

# **SYSTEM V/68 Release 3 Programmer's Guide**

**SYSTEM V/68 RELEASE 3  
PROGRAMMER'S GUIDE**

Part Number MU43815PG/D2

Version 2

**SYSTEM V/68™ is a trademark of Motorola Inc. UNIX® is a registered trademark of AT&T.**

**SYSTEM V/68 Release 3 is based on the AT&T UNIX System V, Release 3.0. The software described herein is furnished under a licensed agreement and may be used only in accordance with the terms of the agreement.**

**Copyright © 1986, 1987 Motorola Inc. All rights reserved. No part of this manual may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, without the prior written permission of Motorola Inc.**

**Portions of this document are reprinted from copyrighted documents by permission of AT&T, 1986.**



Part Number: MU43815PG/A1

## DOCUMENT SUPPLEMENT

Date: 04/01/88

The attached pages constitute a revision to the *SYSTEM V/68 Release 3 Programmer's Guide* (Part Number MU43815PG/D2). This supplement is required to support the SYSTEM V/68 assembler (*as*) on the MC68030 microprocessor, using SYSTEM V/68 Release 3, Version 4.

Please replace and add pages according to the following table:

Replace old	With new	Add new
ix/x xix-xxv Chapter 18 (pp 1-42)	ix/x xix-xxv Chapter 18 (pp 1-46)	

- A vertical bar in the outside margin of a revised page indicates a text change or addition.
- A double asterisk (\*\*) in the same position indicates a text deletion.

## PREFACE

The *Programmer's Guide* (Part Number MU43815PG/D2) provides information about programming in a SYSTEM V/68 environment.

While reasonable efforts have been made to assure the accuracy of this document, Motorola assumes no liability resulting from any omissions in this document or from the use of the information obtained therein. Motorola reserves the right to revise this document and to make changes from time to time in its content without being obligated to notify any person of such revision or changes.

## CONTENTS

1. INTRODUCTION .....	1-1
Purpose .....	1-1
Audience and Prerequisite Knowledge .....	1-1
Organization .....	1-1
The C Connection .....	1-2
Hardware/Software Dependencies .....	1-2
Notation Conventions .....	1-3
Command References .....	1-4
Information in the Examples .....	1-4
The Scope of This Guide .....	1-4
The Shell as a Prototyping Tool .....	1-5
Three Programming Environments .....	1-6
Single-User Environment .....	1-6
Application Environment .....	1-7
Systems Environment .....	1-7
2. PROGRAMMING BASICS .....	2-1
Introduction .....	2-1
Choosing a Programming Language .....	2-1
Supported Languages in an Operating System Environment .....	2-2
C Language .....	2-2
FORTRAN .....	2-3
Pascal .....	2-3
COBOL .....	2-3
BASIC .....	2-4
Assembly Language .....	2-4
Special-Purpose Languages .....	2-4
awk .....	2-5
lex .....	2-6
yacc .....	2-6
M4 .....	2-6
bc and dc .....	2-6
curses .....	2-6
After Your Code Is Written .....	2-7
Compiling and Link Editing .....	2-7
Compiling C Programs .....	2-8
Compiling FORTRAN Programs .....	2-9
Loading and Running BASIC Programs .....	2-9

Compiler Diagnostic Messages .....	2-9
Link Editing .....	2-9
The Operating System/Programming Language Interface .....	2-12
Why C Is Used to Illustrate the Interface .....	2-12
How Arguments Are Passed to a Program .....	2-12
System Calls and Subroutines .....	2-16
Categories of System Calls and Subroutines .....	2-16
Where to Find Manual Pages .....	2-21
Using System Calls and Subroutines in C Programs .....	2-22
Header Files and Object File Libraries .....	2-27
Header Files .....	2-27
Object File Libraries .....	2-28
Input/Output .....	2-29
Three Files You Always Have .....	2-29
Named Files .....	2-30
Low-level I/O and Why You Shouldn't Use It .....	2-32
System Calls for Environment or Status Information .....	2-32
Processes .....	2-33
system(3S) .....	2-35
exec(2) .....	2-35
fork(2) .....	2-36
Pipes .....	2-38
Error Handling .....	2-39
Signals and Interrupts .....	2-40
Analysis/Debugging .....	2-42
The cflow Command .....	2-45
The ctrace Command .....	2-48
The cxref Command .....	2-51
The lint Command .....	2-56
The prof Command .....	2-57
The size Command .....	2-59
The strip Command .....	2-59
The sdb Command .....	2-59
Program-Organizing Utilities .....	2-61
The make Command .....	2-61
The Archive .....	2-62
Use of SCCS by Single-User Programmers .....	2-68
3. APPLICATION PROGRAMMING .....	3-1
Introduction .....	3-1
Application Programming Considerations .....	3-1

