TANDY®

Technician Series
Diagnostics Software

Preliminary

TS1288 Diagnostics Package

01-0220 Computer Technical Services

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TANDY MS-DOS DIAGNOSTICS PACKAGE

Table of Contents

SOFTWARE DIAGNOSTICS

ROM DIAGNOSTICS

APPENDIX

TROUBLESHOOTING A NON-FUNCTIONAL COMPUTER

SOFTWARE DIAGNOSTICS TABLES

ROM DIAGNOSTICS TABLES

TANDY MS-DOS DIAGNOSTICS PACKAGE

GENERAL INTRODUCTION

The diagnostics package will allow the user to test a Tandy MS-DOS computer and its expansion boards including various I/O ports such as parallel, serial, floppy, and ST-506 hard drive interfaces. The diagnostics will also test the floppy and ST-506 hard drives for proper operation.

FEATURES

* The diagnostic board provides test points for measuring power supply voltages.

* The ROM-based diagnostic software allows the testing of a computer that cannot boot from a drive.

* The diskette-based diagnostic software lets you test other I/O and drive operations.

* The LED display on the diagnostic board will display the current test in progress as well as provide a diagnostic code should the unit fail to boot fully.

COMPATIBLE SYSTEMS

Tandy 1000, 1000A, 1000SX, 1000TX, 1000SL, 1000TL and 1200HD.

Tandy 3000, 3000HD, 3000HL, 3000NL, 3000-12MHZ, 4000, 4000A, 4000LX, and 4000SX.

EQUIPMENT REQUIRED

One digital multimeter.

One single or dual trace oscilloscope rated at 35 MHZ or greater.

One non-conductive alignment tool.

One cross point screwdriver.

One flat blade screwdriver.

SUPPLIED EQUIPMENT

One TS-1288 diagnostic board.

One 34 pin parallel loopback edge connector for the Tandy 1000 line of computers (silver hood).

Two DB25 male parallel loopback connectors for the Tandy 3000/4000 line of computers (grey hood).

Two DB9 female serial loopback connectors (black hood).

Two DB25 male serial loopback connectors (black hood).

Two DB25 female serial loopback connectors (black hood).

Two special floppy analyzer diskettes in 5 1/4 inch format (labelled 'Tandy Diagnostic 3-Level Off-Track Detector') for testing of 360k drives.

One Tandy floppy diagnostics diskette in 5 1/4 inch, 360k format (labelled 'Tandy Diagnostics Disk').

One Tandy floppy diagnostics diskette in 3 1/2 inch, 720k format (labelled 'Tandy Diagnostics Disk').

One 34 pin drive extender cable.

INTRODUCTION

This diagnostics package is provided as a tool to help in troubleshooting a non-functional MS-DOS computer system. This manual explains the usage of the diagnostics and the hardware supplied with the package. Please read the manual carefully before attempting to use this package for the first time. **Due to the complexity of the advanced diagnostic tools that are supplied, damage to the computer under test or damage to the diagnostics tools may result if they are used carelessly.**

SPECIAL NOTATION USED IN THIS MANUAL

The diagnostic programs require that pertinent information and selections be input into them. In this manual when a word or letter is surrounded by <>, simply press the indicated key. For example, **<ENTER>** means to press the keyboard key labelled "ENTER", and **<X>** means to press the keyboard key labelled "X" (either upper case or lower case).

AN OVERVIEW OF THE DIAGNOSTIC SOFTWARE

The diagnostics software is a "menu driven" program. This means that to select a particular utility, you choose from a set of utilities displayed on the screen. If your selection is itself a subset of utilities, the diagnostics will display another menu, made up of more utility options.

There are two different sets of diagnostic programs supplied with this package. One set is supplied on the TS-1288 diagnostic board in ROM and the other set is supplied on floppy diskettes. The functionality of the two sets of diagnostics is similar but the menu selections differ. The ROM-based diagnostic is supplied to allow the diagnosis of a computer that is not functioning well enough to allow booting from a floppy drive. The ROM-based diagnostic does not test the hard drive/controller, serial ports, or parallel ports. The floppy-based diagnostic disk will test these items.

SETTING UP THE SYSTEM

To avoid electrical shock, make sure that all power to the computer is off. **Disconnect the power cord from the electrical source.**

Default jumper settings of the TS-1288 diagnostic board are as follows:

JPR E16 TO E17	JPR E4 TO E5	Do not adjust R1 as this is
JPR E18 TO E19	JPR E8 TO E9	the adjustment for the simulated index timing.

Follow these steps for the installation of the diagnostics board into the computer:

1 - Before removing any cables, note their location. Then when the diagnosis is complete, the cables can be properly reinstalled. Remove any external printer or serial cables.

2 - Remove the case screws and place them in a safe location as you will need them to replace the cover.

3 - Carefully slide the cover off of the unit staying clear of any cables, and set it aside in a safe location.

4 - Disconnect the power cable and **remove all unnecessary expansion boards from the unit** taking all static precautions. A static strap must be used when handling any electronic devices. The boards must be placed in antistatic bags or on a static mat.

5 - Install the TS-1288 diagnostic board into the unit and verify proper seating of the board.

6 - If the computer requires a setup program or jumpers need adjusting for any expansion boards that were removed, change them now.

The computer should now be a basic system. A video board, floppy interface, serial/parallel interface and hard disk interface should be the only boards currently installed. A hard disk interface may or may not be present as it is an expansion option. Note that some computer systems have these interfaces built directly onto the main logic board.

INITIAL DIAGNOSIS

Upon bootup, a screen describing the available power test points should appear. If the screen does not appear, go to 'Troubleshooting A Non-Functional Machine' in the appendix. The power test points on the TS-1288 diagnostic board are color coded as well as marked with their corresponding voltages.

Measure the voltages using a digital multimeter and measure the noise using an oscilloscope at these points. If the voltages or noise levels do not fall within the specifications listed below, the power supply must be adjusted. **Note that this adjustment must be done with all of the expansion options installed into the computer.** This will insure proper voltage levels when the computer system is completed. If the voltages do not fall within the specifications listed below after attempting to adjust the power supply, the power supply must be repaired or replaced.

TEST POINT	VOLTAGE RANGE	MAXIMUM NOISE
TP1	Ground	
TP2	+5.Ø to +5.2 V	5Ø mv
TP3	-5.Ø to -5.36 V	5Ø mv
TP4	+12.Ø to +13.2 V	1ØØ mv
TP5	-12.Ø to -13.2 V	15Ø mv

After verifying the proper operation of the power supply, insert the software diagnostics diskette into the drive and press <ESC>. Pressing the <ESC> key at this screen will cause the computer to attempt to boot the software diagnostics from the floppy drive if functional. **The software diagnostics diskette must be in the drive while the various tests are being performed unless prompted to remove it for floppy diagnosis.**

SOFTWARE DIAGNOSTICS

The diskette-based diagnostic is designed to test the functionality of the computer. If the diskette-based diagnostic fails to boot, then proceed to the ROM-based diagnostic to determine the failure.

Before continuing with the diagnostics, plug in the appropriate parallel and/or serial loop back connectors. Note that some machines may not have a serial port installed.

Clear Error Log

Upon bootup of the diagnostics diskette, this screen may appear. This screen will only appear if the error log that is saved to disk has errors logged into it. The configuration menu will appear if the error log is empty. Press **<ENTER>** to clear the existing error log or press **<N>** to save the error log.

