
Z-SCAN 8000



User Manual

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copy
Zilog

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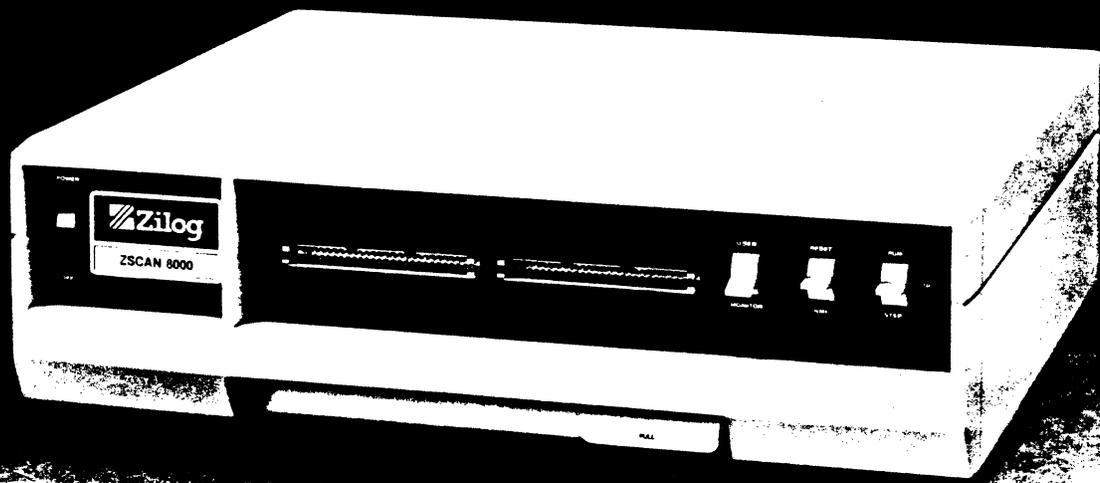
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Z-SCAN 8000 EMULATOR

USER'S GUIDE

This manual applies to serial numbers
3000 and up







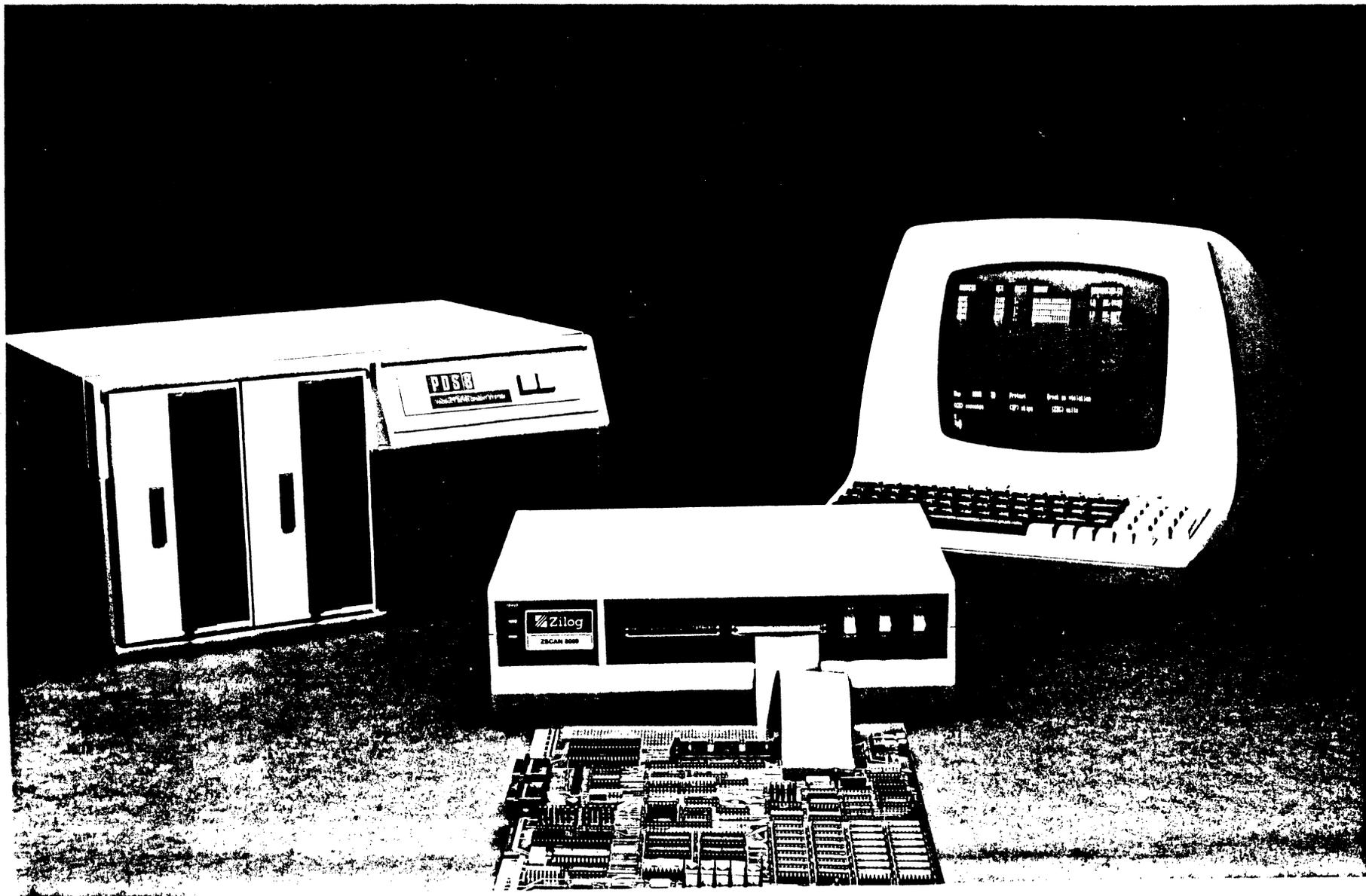




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SECTION ONE

HOW TO USE THIS MANUAL

Z-SCAN 8000, a Zilog Stand-Alone Circuit Analyzer, is a free-standing peripheral unit used for the design, debugging, and testing of equipment based on Zilog's Z8002 16-bit microprocessor. Because different users of the Z-SCAN 8000 have varying backgrounds or needs, various approaches to using this manual are suggested.

Writing conventions used throughout this manual:

1. The complement of a signal is specified by a dash (-) following the signal name, e.g., ABC- specifies that ABC is active low (\overline{ABC}).
2. The capital letter in each screen and/or command name indicates the key used to access each CRT terminal display.
3. Underscores used within text represent exactly how these items appear on the Z-SCAN terminal screen displays.

Important Notations: Three levels of notation are used throughout this manual to bring attention to specific information and safety precautions. The three levels of notation and their purposes are:

NOTE	Calls attention to specific points of technical or procedural importance.
CAUTION	Calls attention to conditions that could cause possible damage to equipment or facilities.
WARNING	Calls attention to conditions that could cause serious injury to personnel.

Suggested Reading Sequences

A. All users:

1. Read Section 3, Unpacking, Installation and Checkout, for special instructions and safety procedures.
2. Continue to those items below that are applicable to your situation and system configuration.

B. New Users Unfamiliar with Z-SCAN:

1. Read Section 2, General Description for an overview and glimpse of the features and capabilities of Z-SCAN.

2. Read Section 3 and perform the installation and checkout procedures applicable to your system configuration. All users should work from Sections 3.1 through 3.6. Users with a host system, see items E and F.
3. Read Section 4, Z-SCAN Monitor Tutorial and then work through the appropriate tutorial for your system configuration. The Z8002 and Z88001 tutorials are designed to accomplish two major tasks:
 - a. Familiarize the user with the functions and capabilities of Z-SCAN.
 - b. Assure that all Z-SCAN functions operate properly.
4. Read Section 6, Monitor Software Description, for more detailed information on commands and displays.
5. Continue to those items below that are best suited to your needs.

C. Users Familiar with Z-SCAN:

1. Review Section 4 and work through the appropriate tutorial for your system configuration.
2. See Section 6, Monitor Software Description for more detailed information on commands and displays.
3. Continue to any of the following items that best suit your needs.

D. Users With a Target System:

1. Complete all items from either B or C above.
2. Read Section 5 for the target system connections and supporting information that describes how the Z-SCAN 8000 interacts with the target during debugging.

E. Users with Z-SCAN and a Host System:

1. Complete all items from either B or C above.
2. If your Z-SCAN configuration includes a target system, complete item 2 of D above.
3. Complete Section 3.7 which describes how to connect a host system to Z-SCAN and initialize Monitor mode and Transparent mode.
4. Read Section 4, Z-SCAN Monitor Tutorials, and then work through the appropriate tutorial for your system configuration. Section 4.6 of the Z8002 tutorial and Section 4.8 of the Z8001 tutorial describe the downloading facility used by a host system.
5. If you have a non-Zilog host system, see F below.

F. Users With a Non-Zilog Host System

Z-SCAN is able to communicate with any system that supports asynchronous serial communication.

1. Complete all items from either B or C above.
2. If your Z-SCAN system configuration includes a target system, complete item 2 of D above.
3. Complete section 3.7 which describes how to connect a host system and initialize Monitor mode and Transparent mode.
4. If your host already supports Z-SCAN's downloading facility, you can familiarize yourself with its operation (Section 4.6 of the Z8002 tutorial and Section 4.8 of the Z8001 tutorial).
5. If your host does not support downloading, Section 7, Interface to Non-Zilog Host, contains the information needed to write the required host resident utility program.



SECTION TWO

GENERAL DESCRIPTION

2.1 INTRODUCTION

Z-SCAN 8000, the Zilog Stand-Alone In-Circuit Analyzer, is a free-standing peripheral unit that emulates Zilog's Z8001 and Z8002 16-bit microprocessors. These are MOS/LSI, register-oriented CPUs designed for general-purpose applications. Features of the Z8000 CPUs include:

- o Available as 40-pin nonsegmented version (Z8002) or 48-pin segmented version (Z8001)
- o 110 instruction types
- o Eight addressing modes
- o 64-kilobyte (Z8002) or 8-megabyte (Z8001) addressing capability in each of the six address spaces
- o Synchronous and asynchronous interrupts
- o Automatic dynamic RAM refresh
- o Single +5 V dc power supply
- o Single-phase clock
- o Advanced instructions, such as hardware signed multiplication and signed division, for both 16-bit and 32-bit words

The Z8000 CPU Technical Manual (document #00-2010-C) gives a detailed description of Z8000 CPU architecture and applications.

The Z-SCAN 8000 can operate with Zilog's family of development hosts by interfacing to the host and a CRT terminal via two RS-232C serial ports. Because it employs a standard serial interface, Z-SCAN can be used with any software host system that runs a cross assembler or cross compiler capable of generating Z8000 code. Z-SCAN supports the development and testing of this code. Z-SCAN communicates with a host system through a standard serial format that requires only simple download and upload utilities in the host system. For PROM-based target systems, the Z-SCAN can operate as a stand-alone unit with a CRT terminal because the monitor and debug software are EPROM resident.

In keeping with Zilog's design philosophy of separating a development system into two identifiable units (the software host and an emulation peripheral), the Z-SCAN fits into three environments.

- o As a peripheral to Zilog's Z-LAB 8000, PDS 8000 and ZDS-1 series of development systems, the Z-SCAN 8000 completes the Zilog development support package for the Z8001 and Z8002 microprocessors.
- o As a peripheral to any development host capable of compiling or assembling Z8000 code, the Z-SCAN 8000 offers a low-cost emulation capability, which precludes substantial reinvestment in a software host system.
- o As a stand-alone in-circuit emulator operating with a CRT terminal, the Z-SCAN 8000 provides simple testing and debugging capability for PROM-based target systems.

2.2 SYSTEM FEATURES

User Interface. Instead of a line-oriented interface, the Z-SCAN 8000 incorporates a two-dimensional, screen-oriented user interface, which makes it easy to use. A choice of screen erase, line erase and cursor addressing sequences is provided, allowing most popular terminals to be used.

The object of the user interface is to provide a screen format with a menu-like approach, which directs the user through the operations of the emulator. At all times, the Z-SCAN 8000 displays information about system parameters, system resources, current execution, and error messages. This feature keeps the user informed of the status of the debug process. When the system is turned on, a bootstrap routine produces a display, which informs the user of the unit's configuration and requests the user to define set-up parameters. A menu of display choices offers the user various system capabilities:

- o The Memory screen display shows the various memory and I/O manipulation commands that give the user access to the target system.
- o The Resources screen display presents the full range of arguments applicable to target system emulation.
- o The Execution screen display lists all the commands and parameters necessary for emulation.
- o The Trace screen presents a disassembled listing of each instruction executed during an emulation.

