can also be **t**, meaning all conditions, or **nil**, meaning none.

If any condition is signalled that is built on the specified flavor (or flavors), the Debugger immediately assumes control, before any handlers are searched or called.

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If the user proceeds, by using RESUME, signalling continues as usual. This might in fact revert control to the Debugger again. This variable is provided for debugging purposes only. It lets you trace the signalling of any condition so that you can figure out what conditions are being signalled and by what function. You can set this variable to **error** to trace all error conditions, for example, or you can be more specific.

This variable replaces the **zl:errset** variable from earlier releases.

flavor:transform-instance *Generic Function*

flavor:transform-instance offers a way for you to specify code that should be run when an instance is changed to *new-flavor*. Because **flavor:transform-instance** is a generic function, you can write a method for it. This generic function is not intended to be called directly; instead, you take advantage of it by writing methods for it. If any methods for the **flavor:transform-instance** generic function are defined for a given flavor, those methods are applied to an instance in two cases:

- When the function **change-instance-flavor** is used on the instance.
- When the flavor of the instance has been redefined (with **defflavor**) and the stored representation of the instance is changed.

It is sometimes desirable to perform some action to update each instance as it is transformed to the new flavor (when **change-instance-flavor** is used) or as it is transformed to the new definition of the flavor (when **defflavor** is used to redefine a flavor), beyond the actions the system ordinarily takes. For example, newly-added instance variables are initialized to the same values they would receive in newly-created instances. Sometimes this is not the appropriate value, and you need to compute a value for the variable. To do this, you can define a method for the generic function **flavor:transform-instance**, with no arguments.

Note that methods for **flavor:transform-instance** cannot access any instance variables that are deleted. By the time the methods are run, any deleted instance variables have been removed from the instance. In this example, the "old" instance variables are ones that existed both in the the old and the new format of the instance.

```
(defmethod (flavor:transform-instance my-flavor) ()
  (unless (variable-boundp new-instance-variable)
    (setq new-instance-variable
          (f old-instance-variable-1 old-instance-variable-2))))
```

By default, **flavor:transform-instance** uses **:daemon** method combination. You can specify a different type of method combination for this generic function by giving the **:method-combination** option to the **defflavor** of the flavor involved. If you want all the methods defined by the various component flavors to run, you can either specify **:progn** method combination or use **:after** methods with the default **:daemon** method combination.

Note: You should be careful to allow for your method being called more than once, if the flavor is redefined several times. A method intended to be used for one particular redefinition of the flavor remains in the system and is used for all future redefinitions, unless you use Kill Definition (m-X) or **fundefine** to remove the definition of the method.

Depending on the purpose of the method, it might be necessary to redefine the flavor before compiling the method for **flavor:transform-instance**. For example, a method that initializes a new instance variable cannot be compiled until the flavor is redefined to contain that instance variable.

Note that if an instance is accessed after its flavor has been redefined and before you have defined a method for **flavor:transform-instance**, the method is not executed on that instance.

math:transpose-matrix *matrix* &optional *into-matrix* *Function*

Transposes *matrix*. If *into-matrix* is supplied, stores the result into it and returns it; otherwise it creates an array to hold the result, and returns that. *matrix* must be a two-dimensional array. *into-matrix*, if provided, must be two-dimensional and have sufficient dimensions to hold the transpose of *matrix*.

tree-equal *x y* &key *test test-not* *Function*

This is a predicate that is true if *x* and *y* are isomorphic trees with identical leaves, that is, if *x* and *y* are atoms that satisfy the predicate specified by the **:test** keyword, or if they are both conses and their *car*s are **tree-equal** and their *cdr*s are **tree-equal**. Thus **tree-equal** recursively compares conses, but not any other objects that have components. The **equal** function compares certain other structured objects, such as strings. For example:

```
(tree-equal '(a b c) '(a b c)) => T

(tree-equal '(a b c) '(b c a)) => NIL
```

The keywords are:

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

For a table of related items: See the section "Predicates That Operate on Lists" in *Symbolics Common Lisp: Language Concepts*.

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true &rest *ignore* *Function*

Takes no arguments and returns **t**. See the section "Functions and Special Forms for Constant Values" in *Symbolics Common Lisp: Language Concepts*.

truncate *number* &optional (*divisor* **1**) *Function*

Divides *number* by *divisor*, and truncates the result toward zero. The truncated result and the remainder are the returned values.

number and *divisor* must each be a noncomplex number. Not specifying a divisor is exactly the same as specifying a divisor of 1.

If the two returned values are Q and R, then (+ (* Q *divisor*) R) equals *number*. If *divisor* is 1, then Q and R add up to *number*. If *divisor* is 1 and *number* is an integer, then the returned values are *number* and 0.

The first returned value is always an integer. The second returned value is integral if both arguments are integers, is rational if both arguments are rational, and is floating-point if either argument is floating-point. If only one argument is specified, then the second returned value is always a number of the same type as the argument.

Examples:

```
(truncate 5) => 5 and 0
(truncate -5) => -5 and 0
(truncate 5.2) => 5 and 0.19999981
(truncate -5.2) => -5 and -0.19999981
(truncate 5.8) => 5 and 0.8000002
(truncate -5.8) => -5 and -0.8000002
(truncate 5 3) => 1 and 2
(truncate -5 3) => -1 and -2
(truncate 5 4) => 1 and 1
(truncate -5 4) => -1 and -1
(truncate 5.2 3) => 1 and 2.1999998
(truncate -5.2 3) => -1 and -2.1999998
(truncate 5.2 4) => 1 and 1.1999998
(truncate -5.2 4) => -1 and -1.1999998
(truncate 5.8 3) => 1 and 2.8000002
(truncate -5.8 3) => -1 and -2.8000002
(truncate 5.8 4) => 1 and 1.8000002
(truncate -5.8 4) => -1 and -1.8000002
```

For a table of related items: See the section "Functions That Divide and Convert Quotient to Integer" in *Symbolics Common Lisp: Language* Concepts.

sys:type-arglist *type* *Function*

This function takes a data type as its argument and checks whether *type* is a defined Common Lisp type.

sys:type-arglist returns two values: if *type* is a defined Common Lisp type, the first value is the lambda-list of specifiers for that type, if any, or **nil**; the second value is **t**. If *type* is not a defined Common Lisp type, both values are **nil**.

sys:type-arglist is useful if you are building software to run on top of the Common Lisp type system.

