

11/24

11/24 ROM M9312
CJM9AA0

AH-T208A-MC
FICHE 1 OF 1

JUL 1982
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IDENTIFICATION

PRODUCT CODE: AC-T207A-MC
PRODUCT NAME: CJM9AA0 11/24 ROM M9312
PRODUCT DATE: APRIL,1982
MAINTAINER: DIAGNOSTIC ENGINEERING

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1.0 GENERAL PROGRAM INFORMATION

1.1 ABSTRACT

THIS DIAGNOSTIC IS GO/NOGO VERIFICATION OF AN 11/24 SYSTEM WHICH TESTS:

1. ALL SINGLE AND DOUBLE OPERAND INSTRUCTIONS, INCLUDING EIS, UTILIZING ALL SOURCE AND DESTINATION ADDRESSING MODES.
2. ALL OF MEMORY, IN 4K PAGES, VIA MEMORY MANAGEMENT AND PRINT THE MEMORY SIZE (LAST MEMORY ADDRESS +2).
3. SLU1 VIA MAINTENANCE MODE (ALSO CHECKS CONSOLE PRINTER AND INTERFACE WHEN PRINTING MEMORY SIZE).
4. THE DIAGNOSTIC IS COMPATIBLE WITH M9312 DIAGNOSTIC ROM FORMAT REQUIREMENTS.

1.2 SYSTEM REQUIREMENTS

A. HARDWARE REQUIREMENTS

THIS DIAGNOSTIC IS DESIGNED TO RUN ON AN 11/24 WITH CONSOLE TERMINAL AND 4K OF MEMORY (MINIMUM). FURTHER, IT ASSUMES THE PRESENCE OF THE MEMORY MANAGEMENT UNIT (MMU) CHIP.

B. SOFTWARE REQUIREMENTS

NONE

1.3 RELATED DOCUMENTS AND STANDARDS

THE FOLLOWING DOCUMENTS WERE USED OR REFERENCED DURING THE CREATION OF THIS DIAGNOSTIC:

1. DIAGNOSTIC ENGINEERING STANDARDS AND CONVENTIONS PROGRAMMING PRACTICES (DOC. NO. 175-003-009-02).
2. PDP-11 SYSMAC PACKAGE (MAINDEC-11-DZQAC-C3).
3. REQUIRMENTS FOR NEW BOOT ROMS AND CPU ROMS USED IN THE M9312 (K-SP-M9312-0-8).

1.4 DIAGNOSTIC HIERARCHY PREREQUISITES

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1.5 ASSUMPTIONS

THE DIAGNOSTIC ASSUMES PROPER STEPUP OF THE DIP SWITCHPAK ON THE M9312 BOOTSTRAP MODULE (SEE M9312 USER'S MANUAL AND TABLE BELOW FOR THIS INFORMATION) AND PRESENCE OF A BOOT ROM IN THE M9312.

BOOTSTRAP:	DIAGNOSTICS	S1 (1-10)		
		FIRST DEVICE (ALL ROMS)	VIRTUAL ADDRESS	SWITCHPACK S1 SWITCHES ON
ODT	NO	2004	165004	1,9
	YES	2006	165006	1,9,10
DEVICE ROM #1	NO	0004	173004	9
	YES	0006	173006	9,10
DEVICE ROM #2	NO	0204	173204	4,9
	YES	0206	173206	4,9,10
DEVICE ROM #3	NO	0404	173404	3,9
	YES	0406	173406	3,9,10
DEVICE ROM #4	NO	0604	173604	3,4,9
	YES	0606	173606	3,4,9,10

2.0 OPERATING INSTRUCTION

2.1 LOADING AND STARTING PROCEDURE

IF DIAGNOSTIC IS SELECTED BY M9312 SWITCHPACK, IT WILL BE RUN ON POWER UP, BUT CAN ALSO SELECTED FROM MICRO-ODT BY COMMAND:

165000G

TO BOOT A DEVICE ROM DIRECTLY, USE THE VIRTUAL ADDRESS COLUMN OF THE ABOVE TABLE. FOR EXAMPLE, TO BOOT DEVICE ROM #3 WITH DIAGNOSTICS, USE 173406G (FROM MICRO-ODT).