Numbers .....	3-2
Portability .....	3-2
Documentation .....	3-2
Language Selection .....	3-3
Influences .....	3-3
Special-Purpose Languages .....	3-4
The <b>awk</b> Utility .....	3-4
Using <b>awk</b> .....	3-5
The <b>lex</b> and <b>yacc</b> Utilities .....	3-5
Using <b>lex</b> .....	3-6
Using <b>yacc</b> .....	3-8
Advanced Programming Tools .....	3-9
Memory Management .....	3-10
File and Record Locking .....	3-10
Using File and Record Locking .....	3-11
The <b>lockf</b> Subroutine .....	3-13
Interprocess Communications .....	3-13
IPC <b>get</b> Calls .....	3-14
IPC <b>ctl</b> Calls .....	3-14
IPC <b>op</b> Calls .....	3-14
Programming Terminal Screens .....	3-15
The <b>curses</b> Package .....	3-15
Programming Support Tools .....	3-16
Link Editor Command Language .....	3-16
Common Object File Format .....	3-17
Libraries .....	3-17
The Object File Library .....	3-18
Common Object File Interface Macros ( <b>ldfcn.h</b> ) .....	3-21
The Math Library .....	3-21
Shared Libraries .....	3-24
Symbolic Debugger .....	3-25
<b>lint</b> as a Portability Tool .....	3-26
Project Control Tools .....	3-26
The <b>make</b> Command .....	3-27
Where to Find More Information .....	3-27
SCCS .....	3-28
<b>liber</b> , A Library System .....	3-29
4. <b>awk</b> PROGRAMMING LANGUAGE .....	4-1
Introduction .....	4-1
Basic <b>awk</b> .....	4-2



Program Structure .....	4-2
Usage .....	4-3
Fields .....	4-3
Printing .....	4-4
Formatted Printing .....	4-5
Simple Patterns .....	4-6
Simple Actions .....	4-7
Built-in Variables .....	4-7
User-defined Variables .....	4-8
Functions .....	4-8
Useful One-Line Programs .....	4-8
Error Messages .....	4-10
Patterns .....	4-10
BEGIN and END .....	4-10
Relational Expressions .....	4-11
Regular Expressions .....	4-12
Combinations of Patterns .....	4-15
Pattern Ranges .....	4-16
Actions .....	4-16
Built-in Variables .....	4-17
Arithmetic .....	4-17
Strings and String Functions .....	4-20
Field Variables .....	4-23
Number or String? .....	4-24
Control Flow Statements .....	4-25
Arrays .....	4-28
User-Defined Functions .....	4-30
Comments .....	4-31
Output .....	4-31
The print Statement .....	4-31
Output Separators .....	4-31
The printf Statement .....	4-32
Output into Files .....	4-33
Output into Pipes .....	4-34
Input .....	4-35
Files and Pipes .....	4-35
Input Separators .....	4-36
Multi-Line Records .....	4-36
The getline Function .....	4-37
Command-line Arguments .....	4-39
Using awk With Other Commands and the Shell .....	4-40
The system Function .....	4-40

Cooperation with the Shell .....	4-40
Example Applications .....	4-42
Generating Reports .....	4-42
Additional Examples .....	4-44
<b>awk</b> Summary .....	4-47
Command Line .....	4-47
Patterns .....	4-47
Control Flow Statements .....	4-47
Input-Output .....	4-47
String Functions .....	4-48
Arithmetic Functions .....	4-49
Operators (Increasing Precedence) .....	4-49
Regular Expressions (Increasing Precedence) .....	4-49
Built-In Variables .....	4-50
Limits .....	4-50
Initialization, Comparison, and Type Coercion .....	4-50
5. <b>lex</b> .....	5-1
An Overview of <b>lex</b> Programming .....	5-1
Writing <b>lex</b> Programs .....	5-2
The Fundamentals of <b>lex</b> Rules .....	5-3
Specifications .....	5-3
Actions .....	5-5
Advanced <b>lex</b> Usage .....	5-6
Some Special Features .....	5-7
Definitions .....	5-11
Subroutines .....	5-12
Using <b>lex</b> with <b>yacc</b> .....	5-13
Running <b>lex</b> under the Operating System .....	5-16
6. <b>yacc</b> .....	6-1
Introduction .....	6-1
Basic Specifications .....	6-3
Actions .....	6-6
Lexical Analysis .....	6-9
Parser Operation .....	6-10
Ambiguity and Conflicts .....	6-15
Precedence .....	6-20

Error Handling .....	6-23
The yacc Environment .....	6-26
Hints for Preparing Specifications .....	6-27
Input Style .....	6-27
Left Recursion .....	6-27
Lexical Tie-Ins .....	6-28
Reserved Words .....	6-29
Advanced Topics .....	6-30
Simulating error and accept in Actions .....	6-30
Accessing Values in Enclosing Rules .....	6-31
Support for Arbitrary Value Types .....	6-32
yacc Input Syntax .....	6-33
Examples .....	6-36
1. A Simple Example .....	6-36
2. An Advanced Example .....	6-39
7. FILE AND RECORD LOCKING .....	7-1
Introduction .....	7-1
Terminology .....	7-1
File Protection .....	7-3
Opening a File for Record Locking .....	7-3
Setting a File Lock .....	7-4
Setting and Removing Record Locks .....	7-6
Getting Lock Information .....	7-10
Deadlock Handling .....	7-13
Selecting Advisory or Mandatory Locking .....	7-13
Caveat Emptor—Mandatory Locking .....	7-15
Record Locking and Future Releases of the Operating System .....	7-15
8. SHARED LIBRARIES .....	8-1
Introduction .....	8-1
Using a Shared Library .....	8-1
What is a Shared Library? .....	8-2
Shared Libraries Provided with the Operating System .....	8-3
Building an a.out File .....	8-3
Coding an Application .....	8-4
Deciding Whether to Use a Shared Library .....	8-4
More About Saving Space .....	8-5
How Shared Libraries Save Space .....	8-5
How Shared Libraries Are Implemented .....	8-8