Examples:

```
(sys:type-arglist 'integer)
  => (&OPTIONAL (LOW '*) (HIGH '*)) and T
(sys:type-arglist 'array)
 => (&OPTIONAL (ELEMENT-TYPE '*) (DIMENSIONS '*)) and T
(sys:type-arglist 'single-float) => NIL and T
(sys:type-arglist 'foo)  => NIL
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

typecase *object* &body *body* *Special Form*

typecase is a conditional that chooses one of its clauses by examining the type of an object. Structurally **typecase** is much like **cond** or **case**, and it behaves like them in selecting one clause and then executing all consequences of that clause. It differs in the mechanism of clause selection.

Its form is as follows:

```
(typecase form
   (types consequent consequent ...)
   (types consequent consequent ...)
   ...
   )
```

First **typecase** evaluates *form*, producing an object. **typecase** then examines each clause in sequence. *types* in each clause is a type specifier in either symbol or list form, or a list of type specifiers. The type specifier is not evaluated. If the object is of that type, or of one of those types, then the consequents are evaluated and the result of the last one is returned (or **nil** if there are no consequents in that clause). Otherwise, **typecase** moves on to the next clause. If no clause is satisfied, **typecase** returns **nil**.

For an object to be of a given type means that if **typep** is applied to the object and the type, it returns **t**. That is, a type is something meaningful as a second argument to **typep**. A chart of supported data types appears elsewhere. See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

As a special case, *types* can be **otherwise**; in this case, the clause is always executed, so this should be used only in the last clause.

It is permissible for more than one clause to specify a given type, particularly if one is a subtype of another; the earliest applicable clause is chosen. Thus, for **typecase**, the order of the clauses can affect the behavior of the construct.

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

zl:typecase *object* &body *body* *Special Form*

Selects various forms to be evaluated depending on the type of some object. It is something like **select**. A **zl:typecase** form looks like:

```
(zl:typecase form
   (types consequent consequent ...)
   (types consequent consequent ...)
   ...
   )
```

form is evaluated, producing an object. **zl:typecase** examines each clause in sequence. *types* in each clause is either a single type (if it is a symbol) or a list of types. If the object is of that type, or of one of those types, then the consequents are evaluated and the result of the last one is returned. Otherwise, **zl:typecase** moves on to the next clause. As a special case, *types* can be **otherwise**; in this case, the clause is always executed, so this should be used only in the last clause. For an object to be of a given type means that if **zl:typep** is applied to the object and the type, it returns **t**. That is, a type is something meaningful as a second argument to **zl:typep**.

Examples:

```
(defun tell-about-car (x)
  (zl:typecase (car x)
    (string "string"))) => TELL-ABOUT-CAR
(tell-about-car '("word" "more")) => "string"
(tell-about-car '(a 1)) => NIL
```

```
(defun tell-about-car (x)
  (zl:typecase (car x)
    (fixnum  "number.")
    ((or string symbol) "string or symbol.")
    (otherwise "I don't know.")))  => TELL-ABOUT-CAR
(tell-about-car '(1 a))  => "number."
(tell-about-car '(a 1))  => "string or symbol."
(tell-about-car '("word" "more")) => "string or symbol."
(tell-about-car '(1.0))  => "I don't know."
```

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

See the special form **typecase**, page 594.

type-of *object* *Function*

Returns a type of which *object* is a member. **type-of** returns the most specific type that can be conveniently computed and is likely to be useful to the user. If the argument is a user-defined structure created by **defstruct**, then **type-of** returns the name of that structure. If the argument is a user-created structure created by **defflavor** then **type-of** returns the type **symbol**. (type-of *instance*) returns the symbol that is the name of the instance's flavor.

Examples:

```
(type-of 4) => FIXNUM

(type-of "Ariadne's thread") => STRING

(type-of 5/7) => RATIO
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

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typep *object type* *Function*

The predicate **typep** is true if *object* is of type *type*, and is false otherwise. Note that an object can be "of" more than one type, since one type can include another, or the types can overlap without inclusion.

type can be any of the type specifiers discussed in the chapter on Data Types. See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* The exception is that *type* cannot be or contain a type specifier list whose first element is **function** or **values**. A specifier of the

form (satisfies fn) is handled simply by applying the function *fn* to *object* (see **funcall**); the *object* is considered to be of the specified type if the result is not **nil**.

(**typep** *instance 'flavor-name*) returns **t** if the flavor of *instance* is named *flavor-name* or contains that flavor as a direct of indirect component; it returns **nil** otherwise.

Examples:

```
(typep 'my-dog-rover 'common) => T
(typep 'a 'atom) => T
(typep 0 'bit) => T

(defstruct ship
  x-postion
  y-postion)  => SHIP

(setq my-boat (make-ship)) => #S (SHIP :X-POSTION NIL
                                       :Y-POSTION NIL)

(typep my-boat '(structure ship)) => T
(typep my-boat 'vector) => T

(typep #(a b c) 'vector) => T
(typep #*1010 'bit-vector) => T
(typep 4 'number) => T
(typep #c(3 4) 'complex) => T
(typep 4 'bit-vector) => NIL
```

See the section "Type-checking Differences Between Symbolics Common Lisp and Zetalisp" in *Symbolics Common Lisp: Language Concepts*. See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts*.

zl:typep *x* &optional *type* *Function*

zl:typep is really two different functions. With one argument, **zl:typep** is not really a predicate; it returns a symbol describing the type of its argument. With two arguments, **zl:typep** is a predicate that returns **t** if *arg* is of type *type*, and **nil** otherwise. Note that an object can be "of" more than one type, since one type can be a subset of another.

The symbols that can be returned by **zl:typep** of one argument are:

:symbol	*arg* is a symbol.
:fixnum	*arg* is a fixnum (not a bignum).
:bignum	*arg* is a bignum.

:rational	*arg* is a ratio.
:single-float	*arg* is a single-precision floating-point number.
:double-float	*arg* is a double-precision floating-point number.
:complex	*arg* is a complex number.
:list	*arg* is a cons.
:locative	*arg* is a locative pointer.
:compiled-function	*arg* is the machine code for a compiled function.
:closure	*arg* is a closure.
:select-method	*arg* is a select-method table.
:stack-group	*arg* is a stack-group.
:string	*arg* is a string.
:array	*arg* is an array that is not a string.
:random	Returned for any built-in data type that does not fit into one of the above categories.
foo	An object of user-defined data type *foo* (any symbol). The primitive type of the object could be array, or instance.

(**zl:typep** *instance*) returns the symbol that is the name of the instance's flavor.

(**zl:typep** *instance 'flavor-name* returns **t** if the flavor of *instance* is named *flavor-name* or contains that flavor as a direct or indirect component, **nil** otherwise.

Examples:

```
(zl:typep 'common :SYMBOL) => T
(zl:typep 4 ) => :FIXNUM
(zl:typep .00001) => :SINGLE-FLOAT
(zl:typep 0d0 :DOUBLE-FLOAT) => T
(zl:typep #c(1.2 3.3)) => :COMPLEX
(zl:typep "good day sunshine" :STRING) => T
(zl:typep #(a b c)) => :ARRAY
```

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The *type* argument to **zl:typep** of two arguments can be any of the above keyword symbols (except for **:random**), the name of a user-defined data type (either a named structure or a flavor), or one of the following additional symbols:

:atom	Any atom (as determined by the **atom** predicate).
:fix	Any kind of fixed-point number (fixnum or bignum).
:float	Any kind of floating-point number (single- or double-precision).
:number	Any kind of number.
:non-complex-number	Any noncomplex number.

