IDENTIFICATION

Product Code:	MAINDEC-9A-D0CA-D
Product Name:	Memory Address Test
Date:	June 15, 1967
Maintainer:	Diagnostics Group
Author:	Edward P. Steinberger

1 ABSTRACT

The Memory Address Test checks the memory system of the PDP-9 to ensure that all memory locations not occupied by the program in a given 8K memory stack can be uniquely addressed. It does this by writing the address of a memory location into itself and checking to see that it is there. The complement of the address is also written to ensure that all bits of a word can be accessed. Checks are also made to ensure that only one memory location is written into whenever memory is addressed, and that cores of different memory locations are not shorted together inside the memory stack. Errors are indicated to the operator via the teleprinter.

2 REQUIREMENTS

Equipment

Standard PDP-9 Computer

Storage

The program uses all of 8K memory for the program or as a test area. The program occupies memory from location 17200 to 17777 and tests all locations below 17200.

3 LOADING PROCEDURE

Method

Put HRI tape of program in reader.
Set ADDRESS SWITCHES to 17200.
Depress I/O RESET.
Depress and release READIN key.

4 STARTING PROCEDURE

4.1 Control Switch Settings

The following is a table of accumulator switch settings and their action on the program.

AC Switch	Set As	Action
0	1	Halt on error
	0	Don't halt on error
1	1	Don't print errors
	0	Print errors
2	1	Ring bell on error
	0	Ring bell after N passes

AC Switch	Set As	Action
3	1 0	Loop on current number (address or complement)
4	1 0	Loop on current location
5	1 0	Loop on current test
6	1 0	Skip 1's in 0's test (Test 4)
7	1 0	Halt after completing all tests

Switch 3 operates only with the first test, switch 4 with first and fourth, 3 has precedence over 4 (in first test), and 4 over 5 (in first and fourth tests). N is an arbitrary number (initially 20000_8) for the first and fourth tests, and 4_8 for the second and third. It may be changed at the operator's discretion by modifying the contents of locations 17302 and 17300 respectively to the appropriate LAW-N instruction.

4.2 Starting Address

The starting address of the program is 17200. The restart addresses are 17200, 17262, 17320, and 17367 (see listing).

4.3 Program and/or Operator Action

Set ADDRESS SWITCHES to 17200.

Set ACCUMULATOR SWITCHES to desired positions (see section 4.1). Normal setting is 500000.

Depress I/O RESET.

Depress START.

5 OPERATING PROCEDURE

5.1 Operational Switch Settings

See section 4.1

5.2 Program and/or Operator Action

a. To put the program in the 'SCOPE mode, the ACCUMULATOR SWITCHES should be set to 260000 (don't halt, don't print, bell after N passes, loop on current number, loop on current location).

b. To test an individual location (first test), store the address to be tested, in location 17765 (POINT) and restart the computer at location 17211 (FIRST+7) to store the address in itself, or location 17224 (SECOND) to store the complement (1's) in the address. ACCUMULATOR SWITCHES should be set to 260000 (see a).

c. To run the Individual Location test (whole first test), restart the computer at location 17200 (FIRST-2) with AC Switches 3 and 4 a 0 and 5 a 1.

d. To narrow the first test to less than all of memory occupied by the program, place the new upper limit in location 17773 (UPLIM), then start the computer at location 17200 (FIRST-2).

e. To test all of memory in the forward direction only, restart the computer at location 17262 (THIRD) with AC switch 5 = 1.

f. To test all of memory in the reverse direction only, restart the computer at location 17320 (FIFTH) with AC switch 5 = 1.

g. To narrow the second and third tests to less than all of memory not occupied by the program, place the new upper limit in location 17774 (UPLIM1), then restart at the appropriate address for the particular test. Checks will still be made starting from location 00000 up to the limit for the forward test, or from the limit down to location 00000 for the reverse test.

h. To write 1's into a particular memory location (fourth test) store the address to contain all 1's in location 17764 (PNTR1) and restart the computer at location 17374 (SEVENH+5) with AC switch 4 = 1.

i. To narrow the fourth test to less than all of memory occupied by the program, place the new upper limit in location 17773 (UPLIM), then start the computer at the appropriate starting address. Checks will still be made starting from location 00000 up to the limit.

j. To run the Write 1's in a Field of 0's test (fourth test), restart the computer at location 17367 (SEVENH) with AC switch 5 = 1.