2.2 PROGRAM OPTIONS

NONE

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2.3 EXECUTION TIMES

A. FIRST PASS (QV)

A PASS OF THIS CODE TAKES APPROXIMATELY 6 SECONDS TO COMPLETE INCLUDING THE PRINTING OF THE MEMORY SIZE. THIS TIMING IS BASED ON A 11/24 CPU WITH 128K WORD OF MOS MEMORY.

B. LONGEST TEST

THE LONGEST SINGLE TEST IS THE MEMORY TEST WHICH TAKES APPROXIMATELY 5 SECONDS PER 128K WORDS OF MEMORY.

C. ADDITIONAL TIME FOR UNITS

APPROXIMATELY 5 SECONDS IS ADDED TO THE TEST TIME FOR EVERY ADDITIONAL 128K WORDS OF MEMORY. THIS TIMING IS BASED ON AN 11/24 WITH MOS MEMORY.

SAMPLE TEST TIMES BASED ON ABOVE FIGURES:

128KW= 6 SECONDS
256KW= 11 SECONDS
512KW= 21 SECONDS
1024KW= 41 SECONDS
1536KW= 61 SECONDS
1920KW= 76 SECONDS

D. FULL PASS TIME (ITERATIONS)

THIS PROGRAM DOES NOT DO ANY ITERATIONS ON ANY OF THE TESTS AND IN FACT ONLY MAKES ONE PASS THRU THE CODE FOR EACH START.

3.0 ERROR INFORMATION

3.1 ERROR REPORTING PROCEDURES

SINCE THIS DIAGNOSTIC IS A GO/NOGO, LOW-LEVEL TEST, NO ERROR REPORTING, AS SUCH, IS IMPLEMENTED; HOWEVER, IF THE MICRO-ODT AND CONSOLE TERMINAL ARE OPERATIONAL THE ERROR HALT ADDRESS+2 WILL BE TYPED FOR THE OPERATOR.

3.2 ERROR HALTS

BADADD = 165144 THIS ERROR IS CAUSED BY TRAPPING TO LOCATION 4 AT ANY TIME PRIOR TO EXECUTING THE MEMORY TEST ON THE FIRST 4K OF MEMORY. THE PROGRAM DOES ACCESSES TO SOME OF THE MEMORY MANAGEMENT REGISTERS DURING THIS TIME. IT MAY BE HELPFUL TO EXAMINE THE STACK BUT SINCE THE PROGRAM HAS NOT SET IT UP THE INFORMATION RECIEVED MAY NOT BE VALID.

CPUERR = 165146 THIS ERROR INDICATES A FAILURE WITH EITHER THE BASE INSTRUCTION SET OR THE EIS INSTRUCTION SET. FIRST SUSPECT THE DCF11-A HYBRID OR THE CPU BOARD.

MEMERR = 165550 THIS ERROR INDICATES A MEMORY SYSTEM FAILURE. FIRST SUSPECT THE MEMORY THEN THE KTF11-A. TO LOCATE THE FAILING BANK DIVIDE THE CONTENTS OF PAR0 (1772342) BY 200(8) THEN MULTIPLY BY 4.

SLUERR = 165702 THIS HALT INDICATES A DATA ERROR IN THE CONSOLE SLU. THE GOOD DATA IS IN R2.

