

MEMORY

IDENTIFICATION

PRODUCT CODE: MAINDEC-15-D1GA-D (D)  
PRODUCT NAME: PDP-15 MEMORY ADDRESS TIMING TEST  
DATE CREATED: JANUARY 10, 1970  
MAINTAINER: DIAGNOSTICS GROUP  
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1. ABSTRACT

This program is designed to test the action of long carry chains under the extremely tight timing conditions that obtain at the far end of extended memory. In each register from 10000 to the upper limit of memory, a word of all 1s is stored, then incremented using ISZ. The result is tested to see whether the carry chain was successfully propagated -- the correct result in each case is 000000. Provisions are made for error printout and halt, scoping, and repetition.

2. REQUIREMENTS

2.1 Equipment

A PDP-15 with at least 8192 words of memory.

2.2 Storage

The program occupies registers 00000-00644.  
The test field extends from 10000 to the top of memory.

2.3 Preliminary Programs

None

3. LOADING PROCEDURE

The program tape is in absolute binary.  
Place the program tape in the reader.  
Set the Address Switches to 17700.  
Place the BANK MODE Switch on a 1.  
Press I/O RESET, then READIN.

4. STARTING PROCEDURE

4.1 Control Switch Settings

SW 0	1:	Scope Mode. Repeat the current test cycle.
	0:	Normal mode. Do not repeat cycles.
SW 1	1:	Do not halt on error.
	0:	Normal mode. Halt on occurrence of an error, after printout, if any.

- SW 2                    1: Do not print error data.  
                           0: Normal mode. Print error data.
- SW 15-17:             Number of additional 4K memory banks provided. (Must be at least 1 to execute the test.)

NOTE

SW 0 has precedence over SW 1; that is, if SW 0 is set to 1, SW 1 has no effect. Thus, the error halt is automatically suppressed while the program is operating in scope mode.

4.2     Operator Action

- a. Set the ADDRESS switches to 0200.
- b. Set the control switches as desired (see Section 4.1).
- c. Press Reset, then START.

5.     OPERATING PROCEDURE

5.1     Switch Settings

See Section 4.1.

5.2     Operator Action

Normally, the program runs without intervention, until the operator stops it manually. When errors occur, there are several ways to proceed. Here are some common ones.

Set the switches as follows:

0	1	2	15	16	17
0	0	0			

number of additional 4K banks  
(beyond the standard 4K)

Start the program. At the occurrence of the first error, the data will be printed and the program will halt.

- a. Option 1 - To gather more error data, set SW 1 to 1, and press CONT. At the occurrence of each error, the data are printed, and the program continues. When enough information is printed, set SW 0 to 0 and the program will halt after the next printout.

b. Option 2 - For scoping, set SW 0 and SW 2 to 1, connect the scope, and press CONT (SW 1 now has no effect). As long as SW 0 is set to 1, the program will repeat the current test cycle (that is, using the same memory location), regardless of whether the error occurs or not. In this way, an intermittent failure can easily be detected on the scope.

c. Option 3 - If, while scoping, you wish to examine the same signal at the next error site, strike any signal-generating key on the KSR33 keyboard. This will cause the program to break out of the repeat loop and continue the sequential test until the next error occurs, at which point the scope loop resumes. In this way, the operator can step from error to error.

## 6. ERRORS

### 6.1 Error Halts and Description

6.1.1 Not Enough Memory - If the operator forgets to set SW 15-17, the program will print

NOT ENOUGH MEMORY  
and halt (PC=00047).

6.1.2 Timing Errors - At the first occurrence of an error, the following heading is printed:

EXTENDED MEMORY ISZ TEST  
LOCATION CONTENTS

The data are printed in their respective columns. For each error, the LOCATION of the register in error is printed, followed by the actual CONTENTS of the register. In every case, the correct contents should, of course, be 000000. If SW 1 is set to 0, the program halts after the printout (PC=00263).

6.1.3 Skip Failure - If the ISZ instruction fails to skip after incrementing the addressed register to 000000, the following message is printed:

SKIP FAILED

If the data are also in error, these will be printed before the program halts (PC=00263).

6.1.4 Extraneous Errors - If a program interrupt occurs from any device other than the KSR33 keyboard, the program halts at PC=00030, with the I/O status displayed in the AC.