6 ERRORS

Unless AC switch 1 is a 1, all errors will be printed on the teleprinter.

6.1 Error Halts and Description

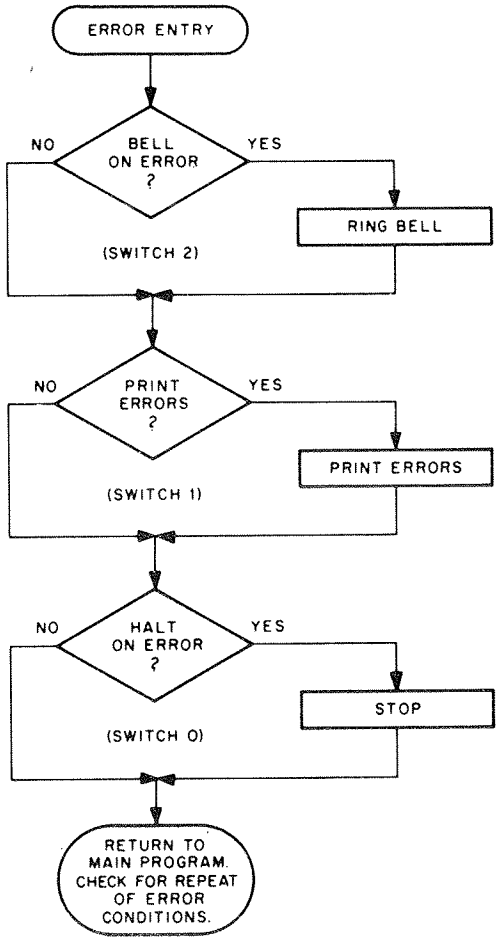
There is only one error halt in the program at location 17526. This halt will occur any time there is an error; there is no useful information in the AC. The computer will halt at location 17472 if all tests are not repeated.

6.2 Error Recovery

If AC switch 0 = 1, the computer will halt on an error. To recover and repeat the failure, reset AC switches 0 to 5 as necessary (see section 4.1) and then depress CONTINUE.

To test a particular location, see section 5.2.

6.3 Error Switch Hierarchy



6.4 Error Typeout Examples

6.4.1 Individual Location Test

ADDRESS	GOOD	BAD
001234	001234	001230

The above example shows that location 1234 dropped bit 15 when its ADDRESS was written in it.

6.4.2 Forward Write-Read and Reverse Complement Write-Read Tests (both typeouts are the same).

Forward Write-Read Test

ADDRESS	GOOD	BAD
001234	001234	003234

The above example shows that location 1234 contained 3234 when it should have contained 001234. This may have been due to "picking up" bit 7 in the memory buffer register when addressing location 001234, or it may have been due to "double addressing" (addressing location 001234 when the memory address register contains 001234 and 003234).

6.4.3 Write 1's in a Field of 0's Test

WRITE ONES IN A FIELD OF ZEROS

ADDRESS	GOOD	BAD
001234	000000	000004
001235	000000	000004

The above example shows that location 01234 contained 000004 when it should have contained 000000. This may have been due to bit 15 of location 01234 being shorted to bit 15 of location 01235. This same error may have caused location 01235 to be in error. If location 17764 (PNTR1) contained 01235 at the first error and 01234 at the second error, this is probably true.