How Shared Libraries Might Increase Space Usage .....	8-11
Identifying <b>a.out</b> Files that Use Shared Libraries .....	8-11
Debugging <b>a.out</b> Files that Use Shared Libraries .....	8-12
Building a Shared Library .....	8-12
The Building Process .....	8-12
Step 1: Choosing Region Addresses .....	8-12
Step 2: Choosing the Target Library Path Name .....	8-14
Step 3: Selecting Library Contents .....	8-15
Step 4: Rewriting Existing Library Code .....	8-15
Step 5: Writing the Library Specification File .....	8-15
Step 6: Using <b>mkshlib</b> to Build the Host and Target .....	8-17
An Example .....	8-18
Guidelines for Writing Shared Library Code .....	8-23
Choosing Library Members .....	8-24
Changing Existing Code for the Shared Library .....	8-26
Importing Symbols .....	8-28
Providing Archive Library Compatibility .....	8-34
Tuning the Shared Library Code .....	8-35
Making A Shared Library Upward Compatible .....	8-38
Summary .....	8-40
9. INTERPROCESS COMMUNICATION .....	9-1
Introduction .....	9-1
Messages .....	9-1
Getting Message Queues .....	9-6
Using <b>msgget</b> .....	9-6
Example Program .....	9-9
Controlling Message Queues .....	9-14
Using <b>msgctl</b> .....	9-14
Example Program .....	9-15
Operations for Messages .....	9-21
Using <b>msgop</b> .....	9-21
Example Program .....	9-24
Semaphores .....	9-32
Using Semaphores .....	9-35
Getting Semaphores .....	9-38
Using <b>semget</b> .....	9-38
Example Program .....	9-42
Controlling Semaphores .....	9-46
Using <b>semctl</b> .....	9-46
Example Program .....	9-47

Operations on Semaphores .....	9-57
Using <b>semop</b> .....	9-57
Example Program .....	9-58
Shared Memory .....	9-62
Using Shared Memory .....	9-63
Getting Shared Memory Segments .....	9-67
Using <b>shmget</b> .....	9-67
Example Program .....	9-71
Controlling Shared Memory .....	9-75
Using <b>shmctl</b> .....	9-75
Example Program .....	9-76
Operations for Shared Memory .....	9-83
Using <b>shmop</b> .....	9-83
Example Program .....	9-84
10. <b>curses/terminfo</b> .....	10-1
Introduction .....	10-1
Overview .....	10-2
<b>curses</b> .....	10-2
<b>terminfo</b> .....	10-4
How <b>curses</b> and <b>terminfo</b> Work Together .....	10-5
Other Components of the Terminal Information Utilities .....	10-5
Working with <b>curses</b> Routines .....	10-6
What Every <b>curses</b> Program Needs .....	10-7
The Header File <b>&lt;curses.h&gt;</b> .....	10-7
The Routines <b>initscr()</b> , <b>refresh()</b> , <b>endwin()</b> .....	10-8
Compiling a <b>curses</b> Program .....	10-10
Running a <b>curses</b> Program .....	10-10
More about <b>initscr()</b> and Lines and Columns .....	10-11
More about <b>refresh()</b> and Windows .....	10-11
Getting Simple Output and Input .....	10-15
Output .....	10-15
Input .....	10-26
Controlling Output and Input .....	10-32
Output Attributes .....	10-32
Bells and Flashing Screens .....	10-37
Input Options .....	10-38
Building Windows and Pads .....	10-43
Output and Input .....	10-43
The Routines <b>wnoutrefresh()</b> and <b>doupdate()</b> .....	10-44
New Windows .....	10-49