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4.0 PERFORMANCE AND PROGRESS REPORTS

4.1 PERFORMANCE REPORTS

NONE

4.2 PROGRESS REPORTS

THE PROGRAM REPORTS ITS PROGRESS USING TWO LEDS LOCATED ON THE 11/24 CPU BOARD. THEY ARE LOCATED ON THE HANDLE EDGE OF THE BOARD ALONG WITH THE RUN LIGHT. THEY ARE DRIVEN THROUGH BITS 0 AND 1 OF THE DISPLAY REGISTER WITH BIT 0 DRIVING THE LED FURTHEST FROM THE FRONT OF THE BOX AND BIT 1 DRIVING THE LED IN THE CENTER OF THE THREE LIGHTS. THE LIGHT CLOSEST TO THE FRONT OF THE BOX IS THE RUN LIGHT. THE PROGRAM FIRST WRITES AN OCTAL 3 TO THE REGISTER (TURNING BOTH LEDS ON) TO SIGNAL THE START OF THE CPU TEST. THE COUNT IS DECREMENTED BY ONE AT THE START OF EACH OF THE NEXT THREE TEST SECTIONS.

LIGHT COUNT	LAST TEST COMPLETED
3	NONE-SUCCESSFUL ENTRY TO PROGRAM
2	CPU TEST
1	MEMORY TEST
0	SLU TEST

5.0 DEVICE INFORMATION TABLES

POOL (LOC 165102) CONTAINS DATA USED BY DOUBLE OPERAND SECTION.

6.0 PROGRAM DESCRIPTION

6.1 PROGRAM EXECUTION CHARACTERISTICS

PROPER EXECUTION OF THE DIAGNOSTIC RESULTS IN PRINTOUT OF THE MEMORY SIZE AND BOOTING A PERIPHERAL OR ENTERING MICRO-ODT (DEPENDING ON M9312 SWITCH SETTINGS).

6.2 SUBTEST SUMMARIES

A. CPUTST - THIS SUBTEST VERIFIES THE PDP-11 INSTRUCTION SET, INCLUDING EIS, FOR BOTH WORD AND BYTE FORMATS. IT CONSISTS OF FIVE SECTIONS - SINGLE OPERAND (DESTINATION MODE 0), DOUBLE OPERAND (ALL SOURCE MODES, DESTINATION MODE 0), CONDITIONAL BRANCHES, BYTE INSTRUCTIONS (ALL DESTINATION MODES), AND JSR/RTS WITH EIS.

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B. MEMTST - THIS SUBTEST CHECKS ALL OF MEMORY IN 4K PAGES USING THE MMU, DETERMINES MEMORY SIZE, AND CONSTRUCTS A PHYSICAL ADDRESS FROM THE VIRTUAL ADDRESS WHICH CAUSED A TIMEOUT TRAP. LOOPING THROUGH EACH 4K PAGE IS CONTROLLED BY THE 1\$ LOOP, AND; WITHIN THIS LOOP, THE 2\$ LOOP LOADS EACH LOCATION WITH ITS ADDRESS, THE 3\$ LOOP CHECKS THE DATA AND COMPLEMENTS IT, THE 4\$ LOOP ADDS THE CONTENTS OF EACH LOCATION TO ITS COMPLEMENT AND INCREMENTS THE RESULT TO PRODUCE ZERO. SECTION TIMEOUT TURNS OFF MEMORY MANAGEMENT AND BUILDS A PHYSICAL ADDRESS IN R0 AND R1.

NOTE: BECAUSE OF SPACE LIMITATIONS THERE IS A KNOWN FLAW IN THE MEMORY SIZING ROUTINE. IF MAXIMUM MEMORY IS CONFIGURED ON THE SYSTEM(1920KW) THE SIZING ROUTINE WILL REPORT A MEMORY SYSTEM SIZE OF 2044KW. THIS IS BECAUSE OF THE UNIBUS MAP WILL MAP THE LAST 124K OF VIRTUAL ADDRESS SPACE TO THE LOWER 124K OF MAIN MEMORY.

C. SLUTST - THIS SUBTEST PLACES SLU1 IN MAINTENANCE MODE (SERIAL OUT OF UART TIED TO SERIAL IN OF UART) AND TESTS THAT ALL 8-BIT PATTERNS CAN BE TRANSMITTED AND RECEIVED. SECTION PRINT PRINTS THE MEMORY SIZE CALCULATED BY MEMTST, AND TRANSFERS CONTROL BACK TO ODT OR THE APPLICABLE BOOT ROM.

