USERS' MANUAL

FOR

MEMORY CHECK PROGRAM

Versions 1.0 and 2.0.

PREFACE

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This manual outlines the use of the Memory Check Program.
There are two versions of this program: version 1.0 for use with
the NORD-1 computer and version 2.0 for use with the NORD-2B
computer. The two versions function identically.

The Memory Check Program consists of 12_8 different subprograms
called sections, and this manual provides a description of the sec-
tions and a detailed explanation of their use. For a quick reference
to the sequences the program may follow, a flowchart is included.

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SECTION A: INTRODUCTION

I   PURPOSE

The program is intended to check the memory of the NORD-1 and
NORD-2B computers. Special attention has been given to the pro-
gram's flexibility and ease of use. No technical background should
be required to use this memory check program.

The program is written in MAC assembly language, and a complete
program listing is available. The program exists in symbolic and
binary versions for use with half duplex teletypes. Also a binary
version exists for use with full duplex teletypes.

II   SYSTEM CONFIGURATION

The equipment needed to make use of this program is a Tape reader,
a Teletype and a NORD-1 or NORD-2B CPU with 4K or more of memory.

III   FUNCTION

The program tests a block of memory, specified by a lower bound
(called "Start Address") and an upper bound (called "Stop Address"),
in up to 12_8 different ways. These 12_8 different tests (sections) are
described in part A. Program Sections.

A. Program Sections

Section 1.   This test stores all ones from Start Address
                        through Stop Address.

Section 2.   This test stores all zeroes from Start Address
                        through Stop Address.

Section 3.   This is an address test. The address of the
                        Start Address through the address of the Stop
                        Address is stored in consecutive locations,
                        thus testing the addressing logic.

Section 4.   This test is devided into 3 subtests.

                        a. The pattern 125252 is stored in the area
                           of memory to be tested, and all cores are
                           read disturbed 32 times and then checked
                           to see if they are in the correct state.

                        b. The pattern 052525 is stored in memory and
                           tested as above.

                        c. The pattern 177777 is stored in memory and
                           tested as above.

Section 5. This test also contains 3 subtests.

a. The pattern 000000 is stored throughout the part of memory to be tested. Next, the cores are write disturbed 32 times with the pattern 177777 before being selected to check if they are in the correct state.

b. The pattern 125252 is stored in memory and tested as above.

c. The pattern 052525 is stored in memory and tested as above.

Section 6. This test goes through the same sequences as test 5 except the pattern used for write disturbing the cores is 000000 instead of 177777.

Section 7. This test is executed in the following sequence:

a. Set n = 0.

b. Store 177777 in all locations under test.

c. Store 052525 in Start Address + n.

d. Check if any addresses changed.

e. Increment n by one.

f. Repeat steps b.-f.

The sequence is terminated when Start Address + n = Stop address.

Next, step (b) is replaced by:

b. Store 000000 in all locations under test.

The steps a.-f. are then executed as above and the test is terminated when Start Address + n = Stop Address.

Section 10. This test first stores the word 125252 then the word 052525 in every location under test. The test is repeated 100_8 times.

Section 11. This is the "worst case" test. When the address bits A3 and A8 meet the condition

$$A3 \cdot A8 + \overline{A3} \cdot \overline{A8} = 1$$

the data word stored in this location will be 177777. If not the word will be 000000. The test is repeated 100_8 times.

Section 12.　　　　　　This is the "compliment worst case" test.
Whenever the equation of section 11 is true,
the data word stored will be 000000. If the
equation is false, the data word becomes
177777. The test is repeated 100_8 times.

B. Restrictions

The program resides in locations $0 - 2100_8$. The Start Address must
therefore be:

$$\text{Start Address} \geq 2100_8$$

If not, the program will destroy itself and must be reloaded.

IV　　　EXECUTION TIMES

The execution times for the different tests depend upon the number of
locations to be tested. Some typical execution times for 4K of memory
are:

Sections 1, 2, 3, 4	- approx.	1 sec (each)
Sections 5, 6	- "	1.5 sec (each)
Section 7	- "	11 min
Section 10	- "	6 sec
Sections 11, 12	- "	5 sec (each)

If errors are detected, additional time will be added for error pro-
cessing.

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SECTION B: USE

I LOADING THE PROGRAM

A. Symbolic

A standard MAC assembler has to be loaded.

