National Semiconductor Corporation

MicroVAX II

Memory Diagnostics

Operations Manual

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1. INTRODUCTION

The MicroVAX™ II Memory Diagnostics have been created to provide the user with a service currently not available from DEC®, namely the ability to locate faulty DRAMs within the memory subsystem in the MicroVAX II series of computers.

These diagnostics are primarily intended for testing the National Semiconductor NS630, NS638 and NS6316 modules. As an added service to the user, they also test the memory resident in the CPU module, as well as any other Private Memory Interconnect (PMI) modules installed in the system.

The sections below describe the theory of operations, explain how to run the diagnostics and how the errors are displayed. The various appendices show the RAM array layouts for the various National Semiconductor modules.

2. FURTHER ASSISTANCE

The diagnostics require inputs from the user to properly identify the expected configuration. These are entered via prompts on the console menus. Please refer to the sections below if any of these steps is unclear.

If this manual proves insufficient to resolve any remaining questions, do not hesitate to contact National Semiconductor Technical Support for assistance. Please use the phone numbers shown on the Customer Service Information sheet attached to the warranty.

NOTE
National Semiconductor's Technical Support personnel are in no position to help the user when problems with non-NSC modules (including DEC's) are encountered. Please contact the module manufacturer or DEC Field Service for assistance.

3. PRINCIPLES OF OPERATION

The intent of the tests is to identify any failing devices within the memory subsystem. Its operation assumes that at least a minimal portion of this is useable. To reduce complications introduced by virtual memory management, as well as to eliminate any dependence on the various operating systems, the diagnostics operate in a stand-alone mode.

Before loading the diagnostics, facilities of the Boot ROM loader are used to identify a section of good memory where the program can be loaded. From that point on, the diagnostics take control of the machine and test all remaining memory, including that present on the CPU module, if enabled. The diagnostics perform the following tests:

- A check of the amount of memory which the system boot loader identified as being present compared to the amount specified by the user to the diagnostic program. This ensures that no installation problems have been encountered.
- A card selection test, whereby each card on the expansion slots is selected in sequence to ensure that no interference occurs between the two slots.
- A RAM addressing test, whereby an incrementing number is deposited into each memory location and later checked to ensure no problems are found in the address paths and

controls.

- A RAM data test, whereby alternating patterns are written into each RAM location to verify that all data bits can be set and cleared.
- A RAM refresh test, whereby the RAM devices' ability to retain the stored information is validated.

Errors caused by failing parity RAMs or failing parity generation or checking logic are not segregated by the diagnostics. Please see the *Parity Circuitry* section below for details.

4. PARITY CIRCUITRY

There are no built-in facilities in the system that would allow easy test of the parity RAMs and parity support circuitry. These are thus not identified as such by the diagnostics and may even cause problems in their execution, such as an error halt or trap.

The situation where an operating system such as MicroVMS™ identifies RAM failures while the diagnostic does not could be caused by this same problem.

If this situation is encountered, identify the failing module by turning the memory modules off-line (or physically removing them from the system) one by one, starting with the one furthest from the CPU and repeating the test until the diagnostics (or the system) are able to execute without problems.

Once the failing module has been identified using this method, it should be physically removed from the system and returned to the factory for repair. Contact National Semiconductor Technical Support for assistance.

5. RUNNING THE DIAGNOSTICS

This section illustrates the procedure for starting the diagnostics, for entering the system configuration and for interpreting the error displays.

5.1. Booting the Diagnostics

The diagnostics are supplied by means of a floppy diskette which is compatible with the DEC RX50 Floppy subsystem configured on all MicroVAX II systems. Versions which may have to be supplied via DEC TK50 half-inch tape cartridges operate in the same manner except for the boot device specification.

To access the diagnostics, insert the diskette into the floppy drive with the label facing towards the *outside* of the dual drive. The procedure below illustrates the use of floppy drive *0*. If floppy drive *1* is utilized, make sure to specify the proper boot device.