Execution of specific Z-SCAN monitor commands is always possible, and information on other relevant system parameters and resources is always displayed. This highly interactive user interface makes it possible to use the Z-SCAN 8000 without frequent reference to the operating manual.

Shadow Memory. Although the Z-SCAN system uses a single CPU for both monitor and emulation functions, no restrictions are placed on the size of the target system memory. This is because the entire Z-SCAN monitor resides in Z-SCAN PROM (shadow) memory and therefore does not use the target system memory space or addresses.

Hardware Trigger. The Z-SCAN 8000 offers the versatility of setting breakpoints in either of two fields or in a combination of these fields: the address/data field and the control/status field. A pass counter can be set from 0 to a maximum of 255 counts to allow multiple-pass triggering. In addition, Z-SCAN 8000 can also be set to break on instruction fetches only (single-step execution) or, by using a pass counter, can be set for a maximum of 250 counts to allow triggering on multiple instruction fetches (multi-step execution).

The breakpoint logic has two operating modes. In the first, the address/data field and the control/status field must simultaneously match the programmed breakpoint condition to terminate an emulation. The second mode allows either an address/data match or a control/status match to terminate an emulation. This mode can be used to terminate emulation when either of two conditions is detected during an emulation, for example, execution of an instruction at a particular address or acknowledgement of an interrupt. This feature, when

combined with the multi-step mechanism, allows a break to be programmed on either of two target bus conditions or, if those conditions do not occur, after a set number of instruction fetches.

Mappable Memory. The Z-SCAN 8000 offers a 4K word (8192 bytes) block of high-speed static RAM. This block simulates a target system memory block, which typically is ROM. No wait states are required at 4 MHz. This block is mappable anywhere in the Z8000 address space and can be specified to respond to any combination of normal code, normal data, normal stack, system code, system data or system stack accesses. Mapping must be done on 4K word boundaries only, and the entire block can be protected against illegal emulation memory writes, causing the emulation to either terminate or continue, depending on user options. When a break results from a write protect violation, an error message appears on the CRT display informing the user of an illegal write.

Memory Peek. The Z-SCAN 8000 has a software feature that displays the contents of three 4-word areas of target memory. The display is updated every time an emulation terminates and it supplements the information displayed in the register contents. The three areas displayed, can be at any address in any memory space (system code, normal data, etc.). In addition, the Trace screen displays the data at the top of normal and system stacks.

Wait States. Under software control, Z-SCAN can insert zero to eight wait states in each bus transaction.

2.3 Z-SCAN 8000 SPECIFICATIONS

Processor:	Nonsegmented 40-pin Z8002 CPU or segmented 48-pin Z8001 CPU
Clock Rate:	3.3 MHz (internal), 500 kHz to 4.0 MHz (external)
I/O:	Two RS-232C serial ports for terminal and host
CRT:	A choice of popular types (see Table 6.6)
Baud Rate:	Automatically adjusted from 50 to 19.2K per baud set on the terminal
Mappable Memory:	4096 x 16 static RAM (no wait states at 4 MHz when operating off user clock)
Breakpoint:	Address, data, control, address and control, data and control, instruction fetch; or a combination of instruction fetch and any field argument. The address field on the Z8001 may be offset, segment or segment and offset.
Emulator Input Loading	Reset (RESET-), data strobe, (DS-), non-maskable interrupt (NMI-), vectored interrupt (VI-), non-vectored interrupt (NVI-), segment trap (SEGT-): one low-power Schottky transistor-to-transistor logic (LS-TTL) load plus 10k pullup plus 30 pF max. All others: one LS-TTL load plus 30pF max.

Emulator Output Drive:	Driven by LS-TTL buffer with 33 ohm series termination
Cables:	
Z8002 Emulator Cable	18 inches
Z8001 Emulator Cable	18 inches
Terminal Cable:	48 inches
Front Panel:	TARGET/MONITOR toggle switch, RESET and NMI momentary switches, POWER rocker switch with indicator. 40-pin connector, 3M type 3495 (Z8002) 48-pin connector, 3M type 3496 (Z8001)
Rear Panel:	BNC connector for pulse output, standard LS-TTL level 2x25 pin connectors, 3M type 3483 (terminal and host) 3-pin power connector 1-1/4 in. fuseholder, screwdriver-release type 115/220 voltage selection slide switch
Power:	180-264V ac or 90-130V ac switch selectable; 47-63 Hz; 60 VA max.
Fuse:	1-1/4 in. antisurge, 3 A (120 V), 1.5A (220 V)
Dimensions:	4 in. (10.2 cm) (H) x 17.5 in. (44.5 cm) (W) x 14.5 in. (36.8 cm) (D)
Environmental:	Operates at 10°C to 50°C: relative humidity 10% to 90%
Unit Weight:	25 pounds
Shipping Weight:	30 pounds

2.4 ORDERING INFORMATION

05-0103-01	Z-SCAN 8000 Emulator (Supports Z8001 and Z8002 Emulation and Control)
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2.5 RECOMMENDED SYSTEMS FOR USE WITH Z-SCAN 8000

Model	Description	Prerequisite
ZDS-1/25, 1/40	Zilog Development Systems, Floppy-based	Z8000 Software Development Package
PDS 8000, Models 10, 15, 30, 35	Zilog Product Development Systems, Floppy and Hard Disk	Z8000 Software Development Package
Z-LAB 8000	Development Station	None

SECTION THREE

UNPACKING, INSTALLATION AND CHECKOUT

3.1 INTRODUCTION

This section contains instructions for unpacking, installing, checking, and verifying a Z-SCAN unit equipped with either a Z8001 or a Z8002 CPU. The latter part of the section describes the set-up and initialization of a link between the Z-SCAN and a host system. A trouble shooting guide is also included to help users. Refer to Section Five for the target system connection and verification procedures.

All Z-SCAN 8000 shipments include factory-selected 6MHz Z8001A CPU and Z8002A CPU components. The performance of the unit is impaired if standard speed 4MHz parts are used. Z-SCAN units are shipped with the Z8001A CPU already installed in the unit and the Z8002A CPU separately packaged in a plastic box inside the shipping container.

The following procedures should be followed only if there is no indication of damage. If any damage is detected, installation of the equipment should be immediately suspended and a Zilog field service representative should be contacted.

Three levels of important notations appear within this section to bring attention to specific information and safety precautions. These notations and their purposes are:

NOTE	Calls attention to specific points of technical or procedural importance.
CAUTION	Calls attention to conditions that could cause possible damage to equipment or facilities.
WARNING	Calls attention to conditions that could cause serious injury to personnel.

3.2 UNPACKING

Every Z-SCAN 8000 system is fully inspected and tested before shipment to ensure that it meets specifications. All equipment is packaged for safe transit under normal freight-handling conditions and should arrive ready to be installed. Before unpacking the system, inspect the shipping container for signs of possible damage to the unit during transit. If shipping damage is suspected, claims with the freight carrier should be filed immediately.

To unpack the system, the following steps should be taken:

1. Open top end of box and remove packing.
2. Lift system out of the carton and remove polyethylene plastic covering.

3. Locate the packing list, cables, and accessories and check to see that all items on the packing list are accounted for.
4. Replace all packing in the shipping container and store the container until the unit has been checked out and is considered operational, or if possible, keep all packing material for future use (see Section 3.2.1).
5. Inspect the Z-SCAN unit for external damage, such as dents, broken switches or loose connections. Any sound of loose items inside the cabinet is evidence of damage. **If damage is evident or suspected, make no further attempt to operate the system.**

If there is no damage a unit checkout followed by a system setup and checkout (see sections 3.5 and 3.6) should be performed without the target or host system.

3.2.1 Reshipment or Relocation

The packing material has been specially tested to protect Z-SCAN for shipment, therefore the packing boxes and materials should be retained after unpacking.

--NOTE--

Refer to Section 5.2.4, Care of the Emulator Cable, before disconnecting or relocating the Z-SCAN system.

Repack the Z-SCAN equipment in the original packing material for reshipment.

3.3 Z-SCAN 8000 POWER CONNECTION

Connecting power to a Z-SCAN 8000 is the same regardless of whether the system will be used as a Z8001 or a Z8002 system. **Special consideration must be given, however, to the power cord used for Z-SCAN, especially if the system is to be used in countries outside United States.** See Section 3.3.1 for information regarding Z-SCAN's power cord for U.S. usage, or Section 3.3.2 for information on Z-SCAN's special power cord to be used in all foreign countries.

--WARNINGS--

- a. The Z-SCAN 8000 must be operated with a three-wire grounded power system. Do not use a two-wire power system, as this can damage the Z-SCAN unit and poses a safety hazard to operators and maintenance personnel.
- b. The top cover of the unit must not be removed while the unit is connected to a power receptacle. Hazardous voltages exist around the power transformer, the fuse and the power switch. These areas are shown in Figures 3-1 and 3-2.

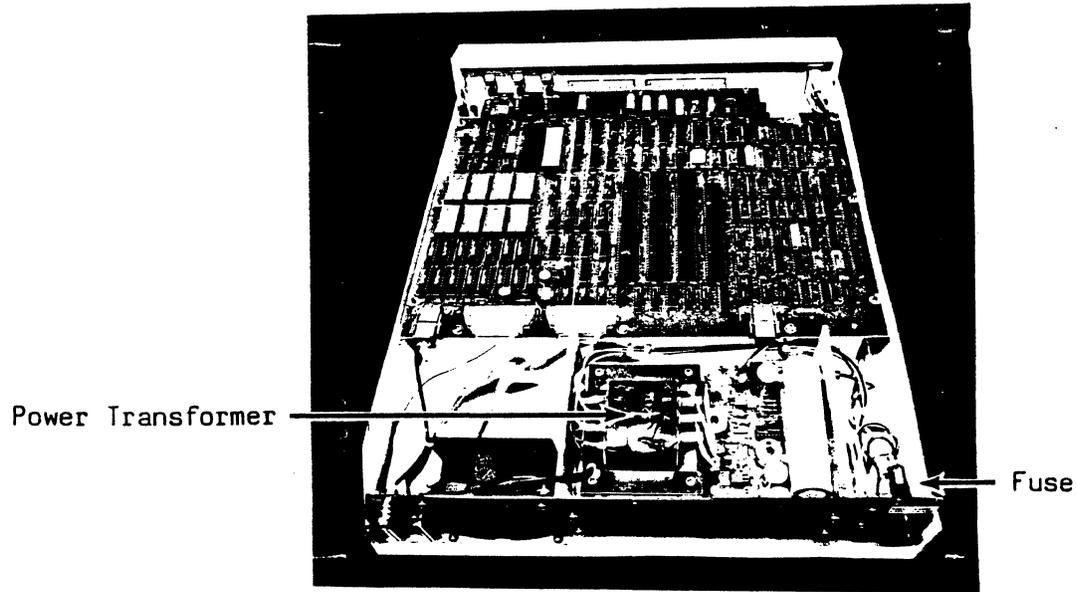


Figure 3-1. High Voltage Areas - Rear

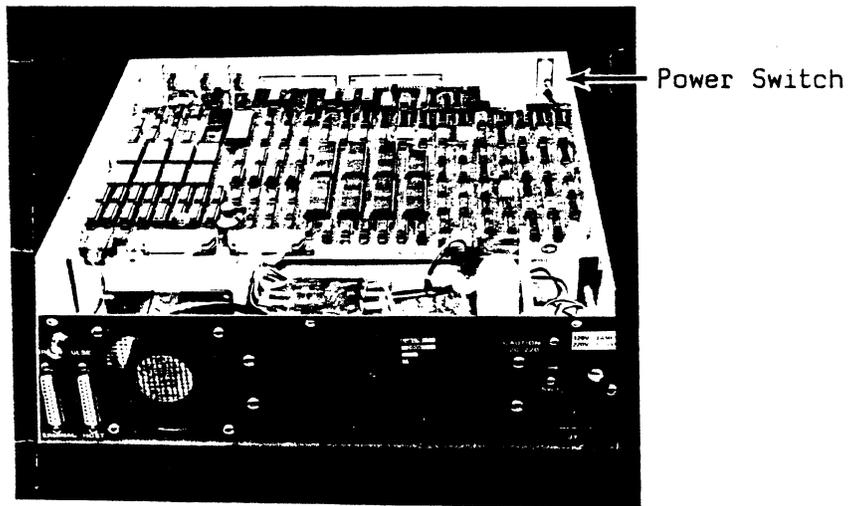


Figure 3-2. High Voltage Areas - Front

Power Up Sequence

1. Turn the red power switch on the Z-SCAN front panel to the OFF position. Figure 3-3 illustrates the switches and connections on the Z-SCAN front panel.

