Diagnostics

DIAGNOSTICS MANUAL

Specifications Subject to Change.

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This manual is one of a set that documents the Convergent™ Family of Information Processing Systems. The set can be grouped as follows:

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This section outlines the contents of these manuals.

INTRODUCTORY

The Installation Guide describes the procedure for unpacking, cabling, and powering up a system.

The Operator's Guide addresses the needs of the average user for operating instructions. It describes the workstation switches and controls, keyboard function, and floppy disk handling.

The Executive Manual describes the command interpreter, the program that first interacts with the user when the system is turned on. It specifies commands for managing files and

invoking other programs such as the Editor and the programming language compilers.

The NGEN Installation Guide describes the procedure for unpacking, assembling, cabling, and powering up an NGEN workstation.

The NGEN Operator's Guide is a link between you, the NGEN workstation, and the workstation's documentation. The Operator's Guide describes the operator controls and the use of the floppy disk drives, as well as how to verify that the workstation is operational and how to use software release notices.

HARDWARE

NGEN

The Processor Manual: Model CP-001 describes the Processor Module, which houses the CPU board, Memory board, I/O board, Video/Keyboard board, and Motherboard. It details the architecture and theory of operations of the printed circuit boards, external interfaces, and the Memory Expansion Cartridge, as well as the X-Bus specifications.

The Dual Floppy Disk Manual and the Floppy/Hard Disk Manual describe the architecture and theory of operation for the NGEN modules. They discuss the respective disk drives, the controller, and contain the applicable OEM disk drive manuals.

The Diagnostics Manual describes the diagnostics available for the NGEN workstation. It discusses the Processor Module's bootstrap ROM program and error codes, and individual software diagnostics for modules in the workstation.

The Keyboard Manual describes the theory of operation for the NGEN keyboard.

The Power System Manual describes the operation and connections for the 36-Volt Power Supply Module and the dc/dc converters used with the NGEN workstation.

The Monochrome Monitor Manual: Model VM-001 describes the operation and connections of the 12-inch Monochrome Monitor Module used with the NGEN workstation.

The Color Monitor Manual describes the operation and connections of the 15-inch Color Monitor Module used with the NGEN workstation.

IWS

The Workstation Hardware Manual describes the mainframe, keyboard, and video display for the IWS family of workstations. It specifies system architecture, printed circuit boards (Motherboard, Processor, I/O-Memory, Multiline Communications Processor, Video Control, Graphics Control Board, ROM and RAM Expansions), keyboard, video monitor, Multibus interface, communications interfaces, power supply, and environmental characteristics of the workstation.

The Peripherals Hardware Manual describes the non-SMD single-board Mass Storage Subsystem (MSS) and Mass Storage Expansion (MSX) disk subsystems for the IWS family of workstations. It contains descriptions of the disk controller Motherboard, the two controller boards for floppy and Winchester disks, power supplies, disk drives, and environmental characteristics.

The IWS Peripherals Hardware Manual (SMD Version) describes the SMD MSS and MSX disk subsystems having one controller board.

AWS

The AWS-210 Hardware Manual describes the mainframe, keyboard, and video display of the AWS-210 workstation. It specifies architecture, theory of operation of the printed circuit boards (Motherboard, Deflection, and CPU), keyboard, video monitor, expansion interface, cluster communications interface, power supply, and environmental characteristics of the workstation.

The AWS-220, -230, -240 Hardware Manual describes the mainframe, keyboard, disk controllers, and video display of the AWS-220, -230, and -240 workstations. It specifies architecture, theory of operation of the printed circuit boards (Motherboard, Deflection, 8088 CPU, 8086 CPU, Floppy Disk Controller, and Hard Disk Controller), keyboard, video monitor, cluster communications interface, external interfaces, power supply, and environmental characteristics of the workstation.

The AWS Color Workstation Hardware Manual describes the mainframe, keyboard, and color video display of the AWS Color Workstation. This manual reports the architecture and theory of operation of the printed circuit boards (Motherboard, Graphics Control Board, Hard Disk Controller, Color Video, Color Deflection, and CPU), keyboard, color monitor, peripheral interfaces, cluster communications interface, power supply, and environmental characteristics of the workstation. This manual also contains four OEM disk drive manuals and a summary of adjustments for the color monitor.

OPERATING SYSTEM

The CTOS™ Operating System Manual describes the Operating System. It specifies services for managing processes, messages, memory, exchanges, tasks, video, disk, keyboard, printer, timer, communications, and files. In particular, it specifies the standard file access methods: SAM, the sequential access method; RSAM, the record sequential access method; and DAM, the direct access method.

The System Programmer's Guide addresses the needs of the system programmer or system manager for detailed information on Operating System structure and system operation. It describes (1) cluster architecture and operation, (2) procedures for building a customized Operating System, and (3) diagnostics.

The System Utilities Manual describes utilities such as Backup Volume, IVolume, Restore, Change Volume Name, PLog, Maintain File, Dump.

The Batch Manual describes the batch manager, which executes batch jobs under control of job control language (JCL) files.

GUEST OPERATING SYSTEMS

The CP/M-86 and MS-DOS Manuals describe the single-user operating systems originally designed for the 8086-based personal computer systems.

The XENIX Manuals describe the 16-bit adaptation of the UNIX system, including the XENIX environment for software development and text processing.

PROGRAMMING LANGUAGES

The COBOL, FORTRAN, FORTRAN-86, BASIC (Interpreter), BASIC Compiler, PASCAL, and Assembly Language Manuals describe the system's programming languages. Each manual specifies both the language itself and also operating instructions for that language.

The Pascal Manual is supplemented by a popular text, Pascal User Manual and Report.

The Assembly Language Manual is supplemented by a text, the Central Processing Unit, which describes the main processor, the 8086. It specifies the machine architecture, instruction set, and programming at the symbolic instruction level.

PROGRAM DEVELOPMENT TOOLS

The COBOL Animator describes the COBOL Animator, a debugger that allows the user to interact directly with the COBOL source code during program execution.

The Editor Manual describes the text editor.

The Debugger Manual describes the Debugger, which is designed for use at the symbolic instruction level. Together with appropriate interlistings, it can be used for debugging FORTRAN, Pascal, and assembly language programs. (COBOL and BASIC, in contrast, are more conveniently debugged using special facilities described in their respective manuals.)

The Linker/Librarian Manual describes the Linker, which links together separately compiled object files, and the Librarian, which builds and manages libraries of object modules.

DATA MANAGEMENT FACILITIES

The CT-DBMS™ Manual describes Convergent's data base management system (CT-DBMS), which consists of (1) a data manipulation language for accessing and manipulating the data base and (2) utilities for administering the data base activities such as maintenance, backup and recovery, and status reporting.

The ISAM Manual describes both the single- and the multiuser indexed sequential access method. It specifies the procedural interfaces (and how to call them from various languages) and the utilities.

The Forms Manual describes the Forms facility that includes (1) the Forms Editor, which is used to interactively design and edit forms, and (2) the Forms run time, which is called from an application program to display forms and accept user input.

The Sort/Merge Manual describes (1) the Sort and Merge utilities that run as a subsystem invoked at the Executive command level, and (2) the Sort/Merge object modules that can be called from an application program.

TEXT MANAGEMENT FACILITIES

The Word Processing User's Guide introduces the Word Processor to the first-time user. It provides step-by-step lessons that describe basic word processing operations. The lessons show how to execute operations and apply them to sample text.

The Word Processing Reference Manual is a reference tool for users already familiar with the Word Processor. It describes the Word Processor keyboard and screen; basic, advanced, and programmer-specific operations; list processing; printer and print wheel configurations; and hardware considerations.

The Word Processing Quick Reference provides a concise summary of all word processing operations and briefly describes the keyboard and commands.

APPLICATIONS FACILITIES

The Project Scheduler schedules and analyzes tasks, milestones, and the allocation of resources in a project. By means of diagrams and several kinds of bar charts, Project Scheduler presents time and resource allocation results and shows the occurrence of project milestones. The Project Scheduler Manual explains the use of the program and also serves as a reference once the user is familiar with it.

The CT-MAIL™ User's Reference Manual introduces the first-time user to the CT-MAIL electronic mail system. It provides step-by-step instructions for using the basic CT-MAIL operations to create, send, and receive mail.

The CT-MAIL™ Administrator's Reference Manual provides the System Administrator with instructions for installing, configuring, and maintaining the CT-MAIL electronic mail system; setting up communication lines; creating and maintaining mail centers; adding mail users; creating distribution lists; and troubleshooting.

Multiplan is a financial modeling package designed for business planning, analysis, budgeting, and forecasting.

The Business Graphics User's Guide introduces Business Graphics to the first-time user. It provides step-by-step lessons that describe basic Business Graphics operations. The lessons show how to execute operations and apply them to sample charts.

The Business Graphics Reference Manual is a reference tool for users already familiar with Business Graphics. It describes the Business Graphics keyboard and screen; box and arrow cursor movement; obtaining information from Multiplan; operations; and plotter configurations.

The Graphics Programmer's Guide is a reference for applications and systems programmers. It describes the graphics library procedures that can be called from application systems to generate graphic representations of data, and it includes a section on accessing Business Graphics from an application system.

The Font Designer Manual describes the interactive utility for designing new fonts (character sets) for the video display.

COMMUNICATIONS

The Asynchronous Terminal Emulator Manual describes the asynchronous terminal emulator.

The 3270 Terminal Emulator Manual describes the 3270 emulator package.

The 2780/3780 RJE Terminal Emulator Manual describes the 2780/3780 emulator package.

The SNA Network Gateway Manual describes the SNA Network Gateway, which supports data communications over an SNA network. The SNA Network Gateway comprises the Transport Service and Status Monitor. The Transport Service allows a Convergent workstation to function as cluster controller and forms the foundation for Convergent SNA products.

The SNA 3270 Emulator Manual describes the SNA 3270 emulator package. The SNA 3270 emulator provides CRT and printer subsystems in addition to a Virtual Terminal Interface for use in application programs.

The X.25 Network Gateway Manual describes the X.25 Network Gateway, which supports CCITT Recommendation X.25 communications over a public data network. There are three levels of access to the network: packet, X.25 sequential access method, and the Multimode Terminal Emulator X.25 communications option.

The Multimode Terminal Emulator User's Guide introduces the Multimode Terminal Emulator to the first-time user. It describes the MTE video display, keyboard, display memory, and advanced operations for the X.25 communications option.

The Multimode Terminal Emulator Reference Manual is a reference tool for sophisticated users of the Multimode Terminal Emulator. It describes the MTE escape sequences and field verification program.

1 OVERVIEW

INTRODUCTION TO THE WORKSTATION

The workstation is composed of modules that provide data storage and processing functions. Depending on the configuration of the workstation, it will run application software as a standalone workstation, as a master workstation providing facilities for several cluster workstations, or as a cluster workstation.

In its most basic form, a workstation with Processor Module, keyboard, and Monitor can run a software application as a cluster workstation. This configuration uses disk space on a cluster master to call up software applications and files. If disk storage space is added, a workstation can store its own software applications and files. In this configuration, the workstation operates either as a standalone or provides disk storage services to cluster workstations as a cluster master.

Other modules, such as different or additional displays, processor, storage modules, communications modules, or keyboards can be added to (or easily removed from) the workstation as processing needs change.

Since the workstation is modular, separate manuals provide details about logic, operation, and interface for the various modules of the system. The "Guide to Technical Documentation" in the front of this manual provides the complete list of manuals.

For more detailed information on the interface of the modules with the processor, see the Processor Manual for your system. An explanation of the system capabilities and the system bus, designated as the X-Bus, is also in the Processor Manual for your system.

INTRODUCTION TO DIAGNOSTICS

The diagnostics available for the workstation include a bootstrap ROM firmware program and software diagnostics.

Section 2 describes the bootstrap ROM firmware. The bootstrap ROM provides an automatic self-test of both hardware and memory in the workstation, a diagnostic bootstrap from a local disk drive, and an options menu, which allows the user to select special System Image files, memory dumping, memory testing, or a panel debugger routine.

Section 3 describes how to use the software diagnostics. The diagnostics are loaded from a local disk drive or from a master workstation and provide complete tests of every module available for the workstation.

2 BOOTSTRAP ROM FIRMWARE

INTRODUCTION

The bootstrap ROM firmware on the Processor Module's CPU board is executed when the workstation receives a manual or power-up reset, or when a program running in RAM enters it. The firmware features include

- Automatic self-test of both hardware and memory. Errors are reported to the user by an alarm and the display of a unique error code on the keyboard LEDs, or the display of an error code on the video display.

