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FLOATING POINT INSTRUCTIONS DIAGNOSTIC

for

hp-2100 SERIES COMPUTERS

reference manual

HEWLETT PACKARD

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Floating Point Instructions Diagnostic

Introduction

The Floating Point Instructions Diagnostic performs a "Go/no-go" test of the floating point instruction set. It operates in any 2100 series computer with a minimum of 4K of memory and is one of the HP 2000 computer system diagnostics executed in conjunction with the HP 2000 Computer Systems Diagnostic Configurator. Communication to the operator is provided through a teleprinter, through the computer Memory Data Register (T-register), and the A- and B-registers. The only operator input required is through the switch register.

The diagnostic consists of seven tests, one for each floating point instruction and one additional test, which tests both the memory protect fence register and the multi-level indirect addressing function, while executing the floating point add (FAD) instruction.

The test method consists of executing the test instructions in the normal CPU mode and then comparing the results to those obtained by simulating the instruction with a routine not involving the instruction. This involves the use of many other CPU instructions and thus requires that they be fully tested first. Hence this diagnostic should be run only after the following other CPU diagnostics have been successfully completed.

- Memory Reference Instruction Diagnostic
- Alter-skip Instruction Diagnostic
- Shift-rotate Instructions Diagnostic
- Extended Arithmetic Instructions Diagnostic
- Memory Protect Diagnostic
- Teleprinter Diagnostic (optional)

GENERAL ENVIRONMENT

Hardware Requirements

1. The diagnostic can be run on any 2100 series computer with 4K of memory.
2. The Extended Arithmetic Unit (EAU) must be installed on the CPU.
3. A paper tape reader is required to load the program; a teleprinter paper tape reader can be used, if available.
4. A system console teleprinter is a recommended option.

Software Requirements

The required software consists of the following binary object tapes:

1. HP 2000 Computer Systems Diagnostic Configurator (HP 24296)
2. Floating Point Instructions Diagnostic, part no. 24320-16001.

Loading is performed using the Binary Loader (usually memory resident). See the appropriate *Front Panel Procedures* for the 2100 series computer being used for use of the Binary Loader. The loader is described in the HP manual *Basic Binary Loader — Basic Binary Disc Loader* (HP 5951-1376).

Operating Procedures

Operating procedures are divided into three parts: Preparation for Diagnostic Run, Running the Diagnostic, and Diagnostic Messages and Halts.

PREPARATION FOR DIAGNOSTIC RUN

Before the tests can be initiated, the user performs the following actions in order:

- Load the Diagnostic Configurator
- Configure to available system hardware
- Dump the configuration for later use (optional)
- Load this diagnostic

Loading

Using the Binary Loader, load the Diagnostic Configurator. Perform the configuration procedure (see "Configuring" below), before loading the diagnostic. Then load the Floating Point Instructions Diagnostic using the Binary Loader. The user may ensure that the proper diagnostic is loaded by checking memory location 126_8 for the Diagnostic Serial Number = 101107_8.

Configuring

Procedures for inputting the system hardware configuration parameters are found in the *HP 2000 Computer Systems Diagnostic Configurator* manual (02100-90157) under "CONFIGURING." At the back of this same manual is a PRODUCT APPLICABILITY sheet, which describes which computers are compatible with this diagnostic.

The configuration procedure accepts six groups of parameters. This diagnostic requires only four groups to be defined. They are

- Computer type and options
- Teleprinter as system slow input device (optional)
- Teleprinter as system slow output device (optional)
- Memory size and type

The other parameters may be left undefined (zero).

Computer Type and *Options* and *Memory Size* and *Type* vary from one 2100 series installation to the other. The user must determine the parameters of his installation and configure accordingly. The Memory Protect and Extended Arithmetic Unit options are used by this diagnostic. Without the EAU this diagnostic will not run. Without Memory Protect the first test will be skipped.

A Teleprinter may be configured as the *Slow System Input Device* and *Slow System Output Device* to serve as operator/diagnostic communicator.