Configuration Menu

Upon bootup of the diagnostic diskette, a screen with the system configuration of the computer is displayed. If the configuration is correct, press **<ENTER>** to continue to the diagnostics menu. If the configuration is not correct, press **<N>** to reconfigure the system. Note that this setup does not change the setup that is stored in CMOS RAM.

Reconfiguration of the diagnostics.

To reconfigure the setup screen, press **<N>** to allow for the selection of the item to be changed. An item can be selected in two ways. The first way is to use the up and down arrow keys to select the item. After the proper item is highlighted, press **<ENTER>** to allow the item to be changed. The second way to select an item is to press the letter corresponding to that selection. Once the item has been selected, a small window with the various possibilities for that item is displayed. Using the arrow keys, select the appropriate setting for that selection. Pressing **<ENTER>** at this time will change the selection to the setting that was chosen. Pressing **<ESC>** while the small window for the settings are displayed will abort the setting of that item. Once the configuration is correct, press **<X>** to exit the system configuration menu.

Diagnostics Menu

This screen is divided into two sections. The window on the right is the status screen. Any information about the current status of any test will be displayed here. The window on the left is the main selection window. There are four possible selections within this window.

1 - Automatic Testing.

Pressing <1> will cause the diagnostics to test the following automatically:

Main Logic
Keyboard
Video Adapter
Serial Ports
Parallel Ports
Floppy Drives
Hard Disk Drives
System Memory

To see a detailed description of the tests that the automatic selection will perform and their errors, refer to the 'Manual Testing' section below.

2 - Manual Testing.

Pressing <2> will cause the diagnostics to display a window that will allow the selection of individual tests. This menu is separated into three major windows. The upper left hand window is the test selection area. The upper right hand window displays the pass/fail status of the tests that have been executed. The lower right hand window is a display of the current configuration. The tests that are available from this screen follow:

<1> - Main Logic Board

Pressing <1> will test the following functions of the main logic board:

CPU
Numeric Data Processor (NDP) - if present
Programmable Interval Timer (PIT)
Programmable Peripheral Interface (PPI)
Programmable Interrupt Controller (PIC)
CMOS Battery
CMOS RAM

When the test starts, a graphic bar representing the percentage of the test that has been completed will be displayed. As the test progresses, the bar will fill with white from left to right.

If any failures occur during the test, an error code will be displayed on the screen after completion of the test. The error code is displayed as a four digit hexadecimal code. An example is MAIN LOGIC BOARD FAILED 161Øh. The first two digits represent the last test that was performed and the second two digits represent the error code. The chart below is the error codes and their meanings.

MAIN LOGIC BOARD FAILURE CODES

TEST	FAILURE BIT
1Ø = CPU	LSB Ø = CPU
11 = NDP	1 = NDP
12 = PIT/PPI PortB bit 5	2 = PIT/PPI PortB Bit 5
13 = PPI	3 = CMOS Battery
14 = PIC	4 = CMOS RAM
15 = CMOS-Battery	5 = PPI PortB Bits Ø-4
16 = CMOS	6 = PIC Mask Register
	MSB 7 = Not Used

To use the chart simply convert the second two digits into binary and the failure or failures will be revealed.

Using the above example of '161Øh', the '16' is the last test that was executed by the ROM, the CMOS RAM test. The '1Ø' is to be converted from hexadecimal into binary giving the result of 'ØØØ1ØØØØ'; the '1' is in bit 4 which corresponds with CMOS RAM.

Let's say that the error that occurred was '163Øh'. If we convert the '3Ø' into binary we get 'ØØ11ØØØØ'; this would mean that a multiple error has occurred. Looking at the chart we find that the CMOS RAM and the PPI port B bits Ø-4 test failed.

<2> - Keyboard

Pressing <2> will cause a picture of the keyboard layout to be displayed. As keys are pressed, the blocks depicting the keys are replaced by the name of that key. After pressing all of the keys on the keyboard, press **<ALT><SYSRQ>** for the enhanced style keyboard or **<ALT><BREAK>** for the 1000 style keyboard to exit the test. A window will appear asking if all keys functioned correctly. Press **<Y>** if no blocks are left on the screen. If any blocks are still present, the keyboard has failed and **<N>** should be pressed.

After pressing either **<Y>** or **<C>** at the prompt, the second part of the test will be displayed. This test is to see if the keyboard repeat rate works correctly. Following the instructions on the screen, the slow and fast repeat rate should be demonstrated.

After completing the test, press **<ESC>**. A window will appear asking if the repeat rate changed between the fast and slow rate. Press **<Y>** if the repeat rate changed from fast to slow when the spacebar was pressed. Press **<N>** if the repeat rate failed to change.

If either test failed, repair or replace the keyboard assembly. If the test still fails with a new keyboard, check and repair the associated circuitry on the main logic board. Note that the keyboard repeat test will not be displayed if run on a Tandy 1000.

KEYBOARD FAILURE CODES

The three possible failure codes are:

2001h = Key Press Test
2010h = Keyboard Repeat Rate
2011h = Both Key Press Test and Keyboard Repeat Rate

<3> - Video Adapter

Pressing <3> will test the following functions of the video adapter:

Character Set 8Ø Column
Character Set 4Ø Column (color only)
All Video Guns Off
All Video Guns On
Blue Gun On (color only)
Green Gun On (color only)
Red Gun On (color only)
Monochrome Attributes (monochrome only)
Attributes Without Blink (color only)
Attributes With Blink (color only)

Character Set 8Ø Column:

Will cause the diagnostics to display a screen of characters within blocks. The blocks of characters are in a matrix of 19 rows by 11 columns with a block missing in the lower right corner. Every block should have a character within it and no character should repeat. If the display is as described above, press **<Y>**. If the display has errors such as repeating characters or missing characters, press **<N>**.

Character Set 4Ø Column (color only):

Will cause the diagnostics to display a screen of characters within blocks. The blocks of characters are in a matrix of 19 rows by 11 columns with a block missing in the lower right corner. Note that the characters are larger due to being displayed in 4Ø character mode. Every block should have a character within it and no character should repeat. If the display is as described above, press **<Y>**. If the display has errors such as repeating characters or missing characters, press **<N>**. This test will not be run if the computer has a monochrome display adapter.

All Video Guns Off:

Will cause the diagnostics to display a black screen with a message asking if the entire screen is black. This test is used to see if all the video guns can be turned off. If the screen is black, press **<Y>**. If the screen is white or some color other than black, press **<N>**.

All Video Guns On:

Will cause the diagnostics to display an all gray screen with a message asking if the entire screen is gray. This test is to see if all the video guns can be turned on. If the screen is gray, press <Y>. If the screen is black or some other color than gray, press <N>. Note that in color mode this test will follow the testing of the three primary color guns.

Blue Gun On:

Will cause the diagnostics to display an all blue screen with a message asking if the entire screen is blue. This test is to see if the blue gun can be turned on. If the screen is blue, press <Y>. If the screen is black or some other color than blue, press <N>.

Green Gun On:

Will cause the diagnostics to display an all green screen with a message asking if the entire screen is green. This test is to see if the green gun can be turned on. If the screen is green, press <Y>. If the screen is black or some other color than green, press <N>.

Red Gun On:

Will cause the diagnostics to display an all red screen with a message asking if the entire screen is red. This test is to see if the red gun can be turned on. If the screen is red, press <Y>. If the screen is black or some other color than red, press <N>.