### 6.2 Error Recovery

- Place the number of additional 4K banks in SW 15-17, and press CONT.
- Press CONT. See Section 5.2 for various operating options.
- Disable the external device causing the interrupt, then press CONT.

6.3 Summary

<u>C(PC)</u>	<u>C(AC)</u>	<u>Message or Data Printed</u>
00030	I/O status	None  A device other than the KSR33 keyboard caused a program interrupt. Recovery: disable the offending device, and press CONT.
00047	000000	NOT ENOUGH MEMORY  Switches 15-17 are all set to 0. Recovery: Set these switches to the number of additional 4K memory banks attached, and press CONT.
00263	TTTTTT	Location and contents of register. The contents of the addressed register were not successfully incremented to 000000. Bits appearing as 1 indicate failure of the carry chain. Recovery: Set the control switches as desired, and press CONT.
00263	TTTTTT	SKIP FAILED  The ISZ instruction failed to skip when the addressed register was incremented to 000000. If the register data were also printed, the skip probably functioned properly; if no data were printed (indicating that the incrementing was successful), then the fault is in the skip itself. Recovery: Set the control switches as desired and press CONT.

7. RESTRICTIONS

The program will not operate in a machine with less than 8192 words of memory.

8. MISCELLANEOUS

8.1 Execution Time

0.125 x n second for one complete pass through (4n)K of memory.

```

        .TITLE EMTI
        .ABS
        /
        /COPYRIGHT 1970. DIGITAL EQUIPMENT CORP.,
        /MAYNARD, MASS.
        /EXTENDED MEMORY ADDRESS TIMING TEST USING ISZ
        /
00001      .LOC 1
00001      600001      JMP      .
00002      777777      LAW      -1
00003      777777      LAW      -1
00004      777777      LAW      -1
        /
00010      .LOC 10      /AUTOINDEX REGISTERS
00010      000000      AXP      0      /TEXT STRING
00011      000000      AXT      0      /TAB COUNT
00012      000000      AX3      0      /SPARE
        /
00021      .LOC 21      /CAL CATCHER
00021      740040      HLT
00022      620020      JMP*      20
        /
        /KEYBOARD HANDLER
        /
00023      750001      KHAN      CLC
00024      040554      DAC      #KSI      /SET KEYBOARD SIGNAL
00025      600030      JMP      SPEX
        /
        /SPURIOUS INTERRUPT
        /
00026      700314      SPIN      IORS
00027      740040      HLT      /AC CONTAINS I/O STATUS
00030      200560      SPEX      LAC      SAC
00031      703302      CAF
00032      700042      ION
00033      703344      DBR
00034      620000      JMP*      0
        .EJECT

```

```

/
/PROGRAM STARTS HERE
/
. LOC 200
00200 703302 IBGIN CAF
00201 200563 LAC (DAC #SAC
00202 040001 DAC 1
00203 200564 LAC (KSF
00204 040002 DAC 2
00205 200565 LAC (JMP SPIN
00206 040003 DAC 3
00207 200566 LAC (JMP KHAN
00210 040004 DAC 4
00211 750004 LAS
00212 500567 AND (7 /SWITCHES 15-17
00213 740200 SZA /EXTENSION ATTACHED?
00214 600221 JMP INIT /YES.
00215 200321 LAC NOMAD /NO.
00216 100324 PRINT /GO TELL THE MAN
00217 750040 ENOM HLT!CLA
00220 600200 JMP IBGIN
/
.EJECT
```

```

/INITIALIZING SEQUENCE
/
00221 700042 INIT ION
00222 740001 CMA
00223 040552 DAC #BANKS /BANK COUNT
00224 750000 CLA /FORM LIMITING ADDRESS
00225 300570 ADD (10000
00226 440552 ISZ BANKS
00227 600225 JMP .-2
00230 040555 DAC #LIMIT /ADDRESS OF HIGHEST REGISTER
00231 750001 CLC
00232 040553 DAC #HSIG /SET HEADING SIGNAL
00233 040554 DAC KSIG /PRESET KEYBOARD SIGNAL
00234 200570 INIT2 LAC (10000 /SET Y-ADDRESS POINTER
00235 040562 DAC #YAP
/
/MAIN TEST SEQUENCE
/
00236 707702 TEST EEM
00237 750001 CLC
00240 060562 DAC* YAP /ALL 1S TO Y
00241 460562 ISZ* YAP /THIS IS IT!
00242 600312 JMP SKIF /SKIP FAILED
00243 220562 TEY LAC* YAP /GET C(Y)
00244 741200 SNA /C(Y)=0?
00245 600306 JMP TOK /YES; TEST OK
00246 140554 DZM KSIG /NO: CLEAR KRD SIGNAL
00247 707704 LEM
00250 750004 LAS
00251 742010 RTL /SW-2
00252 751100 SPA!CLA /PRINTING?
00253 600267 JMP TNG /NO.
00254 540553 SAD HSIG /YES. PRINT HEADING?
00255 600261 JMP TELL /NO.
00256 140553 DZM HSIG /YES. CLEAR SIGNAL
00257 340322 TAD HEAD
00260 100324 PRINT
/
00261 200562 TELL LAC YAP /GET ADDRESS
00262 100444 PROCS /PRINT IT
00263 100415 TAB
00264 220562 LAC* YAP
00265 100437 PROCT /PRINT CONTENTS
00266 100430 CRLF /NEXT LINE
/
.EJECT