:instance	An instance of any flavor.
:null	**nil** is the only value that has this type.
:list-or-nil	A cons or **nil**.

Examples:

```
(zl:typep 3 :number) => T
(zl:typep nil :null) => T
(zl:typep '(a b c) :list-or-nil) => T
```

Note that **(zl:typep nil) => :symbol**, and **(zl:typep nil :list) => nil**; the latter might be changed.

```
(zl:typep nil :list) => NIL
```

```
(defflavor ship
  (name x-velocity y-velocity z-velocity mass)
   ()    ; no component flavors
  :readable-instance-variables
  :writable-instance-variables
  :initable-instance-variables) => SHIP
(setq my-ship
  (make-instance 'ship :name "Enterprise"
                       :mass 4534
                       :x-velocity 24
                       :y-velocity 2
                       :z-velocity 45)) => #<SHIP 43004623>
(typep my-ship :instance) => T
(typep my-ship) => SHIP
(type-of my-ship) => SHIP
```

See the section "Type-checking Differences Between Symbolics Common Lisp and Zetalisp" in *Symbolics Common Lisp: Language Concepts.*

unbreakon &optional *function* (*condition* **t**) *Function*

Turns off a breakpoint set by **breakon**. If *function-spec* is not provided, all breakpoints set by **breakon** are turned off. If *condition-form* is provided, it turns off only that condition, leaving any others. If *condition-form* is not provided, the entire breakpoint is turned off for that function.

For a table of related items: See the section "Breakpoint Functions" in *Symbolics Common Lisp: Language Concepts.*

:unclaimed-message *operation* &rest *arguments* *Message*

When an *operation* is performed on a flavor instance, whether the operation is a generic function or a message, the Flavors system checks to be sure that a method exists for performing the operation on the object. If no method is found, it checks for a method for the **:unclaimed-message** mes-

sage. If such a method exists, it is invoked with arguments *operation* and any arguments that were given to the operation.

This is equivalent to using the **:default-handler** option to **defflavor**.

flavor:vanilla does not provide a method for **:unclaimed-message**. If no method for **:unclaimed-message** exists, and the **:default-handler** option was not used, then the default action of the Flavors system is to signal an error.

undefine-global-handler *name* *Macro*

Removes a global handler defined with **define-global-handler.**

name is the name of the global handler to be removed.

undefine-global-handler returns **t** if it finds the named handler. Otherwise it signals a proceedable error, and, if the condition proceeds, returns **nil.**

Examples:

```
(define-global-handler infinity-is-three sys:divide-by-zero
    (error)
  (values :return-values '(3)))


(undefine-global-handler infinity-is-three)
```

For a table of related items: See the section "Basic Forms for Global Handlers" in *Symbolics Common Lisp: Language Concepts.*

undefun *function-spec* *Function*

If *function-spec* has a saved previous basic definition, this interchanges the current and previous basic definitions, leaving the encapsulations alone. This undoes the effect of a **defun, compile**, and so on. (See the function **uncompile** in *Program Development Utilities.*)

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si:unencapsulate-function-spec *function-spec* &optional *encapsulation-types* *Function*

This takes one function spec and returns another. If the original function spec is undefined, or has only a basic definition (that is, its definition is not an encapsulation), then the original function spec is returned unchanged.

If the definition of *function-spec* is an encapsulation, then its debugging info is examined to find the uninterned symbol that holds the encapsulated definition, and also the encapsulation type. If the encapsulation is of a type that is to be skipped over, the uninterned symbol replaces the original function spec and the process repeats.

The value returned is the uninterned symbol from inside the last encapsulation skipped. This uninterned symbol is the first one that does not have a definition that is an encapsulation that should be skipped. Or the value can be *function-spec* if *function-spec*'s definition is not an encapsulation that should be skipped.

The types of encapsulations to be skipped over are specified by *encapsulation-types*. This can be a list of the types to be skipped, or **nil**, meaning skip all encapsulations (this is the default). Skipping all encapsulations means returning the uninterned symbol that holds the basic definition of *function-spec*. That is, the *definition* of the function spec returned is the *basic definition* of the function spec supplied. Thus:

```
(fdefinition (si:unencapsulate-function-spec 'foo))
```

returns the basic definition of **foo**, and:

```
(fdefine (si:unencapsulate-function-spec 'foo) 'bar)
```

sets the basic definition (just like using **fdefine** with *carefully* supplied as **t**).

encapsulation-types can also be a symbol, which should be an encapsulation type; then we skip all types that are supposed to come outside of the specified type. For example, if *encapsulation-types* is **trace**, then we skip all types of encapsulations that come outside of **trace** encapsulations, but we do not skip **trace** encapsulations themselves. The result is a function spec that is where the **trace** encapsulation ought to be, if there is one. Either the definition of this function spec is a **trace** encapsulation, or there is no **trace** encapsulation anywhere in the definition of *function-spec*, and this function spec is where it would belong if there were one. For example:

```
(let ((tem (si:unencapsulate-function-spec spec 'trace)))
  (and (eq tem (si:unencapsulate-function-spec tem '(trace)))
       (si:encapsulate tem spec 'trace '(...body...))))
```

finds the place where a **trace** encapsulation ought to go, and makes one unless there is already one there.

```
(let ((tem (si:unencapsulate-function-spec spec 'trace)))
  (fdefine tem (fdefinition (si:unencapsulate-function-spec
                              tem '(trace)))))
```

eliminates any **trace** encapsulation by replacing it by whatever it encapsulates. (If there is no **trace** encapsulation, this code changes nothing.)

These examples show how a subsystem can insert its own type of encapsulation in the proper sequence without knowing the names of any other types of encapsulations. Only the **si:encapsulation-standard-order** variable, which is used by **si:unencapsulate-function-spec**, knows the order.

unexport *symbols* &optional *package* *Function*

The *symbols* argument should be a list of symbols or a single symbol. If *symbols* is **nil**, it is treated like an empty list. These symbols become internal symbols in *package*. *package* can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t**. It is an error to **unexport** a symbol from the **keyword** package.

unintern *sym* &optional (*pkg* **(symbol-package si:sym)**) *Function*

Removes *sym* from *pkg* and from *pkg*'s shadowing-symbols list. If *pkg* is the home package for *sym*, then *sym* is made to have no home package. In some circumstances, *sym* may continue to be accessible by inheritance. **unintern** returns **t** if it removes a symbol and **nil** if it fails to remove a symbol. **unintern** should be used with caution since it changes the state of the package system and affects the consistency rules (See the section "Consistency Rules for Packages" in *Symbolics Common Lisp: Language Concepts*.).

union *list1 list2* &key (*test* **#'eql**) *test-not* (*key* **#'identity**) *Function*

union takes two lists and returns a new list containing everything that is an element of either of the lists. If there is a duplication between the two lists, only one of the duplicate instances will be in the result. If either of the arguments has duplicate entries within it, the redundant entries may or may not appear in the result. There is no guarantee that the order of the elements in the result reflect the ordering of the arguments in any particular way. The keywords are

:test Any predicate specifying a binary operation to be applied to a supplied argument and an element of a target list. The *item* matches the specification only if the predicate returns **t**. If **:test** is not supplied the default operation is **eql**.