- Operating system or diagnostic bootstrap from a local disk drive, or from the master workstation.

- An options menu. Options include loading special System Image files (such as diagnostics), dumping the content of RAM to the local disk drive or the master workstation, repetitive testing of memory, and running the panel debugger routine.

- Automatic identification of hardware modules and devices on the X-Bus (modules, such as disks and communications) and I-Bus (input devices, such as the keyboard).

The bootstrap ROM tests the hardware and checks and tests all installed memory, displaying an asterisk (*) for every 64K bytes tested. Next, the bootstrap ROM loads the System Image from the local disk drive or master workstation, displaying a period (.) for every sector transferred.

The bootstrap ROM in the workstation first attempts to load <Sys>SysImage.Sys from each floppy disk drive connected to the workstation, in order from left (the one closest to the Processor Module) to right (the one farthest away from the Processor Module). If not successful, the bootstrap ROM firmware attempts to load <Sys>SysImage.Sys from each hard disk drive connected to the workstation, in order from left to right. If still unsucessful, the bootstrap ROM attempts to load [Sys]<Sys>WSnnn>SysImage.Sys from the master workstation over the cluster communications line.

The number nnn in [Sys]<Sys>WSnnn>SysImage.Sys is the number of the operating system for the workstation. The bootstrap ROM determines which operating system is appropriate for it depending on the presence and type of mass storage peripherals connected to the X-Bus. Operating system number 252 is used for a workstation with no mass storage, number 251 is used for

a workstation with floppy disk storage only, and number 250 is used for a workstation with both floppy and hard disk storage.

If the bootstrap ROM can not find a System Image file at the master workstation, error B3h occurs. (See the "Error Codes" subsection below).

When the System Image is being loaded, the screen displays the message

```
T
****
L..... (etc.)
```

If more than 256K bytes of RAM are being tested, one more asterisk is displayed for every 64K bytes tested. Similarly, a typical System Image file (CTOS operating system or diagnostic) displays several lines of periods, one for every sector transferred from the local disk drive or master workstation.

If the space bar is held down while the bootstrap ROM is initializing, the sequence described above does not occur. Instead, the bootstrap ROM enters the menu mode, in which the user can change the type of operating system, dump the content of RAM to the local disk drive or a master workstation, run diagnostic tests, or use the panel debugger. (See the "Menu Mode" subsection below.)

Since the bootstrap ROM uses a variable identification mode of cluster protocol (described below in the subsection "Cluster Protocol") it cannot work properly if IWS cluster workstations on the communications line are using a fixed identification mode.

MENU MODE

The bootstrap ROM enters the menu mode when the user holds down the space bar while pressing the reset button on the workstation's back panel or powers up the workstation. The screen initialization is then complete, and the following message appears on the screen:

```
V x.y

B,D,L,M,P,T:
```

where

x.y is the version number of the bootstrap ROM.

An option is selected when the user enters the appropriate character from the menu without pressing SHIFT or RETURN.

The keyboard input routine of the bootstrap ROM uses the keyboard codes directly (that is, it does not translate them). Thus, keys such as SHIFT, CODE, and those on the numeric keyboard are interpreted as invalid characters and should not be used. Also, in the panel debugger routine, the ";:" key is used without the SHIFT key to get the ":" character.

The menu options are

B Bootstrap
D Dump
L Load
M Memory test
P Panel debugger
T Type of Operating System

B (Bootstrap)

The bootstrap ROM loads the System Image file. If the Type of Operating System (T) option is not selected, the bootstrap ROM attempts to load the System Image file from the following sources, in order, as if the reset button had been pressed:

1. local floppy disk drives (left to right)

2. local hard disk drives (left to right)

3. [Sys]<Sys>WSnnn>SysImage.Sys (where nnn is the number of the operating system as listed in the Release Notice for the operating system) at the master workstation

4. [Sys]<Sys>WS>SysImage.Sys, the default System Image file, at the master workstation

If the bootstrap ROM does not find a System Image file at the master workstation, error B3h occurs. (See the "Error Codes" subsection below.)

Note that if the T option is selected, the local disks are not checked for the presence of a valid System Image file. Instead, the System Image is loaded from the specified System Image at the master workstation. (See the "T (Type of Operating System)" subsection below).

D (Dump)

The content of RAM is dumped to the local disk drive or, if an error occurs (for example, no disk drive is present), to the master workstation. The bootstrap ROM will attempt to dump to the following files, in order:

1. <Sys>CrashDump.Sys at a local floppy disk drive

2. <Sys>CrashDump.Sys at a local hard disk drive

3. [Sys]<Sys>WSnnn>CrashDump.Sys (where nnn is the workstation number, not type, between 1 and 15 at the master workstation)

4. [Sys]<Sys>WS>CrashDump.Sys, the default System Image file at the master workstation

If none of these four CrashDump files exists at the master workstation, error ADh occurs. (See the "Error Codes" subsection below.)

L (Load)

The bootstrap ROM loads the System Image file from the local disk drive or master workstation, as described above in the subsection "B (Bootstrap)." However, instead of starting at the first location of the System Image, the bootstrap ROM enters the panel debugger. As soon as the panel debugger exits, the System Image executes. (See the "Panel Debugger Routine" subsection below.)

M (Memory Test)

The bootstrap ROM repeatedly tests the RAM array. The test terminates when you press the reset button on the back panel of the workstation. Any error halts the memory test and the appropriate error code and message appear on the screen.

P (Panel Debugger)

This test enters and exits as described below in the subsection "Panel Debugger Routine."

T (Type of Operating System)

When the bootstrap ROM prompts with "OS:", enter the number of the desired System Image at the master workstation and press RETURN. The file to be loaded is [Sys]<Sys>WSnnn>SysImage.Sys, where nnn is the number of the operating system entered in response. Only the digit keys on the typewriter pad of the keyboard should be used, not the keys on the numeric keypad. The T option influences the operation of subsequent Bootstrap and Load options.

PANEL DEBUGGER ROUTINE

The bootstrap ROM includes a panel or virtual console. The panel debugger routine is of limited use as a general software debugger, but is useful when the workstation cannot successfully run the operating system.

When the panel debugger routine is entered (that is, when the bootstrap ROM is in the menu mode, and you press P), the address of the instruction that caused it to be entered is displayed in Intel CS:IP format. Then, the panel debugger routine prompts with a plus (+) character and waits for a command to be keyed in, as described below.

All numbers in the panel debugger routine are hexadecimal words (not bytes). Addresses are entered in the format SA:RA, where SA is the Segment Base Address and RA is the Relative Address or offset. The number of bytes from the beginning of the segment pointed to by the Segment Base Address are entered in hexadecimal format. The first digit must be numeric (for example, the user enters 0FFFF rather than FFFF). Only the last four digits of any word are used, although more can be keyed in. Because the SA (initially FF00h) is always remembered by the panel debugger routine, the SA does not have to be keyed in every time. Thus, an address can be specified by SA:RA, or just RA. If an I/O port is specified, RA is used by the panel debugger routine as the port address.

Upon entry to the panel debugger routine, the 12 CPU Word registers, the Instruction Pointer, and the Flag register are saved on the user stack. The RAM location of each register can be addressed by keying in the name of the register.

The names of the registers (in the order in which they are located in memory) are: SP, SS, ES, DS, DP, DI, DX, CX, BX, AX, SI, IP, CS, and FL. The Byte registers cannot be specified explicitly, since the panel debugger routine does not support byte memory operations. Note that, due to the characteristics of the 80186 microprocessor, the AX register is composed of the AL and AH registers, the BX register is composed of the BL and BH registers, etc.

The panel debugger routine recognizes RETURN and NEXT, and the following characters: a semicolon (;), which is printed as a colon (:), a slash (/), 0 to 9, and A to Z. Typing other characters causes the alarm to sound and the current command to terminate without executing. In the examples below, the information typed on the screen by the panel debugger routine is represented in **bold** type.

The panel debugger routine has five commands:

- Open/Modify RAM
- Open/Modify Register
- Input/Output from or to a Port
- Set Haltpoint
- Proceed/Go

To use the Open/Modify RAM command, enter an address, followed by a slash (/) to examine a RAM location. The content of the RAM location can be either modified or left as is (and the next sequential RAM location examined). The Open/Modify command can also be terminated without changing the RAM location.
To modify the word at RAM location F00:3Ch to contain 701h, enter

```
+0F00:3C/ xxxx 701<RETURN>
+
```

To modify words at 0:0 and 0:4 to contain 3F0h and 23h, respectively, and to examine words at 0:2 and 0:6 without modification, enter

```
+0:0/ xxxx 3F0<NEXT>
0000:0002 xxxx<NEXT>
0000:0004 xxxx 23<NEXT>
0000:0006 xxxx<RETURN>
+
```

To use the Open/Modify Register command, enter a register name in response to the "+" prompt. A "/" character is not required.

To change the content of the DX register to contain A03h, enter

```
+DX xxxx 0A03<RETURN>
+
```

(Note that you must enter 0A03 instead of A03.)

To use the Input/Output from or to a Port command to input a byte from the port, enter the address in the format SA:RA (SA is ignored), followed by the command I. A byte is input from the port, the byte is displayed, and the command is terminated.

To use the Input/Output from or to a Port command to output a byte to a port, enter the address, followed by the command O. The panel then displays an equals sign (=). Then enter the byte to be output to the port, and press RETURN. Note that the output command does not input from the port. This is to accommodate I/O controllers that change state when their input/output port is read. Also note that port operations are

byte, not word operations. The I/O port addresses for each module in the system are listed in the hardware manual for that module.

To input the content of Port A0h, enter

```
+0A0I xx
+
```

To output 7Ah to Port A1h, enter

```
+0A1O=7A<RETURN>
+
```

The Set Haltpoint command sets a haltpoint when you enters the RAM address, followed by the H command. This sets a flag in an internal panel debugger routine and stores the address for later use. When the panel debugger routine is exited by pressing G (Go) or P (Proceed), the haltpoint is inserted in RAM at the specified address. Only one haltpoint can be set at a time; if more than one is specified, the one set most recently is used.

When the haltpoint is executed, the original instruction is restored and can be executed using the P command. The panel debugger routine remembers the existence and location of a haltpoint by storing information in the 16 bytes reserved at 0000:01F0h.

To avoid conflict with the single-byte INT 3 instruction of the Software Debugger, the haltpoint is a 2-byte instruction (INT 7Ch). If the haltpoint is set as a single-byte instruction, and there is a jump to the next instruction, the result is unpredictable. A haltpoint cannot be set in ROM.

Setting a haltpoint at the current CS:IP causes the panel debugger routine to be reentered immediately if you use the P command. A haltpoint at the same address is reestablished by setting the haltpoint at the next instruction, proceeding, setting the haltpoint at the desired address, and proceeding again.

To set a haltpoint at 1E21:C3h, enter

```
+1E21:0C3H
+
```

To reestablish the haltpoint at 1E21:C3h after it is encountered, enter

```
1E21:00C3          (haltpoint encountered)
+1E21:0CxH         (address of next instruction,
                    not the next byte)
```

```
+P
1E21:00Cx          (haltpoint encountered)
+1E21:0C3H
+P
```

The panel debugger routine is exited when you use the P (Proceed) command or key in an address, followed by the G (GO) command. In the first case, execution is resumed at the current CS:IP, which is saved on the stack. In the second case, execution is resumed at the specified address.

To proceed from the current CS:IP, enter

```
+P
```

To go from 1E43:90h, enter

```
+1E43:90G
```

FIRMWARE FUNCTIONAL DESCRIPTION

CLUSTER PROTOCOL

Cluster architecture is discussed in detail in the System Programmer's Guide. The general protocol of the operating system dictates that the master workstation poll the cluster workstations, and the master workstation and the cluster workstations exchange messages. The protocol requires that each workstation on the cluster communications line have a unique workstation identification number.

The master workstation initiates all communications; a cluster workstation recognizes messages intended for it by the workstation identification number. The cluster workstation picks a workstation identification number by (1) monitoring the cluster communications line to find an unused one, (2) taking an unused number, and then (3) monitoring the cluster communications line again to see if it has collided with another workstation that may have picked the same number. If a collision occurs, both workstations wait a random time interval before restarting the search for another indentification number.

