THE MICRO CLINIC

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TRS-80* FLOPPY DISK DIAGNOSTIC

TRS-80* MEMORY DIAGNOSTIC

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Good diagnostic software is a <u>must</u> in diagnosing those occasional system foulups and especially in verifying the long-term reliability of the hardware. THE MICRO CLINIC offers two programs designed to weed out problems in the two most trouble-prone sections of the Model I TRS-80* -- the memory arrays and the disk controller and drives. Both programs are written in Z-80 machine code and are supplied on diskette for a minimum 16K single disk system.

While every attempt has been made to make these diagnostics as complete and as thorough as possible, there may be certain hardware problems in your system which escape detection by these tests. In particular, MOS memory problems can be especially difficult to find due to "pattern sensitivity" in some 16K memory chips. In any case, these two diagnostics together will provide you with a high degree of confidence in the integrity of your system, something we TRS-80* users have needed badly! If you have any questions or suggestions, contact the author, Dave Stambaugh, at THE MICRO CLINIC.

LOADING THE PROGRAMS

The master diskette contains its own loader and <u>CANNOT</u> be read by your DOS software; there is no 'system' or directory on it. To boot the loader, put the master disk in drive 0 and press the "RESET" button at the left rear of the keyboard. After a few seconds, the screen will clear and you will be asked:

    LOAD WHICH PROGRAM? (1=FLOPPY, 2=MEMORY)

Select the test you want to run by pressing either "1" or "2". The selected test will begin loading and in a few seconds will announce itself. The master diskette should be removed from the system after the program finishes loading.

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TRS-80* FLOPPY DISK DIAGNOSTIC

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FLOPPY DISK DIAGNOSTIC from The Micro Clinic is the most complete
diagnostic program available for the Model I TRS-80* disk system,
and could be the most important program in your software library.
This program provides a positive means for thoroughly checking out
the disk controller circuits and disk drives and for verifying the
reliability of the entire system. Problems in the disk system can
remain "hidden" from the user since the system DOS software per-
forms retires when errors occur. These problems can surface later
as data which cannot be accessed or diskettes which can only be
read in the same drive they were written on.

From one to four drives can be tested at the same time, 35 or 40
tracks. Three stepping rates are available to test drives at full
rated speed. Read/write compatibility between drives can be checked,
and tests can be run continuously if desired to test for long-term
reliability. Complete and detailed error messages will be report-
ed when errors are detected, and error totals for each drive will
be displayed at the end of each pass of the diagnostic.

There are six separate tests in the diagnostic. The purpose of
each test is summarized below. A more complete description is giv-
en in the "Test Descriptions" section.

        TEST A - Tests the basic controller functions and status
                 bits and checks function of mechanical components
                 (track zero switch, write protect switch, and
                 index pulse sensor).
        TEST B - Verifies that data is being transferred from drive
                 to controller; forces certain error conditions;
                 tests drive seek function.
        TEST C - Performs a single-sector write/read. Data read
                 back is verified byte-by-byte to insure correct
                 data transfer to CPU.
        TEST D - Tests the write/read function across the entire
                 diskette; checks cross-cylinder interference.
        TEST E - Tests the write/read function across the entire
                 diskette using all possible data patterns.
        TEST S - Tests the accuracy of the drive motor speed.
                 Adjustments may be made while the test is running.

FLOPPY DISK DIAGNOSTIC is a stand-alone program, not using or de-
pending in any way on your DOS software.

RUNNING THE DIAGNOSTIC

*** NOTE *** RUNNING THIS PROGRAM REQUIRES THAT A FORMATTED DATA
DISK BE INSTALLED IN EACH DRIVE TO BE TESTED. DO NOT USE DISKETTES
WHICH CONTAIN PROGRAMS OR DATA YOU WANT TO SAVE -- EVERYTHING
(DIRECTORY, DOS, DATA, PROGRAMS) ON THE DISK WILL BE ERASED DURING
THE TEST. DISKETTES MUST BE RE-FORMATTED WHEN YOU FINISH RUNNING
THE TEST TO MAKE THEM READABLE AGAIN BY YOUR DOS. DO NOT LEAVE
THE PROGRAM DISK IN A DRIVE YOU ARE GOING TO TEST, AND DO NOT RE-
MOVE THE WRITE PROTECT TAB FROM THE MASTER PROGRAM DISK!!

