EAE II

B3

IDENTIFICATION

Product Code:	MAINDEC-9A-D0HC-D
Product Name:	EAE Part II
Date Created:	September 23,1968
Maintainer:	Diagnostic Group
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1. ABSTRACT

Part 2 of the PDP-9 EAE Diagnostic verifies only correct operation of the EAE multiply and divide instructions. Part 2 is written in two sections: Section 1 checks EAE instructions against predetermined results. This ranges from setup operation, through multiply and divide instructions executed back to back; Section 2 is a random-number check of the signed multiply and signed divide instructions.

Hardware malfunctions in Section 1 result in an error halt. Hardware malfunctions in Section 2 result in an error message on the teleprinter.

2. REQUIREMENTS

Storage

The program when loaded occupies locations 20 to 7100.

Subprograms and/or Subroutines

Teletype Output Package

Signed Multiply Subroutine (modified)

Signed Divide Subroutine (modified)

Equipment

Minimum configuration PDP-9 with EAE option installed

3. USAGE

3.1 Loading

Hardware read in (HIR) SA=017720

3.2 Calling Sequence

The program is self-starting; after an explanatory printout, press CONTINUE button to proceed.

3.3 Switch Settings

AC Switches = 0 or Down

With all AC switches down, the program results in the following:

a. Hardware malfunctions detected in Section 1 result in an error halt.

b. Hardware malfunctions detected in Section 2 result in an error typeout.

c. At the completion of the error typeout, the processor halts.

d. The program completes whichever section of test it was started in, sequence from each subtest of the section to the next, without halting.

AC Switches 1 or Up

SW	Operation	Description
0	Delete error typeouts	The program will not type out error messages, but will ring bell on error.
1	Halt after EAE operation	The processor halts after each EAE operation is initiated and its results are verified. (Note: Press CONTINUE to proceed.)
2	Repeat EAE operation (Scope Loop)	The program repeats the last EAE operation. If SW2 is set during an error typeout or halt, the program repeats the operation that caused the error (Note: SW1 is tested before SW2.)
3	Halt after EAE sequence	The processor halts after each sequence of testing an EAE operation.
4	Repeat EAE sequence	The program repeats the last sequence of testing an EAE operation; i.e., the program repeats the EAE AC sign test and does not proceed to multiply/divide test. (Note: The program tests SW3 before SW4.)
5	Cycle all sections	At the completion of 77 passes through the Set-Up Test, the program proceeds to the Random Multiply and Divide Test. At the completion of passes through Random Test the program repeats the Set-Up Test.
6		Halt after Set-Up or Random Test.
7		Error printout for module lookup (to be supplied later).

3.4 Start-Up and/or Entry

Start up, Section 1

Set AC switches = 000000

Set address = 6512

Press START

Start Up, Section 2

Set AC switch = 000000

Set address = 6515

Press START

3.5 Errors in Usage

Hardware malfunctions detected in Section 1 will result in an error halt. Refer to the listing using the address in the memory register to identify the error.

Hardware malfunctions detected in Section 2 will result in an error typeout on the teleprinter, and a processor halt.

a. Error typeouts are in standard format and include the following information.

b. Type of failure, multiply or divide.

c. Initial problem set-up, contents of the AC, MQ, and the divisor and multiplicand.

d. The results of the instruction, i.e., if divide, the quotient and remainder; if multiply, the high and low order product. A comparison of the results (software vs hardware).

e. A printout of the ratio of failure, based on 100 octal iterations.

f. If the ration is small, it is recommended that CONTINUE be depressed to find a setup that produces a higher failure ratio.

g. Then set the address register equal to the contents of the AC and depress START. This will generate a simulated printout of the EAE failure. After the printout the program will go into a scope loop, executing the instruction that failed.

The abbreviations used by the header are as follows:

Abbreviation	Meaning
C(L)	The information under this header is the contents of LINK.
C(AC)	The information under this header is the contents of AC.
C(MQ)	The information under this header is the contents of MQ.
C(SC)	The information under this header is the contents of SHIFT COUNT.
(DIVISOR)	The information under this header is the contents of MB - not sign corrected.
(MULTIPLICAND)	The information under this header is the contents of MB - not sign corrected.

Error Typeout Examples:

a. Sign Multiply

MULS FAILED

MULTIPLIER
705722

MULTIPLICAND
167372

HIGH ORDER PRODUCT

LOW ORDER PRODUCT

SOFTWARE	762343	133015
HARDWARE	762443	762343

OUT OF 100 CHECKS BAD 100
6571XX (XX = SHIFT COUNT)

b. Sign Divide

DIVS

C(DIVISOR)
235012

C(AC)
223506

C(MQ)
304176

QUOTIENT

REMAINDER

SOFTWARE	741320	146136
HARDWARE	741320	146135

OUT OF 100 CHECKS BAD 1
6443XX (XX = SHIFT COUNT)

c. (Overflow condition that should set link on divide)