The workstation identification number can be between 1 and 15. Identification numbers are not the same as user numbers. A different user number is assigned to each workstation in a cluster by the operating system of the master workstation. Identification numbers are determined by the cluster workstations and can be duplicated on the different cluster communications lines of a cluster.

The actual protocol used for cluster communications is a subset of the American National Standard for Advanced Data Communications Control Procedures (ADCCP), as defined in ANSI X3.66, published by the American National Standards Institute, Inc. The sequence used during the dump and bootstrap routines is illustrated in Figure 2-1 below. The protocol symbols are

Symbol	Meaning
SNRM	Set Normal Response Mode
RIM	Request Initialization Mode
SIM	Set Initialization Mode
XID	Identification Frame (contains workstation type)
UP	Unnumbered Poll
UI	Unnumbered Data Frame
RD	Request Disconnect
DISC	Disconnect
UA	Unnumbered Acknowledge
UI'	Unnumbered Data Frame (with termination data)

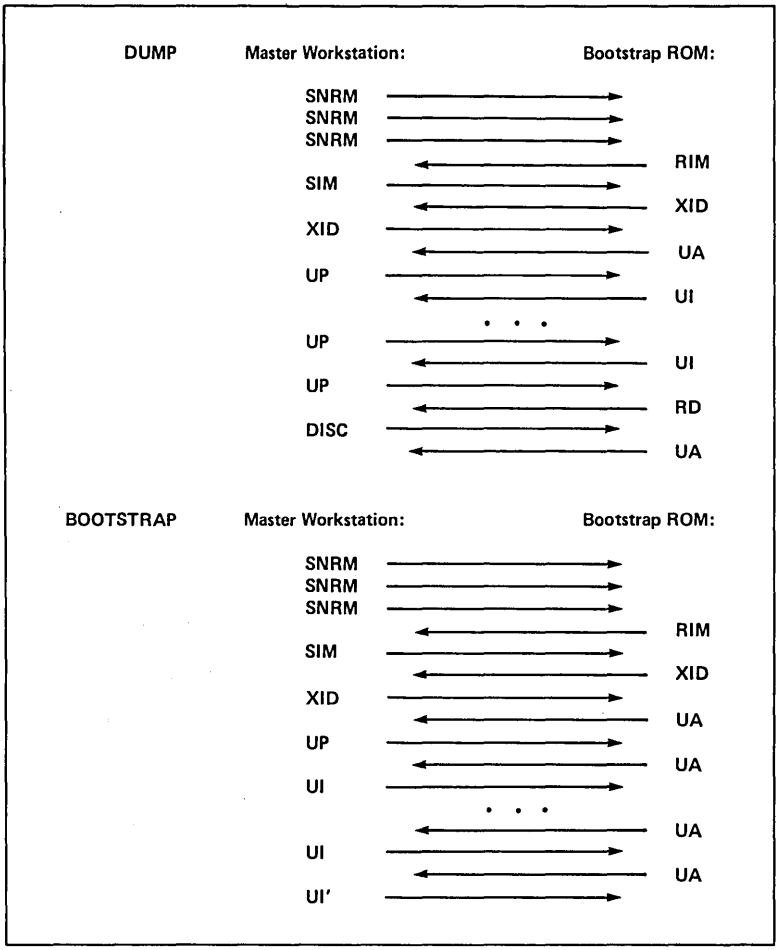


Figure 2-1. Communications Dump and Bootstrap Protocol.

BOOTSTRAP INTERFACE BLOCK

When a program is loaded, and before execution is transferred to it, the bootstrap ROM places a 16-byte structure in memory with a pointer to the structure at location 1FCh. The structure of the bootstrap interface block is:

```
BootBlock:          RECORD
                    pProgramStart,
                    pCtosBuffer:  POINTER;
                    DumpDevice,
                    BootDevice,
                    WsType,
                    DumpWsNumber/DumpErrorCode,
                    BootWsNumber,
                    unused
                    unused
                    unused:  BYTE;
                    END;
```

The dump and bootstrap device numbers are either 0 (failed), 1 (floppy disk drive 0), 2 (hard disk drive), or 3 (communications line). The workstation type (WsType) is listed in the Release Notice or can be some other type selected using the T option on the menu. (See the "Menu Mode" subsection above.) Dump and bootstrap workstation identification numbers (WsNumbers) are those that the bootstrap ROM picked during the dump and/or the bootstrap. If a dump or bootstrap from a disk drive is successful, the WsNumbers will indicate which disk unit was dumped to or bootstrapped from. If the dump failed, the failing error code is saved in the Dump/WsNumber field.

The CTOS operating system also examines the ROM type number, which is a word (80h for the bootstrap ROM) found at location FFFF:0006h. To access this ROM type number, an application must have its parity disabled or a parity error results.

CTOS OPERATING SYSTEM BUFFER

The bootstrap ROM saves a 64-byte buffer for the CTOS operating system. The CTOS operating system has a pointer to the buffer at location 0000:0240h. The buffer must lie beyond the first 6K bytes of RAM, which are the bootstrap ROM's work area. The bootstrap ROM copies the buffer into its work area and sets the pointer to this copy (pCtosBuffer) in the Bootstrap Interface Block. The CTOS operating system uses this pointer to recover the buffer after it has been bootstrapped.

MODULE IDENTIFICATION TABLES

The bootstrap ROM saves two tables, which describe the configuration of the X-Bus and I-Bus for the operating system.

The address of the X-Bus ID table is calculated by subtracting 10h from the segment address of the Bootstrap Interface Block and using the offset found at location 1FCh.

The address of the I-Bus ID table is calculated by subtracting 20h from the segment address of the Bootstrap Interface Block and using the offset found at location 1FCh.

The format of both tables is a word, which is the number of IDs found in the table, followed by the actual IDs, also words. The high byte of each word in the module ID table contains the module type code. The module type code for a Dual Floppy Disk Module is, for example, 40h. See the hardware manual for the specific modules for more information about module type codes.

BOOTSTRAP ROM ERRORS

When the workstation is bootstrapped, it goes through diagnostic and bootstrapping routines, which are resident in the ROM of the CPU. When an error is detected by the bootstrap ROM, the error code appears on the screen. Detailed information on all system status codes, including bootstrap error codes, can be found in the Status Codes Manual.

ERRORS DURING BOOTSTRAP OR DUMP

The communications bootstrap or dump routines do not stop to report an error if there is no activity on the RS-422 cluster communications line. An error can occur when the cable to the master workstation is disconnected, when the master workstation fails, or when the master workstation is disabled by the Disable Cluster utility. When the connection with the master workstation is reestablished, the bootstrap or dump routine automatically starts (shown on the screen by a "." for every sector transferred).

ERROR CODES

Interpreting Keyboard Error Codes

The E0h and E1h error codes are displayed on the keyboard LEDs. They are interpreted as follows:

LED	E0h	E1h
OVERTYPE	on	on
LOCK	on	on
f1	on	on
f2	off	off
f3	off	off
f8	off	off
f9	off	off
f10	off	on

Screen Error Codes

For most of the error codes listed in hexadecimal format below, there is also a list of possible causes for the error. The causes are listed with the most likely one first.

Error Code	Message/Meaning/Possible Causes
00-01	Unused
02	No floppy controller Processor cannot communicate with floppy controller. Check: Dual Floppy Disk Module connection to X-Bus.
03	Timeout waiting for an interrupt after a Seek command. The floppy disk controller did not interrupt the CPU after being issued a seek command. Check: 1. that the user did not open the door of the floppy disk drive, or 2. Dual Floppy Disk Module connection to X-bus.
04-05	Unused
06	DMA never finished. The Byte Count Register of the 80186 DMA Channel 0 never decremented to 0, which means that the DMA operation never finished. Check: 1. CPU board (Processor Module) or 2. Dual Floppy Disk Module (8253, WD2797).
07-08	Unused
09	Run file checksum error. Floppy disk contains no run file.

Error Code	Message/Meaning/Possible Causes
09	Check: 1. CPU board (Processor Module) or 2. Dual Floppy Disk Module.
0A	File header invalid. The System Image file on the floppy disk does not contain a valid run file. Since the Initialize Volume utility does not automatically copy a System Image onto the volume it is initializing, the user must copy a valid System Image onto the volume. Check: floppy disk.
0B	Floppy Control Register inconsistent. The Status Register was polled until it became ready. The Floppy Status Register was then polled again and it was not ready. Check: dual floppy controller (WD2797).
0C	Floppy disk drive became not ready during a seek. The floppy disk drive became not ready while performing a Seek command. This error can be caused by opening the door of the floppy disk drive or by a bad cable from the floppy disk drive to the Motherboard. Check: 1. user intervention, 2. cable from the floppy disk drive to the Floppy Disk controller, 3. floppy disk drive, or 4. Dual Floppy controller (WD2797).
OD-OE	Unused

Error Code	Message/Meaning/Possible Causes
0F	Floppy disk drive fault condition during a Seek or Recalibrate command. The floppy disk drive did not recalibrate to track 00 after 77 step pulses, or the drive fault line went active. Check: 1. cable between the floppy disk drive and the floppy disk controller board, 2. floppy disk drive, or 3. dual floppy controller (WD2797).
10	Abnormal termination of Seek command. The floppy disk drive did not complete the Seek command correctly. Either the floppy disk drive failed, or the ready status changed. Check: 1. user intervention, 2. floppy disk, 3. cable between floppy disk drive and floppy disk controller board, 4. floppy disk drive, or 5. dual floppy controller (WD2797).
11-12	Unused
13	Floppy disk drive not ready. The floppy disk drive was not ready when a Read or Write command was issued. This error can only occur if the floppy disk drive was ready during a previous Recalibrate command and a previous Seek command. Check: user intervention.
14	Unused

Error Code	Message/Meaning/Possible Causes
15	End of track. After a Read or Write command, no Terminal Count signal was received from the DMA. Check: 1. cable between the floppy disk drive and floppy disk controller board, 2. CPU board (Processor Module), or 3. dual floppy controller (8253).
16	Data error (data field). The floppy disk drive controller cannot read data from the floppy disk drive correctly. Check: 1. floppy disk, 2. cable between floppy disk drive and floppy disk controller board, 3. floppy disk drive, or 4. dual floppy controller (WD2797).
17	Data error (identification field). The floppy disk drive controller cannot read the identification field of the addressed sector. Check: 1. floppy disk, 2. cable between floppy disk drive and floppy disk controller, 3. floppy disk drive, or 4. dual floppy controller (WD2797).
18	Data late. The floppy disk drive controller did not get service from the 80186 DMA in time. Check: 1. seating of the CPU on Motherboard, 2. CPU board (Processor Module),

Error Code	Message/Meaning/Possible Causes
18	3. dual floppy controller (WD2797), or 4. Dual Floppy Disk Module connection to the X-Bus.
19-1B	Unused
1C	Floppy disk write protected. This error code appears only during the dump operation and indicates that the floppy disk has a write protect tab in place. Check: floppy disk.
1D-1E	Unused
1F	Abnormal termination of command. The floppy disk drive controller reported abnormal termination of a command without reporting the cause. Check: dual floppy controller (WD2797).
20-22	Unused
23	Timeout waiting for an interrupt. The hard disk controller did not interrupt the CPU after being issued a command. Check: 1. Floppy/Hard Disk Module connection to the X-Bus, 2. hard disk controller board, or 3. CPU board (Processor Module).
24-25	Unused

Error Code	Message/Meaning/Possible Causes
26	DMA not done. The Word Count register of the 8237 DMA Channel 3 never decremented to 0FFFFh, which means that the DMA operation never finished. Check: 1. CPU board (Processor Module) or 2. hard disk controller (8253s, WD1010).
27	No valid volume home block. No volume home block could be found within the first track of the disk. Check: that the disk was initialized by the Initialize Volume utility.
28	No file. No System Image or Crash Dump file exists. Check: that the disk was initialized by the Initialize Volume utility.
29	Run file checksum error. The System Image file on the hard disk failed a checksum test. Check: 1. that a valid run file was copied to the System Image file, 2. Memory board and Memory Expansion Cartridges (Processor Module), 3. CPU board (Processor Module), or 4. Floppy/Hard Disk Module.