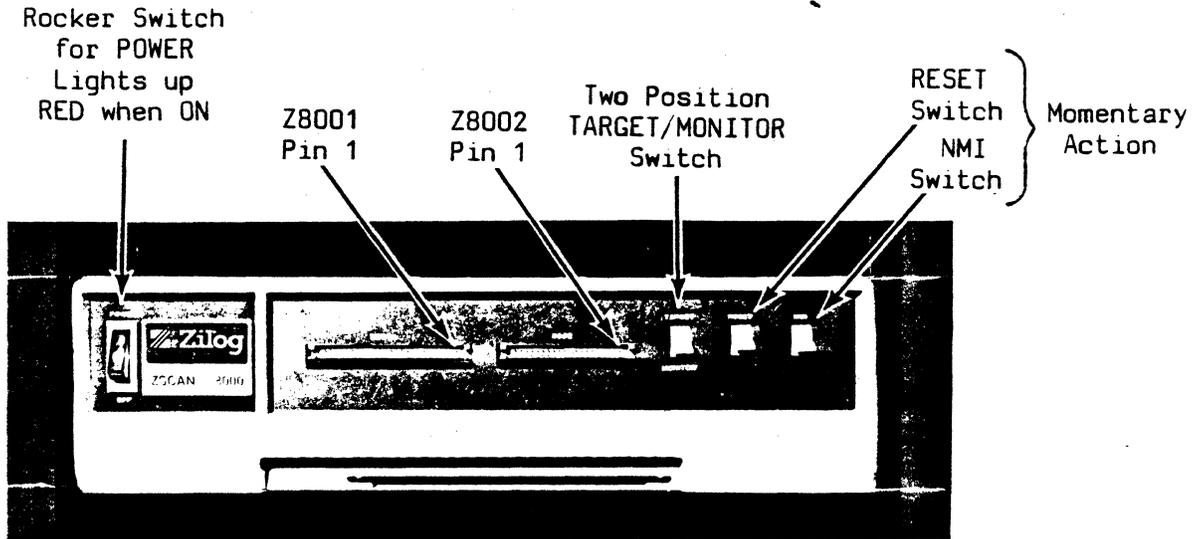


Figure 3-3. Z-SCAN Front Panel

2. Locate the 115/220 voltage selection switch on the Z-SCAN rear panel and verify that it is set correctly for the electrical power source to be connected to the Z-SCAN system. Refer to Figure 3-4 for the approximate location of the voltage selection switch.
3. Locate the correct power cord for your country, and discard the other one. Two power cords are included in Z-SCAN 8000 shipments: the power cord to be used in the United States is shipped completely assembled (see Section 3.3.1); the power cord shipped without a plug is to be used in countries outside the United States. Refer to Section 3.3.2 for the instructions to attach a three-wire grounded power plug to this cord.

3.3.1 U.S. Power Cord

The U.S. power cord meets the U.S. National Electrical and Manufacturing regulations and is suitable for use in the United States only. This power cord is identified by the molded plug attached to the cord and is ready to be connected to the Z-SCAN unit. Figure 3-4 identifies the location for the power connection on Z-SCAN's rear panel.

--WARNING--

Do not use the U.S. power cord in any other country as it could damage the Z-SCAN system and pose a safety hazard to operators and maintenance personnel.

Should Z-SCAN's power cord for U.S. usage at any time require a new plug, be sure that the new plug is a three-wire plug and that it is properly grounded.

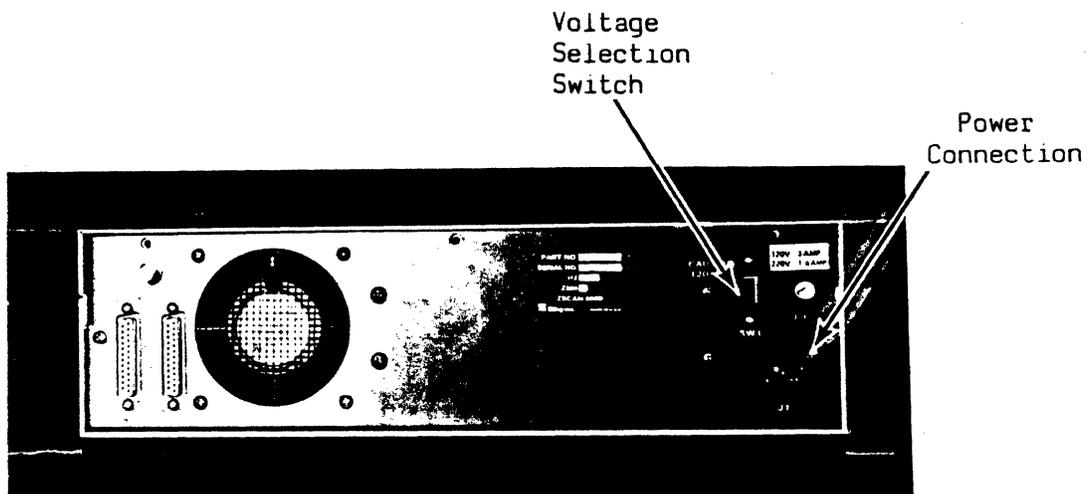


Figure 3-4. Z-SCAN Rear Panel

3.3.2 Power Cord for Other Countries

--WARNING--

The Z-SCAN unit must be safety grounded (earthed).

The power cord for countries outside the United States is shipped without a plug attached. Use the following instructions to connect a plug:

Connecting a Three-wire Plug for Usage In All Countries Except the United States

The wires in European power cable (mains lead) are colored in accordance with the following code:

- Green and Yellow - Earth (safety grounded)
- Blue - Neutral
- Brown - Live

Since these colors might not correspond with the colored markings identifying the terminals in your plug, connect as indicated in Table 3-1.

Table 3-1. Cable Leads to Connector Terminal Interconnections

Cable Lead (Wire Color)	Use	Connector Terminals: Marking or Color	
1. Green and yellow	Ground (Earth)	E or Earth	Green or Yellow and Green
2. Blue	Neutral	N	Black
3. Brown	Live	L	Red

3.4 Z-SCAN UNIT OPERATIONAL CHECK

It is important that following the unpacking and installation of the proper power cord to the Z-SCAN unit, all users perform the following initial check of the Z-SCAN unit. **These procedures determine if your Z-SCAN unit is operational and must be done before connecting the CRT terminal to Z-SCAN or before changing the CPU to the Z8002 CPU.**

--NOTE--

If during the unpacking the Z-SCAN unit appeared undamaged and the power cord installation has been successfully completed, this procedure must be attempted before requesting repair service.

1. Set the voltage selection switch (rear panel of Z-SCAN) to the proper setting for your facility. The two settings on Z-SCAN's voltage selection switch are 115 and 230. See Figure 3-4, Z-SCAN Rear Panel.
2. Power up Z-SCAN by turning the red rocker-type switch on the front left panel to the POWER position. This turns the electrical power on to the Z-SCAN unit. See Figure 3-3, Z-SCAN Front Panel.
3. Make sure that the red indicator in Z-SCAN's power switch is illuminated.
4. Make sure that the Z-SCAN cooling fan is running; do not block the fan exhaust area with cables, books, prints, etc.
5. Place the front panel TARGET/MONITOR switch in the MONITOR position. This is a two-position switch; the "up" position is used for Target mode operations, and the "down" position is used for Monitor mode operations.
6. Verify that the two other front-panel switches (to the right of the TARGET/MONITOR switch) toggle correctly. These toggle switches are the RESET switch and the NMI switch. Push up on each switch to toggle it. When released the switches should return to their original positions.
7. Turn the power switch to the OFF position.

3.5 Z-SCAN 8000 AND CRT TERMINAL CONNECTION

Three ribbon cables are included with Z-SCAN as follows:

- o A 25-pin terminal cable, 1-1/4" (3.2 cm) wide with identical 25-pin connectors at each end
- o A 48-pin emulator cable for the Z8001, 2-1/2" (6.5 cm) wide
- o A 40-pin emulator cable for the Z8002, 2" (5.2 cm) wide

1. Select the terminal cable.
2. Connect one end of the terminal cable to the Z-SCAN rear panel RS-232 connector labeled "terminal." Figure 3-5 illustrates the connecting areas for the CRT terminal and Z-SCAN 8000 (stand-alone configuration).

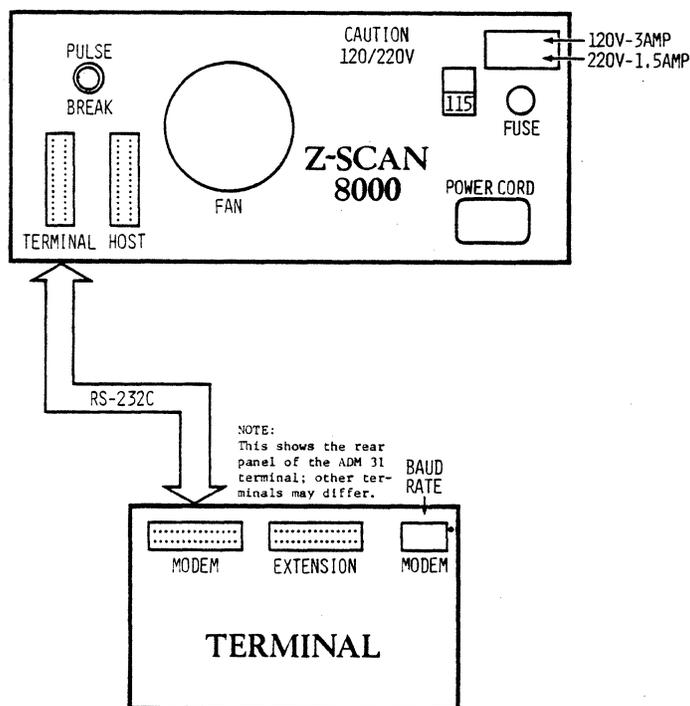


Figure 3-5. Z-SCAN Unit and Terminal Connections (Stand-Alone Configuration)

3. Connect the other end of the terminal cable to the main port connector on the rear panel of the CRT terminal. This socket is labeled "MODEM" on most types of terminals.

--NOTE--

Other CRT terminal connectors for printers or auxillary equipment are not used by Z-SCAN.

4. Verify that the Z-SCAN 8000 and the CRT terminal are connected to a working power outlet. DO NOT TURN ON EITHER UNIT AT THIS TIME.
5. Ensure that the CRT terminal is set to a baud rate supported by the Z-SCAN. Table 3-2 lists supported speeds. Appendix A gives details of specific terminals. A baud rate of 9600 is recommended for most applications.
6. Power up the CRT terminal only. A cursor should appear at top left of the CRT display shortly after power up.
7. Depress the Cap Lock key and ensure that the CRT terminal is in Cap Lock Mode. All of Z-SCAN's system operations require that the Cap Lock mode be selected on the CRT terminal. This mode is identified on the ADM 31 by the illumination of the red cap lock indicator when the key is depressed. This mode is exited by pressing the Cap Lock key again. Consult Appendix A and the terminal documentation for information on other types of terminals.
8. Turn the CRT terminal power switch to OFF.

3.6 Z-SCAN 8000 VERIFICATION

It is assumed that all previous procedures have been correctly performed up to this point. Begin the following procedures with both the Z-SCAN unit and the CRT terminal turned OFF.

A. CRT Terminal Power Up and Setting the Hardware Baud Rate.

1. Power up the CRT terminal connected to Z-SCAN. A cursor should appear at the top left of the CRT display about 10 seconds after power up.
2. Make sure that the cursor is displayed on the CRT terminal. If the cursor does not appear, refer to the Troubleshooting Guide at the end of this section.
3. Ensure that the terminal is set to a baud rate supported by the Z-SCAN. Table 3-2 lists supported speeds. Appendix A gives details of specific terminals. A baud rate of 9600 is recommended for most applications.
4. Make sure that the terminal is in Cap Lock mode.