Monochrome Attributes:

Will cause the diagnostics to display a window that is split into two sections. The section on the left is a description of an attribute and the section on the right has the word 'TANDY' in the various attributes that are described in the left section. If all of the attributes are displayed as described in the left section, press <Y>. If any attribute does not match the description of that attribute, press <N>. Note that this test will run in monochrome mode only.

Attributes Without Blink:

Will cause the diagnostics to display a window that has the word 'TANDY' in various foreground and background colors. Across the top is a listing of the background colors and down the left side is a listing of the foreground colors. The word 'TANDY' should be displayed in the attribute specified by the row and column of that block. If all of the attributes are displayed as specified, press **<Y>**. If any of the foreground or background colors are wrong, press **<N>**.

Attributes With Blink:

Will cause the diagnostics to display a window that has the word 'TANDY' in various foreground and background colors. The word 'TANDY' should be blinking in all possible attributes. Across the top is a listing of the background colors and down the left side is a listing of the foreground colors. The word 'TANDY' should be displayed in the attribute specified by the row and column of that block while blinking. If all of the attributes are displayed as specified, press **<Y>**. If any of the attributes are wrong, press **<N>**.

Note that any failures that are observed must be noted by the user. The diagnostic cannot tell if the proper display is actually output. Any error noted by the user will be logged in the error table and displayed as a hexadecimal number. Using the table in the appendix, the failure will be revealed. A video board failure is usually the reason for an improper display. Replacing the video board will usually rectify the problem.

<4> Serial Port(s)

Pressing <4> will cause the diagnostic to test COM 1 and COM 2 serial ports automatically. Make sure that all loop back connectors are installed prior to running the serial port tests.

When the test starts, two graphic bars representing the percentage of the test that has been completed will be displayed. As the test progresses, the bars will fill with white from left to right. Note that some computers may not have any serial ports installed.

If a failure occurs during the test, a four digit hexadecimal number will be displayed. Using the table in the appendix, the baud rate and COM port failure will be revealed.

<5> Parallel Port(s)

Pressing <5> will cause the diagnostic to test LPT 1 and LPT 2 parallel printer ports automatically. Make sure that the loopback connector is installed prior to running the parallel port tests.

When the test starts, two graphic bars representing the percentage of the test that has been completed will be displayed. As the test progresses, the bars will fill with white from left to right.

If a failure occurs during the test, a four digit hexadecimal number will be displayed. Using the table in the appendix, the error that occurred during the test will be revealed.

<6> Floppy Drive(s)

Pressing <6> will cause the diagnostic to test the floppy drives for proper alignment and operation. The diagnostic will prompt you to remove the PROGRAM diskette and insert the test diskette into the drive(s), do this now. **Note that the analyzer diskette is a special diskette, it cannot be duplicated with normal means due to a set of tracks that are written in an analog format.**

Press **<ENTER>** to start the diagnosis of the drives or press **<ESC>** to abort the test and return to the main menu. When **<ENTER>** is pressed to start the test, two graphic bars representing the percentage of the test that has been completed will be displayed. As the test progresses, the bars will fill with white from left to right.

If any failures occur during the test, a four digit hexadecimal error will be displayed on the screen. The first two digits represent the last test performed and the last two digits represent any errors that occurred. Converting the second two digits into binary will reveal which tests failed during the diagnosis.

FLOPPY DRIVE FAILURE CODES

TEST	FAILURE BIT
6Ø = Drive A Reading	Ø-2 Drive B Test Code
61 = Drive A Seeking	3 Drive B Pass/Fail
62 = Drive A Alignment Check	4-6 Drive A Test Code
63 = Not Used	7 Drive A Pass/Fail
64 = Drive A Writing	
65 = Not Used	TEST CODE
66 = Not Used	
67 = Not Used	2/6 1/5 Ø/4 <-BIT
68 = Drive B Reading	Ø Ø Ø - Read
69 = Drive B Seeking	Ø Ø 1 - Seek
6A = Drive B Alignment Check	Ø 1 Ø - Alignment
6B = Not Used	Ø 1 1 - Not Used
6C = Drive B Writing	1 Ø Ø - Write

Bit 3 and 7 Pass=Ø Fail=1

After the test is completed, the diagnostic will prompt you to remove the analyzer diskette(s) and insert the PROGRAM diskette into drive 'A'. After removing the analyzer diskette and inserting the diagnostic diskette, press **<ENTER>** to continue.

<7> - Hard Drive(s)

Pressing <7> will cause the diagnostic to start testing all available hard drives in the system automatically. When the test starts, two graphic bars representing the percentage of the test that has been completed will be displayed. As the test progresses, the bar will fill with white from left to right. If any errors occur during the test, a four digit hexadecimal number is displayed after the test is completed.

The first two digits represent the last test performed and the last two digits represent the error code. Converting the last two digits into binary and using the table below will reveal the error.

HARD DRIVE FAILURE CODES

TEST	FAILURE BIT
7Ø = Drive C Slew Seek	Ø = Drive D Test Code
71 = Drive C Sequential Read	1-2 = Not Used
	3 = Drive D Pass/Fail
78 = Drive D Slew Seek	4 = Drive C Test Code
79 = Drive D Sequential Read	5-6 = Not Used
	7 Drive C Pass/Fail
Bit 3 and 7 Pass=Ø Fail=1	TEST CODE
	Ø = Slew Seek
	1 = Sequential Read

<8> - Memory

Pressing <8> will cause the diagnostics to test the base memory and the extended memory (if present) in the computer. A graphic bar representing the percentage of the base memory that has been tested will be displayed. As the test progresses, the bar will fill with white from left to right.

When the base memory test is completed, the extended memory test will proceed. The extended memory test will run only if there was no errors during the base memory test and extended memory is present in the computer. A second graphic bar representing the percentage of the extended memory that has been tested will be displayed. As the test progresses the bar will fill with white from left to right.

An error, if present, will be displayed as a four digit hexadecimal number. Use the chart below to determine which memory bits have errors. Once the memory bit failures have been determined, refer to the appropriate schematics for the computer being tested to determine which memory chip(s) have failed.

SYSTEM MEMORY FAILURE CODES

```
ERROR 8x     xx
       :     ||
    SEGMENT  |
    Bit Ø-3          FAILURE BIT
8E = Even Parity
8F = Odd Parity      7 6 5 4 3 2 1 Ø
8A = Video Memory    Ø Ø Ø Ø x x x x
                               : : : :
      Ø=Even Bank, 1=Odd Bank    Data bit failure Ø-7
```

EXTENDED MEMORY FAILURE CODES

```
ERROR 8x        xx
       |        ||
Meg Ram Tested  |
Bit Ø-3               FAILURE BIT

                      7 6 5 4 3 2 1 Ø
                      x x x x x x x x
                      : : : : : : : :
                      Segment :    Data bit failure Ø-7
                              :
                              :__  Ø=Even Bank 1=Odd Bank
```

Note the 3ØØØNL and 4ØØØ series computers use interleaved memory. The physical memory location may be different than the logical memory location.

As an example, let's say that we are testing a Tandy 4ØØØ with one meg of base memory and one meg of extended memory. After the memory test is completed, we get an error during the expansion memory portion of the test. The error code that was displayed is '8Ø34h'. To decode this error, use the extended memory chart.

When we break this number down and use the chart, we can determine where the memory error occurred. The '8' refers to the memory test, the 'Ø' is converted to binary and refers to the first meg of extended memory, the '3' is converted to binary and refers to the third segment of memory, and the '4' is converted to binary and refers to bit four in the even bank of the memory.

<D> - Diagnostic Board

This diagnostic will test the various control signals from the hard drive interface. The control signals will be emulated by the diagnostic board which will be read by the hard drive interface through the control cable.