6.3 SPECIAL SUBROUTINE DESCRIPTION

THE PRINT ROUTINE TYPES THE LAST 22-BIT MEMORY ADDRESS+2 FOUND BY THE MEMORY SIZE ROUTINE. THE 16 HIGH ORDER BITS ARE SAVED IN R0 AND THE 6 LOW ORDER BITS ARE SAVED IN R1.

7.0 LISTING

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356                                     .TITLE  CJM9AA
357                                     .SBTTL  ROM AREA 165000-165776
358                                     .SBTTL  GO/NOGO MINIMUM DIAGNOSTIC
365                                     .TITLE  CJM9AA0 11/24 ROM M9312
(1)                                     :*COPYRIGHT (C) APRIL,1982
(1)                                     :*DIGITAL EQUIPMENT CORP.
(1)                                     :*MAYNARD, MASS. 01754
(1)                                     :*
(1)                                     :*PROGRAM BY D. SOBIK
(1)                                     :*
(1)                                     :*THIS PROGRAM WAS ASSEMBLED USING THE PDP-11 MAINDEC SYSMAC
(1)                                     :*PACKAGE (MAINDEC-11-DZQAC-C5), JAN, 1981.
(1)                                     :*
(1)                                     $TN=1
(1)                                     $SWR=160000      ;:HALT ON ERROR, LOOP ON TEST, INHIBIT ERROR TYP0UT
366
367                                     .SBTTL  REGISTER DEFINITIONS
368                                     SWR=    177570      ;SWITCH REGISTER (DIAGNOSTIC LIGHTS)
369                                     PS=    177776      ;PROCESSOR STATUS WORD
370                                     :SLU1 REGISTERS
371                                     RCSR=   177560      ;RECEIVER CSR
372                                     RBUF=   177562      ;RECEIVER BUFFER
373                                     XCSR=   177564      ;TRANSMITTER CSR
374                                     XBUF=   177566      ;TRANSMITTER BUFFER
375
376                                     :MMU REGISTERS
377                                     PAR0=   172340      ;KERNAL PAGE ADDRESS REGISTERS
378                                     PAR1=   172342
379                                     PAR7=   172356
380                                     PDR0=   172300      ;KERNAL PAGE DESCRIPTOR REGISTERS
381                                     PDR1=   172302
382                                     PDR7=   172316
383                                     UPAR0=  177640      ;USER PAGE ADDRESS REGISTERS
384                                     UPAR1=  177642
385                                     SR0=    177572      ;STATUS REGISTER 0
386                                     SR3=    172516      ;STATUS REGISTER 3 (22-BIT)
    
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388      165000      165000
389      165000      000177      006020      START:  .=165000      JMP      @173024      ;TRANSFER TO SELECTED BOOT ROM OR ODT
390      165004      000000      HALT      ;ENTRY POINT FOR ODT, NO DIAGNOSTICS
391
392      165006      012704      165002      MOV      #165002,R4      ;ENTRY POINT FOR ODT WITH DIAGNOSTICS
393
394      ;SBTTL CPU TEST      ;SET UP RETURN ADDRESS-2 IN R4
395      ;:*****
396
397      ; BASIC CPU TEST
398
399      ;:*****
400      165012      012737      000003      177570      CPUTST: MOV      #3, @#SWR      ;LIGHTS = 3, INDICATING CPUTST
401      165020      012737      165144      000004      MOV      #BADADD,@#4      ;SET UP TIME OUT VECTOR INCASE OF TRAP
402      165026      005037      000006      CLR      @#6      ;CLEAR PRIORITY OF TRAP ROUTINE
403      165032      010037      177640      MOV      R0, @#UPAR0      ;WE ARE USING THE UPAR'S HERE SIMPLY BECAUSE
404      165036      010137      177642      MOV      R1, @#UPAR1      ;THEY ARE AVAILABLE UNUSED INTERNAL REGS.
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    165042      005001      CLR      R1      ;R1 CONTENTS      N Z V C
    165044      005201      INC      R1      ;000000      0 1 0 0
    165046      005101      COM      R1      ;1      0 0 0 0
    165050      006201      ASR      R1      ;177776      1 0 0 1
    165052      006301      ASL      R1      ;177777      1 0 1 0
    165054      006001      ROR      R1      ;177776      1 0 0 1
    165056      005701      ROR      R1      ;177777      1 0 1 0
    165060      005401      TST      R1      ;177777      1 0 0 0
    165062      005301      NEG      R1      ;1      0 0 0 1
    165064      005601      DEC      R1      ;0      0 1 0 1
    165066      005501      SBC      R1      ;177777      1 0 0 1
    165070      001026      ADC      R1      ;0      0 1 0 1
    BNE      CPUERR      ;ERROR IF NOT ZERO