Table 3-2. ADM 31 Baud Rates Supported by Z-SCAN

Baud Rate	ADM 31 Switch Setting
75	1
110	2
134.5	3
150	4
300	5
600	6
1200	7
1800	8
2400	10
4800	12
9600	14

B. Z-SCAN Unit Power Up and Power Check

1. Power up Z-SCAN by turning the red rocker-type switch on the front left panel to the POWER position.
2. Make sure that red indicator in Z-SCAN's power switch is illuminated. This tells you that the Z-SCAN unit is turned on, and that power is being received from the power outlet.
3. Make sure that the Z-SCAN cooling fan is running and that the fan exhaust area is kept clear.

C. Initialize the Monitor Mode, Terminal Selection Screen and System Screen.

1. Place the front panel TARGET/MONITOR switch in the MONITOR position. This switch must be in the MONITOR position for Z-SCAN system verification.
2. Toggle the RESET switch. This initializes the Z-SCAN monitor software, instructing it to synchronize its baud rate with that of the terminal as soon as a RETURN character is received.
3. Press RETURN once (on the terminal keyboard). Z-SCAN uses this character to complete the baud rate synchronization with the terminal and then display the Terminal Selection screen. This display is shown in Figure 3-6.

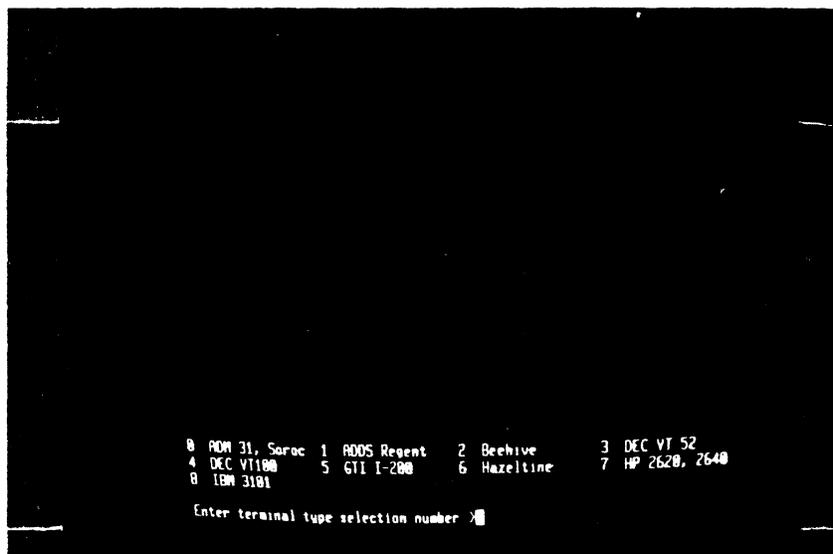


Figure 3-6. The Terminal Selection Screen

4. Enter the appropriate terminal type selection number for your particular terminal. For convenience, the selection is shown on the Terminal Selection screen display. Refer to Appendix A for further information regarding the terminals supported by Z-SCAN.

If an incorrect number was entered for the terminal type selection number (Terminal Selection), you must retrace the first three steps of item C to display the Terminal Selection screen again.

5. Enter a RETURN to display the System screen. As indicated in Figure 3-7, the System screen contains the following information:

- o Z-SCAN 8000 (top line), Monitor and Version (second line) followed by a broken line.

- Terminal baud rate displays the speed at which the terminal is running.
- Host baud rate. This variable field defaults to the same value as the terminal baud rate. See Section 6.9 for further information regarding the host baud rate.
- Status to target. The default value, internal_op, appears in this variable field when the System screen is initially displayed. A broken line is displayed below the status to target field. See Section 6.9 for further information on the System screen and this field.
- The bottom line on the System screen contains the name of the screen displayed (in parentheses) with the additional names of screens available from that screen. Detailed information on the monitor software is found in Section 6.

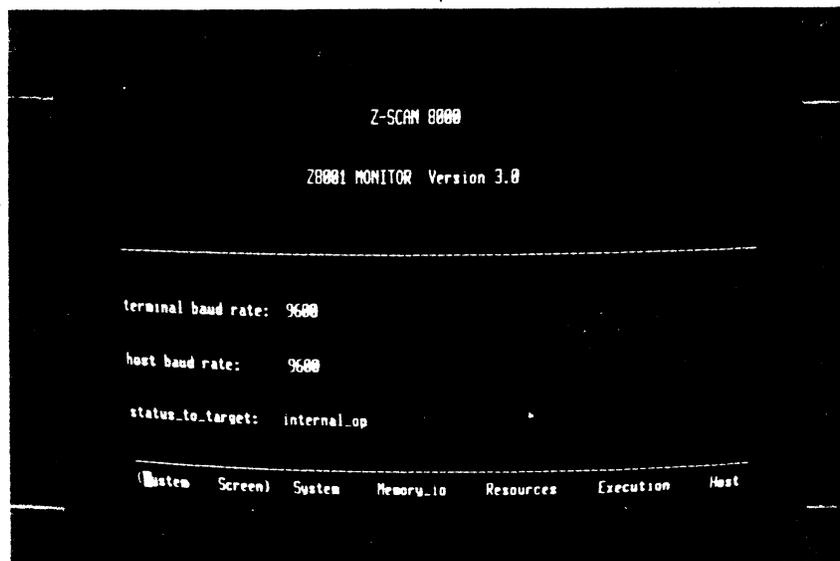


Figure 3-7. The System Screen

If you have had problems executing the procedures in this section, refer to the Troubleshooting Guide at the end of this section.

Refer to Section 4 and review the monitor tutorial for your system. Section 4 contains Z8001 and the Z8002 tutorials, both of which exercise the Z-SCAN monitor and familiarize the user with the various functions performed in Monitor mode.

3.7 Z-SCAN CONNECTION TO HOST SYSTEM

It is assumed that the user has successfully completed all of the previous installation and checkout procedures for the Z-SCAN 8000 unit and the CRT terminal connection.

The following step-by-step procedures specify how to **safely** connect a host system to the Z-SCAN system, and perform the basic initialization of the Monitor mode and Transparent mode operations.

If you have problems performing any of the following steps, refer to the Troubleshooting Guide at the end of this section.

A. Connect Host System to Z-SCAN.

1. Before connecting the host system to Z-SCAN, turn all units OFF: the Z-SCAN unit, the CRT terminal, and the host system.
2. Connect the host system terminal cable to the RS-232C connector on the rear panel of Z-SCAN that is marked "Host". Figure 3-8 illustrates the proper connections. Table 3-3 lists the socket to which the terminal cable should be attached on Zilog host systems.

Table 3-3. Zilog Host System Terminal Connectors

System Type	Socket Designation
PDS 8000 Model 5, 10, 15	J106
PDS 8000 Model 20, 25, 30	J106
ZDS 1/25	J108
ZDS 1/40	J106

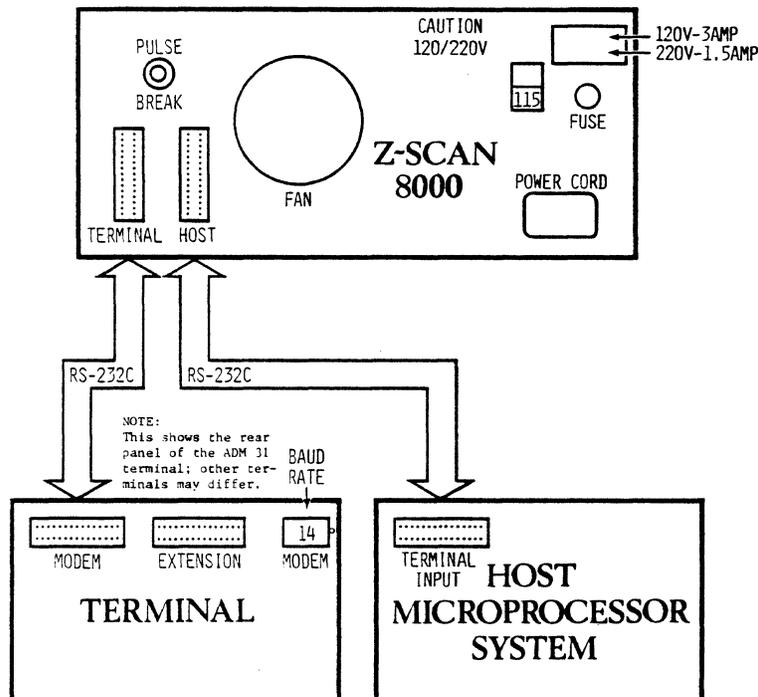


Figure 3-8. Z-SCAN/Terminal/Host Configuration

B. Initialize Monitor Mode, Terminal System Screen and System Screen.

1. Turn all units ON (CRT terminal, Z-SCAN and host system).
2. Toggle the RESET switch again and press RETURN once. The Terminal Selection screen appears.
3. Enter the appropriate terminal type selection number on the Terminal Selection screen and press RETURN once. The System screen appears on the terminal and Z-SCAN is now in Monitor mode.

If an incorrect terminal type selection number for your type of terminal is entered on the Terminal Selection screen, it is necessary to redo step two which re-initializes the Terminal Selection screen and then enter a RETURN to initialize the System screen.

C. Select Parameters for Variable Fields on System Screen.

1. If the host operates at a baud rate which differs from that of the terminal enter RETURN to move the cursor into the first variable field (host baud rate) on this screen.
2. Use the SHIFT and > keys to select the appropriate baud rate for your host terminal. Refer to Table 3-4 for the host baud rates supported by Z-SCAN.

Table 3-4. Host Baud Rates Supported by Z-SCAN

19,200	1,200	134.5
9,600	600	110
4,800	300	75
2,400	200	50
1,800	150	

3. If you wish to change the default value of the status_to_target field, use the cursor down key to move the cursor from the host_baud rate to this variable field, then use the SHIFT and > keys repeatedly to select the parameter desired.
4. A RETURN must be entered to move the cursor from either of the two variable fields in the System screen to the System screen name (menu area).

NOTE

The cursor must be on the System screen name to either continue operations in Monitor mode or to change to Transparent mode.

D. Change to Transparent Mode from Monitor Mode.

1. To select Transparent mode, type H. The initialization message for the Host screen is the word HOST which appears in the upper left-hand corner of the screen. If the terminal and host baud rates differ, set the terminal baud rate to match that of the host, then enter RETURN.

The Z-SCAN system is now in the Transparent mode and serves only as a link between the terminal and the host system.

Entry of a RETURN should elicit the same response from the host, as would be expected if the terminal was directly connected to the host. Refer to the host's documentation for further details.

E. Return to Monitor Mode from Transparent Mode.

1. Press the terminal keyboard BREAK key.
2. If the baud rates selected for host and terminal differ, set the terminal baud rate to match that required by the Z-SCAN monitor, then enter RETURN. When the terminal baud rate is correct, the Z-SCAN returns to Monitor mode and displays the System screen.

3.8 TROUBLESHOOTING GUIDE

It may happen that the correct display does not appear on the terminal screen at the end of the verification procedure, or that the host system does not respond correctly. In most cases, this indicates a small oversight in connection or verification rather than a fault with the Z-SCAN or the terminal. Table 3-5 lists the most common symptoms of problems and their causes.

Table 3-5. Troubleshooting Guide

Symptom	Cause	Solution
1. Cursor does not appear and cap lock indicator does not illuminate when terminal switched on.	Terminal is not receiving power from the power outlet.	Use a live power outlet and check terminal power connection and switch.
2. Cursor does not appear when terminal switched on.	Brightness control incorrectly adjusted.	Adjust control (small adjacent to baud rate switch on ADM 31 rear panel).