```



```

                                /SWITCH TESTERS
                                /
00267 750004 TNG LAS /HERE WHEN THERE'S AN ERROR
00270 740010 RAL /SW0 AND SW1
00271 740500 SNL:SMA /SCOPING OR HALT?
00272 750041 E1 HLT:CLC /HALT
00273 750004 LAS
00274 750100 SMA:CLA /SCOPING?
00275 600301 JMP XPO /NO.
00276 200554 LAC KSIG /YES
00277 741200 SNA /IS KBD SIGNAL SET?
00300 600236 JMP TEST /NO. REPEAT THE CYCLE

                                /
00301 440562 XPO ISZ YAP /YES. GO ON
00302 200555 LAC LIMIT
00303 540562 SAD YAP /END OF MEMORY?
00304 600234 JMP INIT2 /YES. START AGAIN
00305 600236 JMP TEST /NO. NEXT CYCLE

                                /
00306 750004 TOK LAS /HERE WHEN NO ERROR
00307 751100 SPA:CLA /SCOPING?
00310 600236 JMP TEST /YES
00311 600301 JMP XPO /NO.

                                /
                                /SKIP FAILED
                                /
00312 750004 SKIF LAS
00313 742010 RTL /SW-2
00314 741100 SPA /PRINTING?
00315 600243 JMP TEY /NO.
00316 200323 LAC SKAD /YES
00317 100324 PRINT
00320 600243 JMP TEY

                                /
00321 000500 NOMAD NOMEM-1
00322 000520 HEAD HEADER-1
00323 000512 SKAD SKIM-1

                                /
                                .EJECT

```

```

/TEXT PRINTER
/
PRINT.          0
00324  000000   DAC      AXP
00325  040010   PRINGO   LAC*    AXP
00326  220010           #ASTEM
00327  040550   DAC
00330  100354   CHAR
00331  100366   TESP
00332  100354   CHAR
00333  100366   TESP
00334  100354   CHAR
00335  500571   AND      (170
00336  040551   DAC      #AST3
00337  220010   LAC*    AXP
00340  744010   RCL;    RTL
00341  742010
00342  040550   DAC      ASTEM
00343  740010   RAL
00344  500567   AND      (7
00345  240551   XOR      AST3
00346  100366   TESP
00347  100354   CHAR
00350  100366   TESP
00351  100354   CHAR
00352  100366   TESP
00353  600326   JMP     PRINGO
/
.EJECT

```

```

/ADDRESS OF TEXT STRING
/FIRST PAIR-WORD
/POSITION FIRST CHARACTER ...
/...SECOND...
/...PUT THE THIRD TOGETHER...
/SECOND PAIR-WORD
/ADJUST
/3RD CHAR LOW-ORDER BITS
/ASSEMBLE THE PARTS
/...FOURTH...
/...AND FIFTH