7 EXECUTION TIME

Tests 1, 2 and 3 - Insignificant

Test 4 - 20 minutes

8 PROGRAM DESCRIPTION

There are four basic parts to the program. The first tests each memory location, not occupied by the program, to assure that all bits of each may be accessed. It does this by first writing the address of a location in itself, and then checking to see if it was properly written. The 1's complement of the address is then written into the same location and checked, to assure that all bits of a memory location may be written and read. The second portion writes sequential addresses into their respective memory locations in the forward direction for all of memory not occupied by the program, and then each location is checked in the forward direction to assure that it contains its own address. The third portion writes the complement of each address not occupied by the program into sequential memory locations respectively in the reverse direction (from the highest location down to the lowest) and then checks each of the locations in the reverse direction to ensure that it contains its respective address complemented.

e. The internal pointer is then set back to 0.

f. The number which has been stored in the location specified by the pointer is obtained and checked to see that it is correct.

g. The pointer is then incremented and (f) is repeated until all memory locations have been checked. Any error causes typeout on the teleprinter.

h. A check is then made to see if this test should be repeated (switch 5). If so, the program goes to (b). If not, the program goes on to the next portion.

8.3 Reverse - Complement Write-Read Test

a. The first function performed is that of initialization. Several message header locations are initialized.

b. An internal pointer for the program is initialized to the first location under the program (17177).

c. The number which is in the internal pointer is obtained, complemented (1's) and then stored in the memory location specified by the pointer.

d. The pointer is then decremented (1 is subtracted from it) and (c) is repeated until all memory locations have had the complement addresses stored in them.

e. The internal pointer is then set back to 17177.

f. The number which has been stored in the location specified by the pointer is obtained and checked to see that it is correct.

g. The pointer is then decremented and (f) is repeated until all memory locations have been checked. Any error causes typeout on the teleprinter.

h. A check is then made to see if this test should be repeated (switch 5). If so, the program goes to (b). If not, the program goes to (i).

i. A check is then made to see if the next test should be skipped (switch 6). If so, the program goes to 8.1 (a). If not, the computer goes to 8.4 (a).

8.4 Write 1's in a Field of 0's Test

a. The first function performed is that of initialization. Several message header locations are initialized.

b. The all 1's pointer is set to 0.

c. All of memory tested is then cleared.

d. All 1's is then stored in the location pointed to by the all 1's points.

e. A memory pointer is then set to 00000.