Table 3-5. Troubleshooting Guide

Symptom	Cause	Solution
3. Terminal displays meaningless data as soon as it is switched on.	Z-SCAN was powered on before terminal and has interpreted switch-on of terminal as a baud rate synchronization signal.	Toggle Z-SCAN RESET switch, then enter RETURN. Check to see that the selected baud rate is supported by Z-SCAN (Table 3-4).
4. Terminal displays meaningless data after RETURN entered.	The value set on the baud rate switch at the rear of the terminal corresponds to a rate not supported by Z-SCAN.	Reset the baud rate switch at the rear of the terminal to a baud rate supported by Z-SCAN. Then toggle Z-SCAN RESET switch and enter RETURN.
5. No display after RESET and RETURN entered.	Z-SCAN not correctly connected to terminal.	Check that cable links modem socket on terminal to terminal socket on Z-SCAN. Then toggle the Z-SCAN RESET switch and enter RETURN again.
	Z-SCAN's internal clock source jumper is in "external" position. (All units are shipped with this jumper in the "internal" position.)	Refer to Section 5.2.1 for instructions on altering clock jumper position.
6. System screen not displayed correctly after entry of terminal selection number and return.	Terminal selection number incorrect. Terminal's option switch settings incorrect.	Repeat instructions of Section 3.6 using correct selection number. Refer to Appendix A and terminal documentation. Repeat instructions of Section 3.6 with correct settings.
7. Host system does not respond to characters entered after Z-SCAN has displayed "host" message or responds with garbage.	Host incorrectly connected or in need of initialization. Host baud rate does not match Z-SCAN and terminal baud rate.	Check cable and refer to host system documentation. Set terminal baud rate (Table 3-1), toggle Z-SCAN RESET switch, then enter return H.

3.9 CHANGING THE CPU

The Z-SCAN 8000 can emulate either the Z8001 or the Z8002 CPU, depending on the CPU type installed in the unit. The same monitor software PROMs and option jumper settings are used for either CPU type.

To change the CPU, proceed as follows:

1. Switch Z-SCAN power off by pressing the red power switch located on the front panel to the OFF position.
2. Remove the power cord from the socket on the rear of the unit.

--WARNING--

Failure to remove power from the unit prior to removal of the cover may result in exposure to hazardous voltages.

3. Remove the three screws and washers that secure the top cover of the unit, at the left, center and right of the rear panel, as shown in Figure 3-9. Store the screws and washers in a safe place.
4. Grasping the rear of the top cover, lift it upwards and move to the rear to release the cover from the top panel (Figure 3-9).

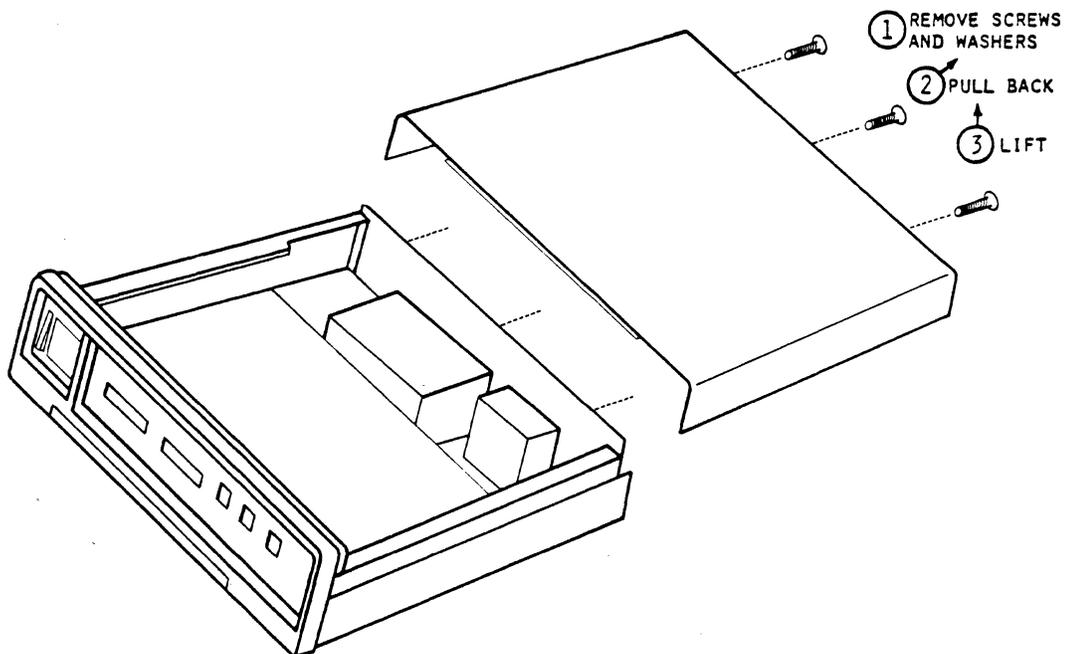


Figure 3-9. Top Cover Removal

5. Locate the two CPU sockets towards the front right of the Z-SCAN circuit board. Using a small screwdriver or IC removal tool, gently pry the installed CPU from its socket and place in conductive foam for safekeeping.

--CAUTION--

To avoid possible damage to NMOS components by static discharge, it is recommended that both the Z-SCAN chassis and the user are grounded through a high-impedance circuit while the CPU is changed. **Do not use the power cord to effect a ground connection.**

6. Install the alternative CPU in the correct socket. Care is required to avoid bending the pins. The 40-pin socket for the Z8002 is on the left, and the 48-pin socket for the Z8001 is on the right. The notch identifying pin 1 of the component must face towards the rear of the unit.
7. To replace the top cover, locate the front flange under the front bezel; insert the front edge of the top cover under the front bezel and swing the rear down. Make sure that the rear flange is inside the rear panel of the unit.

--WARNING--

Do not connect power to the unit until the top cover has been replaced and secured.

8. Replace the screws and washers removed in step three.
9. Reconnect the power cord to the rear of the unit and verify correct system operation by following the procedure of Section 3.6.

SECTION FOUR

Z-SCAN MONITOR TUTORIAL

4.1 INTRODUCTION

Z-SCAN monitor software is designed to utilize the facilities offered by a CRT (cathode ray tube) terminal. The entire CRT is used to present the required information, which gives a more complete picture of emulation status than would be possible on a printing terminal. This two-dimensional user interface also allows Z-SCAN to display, for user reference, all the commands that might be entered in a particular context.

These features make the monitor software very easy to use. The tutorial sessions in this section provide keystroke-by-keystroke and screen-display-by-screen-display introduction to the Z-SCAN monitor software. As the keystrokes and displays differ slightly between the Z8001 and Z8002 CPUs, two versions of the same tutorial are presented.

The tutorials are not designed to present every feature of the Z-SCAN monitor in detail. Instead, they give a feeling for the way the software operates. Section 6 gives definitive information about each of the Z-SCAN monitor commands.

4.2 TUTORIAL HARDWARE REQUIREMENTS

The majority of the session requires no equipment other than a Z-SCAN unit and a terminal. There is no need for Z8000-based target equipment, because Z-SCAN can run emulations even when no target is connected. The final part of each tutorial requires a Zilog host system for demonstrating the Z-SCAN downloading facility. If you do not have a Zilog host system, you can still run the download demonstration if download software compatible with Z-SCAN exists on your host. For most hosts, this software is provided by the supplier of the Z8000 support software that operates on the host. If your host does not support the Z-SCAN download protocol, Section 7 provides the information required to write a suitable utility program. If you do not have a host system, the example programs can be copied from the Z-SCAN monitor ROM instead of being downloaded.

The parts of the tutorials that demonstrate the download facility do not depend on conditions set up in the previous sections of the tutorials. This means that you do not need to work through the first part of the tutorial script if you only want to use the part dealing with the Load command.

4.3 THE KEYBOARD AND USER CONTROLS

Figure 4-1 shows the layout of the Lear Siegler ADM 31 terminal keyboard. Before starting this tutorial, it is important to know the positions of the keys required and the symbols used in the text to designate these keys. This information is listed in Table 4-1. If your terminal is not an ADM-31, consult Appendix A and the terminal's documentation to find the corresponding keys on its keyboard.

Table 4-1. Key Names and Locations

Key Name	Key Symbol	Text Symbol	ADM-31 Keyboard Position
(letters)	A through Z	A through Z	Center left. Ensure cap lock key is lit.
(numbers)	0 through 9	0 through 9	Top left to center or numeric pad at right
return	RETURN	RETURN	Far right or center right
space	(blank)	space	Bottom
control-R	CTRL R	CTRL R	Press the control key and R simultaneously.
break	BREAK	BREAK	Top center right
less than	<	<	Bottom center - press shift key and comma simultaneously
greater than	>	>	Bottom center - press shift key and period simultaneously
cursor down	↓	down	Bottom right
cursor up	↑	up	Bottom right
cursor left	<--	left	Bottom right
cursor right	-->	right	Bottom right

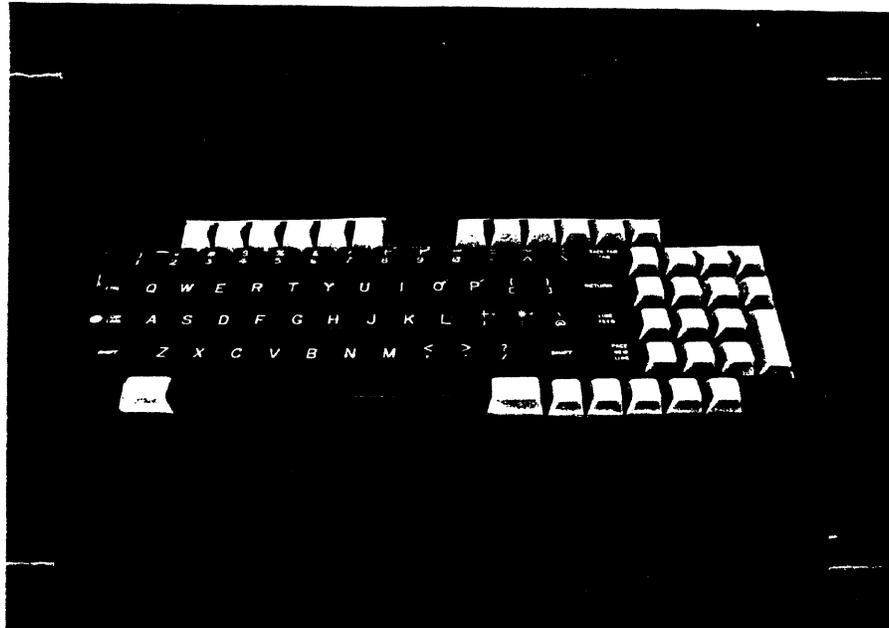


Figure 4-1. Lear Siegler ADM 31 Keyboard Layout

NOTE

When using the Lear Siegler terminal with Z-SCAN, the indicator in the cap lock key at the far left of the keyboard must be illuminated; Z-SCAN ignores lower case letters except when they are used in file names. The cap lock or shift lock key must also be engaged on other terminal types.

Certain key symbols are set in boldface in the tutorial to aid in identifying error recovery points, (as described in Section 4.4.1). Enter these keys as you would normally.

Table 4-2 describes the four operations possible with the Z-SCAN front panel switches. Section 5.3 describes the effects of the TARGET/MONITOR, RESET and NMI switches.

Table 4-2. Z-SCAN Front Panel Switch Operation

Text Representation	User Action
Monitor RESET	1) Check that MONITOR/TARGET switch points to MONITOR 2) Push RESET switch up
Monitor NMI	1) Check that MONITOR/TARGET switch points to MONITOR 2) Push NMI switch up
Target RESET	1) Check that MONITOR/TARGET switch points to TARGET 2) Push RESET switch up
Target NMI	1) Check that MONITOR/TARGET switch points to TARGET 2) Push NMI switch up

Photographs of the Z-SCAN screen illustrate the sequence of operations. Each step in the sequence is separated by a comma and a space. Do not enter either. Table 4-3 gives examples of keying sequences as they are shown in the tutorial script and as they are actually entered.

Table 4-3. Key Sequence Examples

<u>Script</u>	<u>Keystrokes Required</u>
A, 8, 0, B	A80B
>, <, <, 0, 1	><<01
Q, S, R, A	QSRA

4.4 TUTORIAL PRESENTATION

Before beginning the tutorial, the Z-SCAN must be powered up and connected to a terminal, as described in Section 3.5, steps 1 through 8. If you have a Zilog host system, it must also be connected to the Z-SCAN in order to demonstrate the download feature. Host connection is detailed in Section 3.7, steps 1 through 7.

The tutorials are presented as a series of steps in tabular form. For each step, a sequence of operator actions is given. For the first few steps, you will probably want to enter each keystroke separately, examining its effect on the display before entering the next. As you become more familiar with the monitor, you will recognize common keystroke sequences that can be entered as a block. The Z-SCAN monitor has a type-ahead feature that allows it to accept

new user input before it has finished processing previous input. Note, however, that type-ahead only operates when the monitor software is running, not when a user program is running during an emulation. You will also recognize that not all the keystrokes listed for each step are strictly necessary. Some redundant entries are included simply to illustrate their effect.