:test-not Similar to **:test**, except the *item* matches the specification only if there is an element of the list for which the predicate returns **nil**.

For all possible ordered pairs consisting of one element from *list1* and one element from *list2*, the predicate is used to determine whether they match. For every matching pair, at least one of the two elements of the pair will be in the result. Moreover, any element from either list that matches no element of the other will appear in the result.

```
(union '(a b c) '(f a d a)) => (D F A B C)

(union '((x 5) (y 6) (x 3)) '((z 2) (x 4)) :key #'car) =>
((Z 2) (X 5) (Y 6) (X 3))
```

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For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

zl:union &rest *lists* *Function*

Takes any number of lists that represent sets and creates and returns a new list that represents the union of all the sets it is given. **zl:union** uses **eq** for its comparisons. You cannot change the function used for the comparison. **(zl:union)** returns **nil.**

This Zetalisp function is shadowed by the Common Lisp function of the same name.

For a table of related items: See the section "Functions for Comparing Lists" in *Symbolics Common Lisp: Language Concepts.*

unless *condition* &rest *body* *Macro*

The forms in *body* are evaluated when *condition* returns **nil.** It returns the value of the last form evaluated. When *condition* returns something other than **nil,** **unless** returns **nil.**

Examples:

```
(unless) => error

(unless nil "rain, rain, rain") => "rain, rain, rain"

(unless (eq 1 1) (setq a b) "foo") => NIL

(unless (eq 1 2) (setq a 4) "foo") => "foo"
a => 4
```

When *body* is empty, **unless** always returns **nil.**

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

See the section "**loop** Clauses", page 310.

unless Keyword For loop

unless *expr*

If *expr* evaluates to **t,** the following clause is skipped, otherwise not. This is equivalent to **when (not** *expr*).

Examples:

```
(defun loop1 ()
  (loop for i from 0 to 9
        unless (> i 5) collect i
        finally (print " so long, goodbye...."))) => LOOP1
(loop1) =>
" so long, goodbye...." (0 1 2 3 4 5)
```

While the keyword **when** would do the following.

```
(defun loop1 ()
  (loop for i from 0 to 9
        when (> i 5) collect i
        finally (print " so long, goodbye...."))) => LOOP1
(loop1) =>
" so long, goodbye...." (6 7 8 9)
```

Multiple conditionalization clauses can appear in sequence. If one test fails, then any following tests in the immediate sequence, and the clause being conditionalized, are skipped.

In the typical format of a conditionalized clause such as

when *expr1 keyword expr2*

expr2 can be the keyword **it**. If that is the case, then a variable is generated to hold the value of *expr1*, and that variable gets substituted for *expr2*. Thus, the composition:

when *expr* **return it**

is equivalent to the clause:

thereis *expr*

and one can collect all non-**null** values in an iteration by saying:

when *expression* **collect it**

If multiple clauses are joined with **and**, the **it** keyword can only be used in the first. If multiple **whens**, **unlesses**, and/or **ifs** occur in sequence, the value substituted for **it** is that of the last test performed. The **it** keyword is not recognized in an **else**-phrase.

Conditionals can be nested.

See the section "**loop** Clauses", page 310.

unsigned-byte &optional (*s* '*) *Type Specifier*

unsigned-byte is the type specifier symbol for the predefined Lisp unsigned byte data type.

This type specifier can be used in either symbol or list form. Used in list form, **unsigned-byte** allows the declaration and creation of a specialized set of non-negative integers that can be represented in a byte of *s* bits.

(unsigned-byte s) ≡ (integer 0 2^s-1); (unsigned-byte *) ≡ (integer 0 *), the set of non-negative integers.

The type **unsigned-byte** is a *subtype* of the type *signed-byte.*

The type **unsigned-byte** is a *supertype* of the type **bit.**

Examples:

```
(typep 778 'unsigned-byte) => T

(typep 1 '(unsigned-byte 1)) => T

(subtypep 'unsigned-byte 'signed-byte)
 => T and T ;subtype and certain

(equal-typep 'bit '(unsigned-byte 1)) => T

(sys:type-arglist 'unsigned-byte) => (&OPTIONAL (S '*)) and T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Numbers" in *Symbolics Common Lisp: Language Concepts.*

until Keyword For loop

until *expr*

If *expr* evaluates to **t**, the loop is exited, performing exit code (if any), and returning any accumulated value. The test is placed in the body of the loop where it is written. It can appear between sequential **for** clauses.

Examples:

```
(defun trivial-loop ()
  (loop for i from 0 until (= i 12)
        do
    (princ i)(princ " "))) => TRIVIAL-LOOP
(TRIVIAL-LOOP) => 0 1 2 3 4 5 6 7 8 9 10 11 NIL
```

See the section "**loop** Clauses", page 310.

unuse-package *packages-to-unuse* &optional *package* *Function*

The *packages-to-unuse* argument should be a list of packages or package names, or a single package or package name. These packages are removed from the use-list of *package* and their external symbols are no longer accessible, unless they are accessible through another path. *package* can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t.**

unwind-protect *protected-form* &rest *cleanup-forms* *Special Form*

Sometimes it is necessary to evaluate a form and make sure that certain side effects take place after the form is evaluated. A typical example is:

```
(progn
  (turn-on-water-faucet)
  (hairy-function 3 nil 'foo)
  (turn-off-water-faucet))
```

The nonlocal exit facility of Lisp creates a situation in which the above code does not work. However, if **hairy-function** should do a **throw** to a **catch** that is outside of the **progn** form, **(turn-off-water-faucet)** is never evaluated (and the faucet is presumably left running). This is particularly likely if **hairy-function** gets an error and the user tells the Debugger to give up and abort the computation.

In order to allow the above program to work, it can be rewritten using **unwind-protect** as follows:

```
(unwind-protect
    (progn (turn-on-water-faucet)
           (hairy-function 3 nil 'foo))
  (turn-off-water-faucet))
```

If **hairy-function** does a **throw** that attempts to quit out of the evaluation of the **unwind-protect**, the **(turn-off-water-faucet)** form is evaluated in between the time of the **throw** and the time at which the **catch** returns. If the **progn** returns normally, then the **(turn-off-water-faucet)** is evaluated, and the **unwind-protect** returns the result of the **progn**.

Examples:

```
(tagbody
  (let ((num 4))
    (unwind-protect
        (if (= num 4) (go home))
      (princ "reach out")))
home
   (princ " and "))  => reach out and NIL