At this time, remove the diagnostic diskette and turn off the machine. Disconnect the control cable from the hard drive and connect it to P2 of the diagnostic board. The control cable is the wider of the two cables going to the hard drive. Make sure that pin 1 of the control cable is connected to pin 1 of P2. Reconnect the power, turn on the computer and boot up the diagnostics diskette. Return to this menu and continue the diagnostic.

Pressing **<D>** will cause the diagnostic to display a warning message telling you to make sure that the control cable is installed onto the diagnostic board. Press **<ESC>** to abort the test or press **<ENTER>** to start the hard drive controller diagnostic. When the test starts, a small graphic bar representing the percentage of the test that has been completed will be displayed. As the test progresses, the bar will fill with white from left to right.

When the bar is three quarters full, two small graphic blocks and a message of 'please wait' will appear below the graphic bar. The graphic blocks will bounce up and down alternately, signifying that the test is active. If the blocks do not bounce up and down, this is an indication that the computer is locked up.

After the test is completed, a message will appear warning you to return the hard drive cable back to the hard drive.

Do not do this now, just press **<ENTER>** to continue. At this point the diagnostic will either pass or give an error code. If an error occurs, a four digit hexadecimal number will be displayed. The first two digits represent the test that failed and the last two digits represent the error code. The charts below are the error codes and their meanings for 3000/4000 computers and 1000 computers.

3000/4000 COMPUTER FAILURE CODES

TEST	FAILURE BIT
D1 = All Status Lines Off	0 = Seek Complete
D2 = 55h Pattern On Status Lines	1 = Track 00
D3 = AAh Pattern On Status Lines	2 = Ready
D4 = All Status Lines On	3 = Head Select 0
D6 = All Head Select Lines Off	4 = Head Select 1
D7 = 55h Pattern on Head Select Lines	5 = Head Select 2
D8 = AAh Pattern on Head Select Lines	6 = Head Select 3
D9 = All Head Select Lines On	7 = Not Used
DB = Track 00 With Restore Command	

1000 COMPUTER FAILURE CODES

TEST	FAILURE BIT
D1 = Set/Reset Seek Complete	0 = Seek Complete
D2 = Set/Reset Fault	1 = Fault
D3 = Set/Reset Ready	2 = Track 00
D6 = All Head Select Lines Off	3 = Ready
D7 = 55h Pattern on Head Select Lines	4 = Head Select 0
D8 = AAh Pattern on Head Select Lines	5 = Head Select 1
D9 = All Head Select Lines On	6 = Controller
DB = Track 00 With Restore Command	7 = Not Used
DC = Controller Self Test	

Status lines that are tested are ready, fault, and seek complete.
If Ready, Seek, and Track 00 fail, this indicates a drive timeout error.

E - Error Log Display

Pressing <E> will cause the diagnostic to display a window at the bottom half of the screen. This window is split into two sections. The upper section is the selection window and the lower section is the error count window. There are three possible selections while in the error log. Following is an explanation of their functions.

<1> - Display Detailed Errors

Pressing <1> will cause the diagnostic to display letters to the left of each test and allow the selection of one of test groups using the letters. Pressing a letter that corresponds to that test group will display a detailed list of the errors that the test has encountered. After displaying the errors of the selected test, press <ENTER> to return to the selection window.

<2> - Clear Error Counts

Pressing <2> will cause the diagnostic to clear any errors that have been logged onto the error count window as well as clearing the error log that is saved on the diskette. Note that this selection does not clear the test status window.

<3> - Return To Test Options

Pressing <3> will exit the error log display and restore the screen.

G - Group Testing

Pressing <G> will cause the lower left hand window to be replaced by a sub menu of the tests. The following are the tests that can run with group testing:

Main Logic Board
Serial Port(s)
Parallel Port(s)
Hard Drive(s)
Memory

Pressing any of the keys corresponding to that test will toggle an arrow on and off in the upper left hand window next to that test. This is selecting and deselecting the test for group testing.

Once the desired tests have been selected, press either <B> to begin testing or first press <T> to toggle continuous testing on and off. If the continuous option is used, press <ESC> to abort the test in progress. The <ESC> key will not have an immediate effect. The group test will abort after the test currently in progress when the <ESC> key was pressed is done.

R - Reconfigure System

Pressing <R> will redisplay the configuration menu to allow the user to modify the configuration of the diagnostic. Pressing <ENTER> after selecting the desired configuration will restore the test options window.

Q - Quit To DOS

Pressing <Q> will exit the diagnostics program and return the computer to the DOS prompt.

3 - Modem Test

Pressing <3> will cause the diagnostics to display a window that will allow the operation and testing of various modem types to be performed. This selection can be used as a simple terminal package to log onto remote systems as well. The BAUD rate, COM port, dial mode, and protocol can be toggled for easy configuration to suit the type of modem installed.

<C> - Channel

Pressing <C> will toggle between COM1 and COM2.

<B> - Baud Rate

Pressing <B> will toggle between 3ØØ and 12ØØ BAUD.

<P> - Protocol

Pressing <P> will toggle between Hayes and Tandy protocols.

<D> - Dial Mode

Pressing <D> will toggle between tone or pulse dialing.

<T> - Test Modem

Pressing <T> will cause the diagnostic to display a window with two selections. The two selections are:

<T> - Telephone Number

Pressing <T> will enable the phone number to be changed. After entering the desired phone number, press <ENTER> to continue.

<D> - Dial Modem

Pressing <D> will dial the number that is currently displayed. After the modem dials the number, the diagnostic will enter the terminal mode. Press <ESC> to exit terminal mode.

<S> - Save Configuration

Pressing <S> will save the current configuration of the modem test onto the diskette.

<Q> - Quit Modem Test

Pressing <Q> will exit the modem test and restore the main diagnostics menu.

ROM DIAGNOSTICS

Upon bootup, a screen describing the available power test points should appear. If the screen does not appear, go to 'Troubleshooting A Non-Functional Machine' in the appendix. The power test points on the diagnostic board are color coded as well as marked with their corresponding voltages.

Measure the voltages using a digital meter and measure the noise with an oscilloscope at these test points. If the voltages or noise levels do not fall within the specifications listed below, the power supply must be adjusted. Note that this adjustment must be done with all of the expansion boards installed into the computer. This will insure proper voltage levels when the computer system is completed. If the voltages do not fall within the specifications listed below after attempting to adjust the power supply, the power supply must be repaired or replaced.

TEST POINT	VOLTAGE RANGE	MAXIMUM NOISE
TP1	Ground	
TP2	+5.Ø to +5.2 V	5Ø mv
TP3	-5.Ø to -5.36 V	5Ø mv
TP4	+12.Ø to +13.2 V	1ØØ mv
TP5	-12.Ø to -13.2 V	15Ø mv

Pressing the **<ESC>** key at this screen will cause the computer to attempt to boot from the floppy or hard drive if installed and functional. Pressing any other key will cause the computer to display the main ROM diagnostics menu.

Main Menu

This menu will allow the selection of four tests and another chance to boot DOS. The tests are designed to test the various basic functions of the computer.

1 - Main Logic Board.