The accompanying text explains the effect of your input for each step in the script. In most cases, photographs of the screen highlight areas of interest. The text introduces a number of technical terms specific to Z-SCAN. The first appearance of each term is in boldface.

4.4.1 Error Recovery

It is quite likely that sometime during the tutorial you will make a keying error. Often this has no effect, because in many situations Z-SCAN ignores invalid input. You simply need to follow the incorrect keystroke with the correct one.

In other cases, an incorrect key can be accepted as valid input. When this happens, what you see on the screen at the end of a step is not the same as the photograph in the manual. It is important to backtrack and fix the incorrect parts of the screen before proceeding to the next step in the tutorial. To make this easier, error recovery points are identified in the script. If, at the end of a step, the display is incorrect, proceed as follows:

1. If the cursor is not inside the parentheses on line 23 of the display, enter RETURN. If this does not move the cursor to line 23, try a second RETURN, BREAK or monitor NMI.
2. If the screen name at the left of the line in which the cursor now rests is not that shown in the most recent photograph, call up the correct screen by entering the first character of its name.
3. Re-enter tutorial input from and including the last boldface keystroke in the script to the end of the current step.
4. If the display is still incorrect, try to correct it by using unscripted key sequences. Make sure that the cursor is in the position shown on the photograph at the end of the sequence.
5. Should this fail to correct the error, the safest thing to do is to restart the tutorial from step 1. It should seldom be necessary to restart, especially as you become more familiar with the Z-SCAN commands.

4.5 TUTORIAL SCRIPT FOR Z8002

The Tutorial Script for the Z8002 begins on the following page. If your unit has a Z8001 installed, follow the tutorial of Section 4.7. Be sure not to type the commas or spaces shown throughout the key sequence.

- | Step | Key Sequence | Commentary |
|------|--------------------------|--|
| 1. | Monitor RESET, RETURN | Z-SCAN is RESET. All information about the previous state of the hardware and software is lost. The monitor software uses the RETURN character to set up a baud rate generator, then displays a menu of the CRT terminal types supported by the software. The cursor (a steady or flashing bright square on most terminals) appears in the center of the bottom screen line. |
| 2. | Terminal selection digit | To configure the monitor for your terminal, enter one of the digits listed in the menu. If your terminal is not one of those listed on the menu, consult Appendix A and the documentation for the terminal. Pick a digit that corresponds to a protocol supported by the terminal. |
| 3. | RETURN | The CRT screen is cleared, and the System screen is displayed. The cursor rests on the name of the screen, which is in parentheses on line 23, part of the menu area . This screen gives information about the status of the Z-SCAN hardware, for example, the installed CPU type and software revision level. The displayed baud rates and revision level may differ from those shown in the figure, but the CPU type must be the same. If it is not, follow the alternative tutorial of Section 4.7. If the display is corrupted, the digit entered in step 2 is incorrect and you must repeat the tutorial from step 1. |

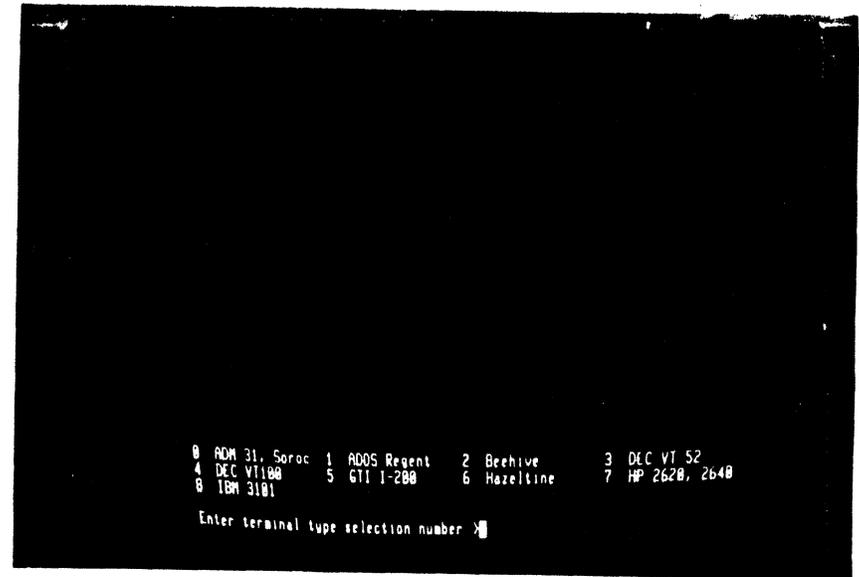


Figure 4-2. Terminal Selection Screen

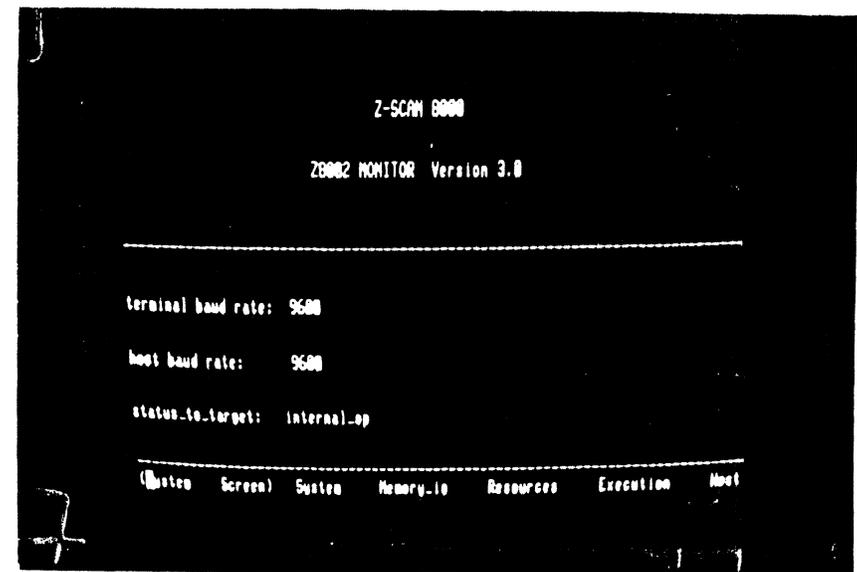


Figure 4-3. 78002 Monitor System Screen

Step	Key Sequence	Commentary
4.	M	The single-keystroke commands you are allowed to enter appear as upper-case letters in the words outside the parentheses in the menu area. The command M calls up the Memory_io screen. Again, the cursor rests on the name of the screen, which appears on line 23 in the menu area.

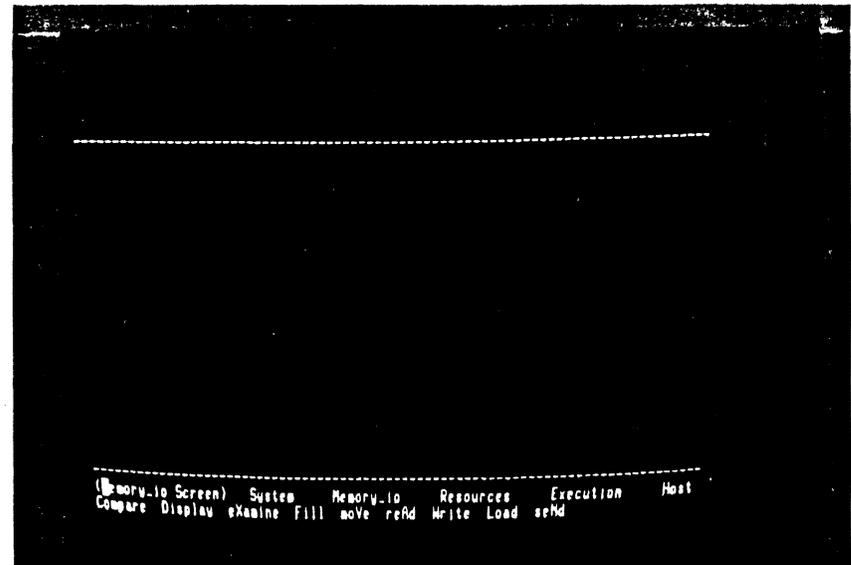


Figure 4-4. Z8002 Monitor Memory_io Screen

5.	S, R	Among the valid commands shown in the menu area is S. Entering the command reactivates the system screen. A third screen, the Resources screen, can be called up by entering R. As usual, the cursor rests on the screen name, and legal commands are listed in the rest of the menu area.
----	------	---

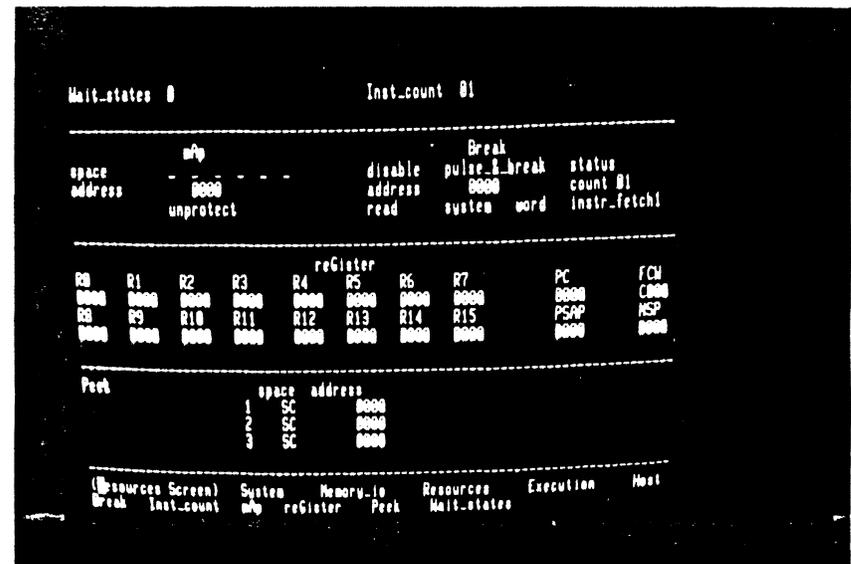


Figure 4-5. Z8002 Monitor Resources Screen

Step	Key Sequence	Commentary
6.	E	In step 5, you went from one screen to another by way of the System screen. However, it is usually possible to move from one screen to another with a single keystroke. The Execution screen is activated by the command E.

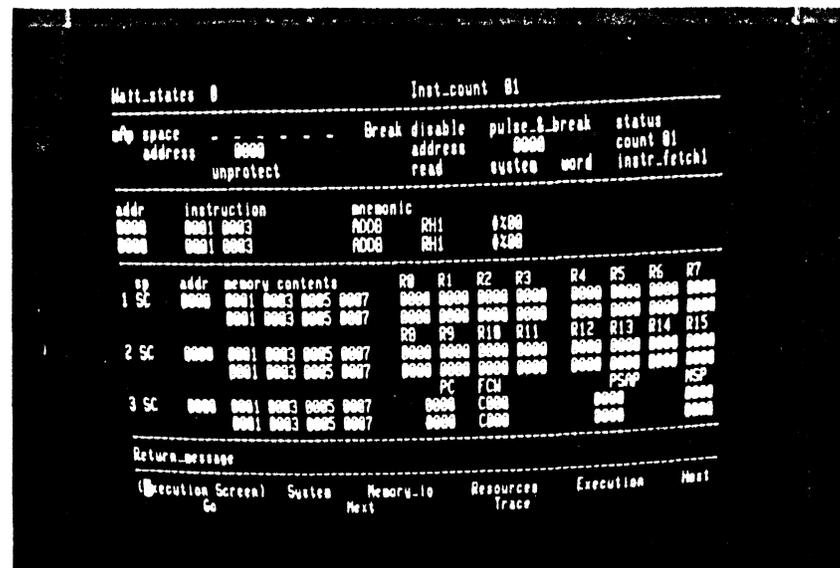


Figure 4-6. Z8002 Monitor Execution Screen

7.	F	One display, the Trace screen, is accessible only from the Execution screen. Notice that there is no menu area because this screen does not support a variety of commands. It is dedicated to providing a detailed picture of program execution.
----	---	--

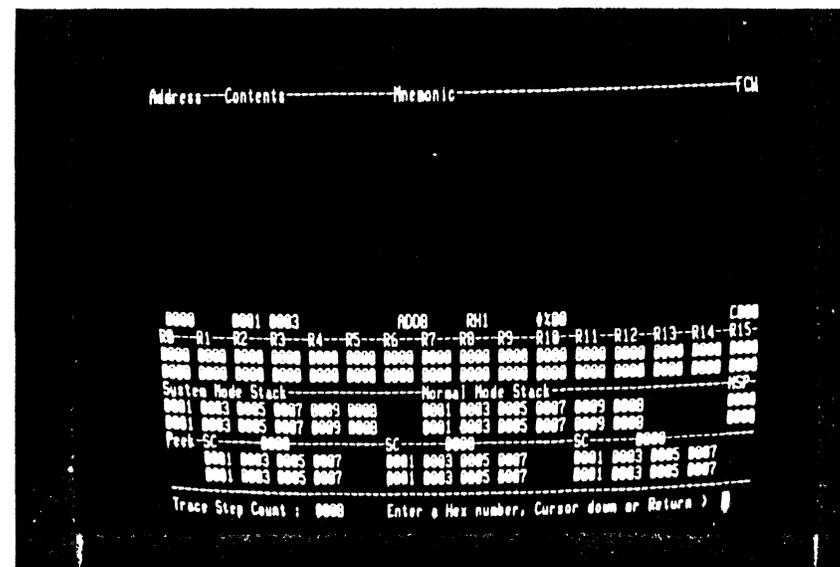


Figure 4-7. Z8002 Monitor Trace Screen

Step	Key Sequence	Commentary
8.	RETURN, H	Enter a RETURN to exit from the Trace screen to the Execution screen, then enter H. The Host command selects Transparent mode, allowing the terminal to communicate with a host system through Z-SCAN. You can enter the command even if no host is connected.