; SECTION FOR DOUBLE OPERAND, ALL SOURCE MODES, DEST MODE 0
    MOV      #POOL, R2      ;SET UP ADDRESS OF DATA TABLE
    MOV      (R2), R1      ;R1/POOL, SMODE 1
    CMP      (R2)+, R1      ;DATA CORRECT? SMODE 2
    BNE      CPUERR
    ADD      @(R2)+, R1      ;R1/POOL + 1, SMODE 3
    SUB      @-(R2), R1      ;R1/POOL, SMODE 5
    BIC      -(R2), R1      ;R1/0, SMODE 4
    BIS      4(R2), R1      ;R1/177777, SMODE 6
    BIT      @6(R2), R1      ;RESULT IS 177777, SMODE 7
    BEQ      CPUERR
    BR      CONT      ;BRANCH AROUND DATA TABLE

POOL:      .WORD      POOL
          .WORD      DATA1
DATA2:      .WORD      177777
          .WORD      DATA2
DATA1:      .WORD      1
DOUBLE:     .WORD      500
          .WORD      500
BADADD:     HALT
CPUERR:     HALT
    
```

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445
446      :      CHECK CONDITIONAL BRANCHES
447
448      165150 000277      CONT:  SCC      :SET ALL CONDITION CODES
449      165152 001375      BNE      CPUERR  :BR IF Z=0
450      165154 100374      BPL      CPUERR  :.. .. N=0
451      165156 102373      BVC      CPUERR  :.. .. V=0
452      165160 103372      BCC      CPUERR  :.. .. C=0
453      165162 002771      BLT      CPUERR  :.. .. N XOR V=1
454      165164 003370      BGT      CPUERR  :.. .. Z OR (N XOR V)=0
455      165166 101367      BHI      CPUERR  :.. .. C OR Z=0
456      165170 000257      CCC      :CLR ALL CONDITION CODES
457      165172 001765      BEQ      CPUERR  :BR Z=1
458      165174 100764      BMI      CPUERR  :BR N=1
459      165176 102763      BVS      CPUERR  :BR V=1
460      165200 105762      BCS      CPUERR  :BR C=1
461      165202 003761      BLE      CPUERR  :BR Z OR (N XOR V)=1
462      165204 101760      BLOS     CPUERR  :BR C OR Z=1
463      165206 000270      SEN      :N=1
464      165210 002356      BGE      CPUERR  :BR N XOR V=0
465
466      :      CHECK BYTE INSTRUCTIONS, ALL DEST MODES
467
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469
470      165212 105001      CLRB     R1      :R1 CONTENTS      N Z V C
471      165214 105201      INCB     R1      :177400            0 1 0 0
472      165216 105101      COMB     R1      :177401            0 0 0 0
473      165220 106201      ASRB     R1      :177776            1 0 0 1
474      165222 106301      ASLB     R1      :177777            1 1 0 0
475      165224 106001      RORB     R1      :177776            1 0 0 1
476      165226 105401      NEGB     R1      :177777            1 0 1 0
477      165230 105301      DECB     R1      :177401            0 0 0 1
478      165232 105601      SBCB     R1      :177400            0 1 0 1
479      165234 106101      ROLB     R1      :177777            1 0 0 1
480      165236 105501      ADCB     R1      :177777            1 0 0 1
481      165240 000301      SWAB     R1      :177400            0 1 0 1
482      165242 012703 000500      MOV      #500, R3 :000377            1 0 0 0
483      165246 105063 000001      CLRB     1(R3)   :SETUP FOR DMODE TESTING
484      165252 110113      MOVB     R1, (R3) :CLR LOC 501, DMODE 6
485      165254 120123      CMPB     R1, (R3)+ :500/000 377, DMODE 1
486      165256 001333      BNE      CPUERR  :SHOULD COMPARE, DMCDE 2
487      165260 105143      COMB     -(R3)   :500/000 000, DMODE 4
488      165262 012703 165140      MOV      #DOUBLE, R3 :SETUP DEFERRED DMODES
489      165266 153733 165136      BISB     @DATA1, @-(R3)+ :500/1, DMODE 3
490      165272 143753 165132      BICB     @DATA2, @-(R3) :500/0, DMODE 5
491      165276 130173 000002      BITB     R1, @2(R3) :Z=1, DMODE 7
492      165302 001321      BNE      CPUERR
    