M.A.T. PAGE 1

```
                        .TITLE M.A.T.
                        /
                        /MEMORY ADDRESS TEST
                        .FULL
17200                   .LOC 17200
                        /INDIVIDUAL LOCATION TEST
17200   777774          LAW 17774           /INITIALIZE LOOP
17201   057753          DAC COUNT1
17202   760000  FIRST   LAW
17203   057752          DAC COUNT           /COUNTER
17204   217754          LAC JMPT
17205   057510          DAC CHANGE          /CHANGE
17206   777635          LAW MESS1
17207   057763          DAC PNTR            /AND MESSAGE POINTER
17210   157765          DZM POINT           /ZERO POINTER
17211   217765          LAC POINT           /GET ADDRESS TO BE STORED
17212   077765          DAC* POINT                  /AND STORE IT IN ITSELF
17213   057772          DAC TEMP            /AND TEMP
17214   237765          LAC* POINT                  /GET THE NUMBER WRITTEN IN MEMORY
17215   557765          SAD POINT           /AND CHECK IT AGAINST ITSELF
17216   741000          SKP                 /ALL OK, SKIP
17217   117474          JMS ERROR           /ERROR
17220   750004          LAS
17221   517755          AND MASK1
17222   740200          SZA                 /LOOP ON CURRENT NUMBER?
17223   617211          JMP FIRST+7         /YES, LOOP
17224   217765  SECOND  LAC POINT           /NO, GET ADDRESS TO BE TESTED
17225   740001          CMA
17226   077765          DAC* POINT                  /STORE COMPLEMENT
17227   057772          DAC TEMP
17230   237765          LAC* POINT                  /GET NUMBER STORED
17231   740001          CMA
17232   557765          SAD POINT           /AND CHECK IT
17233   741000          SKP                 /ALL OK, SKIP
17234   117474          JMS ERROR           /ERROR
17235   750004          LAS
17236   517755          AND MASK1
17237   740200          SZA                 /LOOP ON CURRENT NUMBER?
17240   617224          JMP SECOND          /YES, LOOP
17241   750004          LAS
17242   517756          AND MASK2
17243   740200          SZA                 /LOOP ON CURRENT LOCATION?
17244   617211          JMP FIRST+7         /YES, LOOP
17245   750004          LAS
17246   742010          RTL
17247   740100          SMA                 /BELL AFTER N PASSES?
17250   117601          JMS BELL            /YES
17251   457765          ISZ POINT           /INCREMENT POINT FOR
17252   217765          LAC POINT           /NEXT LOCATION
17253   557773          SAD UPLIM           /IS IT THE UPPER LIMIT?
17254   741000          SKP                 /YES, SKIP
17255   617212          JMP FIRST+10        /NO, TEST NEXT LOCATION
17256   750004          LAS
```

```
                                /FORWARD WRITE- READ TEST
                                /
17262   217754          THIRD   LAC JMPT                /INITIALIZE
17263   057510                  DAC CHANGE              /CHANGE
17264   777653                  LAW MESS2
17265   057763                  DAC PNTR                /AND MESSAGE POINTER
17266   157765                  DZM POINT               /ZERO POINTER
17267   217765                  LAC POINT               /GET NUMBER TO BE STORED
17270   477765                  DAC* POINT                      /STORE IT
17271   557774                  SAD UPLIM1              /WAS IT THE UPPER LIMIT?
17272   617275                  JMP .+3                 /YES
17273   457765                  ISZ POINT               /NO, INCREMENT POINT
17274   617267                  JMP THIRD+5             /GO BACK AND STORE
17275   157765          FOURTH  DZM POINT               /CLEAR POINT
17276   217765                  LAC POINT
17277   057772                  DAC TEMP
17300   237765                  LAC* POINT                      /GET WORD STORED
17301   557765                  SAD POINT               /CHECK IT
17302   741000                  SKP                     /CORRECT, SKIP
17303   117474                  JMS ERROR               /ERROR
17304   557774                  SAD UPLIM1              /UPPER LIMIT
17305   617310                  JMP .+3                 /YES
17306   457765                  ISZ POINT               /NO, INCREMENT POINT
17307   617276                  JMP FOURTH+1            /GO BACK AND CHECK NEXT LOCATION
17310   750004                  LAS
17311   742010                  RTL
17312   740100                  SMA                     /RING BELL?
17313   117611                  JMS BELL1               /YES
17314   750004                  LAS
17315   517757                  AND MASK3
17316   740200                  SZA                     /REPEAT TEST?
17317   617266                  JMP THIRD+4             /YES
```

```
                        /WRITE 1'S IN A FIELD OF Ø'S
                        /
17376   217754  SEVENH  LAC JMPT            /INITIALIZE
17377   057510          DAC CHANGE                  /CHANGE
17400   777713          LAC MESS4           /AND MESSAGE
17401   057763          DAC PNTR            /POINTER
17402   157764          DZM PNTR1           /ZERO ALL ONES POINTER
17403   157765          DZM POINT           /ZERO POINT
17404   177765          DZM* POINT                  /CLEAR MEMORY
17405   457765          ISZ POINT
17406   217765          LAC POINT
17407   557773          SAD UPLIM
17410   751001          SKP!CLA!CMA
17411   617375          JMP .-5
17412   057764          DAC* PNTR1                  /STORE 1'S IN 1 MEMORY LOCATION
17413   157765  EIGHTH  DZM POINT           /ZERO POINT
17414   217765          LAC POINT           /GET POINT
17415   557764          SAD PNTR1           /SAME AS PNTR1
17416   751000          SKP!CLA             /YES, CLEAR AC AND SKIP
17417   750001          CLA!CMA             /NO, SET AC TO -1
17420   744001          CMA!CLL             /COMPLEMENT AC, IF POINT = PNTR1
17421   057772          DAC TEMP            /AC = 1'S, OTHERWISE Ø
17422   237765          LAC* POINT                  /PICK UP CONTENTS OF MEMORY
17423   557772          SAD TEMP            /GOOD DATA?
17424   741000          SKP                 /YES
17425   117474          JMS ERROR           /NO
17426   457765          ISZ POINT           /INCREMENT POINT
17427   217765          LAC POINT           /TO NEXT LOCATION
17430   557773          SAD UPLIM           /UPPER LIMIT?
17431   741000          SKP                 /YES
17432   617406          JMP EIGHTH+2        /NO, GO BACK TO TEST NEXT LOCATION
17433   750004          LAS
17434   742410          RTL
17435   741100          SMA                 /RING BELL?
17436   117501          JMS BELL            /YES
17437   750004          LAS
17440   517756          AND MASK2
17441   741200          SNA                 /LOOP ON CURRENT LOCATION?
17442   617443          JMP .+10            /NO
17443   217474          LAC ERROR           /YES, GET C(ERROR)
17444   557751          SAD CONST           /WAS THERE A 1'S IN Ø'S ERROR
17445   617441          JMP .+3             /YES
17446   177764          DZM* PNTR1                  /NO, ZERO 1'S LOCATION
17447   617401          JMP EIGHTH-3        /GO BACK TO STORE 1'S
17450   157474          DZM ERROR           /ZERO ERROR
17451   617374          JMP SEVENH+5        /GO BACK TO ZERO MEMORY FIRST
17452   217474          LAC ERROR
17453   557751          SAD CONST           /WAS THERE A 1'S IN Ø'S ERROR?
17454   741000          SKP                 /YES, SKIP
17455   617455          JMP .+7             /NO
17456   157474          DZM ERROR           /ZERO ERROR
```