Using Advanced curses Features .....	10-52
Routines for Drawing Lines and Other Graphics .....	10-52
Routines for Using Soft Labels .....	10-54
Working with More than One Terminal .....	10-55
Working with terminfo Routines .....	10-56
What Every terminfo Program Needs .....	10-57
Compiling and Running a terminfo Program .....	10-58
An Example terminfo Program .....	10-58
Working with the terminfo Database .....	10-61
Writing Terminal Descriptions .....	10-61
Name the Terminal .....	10-62
Learn About the Capabilities .....	10-63
Specify Capabilities .....	10-63
Compile the Description .....	10-68
Test the Description .....	10-69
Comparing or Printing terminfo Descriptions .....	10-70
Converting a termcap Description to a terminfo Description .....	10-71
curses Program Examples .....	10-72
The editor Program .....	10-72
The highlight Program .....	10-77
The scatter Program .....	10-79
The show Program .....	10-81
The two Program .....	10-82
The window Program .....	10-85
11. COMMON OBJECT FILE FORMAT (COFF) .....	11-1
The Common Object File Format (COFF) .....	11-1
Definitions and Conventions .....	11-3
Sections .....	11-3
Physical and Virtual Addresses .....	11-3
Target Machine .....	11-4
File Header .....	11-4
Magic Numbers .....	11-5
Flags .....	11-5
File Header Declaration .....	11-6
Optional Header Information .....	11-6
Standard Operating System a.out Header .....	11-6
Optional Header Declaration .....	11-8
Section Headers .....	11-8
Flags .....	11-10
Section Header Declaration .....	11-11

	11-11
Sections .....	11-12
Relocation Information .....	11-12
Relocation Entry Declaration .....	11-13
Line Numbers .....	11-14
Line Number Declaration .....	11-15
Symbol Table .....	11-15
Special Symbols .....	11-17
Inner Blocks .....	11-18
Symbols and Functions .....	11-20
Symbol Table Entries .....	11-21
Auxiliary Table Entries .....	11-34
String Table .....	11-43
Access Routines .....	11-44
12. THE LINK EDITOR .....	12-1
The Link Editor .....	12-1
Memory Configuration .....	12-1
Sections .....	12-2
Addresses .....	12-2
Binding .....	12-2
Object File .....	12-2
Link Editor Command Language .....	12-3
Expressions .....	12-3
Assignment Statements .....	12-4
Specifying a Memory Configuration .....	12-5
Section Definition Directives .....	12-7
File Specifications .....	12-8
Load a Section at a Specified Address .....	12-9
Aligning an Output Section .....	12-10
Grouping Sections Together .....	12-10
Creating Holes Within Output Sections .....	12-12
Creating and Defining Symbols at Link-Edit Time .....	12-14
Allocating a Section Into Named Memory .....	12-15
Initialized Section Holes or .bss Sections .....	12-16
Notes and Special Considerations .....	12-17
Changing the Entry Point .....	12-17
Use of Archive Libraries .....	12-18
Dealing With Holes in Physical Memory .....	12-20
Allocation Algorithm .....	12-21
Incremental Link Editing .....	12-21

DSECT, COPY, NOLOAD, INFO, and OVERLAY Sections .....	12-23
Output File Blocking .....	12-24
Nonrelocatable Input Files .....	12-25
Syntax Diagram for Input Directives .....	12-25
13. make .....	13-1
Introduction .....	13-1
Basic Features .....	13-2
Description Files and Substitutions .....	13-6
Comments .....	13-6
Continuation Lines .....	13-6
Macro Definitions .....	13-7
General Form .....	13-7
Dependency Information .....	13-7
Executable Commands .....	13-8
Extensions of \$*, \$@, and \$< .....	13-8
Output Translations .....	13-9
Recursive Makefiles .....	13-9
Suffixes and Transformation Rules .....	13-10
Implicit Rules .....	13-10
Archive Libraries .....	13-12
Source Code Control System Filenames: the Tilde .....	13-14
The Null Suffix .....	13-15
include Files .....	13-16
SCCS Makefiles .....	13-16
Dynamic Dependency Parameters .....	13-16
Command Usage .....	13-17
The make Command .....	13-18
Environment Variables .....	13-19
Suggestions and Warnings .....	13-20
Internal Rules .....	13-21
14. SOURCE CODE CONTROL SYSTEM (SCCS) .....	14-1
Introduction .....	14-1
SCCS For Beginners .....	14-1
Terminology .....	14-1
Creating an SCCS File via admin .....	14-2
Retrieving a File via get .....	14-2
Recording Changes via delta .....	14-3
Additional Information about get .....	14-4



The help Command .....	14-5
Delta Numbering .....	14-6
SCCS Command Conventions .....	14-8
x.files and z.files .....	14-8
Error Messages .....	14-9
SCCS Commands .....	14-9
The get Command .....	14-10
ID Keywords .....	14-11
Retrieval of Different Versions .....	14-12
Retrieval With Intent to Make a Delta .....	14-13
Undoing a get e .....	14-14
Additional get Options .....	14-14
Concurrent Edits of Different SID .....	14-15
Concurrent Edits of Same SID .....	14-18
Keyletters That Affect Output .....	14-18
The delta Command .....	14-20
The admin Command .....	14-23
Creation of SCCS Files .....	14-23
Inserting Commentary for the Initial Delta .....	14-24
Initialization and Modification of SCCS File Parameters .....	14-24
The prs Command .....	14-26
The sact Command .....	14-27
The help Command .....	14-27
The rmdel Command .....	14-28
The cdc Command .....	14-29
The what Command .....	14-30
The sccsdiff Command .....	14-30
The comb Command .....	14-31
The val Command .....	14-32
The vc Command .....	14-32
SCCS Files .....	14-32
Protection .....	14-33
Formatting .....	14-34
Auditing .....	14-35
15. sdb—THE SYMBOLIC DEBUGGER .....	15-1
Introduction .....	15-1
Using sdb .....	15-1
Printing a Stack Trace .....	15-2
Examining Variables .....	15-3
Source File Display and Manipulation .....	15-5