After you have selected the FLOPPY DISK DIAGNOSTIC, the program
will load, the screen will clear and you will be asked to specify
the desired operating parameters. At this time, insure there is a
formatted data disk in each drive to be tested and that the pro-
gram disk is not in Drive 0. When entering parameters, if you ac-
cidentally make an incorrect response, enter "↑" (up-arrow) to re-
start the questions. In the following descriptions, "(CR)" de-
notes a question which may require the "ENTER" key to be pressed
as the last character entered.

ENTER THE UNITS TO BE TESTED (0-3)? - Enter up to four digits cor-
responding to which drives you want to test. These unit desig-
nations correspond to the standard TRS-80* designations, IE, drive
zero is positioned closest to the expansion interface on the con-
necting cable. For example, to test drives 0 and 1, you would en-
ter "01"(CR). To test all four drives you would enter "0123" (no
CR necessary after the 4th character in this case).

HOW MANY TRACKS? (1=35, 2=40) - Enter the number of tracks the
drives under test have. For Shugart/RS drives, enter "1" (they
have 35 tracks). For MPI, Vista, Pertec, etc., enter "2".

TRACK-TO-TRACK ACCESS TIME? (1=40 MS, 2=20MS, 3=12MS) - This op-
tion sets the controller delay between stepping pulses during seeks.
The manufacturer's spec for Shugart/RS drives is 40 milliseconds
although most will run without problems at 20 milliseconds. Many
other drives are rated faster than this. These are the only rates
available from the disk controller and may not necessarily cor-
respond exactly to the spec for the drives you are using.

TESTS? (A-E) - Enter the tests you want to run. For example, to
run tests A and C, you would enter "AC"(CR). To run all tests en-
ter "ABCDE"(CR). Tests may be run in any order and may be speci-
fied more than once, up to a maximum of 50 total characters. If
you were to enter "EACDDBA"(CR) one pass of the diagnostic would
consist of running those tests in that order on each requested
drive. Entering "S" at any time will cause immediate execution of
the Speed Test on the first requested drive.

*** NOTE *** RUNNING ANY GIVEN TEST ASSUMES THAT THE TESTS PRIOR
TO IT WILL RUN WITHOUT ERRORS, IE, TEST B ASSUMES THAT TEST A WILL
PASS, TEST C ASSUMES THAT BOTH A & B WILL PASS, ETC.

RUN CONTINUOUSLY? (Y OR N) - To run the specified tests continu-
ously, enter "Y". If you only want to run through them once,
enter "N".

*** NOTE *** IF YOU ARE GOING TO RUN THE TESTS CONTINUOUSLY, YOU
SHOULD PROVIDE SOME MEANS OF EXTRA COOLING FOR THE DRIVES, SUCH AS
A MUFFIN FAN, TO PREVENT OVERHEATING OF THE POWER SUPPLIES.

TERMINATE TEST ON EXCESSIVE ERRORS? (Y OR N) - This option pro-
vides for recovery from "endless" error loops. If answered "Y"
all testing would terminate after 10 errors of any type have accumu-
lated. For example, the test would terminate after 10 seek errors
or 10 CRC errors. If this option is answered "N" testing will con-
tinue regardless of the number of errors accumulated. This option
does not affect any part of Test A or portions of Test B where
error conditions are forced or where drive components are tested--
errors in these areas are always considered fatal and cause testing
to be suspended.

OPERATOR INTERVENTION? (Y OR N) - Portions of Test A and the disk-
ette interchangeability test require that this option be answered
"Y". If this option is answered "N" the write protect and index
sensors are not completely checked out. This option will be auto-
matically disabled after the first pass of the test.

TEST DISKETTE INTERCHANGEABILITY? (Y OR N) - If the previous ques-
tion was answered NO, this question is skipped. When this question
is answered "Y" and when tests D or E have been requested, the op-
erator will be prompted to remove the diskette from the drive under
test and insert it in another drive (after writing on it) to test
drive-to-drive compatibility. This option will be automatically
disabled after the first pass of the test.