(unwind-protect
    (progn (start-car)
           (drive-car))
  (stop-car))
```

The general form of **unwind-protect** looks like:

```
(unwind-protect protected-form
    cleanup-form1
    cleanup-form2
    ...)
```

protected-form is evaluated, and when it returns or when it attempts to quit out of the **unwind-protect**, the *cleanup-forms* are evaluated. To ensure that **unwind-protect** does not return without completely executing its cleanup forms, macro **sys:without-aborts** is automatically and atomically wrapped around all *cleanup-forms*, preventing them from being aborted by user action.

unwind-protect catches exits caused by **return-from** or **go** as well as those caused by **throw**. The value of the **unwind-protect** is the value of *protected-form*. Multiple values returned by the *protected-form* are propagated back through the **unwind-protect**.

The cleanup forms are run in the variable-binding environment that you would expect: that is, variables bound outside the scope of the **unwind-protect** special form can be accessed, but variables bound inside the *protected-form* cannot be. In other words, the stack is unwound to the point just outside the *protected-form*, then the cleanup handler is run, and then the stack is unwound some more.

Note: It is almost never adequate to do something of the form

```
(unwind-protect (progn (foo) ... code ...)
  (undo-foo))
```

Nearly always you should write

```
(let ((old-foo-state (read-foo-state)))
  (unwind-protect (progn (foo) ... code ...)
    (set-foo-state old-foo-state)))
```

You should also consider that other processes may see your data structure in the modified state. If you have a shared structure, you may need to use a lock to only allow one process to use it while it is modified.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

unwind-protect-case (&optional *aborted-p-var*) *body-form* &rest *cleanup-clauses* *Macro*

body-form is executed inside an unwind-protect form. The cleanup forms of the unwind-protect are generated from *cleanup-clauses*. Each cleanup-clause is considered in order of appearance and has the form *(keyword forms ...)*. *keyword* can be **:normal**, **:abort** or **:always**. The forms in a **:normal** clause are executed only if *body-form* finished normally. The

forms in an **:abort** clause are executed only if *body-form* exited before completion. The forms in an **:always** clause are always executed. The values returned are the values of *body-form*, if it completed normally.

To ensure that **unwind-protect-case** does not return without completely executing its cleanup forms, macro **sys:without-aborts** is automatically and atomically wrapped around all *cleanup-forms*, preventing them from being aborted by user action.

aborted-p-var, if supplied, is **t** if the *body-form* was aborted, and **nil** if it finished normally. *aborted-p-var* can be used in forms within *cleanup-clauses* as a condition for executing abort instead of normal cleanup code. It can be set within *body-form*, but should be done so with great care. It should only be set to **nil** if the remaining subforms of *body-form* do not need protecting.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts*.

upper-case-p *char* *Function*

Returns **t** if *char* is an upper-case letter.

```
(upper-case-p #\A) => T
(upper-case-p #\a) => T
```

use-package *packages-to-use* &optional *package* *Function*

The *packages-to-use* argument should be a list of packages or package names, or a single package or package name. These packages are added to the use-list of *package* if they are not there already. All external symbols in the packages to use become accessible in *package*. *package* can be a package object or the name of a package (a symbol or a string). If unspecified, *package* defaults to the value of ***package***. Returns **t**.

zl:value-cell-location *sym* *Function*

This function is obsolete on local and instance variables; use **zl:variable-location** instead.

zl:value-cell-location returns a locative pointer to *sym*'s internal value cell. See the section "Cells and Locatives". It is preferable to write:

```
(locf (symeval sym))
```

instead of calling this function explicitly.

(value-cell-location 'a) is still useful when **a** is a special variable. It behaves slightly differently from the form **(variable-location a)**, in the case that **a** is a variable "closed over" by some closure. See the section "Dynamic Closures" in *Symbolics Common Lisp: Language Concepts.* **zl:value-cell-location** returns a locative pointer to the internal value cell of the symbol (the one that holds the invisible pointer, which is the real value cell of the symbol), whereas **zl:variable-location** returns a locative pointer to the external value cell of the symbol (the one pointed to by the invisible pointer, which holds the actual value of the variable).

values *value1-type value2-type...* *Type Specifier*

This type specifier can be used only as the value type in a **function** type specifier or in a **the** special form. It is used to specify individual types when multiple values are involved.

Examples:

```
(defun foo (x)
   (the (values integer integer)
        (floor x 2))) => FOO
(foo 8) => 4 and 0
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

values &rest *args* *Function*

Returns multiple values, its arguments. This is the primitive function for producing multiple values. It is valid to call **values** with no arguments; it returns no values in that case.

flavor:vanilla *Flavor*

This flavor is included in all flavors by default. **flavor:vanilla** has no instance variables, but it provides several basic useful methods, some of which are used by the Flavor tools.

Every flavor has **flavor:vanilla** as a component flavor, unless you specify not to include **flavor:vanilla** by providing the **:no-vanilla-flavor** option to **defflavor**. It is unusual to exclude **flavor:vanilla**.

variable-boundp *variable* *Special Form*

Returns **t** if the variable is bound and **nil** if the variable is not bound. *variable* should be any kind of variable (it is not evaluated): local, special, or instance. Note: local variables are always bound; if *variable* is local, the compiler issues a warning and replaces this form with **t**.

If **a** is a special variable, **(boundp 'a)** is the same as **(variable-boundp a)**.

zl:variable-location *variable* *Special Form*

Returns a locative pointer to the memory cell that holds the value of the variable. *variable* can be any kind of variable (it is not evaluated): local, special, or instance.

zl:variable-location should be used in almost all cases instead of **zl:value-cell-location**; **zl:value-cell-location** should only be used when referring to the internal value cell. For more information on internal value cells: See the section "What is a Dynamic Closure?" in *Symbolics Common Lisp: Language Concepts*.

You can also use **locf** on variables. **(locf zl-user:a)** expands into **(zl:variable-location zl-user:a)**.

variable-makunbound *variable* *Special Form*

Makes the variable be unbound and returns *variable*. *variable* should be any kind of variable (it is not evaluated): local, special, or instance. Note: since local variables are always bound, they cannot be made unbound; if *variable* is local, the compiler issues a warning.

If **a** is a special variable, **(makunbound 'zl-user:a)** is the same as **(variable-makunbound 'a)**.

vector &rest *objects* *Function*

Creates a simple vector with specified initial contents. For example:

```
(vector 3 4 5)
```

vector &optional (*element-type* '*) (*size* '*) *Type Specifier*

vector is the type specifier symbol for the predefined Lisp structure of that name.

The type **vector** is a *subtype* of the type **array**: for all types of *x*, the type `(vector x)` is the same as the type `(array x (*))`.

The types **vector** and **list** are *disjoint subtypes* of the type **sequence**.