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```
                        /ERROR PRINT ROUTINE
                        /
17474   [illegible]     ERROR   0
17475   057747                  DAC ANSWER      /STORE BAD NUMBER
17476   750744                  LAS
17477   742110                  RTL
17500   740100                  SMA             /RING BELL?
17501   617504                  JMP .+3         /NO
17502   760207                  LAW 207
17503   117621                  JMS TYPE
17504   750704                  LAS
17505   740010                  RAL
17506   741100                  SPA             /PRINT ERRORS
17507   617524                  JMP HALT1       /NO
                                                /YES
17510   617531          CHANGE  JMP TITLE
17511   217765                  LAC POINT
17512   117561                  JMS PRINT       /TYPE OUT ADDRESS
17513   760240                  LAW 240
17514   117621                  JMS TYPE        /1 SPACE
17515   217772                  LAC TEMP
17516   117561                  JMS PRINT       /TYPE OUT CORRECT ANSWER
17517   760240                  LAW 240
17520   117621                  JMS TYPE        /1 SPACE
17521   217747                  LAC ANSWER
17522   117561                  JMS PRINT       /TYPE OUT BAD ANSWER
17523   117627                  JMS CRLF
17524   750004          HALT1   LAS
17525   741100                  SPA             /HALT ON ERROR?
17526   740040                  XX              /YES
17527   217765                  LAC POINT       /RESTORE AC
17530   637474                  JMP* ERROR              /EXIT
                        /
17531   217762          TITLE   LAC NOOP
17532   057510                  DAC CHANGE      /CHANGE  CHANGE
17533   117627                  JMS CRLF
17534   117541                  JMS TMESS1              /TYPE OUT APPROPRIATE MESSAGE
17535   777734                  LAW MESS5
17536   057763                  DAC PNTR
17537   117541                  JMS TMESS1              /TYPE OUT REST OF HEADER
17540   617511                  JMP CHANGE+1
```

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                        /SOME USEFUL SUBROUTINES
                        /
17611   000000  RELL    0
17612   457753          ISZ COUNT
17613   637611          JMP* BELL
17614   417200          XCT FIRST
17615   057753          DAC COUNT
17616   760207          LAW 207
17617   117621          JMS TYPE
17620   637601          JMP* BELL
                        /
17621   000000  RELL1   0
17622   457753          ISZ COUNT1
17623   637611          JMP* BELL1
17624   417200          XCT FIRST-2
17625   057753          DAC COUNT1
17626   760207          LAW 207
17627   117621          JMS TYPE
17630   637611          JMP* BELL1
                        /
17631   000000  TYPE    0
17632   517766          AND ROUOUT
17633   700406          TLS
17634   700401          TSF
17635   617634          JMP .-1
17636   637631          JMP* TYPE
                        /
17637   000000  CRLF    0
17640   760215          LAW 215
17641   117621          JMS TYPE
17642   760212          LAW 212
17643   117621          JMS TYPE
17644   637637          JMP* CRLF
```