Error Code	Message/Meaning/Possible Causes
2A	File header invalid. The System Image file on the hard disk does not contain a valid run file. Since the Initialize Volume utility does not automatically copy a System Image onto the volume it is initializing, the user must copy a valid System Image onto the volume. Check: hard disk System Image file.
2B	Hard Disk Status register inconsistent. The Status register was polled until it became ready. The Status register was then polled again and it was not ready. Check: hard disk controller board (WD1010).
2C	No seek complete. The seek complete status was not set after an implied seek. Check: 1. cable from the hard disk drive to the hard disk controller motherboard, 2. hard disk drive, or 3. hard disk controller (WD1010).
2D-30	Unused
31	Drive not ready. The hard disk drive became not ready during and operation. Check: 1. cable from the hard disk drive to the hard disk controller motherboard, 2. hard disk drive, or 3. hard disk controller (WD1010).

Error Code	Message/Meaning/Possible Causes
32	Unused
33	Hard disk controller not ready. The hard disk controller remained in a busy state after a write or read operation should have completed. Check: 1. hard disk controller (WD1010) or 2. hard disk drive.
34	Unused
35	Sector not found. The hard disk controller could not locate a particular sector on a track. Check: 1. that the hard disk drive has been formatted, 2. cables between the hard disk drive and hard disk controller, 3. hard disk controller (WD1010), or 4. hard disk drive.
36	Data error (data field). The hard disk controller could not read data from the hard disk drive correctly. Check: 1. that the hard disk drive has been formatted, 2. cables between the hard disk drive and hard disk controller, 3. hard disk controller (WD1010), or 4. hard disk drive.
37	Unused

Error Code	Message/Meaning/Possible Causes
38	Data late. The hard disk drive controller did not get service from the 8237 DMA controller in time. Check: 1. seating of the CPU board on the Processor Module motherboard, 2. CPU board (Processor Module), 3. hard disk controller (WD1010) or 4. Floppy/Hard Disk Module connection to the X-Bus.
39-3B	Unused
3C	Hard disk write fault. This error code appears only during the dump operation. Check: 1. cables from the hard disk drive to the motherboard, 2. hard disk controller (WD1010), or 3. hard disk drive.
3D-3E	Unused
3F	Abnormal termination of command. The hard disk drive controller reported abnormal termination of a command without reporting the cause. Check: hard disk controller (WD1010).
3E-A2	Unused

Error Code	Message/Meaning/Possible Causes
A3	Serial input/output error. The serial input/output initialization routine detected an error in the serial input/output communications controller chip. Check: 1. I/O board (Processor Module) or 2. CPU board (Processor Module).
A4	8254 error. The clock initialization routine detected an error in the 8254 programmable counter/timer chip. Check: CPU board (Processor Module).
A5	No SIM. RIM was sent to the master workstation but no SIM was received. This indicates that the workstation is able to receive but not transmit, or that the master workstation is able to transmit but not receive. Check: 1. I/O board (Processor Module) (cluster communications logic), 2. master workstation, 3. communications cable, or 4. operating system of the master workstation, which may have crashed.
A6	No UP in initialization (SNRM). A UA or XID was sent to acknowledge the SIM sent by the master workstation, but the master workstation sent back an SNRM instead of a UP. The master workstation probably timed out, while waiting for the UA or XID.

Error Code	Message/Meaning/Possible Causes
A6	Check: 1. I/O board (Processor Module), 2. master workstation, 3. communications cable, or 4. operating system of the master workstation, which may have crashed.
A7	No UP in initialization (DISC). A UA or XID was sent to acknowledge the SIM sent by the master workstation. The master workstation sent back a DISC instead of a UP. Check: 1. I/O board (Processor Module) 2. master workstation, 3. communications cable, or 4. the operating system of the master workstation, which may have crashed.
A9	No identification available. The initialization routine monitored the cluster communications line but did not find a free identification number. This is usually caused by attaching more workstations to a cluster communications line than the operating system of the master workstation is designed to accept. Check: the operating system of the master workstation, which may have crashed.
AA	Identification failure. The initialization routine found free workstation identification numbers by monitoring the communications line, but errors were detected when it tried to use one. This is usually caused by a failure of the collision recovery algorithm and can be overcome by pressing the reset button on the back panels of each workstation that collided.

Error Code	Message/Meaning/Possible Causes
AB	Read identification timeout. The initialization routine timed out after waiting 10 seconds while monitoring the communications line for a workstation identification number. This error code is generated only after a number of unsuccessful reads. Check: 1. I/O board (Processor Module), 2. master workstation, 3. communications cable, or 3. operating system of the master workstation, which may have crashed.
AC	Bad address (dump routine). The workstation identification number sent in a frame by the master workstation did not match the one expected. Check: 1. communications cable or 2. I/O board (Processor Module).
AD	Disconnected (dump routine). The master workstation sent a DISC because of excessive line or protocol errors or because of a conflict with the crash/dump file at the master workstation. Check: 1. that either the file [Sys]<Sys>WSnnn>Crash Dump.Sys or [Sys]<Sys>WS>CrashDump.Sys at the master workstation exists, 2. that the file is not in use by another workstation that is dumping, 3. that the file is large enough, 4. communication cable, or 5. I/O board (Processor Module).

Error Code	Message/Meaning/Possible Causes
AE	No UP - SNRM. Check: 1. I/O board (Processor Module) or 2. master workstation.
AF	No UP - REJ. Check: 1. I/O board (Processor Module) or 2. master workstation.
B0	No UP. After transmitting a dump block, an unexpected response was received from the master workstation. Check: 1. whether a cluster workstation is using the fixed identification mode, or 2. I/O board (Processor Module).
B1	Read UI error. A bootstrap block (frame type UI) was expected, but another frame type was received. Check: I/O board (Processor Module).
B2	Read SNRM error. A bootstrap block (frame type UI) was expected, but a SNRM was received. Check: I/O board (Processor Module).

Error Code	Message/Meaning/Possible Causes
B3	Disconnected. The master workstation chose to send a DISC because of a conflict with the System Image file, or possibly because of excessive errors during transmission. Trying to bootstrap a nonexistent operating system can cause this error to occur. Operating system number 252 is used for a workstation with no mass storage, number 251 is used for a workstation with floppy disk storage only, and number 250 is used for a workstation with both floppy and hard disk storage. Check: 1. that there is a [Sys]<Sys>WSnnn>SysImage.Sys file at the master workstation for the workstation type selected (nnn). The master workstation does not have the operating system requested. If [Sys]<Sys>WSnnn>SysImage.Sys cannot be found, the default System Image file [Sys]<Sys>WS>SysImage.Sys is loaded. 2. cluster communications cables, or 3. I/O board (Processor Module).
B4	Bad checksum of System Image. The System Image transferred from the master workstation is not a valid run file. Either the file is invalid, or the transmission was faulty or incomplete. Check: 1. whether the operating system of the cluster workstation is invalid, 2. I/O board (Processor Module), 3. CPU board (Processor Module), or 4. Memory board (Processor Module).

Error Code	Message/Meaning/Possible Causes
B5	Read error. Excessive input/output errors occurred while the bootstrap interface block was being read. Check: 1. I/O board (Processor Module), or 2. cluster communications cables.
B6	Read timeout. During a read operation, no response was received from the master workstation. Check: the operating system of the master workstation, which may have failed.
B7	Write DMA count is bad. After completion of a write operation, the bootstrap ROM determined that the entire block was not sent. Check: 1. I/O board (Processor Module). 2. CPU board (Processor Module).
B8	Write timeout. A write operation did not properly complete. Check: I/O board (Processor Module).
B9	Bad bootstrap block format. A bootstrap block of an invalid length was received. Check: whether the format of the bootstrap file is correct.

Error Code	Message/Meaning/Possible Causes
BA	DMA error. After initializing the DMA channel for a Read or Write operation, the DMA controller did not contain the same information that was written to it. Check: CPU board (Processor Module).
BB to DF	Unused.
E0	ROM checksum error. There is a bad 2732 ROM on the CPU board. This error is displayed on the keyboard LEDs, not the video display. (See "Interpreting Keyboard Error Codes," above.) Check: CPU board (Processor Module).
E1	RAM error. There is a failure in the Bootstrap ROM's RAM work area. The Bootstrap ROM uses this work area to compose error codes. If a failure occurs, the error appears on the keyboard LEDs, not on the screen. (See "Interpreting Keyboard Error Codes," above.) Check: CPU board (Processor Module).
E2	RAM read and write 0's error. See E4 below.
E3	RAM read and write 1's error. See E4 below.

Error Code	Message/Meaning/Possible Causes
E4	RAM read and write address error.

An error occurred during the read and write RAM test. All 1's, all 0's, or an address pattern are written, read, and compared. The comparison showed that the data written and read were not identical. Note that if a failure is confined to a small number of memory locations, the likely source of the failure can be derived from the high-order bit of failed of the failed addresses. The high-order addresses in the Processor Module are:

0-3	Memory board
4-7	1st RAM Expansion Cartridge
8-B	2nd RAM Expansion Cartridge
C-F7	3rd RAM Expansion Cartridge
F8-F9	Video RAM
FA-FB	Font RAM

The error display for E2, E3, E4, and E5 (below) is:

```
E: E2
1000:675C 0000 0002
```

where

E: E2	is the error code,
1000:675C	is the hexadecimal address,
0000	is the expected value, and
0002	is the received value.

Check:

1. Memory board (Processor Module, includes expansion),
2. CPU board (Processor Module), or
3. motherboard for any module connected on the X-Bus.

Error Code	Message/Meaning/Possible Causes
E5	RAM address test error. An error occurred during the RAM addressing test. After completion of the RAM read/write address test, each RAM word should contain the sum of its own address. The RAM address test verifies that this is still true after one complete cycle of the test. This error can be caused by a short or a shorted address line allowing different RAM locations to respond to the same CPU. It may also be caused by memory that picks up or drops bits when idle. Check: 1. Memory board (Processor Module) or 2. RAM Expansion Cartridges (Processor Module).
E6	Keyboard initialization error. An error occurred while the bootstrap ROM was initializing the hardware. Check: 1. Video board (Processor Module) or 2. I/O board (Processor Module).
E7-FF	Unused.

3 USING DIAGNOSTICS

INTRODUCTION

The set of diagnostic programs for the workstation allows test selection and execution from a graphic menu. The menu is made up of symbols (icons) of the modules in the system under test.

When the diagnostic program is loaded into the workstation, the group of module icons appear on the screen. Only icons for the modules in the workstation under test appear on the screen. The user must verify that the diagnostic program has recognized all of the modules in the workstation. If a configuration rule has been violated, such as having Memory Expansion cartridges installed nonsequentially in the Processor Module's slots, the program displays the error before diagnostic execution begins.

BOOTSTRAPPING THE DIAGNOSTICS PACKAGE

The diagnostics package is a single, bootstrapable System Image. All the diagnostics software for all types of hardware modules is contained in this package. The diagnostics package should be the first software run on the system after it is assembled.

The diagnostics package can be bootstrapped from a floppy disk, or from the master workstation if the workstation is being used in a cluster. To identify the diskette in the distribution diskette package containing the diagnostics SysImage.Sys file, see the Release Notice accompanying the diagnostics.

To bootstrap the diagnostics package from a floppy disk, insert the floppy disk in the left-most floppy disk drive and press the reset switch on the back of the Processor Module. To install the diagnostics on a master and bootstrap them over the cluster line, see the "Release Notice for Standard Software x.x," where x.x is your version of Standard Software.

WARNING

If you are planning to test the floppy disk drive, remove the bootstrapable diskette and place scratch diskettes in the floppy drives after bootstrapping. The floppy disk portion of the diagnostics package will destroy the contents of the diskettes in the drives it tests.

SCREEN FORMAT

The diagnostics divides the screen into three horizontally separated windows.

- The top window contains a menu describing the user's options and the meaning of display terms in the bottom window.

- The middle window is where prompts are displayed that require you to type in responses. This window scrolls upward as the diagnostics proceed.

- The bottom window displays the hardware configuration (the icons) and the current state of the test. Soft and hard errors are shown under each module icon after the test has been run at least once.

Certain tests change the format of the screen while they are running. When the tests are finished, they restore the screen format and its contents.

CONFIGURATION DISPLAY

When the diagnostics are bootstrapped, the bottom window displays the workstation configuration showing, from left to right, the workstation modules that are present on the X-Bus, the video monitor, and the keyboard. The display is detailed enough to portray the memory configuration of the Processor Module and to distinguish between different types of video monitors.

In all but very large configurations, the entire configuration will fit on the screen. If three dots ("...") appear at the right edge of the display, there are additional components in the configuration that could not be displayed. They can be made visible by moving the cursor during test selection, as described below.