The type **vector** is a supertype of the types **string**, **bit-vector**, **simple-vector**;

string means (vector string-char), or (vector character)
bit-vector means (vector bit)
simple-vector means (simple-array t (*))

The types **vector t**, **string**, and **bit-vector** are *disjoint.*

This type specifier can be used in either symbol or list form. Used in list form, **vector** allows the declaration and creation of specialized one-dimensional arrays whose elements are all of type *element-type* and whose lengths match *size.* This is entirely equivalent to

```
(array (element-type size)).
```

element-type must be a valid type specifier, or unspecified. For standard Symbolics Common Lisp type specifiers: See the section "Type Specifiers" in *Symbolics Common Lisp: Language Concepts.*

size can be a non-negative integer, or it can be a list of non-negative integers, or it can be unspecified.

The specialized types (vector string-char) and (vector bit) are so useful that they have the special names **string** and **bit-vector.**

Examples:

```
(typep  #(a b c) 'vector) => T

(subtypep 'vector 'array) => T and T

(subtypep 'vector 'sequence) => T and T

(sys:type-arglist 'vector)
=> (&OPTIONAL (ELEMENT-TYPE '*) (SIZE '*)) and T

(vectorp #()) => T

(typep #*010 '(vector bit 3)) => T
```

See the section "Data Types and Type Specifiers" in *Symbolics Common Lisp: Language Concepts.* See the section "Arrays" in *Symbolics Common Lisp: Language Concepts.*

sys:vector-bitblt *alu size from-array from-index to-array to-index* *Function*

sys:vector-bitblt copies a linear portion of *from-array* of length *size* starting at *from-index* into a linear portion of *to-array* starting at *to-index.* The value stored can be a Boolean function of the new value and the value already there, under the control of *alu.* This function is a one-dimensional **bitblt.** See the function **bitblt,** page 48.

from-raster and *to-raster* are allowed to be the same array. If *size* is negative, then the processing is done backwards, using **(abs** *size*) as the number

of elements. For arrays of different elements it works bitwise, and *size* is in units of *to-array*.

sys:vector-bitblt might not work well if *from-array* is indirected with an index-offset.

vectorp *object* *Function*

Tests whether the given *object* is a vector. A vector is a one-dimensional array. See the type specifier **vector**, page 610.

```
(vectorp (make-array 5 :element-type 'bit :fill-pointer 2))
 => T

(vectorp (make-array '(5 2)))
 => NIL
```

vector-pop *array* *Function*

Decreases the fill pointer by one and returns the vector element designated by the new value of the fill pointer. *vector* must be a one-dimensional array with a fill pointer.

vector-push *new-element vector* *Function*

Stores *new-element* in the element designated by the fill pointer and increments the fill pointer by one. *vector* must be a one-dimensional array with a fill pointer, and *new-element* can be any object allowed to be stored in the array.

If the fill pointer does not designate an element of the array (specifically, when it gets too big), it is unaffected and **vector-push** returns **nil**. Otherwise, the two actions (storing and incrementing) happen uninterruptibly, and **vector-push** returns the *former* value of the fill pointer, that is, the array index in which it stored *new-element*.

vector-push-extend *new-element vector* &optional *extension* *Function*

Stores *new-element* in the element designated by the fill pointer and increments the fill pointer by one. If the vector is not large enough, **vector-push-extend** extends the vector if the array is adjustable. However, if the array is not adjustable, **vector-push-extend** signals an error.

vector-push-portion-extend *to-array from-array* &optional (*from-start* **0**) *from-end* *Function*

Copies a portion of one array to the end of another, updating the fill pointer of the second to reflect the new contents. The destination array must have a fill pointer. The source array need not.

vector-push-portion-extend returns the *to-array* and the index of the next location to be filled.

Example:

```
(setq to-string
      (array-push-portion-extend
         to-string from-string (or from 0) to))
```

If the optional arguments are not provided, the default is to copy all of *from-array* to the end of *to-array*.

warn *optional-options optional-condition-name format-string* &rest *format-args* — *Function*

If the flag ***break-on-warnings*** is **nil**, **warn** prints a warning message without entering the Debugger.

If the flag, ***break-on-warnings*** is not **nil**, **warn** enters the Debugger and prints the warning message. If you continue from the error, **warn** returns *args*.

The optional arguments *optional-options* and *optional-condition-name* can be omitted. They represent more advanced features of **warn**, the documentation of which is being deferred.

format-string is an error message string.

format-args are additional arguments; these are evaluated only if a condition is signalled.

Examples:

```
(defun sum-numbers (list-of-numbers)
  (when (< (length list-of-numbers) 2)
    (warn "You are trying to only add ~D number~:P."
          (length list-of-numbers)))
  (reduce #'+ list-of-numbers))  => SUM-NUMBERS

(sum-numbers '(1))
=> Warning: You are trying to only add 1 number.

(setq *break-on-warnings* t) => T

(sum-numbers '(1))=>
Warning: You are trying to only add 1 number
```

```
SUM-NUMBERS:
   Arg 0 (LIST-OF-NUMBERS): (1)
 Debugger was entered because *BREAK-ON-WARNINGS* is set
s-A, <RESUME>: Return from WARN
s-B:           Proceed without any special action
s-C, <ABORT>:  Return to Lisp Top Level in Dynamic Lisp Listener 1
→ Return from WARN
1
```

For a table of related items: See the section "Condition-Checking and Signalling Functions and Variables" in *Symbolics Common Lisp: Language Concepts.*

when *condition* &rest *body* *Macro*

The forms in *body* are evaluated when *condition* returns non-**null**. In that case, it returns the value(s) of the last form evaluated. When *condition* returns **nil**, **when** returns **nil**.

Examples:

```
(when) => error

(when t "Climb Tree") => "Climb Tree"

(when (atom 'x) (setq a 1) "foo") => "foo"
a => 1

(when (eq 1 2) "day" "night") => NIL
```

When *body* is empty, **when** always returns **nil**.

For a table of related items: See the section "Conditional Functions" in *Symbolics Common Lisp: Language Concepts.*

when Keyword For loop

when *expr*If *expr* evaluates to **nil**, the following clause is skipped, otherwise not. Examples:

```
(defun loop1 ()
  (loop for i from 1 to 10
        when (= i 5 ) return i
        finally (print "Finally triggered"))) => LOOP1
(loop1) => 5
```

V
Z

```
(defun loop1 ()
  (loop for i from 1
        when (> i 5 ) collect i
        until (> i 20))) => LOOP1
(loop1) => (6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21)
```

Multiple conditionalization clauses can appear in sequence. If one test fails, then any following tests in the immediate sequence, and the clause being conditionalized, are skipped.

In the typical format of a conditionalized clause such as

when *expr1 keyword expr2*

expr2 can be the keyword **it**. If that is the case, then a variable is generated to hold the value of *expr1*, and that variable gets substituted for *expr2*. Thus, the composition:

when *expr* **return it**

is equivalent to the clause:

thereis *expr*

and one can collect all non-**null** values in an iteration by saying:

when *expression* **collect it**

If multiple clauses are joined with **and**, the **it** keyword can only be used in the first. If multiple **when**s, **unless**es, and/or **if**s occur in sequence, the value substituted for **it** is that of the last test performed. The **it** keyword is not recognized in an **else**-phrase.