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494
495
496
497 165304 012706 000500
498 165310 004767 000006
499 165314 000714
500 165316 000167 000042
501 165322 012701 000040
502 165326 070127 000010
503 165332 006700
504 165334 072127 000006
505 165340 073127 000071
506 165344 071027 000200
507 165350 005201
508 165352 074001
509 165354 001274
510 165356 062716 000002
511 165362 000207

; CHECK JSR/RTS AND EIS

MOV #500, SP ;SET UP STACK
JSR PC, EISTST
BR CPUERR
JMP MEMTST ;EXIT CPU TEST
EISTST: MOV #40, R1 ;R1/ 40
MUL #10, R1 ;R1/ 400
SXT R0 ;R0/ 0
ASH #6, R1 ;R1/ 40000
ASHC #71, R1 ;R1/ 200
DIV #200, R0 ;R0/1 R1/0
INC R1 ;R1/1
XOR R0, R1 ;R1/0
BNE CPUERR
ADD #2, (SP) ;FIX RETURN ADDRESS TO BYPASS ERROR BR
RTS PC ;EXIT TO MEMORY TEST
  
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513      ;:*****
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515      .SBTTL  MEMTST
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517      ;:*****
518
519      ;+
520      ;:
521      ;:   THIS TEST SIZES MEMORY AND CHECKS MEMORY FROM LOC 1000 TO END OF
522      ;:   MEMORY BY WRITING IN EACH LOCATION THE ADDRESS OF THE LOCATION
523      ;:   AND COMPARING THE LOCATION AND ITS CONTENTS. THE PROCEDURE IS
524      ;:   REPEATED USING THE COMPLEMENTS OF THE ADDRESS IN EACH LOCATION.
525      ;:   MEMORY IS CLEARED ON EXIT FROM THIS TEST IN 4K BLOCKS; THAT IS,
526      ;:   IF 122K IS PRESENT, 120K GETS CLEARED, THE REST HAS THE ADDRESS
527      ;:   WRITTEN IN IT.
528      ;:-
529
530      ;:*****
531
532 165364 0 2737 000002 177570 MEMTST: MOV #2, @#SWR ;LIGHTS = 2, INDICATING MEMTST
533 165372 0J5037 172340 CLR @#PAR0 ;MAP VECTOR SPACE TO PAR0
534 165376 012737 077406 172300 MOV #77406, @#PDR0 ;4K PAGE R/W
535 165404 005037 172342 CLR @#PAR1 ;PAR1 IS MOVABLE WINDOW INTO MEMORY
536 165410 012737 077406 172302 MOV #77406, @#PDR1
537 165416 012737 177600 172356 MOV #177600, @#PAR7 ;MAP PAR7 TO I/O PAGE
538 165424 012737 077406 172316 MOV #77406, @#PDR7
539 165432 005037 177776 CLR @#PS ;ENSURE KERNEL MODE
540 165436 005237 77572 INC @#SRO ;TURN ON KT
541 165442 012737 000020 172516 MOV #20, @#SR3 ;SET UP FOR 22-BIT RELOCATION
542 165450 012702 000002 MOV #2, @#2 ;WORD INCREMENT
543 165454 012737 165552 000004 1$: MOV #TIMOUT, @#4 ;SETUP TIMEOUT VECTOR FOR MEMORY SIZE
544 165462 012703 020000 MOV #20000, R3 ;START AT VIRTUAL ZERO
545 165466 012705 010000 MOV #10000, R5 ;PAGE LENGTH = 4K
546 165472 010301 MOV R3, R1 ;WORKING COPY OF FIRST ADDRESS
547 165474 010500 MOV R5, R0 ;COPY PAGE LENGTH
548 165476 010111 2$: MOV R1, (R1) ;WRITE ADDRESS INTO LOCATION
549 165500 060201 ADD R2, R1 ;INCREMENT ADDRESS
550 165502 077003 SOB R0, 2$ ;LOOP TILL PAGE DONE
551 165504 010301 MOV R3, R1 ;RESTORE INITIAL CONDITIONS FOR
552 165506 010500 MOV R5, R0 ; DATA CHECK AND COMPLEMENTING
553 165510 020111 3$: CMP R1, (R1) ;GOOD DATA?
554 165512 001014 BNE MEMERR ;NO, HALT
555 165514 005121 COM (R1)+ ;COM DATA AND INC ADDRESS
556 165516 077004 SOB R0, 3$ ;LOOP TILL PAGE DONE
557 165520 010301 MOV R3, R1 ;START AGAIN TO TEST COM DATA
558 165522 010500 MOV R5, R0
559 165524 060111 4$: ADD R1, (R1) ;RESULT SHOULD BE -1
560 165526 005221 INC (R1)+ ;RESULT=0 AND SETUP NEXT ADDRESS
561 165530 001005 BNE MEMERR
562 165532 077004 SC? R0, 4$ ;FINISH THE PAGE
563 165534 062737 000200 172342 ADD #200, @#PAR1 ;RELOC TO A NEW PAGE
564 165542 000744 BR 1$ ;CHECK OUT A NEW PAGE
565 165544 005037 177572 MEMERR: CLR @#SRO ;TURN OFF KT
566 165550 000000 HALT ;BAD MEMORY
567 165552 005037 177572 TIMEOUT: CLR @#SRO ;TURN OFF KT
568 165556 005037 172516 CLR @#SR3 ;RESTORE 18-BIT RELOCATION
    
```