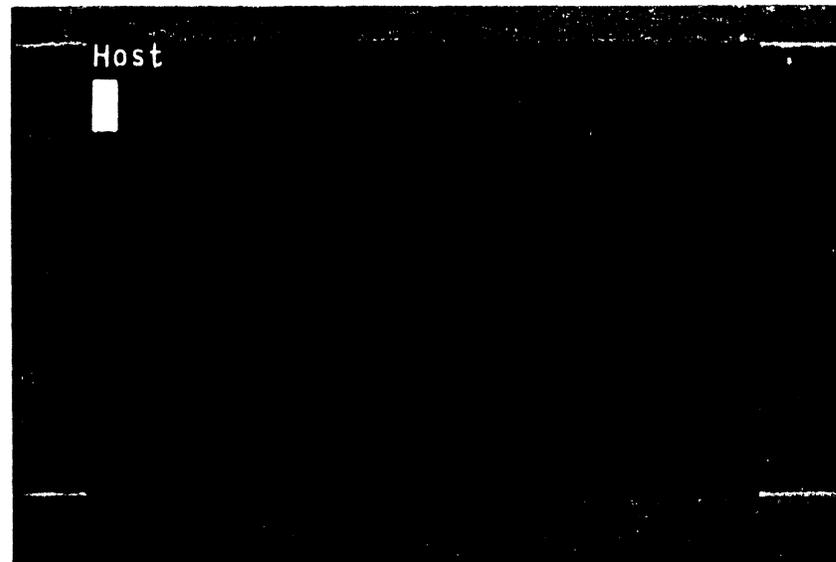


Figure 4-8. Host Screen, Transparent mode

Step Key Sequence

Commentary

11. RETURN, B

To move the cursor back to the menu area, enter a RETURN. The menu display does not change because the mAp command is still active. It is altered when a new command, Break, is activated. The cursor moves to the top left field in the Break subscreen.

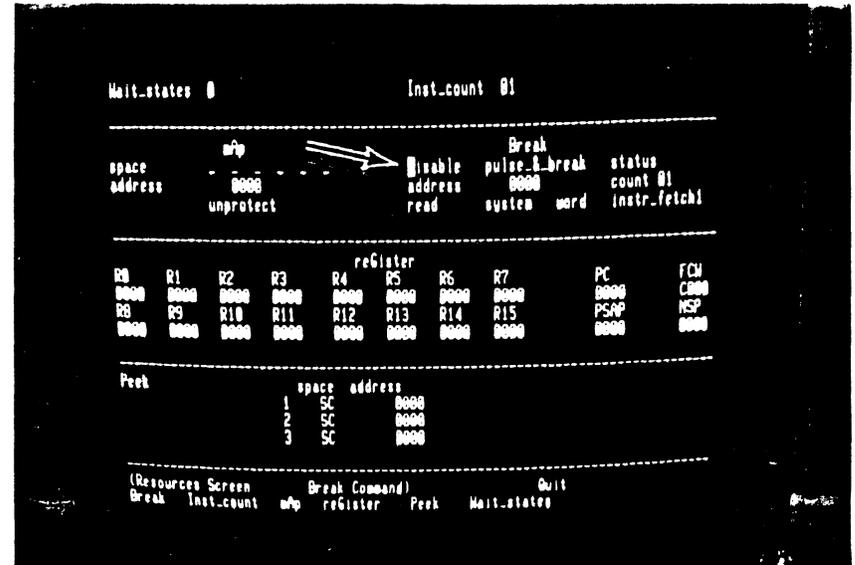


Figure 4-10. Cursor in Break Subscreen,

Step	Key Sequence	Commentary
12.	RETURN, Q, S, R, A	You should now be comfortable with activating screens and commands. The only new command in this sequence is Quit. It deactivates the current command and modifies the menu to show the names of the other screens.
13.	RETURN, S, R, A	It is not necessary to use the Quit command before moving to another screen. You can enter the initial letter of the new screen name even if it is not currently listed in the menu area.
14.	right, right, right left, left, left, left	Most subscreens consist of more than one field. Once the cursor is in a subscreen, it can be moved to the other fields in the same subscreen by using the cursor control keys. If the cursor left key is entered while the cursor is in the leftmost field, the cursor wraps around to the rightmost field in a subscreen line.

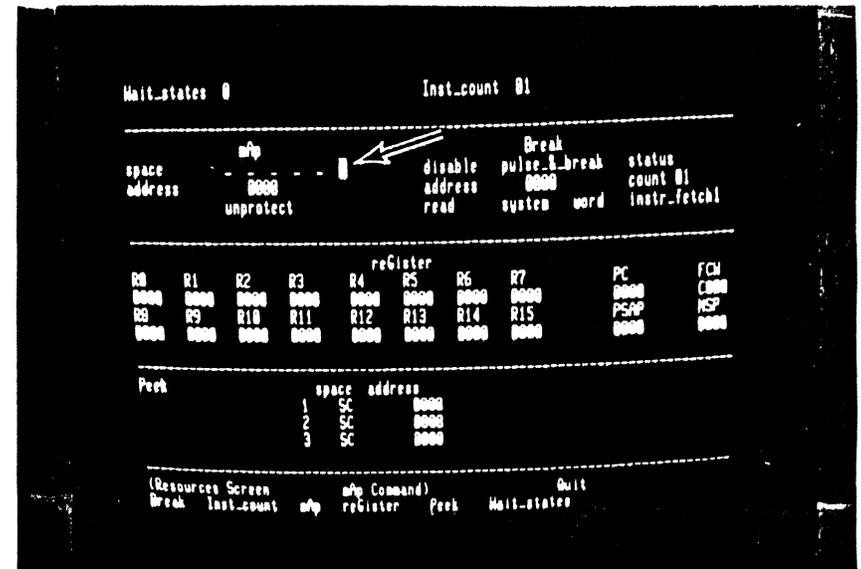


Figure 4-11. Horizontal Cursor Movement

Step Key Sequence

Commentary

15. right, down, down,
down, up, left, right

The same wrap-around applies in the vertical direction. Note that when there is only one field on a particular line of a subscreen, the horizontal cursor movement keys cannot move the cursor out of that field. The cursor keys can never move the cursor out of the active subscreen.

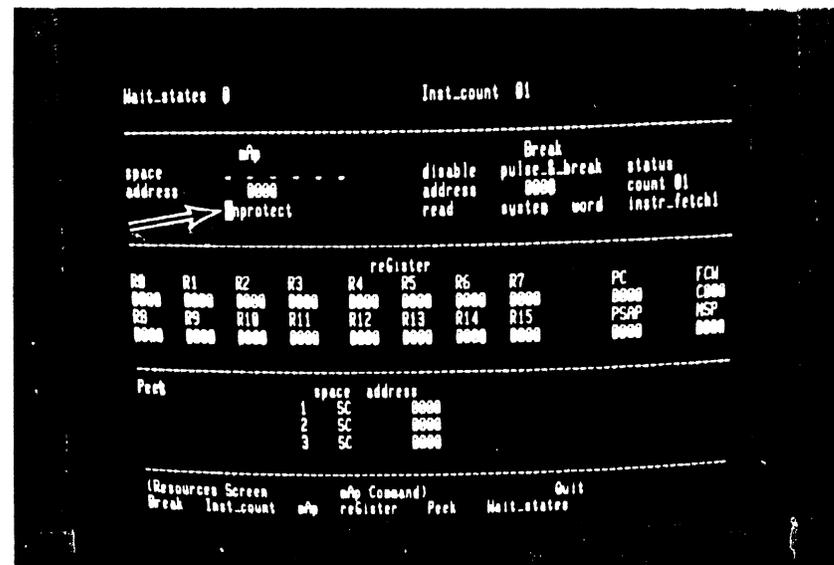


Figure 4-12. Vertical Cursor Movement

Step	Key Sequence	Commentary
------	--------------	------------

16.	RETURN, RETURN	
-----	----------------	--

The RETURN key moves the cursor back to the menu area. Because the command remains active, a second RETURN moves the cursor to the top left field in its subscreen: there is no need to re-enter the command name.

17.	>, >, <, 0, 1, space G, F, H, CTRL R, >	
-----	--	--

Each of the six fields on the first line of the mAp subscreen corresponds to one of the Z8002's address spaces, and each has just two possible values. In the default state, an underbar is displayed, indicating that the 8K bytes of **mappable memory** will not respond to CPU accesses made to a particular address space during an emulation. In the alternative state, a two-letter abbreviation for the name of the address space (for example, SC for System Code) shows that the mappable memory will respond. You can step forward or backward through the possible values with the > and < keys or you can access them directly by entering 0 for the first choice and 1 for the second. Alternatively, space and F select the default and final values. CTRL R restores the field to the value it held when the cursor entered it. Other printable characters that are not hexadecimal digits do not affect the field.

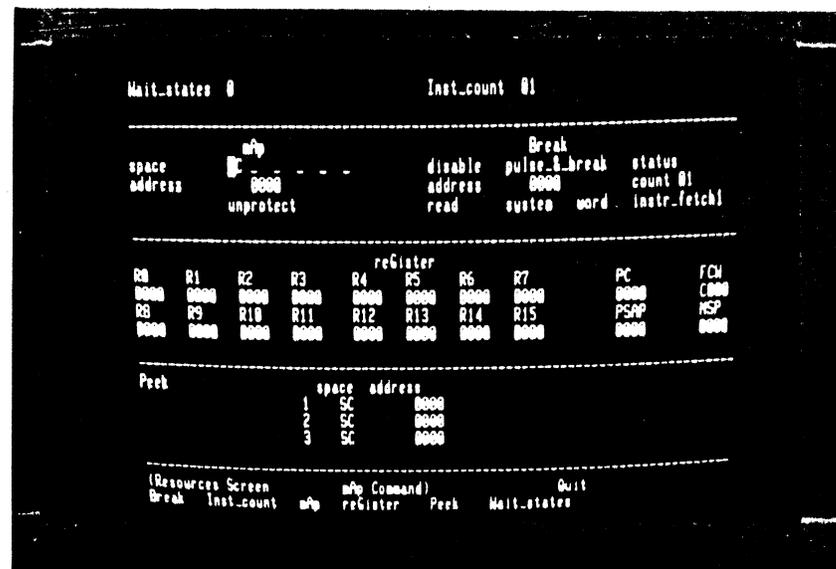


Figure 4-13. Enabling Mappable Memory

Step Key Sequence Commentary

18. RETURN, B, 2

The emulation you are going to run requires a **breakpoint**, so you must enable the breakpoint logic by setting the first field of the Break subscreen to "enable*". This tells the logic to search for a simultaneous match in both the address field and the various status fields.