Dumping

Using procedures described in the Diagnostic Configurator manual, the user may dump the configured diagnostic from memory onto paper tape so that the configuration procedures need not be repeated. The dumped paper tape holding the configured diagnostic can thereafter be loaded via the Binary Loader.

RUNNING THE DIAGNOSTIC

Switch Register Settings

Table 1 gives a summary of switch register options.

If *switches 0 through 5* are clear, all tests are executed in sequence.

Normally a random number generator produces new test argument for each instruction test. *Switch 6* is used to suppress the random number generator allowing test to proceed with existing arguments.

Switch 9 is used to produce message H4 (see Table 2) which displays the number of cycles executed of the diagnostic and the corresponding number of errors detected.

Table 1. Switch Register Settings

Switch	Meaning If Set
0	Execute Test 2 – Floating Point Add Instruction (FAD)
1	Execute Test 3 – Floating Point Subtract Instruction (FSB)
2	Execute Test 4 – Floating Point Multiply Instruction (FMP)
3	Execute Test 5 – Floating Point Divide Instruction (FDV)
4	Execute Test 6 – Fix Floating Point Number Instruction (FIX)
5	Execute Test 7 – Float a Fixed Point Number Instruction (FLT)
6	Suppress Random Number argument generation
7	Reserved
8	Reserved
9	Print number of cycles and errors (Message H4)
10	Reserved
11	Suppress Error Message printing
12	Loop on diagnostic. Clear to HALT at end of 1000 passes.
13	Loop on last executed test
14	Suppress Error HALT's
15	HALT after each test performed

Note: If switches 0 through 5 are clear, all tests are executed in normal sequence.

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Diagnostic Execution

1. Set P-register to 100_8.
2. Make switch register settings required.
3. Press PRESET (INTERNAL and EXTERNAL, if applicable).
4. Press RUN.

The execution of 1000 cycles of the diagnostic requires approximately 5 to 10 seconds (Switch 12 clear causes diagnostic to HALT after 1000 passes).

DIAGNOSTIC MESSAGES AND HALTS

The diagnostic communicates to the operator by teleprinter (if available), HALTs or both, based on switch register settings. Thus messages consist of both HALT codes (MDR or T-register) and teleprinter text.

There are two types of messages and HALT's: information and error.

Information Messages

Information message formats consist of the letter "H", followed by message number, followed by message text. Information messages and meaning are shown in Table 2.

Table 2. Information Messages

	Text	Meaning
H1	2100 SERIES FLOATING POINT DIAGNOSTIC	Diagnostic header message.
H4	*xxxxx* CYCLES WITH *yyyyy* ERRORS	Invoked whenever switches 9 set or 12 clear (and switch 11 clear); *xxxxx* is decimal number of cycles, *yyyyy* is decimal number of errors; neither number greater than 32767.
H5	TEST COMPLETE	Test terminated by clearing switch 12.

Error Messages

Error message formats consist of the letter "E", followed by message number, followed by message text. Error messages are only printed if switch 11 is clear. Text and meaning of the error messages is shown in Table 3. Note that message E1 to E3 are not printed if Memory Protect option is not installed on system.

The following codes are used in Table:

m	refers to a memory location	*b*	refers to B-register
v	refers to overflow register	*a*	refers to A-register