Pressing <1> will test the following functions of the main logic board:

CPU
Programmable Interval Timer (PIT)
Programmable Peripheral Interface (PPI)
Programmable Interrupt Controller (PIC)
CMOS Battery
CMOS RAM

If any failures occur during the test, an error code will be displayed on the screen. The error code is displayed as a four digit hexadecimal code. An example would be, MAIN LOGIC BOARD FAILED 164Øh. The first two digits represent the last test that was performed and the second two digits represent the error code. The following is a chart of the error codes and their meanings:

TEST	FAILURE BIT
1Ø = CPU	LSB Ø = CPU
11 = PIT Channel Ø & 1	1 = PIT Channel Ø & 1
12 = PIT 2/PPI Port B bit 5	2 = PIT 2/PPI Port B bit 5
13 = PPI Port B bits Ø-4	3 = PPI Port B bits Ø-4
14 = PIC	4 = PIC
15 = CMOS Battery	5 = CMOS Battery
16 = CMOS RAM	6 = CMOS RAM
	MSB 7 = Not Used

To use the chart simply convert the second two digits into binary and the failure or failures will be revealed.

Using the above example of '164Øh', the '16' is the last test that was executed by the ROM, the CMOS RAM test. The '4Ø' is to be converted from hexadecimal into binary giving the result of 'Ø1ØØØØØØ' which is failure bit number 6 in the chart. This corresponds with the CMOS RAM failure bit.

Let's say that the error that occurred was '1648h'. If we convert the '48' from hexadecimal into binary we get 'Ø1ØØ1ØØØ', this would mean that a multiple error has occurred. Looking at the chart we find that the CMOS RAM and the PPI port B bits Ø-4 test failed. At this point, the main logic board must be repaired or replaced.

2 - Memory.

Pressing <2> will cause a memory diagnostic menu to appear. Note that the only way to exit this menu is to reset the computer.

<1> - Test System Memory.

This test is for all Tandy MS-DOS computers except the Tandy 4000 series. Do not run this this test on a 4000 as it will not properly diagnose its memory. This test will diagnose the base memory in the computer. An error, if present, will be displayed as a four digit number in hex. Refer to the chart on page 6 for an explanation of the codes. Note that if this test is run on certain 1000 series computers, garbage may appear on the video display. This is due to the testing of shared video memory and is normal.

<2> - Test 4000 System Memory.

This test is for the Tandy 4000 series computers only. Do not run on any other computer as this may cause the computer to display garbage and lock up. The "X"s within the indicator bar denotes memory used by the diagnostic ROM.

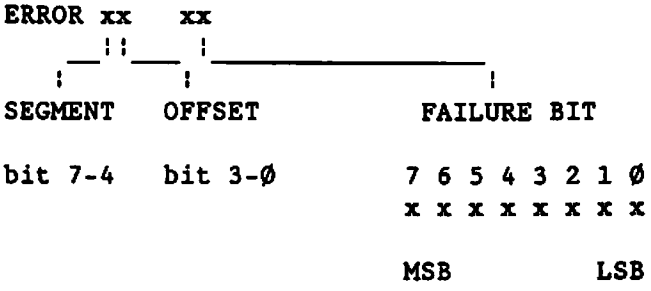
An error, if present, will be displayed as a four digit number in hex. Refer to the chart in the appendix for an explanation of the codes. This selection will not be present if the diagnostic board is installed into a 1000 series computer.

<3> - Increase System Memory.

This selection is only displayed if the computer has less than 640K RAM or if a memory miscompare has occurred. Pressing <3> will increase the amount of memory to be tested until 640K RAM is reached. When 640K RAM is reached, selection <3> will be deleted from the screen. If the diagnostic board is installed into a 1000 series computer, this selection will be displayed as selection <2>.

If any errors occur during the test, an error code will be displayed on the screen. The error code is displayed as a four digit hexadecimal code.

An example is SYSTEM MEMORY FAILED 822Øh. The first two digits represent the most significant digit of the segment and offset of the memory failure. The last two digits represent the memory bit location(s) that failed.



The first digit is the highest byte of the segment and the second digit is the highest byte of the offset location of the memory failure. The memory segment refers to a bank of memory, and the memory offset refers to a location within that bank. Note that some computers have interleaved memory or multiple segments are in a single bank of memory.

To find which bit or bits that failed, convert the second two digits from hexadecimal into binary and put them into the chart above in place of the letter "X"s noting the least significant bit to the most significant bit. Anywhere a bit is set to one is a failure of that bit.

Using the error mentioned earlier (822Øh), the '8' is the segment location, the '2' is the offset location, and the last two digits are the bit failure locations. Converting the last two digits into binary, the 2Øh, giving the result of 'ØØ1ØØØØØ'. Putting this number in place of the "X"s will reveal that bit '5' is the bad bit. Once the bad bit is determined, refer to that computer's schematic to figure out which memory chip(s) failed.

If a value of ØØh is displayed for the second two digits, a parity RAM chip has failed. If a severe failure in the lower banks of RAM occur, the computer may not boot at all. A beep code may be emitted and a two digit hex code will be displayed on the diagnostic board. Refer to the table of beep codes in the appendix.

3 - Floppy Drive(s).

Pressing <3> will cause the diagnostic to display what floppy drive(s) the computer thinks are installed. If the display is correct, press <Y> to continue with the diagnostic. If there is an error, press <N> to allow the configuration to be changed. A table of available selections will appear. Select the proper configuration from this table to allow for proper testing of the drives.

After selecting <Y> or completing the drive selection, the test will prompt you to insert the test diskette. Insert the proper analyzer diskette into the drive(s) and press <ENTER> to start the diagnosis of the drives or press <ESC> to abort the test and return to the main menu. **Note that the analyzer diskette is a special diskette, it cannot be duplicated by normal means due to a set of tracks that are written in an analog format.**

If any failures occur during the test, a four digit hexadecimal error will be displayed on the screen. The first two digits represent the last test performed and the last two digits represent any errors that occurred. Converting the second two digits from hexadecimal into binary will reveal which tests failed during the diagnosis.

FLOPPY DRIVE FAILURE CODES

TEST	FAILURE BIT
3Ø = Drive A Alignment	LSB Ø = Drive B Alignment
31 = Drive A Write/Read	1 = Drive B Write/Read
32 = Drive A Slew Read	2 = Drive B Slew Read
33 = Drive B Alignment	3 = Drive B WP/CTRLR/DMA
34 = Drive B Write/Read	4 = Drive A Alignment
35 = Drive B Slew Read	5 = Drive A Write/Read
	6 = Drive A Slew Read
	MSB 7 = Drive A WP/CTRLR/DMA

As an example, when the floppy drive test is run we get an error code of '34Ø2h'. Converting the second two digits from hexadecimal into binary we get 'ØØØØØØ1Ø'. Looking at the above chart we see that the '34' corresponds to 'Drive B Write/Read' and the 'Ø2' confirms the failure.

4 - Floppy Test Fixture

At this time, turn off the computer and remove all power. Disconnect the floppy drive interface cable from the floppy drive. Connect the floppy cable using the connector that is for the 'B' drive to connector P2 of the diagnostic board. Make sure pin 1 of the cable is connected to pin 1 of P2. Reconnect the power and turn on the computer.