Close the door and proceed to apply power to or reset the machine. The display on the system console will be:

```
KA630-A.V1.2
Performing normal system tests.
   7..6..5..4..3..
Tests completed.
>>>
```

At this point, the boot device should be specified. If floppy drive unit *0* is used, enter **B** after the console prompt. The display will then be as follows:

```
>>>B
   2..1..0..
MicroVAX II Memory Diagnostics
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                Strike any key
```

At this point, hit any key to go into the memory configuration menu.

5.2. Memory Configuration Menu

The menu which allows the user to specify its installed configuration is shown below:

```
Memory Board Type Code:                Foreign Memory Size Code:
    NS630-001    =  1                      0 MByte    =  0
    NS630-002    =  2                      1 MByte    =  1
    NS630-004    =  3                      2 MByte    =  2
    NS638-008    =  4                      4 MByte    =  3
   NS6316-004    =  5                      8 MByte    =  4
   NS6316-008    =  6                     16 MByte    =  5
   NS6316-016    =  7
 Foreign Board   =  0
(or empty slot)

Enter Memory Board Type Code for slot 1
```

The menu above shows the board type on the left column, indicated by the National Semiconductor product name followed by a dash number indicating the configured memory size

(in megabytes) for that card.

The NS630 can be configured as a 1-, 2-, or 4-MByte unit. The NS638 is only available in the 8-MByte configuration. The NS6316 can be configured as either a 4-, 8- or 16-MByte unit. For a foreign board or if no module is installed into slot 1 (closest to the CPU), choose *0*. For the NSC models listed above, choose the appropriate number *1 through 7*.

If a *0* is entered, indicating a foreign board or an empty slot, the diagnostics will request the expected size of the installed module in the slot. If empty enter *0* for zero megabytes. If a foreign board is installed, choose the board capacity by using one of the codes *1 through 5* shown on the right hand column of the table.

5.3. Incorrect Configuration

The example will assume an NS638 is installed into slot 1 and no module (empty slot) in slot 2 and will illustrate the case where the system is configured incorrectly.

```
Enter   Memory Board Type Code for slot 1              4
Enter   Memory Board Type Code for slot 2 (0-7)   =   0
        Memory Size Code in this slot (0-5)       =   0

Total Memory detected by System at POWER UP = 05 MBytes
Is this correct (Y/N)  N
Do you want to try again (Y/N)        N

If the board(s) are from National Semiconductor Corp.

CONTACT:        In California    (800)  672-1811
              Outside California (800)  538-1866

Type 'S' to restart the tests
```

Here the user indicated that an NS638 with 8 Megabytes of memory was installed into slot 1. Since no additional expansion memory was installed, the total system configuration expected was nine megabytes, including the one megabyte on the CPU module.

The system detected only five megabytes. The installation and cabling should be verified. If the module code was chosen in error, respond *N* to the *Is this correct* question and try again.

The system may also detect and indicate less memory than expected when a serious problem is encountered with a module, such as a full row being bad or a stuck bit on all rows. In this case and prior to contacting Technical Support, the user should restart the tests ignoring the incorrect size shown and record the results. The diagnostics will test the memory subsystem using the memory configuration provided by the user.

If the installation was performed flawlessly and there is still an error shown, the diagnostics will display the toll free numbers which access our Technical Support Services, as shown above. Canadian customers should use (800) 223-3248, all other countries should contact their sales office for assistance.

5.4. Correct Configuration - No errors detected

This section shows the diagnostic displays when a proper configuration is encountered and the tests are completed without errors. Here the configuration is of a sole NS630 module of four megabytes, which together with the memory on the CPU module yields a total installed memory of five megabytes.

```
KA630-A.V1.2

Performing normal system tests.

   7..6..5..4..3..

Tests completed.

>>>B

   2..1..0..

MicroVAX II Memory Diagnostics
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                Strike any key

Memory Board Type Code:                 Foreign Memory Size Code:

    NS630-001    =   1                    0 MByte    =   0
    NS630-002    =   2                    1 MByte    =   1
    NS630-004    =   3                    2 MByte    =   2
    NS638-008    =   4                    4 MByte    =   3
   NS6316-004    =   5                    8 MByte    =   4
   NS6316-008    =   6                   16 MByte    =   5
   NS6316-016    =   7
 Foreign Board   =   0
(or empty slot)

Enter   Memory Board Type Code for slot 1                3
Enter   Memory Board Type Code for slot 2 (0-7)    =     0
        Memory Size Code in this slot (0-5)        =     0

Total Memory detected by System at POWER UP = 05 MBytes
Is this correct (Y/N)  Y

Default number of test cycle = 1
Enter '0' for continuous testing OR any other key to continue
```