POWER CONFIGURATION CHECK

If the display does not correspond to the actual configuration, check the power configuration. Failure to power a module or group of modules correctly with a 36-volt Power Supply Module can cause the modules to remain without power. For example, failure to plug a 36-volt Power Supply Module into the wall or into another 36-volt Power Supply Module can cause a whole group of modules to go without power and therefore to be unnoticed by the system.

The required location of the power inputs from the floor power module(s) is shown by flashing plug symbols on the appropriate modules. These modules must be powered. It is the user's reponsibility to verify that this is the case. If required power is not supplied, the system may still operate but will malfunction.

After checking the power configuration, press any key to continue. The power plugs will stop flashing. Refer to the Power System Manual for further information about the power requirements for the workstation.

CONFIGURATION RULES CHECK

If a configuration rule is violated, a message describing the violation appears on the screen. An example of a configuration rule is that the overall length of the X-Bus (from the right side of the Processor Module to the left side of the rightmost module) should not exceed 24 inches.

These messages are warnings only. To ignore the warning, press any key to continue.

SELECTING HARDWARE MODULES FOR TEST

Once you have checked the power configuration and the configuration rules, the icon of the leftmost module (the Processor Module) changes to reverse video. This indicates that the cursor is on it.

From the screen, select the components to be tested by moving the cursor with the arrow keys and pressing MARK when the cursor is on the selected module. (The right arrow and left arrow keys can be used to move through the display from module to module.) The brightness of the display increases when a module is marked for testing. The modules will be tested in the order that you marked them, not necessarily from left to right.

A menu at the top of the screen shows the four possible states of the display for each module. This menu also lists the keys that move the cursor or change the display.

If, because of a large number of modules in the workstation, the complete display will not fit on the screen, the entire frame can be shifted when the cursor is moved off the screen to the right or left side. Dots (...) indicate the presence of additional modules off the screen to the right side, the left side, or both sides.

SELECTING SUBCOMPONENTS WITHIN A MODULE FOR TESTING

The down arrow key can be used to move around inside a module. This is possible with modules that have submodules that are separately testable, such as the CPU or a disk module with multiple drives. (With modules that have no submodules, such as the keyboard, the down arrow key has function.) When you press the down arrow key, the leftmost submodule within the module is displayed in reverse video, and the name of the submodule replaces the name of the whole module above the icon. The right arrow and left arrow keys can now be used to move about within the module. Submodules can be selected for testing by pressing MARK in the same way that whole modules are selected. If submodules are not individually selected, but the entire module is marked, all of the tests for that module will be run.

When the desired submodules have been marked, press the up arrow key to return the diagnostics to the module level. You can not to move out of one module to another until the up arrow key is pressed.

INITIAL DIALOGUE

When all the desired modules and submodules have been selected and marked, press GO. This begins the initial dialogue phase.

For each kind of test to be performed, a series of prompts appear. There is a default response to each prompt that meets the needs of a first-time user attempting to bootstrap the diagnostics on a newly assembled system. The default is displayed in brackets immediately after the prompt. For example,

Stop diagnostic on a memory error? [Y]

To use the default ("Y" for "yes" in this case), press "RETURN". Alternatively, you may enter your own response. Many of the prompts require a Y/N (yes/no) response. Some require an integer or a string answer.

> **WARNING**
>
> If you have selected the floppy disk drive from which you bootstrapped the diagnostics to be tested, you should remove the boot diskette and replace it with a scratch diskette before proceeding. The floppy disk diagnostic will destroy the contents of diskettes in any drives it tests.

STARTING THE TESTS

The final prompt appearing before the tests are run is

Enter the number of times to run the diagnostic: [1]

If you enter a number larger than 1, the entire test sequence will be repeated that many times, without further dialogue. This assumes that you responded with an "N" to all "stop on error" prompts.

When you press RETURN after responding to this last prompt, the tests begin.

DISPLAY BEHAVIOR DURING AND AFTER THE TESTS

As each module or submodule is tested, the cursor (reverse video) is placed on that component (or components, if the test involves the interaction of multiple components). A successful test causes the display for that component to remain in reverse

video, but to become half-bright. A failure of the test causes that part of the display to blink and to remain in bright reverse video. These indicators persist until you reset them at the end of the entire test cycle.

During the test, a small menu at the top of the screen replaces the larger menu displayed during the selection process. This menu describes the display attributes and the keys that can be used to interrupt the test.

KEYBOARD INTERACTION DURING THE TESTS

The test can be interrupted at most times by holding down FINISH. Exceptions to this rule are the keyboard and CPU timer tests, which monopolize the data path to the keyboard; pressing any key during these tests is unexpected and will cause the test to fail. However, these tests are very brief and therefore should normally not require interruption.

Some tests require user interaction, usually in the form of prompts like the initial dialogue. Certain tests always require interaction and others only do so if the test fails or intervention is required (for example, to insert a blank diskette in a drive to be tested). In general, interaction during the tests is not required when the default answers to the initial dialogue prompts are used, unless a failure is detected. Note however, that the video monitor diagnostic needs you to verify correct operation of the display by watching the test run, although it will detect a failure of video RAM on its own.

INDIVIDUAL DIAGNOSTICS

Each of the hardware modules has its own unique software for testing it. Some, like the CPU, have submodules that have unique tests.

The individual diagnostics have been made as self-explanatory as possible. See the "Diagnostic Test Descriptions" subsection below for detailed information about each test.

DIAGNOSTICS SELECTION PROGRAM (SP)

The Selection Program (SP) is a CTOS application program that allows the user to preconfigure the diagnostic package for particular tasks. This may be desirable to permit a particular battery of tests to be run without user intervention, or to restrict the user to a subset of the available tests.

SP enables Original Equipment Manufacturers (OEMs) and manufacturing personnel to put together custom diagnostics run files that can be bootstrapped in exactly the same way as the distributed diagnostics package. SP runs only on the CTOS operating system on an NGEN or an IWS workstation; it will not run on an AWS workstation because it makes use of the soft font capability.

SP can be used to

- Change the default values for prompts made by the diagnostics, so that the most frequently used response can be selected by simply pressing RETURN.

- Completely suppress some or all prompts, so that the default values you specify are always used. The tests run with no input from the user.

- Replace the normal module selection process with a preselection by module types. Diagnostics preconfigured in this way will test any of the module types preselected, and only those types, without requiring the user to mark modules for testing.

INSTALLING SP

To run SP, the contents of the diagnostics distribution diskette must have been previously installed on the workstation by submitting the HDInstall.sub file located in the <sys> directory of the diskette.

Note that if you will not be using SP, you do not need to install the diagnostics. It is generally more economical in such cases to bootstrap the diagnostics from a copy of the distribution diskette, to avoid using space on your hard disk for the diagnostics.

However, it is often convenient to install the diagnostics at the master workstation and rename the bootstrapable SysImage file (CP.run), as well as any custom diagnostics, to names of the form "Ws...>SysImage.Sys" so they can be bootstrapped over the cluster.

RUNNING SP

To run SP, type the command "Diagnostic Selection Program" (or an abbreviation such as "D S P") while in the CTOS Executive.

SP INPUT AND OUTPUT FILES

SP asks the user for input and output files. The default for the input file is CP.run, the normal diagnostic bootstrapable System Image. The output file, which must be specified by the user, is another bootstrapable System Image of the diagnostics, except that some or all of the user intervention has already been performed in advance. The preconfiguring applies only to this new output file, not to the original input file, which continues to operate as previously.

SP OPTIONS

SP then prompts

Do you want the custom diagnostic to:

Pause for power configuration check? [Y]

Stop on a configuration violation? [Y]

Allow user to do his own selections? [Y]

If you want to create custom diagnostics that will run entirely without user intervention, answer "N" to the first prompt and possibly the second as well.

The third query affects the manner in which hardware modules are chosen for testing. The default, "Y", lets the user select the modules to be tested, as in the normal case. If you specify "N", you are not given the opportunity to select modules; instead, all hardware modules of the types you select, and only those modules, are tested. This is explained in the following section.

MODULE SELECTION IN SP

The SP display is similar to that of the actual diagnostics, except that SP displays all the various types of hardware modules, not just those that are actually present in the configuration at the time. SP does not, in fact, examine the actual configuration. The appearance of the display is like one that has one of each possible type of hardware module.

There will be more modules in the SP display than will fit across the bottom of the screen, as indicated by dots ("...") at the right edge. The display will scroll when the cursor is moved off the right edge, revealing more modules. When the cursor is moved off the left edge, the display scrolls back.

SP allows dialogue queries to be marked and answered for each module, exactly as if the modules were actually present and the tests were to be executed immediately.

If the "Allow user to do his own selections?" prompt was responded to with "N", modules will be selected for testing by type; only the types of modules chosen will be tested. If "Y" was answered, the only purpose of making a selection in SP is to customize the dialogue. Defaults or suppress prompts (as explained below) can be changed, but you make your own selection of modules to test.

If "N" was responded to "Allow user to do his own selections?", all of the modules that you want to test with the preconfigured diagnostic should be marked. If a module is marked and no modules of that type are present later when the new diagnostic is bootstrapped, the diagnostics will still operate normally. The diagnostics will test all of the modules of the specified type(s) that it can find. If you wish, more types of modules can be selected than are actually expected to be present, or even all the types. In most cases, therefore, the exact configuration of the system to eventually be diagnosed need not be known to produce the custom diagnostic.

What constitutes a module type? Disk modules and some other kinds of hardware modules come in various configurations, and each configuration is considered to be a separate type. For example, each different configuration of the combined hard disk/floppy disk module is considered a different module type. Hard disk drives of different sizes are also considered to be different types of modules. For example, if you wish to test all hard disks, regardless of size, be sure to mark all the hard disk types shown in the display.

Expansion disks are considered part of the hard disk module they are attached to. A hard disk module with an expansion disk is a different type of module than a hard disk without an expansion. Again, to test both kinds you must mark both.

Similar rules apply to submodules. For example, the Processor Module displayed by SP always shows all three memory expansion units (regardless of the actual configuration on which it is run). If all three are marked, and the system on which the diagnostics is later bootstrapped has only two expansion units, the diagnostic will act as if only two were marked.

CHANGING DEFAULTS IN THE DIALOGUE

After you have marked the modules and pressed GO, SP proceeds with the initial dialogue for each marked module, exactly as the real diagnostics would.

Instead of running tests, however, SP merely records the responses to the prompts in the output file. When all the prompts have been answered, SP writes the output file and then exits to CTOS.

After running SP, the output file can be bootstrapped in the same way as the original diagnostics. The responses given during the SP session will be the default values displayed in brackets after each prompt. For example,

Enter the number of times to run the diagnostic: [1]

The normal default of [1] in this example could have been changed to some other number using SP.

SUPPRESSING QUERIES WITH SP

SP provides the ability to eliminate user intervention altogether, for one, several, or all queries. This feature is invoked by pressing CODE-s as the response to any prompt, instead of RETURN. The result is the suppression of any query during the execution of the custom diagnostics. For example,

Enter the number of times to run the diagnostic: [10]

Press CODE-s

The diagnostic will run ten times without asking the user for permission.

Properly used, this feature makes it possible to preconfigure custom diagnostics that run entirely unattended. Among other uses, this is particularly useful on keyboardless systems in a manufacturing environment.

WARNING

Since any query can be suppressed with CODE-S, potentially dangerous custom diagnostics can be created, such as those that destroy disk data without asking the user's permission. Control the distribution of custom diagnostics that have dangerous properties.

SUPPRESSING QUERIES DURING THE ACTUAL DIAGNOSTICS

CODE-s can be used at any time when answering a prompt, including during execution of the actual diagnostic, not only during SP. Used during the diagnostic itself, CODE-s means "don't ask me this prompt again." However, rebootstrapping the diagnostics will reenable keyboard input for that query.

DIAGNOSTICS DESCRIPTIONS

The diagnostics described here ask the user for certain information before they will execute. All of the prompts have a default value shown in square brackets [ ], which may be different from one version of the diagnostics to another. The original default values for the tests can be restored by rebootstrapping the diagnostics program.

The diagnostic tests remember what the previous responses to the prompts were, so that when the same test is run again, the user can merely press RETURN to run under the same conditions.

PROCESSOR MODULE TESTS

The following description of the Processor Module tests are not in themselves sufficient to enable troubleshooting of a malfunctioning Processor Module. Refer to the Processor Manual for information on the module. This information, especially the command set for the Large Scale Integrated Circuit (LSI) components and the format and content of the control and status registers, is vital to understanding the status information included in error messages.

This description is sufficiently self-contained however to permit you to perform an extensive battery of tests and to determine whether the Processor Module is performing correctly or requires remedial attention.