Conditionals can be nested.

See the section "**loop** Clauses", page 310.

where-is *pname* *Function*

Finds all symbols named *pname* and prints on **zl:standard-output** a description of each symbol. The symbol's home package and name are printed. If the symbol is present in a different package than its home package (that is, it has been imported), that fact is printed. A list of the packages from which the symbol is accessible is printed, in alphabetical order. **where-is** searches all packages that exist, except for invisible packages.

If *pname* is a string it is converted to uppercase, since most symbols' names use uppercase letters. If *pname* is a symbol, its exact name is used.

where-is returns a list of the symbols it found.

The **find-all-symbols** function is the primitive that does what **where-is** does without printing anything.

:which-operations *Message*

The object should return a list of the messages and generic functions it supports with methods.

The **:which-operations** method supplied by **flavor:vanilla** generates the list once per flavor and remembers it, minimizing consing and compute time. The list is regenerated when a new method is added.

while Keyword For loop

while *expr*

If *expr* evaluates to **nil**, the loop is exited, performing exit code (if any), and returning any accumulated value. The test is placed in the body of the loop where it is written. It can appear between sequential **for** clauses.

Examples:

```
(defun x-power (x)
  (loop for stepper = x then (* stepper x)
        while (< stepper 100)
        do
    (print stepper))) => X-POWER
(x-power 3) =>
3
9
27
81 NIL
```

&whole *Lambda List Keyword*

This keyword is used with macros only. It should be followed by a single variable that is bound to the entire macro-call form or subform. This variable is the value that the macro-expander function receives as its first argument. **&whole** and its following variable should appear first in the lambda-list, before any other parameter or lambda-list keyword.

with Keyword For loop

with *var1* {*data-type*} {= *expr1*} {**and** *var2* {*data-type*} {= *expr2*}}...

The **with** keyword can be used to establish initial bindings, that is, variables that are local to the loop but are only set once, rather than on each iteration.

The optional argument, *data-type*, is reserved for data type declarations. It is currently ignored.

If no *expr* is given, the variable is initialized to the appropriate value for its data type, usually **nil**. **with** bindings linked by **and** are performed in parallel; those not linked are performed sequentially. That is:

```
(loop with a = (foo) and b = (bar) and c
      ...)
```

binds the variables like:

```
((lambda (a b c) ...)
 (foo) (bar) nil)
```

whereas:

```
(loop with a = (foo) with b = (bar a) with c ...)
```

binds the variables like:

```
((lambda (a)
   ((lambda (b)
      ((lambda (c) ...)
       nil))
    (bar a)))
 (foo))
```

All *expr*'s in **with** clauses are evaluated in the order they are written, in lambda-expressions surrounding the generated **prog**. The **loop** expression:

```
(loop with a = xa and b = xb
      with c = xc
      for d = xd then (f d)
      and e = xe then (g e d)
      for p in xp
      with q = xq
        ...)
```

produces the following binding contour, where **t1** is a **loop**-generated temporary:

```
((lambda (a b)
   ((lambda (c)
      ((lambda (d e)
         ((lambda (p t1)
            ((lambda (q) ...)
             xq))
          nil xp))
       xd xe))
    xc))
 xa xb)
```

Because all expressions in **with** clauses are evaluated during the variable-binding phase, they are best placed near the front of the **loop** form for stylistic reasons.

For binding more than one variable with no particular initialization, one can use the construct:

with *variable-list* {*data-type-list*} {**and ...**}

as in:

```
with (i j k t1 t2) (fixnum fixnum fixnum) ...
```

A slightly shorter way of writing this is:

```
with (i j k) fixnum and (t1 t2) ...
```

These are cases of *destructuring* which **loop** handles specially. See the section "Destructuring", page 316.
Examples:

```
(defun loop1 ()
  (loop for x from 0 to 3
        with (a b)
        with c = '(its constant)
        with d = '(another constant)
        do
    (setq a (+ x 10))
    (setq b (+ x 20))
    (print (list a b c d)))) => LOOP1
(loop1) =>
(10 20 (ITS CONSTANT) (ANOTHER CONSTANT))
(11 21 (ITS CONSTANT) (ANOTHER CONSTANT))
(12 22 (ITS CONSTANT) (ANOTHER CONSTANT))
(13 23 (ITS CONSTANT) (ANOTHER CONSTANT)) NIL
```

See the macro **loop**, page 309.

sys:with-aborts-enabled (*identifiers ...*) *body ...* *Macro*

sys:with-aborts-enabled cancels the effect of one or more invocations of **sys:without-aborts**.

Each of the *identifiers* is a symbol that relates this invocation of **sys:with-aborts-enabled** to a matching invocation of **sys:without-aborts**. The innermost **sys:without-aborts** with a matching *identifier* is nullified for the duration of *body*. The *identifier* **unwind-protect** identifies the automatic **sys:without-aborts** created by **unwind-protect**. It is not possible to nullify a **sys:without-aborts** without an *identifier*.

Use **sys:with-aborts-enabled** when an operation that is generally unsafe to abort contains an interval during which the state is consistent and aborting is safe, especially if an error can be signalled during that interval. In the case of an error, **sys:with-aborts-enabled** allows the user to abort without having to interact further with the Debugger.

You also use **sys:with-aborts-enabled** when you don't need the automatic **sys:without-aborts** created by **unwind-protect**. For example,

```
(unwind-protect (do-something)
  (sys:with-aborts-enabled (unwind-protect)
    (clean-up-something)))
```

If the cleanup form contained an explicit **sys:without-aborts**, to specify a specific reason why it should not be aborted instead of the default generic reason, the **sys:with-aborts-enabled** must specify the identifiers of both the explicit and the implicit **sys:without-aborts**. For example,

```
(unwind-protect (do-something)
  (sys:without-aborts
      (foo "The floor is being cleaned up.
Aborting now could leave a serious mess that will cause
trouble if you enter this room again later.")
    (do-something-not-abortable)
    (sys:with-aborts-enabled (foo unwind-protect)
      (do-something-abortable))))
```

See the macro **sys:without-aborts**, page 620.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts*.

dbg:with-erring-frame (*frame-var condition*) &body *body* *Macro*

dbg:with-erring-frame sets up an environment with appropriate bindings for using the rest of the functions that examine the stack. It binds *frame-var* with the frame pointer to the stack frame that signalled the error.

frame-var is always a pointer to an interesting stack frame.

condition is the condition object for the error, which was the first argument given to the **condition-bind** handler.

```
(defun my-handler (condition-object)
   (dbg:with-erring-frame (frame-ptr condition-object)
      body...))
```

Inside *body*, the variable **frame-var** is bound to the frame pointer of the frame that got the error.