This test will diagnose the various control signals from the floppy controller. Pressing <4> will enter the floppy controller diagnostic. A last notice to connect the floppy cable to the diagnostic board will be displayed. If the cable is not connected, power down the computer and install it at this time. If everything is in proper order, press **<ENTER>** to execute the test or press **<ESC>** to abort the test and return to the main menu. If an error occurs during the test, a four digit hexadecimal number will be displayed. The following is a chart of the error codes and their meanings:

TEST	FAILURE BIT
41 = WP=Ø TK=Ø DC=Ø HD=Ø	LSB Ø = Write Protect
42 = WP=Ø TK=1 DC=Ø HD=1	1 = Track Zero
43 = WP=1 TK=Ø DC=1 HD=Ø	2 = Disk Change
44 = WP=1 TK=1 DC=1 HD=1	3 = Side
45 = Direction Line With Seek	4 = Direction
4Ø = Timeout Error	MSB 5 = Command Timeout
	6 = Not Used
	7 = Not Used
	8 = Not Used

WP=Write Protect TK=Track ØØ DC=Disk Change HD=Head

To use the chart, convert the second two digits from hexadecimal into binary to determine which error bits have been set. Note that disk change is not tested on some of the computers.

Power down the computer at this time and remove the floppy drive cable from the diagnostic board and reinstall it onto the floppy drive. Make sure that the cable is installed correctly. If the cable is installed wrong, the drive light will stay on continuously and any disk that is inserted into the drive will be erased. Retest the floppy drive with the floppy drive diagnostic.

5 - Continue DOS Boot.

Pressing <5> will cause the computer to exit the diagnostic and attempt to boot from the floppy or from the hard drive if installed. Insert the diagnostic disk into the drive at this time to continue with the diagnosis of the computer.

APPENDIX

TROUBLESHOOTING A NON-FUNCTIONAL COMPUTER

The following information is designed to help in the troubleshooting of a computer that does not display anything on the screen. The information is divided into two sections. The first section describes possible fixes to repair a computer that does nothing, i.e. no video or beep codes. The second section describes possible fixes for a computer that has no video but does try to do something, i.e. no video but beeps.

Dead computer with no visible activity.

Symptom: Computer does nothing when turned on. The cooling fan does not spin and the video monitor stays white (if RGB color).

Fix 1: Check for 11ØVAC on the input to the power supply. Check the power supply switch and pertinent wiring. Check any primary fuses or filtering circuits (EMI filters). Is 11ØVAC reaching the power supply? Repair the open connection or replace the bad part.

Fix 2: After verifying that 11ØVAC is reaching the power supply inputs, check the various outputs of the supply. Using the connector to the main logic board, test for +5VDC. If there is no activity from the power supply, remove all excess expansion boards and all drive power connectors. Note that some power supplies may need a load resistor to function correctly with a minimal load.

If the computer powers up, test each individual drive and expansion board for shorts between power and ground. If the computer does not power up, check the main logic board for shorts between the various power connections and ground. Repair or replace the bad assembly when identified. Note that the fan may spin even though the power supply is dead in some computers because the fan is supplied power from the 11ØVAC source.

Symptom: The computer does not display anything on the screen and no beep codes occur. The fan does spin and the video monitor goes black (if RGB color).

FIX 1: Check the +5V going to the main logic board and verify that it is within specifications (+5.Ø to +5.2VDC, 5Ømv noise). Check the power good signal, if present, for a TTL logic high (+3.Ø to +5.2VDC). Check the power supply for proper voltage setting (11Ø/22ØVAC). Repair or replace the power supply if the +5V source or power good signal is faulty. If this does not repair the unit, the main logic board must be repaired or replaced.

Dead computer but emitting beep code:

To determine the meaning of the beep codes refer to the chart on the following page. Note that some computers do not have beep codes.

Refering to the beep code chart on the following page and the two digit error code in hexadecimal on the diagnostic board, the failure may be determined. The two digit hexadecimal number is a representation of the last test performed by the computer upon bootup. This number can be used to double check the beep code. Repair or replace the assembly that is indicated by the error codes.

TANDY 3000/4000 BEEP CODES

DIAG BOARD OUTPUT	BEEP CODES	DESCRIPTION OF TEST OR FAILURE
01h	none	80286/80386 register test in progress or failure
02h	1-1-3	CMOS write/read test in progress or failure
03h	1-1-4	BIOS ROM checksum in progress or failure
04h	1-2-1	Programmable Interval Timer test in progress or failure
05h	1-2-2	DMA initialization in progress or failure
06h	1-2-3	DMA page register write/read test in progress or failure
08h	1-3-1	RAM refresh verification in progress or failure
09h	none	1st 64K RAM test in progress
0Ah	1-3-3	1st 64K RAM segment or data line failure, multi-bit
0Bh	1-3-4	1st 64K RAM odd/even logic failure
0Ch	1-4-1	1st 64K RAM address line failure
0Dh	1-4-2	1st 64K parity failure
10h	2-1-1	1st 64K RAM segment or data line failure, bit 0
11h	2-1-2	1st 64K RAM segment or data line failure, bit 1
12h	2-1-3	1st 64K RAM segment or data line failure, bit 2
13h	2-1-4	1st 64K RAM segment or data line failure, bit 3
14h	2-2-1	1st 64K RAM segment or data line failure, bit 4
15h	2-2-2	1st 64K RAM segment or data line failure, bit 5
16h	2-2-3	1st 64K RAM segment or data line failure, bit 6
17h	2-2-4	1st 64K RAM segment or data line failure, bit 7
18h	2-3-1	1st 64K RAM segment or data line failure, bit 8
19h	2-3-2	1st 64K RAM segment or data line failure, bit 9
1Ah	2-3-3	1st 64K RAM segment or data line failure, bit A
1Bh	2-3-4	1st 64K RAM segment or data line failure, bit B
1Ch	2-4-1	1st 64K RAM segment or data line failure, bit C
1Dh	2-4-2	1st 64K RAM segment or data line failure, bit D
1Eh	2-4-3	1st 64K RAM segment or data line failure, bit E
1Fh	2-4-4	1st 64K RAM segment or data line failure, bit F
20h	3-1-1	slave DMA register test in progress or failure
21h	3-1-2	master DMA register test in progress or failure
22h	3-1-3	master interrupt mask register test in progress or failure
23h	3-1-4	slave interrupt mast register test in progress or failure
25h	none	interrupt vector loading in progress
27h	3-2-4	keyboard controller test in progress or failure
28h	none	CMOS power-fail and checksum checks in progress or failure
29h	none	CMOS configuration information validation in progress
2Bh	3-3-4	screen memory test in progress or failure
2Ch	3-4-1	screen initialization in progress or failure
2Dh	3-4-2	screen retraces tests in progress or failure
2Eh	none	search for video ROM in progress
30h	none	screen believed operable

BEEP CODES FOR THE 4000 ONLY

31h	none	monochrome screen believed operable
32h	none	40 column color screen believed operable
33h	none	80 column color screen believed operable

SOFTWARE DIAGNOSTICS TABLES

Main Logic Board:

TEST	FAILURE BIT
1Ø = CPU	LSB Ø = CPU
11 = NDP	1 = NDP
12 = PIT/PPI PortB bit 5	2 = PIT/PPI PortB Bit 5
13 = PPI	3 = CMOS Battery
14 = PIC	4 = CMOS
15 = CMOS-Battery	5 = PPI PortB Bits Ø-4
16 = CMOS	6 = PIC Mask Register
	MSB 7 = Not Used

Keyboard:

2ØØ1h = Key Press Test
2Ø1Øh = Keyboard Repeat Rate
2Ø11h = Both Key Press Test and Keyboard Repeat Rate

Video:

TEST	FAILURE BIT
3Ø = Character Set - 8Ø	LSB Ø = Character Set - 8Ø
31 = Character Set - 4Ø	1 = Character Set - 4Ø (Color Only)
32 = Full Black Screen	2 = All Guns Off/On (Black/Gray)
33 = Full Blue Screen	3 = Blue Gun On (Color Only)
34 = Full Green Screen	4 = Green Gun On (Color Only)
35 = Full Red Screen	5 = Red Gun On (Color Only)
36 = Full Gray	6 = Attributes Without Blink / Mono
37 = Attributes Without Blink	7 = Attributes With Blink (Color Only)
38 = Attributes With Blink	

Serial Ports:

TEST			FAILURE BIT	
4Ø = COM1 at 11Ø Baud	48 = COM2 at 11Ø Baud		Ø-2 = COM2 Baud Rate	
41 = COM1 at 15Ø Baud	49 = COM2 at 15Ø Baud		3 = COM2 Pass/Fail	
42 = COM1 at 3ØØ Baud	4A = COM2 at 3ØØ Baud		4-6 = COM1 Baud Rate	
43 = COM1 at 6ØØ Baud	4B = COM2 at 6ØØ Baud		7 = COM1 Pass/Fail	
44 = COM1 at 12ØØ Baud	4C = COM2 at 12ØØ Baud			
45 = COM1 at 24ØØ Baud	4D = COM2 at 24ØØ Baud		BIT 3 & 7	Ø = Pass
46 = COM1 at 48ØØ Baud	4E = COM2 at 48ØØ Baud			1 = Fail
47 = COM1 at 96ØØ Baud	4F = COM2 at 96ØØ Baud			

		BAUD RATE						
COM1	11Ø	15Ø	3ØØ	6ØØ	12ØØ	24ØØ	48ØØ	96ØØ
6	Ø	Ø	Ø	Ø	1	1	1	1
BIT 4-6 5	Ø	Ø	1	1	Ø	Ø	1	1
4	Ø	1	Ø	1	Ø	1	Ø	1

		BAUD RATE						
COM2	11Ø	15Ø	3ØØ	6ØØ	12ØØ	24ØØ	48ØØ	96ØØ
Ø	Ø	Ø	Ø	Ø	1	1	1	1
BIT Ø-2 1	Ø	Ø	1	1	Ø	Ø	1	1
2	Ø	1	Ø	1	Ø	1	Ø	1

Parallel Ports:

TEST		ERROR BIT	TEST CODE	
5Ø = LPT1	58 = LPT2	Ø-1 = LPT2 Test Code	1/5 Ø/4 <-BITS	
51 = LPT1	59 = LPT2	2 = Not Used	Ø	Ø = Control Signals
52 = LPT1	5A = LPT2	3 = LPT2 Pass/Fail	Ø	1 = Internal Data
53 = LPT1	5B = LPT2	4-5 = LPT1 Test Code	1	Ø = Data 7 Loop
54 = LPT1	5C = LPT2	6 = Not Used		
		7 = LPT2 Pass/Fail	BIT 3 & 7	Ø = Pass
				1 = Fail

Floppy Drives:

TEST	FAILURE BIT
6Ø = Drive A Reading	Ø-2 Drive B Test Code
61 = Drive A Seeking	3 Drive B Pass/Fail
62 = Drive A Alignment Check	4-6 Drive A Test Code
63 = Not Used	7 Drive A Pass/Fail
64 = Drive A Writing	
65 = Not Used	TEST CODE
66 = Not Used	
67 = Not Used	2/6 1/5 Ø/4 <-BITS
68 = Drive B Reading	Ø Ø Ø - Read
69 = Drive B Seeking	Ø Ø 1 - Seek
6A = Drive B Alignment Check	Ø 1 Ø - Alignment
6B = Not Used	Ø 1 1 - Not Used
6C = Drive B Writing	1 Ø Ø - Write

Bit 3 and 7 Pass=Ø Fail=1

Hard Drives:

TEST	FAILURE BIT
7Ø = Drive C Slew Seek	Ø = Drive D Test Code
71 = Drive C Sequential Read	1-2 = Not Used
	3 = Drive D Pass/Fail
78 = Drive D Slew Seek	4 = Drive C Test Code
79 = Drive D Sequential Read	5-6 = Not Used
	7 = Drive C Pass/Fail
Bit 3 and 7 Pass=Ø Fail=1	TEST CODE
	Ø = Slew Seek
	1 = Sequential Read

Hard Drive Controller For 3ØØØ/4ØØØ Computers:

TEST	FAILURE BIT
D1 = All Status Lines Off	Ø = Seek Complete
D2 = 55h Pattern On Status Lines	1 = Track ØØ
D3 = AAh Pattern On Status Lines	2 = Ready
D4 = All Status Lines On	3 = Head Select Ø
D6 = All Head Select Lines Off	4 = Head Select 1
D7 = 55h Pattern on Head Select Lines	5 = Head Select 2
D8 = AAh Pattern on Head Select Lines	6 = Head Select 3
D9 = All Head Select Lines On	7 = Not used
DB = Track ØØ With Restore Command	

Status lines that are tested are ready, fault, and seek complete.

If both Track ØØ and Ready fail, this indicates a drive timeout.

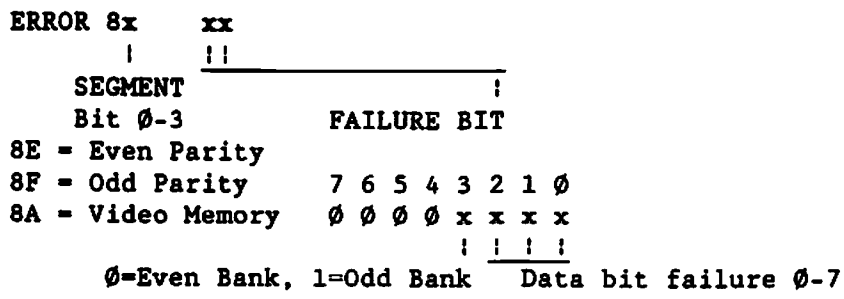
Hard Drive Controller For 1ØØØ Computers:

TEST	FAILURE BIT
D1 = Set/Reset Seek Complete	Ø = Seek Complete
D2 = Set/Reset Fault	1 = Fault
D3 = Set/Reset Ready	2 = Track ØØ
D6 = All Head Select Lines Off	3 = Ready
D7 = 55h Pattern on Head Select Lines	4 = Head Select Ø
D8 = AAh Pattern on Head Select Lines	5 = Head Select 1
D9 = All Head Select Lines On	6 = Controller
DB = Track ØØ With Restore Command	7 = Not Used
DC = Controller Self Test	

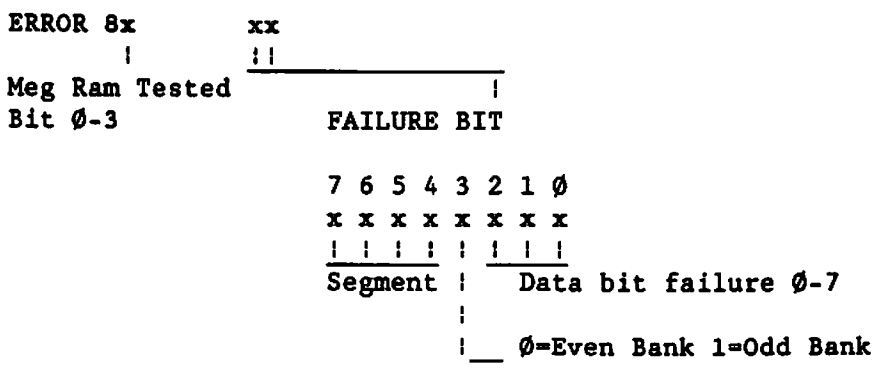
Status lines that are tested are ready, fault, and seek complete.

