Writable Control Store

FIXED CONTROL STORE   WRITABLE CONTROL STORE   MAIN MEMORY
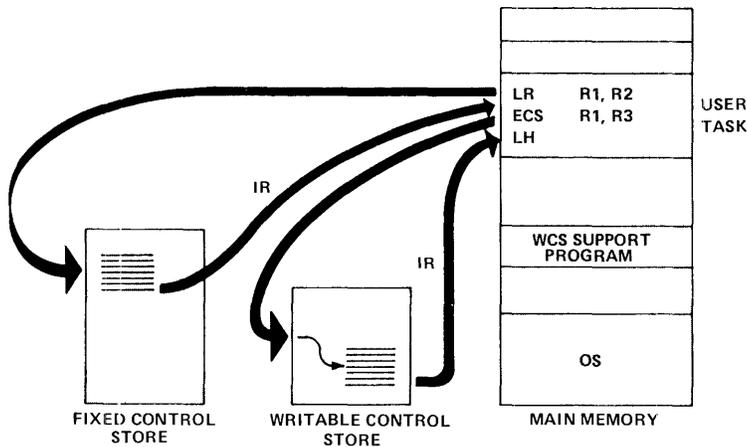
PRODUCT DESCRIPTION

Writable Control Store (WCS) provides the user with 512 32-bit words of high-speed, bipolar, microprogrammable control store memory, permitting the user to upgrade Model 8/32 Megamini performance dramatically by effectively adding frequently used subroutines to the Processor's firmware. Microcoding, loading, testing, and debugging of specially tailored firmware subroutines are easily accomplished using the WCS Support Program.

WCS serves as an extension of the Model 8/32 Megamini architecture. Each of the 217 instructions in the Model 8/32 Instruction Set is implemented by means of one or more microinstructions in fixed control store. As a program is executed, the Processor recognizes successive operation codes in the instruction stream, and directs control to the corresponding microinstruction subroutines in fixed control store for execution. Fixed control store consists of 1280 32-bit words of bipolar read-only memory (ROM) with an access time of 50 nanoseconds. Since fixed control store is read-only, the user cannot modify it. WCS serves as a modifiable adjunct to fixed control store, enabling the user to effectively extend the Instruction Set on his Model 8/32 Megamini without modifying the hardware.

Four instructions support this powerful feature: Enter, Read, Write, and Branch.

The Enter instruction allows the user to execute 16 different functions in WCS from the non-privileged state. Thus, the power of WCS is available to all applications programs. Read, Write, and Branch are all privileged and available only to the operating system, giving it complete control over loading and unloading WCS and over branching into the middle of routines stored there.

WCS FEATURES

● Gives user 512 32-bit words of high speed control memory.
● Allows user to add application-oriented op codes and algorithms to extend Model 8/32 architecture.
● Increases system throughput by 25% to 80% or more.
● Adds four instructions — Enter, Read, Write, Branch.
● Provides data Integrity — Read, Write, and Branch are privileged.
● Saves memory space otherwise needed for subroutines to implement op codes or algorithms.
● Makes programming application simpler and easier.

WCS INSTRUCTIONS

Four user-level instructions pertain to WCS: Enter, Branch, Read, and Write. Only Enter is non-privileged and can be used in a user program.

● Enter Control Store (ECS) and Branch to Control Store (BDCS) transfer processor control to WCS. The ECS instruction located anywhere within a user-level routine can call a WCS routine. The microcoded routine in WCS

returns processor control to the fixed Control Store on completion. The non-privileged ECS instruction transfers control to one of the first 16 locations in WCS to initiate one of 16 different microcoded functions. Unused function codes can initiate the Illegal Instruction Interrupt microsequence in the fixed control store if desired.

- Write Control (WDCS) and Read Control Store (RDCS). The WDCS instruction transfers a data buffer from main memory to WCS. The RDCS transfers a data buffer from WCS to main memory.