```

```

/TEXT PRINTER SUBROUTINES
/
/1. POSITION CHARACTER
/
CHAR. 0
00354 000000 LAC      ASTEM
00355 200550 RCL
00356 744010 RTL;    RTL;    RTL
00357 742010
00360 742010
00361 742010
00362 040550 DAC      ASTEM      /NEXT CHAR. NOW LEFT-JUSTIFIED
00363 740010 RAL      /LAST BIT IN PLACE
00364 500572 AND      (177     /ISOLATE 7 BITS
00365 620354 JMP*    CHAR.
/
/2. TEST AND PRINT CHARACTER
/
TESP. 0
00366 000000 SNA
00367 741200 JMP*    TESP.      /0 CHARACTER? (ASCII FILLER)
00370 620366 SAD      (177     /YES. IGNORE IT.
00371 540572 JMP*    PRINT.    /TERMINATOR?
00372 620324 XOR      (200     /YES. GO AWAY
00373 240573 SAD      (211     /NO. FINISH THE ASCII-CODE
00374 540574 JMP      TETAB    /TAB?
00375 600402 TYPE    /YES.
00376 100404 SAD      (212     /NO.
00377 540575 DZM      TABCT    /LF?
00400 140561 JMP*    TESP.    /YES. CLEAR TAB
00401 620366 TETAB TAB
00402 100415 JMP*    TESP.
00403 620366
/
/3. TYPE A CHARACTER
/
TYPE. 0
00404 000000 IOF
00405 700002 TLS
00406 700406 TSF
00407 700401 JMP      .-1
00410 600407 TCF
00411 700402 ION
00412 700042 ISz     TABCT
00413 440561 JMP*    TYPE.
00414 620404
/
.EJECT

```

```

/4. TABULATOR
/
00415 000000 TAB. 0
00416 200561 LAC #TABCT /COUNT OF SPACES
00417 340576 TAD (-12 /REDUCE MODULO 10
00420 740100 SMA /NEGATIVE YET?
00421 600417 JMP .-2 /NO.
00422 040011 DAC AXT /YES, STORE SPACE COUNT
00423 200577 LAC (240 /(SPACE)
00424 100404 TYPE
00425 440011 ISZ AXT /DONE?
00426 600424 JMP .-2 /NO.
00427 620415 JMP* TAB. /YES

```

```

/5. CARRIAGE RETURN LINE FEED
/
00430 000000 CRLF. 0
00431 200600 LAC (215
00432 100404 TYPE
00433 200575 LAC (212
00434 100404 TYPE
00435 140561 DZM TABCT
00436 620430 JMP* CRLF.

```

```

100324 PRINT=JMS PRINT.
100354 CHAR=JMS CHAR.
100366 TESP=JMS TESP.
100404 TYPE=JMS TYPE.
100415 TAB=JMS TAB.
100430 CRLF=JMS CRLF.

```

```

/
.EJECT

```

```

/OCTAL PRINT SUBROUTINE
/
/ENTRY TO PRINT LEADING ZEROS
/
00437 000000 PROCT. 0
00440 040557 DAC #OCTEM
00441 200466 LAC OPS+3 /NOP
00442 100451 JMS OP1
00443 620437 JMP* PROCT.

/ENTRY TO REPLACE LEADING ZEROS WITH SPACES
/
00444 000000 PROCS. 0
00445 040557 DAC OCTEM
00446 200601 LAC (SZA
00447 100451 JMS OP1
00450 620444 JMP* PROCS.

/PRINTER
/
00451 000000 OP1 0
00452 040463 DAC OPS /SET SWITCH
00453 777772 LAW -6
00454 040556 DAC #OCCT /DIGIT COUNTER
00455 200557 OPGO LAC OCTEM
00456 744010 RCL; RTL
00457 742010 DAC #OCTEM
00460 040557 RAL
00461 740010 AND (7
00462 500567 OPS XX /SZA OR NOP
00463 740040 JMP OPT
00464 600472 ISZ OCCT /LEADING ZERO. COUNT DIGITS
00465 440556 NOP
00466 740000 LAC (240 /TYPE A SPACE
00467 200577 TYPE
00470 100404 JMP OPGO
00471 600455

/
00472 240602 OPT XOR (260 /ASCII MAKER
00473 100404 TYPE
00474 200466 LAC OPS+3 /REPLACE SZA WITH NOP
00475 040463 DAC OPS
00476 440556 ISZ OCCT
00477 600455 JMP OPGO
00500 620451 JMP* OP1

/
100444 PROCS=JMS PROCS.
100437 PROCT=JMS PROCT.
/
.EJECT