Memory Expansion Tests

The tests available for the Processor Module's Memory Expansion Cartridges are as follows.

- **1st MEM EXP (256 to 512K bytes)**
  This tests the first Memory Expansion Cartridge, which is the innermost cartridge in the Processor Module.

- **2nd MEM EXP (512 to 768K bytes)**
  This tests the second Memory Expansion Cartridge, which is the middle cartridge in the Processor Module.

- **3rd MEM EXP (768 to 1024K bytes)**
  This tests the third Memory Expansion Cartridge, which is the outermost cartridge in the Processor Module.

When you select the memory expansion tests, the following two prompts (shown here in **bold** type) appear on the screen:

Stop diagnostic on memory error?

Type "Y" or "N" followed by RETURN. The test will stop when an error is encountered if "Y" is typed. The test will report errors but continue testing if "N" is typed.

The Memory Expansion test is different from the memory test performed by the bootstrap ROM upon power up or reset. The bootstrap ROM does not test RAM with parity enabled, and uses a simpler test pattern. The Memory Expansion test has the following six distinct passes:

- write and read 0's to all test memory
- write and read 1's to all test memory
- write and read address patterns (even addresses)
- reread address pattern from test memory (even addresses)
- write and read address patterns (odd addresses)
- reread address patterns from test memory (odd addresses)

If an error occurs (provided that a "Y" response was given to the "Stop diagnostic on memory error?" prompt), a detected error will cause the relevant error information to be displayed and a prompt will appear:

Continue?

Type "Y" and press RETURN to continue the test, or type "N" and RETURN to restart the diagnostics.

The second prompt is:

Do you want to run the Galpat test rather than the standard memory test?

Type "Y" to run the Galpat test or "N" to run the standard memory test.

The Galpat (galloping pattern) memory test runs an exhaustive test of the memory. This test can take several hours to run, depending on the amount of memory to be tested. A sequence of asterisks are displayed during the test to indicate that it is running. Parity and invalid data are reported.

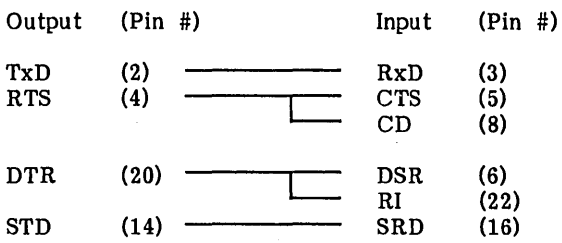
To terminate the memory test, press and hold FINISH.

RS-232-C Tests

The RS-232-C tests exercise the Intel 8274 and its supporting logic on the I/O board. They locate and identify the cause of any malfunction as completely as possible.

Both RS-232-C channels can be tested in several modes of operation. All combinations of operating parameters that are appropriate for each mode of operation are automatically tested. In addition, there are several parameters controlling the operation of the test that can be modified by the user.

For the RS-232-C diagnostics to operate properly, each channel to be tested must be looped back to itself externally. The following pins on the external RS-232-C connectors must be connected to each other as follows:



When you select the RS-232-C tests the following prompts (shown here in **bold** type) appear on the screen:

Do you want to run:
- the Static status test?

Type "Y" to run the test or "N" to skip over it.

The Static Status test actually runs several subtests of increasing complexity. The first subtest checks the interface between the CPU and the 8274 by writing to and reading from

the control register within the 8274. This subtest determines whether the CPU and the 8274 can successfully communicate with each other.

The second subtest checks the interface between the 8274 and the outside world. The following control lines are tested for proper loopback and function:

Data Terminal Ready
Request to Send
Clear to Send
Carrier Detect
Data Set Ready
Ring Indicator
Secondary Transmit Data
Secondary Receive Data

The third and final subtest that is run checks the same control signals as the second subtest, but does so using interrupts between the CPU and the 8274.

When this test executes, nothing is seen on the screen unless there is an error.

Do you want to run:
- Asynchronous mode test?

Type "Y" to run the test or "N" to skip over it.

The Asynchronous Mode test transmits and receives data from the 8274 through the RS-232-C transmitters, the loopback, and the RS-232-C receivers, and back to the 8274. The 8274 is initialized to transmit and receive data in asynchronous format. The transmit data is obtained from a transmit buffer, under interrupts, and the received data is placed into a receive buffer, also under interrupts. After all data in the transmit buffer has been transmitted and received, the buffers are compared for errors. Any errors are displayed. Other errors detected during execution are displayed when they are detected. All combinations of baud rate (2400, 4800, 9600, and 19200 baud), data length (5, 6, 7, and 8 bits), parity (none, odd, and even parity), and stop bits (1, 1 1/2, and 2 bits) are tested.

Do you want to run:
- Character sync CRC-16 test?

Type "Y" to run the test or "N" to skip over it.

The Character Sync CRC-16 test is the same as the Asynchronous Mode test except that the 8274 is initialized to

transmit and receive data in Bi-Sync format with the CRC-16 Cyclic Redundancy Check (CRC) polynomial. The test is run at each of several baud rates (2400, 4800, 9600, and 19200 baud). Data length is fixed at 8 bits and parity is fixed at none during execution.

Do you want to run:
- Bit sync data transfer test?

Type "Y" to run the test or "N" to skip over it.

The Bit Sync Data Transfer test is the same as the Asynchronous Mode test except that the 8274 is initialized to transmit and receive data in Synchronous Data Link Control (SDLC) synchronization format with the SDLC CRC polynomial. The test is run at each of several baud rates (300, 600, 1200, and 2400 baud). Data length is fixed at 8 bits and parity is fixed at none during execution.

Do you want to run:
- Bit sync abort/idle test?

Type "Y" to run the test or "N" to skip over it.

The Bit Sync Abort/Idle test is the same as the Asynchronous Mode test except that the 8274 is initialized to transmit and receive data in SDLC bit synchronization format with the SDLC CRC polynomial. The test is run at each of several baud rates (300, 600, 1200, and 2400 baud). Data length is fixed at 8 bits and parity is fixed at none during execution. Normal data transmission and reception are tested, as in the Bit Sync Data Transfer test. In addition, generation and recognition of an abort transmission sequence and restarting of the transmission are tested. When the Bit Sync Abort/Idle test is running, the message "<<<Abort Received>>>" appears if the test is successful.

Stop on communications error?

Type "Y" to stop the test if an error occurs or "N" to continue. If you type "N", any errors that occur will be reported after the test finishes.

If the diagnostics detect an error during testing, an error information screen is displayed. The information given on this screen is divided into six sections as shown in Figure 3-1.

Test Information Section. This section contains details of the test that was running when the error occurred. The test number and name, the channel being tested, the test sequence pass, and the test parameters at the time of the error are displayed here.

Error Information Section. This section contains details of the error condition that was detected. The actual error that was detected (for example, >>> Receive error - Data <<<), as well as the actual and expected test results (if applicable for this error condition) are displayed (for example, Was - 35 Should be - 34).

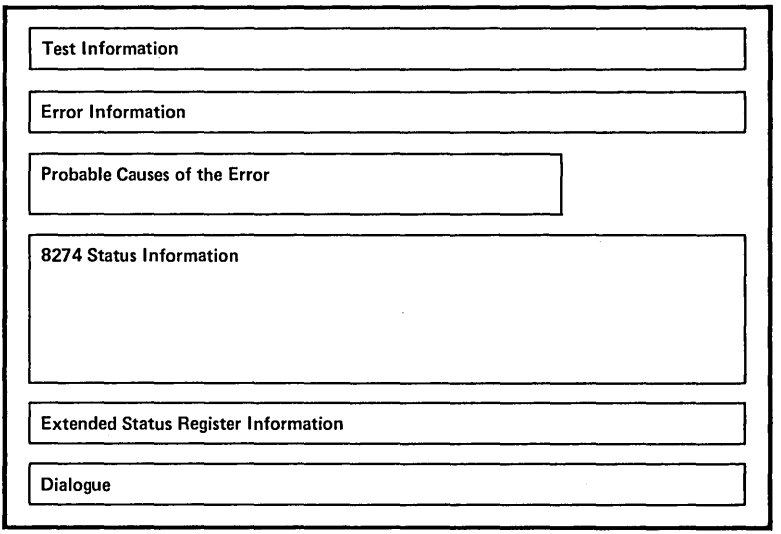


Figure 3-1. RS-232-C Error Information Screen.

Probable Causes Section. This section lists from one to three conditions that may have caused the error. The causes given are by no means the only possible ones that could or would cause the error detected. They do however provide a starting point from which to locate the cause of the error.

8274 Status Information Section. This section displays the status of the 8274 channel that was being tested when the error occurred. In addition to the actual state of each bit in the 8274 status registers at the time of the error, the expected state of each status register bit is given (0, 1, or X; X means "don't care"). A complete description of each bit in the two 8274 status registers (RR0 and RR1) can be found in the Processor Manual for the workstation you are using.

Extended Status Register Information Section. This section displays the information contained in the Extended Communications Status register at the time of the error. The register contains information for both communications channels. However, only the information pertaining to the channel being tested is displayed. As in the 8274 Status Information Section of the error screen, both the actual and the expected state of each bit in the register at the time of the error are displayed.

Dialogue Section. This section is where any dialogue with the diagnostics program takes place. All requests for debugging, continuing, or aborting the tests take place in this section.

RS-422 (Cluster Communications) Tests

The RS-422 Tests exercise the cluster communications channel on the I/O board. There is no loopback connector requirement for the RS-422 tests as there is for the RS-232-C tests described above. The loopback for cluster communications is internal to the interface.

When the RS-422 tests are selected, the following four prompts (shown here in **bold** type) appear on the screen:

Do you want to run
- Cluster maintenance mode test?

Type "Y" to run the test or "N" to skip over it.

The Cluster Maintenance Mode test loops back a number of communications test frames and checks for timeout, CRC, overrun, data, channel hold, and other errors. When the test completes, any errors are reported.

(The second prompt is prefaced by a requirement)

The next test requires that two workstations be taken off the cluster master and connected to each other via a cluster cable.

Do you want to run:
- Interprocessor data transfer test?

Type "Y" to run the test or "N" to skip over it.

The Interprocessor Data Transfer test performs transfers betweeen two workstations, using DMA for both transmission and reception. For proper operation, both workstations must be running this test and be connected by a standard cluster communications cable. They must not, however, be connected to an operational cluster at the time of execution.

Stop on a communications error?

Type "Y" to stop the test on an error or "N" to continue the test even if an error occurs.

Fast cluster communication?

Type "Y" to execute the tests at 1.8 M baud or "N" to execute the tests at the standard cluster speed of 307 K baud.

Parallel I/O (Printer) Tests

The parallel I/O diagnostics test the parallel printer port and its supporting logic, and in the event of a malfunction, locates and identify the cause of the malfunction as completely as possible.

The parallel I/O port can be exercised with or without the use of interrupts. In addition, there are several parameters controlling the test that can be modified by the user.

When you select the parallel I/O tests, the following three prompts (shown here in **bold** type) appear on the screen:

Do you want to run:
- Barber pole test (without interrupts)?

Type "Y" to run the test or "N" to skip over it.

The Barber pole test (without interrupts) test outputs one page (66 lines of 132 columns) of a test pattern consisting of all 96 printable ASCII characters. Each successive line is shifted one character to the left, resulting in a "barber pole" pattern. Before the test pattern is transmitted, the status of the printer is checked. If the printer is busy or not selected, or the print buffer is busy, an error occurs and the test is suspended. If the printer status is all right, the diagnostics then transmits the test pattern. After each character is transmitted to the printer, the diagnostics polls the printer status. If the print buffer does not become free to accept another character before the maximum wait time (see below), an error occurs and the test is suspended.

Do you want to run:
- Barber pole test (with interrupts)?

Type "Y" to run the test or "N" to skip over it.

This test is identical to the Barber pole test (without interrupts) test, except that after a character is transmitted to the printer, instead of polling the printer status, the test waits for an interrupt to be generated by the printer acknowledge line, signaling that the printer is ready to receive another character. If the interrupt is not received before the maximum wait time (see below), or the printer status shows the printer is still busy after the interrupt, an error occurs and the test is suspended.

Max printer wait time (ms)?

Type in a number in milliseconds. The number you type in can depend on many factors, such as the speed of the printer, the character buffer size, etc. See the manual for the printer being used.