Displaying the Source File .....	15-6
Changing the Current Source File or Function .....	15-6
Changing the Current Line in the Source File .....	15-6
A Controlled Environment for Program Testing .....	15-7
Setting and Deleting Breakpoints .....	15-8
Running the Program .....	15-9
Calling Functions .....	15-10
Machine Language Debugging .....	15-10
Displaying Machine Language Statements .....	15-10
Manipulating Registers .....	15-11
Other Commands .....	15-11
An sdb Session .....	15-11
16. lint .....	16-1
Introduction .....	16-1
Usage .....	16-1
lint Message Types .....	16-3
Unused Variables and Functions .....	16-3
Set/Used Information .....	16-4
Flow of Control .....	16-4
Function Values .....	16-5
Type Checking .....	16-6
Type Casts .....	16-7
Nonportable Character Use .....	16-7
Assignments of longs to ints .....	16-8
Strange Constructions .....	16-8
Old Syntax .....	16-9
Pointer Alignment .....	16-10
Multiple Uses and Side Effects .....	16-10
17. C LANGUAGE .....	17-1
Introduction .....	17-1
Lexical Conventions .....	17-1
Comments .....	17-1
Identifiers (Names) .....	17-1
Keywords .....	17-2
Constants .....	17-2
Integer Constants .....	17-2
Explicit Long Constants .....	17-2
Character Constants .....	17-2

Floating Constants .....	17-3
Enumeration Constants .....	17-3
String Literals .....	17-4
Syntax Notation .....	17-4
Storage Class and Type .....	17-4
Storage Class .....	17-4
Type .....	17-5
Objects and lvalues .....	17-6
Operator Conversions .....	17-7
Characters and Integers .....	17-7
Float and Double .....	17-7
Floating and Integral .....	17-7
Pointers and Integers .....	17-8
Unsigned .....	17-8
Arithmetic Conversions .....	17-8
Void .....	17-9
Expressions and Operators .....	17-9
Primary Expressions .....	17-10
Unary Operators .....	17-12
Multiplicative Operators .....	17-13
Additive Operators .....	17-14
Shift Operators .....	17-15
Relational Operators .....	17-15
Equality Operators .....	17-15
Bitwise AND Operator .....	17-16
Bitwise Exclusive OR Operator .....	17-16
Bitwise Inclusive OR Operator .....	17-16
Logical AND Operator .....	17-16
Logical OR Operator .....	17-17
Conditional Operator .....	17-17
Assignment Operators .....	17-17
Comma Operator .....	17-18
Declarations .....	17-19
Storage Class Specifiers .....	17-19
Type Specifiers .....	17-20
Declarators .....	17-21
Meaning of Declarators .....	17-21
Structure and Union Declarations .....	17-23
Enumeration Declarations .....	17-26
Initialization .....	17-27
Type Names .....	17-29
Implicit Declarations .....	17-30

typedef .....	17-30
Statements .....	17-31
Expression Statement .....	17-31
Compound Statement or Block .....	17-31
Conditional Statement .....	17-32
while Statement .....	17-32
do Statement .....	17-32
for Statement .....	17-32
switch Statement .....	17-33
break Statement .....	17-34
continue Statement .....	17-34
return Statement .....	17-34
goto Statement .....	17-35
Labeled Statement .....	17-35
Null Statement .....	17-35
External Definitions .....	17-35
External Function Definitions .....	17-36
External Data Definitions .....	17-37
Scope Rules .....	17-37
Lexical Scope .....	17-37
Scope of Externals .....	17-38
Compiler Control Lines .....	17-39
Token Replacement .....	17-39
File Inclusion .....	17-40
Conditional Compilation .....	17-40
Line Control .....	17-42
Version Control .....	17-42
Types Revisited .....	17-42
Structures and Unions .....	17-42
Functions .....	17-43
Arrays, Pointers, and Subscripting .....	17-44
Explicit Pointer Conversions .....	17-45
Constant Expressions .....	17-45
Portability Considerations .....	17-46
Syntax Summary .....	17-47
Expressions .....	17-47
Declarations .....	17-49
Statements .....	17-51
External Definitions .....	17-52
Preprocessor .....	17-53