*** NOTE *** AFTER A DISKETTE HAS BEEN READ-VERIFIED IN A DIFFERENT
DRIVE, THE PROGRAM WILL PROMPT THE USER TO PUT IT BACK IN ITS
ORIGINAL DRIVE. AT THIS TIME BE SURE TO PUT ALL DISKETTES BACK IN
THEIR ORIGINAL DRIVES BEFORE CONTINUING.

TEST DESCRIPTIONS

TEST A - This test checks for proper operation of mechanical com-
ponents in the drives and tests the most basic controller functions.
The operator is prompted to open the door of the current drive and
pull out the diskette slightly. This trips the write-protect switch
and prevents detection of an index pulse. The drive should also

be sensed 'not ready' at this time. The drive is then selected;
'ready' should be sensed, as should write protect. Index should
not be sensed. If no errors so far, the operator is prompted to
put the diskette back and close the door. The drive is selected
and a Restore command is given. After executing a timing loop,
the 'busy' bit should not be active; track zero should be sensed
and the track register should contain '0'. A step-in command is
given; track 0 should be sensed again, and the track register
should indicate we are on track 1 now. A step-out command is giv-
en; track 0 should be sensed again, and the track register should
again contain '0'. A seek is made to the last track on the disk;
at the end of a timing loop, the controller should indicate the
operation is complete and the track register should have been cor-
rectly updated.

*** NOTE *** IF OPERATOR INTERVENTION WAS NOT SELECTED, WRITE
PROTECT AND INDEX PULSE SENSE ARE NOT COMPLETELY CHECKED. THE
RESTORE/STEP IN/STEP OUT SEQUENCE IS VERY IMPORTANT IN CHECKING
FOR PROPER ADJUSTMENT OF THE TRACK 0 SWITCH: IF IT IS MISALIGNED
OR DEFECTIVE IT CAN DRIVE THE DOS CRAZY!

TEST B - This test will first perform a Restore. A read-track-
address command will then be given. Upon completion of a delay
loop, 'DRQ' should be sensed. If not, either data is not being
transferred from the drive to the controller, or your diskette is
not formatted! A 'lost data' error should also have occured.
The track register is then loaded with a value not corresponding
to the track the head is actually positioned over (which is track
zero). A 'read sector' command is given which should cause a
'record not found' error. A multiple-sector I/O transfer is then
attempted. Proper operation of the 'seek' function is now tested.
Two counters are used to determine the track number -- counter A
starts at zero and increments, counter B starts at the highest
track number and decrements. The seeks are done using verification
to insure correct head positioning. This series of seeks will
result in a damped oscillation across the disk, settling at mid-
point. All possible length seeks in each direction will be per-
formed. Test B is important in checking for binding or other
problems in some drives, especially after a lot of use. The head
carriage mechanism can become so dirty that it causes the cam
follower to slip out of its groove causing the head to "get lost"
during seeks.

TEST C - This test will check the write and read commands by
writing an alternating AA/55 pattern to sector 0 of track 0. The
sector will then be read back and verified byte-by-byte to in-
sure correct data transfer from the data bus drivers to CPU.
Errors caused either by controller flags or by unexpected data
will be listed out, showing the expected and actual data in hexa-
decimal form.

TEST D - This test will perform a write/read across the entire
disk. Cross-cylinder interference (writing on one track causing
data interference on an adjacent track) is checked by writing al-
ternating tracks of ones and zeroes. Diskette interchangeability
may be checked as described under that test option. Data transfer
is done a single sector at a time with complete error checking
after each transfer.

TEST E - This test performs a write/read operation across the en-
tire disk using all possible data patterns. Diskette interchange-
ability may be checked if desired. Complete error checking is
done after each sector transfer.

TEST S - This tests the accuracy of the drive motor speed on the
first requested drive. The results are continuously monitored
and displayed on the screen. The allowable error is +/- 0.33%
from the nominal value of 300 RPM. Adjustments may be made while
the test is running. To exit this test, hold down the "ENTER"
key.