At this point, if any key other than *0* is selected, the diagnostics will perform one pass through the tests and then display the test results. If continuous testing is desired, enter *0* and the test will continue until the *<CNTRL >C* (^C) key on the console terminal is depressed, which will interrupt the test **at the end** of the current test cycle.

Here, the example assumes the user does not select the continuous testing option.

```
Performing Memory Tests . . .

Test cycle number   1   Subtest   1
                              2
                              3
                              4

Test completed . .

Address                  Bit  ....  ....  ....  ....  ....  ....  Bit
Range                    31                                       0

Slot 1:   MByte # 01     ....  ....  ....  ....  ....  ....  ....  ....
Slot 1:   MByte # 02     ....  ....  ....  ....  ....  ....  ....  ....
Slot 1:   MByte # 03     ....  ....  ....  ....  ....  ....  ....  ....
Slot 1:   MByte # 04     ....  ....  ....  ....  ....  ....  ....  ....

CPU:      MByte # 05     ....  ....  ....  ....  ....  ....  ....  ....

Enter any key for error analysis
```

The display above shows no errors encountered. Had an error been detected, the bit position would show a *1*. For non-NSC modules, this error map can then be used to record the failing bit and possibly repair the unit. For NSC modules, hitting any key on the console device at this point will indicate the reference designations of the failing devices, if any. The figures on the appendices can then be used to replace the failing device.

The example assumes the user touched the keyboard at this point to go to the error display.

```
Error analysis to chip level:

No errors detected

Enter '0' to repeat testing OR any key to repeat error display
```

The diagnostics have completed execution without encountering any errors. Remove the floppy diskette from the drive, hit *RESET* and proceed to bring up the Operating System if desired.

5.5. Correct Configuration - Errors detected

This section shows the diagnostic displays when a proper configuration is encountered and errors are encountered. The configuration in this example is again one NS630 of four Megabytes as the sole expansion module.

```
KA630-A.V1.2

Performing normal system tests.

    7..6..5..4..3..

Tests completed.

>>> B

    2..1..0..

MicroVAX II Memory Diagnostics
National Semiconductor Corporation.  Copyright 1986

                Strike any key

Memory Board Type Code:                 Foreign Memory Size Code:

    NS630-001   =   1                       0 MByte   =   0
    NS630-002   =   2                       1 MByte   =   1
    NS630-004   =   3                       2 MByte   =   2
    NS638-008   =   4                       4 MByte   =   3
   NS6316-004   =   5                       8 MByte   =   4
   NS6316-008   =   6                      16 MByte   =   5
   NS6316-016   =   7
  Foreign Board =   0
(or empty slot)

Enter   Memory Board Type Code for slot 1                   3
Enter   Memory Board Type Code for slot 2 (0-7)     =       0
        Memory Size Code in this slot (0-5)         =       0

Total Memory detected by System at POWER UP = 05 MBytes
Is this correct (Y/N)  Y

Default number of test cycle = 1
Enter '0' for continuous testing OR any other key to continue
```

Here again, the example assumes the user does not select the continuous testing option.

```
Performing Memory Tests . . .

Test cycle number   1   Subtest   1
                              2
                              3
                              4

Test completed . .

Address                 Bit  ....  ....  ....  ....  ....  ....  Bit
Range                   31                                       0

Slot 1:  MByte # 01     ....  ....  ....  ....  ....  ....  ....  ..1.
Slot 1:  MByte # 02     ....  ....  ....  ....  ....  ....  ....  .1..
Slot 1:  MByte # 03     ....  ....  ....  ....  ....  ....  ..1.  ....
Slot 1:  MByte # 04     ....  ....  ....  ....  ....  ....  ....  1...

CPU:     MByte # 05     ....  ....  ....  ....  ....  ....  ....  ....

Enter any key for error analysis
```