18. SYSTEM ASSEMBLER .....	18-1
Introduction .....	18-1
Warnings .....	18-2
Comparison Instructions .....	18-2
Overloading of Opcodes .....	18-2
Use of the Assembler .....	18-3
General Syntax Rules .....	18-3
Format of Assembly Language Line .....	18-3
Comments .....	18-4
Identifiers .....	18-4
Register Identifiers .....	18-5
Constants .....	18-7
Numerical Constants. ....	18-7
Character Constants. ....	18-7
Other Syntactic Details .....	18-8
Segments, Location Counters, And Labels .....	18-8
Segments .....	18-8
Location Counters and Labels .....	18-9
Types .....	18-9
Expressions .....	18-10
Pseudo-Operations .....	18-11
Data Initialization Operations .....	18-11
Symbol Definition Operations .....	18-12
Location Counter Control Operations .....	18-13
Symbolic Debugging Operations .....	18-13
file and In .....	18-13
Symbol Attribute Operations. ....	18-14
Switch Table Operation .....	18-15
Span-Dependent Optimization .....	18-16
Address Mode Syntax .....	18-17
Machine Instructions .....	18-21
Instructions For The MC68000/MC68010/MC68020 .....	18-21
Instructions For The MC68881 .....	18-34
Instructions For The MC68851 .....	18-43
19. THE TRANSPORT INTERFACE .....	19-1
Introduction .....	19-1
Background .....	19-1
About This Chapter .....	19-3
Overview of the Transport Interface .....	19-4
Modes of Service .....	19-5

Connection-Mode Service .....	19-6
Local Management .....	19-6
Connection Establishment .....	19-8
Data Transfer .....	19-9
Connection Release .....	19-10
Connectionless-Mode Service .....	19-10
State Transitions .....	19-11
Connection-Mode Service .....	19-12
Local Management .....	19-12
The Client .....	19-14
The Server .....	19-15
Connection Establishment .....	19-19
The Client .....	19-19
Event Handling .....	19-21
The Server .....	19-22
Data Transfer .....	19-25
The Client .....	19-27
The Server .....	19-27
Connection Release .....	19-29
The Server .....	19-30
The Client .....	19-31
Connectionless-Mode Service .....	19-32
Local Management .....	19-32
Data Transfer .....	19-34
Datagram Errors .....	19-36
A Read/Write Interface .....	19-37
write .....	19-39
read .....	19-39
Close .....	19-40
Advanced Topics .....	19-41
Asynchronous Execution Mode .....	19-41
Advanced Programming Example .....	19-42

APPENDIX A: STATE TRANSITIONS .....	A-1
Transport Interface States .....	A-1
Outgoing Events .....	A-1
Incoming Events .....	A-3
Transport User Actions .....	A-4
State Tables .....	A-4

APPENDIX B: GUIDELINES FOR PROTOCOL INDEPENDENCE .....	B-1
--	-----

APPENDIX C: TRANSPORT INTERFACE EXAMPLES .....	C-1
Connection-Mode Client .....	C-1
Connection-Mode Server .....	C-3
Connectionless-Mode Transaction Server .....	C-7
Read/Write Client .....	C-9
Event-Driven Server .....	C-11

## FIGURES

Figure 2-1. Using Command Line Arguments to Set Flags .....	2-14
Figure 2-2. Using argv[n] Pointers to Pass a Filename .....	2-15
Figure 2-3. Manual Page for gets(3S) .....	2-23
Figure 2-4. A Version of stdio.h (part 1 of 2) .....	2-24
Figure 2-5. How gets Is Used in a Program .....	2-26
Figure 2-6. Process Status Display .....	2-34
Figure 2-7. Example of fork .....	2-36
Figure 2-8. Example of a popen Pipe .....	2-38
Figure 2-9. Signal Numbers Defined in /usr/include/sys/signal.h .....	2-40
Figure 2-10. Source Code for Sample Program (part 1 of 4) .....	2-42
Figure 2-11. cflow Output, No Options .....	2-46
Figure 2-12. cflow Output, Using -r Option .....	2-47
Figure 2-13. cflow Output, Using -ix Option .....	2-47
Figure 2-14. cflow Output, Using -r and -ix Options .....	2-48
Figure 2-15. ctrace Output (part 1 of 2) .....	2-48
Figure 2-16. cxref Output, Using -c Option (part 1 of 5) .....	2-51
Figure 2-17. lint Output .....	2-56
Figure 2-18. prof Output .....	2-58
Figure 2-19. make Description File .....	2-61
Figure 2-20. nm Output, with -f Option (part 1 of 5) .....	2-63
Figure 3-1. The fcntl.h Header File .....	3-11
Figure 4-1. awk Program Structure and Example .....	4-2
Figure 4-2. The Sample Input File countries .....	4-4
Figure 4-3. awk Comparison Operators .....	4-11
Figure 4-4. awk Regular Expressions .....	4-15
Figure 4-5. awk Built-in Variables .....	4-17