*** NOTE *** INACCURATE MOTOR SPEED IS THE MOST COMMON CAUSE OF
ERRORS DURING TESTS D & E, ESPECIALLY ON THE HIGHER (INNER) TRACKS.
ON SHUGART/RS DRIVES, THE SPEED ADJUSTMENT POT IS ON THE SMALL
CIRCUIT BOARD AT THE REAR OF THE DRIVE. DO NOT ADJUST THE POT ON
THE LARGE CIRCUIT BOARD ON THE SIDE OF THE DRIVE! YOU MAY WANT
TO LET THE TEST RUN FOR A MINUTE OR SO TO ALLOW THE SPEED TO
STABILIZE.

ERROR HANDLING

Error messages are printed out any time the diagnostic detects an
error or abnormal condition. Errors in Test A and portions of
Test B are considered fatal and will cause termination of testing.
Other errors will be reported by type, with track and sector
information printed out in hexadecimal.

TERMINATING THE TEST

The diagnostic may be terminated at any time by holding down the
"ENTER" key. An opportunity will be given to restart the test or
to boot DOS.

OWNERS OF 40-TRACK DRIVES

Radio Shack* elected to save a buck on the cost of the expansion
interface by utilizing the internal data separator circuits of the
controller chip rather than adding an external separator in spite
of the fact that Western Digital specifically warns against this.
This problem manifests itself as persistent errors on the inner
tracks. Percom manufactures a board called "The Separator" which
plugs into the EI and should cure this problem.

ERROR MESSAGES AND POSSIBLE CAUSES

*************** ERROR MESSAGE ***************	** POSSIBLE CAUSE **
DRIVE SENSED READY WHEN NOT SELECTED	K,M
WRITE PROTECT NOT SENSED	D,G,K,M,N
BUSY FLAG NOT SENSED	G,K,M
DRIVE NOT READY	K,M,N
INDEX MARK SENSED WHEN NOT EXPECTED	C,K,M,N
INDEX MARK NOT SENSED	A,C,K,M,N
WRITE PROTECT SENSED	D,G,K,M,N
CONTROLLER EXCEEDED TIME LIMIT FOR OPERATION	G,K,M
TRACK REGISTER IS NOT BEING UPDATED	G,K,M
TRACK 0 NOT SENSED CORRECTLY	B,D,E,G,K,M
DATA IS NOT BEING TRANSFERRED TO CONTROLLER	F,J,K,M
FORCED RECORD-NOT-FOUND ERROR DID NOT OCCUR	K,M
FORCED LOST DATA ERROR DID NOT OCCUR	K,M
FAILED MULTIPLE-SECTOR I/O OPERATION	F,H,K,M
DATA READ FROM DISK IS INCORRECT	K,M
RECORD NOT FOUND	F,H,I,J,K,L,M
SEEK ERROR	B,E,H,I,J,K,L,M
CRC ERROR	F,H,I,J,K,L,M
LOST DATA	F,H,I,J,K,L,M

A = DRIVE MOTOR BAD
B = STEPPER MOTOR BAD
C = INDEX MARK SENSOR BAD
D = SWITCH MISALIGNED OR BAD
E = HEAD CARRIAGE BINDING (DIRTY OR WORN)
F = HEAD LOAD PAD WORN OR MISSING
G = EXPANSION INTERFACE CLOCK BAD
H = DISKETTE DEFECTIVE OR NOT FORMATTED
I = HEAD MISALIGNED (USUALLY SHOWS UP WHEN TESTING COMPATIBILITY)
J = DRIVE WRITE/READ BOARD BAD
K = EXPANSION INTERFACE CONTROLLER/INTERFACING CIRCUITS BAD
L = DRIVE MOTOR SPEED OUT OF TOLERENCE
M = CABLES BAD OR EDGE CONNECTORS DIRTY
N = OPERATOR ERROR -- READ INSTRUCTIONS AGAIN!!

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TRS-80* MEMORY DIAGNOSTIC

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The Memory Diagnostic is a comprehensive test of the memory arrays
in the keyboard and expansion interface. After the program loads,
the screen will clear and the user will be asked to enter test
parameters as follows:

ENTER SYSTEM MEMORY SIZE? (1=16K, 2=32K, 3=48K) -- Enter the
appropriate total memory size for your system, including the ex-
pansion interface. For example, if you have 16K in the expansion
interface, your total memory size is 32K and you would enter '2'
(16K in keyboard + 16K in the interface).