The symbolic start address of the program is "SERVC". The program may be assembled from any desired core address. (The program occupies 2100_8 locations). Normally location "0" is selected for the "LOWER" version (the program resides in lower core) which can test addresses $\geq 2100_8$ and location 5700_8 for the "UPPER" version (the program resides in upper core) which can test addresses: $5700_8 \geq$ address $\geq 10000_8$.

B. Binary

Turn the Teletype to ON LINE, and load the program as an ordinary binary tape. The program will be read into memory from location 0 and up to 2100_8. The program starts automatically.

II SPECIFYING PARAMETERS

A. Start Address

When the program is started, the Teletype will print the message:

SELECT START ADDRESS:

The operator now enters the desired starting address for the test in the following format:

yyyyyy CR

where y...y denotes an octal number $\geq 2100_8$ and CR = Carriage Return.

B. Stop Address

After receiving the CR, the machine will print the message:

SELECT STOP ADDRESS:

Using the same format as that of the Start Address, type the desired Stop Address which will be the last location to be tested.

C. Select Sections to be run

When the Stop Address is selected, the machine will print the message:

SELECT SECTIONS:

Now type a list of the numbers of the sections desired in the format:

n, n, n, ..., n, CR

For example: 1, 2, 5, CR will cause sections 1, 2 and 5 to be executed. The comma (,) is used as a delimeter and must be the last character before CR.

Usually sections 1, 2, 3, 4, 5, 6, 10, 11 and 12 are sufficient for testing the memory and these sections may be specified by typing:

15,

If a more thorough test is required, section 7 may be included by typing:

7, 15,

and all 12_8 sections will be executed.

D. Parameter "S" and "N"

After having received the section(s) to be run, the machine will print the message:

SPECIFY PARAMETER "S" OR "N":

The parameter "S" may be selected by typing:

S

The machine will respond with Carriage Return and Line Feed, and the test starts.

In a similar way "N" may be selected by typing:

N

The machine will respond with a CR LF, and the test starts.

No other character than "S" or "N" will elicit the correct response from the machine and start the test.

If parameter "N" has been selected, any errors detected will be printed out in sequence and the test will continue until terminated by the operator (see Interrupting the Program).

If parameter "S" has been selected, the machine will wait for operator action after each error is detected and printed out. (See Error Procedures).

III   PROGRAM EXECUTION

At the beginning of each section the machine will print out:

SECTION # RUNNING

where # indicates the section number.. As long as no errors are detected this will be the only message given to the operator.

IV   ERROR PROCEDURES

A. Error Printout Format

Any errors detected are printed out on the Teletype in the format:

$$\underbrace{yyyyy:}_{A} \quad \underbrace{yyyyy}_{C} \quad \underbrace{yyyyy}_{E} \quad S \ \#$$

where

A = the address of the memory location failing.

C = the contents of the failing address.

E = the expected contents of the address.

S = section number.

All values are given in octal.

B. Parameters "C" and "R"

If parameter "S" has been selected and an error is detected, the machine will print:

SPECIFY PARAMETER "C" OR "R":

The operator now has time to analyze the printout before he specifies a new parameter.

To continue the test type:

C

To restart the test type:

R

INTERRUPTING THE TEST

The following applies only for full duplex teletypes.

To interrupt (or restart) the test, just type any character. An interrupt is only checked for at the beginning of every section and at the beginning of every error printout. Thus, there may be some delay before the program restarts itself.

For half duplex teletypes a manual stop and restart may be performed by using the CPU control buttons.

SECTION C: TROUBLE SHOOTING GUIDE

To isolate error(s) in the memory[x] follow the steps outlined below:

I   Determine whether the errors are confined to one 4K memory module or not. i.e. if the failing addresses are within the bounds of a Storage Module.

Control Board no. 1

Storage Module	no. 1	4 K - address	0-7777
"	" 2	8 K - "	10000-17777
"	" 3	12 K - "	20000-27777
"	" 4	16 K - "	30000-37777

Control Board no. 2

Storage Module	no. 5	20 K "	40000-47777
"	" 6	24 K "	50000-57777
"	" 7	28 K "	60000-67777
"	" 8	32 K "	70000-77777

If the problem is limited to only one Storage Module, simply replace the module. If the problem is common to all modules, continue to step II.