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```
                                /ERROR MESSAGE S
                                /
17670   322305          MESS3   322305          /RE
17671   326305                  326305          /V E
17672   322323                  322323          /R S
17673   305255                  305255          /E -
17674   303317                  303317          /C O
17675   315320                  315320          /M P
17676   314305                  314305          /L E
17677   315305                  315305          /M E
17700   316324                  316324          /N T
17701   240327                  240327          /SP W
17702   322311                  322311          /R I
17703   324305                  324305          /T E
17704   255322                  255322          /- R
17705   305301                  305301          /E A
17706   304240                  304240          /D SP
17707   324305                  324305          /T E
17710   323324                  323324          /S T
17711   215212                  215212          /CR LF
17712   377000                  377000          /RO
```

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```
                                /CONSTANTS AND VARIABLES
                                /
17747     000000        ANSWER    0
17750     000260        ASKII     260
17751     017417        CONST     EIGHTH+13
17752     000000        COUNT     0
17753     000000        COUNT1    0
17754     617531        JMPT      JMP TITLE
17755     040000        MASK1     40000
17756     020000        MASK2     20000
17757     010000        MASK3     10000
17760     004000        MASK4     4000
17761     002000        MASK5     2000
17762     740000        NOOP      NOP
17763     000000        PNTR      0
17764     000000        PNTR1     0
17765     000000        POINT     0
17766     000377        RUBOUT    377
17767     000007        SEVEN     7
17770     000000        TALLY     0
17771     000000        TEM1      0
17772     000000        TEMP      0
17773     017200        UPLIM     FIRST-2
17774     017177        UPLIM1    FIRST-3
          000000                  .END
```

FIRST	17202
SECOND	17224
THIRD	17262
FOURTH	17275
FIFTH	17324
SIXTH	17336
SEVENH	17367
EIGHTH	17404
ERROR	17474
CHANGE	17510
HALT1	17524
TITLE	17531
TMESS1	17541
PRINT	17561
BELL	17601
BELL1	17611
TYPE	17621
CRLF	17627
MESS1	17635
MESS2	17653
MESS3	17670
MESS4	17713
MESS5	17734
ANSWER	17747
ASKII	17750
CONST	17751
COUNT	17752
COUNT1	17753
JMPT	17754
MASK1	17755
MASK2	17756
MASK3	17757
MASK4	17760
MASK5	17761
NOOP	17762
PNTR	17763
PNTR1	17764
POINT	17765
RUBOUT	17766
SEVEN	17767
TALLY	17770
TEM1	17771
TEMP	17772
UPLIM	17773
UPLIM1	17774