PAUSE ON ERRORS? (Y OR N) -- If you want the diagnostic to pause
whenever an error occurs, enter 'Y'. This is useful whenever a
great number of errors are occuring since they will scroll off the
screen faster than you can read them. If errors are infrequent or
non-existant you may want to enter 'N'. Whenever the test pauses
after an error, you may resume the test by pressing 'Y' to retain
the pause-on-error mode. Pressing any other key will disable the
pause-on-error mode of operation.

RUN M-1 WORM TEST? (Y OR N) -- It is not recommended that you run
this test until you are sure your system will run the conventional
write/read tests without error. Because this test actually exe-
cutes machine code from the memory being tested, the results can
be somewhat unpredictable sometimes. For details on this test, see
the description which follows. Enter 'Y' to run the test, or 'N'
to suppress it.

A flashing graphics block in the upper right corner of the display
indicates that the program is running; the M-1 Worm test is indi-
cated by a 'W'. The larger the memory, the slower the test will
run. One pass of the test on a 48K machine, with the M-1 Worm
option, will take about 2 hours. At the end of each complete pass,
the total passes and the cumulative error count will be printed
out. The most desirable way to test your system for long-term
reliability is to allow it to run the diagnostic overnight as a
minimum, and longer if possible. Many manufacturers of computer
equipment run diagnostics for 72 hours straight, sometimes at
elevated temperatures.

TEST DESCRIPTIONS

The Memory Diagnostic is broken down into two basic tests, the conventional write/read test and the M-1 Worm test.

WRITE/READ TEST -- This portion of the diagnostic performs a comprehensive check on the ability of each memory location to store data. The test is broken down into 5 basic pattern tests; each of these tests runs as follows: the address under test is written into and immediately read back to insure accuracy. This continues on through the array. Then each address is re-checked to insure 1) data integrity is maintained over a period of time (refresh) and 2) accessing any particular address does not alter data in any other address. One pass of the diagnostic will have tested each address 2560 times using every possible data pattern.

M-1 WORM TEST -- This test attempts to execute a short block of machine code from the memory under test. First the entire test area is filled with X'FF'. Then a special 6-byte clock of code is written into the first 6 locations and is executed. If this works, the 6-byte block will be moved up 1 address, the byte immediately preceding the block will be changed to X'FF', and the block is executed again. This continues, moving the block up 1 address each time, until it has moved throughout memory. Some Z-80 based machines have experienced difficulties running a test such as this due to timing problems.

ERROR HANDLING

Errors are handled differently depending on whether the write/read test failed or the 'M-1 Worm' test failed.

ERRORS IN WRITE/READ TEST -- An error in this portion of the test will cause an error message to print out with the following information in hexadecimal: the error address, followed by the expected data and the actual data. The cumulative error count will be incremented once for each error that occurs. A typical error message might be as follows:

     ERROR: ADDRESS=A045 EXPECTED DATA=55 ACTUAL DATA=5D

See the section on Troubleshooting Hints for help in interpreting error messages.

ERRORS IN THE M-1 WORM TEST -- Errors in this test can be much more tricky to handle. Because we are attempting to actually execute machine code from the address under test, the results can be unpredictable if the machine attempts to execute an unexpected instruction or a non-valid one. This is the reason for filling all addresses with X'FF'; if the CPU pulls the instruction from one of these addresses rather than the 6 we are actually trying to test,

it would execute a RST 38H instruction which would turn over con-
trol to a ROM-based 'trap' routine. If this occurs, or if any
other error occurs, an error message will appear such as this:

        ***** ERROR IN M-1 WORM TEST *****
        ADDRESS OF 1st BYTE OF CODE = ZZZZ
        EXPECTED CODE AT TEST ADDRESS = 7D 55 AA C3 97 41
        ACTUAL CODE AT TEST ADDRESS   = XX XX XX XX XX XX

'ZZZZ' represents the address of the 1st byte of the 6-byte block;
'XX' would equal the actual code at the test addresses at this
time and may or may not match the expected data. If the system
fails this test but will not print out any error message (for
example, it reboots, or does something else crazy) you should try
running the write/read test alone for a long period.

TROUBLESHOOTING MEMORY PROBLEMS

It is not possible to document here every possible cause of memory
problems in the system; only the most common problems will be dis-
cussed. If the system fails the diagnostic, and you do not want
to attempt to troubleshoot it yourself, take it in for repair along
with the error information provided by the diagnostic.