Table 3. Error Messages

Text		Meaning
E1	MEMORY PROTECT BOUNDARY TOO HIGH	The Floating Point hardware modified the memory protect fence value to a higher value (Test 1).
E2	MEMORY PROTECT BOUNDARY TOO LOW	The Floating Point hardware modified the memory protect fence value to a lower value (Test 1).
E3	STORE ON BOUNDARY DID NOT WORK PROPERLY	Attempt made to store on memory protect fence failed but did not cause a memory protect violation (Test 1).
E4	INDIRECT ADDITION	An error occurred in the indirect address type of floating point add (Test 2).
E5	ADDEND1 *bbbbbb aaaaaa*	
E6	ADDEND2 *mmmmmm mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	
E9	ADDITION	Error occurred in a floating point add test (Test 2).
E5	ADDEND1 *bbbbbb aaaaaa*	
E6	ADDEND2 *mmmmmm mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	
E10	SUBTRACTION	Error occurred in the floating point subtract test (Test 3).
E11	MINUEND *bbbbbb aaaaaa*	
E12	SUBTRAHEND *mmmmmm mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	
E13	MULTIPLICATION	Error occurred in the floating point multiply test (Test 4).
E14	MULTIPLICAND *bbbbbb aaaaaa*	
E15	MULTIPLIER *mmmmmm mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	
E16	DIVISION	Error occurred in the floating point division test (Test 5).
E17	DIVIDEND *bbbbbb aaaaaa*	
E18	DIVISOR *mmmmmm mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	
E19	FIX	Error occurred in the fix number test (Test 6).
E20	OPERAND *mmmmmm mmmmmm*	
E21	EXPECTED *v aaaaaa*	
E22	ACTUAL *v aaaaaa*	
E23	FLOAT	Error occurred in the float a number test (Test 7).
E24	OPERAND *mmmmmm*	
E7	EXPECTED *v bbbbbb aaaaaa*	
E8	ACTUAL *v bbbbbb aaaaaa*	

Diagnostic Halts

In a way similar to the messages, HALTS fall into two types: information and error HALTS. They are invoked or suppressed according to switch register settings (see Table 1, bit 11). HALTS are coded by the Memory Data Register (MDR or T-register) contents shown at the time of the HALT. Table 4 lists the HALT codes and meanings. Error HALTS 102002 through 102004 will only occur if the memory protect feature is installed on the system. The second column of the table, headed by E/I, indicates whether the HALT is an error HALT, E, or an information HALT, I.

Table 4. HALT Codes

Octal MDR Code	E/I	Meaning
102002	E	Memory protect did not interrupt on an illegal store operation
102003	E	Memory protect interrupted on a store in the fence boundary
102004	E	Memory protect did not interrupt on an illegal store operation
102010	I	End of first test (Switch 15 set)
102011	I	End of floating addition test (Switch 15 set)
102012	I	End of floating subtraction test (Switch 15 set)
102013	I	End of floating multiplication test (Switch 15 set)
102014	I	End of floating division test (Switch 15 set)
102015	I	End of FIX test (Switch 15 set)
102016	I	End of Float test (Switch 15 set)
102020	E	Indirect floating addition error
102021	E	Floating add error
102022	E	Floating subtract error
102023	E	Floating multiply error
102024	E	Floating divide error
102025	E	Fix error
102026	E	Float error
102077	I	End of test (Switch 12 clear)
106077	E	Unexpected trap cell halt

Test Sections

The diagnostic consists of seven tests; one test checks both the memory protect fence (if this feature is installed on the CPU and configured via the Diagnostic Configurator) and the multiple indirect execution of the Floating Point Add instruction; six more tests are performed, one for each Floating Point (FP) instruction.

TEST SECTIONS

Test Number	Test Performed
1	Memory Protect fence test and multiple indirect test of FAD (FP Add) instruction
2	FAD instruction test
3	FSB (FP Subtract) instruction test
4	FMP (FP Multiply) instruction test
5	FDV (FP Divide) instruction test
6	FIX (Fix a FP number) instruction test
7	FLT (Float a Fixed point number) instruction test

Each test is exercised in sequence using arguments from a number generator, unless switch register option 6 is used to suppress the generation of new arguments. The same arguments are used in FP instruction simulation routines. Errors are reported when a difference is detected between the two instruction execution methods.

NUMBER GENERATION

At the start of each test new arguments are generated using a random number generator unless switch register bit 6 is set.

INDIRECT ADDRESSING

A multi-level indirect FP Add test is executed in the first test. One execution of this test is enough to ensure that indirect addressing is being handled properly. This indirect addressing test is executed at the beginning of each 100 cycles of the diagnostic.

OVERFLOW REGISTER CHECKING

At the beginning of each test the Overflow register (OV) is cleared. The expected OV result is compared to the actual OV result after the test is executed; a difference causes an error message to be printed.