The display above shows four failing RAMs. For an NSC module, entering any key on the console device would display the error analysis identifying the devices by their reference designators. The example assumes the user continues by touching any key at this point.

```
Error analysis to chip level:

Slot 1:

B17 D16 H13 F15

Slot 2:

Empty slot

Enter '0' to repeat testing OR any key to repeat error display
```

NOTE
Do not remove any module from the system without first removing the floppy diskette and turning the system off. If a module is removed while power is on, damage to the module or system may occur.

The example above shows four errors on the NS630 module:

1) Bit *01* on the *first* megabyte which corresponds to the RAM located at reference designator *B17* or at the intersection of row *B* and column *17*.

2) Bit *02* on the *second* megabyte which corresponds to the RAM located at reference designator *D16* or at the intersection of row *D* and column *16*.

3) Bit *05* on the *third* megabyte which corresponds to the RAM located at reference designator *H13* or at the intersection of row *H* and column *13*.

4) Bit *03* on the *fourth* megabyte which corresponds to the RAM located at reference designator *F15* or at the intersection of row *F* and column *15*.

The views on the appendices show the RAM array layouts for the various NSC modules, indicating the row and column numbers which identify the reference designators as well as the data bit numbers which correspond to each device. Note that for board layout reasons, the data bits as well as the word orderings do not necessarily follow logical order patterns.

5.6. Error Interpretation

The diagnostics will show on a display all the failing RAM locations. The error analysis to the chip level, which maps the display to the NSC-modules' reference designators is limited to displaying 16 errors. It is strongly advised that any modules exhibiting more than a few errors be returned to the factory for repair.

NOTE
Do not remove any module from the system without first removing the floppy diskette and turning the system off. If a module is removed while power is on, damage to the module or system may occur.

The display map is also useful in identifying patterns of errors which may be caused by the failure of other components. This would be the case when a whole byte, a whole row or a whole column exhibits failures. This may point to the following causes:

5.6.1. Same bit in all megabytes If the same data bit fails for all megabytes in the module, the problem could be caused by a damaged ribbon cable, a bent pin on the ribbon cable connector or by a failing data transceiver. Check or exchange the cable and connector first. If the problem persists, the board should be returned to the factory for repair.

5.6.2. All bits in one megabyte If all data bits for a full megabyte appear as failing, problems with the address, Row Address Strobe (RAS) or write enable signals or drivers may exist. Check the edge connector fingers to ensure that no foreign substances are encountered which would prevent a good contact with the backplane. Also inspect the backplane contacts for cleanliness or damage. If all appears well, a logic failure is suspected and the module should be repaired.

5.6.3. All bits in one byte If all data bits for a full byte appear as failing, there could be a problem with the Column Address Strobe (CAS) signals. Check the edge connectors and backplane as described on the paragraph above.

A. APPENDIX A - NS630

The *NS630* is organized as eight rows, labelled *A through H* by eighteen columns (1-18). The parity RAMs are adjacent to the corresponding data byte.

Table A below identifies which rows correspond to which megabyte, the detailed view of the card layout is seen on Figure A.