Error Messages. If an error should occur, and the diagnostics detects an error during testing, an error message is displayed and testing is suspended. The error message displayed contains two sections: the error message, and the printer status.

The error message section is a brief explanation of the type of error that occurred, for example, >>> Timeout waiting for printer interrupt <<<.

The printer status section displays the status of the printer port at the time of the error. Each status port bit is displayed (that is, the bit function and the actual state).

Base Memory Test

The Base Memory test is identical to the Memory Expansion test described above, except that the Base Memory Test exercises only the memory that is not occupied by the diagnostics software, that is, the top 64K bytes of base memory (192 to 256K bytes).

186 CPU Test

Only the programmable interval timer in the 80186 microprocessor on the CPU board can be tested. When selected, this test sets time intervals between 100 and 800 milliseconds in 100-millisecond increments to verify the operation of the 80186's internal timer. You must have a keyboard connected to the workstation to run this test. Do not touch the keyboard during the test.

DUAL FLOPPY DISK MODULE TESTS

These descriptions of the Dual Floppy Disk Module tests are not in themselves sufficient to enable troubleshooting of a malfunctioning Dual Floppy Disk Module controller or floppy disk drive. Refer to the Dual Floppy Disk Manual for further information on the module. This information, especially the command set for the Western Digital WD2797 and the format and content of the control and status registers is vital to understanding the status information included in error messages. The same tests described here are used for the floppy disk drive in the Floppy/Hard Disk Module.

However, this extensive battery of tests will permit you to determine whether the Dual Floppy Disk Module is performing correctly or requires remedial attention.

The tests available for the Dual Floppy Disk Module and the floppy disk drive in the Floppy/Hard Disk Module are as follows.

- **CONTROLLER.** Tests the controller in the floppy module
- **F0.** Identical to the Controller test described above
- **F1.** Identical to the Controller test except that Floppy Drive 1 is used instead of Floppy Drive 0

WARNING

Some of these tests destroy any data present on the floppy disks in the drives. When executing any Dual Floppy Disk Module test, make sure that only scratch floppy disks are used.

When you select the floppy disk diagnostics, the following prompts (shown here in **bold** type) appear on the screen:

Stop diagnostic on floppy error?

Type "Y" and press RETURN to stop the test on an error, or type "N" and press RETURN to continue the test regardless of an error.

Run quick verification?

Type "Y" and press RETURN to run a quick verification (Recalibrate and Format/Verify) or type "N" and press RETURN to run the full verification tests or to allow each test to be individually selected.

A quick verification recalibrates the read/write head (returns it to track 00), formats the floppy disk, and then reads back the format to make sure it was written correctly. These tests are described below under "Recalibrate Test" and "Format with Verify."

Run full verification (some of the tests will destroy data)?

Type "Y" and press RETURN to run a full verification (all tests) or type "N" and press RETURN to individually select tests and other functions (if "N" was answered to the previous prompt).

If you respond with "Y", the next prompt is

Change detail parameters?

The detail parameters are the characteristics of the floppy disk format, the number of read retries, etc. If you respond with "Y", the following prompts appear on the screen:

Number of retries?

The number of retries refers to the number of times the test will try to read data from a sector of a floppy disk. Several retries are usually acceptable. Type a number corresponding to the number of retries desired.

Use interrupts?

This parameter determines whether all floppy status checking should be done by using interrupts from the floppy disk controller, or by polling the floppy disk controller. Type "Y" to use interrupts or "N" to use polling.

Number of bytes per sector?
Number of sectors per track?
Number of tracks per cylinder?
Number of cylinders per floppy?

These parameters specify the number and size of the data areas on the floppy disk. Enter the appropriate numbers or use the defaults. Bytes per sector must be either 128, 256, 512, or 1024.

Suppress error messages?

This parameter determines if the floppy controller status is to appear on the screen each time an error occurs. Type "Y" to suppress error messages or "N" to allow error messages to appear on the screen.

If you respond with "N" to the prompt "**Run full verification (some of the tests will destroy data)?**," you can select specific tests to be run, as well as a group of functions used for hardware debugging. Press RETURN and then select the individual tests and functions.

When all of the tests and functions have been selected, the floppy/hard disk diagnostic asks:

Debug?

Type "Y" to use the Debugger or type "N" to skip over it.

When Debug is selected, it shows a dot on the screen as sectors are being written to or read. In the event of an error, it also shows the contents of the 8253 counter registers and asks:

Enter the Debugger?

Type "Y" to enter the Debugger or type "N" to return to the display manager.

See the Debugger Manual for information about using the debugger for software debugging.

Recalibrate test

Type "Y" to run the test or "N" to skip over it.

The Recalibrate test checks the basic function of the read/write head positioning mechanism and track 00 sensor. The test first initializes the floppy disk interface, issuing a Recalibrate command to the floppy controller in the process. The test then issues a command to step the head inward to the center of the disk. The test finally issues another recalibrate command, stepping the head to track 00. Any errors detected are displayed.

Sequential seek test

Type "Y" to run the test or "N" to skip over it.

The Sequential Seek test checks the function of the head positioning mechanism by stepping the head from track 00 to the innermost track on the disk, one track at a time. Any errors detected are displayed.

Random seek test

Type "Y" to run the test or "N" to skip over it.

The Random Seek test checks the function of the head positioning mechanism by stepping the head from track TPD/2 to track TPD/2-1 to track TPD/2+1 to track TPD/2-2 to track TPD/2+2 etc., where TPD is the number of tracks per floppy disk. Any errors detected are displayed.

The following test will destroy data on the disk
Format with verify

Type "Y" to run the test or "N" to skip over it.

The Format with Verify test formats the floppy disk (or disks if both drives were specified) in the selected drives. The floppy disks are formatted one track at a time. Data is first written to the disk, then read back.

The following test will destroy data on the disk
Sequential write/read single sectors

Type "Y" to run the test or "N" to skip over it.

The Sequential Write/Read Single Sectors test writes data to each sector on a track, one sector at a time. First, the odd-numbered logical sectors are written with filler data. Next, the even-numbered logical sectors are written, using the ones complement of the filler data. After all of the sectors on the track are written, the data in each sector is verified against the data written. The test is repeated on three tracks: track 00, track TPD/2, and track TPD-1, where TPD is the number of tracks per disk.

The following test will destroy data on the disk
Random write/read single sectors test

Type "Y" to run the test or "N" to skip over it.

The Random Write/Read Single Sectors test does a write and a read of a random number of sectors on each tested track. All tracks are tested from track TPD/2 to track TPD/2-1 to track TPD/2+1 to track TPD/2-2 to track TPD/2+2 etc., where TPD is the number of tracks per floppy disk.

The following test will destroy data on the disk
Sequential write/read multiple sectors

Type "Y" to run the test or "N" to skip over it.

The Sequential Write/Read Multiple Sectors Test writes data to each sector on a track, one half track at a time. First, sectors 1 to SPT/2 are written using a ramp pattern (0123456789). Then sectors SPT/2+1 to SPT are written. SPT is the number of sectors per track on the disk. The data in each sector is then verified against the data written.

Function - read track format

Type "Y" to use this function or "N" to skip over it.

The Read Track Format function reads an entire track into the DMA buffer, and displays it 256 bytes at a time. The function prompts for a cylinder number and a head number. Any invalid entries will be reported. Press RETURN in response to the cylinder number prompt to exit the function. The track specified is then read into the buffer and the first 256 bytes are displayed. The function prompts with "**More?**". Type "Y"

and press RETURN to display the next 256 bytes in the buffer; or type "N" and press RETURN to read another track.

Function - display/modify sector

Type "Y" to use this function or "N" to skip over it.

The Display/Modify Sector function allows you to display and, optionally, modify any sector on the floppy disk. The function prompts for a cylinder number, a sector number, and a head number. Any invalid entries are reported.

Enter a cylinder number and press RETURN in response to the "**cylinder:**" prompt when it appears. Similarly, enter the head number and sector number when the "**head number:**" and "**sector number:**" prompts appear. The sector specified is then read into the DMA buffer, and the first 256 bytes are displayed.

The function prompts with "**more?**". Type "Y" and press RETURN to display the next 256 bytes in the buffer. Type "N" and press RETURN to modify the sector or inspect another sector.

The function prompts with "**modify?**". Type "Y" and press RETURN to modify the sector. Type "N" in response to the prompt to inspect another sector.

The function prompts with "**byte?**". Type the decimal number of the byte to be modified, or just press RETURN to quit making changes. The function will then display the byte number and its hexadecimal value. Type a new hexadecimal value for the byte then press RETURN to change the byte, or just press RETURN to leave the byte unchanged.

After the sector has been modified, the prompt "**write sector?**" appears. Type "Y" and press RETURN to rewrite the sector on the floppy disk with the modified data. Type "N" and press RETURN to leave the modified sector unchanged.

Pressing just RETURN to the "**cylinder:**" prompt terminates the display modify function.

Function - copy drive to drive

Type "Y" to use this function or "N" to skip over it.

The Copy Drive to Drive function copies the entire contents from one floppy disk to another. The source and destination drives are determined by which drives were marked to select the floppy diagnostics. The source drive is the first drive

marked, and the destination drive is the second. If the entire module was marked in the selection process, the source and destination drives are assumed to be F0 to F1. The destination floppy disk must be formatted using the Format with Verify test (see above) before using the copy drive to drive function. After each track is written to the destination disk, it is verified against the data on the source disk.

Function - read disk address

Type "Y" to use this function or "N" to skip over it.

The Read Disk Address function reads the identification field of the next sector to pass under the read/write head. This function prompts you for the cylinder number and the head number.

The following test will destroy data on the disk
Function - loop on track format

Type "Y" to use this function or "N" to skip over it.

The Loop on Track Format function continuously formats one track on the disk. This function asks the user for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

The following test will destroy data on the disk
Function - loop on sector read

Type "Y" to use this function or "N" to skip over it.

The Loop on Sector Read function continuously reads one track on the disk. This function prompts you for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

The following test will destroy data on the disk
Function - loop on sector write

Type "Y" to use this function or "N" to skip over it.

The Loop on Sector Write function continuously writes one track on the disk. This function prompts you for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

Function - compare drive to drive

Type "Y" to use this function or "N" to skip over it.

The Compare Drive to Drive function compares the data on two floppy disks. It is the same as the verification function of the copy drive to drive function described above.

Error Message Format

When an error is detected by one of the floppy disk tests or functions, a brief description of the error is displayed, followed by the status of the floppy disk interface. The status information includes any or all of the following that are currently in effect or are abnormal:

- The floppy disk controller command most recently executed. The command is displayed as a hexadecimal byte and is also decoded to a message.
- The contents of the working Status register of the floppy controller, since the most recent command.
- The residual byte count from the last DMA transfer.
- The number of soft errors that have occurred during the execution of the current command. This is actually shown underneath the module icon in the display manager when the diagnostics finish.
- The number of hard errors that have occurred during the execution of the current command. This is actually shown underneath the module icon in the display manager when the diagnostics finish.

The interpretation of the bytes displayed in these items above can be found in the Dual Floppy Disk Manual.

FLOPPY/HARD DISK MODULE TESTS

The following description of the Floppy/Hard Disk Module tests are not in themselves sufficient to enable troubleshooting of a malfunctioning Floppy/Hard Disk Module. Refer to the Floppy/Hard Disk Manual for information on the module. This information, especially the command set for the Western Digital WD1010 and the format and content of the control and status registers, is vital to understanding the status information included in error messages. The descriptions of the tests used for the floppy disk drive in the Floppy/Hard Disk Module are given in the "Dual Floppy Disk Module Tests" subsection above.

However, this description is sufficiently self-contained to permit you to perform an extensive battery of tests and to determine whether the Floppy/Hard Disk Module is performing correctly or requires remedial attention.

The tests available for the Floppy/Hard Disk Module are as follows:

- **CONTROLLER:** This tests the controller in the Floppy/Hard Disk Module.
- **D0.** This test is identical to the Controller test described above except that Hard Disk Drive 0 is used for the test.
- **D1.** This test is identical to the Controller test described above except that Hard Disk Expansion is used for the test.

> **WARNING**
>
> Some of these tests destroy any data present on the disk under test. When executing any disk module test, make sure that data on the hard disk drive is backed up.

When you select the hard disk diagnostics, the following prompts (shown here in **bold** type) appear on the screen:

Stop diagnostic on error?

Type "Y" and press RETURN to stop the test on an error or type "N" and press RETURN to continue the test regardless of an error.

Run quick verification?