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569 165562 000402          BR      1$          ;BRANCH AROUND ENTRY POINT
570 165564 000167 177222    JMP     CPUTST      ;BOOT ROM ENTRY POINT
571 165570 012737 000006 000004 1$:  MOV     #6,        @#4      ;TIMEOUT TRAPCATCHER
572 165576 160301          SUB     R3,        R1      ;GET RID OF VIRTUAL OFFSET
573 165600 005000          CLR     R0         ;CLR HIGH HALF OF DOUBLEWORD
574 165602 073027 000012    ASHC   #12,       R0      ;LSH 10. TO BUILD PHYSICAL ADDRESS
575 165606 063700 172342    ADD    @#PAR1,    R0      ;ADD PAGE BASE ADDRESS
576 165612 073027 177776    ASHC   #-2,       R0      ;ACCOUNT FOR 1-BIT MSD
577          .SBTTL  SLU1 TEST
578
579          ;:*****
580
581          ;      CHECK SLU1 VIA MAINTENANCE MODE
582
583          ;:*****
584
585 165616 012737 000001 177570  SLUTST: MOV     #1,        @#SWR    ;LIGHTS = 1, INDICATING SLUTST
586 165624 005002          CLR     R2         ;FIRST ASCII CODE TO BE CHECKED
587 165626 012737 000004 177564    MOV     #4,        @#XCSR   ;ENABLE MAINTENANCE MODE
588 165634 105737 177564    2$:  TSTB   @#XCSR    ;TRANSMITTER READY?
589 165640 100375          BPL     2$         ;NO, WAIT FOR READY
590 165642 110237 177566    MOVB   R2,        @#XBUF   ;TRANSMIT CHAR
591 165646 105737 177560    3$:  TSTB   @#RCSR    ;DATA RECEIVED?
592 165652 100375          BPL     3$         ;NO
593 165654 120237 177562    CMPB   R2,        @#RBUF   ;DID DATA LOOP AROUND CORRECTLY?
594 165660 001006          BNE     SLUERR      ;NO
595 165662 005202          INC     R2         ;SET UP NEXT PATTERN
596 165664 105702          TSTB   R2         ;DONE ALL PATTERNS?
597 165666 001362          BNE     2$         ;NO, CONTINUE
598 165670 005037 177564    CLR     @#XCSR     ;EXIT MAINTENANCE MODE
599 165674 000403          BR      PRINT      ;PRINT LAST ADDRESS
600 165676 005037 177564    SLUERR: CLR    @#XCSR  ;EXIT MAINT MODE
601 165702 000000          HALT
    