II   If the failing addresses are within the first 16 K of memory, replace Control Board 1. If the errors are detected between 16 K and 32 K of the memory, replace Control Board 2.
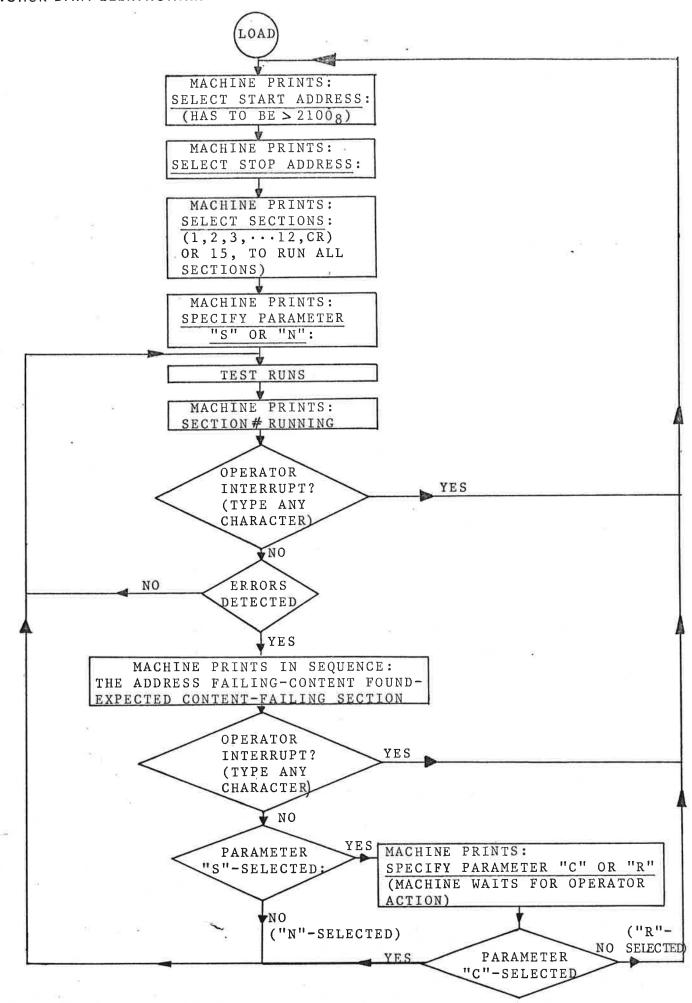
NOTE: Always turn off power before removing any Storage Modules or Control Boards.

Isolation of the problem down to a specific circuit on a Storage Module or a Control Board, should be performed by trained personal.

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x) Cambridge Memories, Inc. (CMI) Expanda core.

```
                        ( LOAD )
                           │
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS:                 │
          │ SELECT START ADDRESS:           │
          │ (HAS TO BE > 2100₈)             │
          └────────────────┬────────────────┘
                           │
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS:                 │
          │ SELECT STOP ADDRESS:            │
          └────────────────┬────────────────┘
                           │
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS:                 │
          │ SELECT SECTIONS:                │
          │ (1,2,3,···12,CR)                │
          │ OR 15, TO RUN ALL               │
          │ SECTIONS)                       │
          └────────────────┬────────────────┘
                           │
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS:                 │
          │ SPECIFY PARAMETER               │
          │ "S" OR "N":                     │
          └────────────────┬────────────────┘
                           │
          ┌────────────────▼────────────────┐
          │          TEST RUNS              │
          └────────────────┬────────────────┘
                           │
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS:                 │
          │ SECTION # RUNNING               │
          └────────────────┬────────────────┘
                           │
                     OPERATOR
                   INTERRUPT?        ───YES──→
                   (TYPE ANY
                    CHARACTER)
                           │ NO
                      ERRORS     ───NO──→
                     DETECTED
                           │ YES
          ┌────────────────▼────────────────┐
          │ MACHINE PRINTS IN SEQUENCE:     │
          │ THE ADDRESS FAILING-CONTENT FOUND- │
          │ EXPECTED CONTENT-FAILING SECTION │
          └────────────────┬────────────────┘
                           │
                     OPERATOR
                   INTERRUPT?        ───YES──→
                   (TYPE ANY
                    CHARACTER)
                           │ NO
                    PARAMETER    ───YES──→  ┌──────────────────────────────┐
                  "S"-SELECTED:            │ MACHINE PRINTS:              │
                           │                │ SPECIFY PARAMETER "C" OR "R" │
                           │ NO             │ (MACHINE WAITS FOR OPERATOR  │
                     ("N"-SELECTED)         │ ACTION)                      │
                                            └──────────────┬───────────────┘
                                                           │
                                          PARAMETER          ("R"-
                                         "C"-SELECTED  ──NO──→  SELECTED)
                                              │ YES
```

OPERATOR INTERRUPT ONLY WITH FULL DUPLEX TELETYPES