Megabyte	Bits 31-16 Row	Bits 15-00 Row
1	A	B
2	C	D
3	G	H
4	E	F

Table A - NS630 RAM Organization

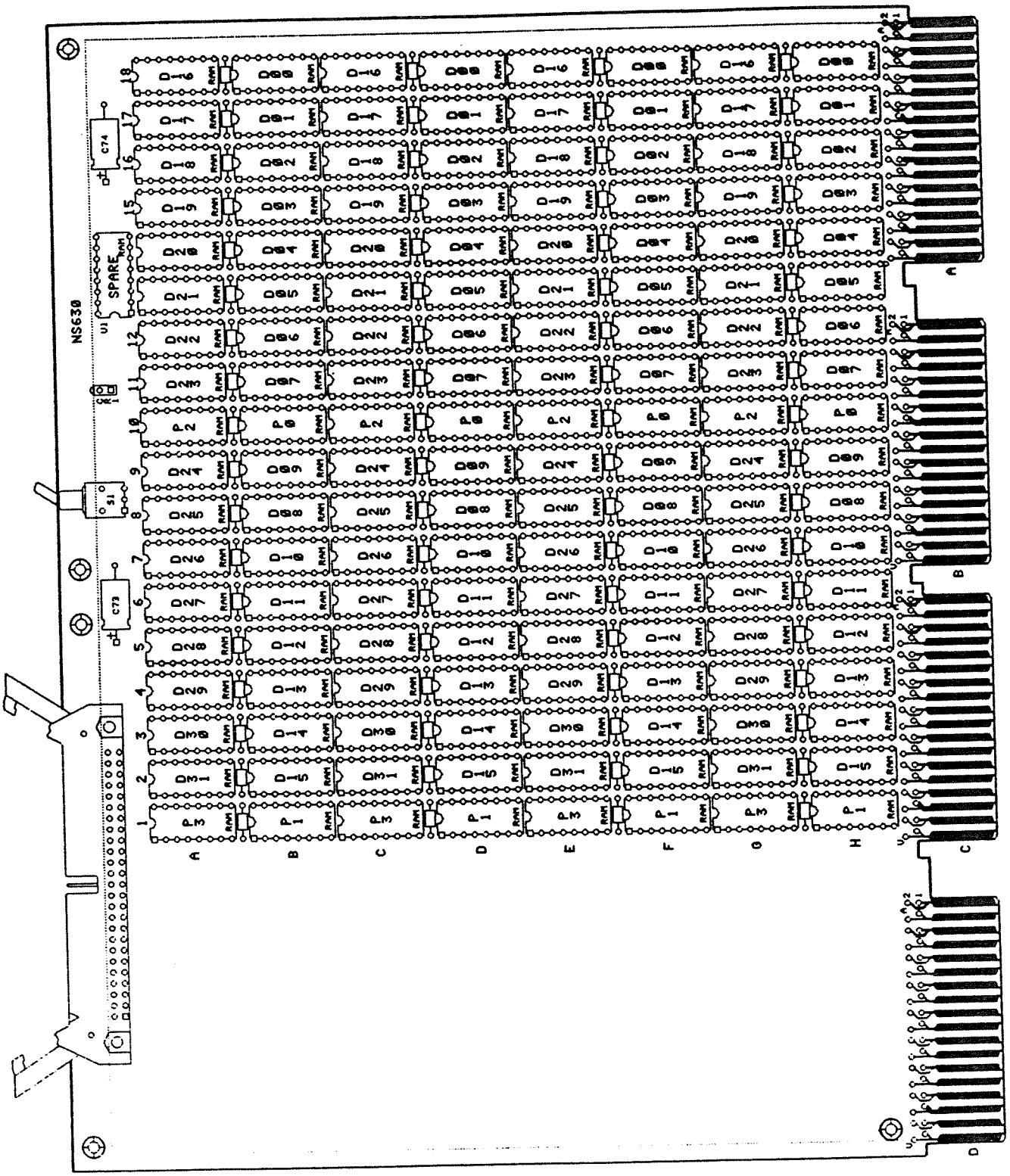

Figure A - NS630 RAM Array Layout

B. APPENDIX B - NS638

The *NS638* is organized as nine columns, labelled *A through I* by 32 rows (1 - 32). The parity RAMs are all located in column *A*.

Table B below identifies which column corresponds to which megabyte, the detailed view is seen on Figure B.