```

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609 165704 005037 177570
610 165710 012705 000010
611 165714 012703 000003
612 165720 005002
613 165722 073027 000001
614 165726 006102
615 165730 077304
616 165732 062702 000060
617 165736 105737 177564
618 165742 100375
619 165744 110237 177566
620 165750 077517
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628 165752 013700 177640
629 165756 013701 177642
630 165762 000164 000002
631 165766 015
632 165767 012
633 165770 000240
634 165772 000240
635 165774 042060
636 165776 113422
637
638 165000
    
```

```

;*****
; PRINT MEMORY SIZE (LAST ADDRESS + 2) AND EXIT
;*****
PRINT: CLR @#SWR ;LIGHTS = 0, ALL TESTS PASSED
MOV #10, R5 ;PRINT 8. DIGITS
1$: MOV #3, R3 ;SHIFT COUNT FOR DIGIT ASSEMBLY
CLR R2 ;CLR DIGIT ASSEMBLY AREA
2$: ASHC #1, R0 ;PUT BIT IN C-BIT
ROL R2 ;MOVE C-BIT TO R2
SOB R3, 2$ ;BUILD A DIGIT IN R2
ADD #'0, R2 ;CNVRT TO ASCII
3$: TSTB @#XCSR ;PRINTER READY?
BPL 3$
MOVB R2, @#XBUF ;PRINT IT
SOB R5, 1$ ;PRINT 8. DIGITS

;////////////////////////////////////
; EXIT TO ODT OR TO BOOT ROM
;////////////////////////////////////

MOV @#UPAR0, R0 ;RESTORE BOOT ROM PARAMETERS
MOV @#UPAR1, R1
JMP 2(R4) ;RETURN TO BOOT ROM OR ODT
CRLF: .BYTE 15
.BYTE 12
NOP
NOP
CRC: .ASCII '0D' ;#4 LPU ROM FOR M9312
.WORD 113422 ;CRC CHECKWORD FOR ROM

.END START
    
```


SLASH	362#	622	626							
STARS	362#	395	399	513	517	530	579	583	603	607
.HEADE	362#	365								

. ABS. 166000 000

ERRORS DETECTED: 0

CJM9AA.BIN,CJM9AA.LST/CRF/NL:TOC=CJM9AA.P11
RUN-TIME: 1 1 .1 SECONDS
RUN-TIME RATIO: 44/2=15.2
CORE USED: 7K (14 PAGES)