If Ready, Seek, and Track ØØ fail, this indicates a drive timeout.

System Memory Failure Codes:



Extended Memory Failure Codes:



ROM DIAGNOSTICS TABLES

Main Logic Board:

TEST	FAILURE BIT
1Ø = CPU	LSB Ø = CPU
11 = PIT Channel Ø & 1	1 = PIT Channel Ø & 1
12 = PIT 2/PPI Port B bit 5	2 = PIT 2/PPI Port B bit 5
13 = PPI Port B bits Ø-4	3 = PPI Port B bits Ø-4
14 = PIC	4 = PIC
15 = CMOS Battery	5 = CMOS Battery
16 = CMOS RAM	6 = CMOS RAM
	MSB 7 = Not Used

Memory:

ERROR xx xx

SEGMENT	OFFSET	FAILURE BIT
bit 7-4	bit 3-Ø	7 6 5 4 3 2 1 Ø
		x x x x x x x x
		MSB LSB

Floppy Drives:

TEST	FAILURE BIT
3Ø = Drive A Alignment	LSB Ø = Drive B Alignment
31 = Drive A Write/Read	1 = Drive B Write/Read
32 = Drive A Slew Read	2 = Drive B Slew Read
33 = Drive B Alignment	3 = Drive B WP/CTRLR/DMA
34 = Drive B Write/Read	4 = Drive A Alignment
35 = Drive B Slew Read	5 = Drive A Write/Read
	6 = Drive A Slew Read
	MSB 7 = Drive A WP/CTRLR/DMA

Floppy Drive Controller:

TEST	FAILURE BIT	
41 = WP=Ø TK=Ø DC=Ø HD=Ø	LSB Ø = Write Protect	BIT 6 & 7
42 = WP=Ø TK=1 DC=Ø HD=1	1 = Track Zero	Not Used
43 = WP=1 TK=Ø DC=1 HD=Ø	2 = Disk Change	
44 = WP=1 TK=1 DC=1 HD=1	3 = Side	
45 = Direction Line With Seek	4 = Direction	
4Ø = Timeout Error	MSB 5 = Command Timeout	

WP=Write Protect TK=Track ØØ DC=Disk Change HD=Head

HARD DRIVE TABLE

Size	Brand	Cylinders	Heads	Sectors	Physical Size
10 meg	Tandon TM502	- 306	4	17	5 1/4" full height
10 meg	Tandon TM252	- 306	4	17	5 1/4" half height
15 meg	Tandon TM503	- 306	6	17	5 1/4" full height
35 meg	Quantum Q540	- 512	8	17	5 1/4" full height
40 meg	CDC 94205-51	- 989	5	17	5 1/4" half height
20 meg	Fuji FK302-26	- 612	4	17	3 1/2" half height
20 meg	Miniscribe	- 615	4	17	3 1/2" half height
20 meg	Tandon TM362	- 615	4	17	3 1/2" half height
40 meg	Seagate ST157R	- 522	6	26	3 1/2" half height
20 meg	Seagate ST225	- 615	4	17	5 1/4" half height
40 meg	Seagate ST251	- 820	6	17	5 1/4" half height
20 meg	Mitsubishi MR522	- 615	4	17	5 1/4" half height
40 meg	CDC WREN II	- 989	5	17	5 1/4" half height
40 meg	Microscience	- 1024	5	17	5 1/4" half height
70 meg	Micropolis 1325	- 1024	8	17	5 1/4" full height
70 meg	Rodime 5090	- 1224	7	17	5 1/4" half height
40 meg	Rodime 3055	- 872	6	17	3 1/2" half height

DRIVE TYPE TABLE

TYPE	CYLINDERS	HEADS	PRECOMP	TYPE	CYLINDERS	HEADS	PRECOMP
1	306	4	128	19	1024	7	512
2	615	4	300	20	733	5	300
3	615	6	300	21	733	7	300
4	940	8	512	22	733	5	300
5	940	6	512	23	306	4	0
6	615	4	-1	25	615	4	0
7	462	8	256	26	1024	4	-1
8	733	5	-1	27	1024	5	-1
9	900	15	-1	28	1024	8	-1
10	820	3	-1	29	512	8	256
11	855	5	-1	35	1023	9	-1
12	855	7	-1	36	512	8	256
13	306	8	128	37	989	5	128
14	733	7	-1	38	1024	5	1024
16	612	4	0	39	820	6	820
17	977	5	300	40	1024	8	1024
18	977	7	-1	41	306	6	153

HEXADECIMAL/BINARY/DECIMAL CHART

LOW NIBBLE			HIGH NIBBLE		
HEX	BINARY	DECIMAL	HEX	BINARY	DECIMAL
Ø Ø	ØØØØ ØØØØ	Ø	Ø Ø	ØØØØ ØØØØ	Ø
Ø 1	ØØØØ ØØØ1	1	1 Ø	ØØØ1 ØØØØ	16
Ø 2	ØØØØ ØØ1Ø	2	2 Ø	ØØ1Ø ØØØØ	32
Ø 3	ØØØØ ØØ11	3	3 Ø	ØØ11 ØØØØ	48
Ø 4	ØØØØ Ø1ØØ	4	4 Ø	Ø1ØØ ØØØØ	64
Ø 5	ØØØØ Ø1Ø1	5	5 Ø	Ø1Ø1 ØØØØ	8Ø
Ø 6	ØØØØ Ø11Ø	6	6 Ø	Ø11Ø ØØØØ	96
Ø 7	ØØØØ Ø111	7	7 Ø	Ø111 ØØØØ	112
Ø 8	ØØØØ 1ØØØ	8	8 Ø	1ØØØ ØØØØ	128
Ø 9	ØØØØ 1ØØ1	9	9 Ø	1ØØ1 ØØØØ	144
Ø A	ØØØØ 1Ø1Ø	1Ø	A Ø	1Ø1Ø ØØØØ	16Ø
Ø B	ØØØØ 1Ø11	11	B Ø	1Ø11 ØØØØ	176
Ø C	ØØØØ 11ØØ	12	C Ø	11ØØ ØØØØ	192
Ø D	ØØØØ 11Ø1	13	D Ø	11Ø1 ØØØØ	2Ø8
Ø E	ØØØØ 111Ø	14	E Ø	111Ø ØØØØ	224
Ø F	ØØØØ 1111	15	F Ø	1111 ØØØØ	24Ø

To use the chart to convert from hexadecimal to binary, first split the high nibble and the low nibble, then convert each nibble using the chart above. Using an example of C7h, the 'C' is the high nibble and the '7' is the low nibble. Consulting the chart, we find that the 'C' is 11ØØ ØØØØ in binary and 192 in decimal, the '7' is ØØØØ Ø111 in binary and 7 in decimal. Adding the two digits gives the result of 11ØØ Ø111 in binary and 199 in decimal. The addition is (11ØØ ØØØØ + ØØØØ Ø111) for binary and (192 + 7) for decimal.

Binary Definitions:

Bit - A bit is a single digit in binary. A bit is either a 'Ø' or a '1'.

Nibble - A nibble is a binary number consisting of four bits. An example of a nibble is 'Ø1Ø1'.

Byte - A byte is a binary number consisting of eight bits or two nibbles. An example of a byte is '1ØØ1Ø1Ø1'.

Word - A word is a binary number consisting of sixteen bits or two bytes or four nibbles. An example of a word is '1Ø11ØØØ1ØØØØ1Ø1Ø'.

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