Megabyte	Column
1	F
2	H
3	G
4	I
5	B
6	D
7	C
8	E

Table B - NS638 RAM Organization

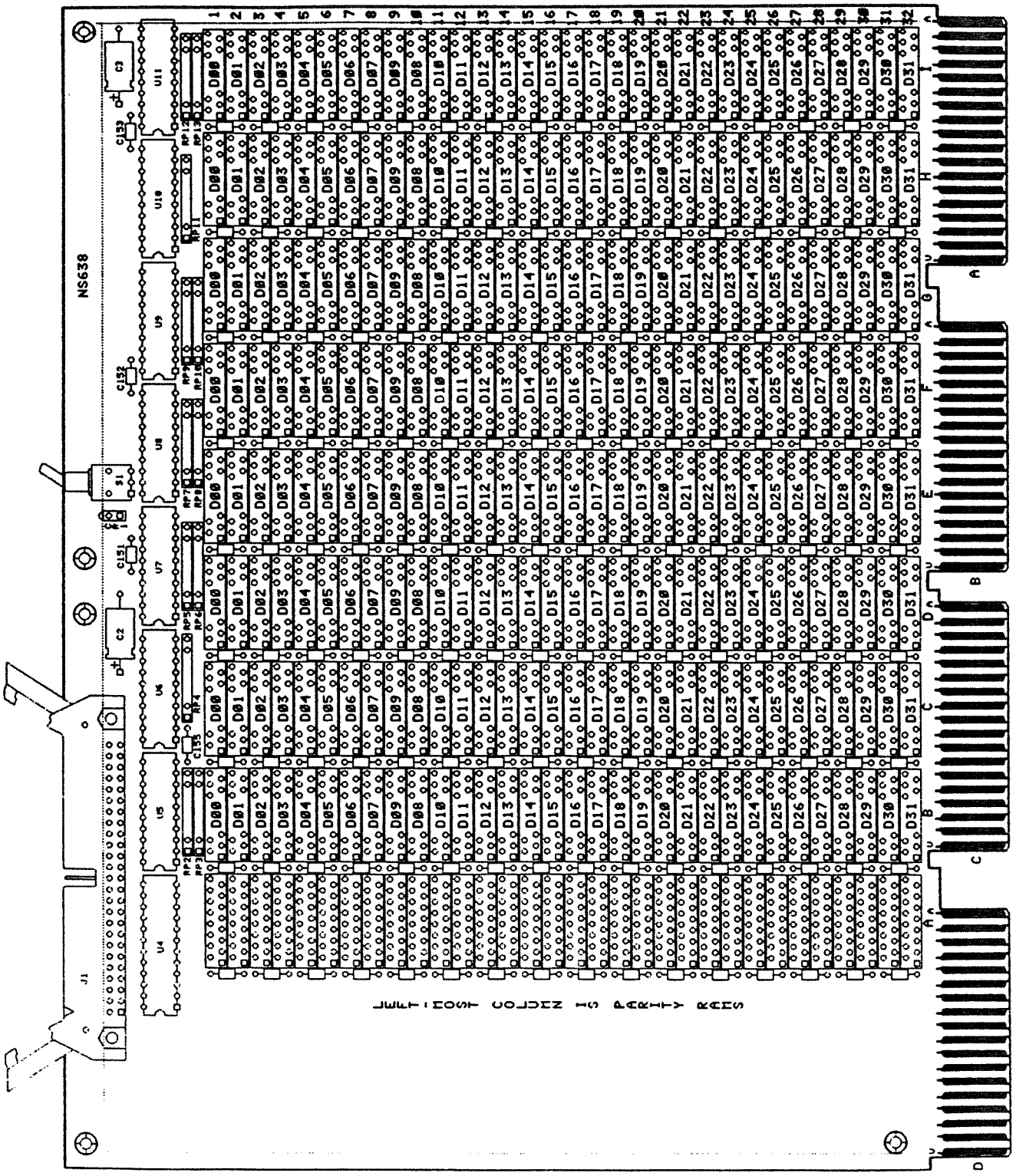

Figure B - NS638 RAM Array Layout

C. APPENDIX C - NS6316

The *NS6316* is organized as eight rows, labelled *A through H* by eighteen columns (1-18). The parity RAMs are adjacent to the corresponding data byte. Note that for this module, each pair of rows contains **four** megabytes instead of one. The error map still shows entries for each megabyte, so a failing RAM on this module will post four entries on that map.

Table C below identifies which rows correspond to which megabyte, the detailed view of the card layout is seen on Figure C.