*** NOTE *** IF YOU OPEN THE KEYBOARD OR THE EXPANSION INTERFACE,
             YOU VOID THE WARRANTY!!!

For the purpose of this discussion, the TRS-80* contains 3-16K
memory arrays; we will refer to each of these arrays as a 'page'.
The 3 pages of memory in the system are addressed and physically
located as follows:
        PAGE 1 - ADDRESSES X'4000' to X'7FFF' -- located in keyboard
        PAGE 2 - ADDRESSES X'8000' to X'BFFF' -- located in exp intf
        PAGE 3 - ADDRESSES X'C000' to X'FFFF' -- located in exp intf

The IC's which make up these pages and the associated data bits are:

	D7	D6	D5	D4	D3	D2	D1	D0		
PAGE 1	Z13	Z14	Z20	Z15	Z19	Z18	Z16	Z17	***	In Keyboard
PAGE 2	Z09	Z10	Z11	Z12	Z13	Z14	Z15	Z16	###	In Exp Intf
PAGE 3	Z01	Z02	Z03	Z04	Z05	Z06	Z07	Z08	###	In Exp Intf

Using the error example given previously, the error address was
X'A045', the expected data was X'55', and the actual data was
X'5D'. In this case, the error occured in page 2 of memory. The
actual data indicates that we picked up data bit 3.

DATA BITS		7	6	5	4	3	2	1	0
X'55'	=	0	1	0	1	0	1	0	1
X'5D'	=	0	1	0	1	1	1	0	1

From the charts, we can see that the memory chip for data bit 3
in Page 2 is Z13 in the expansion interface. The reference des-
ignations are silkscreened on the PC board by each socket.

*** NOTE *** MOS MEMORY CHIPS ARE VERY SENSITIVE TO STATIC ELEC-
              TRICITY AND ARE EASILY DAMAGED BY IMPROPER HANDLING!!

If this were the only bit failing, you could try swapping the
suspect IC with another one which is not failing. If the error
moves to the new location, you have probably found the bad memory
chip. If the error persists at the same location, or if you have
multiple bad bits or cannot otherwise determine any other logical
pattern to the errors occurring, you should probably take the unit
in for repair.

Keep in mind that your system may fail even though there is nothing
technically wrong with it. For example, if you are in an electri-
cally 'noisy' environment such as an office with copy machines or
other electrical equipment, the TRS-80* can pick up 'glitches'
from the AC line causing random errors. A line filter may be
helpful under these conditions.

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THE MICRO CLINIC

OWNER REGISTRATION

Please take the time to fill out and send in the registration form
below. As a service to purchasers of these diagnostics, if
something should happen to the master diskette which makes it
unreadable or otherwise damages the software, THE MICRO CLINIC will
re-copy the programs onto the diskette for a $5.00 charge for
postage and handling. THIS OFFER APPLIES ONLY TO REGISTERED
OWNERS. THE ORIGINAL MASTER DISKETTE MUST BE RETURNED TO THE MICRO
CLINIC. THIS OFFER DOES NOT APPLY TO DISKETTES WHICH HAVE BEEN
MIS-HANDLED OR DAMAGED. When returning diskettes through the mails,
please provide adequate protection such as putting the diskette
between two pieces of cardboard inside a suitable mailer.

Mail to: THE MICRO CLINIC
           17375 Brookhurst #114
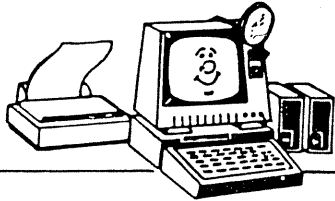   Fountain Valley, CA 92708

NAME:_____

ADDRESS:_____

CITY:_____

STATE:_____   ZIP:_____

PURCHASED FROM:_____

THE MICRO CLINIC

ADDENDUM TO INSTRUCTIONS

ENHANCEMENTS HAVE BEEN MADE TO BOTH DIAGNOSTICS WHICH ENABLE THEM TO DO AN EVEN MORE THOROUGH JOB TESTING YOUR SYSTEM. THESE CHANGES ARE REFLECTED IN VERSION 2.2 OF THE FLOPPY DOCTOR, AND VERSION 2.1 OF THE MEMORY DIAGNOSTIC.