Figure 4-6. <b>awk</b> Built-in Arithmetic Functions .....	4-19
Figure 4-7. <b>awk</b> Built-in String Functions .....	4-20
Figure 4-8. <b>awk</b> Conversion Characters .....	4-32
Figure 4-9. <b>getline</b> Function .....	4-39
Figure 5-1. Creation and Use of a Lexical Analyzer with <b>lex</b> .....	5-2
Figure 8-1. <b>a.out</b> Files Created Using Archive and Shared Library .....	8-7
Figure 8-2. Processes Using an Archive and a Shared Library .....	8-8
Figure 8-3. A Branch Table in a Shared Library .....	8-10
Figure 8-4. Imported Symbols in a Shared Library .....	8-28
Figure 9-1. <b>ipc_perm</b> Data Structure .....	9-4
Figure 9-2. <b>msgget()</b> System Call Example (Sheet 1 of 2) .....	9-11
Figure 9-2. <b>msgget()</b> System Call Example (Sheet 2 of 2) .....	9-12
Figure 9-3. <b>msgctl()</b> System Call Example (Sheet 1 of 4) .....	9-17
Figure 9-3. <b>msgctl()</b> System Call Example (Sheet 2 of 4) .....	9-18
Figure 9-3. <b>msgctl()</b> System Call Example (Sheet 3 of 4) .....	9-19
Figure 9-3. <b>msgctl()</b> System Call Example (Sheet 4 of 4) .....	9-20
Figure 9-4. <b>msgop()</b> System Call Example (Sheet 1 of 5) .....	9-27
Figure 9-4. <b>msgop()</b> System Call Example (Sheet 2 of 5) .....	9-28
Figure 9-4. <b>msgop()</b> System Call Example (Sheet 3 of 5) .....	9-29
Figure 9-4. <b>msgop()</b> System Call Example (Sheet 4 of 5) .....	9-30
Figure 9-4. <b>msgop()</b> System Call Example (Sheet 5 of 5) .....	9-31
Figure 9-5. <b>semget()</b> System Call Example (Sheet 1 of 2) .....	9-43
Figure 9-5. <b>semget()</b> System Call Example (Sheet 2 of 2) .....	9-44
Figure 9-6. <b>semctl()</b> System Call Example (Sheet 1 of 5) .....	9-51
Figure 9-6. <b>semctl()</b> System Call Example (Sheet 2 of 5) .....	9-53
Figure 9-6. <b>semctl()</b> System Call Example (Sheet 3 of 5) .....	9-53
Figure 9-6. <b>semctl()</b> System Call Example (Sheet 4 of 5) .....	9-55
Figure 9-6. <b>semctl()</b> System Call Example (Sheet 5 of 5) .....	9-56
Figure 9-7. <b>semop(2)</b> System Call Example (Sheet 1 of 3) .....	9-60
Figure 9-7. <b>semop(2)</b> System Call Example (Sheet 2 of 3) .....	9-60
Figure 9-7. <b>semop(2)</b> System Call Example (Sheet 3 of 3) .....	9-61
Figure 9-8. <b>shmget(2)</b> System Call Example (Sheet 1 of 2) .....	9-72
Figure 9-8. <b>shmget(2)</b> System Call Example (Sheet 2 of 2) .....	9-73
Figure 9-9. <b>shmctl(2)</b> System Call Example (Sheet 1 of 4) .....	9-78
Figure 9-9. <b>shmctl(2)</b> System Call Example (Sheet 2 of 4) .....	9-79
Figure 9-9. <b>shmctl(2)</b> System Call Example (Sheet 3 of 4) .....	9-80
Figure 9-9. <b>shmctl(2)</b> System Call Example (Sheet 4 of 4) .....	9-81
Figure 9-10. <b>shmop()</b> System Call Example (Sheet 1 of 3) .....	9-86
Figure 9-10. <b>shmop()</b> System Call Example (Sheet 2 of 3) .....	9-88
Figure 9-10. <b>shmop()</b> System Call Example (Sheet 3 of 3) .....	9-89
Figure 10-1. A Simple <b>curses</b> Program .....	10-3
Figure 10-2. A Shell Script Using <b>terminfo</b> Routines .....	10-4
Figure 10-3. The Purposes of <b>initscr()</b> , <b>refresh()</b> , and <b>endwin()</b> in a Program .....	10-8