Megabytes	Bits 31-16 Row	Bits 15-00 Row
1-4	A	B
5-8	C	D
9-12	E	F
13-16	G	H

Table C - NS6316 RAM Organization

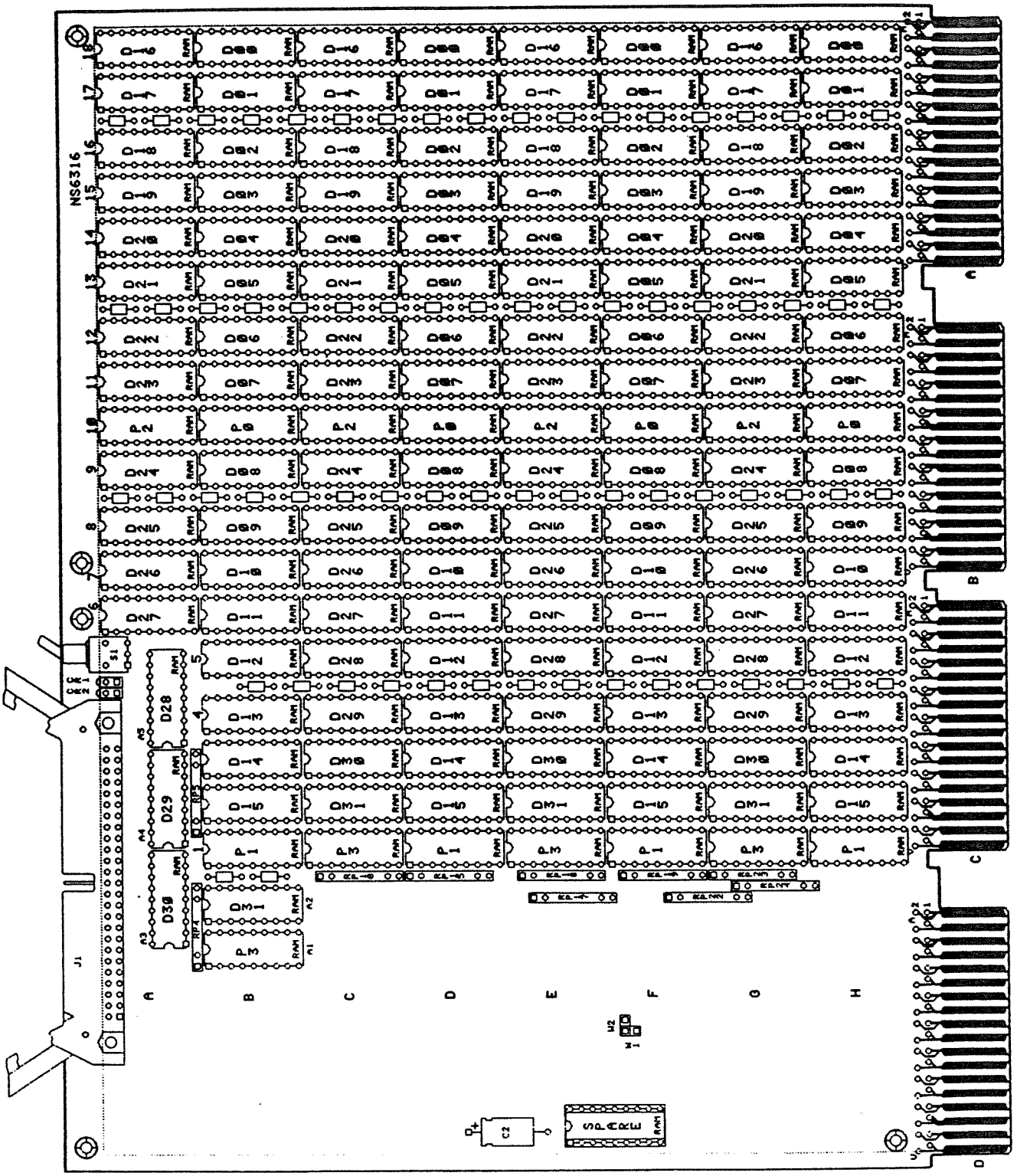

Figure C - NS6316 RAM Array Layout