THE FLOPPY DOCTOR - A SECOND SEEK TEST HAS BEEN ADDED TO TEST B (IN ADDITION TO THE "DAMPED OSCILLATION" TEST) WHICH MAY HELP EXPOSE MECHANICAL PROBLEMS SUCH AS EXCESSIVE WEAR, "PLAY", OR BINDING IN THE HEAD POSITIONING HARDWARE. A SERIES OF SEEKS WILL BE PERFORMED USING THE FOLLOWING PATTERN: 0 TO 2, 2 TO 1, 1 TO 3, 3 TO 2, 2 TO 4, ETC. IN THIS MANNER, EACH TRACK WILL BE APPROACHED FROM BOTH DIRECTIONS OVER A SHORT DISTANCE, WITH CORRECT HEAD POSITIONING VERIFIED EACH TIME.

TESTS D AND E HAVE BEEN ENHANCED BY ADDING A "READ REVERSE" TEST WHICH IS PERFORMED FOLLOWING THE READ IN THE "FORWARD" DIRECTION. EACH TRACK IS READ IN REVERSE ORDER; SECTORS WITHIN EACH TRACK ARE ALSO READ IN REVERSE ORDER. THIS TEST INSURES THAT EACH TRACK CAN BE READ PROPERLY WHEN APPROACHED FROM EITHER DIRECTION.

MEMORY DIAGNOSTIC - SEVERAL ENHANCEMENTS HAVE BEEN MADE TO THE MEMORY DIAGNOSTIC. THE WRITE/READ SECTION HAS BEEN COMPLETELY SEPARATED FROM THE "M-1 WORM" TEST; THE CODE FOR THIS SECTION HAS BEEN STREAMLINED CONSIDERABLY, CAUSING THE PROGRAM TO EXECUTE IN LESS TIME. ONE PASS OF THIS TEST WILL CHECK EACH ADDRESS 520 TIMES VS. 2560 IN VERSION 2.0. HOWEVER, IF THIS TEST WERE RUN FOR THE SAME LENGTH OF TIME, EACH ADDRESS WOULD BE TESTED ABOUT THE SAME NUMBER OF TIMES. AS THE TEST PROGRESSES, THE USER WILL BE KEPT INFORMED OF ITS PROGRESS AT ALL TIMES; A COUNTER ON THE SCREEN WILL INCREMENT FROM X'00' TO X'FF' AND THE DISPLAY WILL ALSO SHOW WHETHER THIS IS THE WRITE/READ OR THE VERIFY PASS. WHEN AN ERROR OCCURS, IN ADDITION TO PRINTING OUT THE ERROR ADDRESS, EXPECTED DATA, AND ACTUAL DATA, THE PROGRAM WILL PROVIDE DETAILED ERROR ANALYSIS. THE FAILING BIT (OR BITS), THE CORRESPONDING IC (OR IC'S) AND THEIR LOCATION (WHETHER IN KEYBOARD OR EXPANSION INTERFACE) ARE ALSO LISTED.

THE "M-1 WORM" TEST (WHEN SELECTED) RUNS AFTER COMPLETION OF THE WRITE/READ TEST. AS IT IS RUNNING, THE ADDRESS OF THE 1ST OF THE 6 TEST BYTES WILL BE DISPLAYED ON THE SCREEN TO KEEP THE USER INFORMED OF ITS PROGRESS THROUGH MEMORY. THE TEST WILL RUN 3 CONSECUTIVE TIMES.

A "RELOCATION TEST" HAS BEEN ADDED TO TEST LOW MEMORY WHERE THE DIAGNOSTIC ITSELF IS NORMALLY LOCATED. THE PROGRAM WILL BE RELOCATED OUT OF THE WAY TO HIGH MEMORY. LOW MEMORY IS CHECKED, AND THE PROGRAM WILL RELOCATE ITSELF BACK WHERE IT BELONGS. THIS COMPLETES A PASS OF THE DIAGNOSTIC; THE NUMBER OF PASSES AND CUMULATIVE ERRORS WILL THEN BE PRINTED OUT ON THE SCREEN.