INSTRUCTION EXECUTION TIMES

Instruction	Execution Time, microseconds
Write Control Store (WDCS)	2.46
Read Control Store (RDCS)	2.94
Enter Control Store (ECS)	1.00
Branch to Control Store (BDCS)	2.94

WCS SUPPORT PROGRAM

A WCS Support Program is available to run under OS/32 MT. It is designed for debugging microcoded routines to be stored in WCS. It also allows a microcoded object program to be loaded into a WCS image buffer in main memory. The buffer contents can then be transferred to WCS. The debug features allow examination and modification of data, insertion of breakpoints in WCS microcode, and execution of microcode routines. WCS is volatile; thus the WCS Support Program provides initialization when power is restored after a power fail.

The WCS Support Program includes a microassembler which allows users to program WCS in a high-level language.

FEATURES

The WCS Support Program is interactive and communicates with the operator through an interactive device. The operator can direct the program to perform the following functions:

- Clear the WCS image
- Load the WCS image from a named file or device
- Output the WCS image (in loader format) to a named file binary device
- Copy the WCS image between limits in WCS
- Dump the WCS image to a named file or ASCII Device
- Disassemble the WCS microcode located between limits
- Examine and modify words of WCS image
- Examine and modify words in WCS
- Examine and modify halfword in main memory
- Insert and delete breakpoints in WCS microcode
- Start executing microcode or continue executing microcode after a breakpoint.
- Enter Wait state except during power fail/restore sequences.

USING WCS

User programs calling routines stored in WCS must go through the first 16 locations. The locations in turn contain branches to the microcoded subroutines.

The example shown in Figure 2 calculates x + TANy. The user must have previously microcoded the subroutine that calculates TANy and loaded it into WCS, locations 400 to 450.
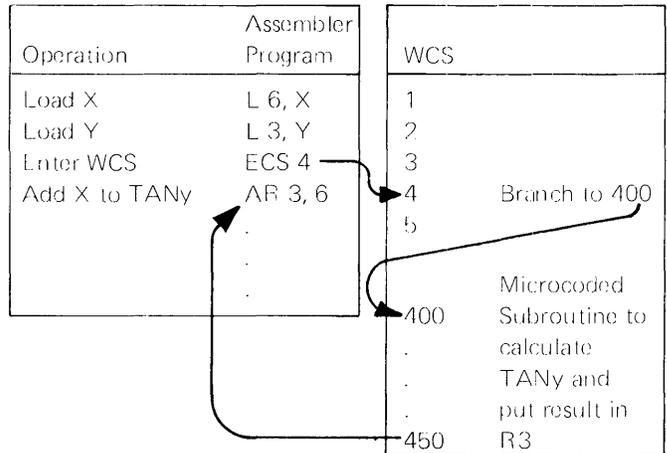

Operation	Assembler Program	WCS	
Load X	L 6, X	1	
Load Y	L 3, Y	2	
Enter WCS	ECS 4	3	
Add X to TANy	AR 3, 6	4	Branch to 400
		5	
		400	Microcoded Subroutine to calculate TANy and put result in
		450	R3

Figure 2. User-Developed Microprogram Implemented in WCS

A user program cannot branch directly into WCS but must Enter via one of the first 16 locations. The WCS location 4 contains a branch to the TANy subroutine; the user program calls the TANy subroutine by entering WCS at location 4.

After TANy is calculated, WCS returns control to the user program, which resumes normal processing.

RELATED DOCUMENTATION

The WCS user should be familiar with the operation of the Model 8/32 processor hardware to understand the microprogramming concepts used with WCS. He should also be familiar with the OS/32 MT operating system. Documentation to be used in conjunction with WCS includes the following:

- 29-428 Model 8/32 User's Manual
- 29-438 Model 8/32 Microinstruction Reference Manual
- 29-479 8/32 Writable Control Store User's Guide
- 29-478 Common Microcode Assembler Language User's Manual

SYSTEM CONFIGURATION

Minimum hardware configuration that can support WCS and the WCS Support program is as follows:

- Model 8/32 Processor with 128KB Memory
- Display Panel
- Console Device
- Binary Input Device

INTERDATA PRODUCT NUMBERS

- M83-108 Writable Control Store (WCS)
- S90-406 Writable Control Store (WCS) Support Program