Sometimes, you might want to use the special variable **dbg:*current-frame*** as *frame-var* because some functions expect this special variable to be bound to the stack frame that signalled the error.

You would use this special variable if you are sending the **:bug-report-description** message to the condition object, which calls stack-

examination routines that depend on the idea of a current frame, in addition to the other things that **dbg:with-erring-frame** sets up. **:bug-report-description** is the message that generates the text that the :Mail Bug Report command (c-M) puts in the mail composition window. See the generic function **dbg:bug-report-description**, page 59.

For a table of related items: See the section "Functions for Examining Stack Frames" in *Symbolics Common Lisp: Language Concepts.*

sys:without-aborts *([identifier] reason format-args ...) body ...* *Macro*

This macro encloses code that should not be aborted. **sys:without-aborts** intercepts abort attempts by user action (such as c-ABORT), but not abort attempts by program action (such as **throw**).

When the macro is activated, it uses *reason*, a format-control string, and *format-args*, additional arguments, to display an explanation of why it is sensitive to the current abort request and what the consequences of aborting now would be. Phrase this explanation so that it is as useful and meaningful as possible to the user who is trying to abort the program. Giving the user the information needed to decide whether to leave the program running or to force it to abort is more important than conciseness. See the example given below.

identifier is optional and usually omitted. If present, *identifier* is a symbol that relates this invocation of **sys:without-aborts** to a matching invocation of **sys:with-aborts-enabled**. See the macro **sys:with-aborts-enabled**, page 618.

Use **sys:without-aborts** to protect those parts of your program, such as manipulations of global data structures, that cannot be aborted partway through their execution without damaging the program. You don't need **sys:without-aborts** if aborting the program would not cause a future execution of it to operate incorrectly.

If a program remains unsafe to abort for only a brief time, c-ABORT simply waits until the program leaves the *body* of **sys:without-aborts** and then aborts it. c-ABORT displays *reason* and queries the user only if the program remains inside **sys:without-aborts** for too long.

If a program enters the Debugger while inside **sys:without-aborts**, and you invoke a restart option that would throw through the **sys:without-aborts**, aborting the execution of *body*, the Debugger displays *reason* and queries you. In this case waiting until the program leaves *body* is not possible because the program is already stopped and sitting in the Debugger.

sys:without-aborts is automatically wrapped around all **unwind-protect** cleanup forms; this decreases the probability of leaving an **unwind-protect** without completely executing its cleanup forms. When **sys:without-aborts**

is invoked during an **unwind-protect**, *identifier* is **unwind-protect** and *reason* is a generic explanation supplied by the system.

You can specify a more precise description of why the cleanup forms of this **unwind-protect** are not safe to abort by invoking **sys:without-aborts** explicitly. You can also specify that the cleanup forms *are* safe to abort by invoking **sys:with-aborts-enabled** with **unwind-protect** as an identifier.

The function **process-abort**, used by the various abort keys, respects **sys:without-aborts**, waiting until the process is abortable, and asking the user what to do if the process is still not abortable after a timeout. See the section "Process Functions" in *Internals, Processes, and Storage Management.*

Example:

```
(sys:without-aborts
  ("The ~:R widget data base is being ~(~A~)d.~@
    Aborting this could leave the data base in an inconsistent state,~@
    and future operations on widgets might fail in unpredictable ways."
   2 :update)
  (+ 1 'foo))
Trap: The second argument...
s-A, <RESUME>:   Supply replacement argument
s-B:             Return a value from the +-INTERNAL instruction
s-C:             Retry the +-INTERNAL instruction
s-D, <ABORT>:    Return to Dynamic Lisp Top Level in Dynamic Lisp Listener 2
s-E:             Restart process Dynamic Lisp Listener 2
-->Abort Abort
Return to Dynamic Lisp Top Level in Dynamic Lisp Listener 2

The program cannot safely be aborted at this time.
  The second widget data base is being updated.
  Aborting this could leave the data base in an inconsistent state,
  and future operations on widgets might fail in unpredictable ways.
Do you want to Skip or Abort? (press <HELP> for help) <HELP>
The current program operation is one that the programmer expected
to run to completion.  Aborting this operation partway through
could leave the program in an inconsistent state and interfere
with its proper operation.
Your choices are:

   Skip   Abandons this attempt to abort the program.
   Abort  Aborts the program by force, accepting the risk of damage.

Do you want to Skip or Abort? Abort
```

```
Back to Dynamic Lisp Top Level in Dynamic Lisp Listener 2.
```

The example assumes the user of this program knows what widgets are and what a widget data base is. If this is not the case, the *reason* string should include a brief explanation.

In this example, the Debugger offers you two choices. If you select Skip, you can use one of the first two proceed options to correct the error in the program and continue execution. If you select Abort, you accept the possibility that the program won't work correctly in the future.

If the program had been aborted with c-ABORT, you would have been offered additional choices, as follows:

Skip	Abandons this attempt to abort the process.
Wait	Waits until the process reaches a point where it can safely be aborted. Offers these choices again if 5 seconds elapse and it still cannot be aborted.
Wait indefinitely	Keeps waiting for as long as it takes. Another attempt to abort stops waiting and offers these choices again.
Abort	Aborts the process by force, accepting the risk of damage.
Debug	Enters the Debugger for detailed investigation.

For a table of related items: See the section "Nonlocal Exit Functions" in *Symbolics Common Lisp: Language Concepts.*

without-floating-underflow-traps *body...* *Special Form*

Inhibits trapping of floating-point exponent underflow traps within the body of the form. The result of a computation which would otherwise underflow is a denormalized number or zero, whichever is closest to the mathematical result.

Example:

```
(describe (without-floating-underflow-traps (expt .1 40))) =>
1.0e-40 is a single-precision floating-point number.
  Sign 0, exponent 0, 23-bit fraction 213302 (denormalized)
1.0e-40
```

xcons *x y* *Function*

xcons ("exchanged cons")creates a cons, whose *car* is *y* and whose *cdr* is *y*. Example:

V
Z

```
(xcons 'a 'b) => (b . a)
```

xcons is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

xcons-in-area *x y area-number* *Function*

xcons-in-area creates a cons, whose *car* is *y* and whose *cdr* is *x*, in the specified *area.* (Areas are an advanced feature of storage management.) See the section "Areas" in *Internals, Processes, and Storage Management.*

xcons-in-area is a Symbolics extension to Common Lisp.

For a table of related items: See the section "Functions for Constructing Lists and Conses" in *Symbolics Common Lisp: Language Concepts.*

zerop *number* *Function*

Returns **t** if *number* is zero. Otherwise it returns **nil.** If *number* is not a number, **zerop** signals an error.

For floating-point numbers, this only returns **t** for exactly **0.0**, **-0.0**, **0.0d0** or **-0.0d0**; there is no "fuzz". For complex numbers, both real and imaginary parts must be zero.

For a table of related items: See the section "Numeric Property-checking Predicates" in *Symbolics Common Lisp: Language Concepts.*