Type "Y" and press RETURN to run a quick verification (Recalibrate, Sequential Seek, Format Disk, and Random Write/Read Single Sectors tests) or type "N" and press RETURN to run the full verification tests or to allow tests to be individually selected.

A quick verification recalibrates the read/write head (returns it to track 00), tests the read/write head mechanism, formats the hard disk, and randomly selects tracks to write to then reads back the data to make sure it was written correctly. For

further information see "Recalibrate test," "Sequential Seek test," "Format Disk," and "Random Write/Read Single Sectors" test below.

Run full verification (some of the tests will destroy data)?

Type "Y" and press RETURN to run a full verification (all tests) or type "N" and press RETURN to individually select tests and other functions (if "N" was answered to the previous prompt).

Assuming a "Y" answer, the next prompt is:

Change detail parameters?

The detail parameters are the characteristics of the hard disk format, the number of read retries, etc. They appear on the screen as follows:

Number of retries?

The number of retries refers to the number of times the test will try to read data from a sector of the hard disk. Several retries are usually acceptable. Type a number corresponding to the number of retries desired.

Use interrupts?

This parameter determines if all status checking should be done using interrupts from the disk controller, or by polling the disk controller. Type "Y" to use interrupts or "N" to use polling.

Number of bytes per sector?
Number of sectors per track?
Number of tracks per cylinder?
Number of cylinders per disk?

These parameters specify the number and size of the data areas on the hard disk. Enter the appropriate numbers or use the defaults. Note that the controller will only support byte per sector sizes of 128, 256, 512, or 1024.

Stepper rate?

This parameter determines the rate at which the read/write head on the hard disk drive steps from track to track. Type a number (in milliseconds) for the stepper rate.

Suppress error messages?

This parameter determines if the disk controller status is to appear on the screen each time an error occurs. Type "Y" to suppress error messages or "N" to allow error messages to appear on the screen.

If you respond with "N" to the prompt "**Run full verification (some of the tests will destroy data)?**," you can select specific tests to be run, as well as a group of functions used for hardware debugging. Press RETURN and then select the individual tests and functions.

When all of the tests and functions have been selected, the floppy/hard disk diagnostic asks:

Debug?

Type "Y" to use the Debugger function or "N" to skip over it.

When you select Debug, it shows a dot on the screen as sectors are being written to or read. In the event of an error, it also shows the contents of the 8253 counter registers and asks:

Enter the debugger?

Type "Y" to enter the Debugger or "N" to return to the display manager.

See the Debugger Manual for information about using the Debugger for software debugging.

Recalibrate test

Type "Y" to run the test or "N" to skip over it.

The Recalibrate test checks the basic function of the read/write head positioning mechanism. It issues a Recalibrate command to the disk controller followed by a Seek command to move the read/write head to the last cylinder on the disk under test. Any errors detected are displayed.

Sequential seek test

Type "Y" to run the test or "N" to skip over it.

The Sequential Seek test checks the function of the head positioning mechanism by stepping the head from track 00 to the innermost track on the disk, one track at a time. Any errors detected are displayed.

The following test will destroy data on the disk
Format disk

Type "Y" to run the test or "N" to skip over it.

Format Disk formats the disk (or disks if both drives were specified) in the selected drives. The disks are formatted one track at a time.

Random seek test with ID scan

Type "Y" to run the test or "N" to skip over it.

The Random Seek Test with ID Scan checks the function of the head positioning mechanism by stepping the head from cylinder CPD/2 to cylinder CPD/2-1 to cylinder CPD/2+1 to cylinder CPD/2-2 to cylinder CPD/2+2 etc., where CPD is the number of cylinders per hard disk. The test also reads the identification areas of the sectors. Any errors detected are displayed.

The following test will destroy data on the disk
Verify disk (full track write/read of entire drive)

Type "Y" to run the test or "N" to skip over it.

The Verify Disk (full track write/read of entire drive) Test sequentially writes a ramp pattern (0123456789) to every track on the disk under test. The test then reads the data back to verify that it was correctly written.

The following test will destroy data on the disk
Sequential write/read single sectors

Type "Y" to run the test or "N" to skip over it.

The Sequential Write/Read Single Sectors test writes data to each sector on a track, one sector at a time. First, the odd-numbered logical sectors are written using a ramp pattern (0123456789). Next, the even-numbered logical sectors are

written, using the ones complement of the ramp pattern. After all of the sectors on the track are written, the data in each sector is verified against the data written. The test is repeated on three cylinders, cylinder 00, cylinder CPD/2, and cylinder CPD-1, where CPD is the number of cylinders per disk.

The following test will destroy data on the disk
Random write/read single sectors

Type "Y" to run the test or "N" to skip over it.

The Random Write/Read Single Sectors test performs a write/read of a random (between one and SPT) number of sectors on each tested track. All tracks in each cylinder are tested. All cylinders are tested from cylinder CPD/2 to cylinder CPD/2-1 to cylinder CPD/2+1 to cylinder CPD/2-2 to cylinder CPD/2+2 etc., where CPD is the number of cylinders per floppy disk.

The following test will destroy data on the disk
Sequential write/read multiple sectors

Type "Y" to run the test or "N" to skip over it.

The Sequential Write/Read Multiple Sectors test writes data to each sector on a track, one-half track at a time. First, sectors 1 to SPT/2 are written using a ramp pattern (0123456789). Then sectors SPT/2+1 to SPT are written. SPT is the number of sectors per track on the disk. The data in each sector is then verified against the data written. All of the cylinders of the hard disk are tested.

Function - display/modify sector

Type "Y" to use this function or "N" to skip over it.

The Display/Modify function allows you to display and, optionally, modify any sector on the disk under test. The function prompts for a cylinder number, a sector number, and a head number. Any invalid entries are reported.

Enter a cylinder number and press RETURN in response to the "**cylinder:**" prompt when it appears. Similarly, enter the head number and sector number when the "**head number:**" and "**sector number:**" prompts appear. The sector specified will be read into the DMA buffer, and the first 256 bytes are displayed.

The function prompts with "**more?**". Type "Y" and press RETURN to display the next 256 bytes in the buffer. Type "N"

and press RETURN to modify the sector or inspect another sector.

The function prompts with "**modify?**". Type "Y" and press RETURN to modify the sector. Type "N" in response to the prompt to inspect another sector.

The function prompts with "**byte?**". Enter the decimal number of the byte to be modified, or just press RETURN to quit making changes. The function will then display the byte number and its hexadecimal value. Type a new hexadecimal value for the byte and press RETURN to change the byte, or just press RETURN to leave the byte unchanged.

After the sector has been modified, the function prompts "**write sector?**". Type "Y" and press RETURN to rewrite the sector on the hard disk with the modified data. Type "N" and press RETURN to leave the modified sector unwritten on the floppy disk. Answering the "**cylinder:**" prompt with just RETURN terminates the display/modify function.

Function - read boot ROM

Type "Y" to use this function or "N" to skip over it.

The Read Boot ROM function is used to read and display the contents of the Floppy/Hard Disk Module's bootstrap ROM.

The following test will destroy data on the disk
Function - loop on track format

Type "Y" to use this function or "N" to skip over it.

The Loop on Track Format function continuously formats one track on the disk. This function asks you for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

Function - loop on sector read

Type "Y" to use this function or "N" to skip over it.

The Loop on Sector Read function continuously reads one track on the disk. This function prompts you for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

The following test will destroy data on the disk
Function - loop on sector write

Type "Y" to use this function or "N" to skip over it.

The Loop on Sector Write function continuously writes one track on the disk. This function prompts you for the cylinder number and the head number. It is designed to support troubleshooting using test equipment and runs until you press FINISH.

Error Message Format

When an error is detected by one of the hard disk tests or functions, a brief description of the error is displayed, followed by the status of the disk controller. The status information includes any or all of the following that are currently in effect or are abnormal:

- The disk controller command most recently executed. The command is displayed as a hexadecimal byte and also decoded to a message.
- The contents of the Status and Error registers of the WD1010 disk controller, as of the most recent command.
- The residual byte count from the last DMA transfer.
- The number of soft errors that have occurred during the execution of the current command. This is shown underneath the module icon in the display manager when the diagnostics finishes.
- The number of hard errors that have occurred during the execution of the current command. This is shown underneath the module icon in the display manager when the diagnostics finishes.

The interpretation of the bytes displayed in these items above can be found in the Floppy/Hard Disk Manual.

VIDEO DIAGNOSTICS

The Video diagnostics available for the VM-001 Monochrome Monitor require no interaction, but do require that you pay close attention to the screen when the diagnostics are running. When the Monochrome Monitor is marked during the selection process and you press RETURN, the diagnostics prompts you only once:

List all errors found?

Type "Y" to list all errors after the diagnostics or "N" to not list any errors that may occur.

The video diagnostics is not just a visual check of the Monochrome Monitor. The tests check the video RAM, the font RAM, and the video logic in the Processor Module, and detect and report errors, unless you answer "N" to the "**List all errors found?**" prompt.

The sequence of the video tests is as follows:

Video Memory Test

The video memory test runs in two phases. The first phase introduces the diagnostics. The second phase shows a representative set of module icons then scrolls the icons, filling the screen with different characters. This test is the video map RAM and font RAM test. The scrolling pattern of different characters results from simultaneous scrolling of both the video map RAM and font RAM, which are adjacent 8K-byte blocks of RAM. At the end of the cycle, the displaying picture should return to its original state, after exercising all of the video memory.

Video Attribute Test

The video attribute test shows all of the attributes on the screen, such as half-bright video, bold, struck-through, etc. This test is repeated several times in the test sequence with different backgrounds.

Font Display Test

The font display test shows the diagnostics font used. Note that this is not the standard workstation font.

Mosquito Net Test

The mosquito net test displays a field of one-pixel-thick lines to test for pincushion distortion and line clarity.

Cursored String Test

The cursored string test fills the screen with text and moves the cursor to each "T" in the text in turn.

When all of the tests have run, any memory errors are displayed (assuming a "Y" answer to the first prompt), or control of the diagnostics is returned to the display manager.

KEYBOARD DIAGNOSTICS

When you mark the keyboard icon during the selection process and press GO, the following prompts (shown here in **bold** type) appear on the screen.

Do you want to run the keyboard echo test?

Type "Y" to run the keyboard echo test or "N" to skip over the keyboard echo test.

The Keyboard Echo test requires user interaction. When this test executes, a picture of the keyboard appears on the screen. When the user presses keys on the keyboard, the corresponding key area lights up. Also, the keyboard LEDs toggle on or off when the corresponding key is pressed. This test can be used to locate malfunctioning keys and inoperative keyboard LED indicators.

Stop diagnostics on keyboard error?

Type "Y" to stop on an error or "N" to continue with test when an error occurs.

Display all hex codes that come from the keyboard (must reset to exit)?

Type "Y" to display hexadecimal codes or "N" to run the keyboard diagnostics conventionally.

If "Y" is answered to this prompt, any keys typed on the keyboard will be represented by their hexadecimal codes on the screen. The only way to exit this test is to press the reset button on the back of the Processor Module and reload diagnostics.

When the keyboard diagnostic starts, several short subtests (shown in **bold** type below) execute. If executed without error, each subtest will show an "OK" when it has completed.

I-Bus Hardware Reset

The I-Bus Hardware Reset tests the software-controlled hardware reset of the keyboard. This reset causes the keyboard to turn on all of its LED indicators.

ID Sequence

The ID Sequence subtest checks to see if the keyboard can identify itself to the Processor Module.

KBD Software Reset

The KBD Software Reset subtest checks the keyboard's ability to execute a command, in this case, a soft reset command. Because it is the first communication received by the keyboard from the Processor Module, it is at this point that the keyboard "learns" which of its ports is connected to the Processor Module. (The keyboard has two ports, at its right and left corners, either of which can be used to connect the keyboard to the video monitor base.) Upon successful receipt of this command, the keyboard turns off its LED indicators.

ROM Checksum

The ROM Checksum subtest perform a checksum of the ROM in the keyboard microcontroller.

Loopback Test

The Loopback test checks the bidirectional serial communications channel between the Processor Module and the keyboard microcontroller. Do not press any key during this test or the test will fail.

After these subtests execute, the keyboard diagnostics test the second port on the keyboard for a pointing device or other accessory. The following status message appears on the screen:

Switching to I-Bus Position 02

If a device is not present at I-Bus position 02, another status message appears:

No device attached

At this point, the keyboard diagnostic ends.

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USER'S COMMENT SHEET

Diagnostics Manual
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