Figure 10-4. Relationship Between <code>stdscr</code> and a Terminal Screen .....	10-11
Figure 10-4. Relationship Between <code>stdscr</code> and a Terminal Screen .....	10-12
Figure 10-5. Multiple Windows and Pads Mapped to a Terminal Screen .....	10-14
Figure 10-6. Relationship Between a Window and a Terminal Screen .....	10-46
Figure 10-6. Relationship Between a Window and a Terminal Screen .....	10-47
Figure 10-6. Relationship Between a Window and a Terminal Screen .....	10-48
Figure 10-7. Sending a Message to Several Terminals .....	10-56
Figure 10-8. Typical Framework of a <code>terminfo</code> Program .....	10-57
Figure 11-1. Object File Format .....	11-1
Figure 11-2. File Header Contents .....	11-4
Figure 11-3. File Header Flags .....	11-5
Figure 11-4. File Header Declaration .....	11-6
Figure 11-5. Optional Header Contents .....	11-7
Figure 11-6. Operating System Magic Numbers .....	11-7
Figure 11-7. <code>aouthdr</code> Declaration .....	11-8
Figure 11-8. Section Header Contents .....	11-9
Figure 11-9. Section Header Flags .....	11-10
Figure 11-10. Section Header Declaration .....	11-11
Figure 11-11. Relocation Section Contents .....	11-12
Figure 11-12. Relocation Types .....	11-13
Figure 11-13. Relocation Entry Declaration .....	11-13
Figure 11-14. Line Number Grouping .....	11-14
Figure 11-15. Line Number Entry Declaration .....	11-15
Figure 11-16. COFF Symbol Table .....	11-15
Figure 11-17. Special Symbols in the Symbol Table .....	11-17
Figure 11-18. Special Symbols ( <code>.bb</code> and <code>.eb</code> ) .....	11-18
Figure 11-19. Nested blocks .....	11-18
Figure 11-20. Example of the Symbol Table .....	11-19
Figure 11-21. Symbols for Functions .....	11-20
Figure 11-22. Symbol Table Entry Format .....	11-21
Figure 11-23. Name Field .....	11-21
Figure 11-24. Storage Classes .....	11-23
Figure 11-25. Storage Class by Special Symbols .....	11-24
Figure 11-26. Restricted Storage Classes .....	11-25
Figure 11-27. Storage Class and Value .....	11-26
Figure 11-28. Section Number .....	11-27
Figure 11-29. Section Number and Storage Class .....	11-28
Figure 11-30. Fundamental Types .....	11-29
Figure 11-31. Derived Types .....	11-30
Figure 11-32. Type Entries by Storage Class .....	11-32
Figure 11-33. Symbol Table Entry Declaration .....	11-33
Figure 11-34. Auxiliary Symbol Table Entries .....	11-35
Figure 11-35. Format for Auxiliary Table Entries for Sections .....	11-36

Figure 11-36. Tag Names Table Entries .....	11-37
Figure 11-37. Table Entries for End of Structures .....	11-37
Figure 11-38. Table Entries for Functions .....	11-38
Figure 11-39. Table Entries for Arrays .....	11-38
Figure 11-40. End of Block and Function Entries .....	11-39
Figure 11-41. Format for Beginning of Block and Function .....	11-40
Figure 11-42. Entries for Structures, Unions, and Enumerations .....	11-40
Figure 11-43. Auxiliary Symbol Table Entry (Sheet 1 of 2) .....	11-42
Figure 11-43. Auxiliary Symbol Table Entry (Sheet 2 of 2) .....	11-42
Figure 11-44. String Table .....	11-43
Figure 12-1. Operator Symbols .....	12-4
Figure 12-2. Syntax Diagram for Input Directives (Sheet 1 of 4) .....	12-26
Figure 12-2. Syntax Diagram for Input Directives (Sheet 2 of 4) .....	12-27
Figure 12-2. Syntax Diagram for Input Directives (Sheet 3 of 4) .....	12-28
Figure 12-2. Syntax Diagram for Input Directives (Sheet 4 of 4) .....	12-29
Figure 13-1. Summary of Default Transformation Path .....	13-11
Figure 13-2. <b>make</b> Internal Rules (Sheet 1 of 5) .....	13-21
Figure 13-2. <b>make</b> Internal Rules (Sheet 2 of 5) .....	13-22
Figure 13-2. <b>make</b> Internal Rules (Sheet 3 of 5) .....	13-23
Figure 13-2. <b>make</b> Internal Rules (Sheet 4 of 5) .....	13-24
Figure 13-2. <b>make</b> Internal Rules (Sheet 5 of 5) .....	13-25
Figure 14-1. Evolution of an SCCS File .....	14-6
Figure 14-2. Tree Structure with Branch Deltas .....	14-7
Figure 14-3. Extended Branching Concept .....	14-7
Figure 14-4. Determination of New SID (sheet 1 of 2) .....	14-16
Figure 14-4. Determination of New SID (sheet 2 of 2) .....	14-17
Figure 15-1. Example of <b>sdb</b> Usage (Sheet 1 of 2) .....	15-12
Figure 15-1. Example of <b>sdb</b> Usage (Sheet 2 of 2) .....	15-13
Figure 17-1. Escape Sequences for Nongraphic Characters .....	17-3
Figure 17-2. M68000 Family-Based Computer Hardware Characteristics .....	17-5
Figure 19-1. OSI Reference Model .....	19-1
Figure 19-2. Transport Interface .....	19-4
Figure 19-3. Channel Between User and Provider .....	19-6
Figure 19-4. Local Management Routines .....	19-7
Figure 19-5. Transport Connection .....	19-8
Figure 19-6. Connection Establishment Routines .....	19-9
Figure 19-7. Connection Mode Data Transfer Routines .....	19-9
Figure 19-8. Connection Release Routines .....	19-10
Figure 19-9. Connectionless-mode Data Transfer Routines .....	19-11
Figure 19-10. Listening and Responding Transport Endpoints .....	19-25
Figure A-1. Transport Interface States .....	A-1
Figure A-2. Transport Interface Outgoing Events .....	A-2
Figure A-3. Transport Interface Incoming Events .....	A-3