```

## /MESSAGES

00501	064251	NOMEM	.ASCII	<15><12>'NOT ENOUGH MEMORY'<15><12><177>
00502	647650			
00503	202131			
00504	647652			
00505	436204			
00506	046612			
00507	466372			
00510	254432			
00511	053760			
00512	000000			
00513	516271	SKIM	.ASCII	'SKIP FAILED'<15><12><177>
00514	150100			
00515	432031			
00516	146212			
00517	420321			
00520	277400			
00521	064250	HEADER	.ASCII	<15><12>'EXTENDED MEMORY ISZ TEST,'<15><12><12>
00522	554250			
00523	426350			
00524	442610			
00525	202330			
00526	546636			
00527	512624			
00530	044646			
00531	551012			
00532	442646			
00533	521341			
00534	505024			
00535	462370		.ASCII	'LOCATION'<11>'CONTENTS'<15><12><12><177>
00536	340650			
00537	446371			
00540	604606			
00541	476352			
00542	442634			
00543	522461			
00544	505024			
00545	774000			
00546	000000			
00547	000603		.SIZE	
	000000		.END	
	00563	040560	*L	
	00564	700301	*L	
	00565	600026	*L	
	00566	600023	*L	
	00567	000007	*L	
	00570	010000	*L	
	00571	000170	*L	
	00572	000177	*L	
	00573	000200	*L	
	00574	000211	*L	

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EMTI

EMTI

00575	000212	*L
00576	777766	*L
00577	000240	*L
00600	000215	*L
00601	740200	*L
00602	000260	*L

SIZE=00603

NO ERROR LINES

ASTEM	00550
AST3	00551
AXP	00010
AXT	00011
AX3	00012
BANKS	00552
CHAR	100354
CHAR.	00354
CLOF	700004
CLOX	700044
CLSF	700001
CRLF	100430
CRLF.	00430
EEM	707702
FNOM	00217
F1	00272
HEAD	00322
HEADER	00521
HSIG	00553
IBGIN	00200
INIT	00221
INIT2	00234
KHAN	00023
KRB	700312
KSF	700301
KSIG	00554
LEM	707704
LIMIT	00555
NOMAD	00321
NOMEM	00501
OCCT	00556
OCTEM	00557
OPGO	00455
OPS	00463
OPT	00472
OP1	00451
PCF	700202
PRINGO	00326
PRINT	100324
PRINT.	00324
PROCS	100444
PROCS.	00444
PROCT	100437
PROCT.	00437
PSA	700204
PSR	700244
PSF	700201
RCF	700102
RRR	700112
RSA	700104
RSB	700144
RSF	700101
SAC	00560
SKAD	00323
SKIF	00312



SKIM 00513  
SPEX 00030  
SPIN 00026  
TAB 100415  
TABCT 00561  
TAB. 00415  
TCF 700402  
TELL 00261  
TESP 100366  
TESP. 00366  
TEST 00236  
TETAB 00402  
TEY 00243  
TLS 700406  
TNG 00267  
TOK 00306  
TSF 700401  
TYPE 100404  
TYPE. 00404  
XPO 00301  
YAP 00562  
.EOT 00000

.EOT	00000
AXP	00010
AXT	00011
AX3	00012
KHAN	00023
SPIN	00026
SPEX	00030
IBGIN	00200
ENOM	00217
INIT	00221
INIT2	00234
TEST	00236
TEY	00243
TELL	00261
TNG	00267
E1	00272
XPO	00301
TOK	00306
SKIF	00312
NOMAD	00321
HEAD	00322
SKAD	00323
PRINT.	00324
PRINGO	00326
CHAR.	00354
TESP.	00366
TETAB	00402
TYPE.	00404
TAB.	00415
CRLF.	00430
PROCT.	00437
PROCS.	00444
OP1	00451
OPGO	00455
OPS	00463
OPT	00472
NOMEM	00501
SKIM	00513
HEADER	00521
ASTEM	00550
AST3	00551
BANKS	00552
HSIG	00553
KSIG	00554
LIMIT	00555
OCCT	00556
OCTEM	00557
SAC	00560
TARCT	00561
YAP	00562
PRINT	100324
CHAR	100354
TESP	100366
TYPE	100404
TAB	100415

CRLF	100430
PROCT	100437
PROCS	100444
CLSF	700001
CLOF	700004
CLON	700044
RSF	700101
RCF	700102
RSA	700104
RRB	700112
RSR	700144
PSF	700201
PCF	700202
PSA	700204
PSB	700244
KSF	700301
KRB	700312
TSF	700401
TCF	700402
TLS	700406
EEM	707702
LEM	707704