BAD LINK FAILED TO SET
DIVS FAILED

C(DIVISOR)
172052

AC
160723

C(MQ)
403073

QUOTIENT

REMAINDER

SOFTWARE	604323	263471
HARDWARE	604323	263471

d. Example of Multiply Simulation

MULS FAILED

MULTIPLIER (AC)
235037

MULTIPLICAND
534247

HIGH ORDER PRODUCT

LOW ORDER PRODUCT

SOFTWARE	754134	257305
HARDWARE	754134	57305

OUT OF 100 CHECK BAD 100
657110 (10 SHIFTS)

C(L)	C(AC)	C(MQ)	C(SC)
0	0	235037	70 (2's compliment of 10)
0	121654	116417	71
0	172602	47207	72
0	217155	23503	73
0	231342	411641	74
0	236435	204720	75
0	117216	502350	76
0	47507	241164	77
0	754134	257305	0

e. Example of Divide Simulation

DIVS FAILED C(DIVISOR) 136760 C(AC) 710272 C(MQ) 567264

QUOTIENT 665007 666112 REMAINDER 666055 113135

SOFTWARE
HARDWARE
OUT OF 100 CHECKS BAD 0
644321 (21 SHIFTS)

C(L)	C(AC)	C(MQ)	C(SC)
		567264	57 (2's compliment of 21)
0	67505	356550	60
1	20232	735321	61
0	701505	672642	62
0	742172	565504	63
1	73344	353211	64
0	747730	726422	65
1	56641	655045	66
0	776522	532112	67
1	134224	264225	70
1	131470	550453	71
1	124201	321127	72
1	111422	642257	73
1	64065	504537	74
1	11172	211277	75
0	663404	422576	76
0	705771	45374	77
0	752742	112770	0
1	111722	665007	0
0	666055		

3.6 Recovery from such Errors

In Section 1, a malfunction causes a processor halt. In Section 2, a malfunction will generate an error typeout, then halt the processor.

One of the following operations may be necessary if more information about the failure is needed to repair the malfunction.

a. Repeat the exact operation that detected the failure (possibly a scope loop).

b. Continue normally in the test to generate more information about the failure.

c. Repeat the sequence of operation, or data patterns that detected the failure.

d. Produce a simulation printout of failing multiply or divide instruction.

AC switch control is built into the program to allow for any of these operations assuming the processor has halted after an error.

These operations may be accomplished as follows:

a. Repeat same operation

Set AC switch 2 up or to a 1

Press CONTINUE

Not that AC switch 0 allows deletion of error typeout for a scope loop.

b. Continue normally

Press CONTINUE

c. Repeat Sequence

Set AC switch 4 up to a 1

Press CONTINUE

d. Simulation Printout

Set Address Switch = C(AC)

Press START

(At completion of Printout the program goes to an automatic scope loop.)

4. PROGRAM DESCRIPTION

4.1 General

The PDP-9 EAE Diagnostic part 2 verifies correct operation of the Multiply and Divide EAE Instruction. Part 2 itself is written in two logical sections as follows.

Section 1 - Set up test using fixed number

Verifies correct operation of all EAE Multiply and Divide instructions with fixed numbers.

Section 2 - Random Number

Verifies correct operation of signed Multiply and Signed Divide instruction with random numbers.

The above sections are to be run sequentially; that is, Section 1 must run before Section 2.

4.2 Test Description

4.2.1 Section 1 Set-Up Test - The Set-Up Test incrementally verifies correct operation of the multiply and divide instruction.

a. "ADVP" Checks that the memory location following the multiply and/or divide instruction is not modified by the execution of the instruction and that the program address counter is properly incremented during the execution of the instruction.

b. "NEAE" Set up check - Checks the set-up of all EAE signed, unsigned, integer and fraction, multiply and divide instructions. These instructions are executed with a shift count of zero.

c. "SHCT" Shift Counter Test - Executes the Multiply instruction sequentially starting at a shift count of 1 and incrementing it up to a shift count of 22.

d. "STMUL" Sign multiply and divide test - Test all signed multiply and divide instructions.

e. "MULTST" Multiply and Divide Test - This test using worse-case number patterns acts as both a EAE and Adder Test.

f. "MSPEED" Speed Multiply and Divide - This test is in three operations: (1) a sequence of multiply instructions are executed back to back, (2) then a sequence of divide instructions are executed, (3) followed by a sequence of MUL, DIV, MUL, and DIV executed back to back.

4.2.2 Section 2 Random Data Multiply and Divide Test - The Random Data Test verifies that the EAE will multiply and divide random numbers at shift counts 1 through maximum (22 for multiply, 23 for divide) and checks that the LINK is set on divide overflow.

The sequence of testing is as follows:

a. Test the Multiply
   (1) Generate a random number
   (2) Do a software multiply
   (3) Do a hardware multiply
   (4) Compare the results of both operations
   (5) LOOP BACK TO 1 TILL DONE

b. Test the Divide
   (1) Generate a random number
   (2) Do a software divide
   (3) Do a hardware divide
   (4) Compare the results of both operations
   (5) LOOP BACK TO 1 TILL DONE