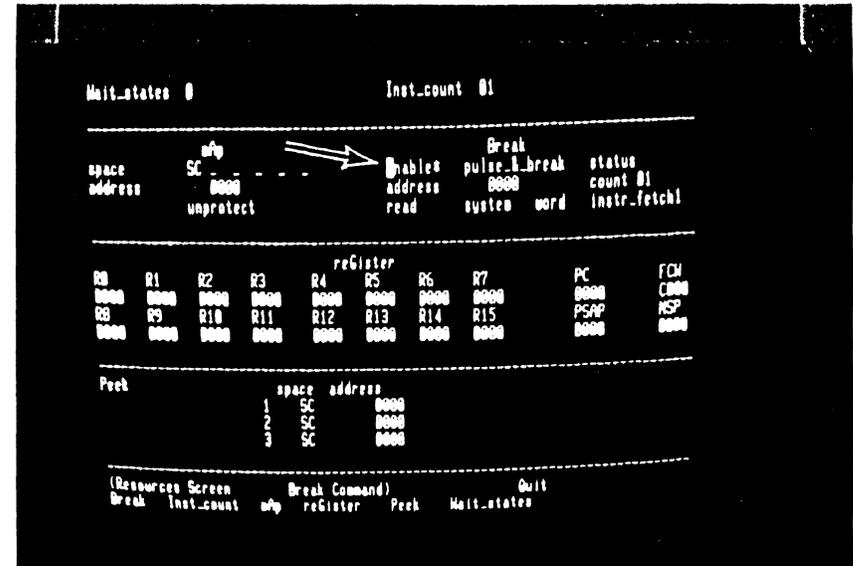


Figure 4-14. Enabling Break Logic

19. down, right, >, >, >, <, 1, RETURN

The breakpoint address is not correct and must be changed. The address field contains four hexadecimal digits and can hold any value between 0000 and FFFF. Use > and < to move the cursor within the field, and enter new hex digits to change the value. You have now set a breakpoint that will be triggered when the first word of an instruction is read from system code location 0010.

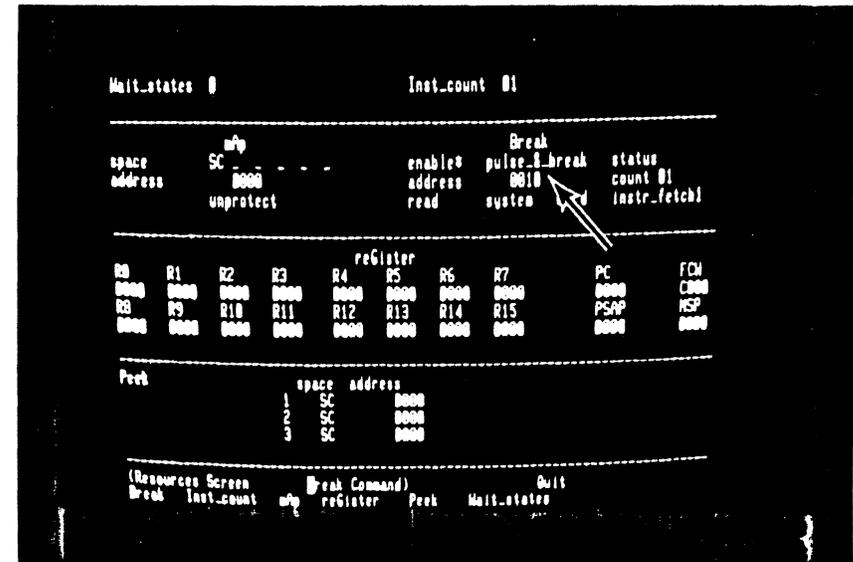


Figure 4-15. Setting Break Address

Step	Key Sequence	Commentary
20.	M	Move to the Memory-io screen. When it is displayed, notice that the top three lines are blank.
21.	F	Fill is listed as a valid command in the menu area. As soon as the command is activated, the cursor moves to the first field of the Fill sub-screen, which appears at the top of the screen.
22.	left, 1, F, F, F, down A, 8, 0, B	Use the Fill command to fill mappable memory, which currently extends from address 0000 to 1FFF in system code space, with increment byte register instructions (opcode A80B, mnemonic INCB RHO, #12). In order to do this, you must change the contents of some of the fields on the subscreen. The Fill string can be up to 16 hex digits long, but only four are required in this case.
23.	RETURN	After the parameters have been set up, the command must be executed by entering a RETURN. Before execution starts, the cursor moves to the bottom of the central window area. The message "DONE" is displayed when execution is complete.

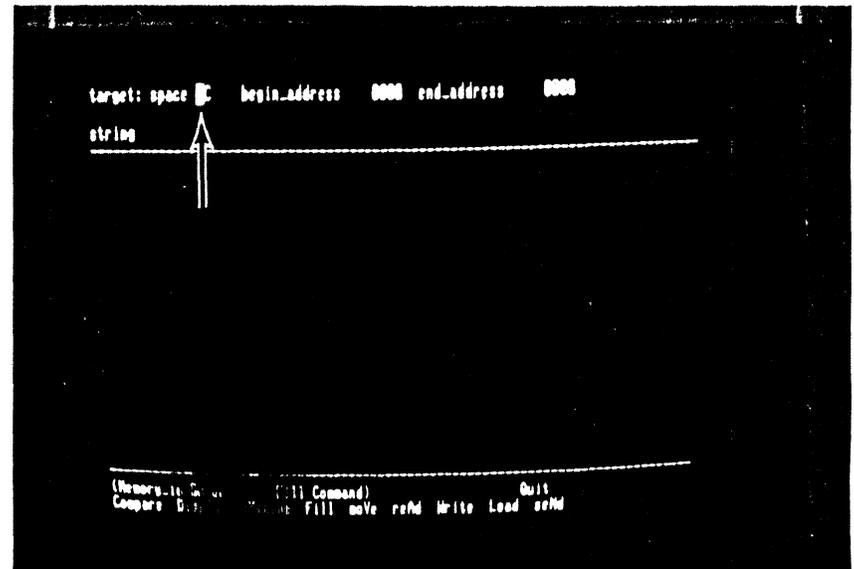


Figure 4-16. Default Fill Command Display

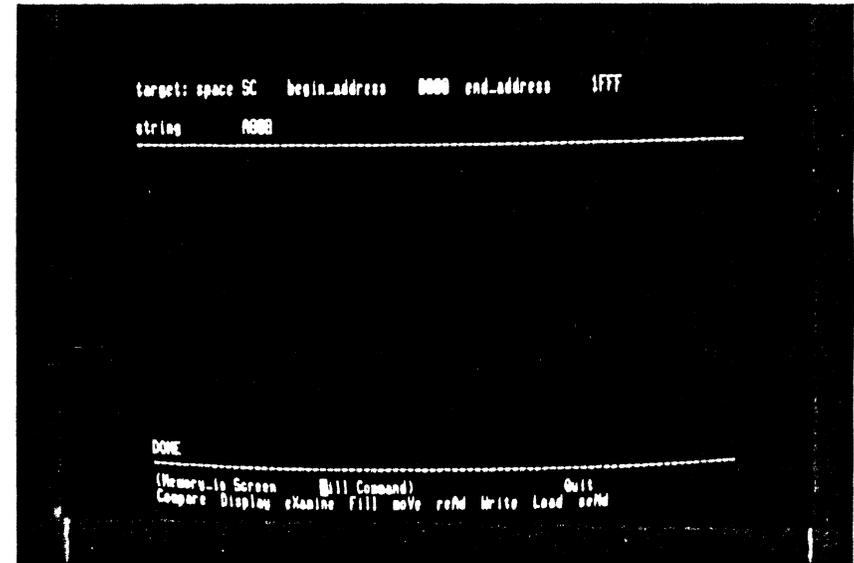


Figure 4-17. Execution of Fill Command

Step Key Sequence

Commentary

24. D, RETURN

The Z-SCAN Display command is used to look at the contents of memory. In order to look at the bottom of system code memory, you do not need to change the default parameters that appear at the top of the screen when the command is activated, so execute the command immediately. Addresses appear at the left of the screen, data in the center and at the right is an ASCII representation of the same data. Neither A8 nor 0B corresponds to a printable character. Periods are used to show this. The asterisks are delimiters.

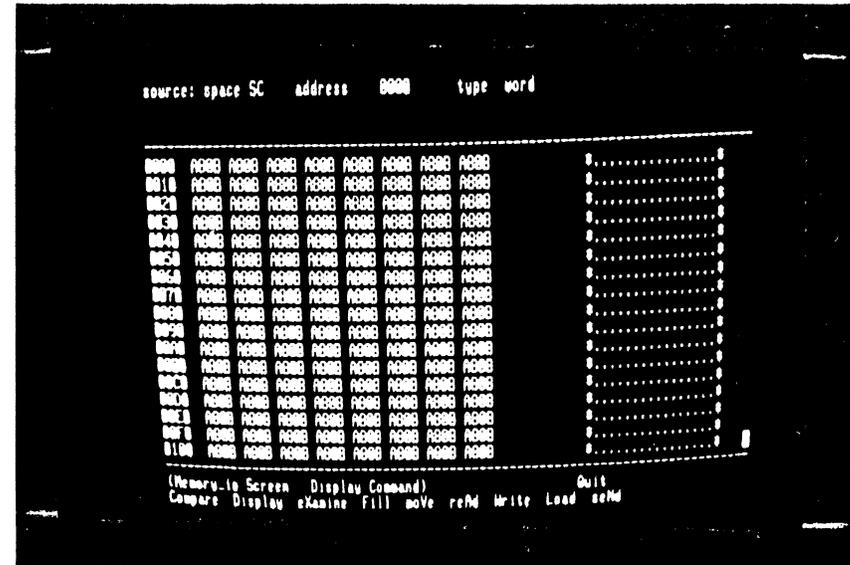


Figure 4-18. Display with Default Parameters

25. down, up, RETURN

After the Display command has filled the window area, the cursor rests at the bottom right of the screen. You can enter cursor down to display the next block of memory or cursor up to display the previous block. The command is terminated when RETURN is entered.

Step	Key Sequence	Commentary
26.	RETURN, left, 3 RETURN, RETURN	The command remains active as long as its name appears inside the parentheses on the menu line, so a second RETURN moves the cursor back into the parameter subscreen. Set the type field so that memory is displayed as disassembled nonsegmented Z8002 instructions.

```

source: space SC  address  0000  type  word
-----
0000  A000  INCB  R00  012
0002  A000  INCB  R00  012
0004  A000  INCB  R00  012
0006  A000  INCB  R00  012
0008  A000  INCB  R00  012
000A  A000  INCB  R00  012
000C  A000  INCB  R00  012
000E  A000  INCB  R00  012
0010  A000  INCB  R00  012
0012  A000  INCB  R00  012
0014  A000  INCB  R00  012
0016  A000  INCB  R00  012
0018  A000  INCB  R00  012
001A  A000  INCB  R00  012
001C  A000  INCB  R00  012
001E  A000  INCB  R00  012
0020  A000  INCB  R00  012
-----
(Memory in Screen  Display Command)  Quit
Compare Display eXamine Fill moVe reAd Write Load seMd

```

Figure 4-19. Disassembled Memory Display

27. X, right, 1, F, F, C
RETURN

The eXamine command allows you to look at and, if desired, modify the contents of memory. Like Fill and Display, it has a private subscreen. The first location you need to examine is the word at system code location 1FFC. Its current contents are displayed when the command is executed, and you are prompted for a new value to replace them.

```

source: space SC  address  1FFC  type  word
-----
CURRENT  NEW
ADDR  CONTENTS  CONTENTS
1FFC  0000  ◀ ←
-----
(Memory in Screen  eXamine Command)  Quit
Compare Display eXamine Fill moVe reAd Write Load seMd

```

Figure 4-20. Set-up of eXamine Command

Step Key Sequence

Commentary

28. 5, E, F, <, 0, 8, 1, 8
down

This step replaces the two INCB instructions at the top of mappable memory with an unconditional jump to location 0018 (opcode 5E08 0018, mnemonic JP %0018). The < key can be used to backspace over incorrect input. When sufficient digits have been entered to fill the open location, the new value is stored and the next location is opened automatically. The cursor down key opens the next location immediately, storing any digits that have been entered. The data seen in location 2000 may vary because no memory responds at that address.

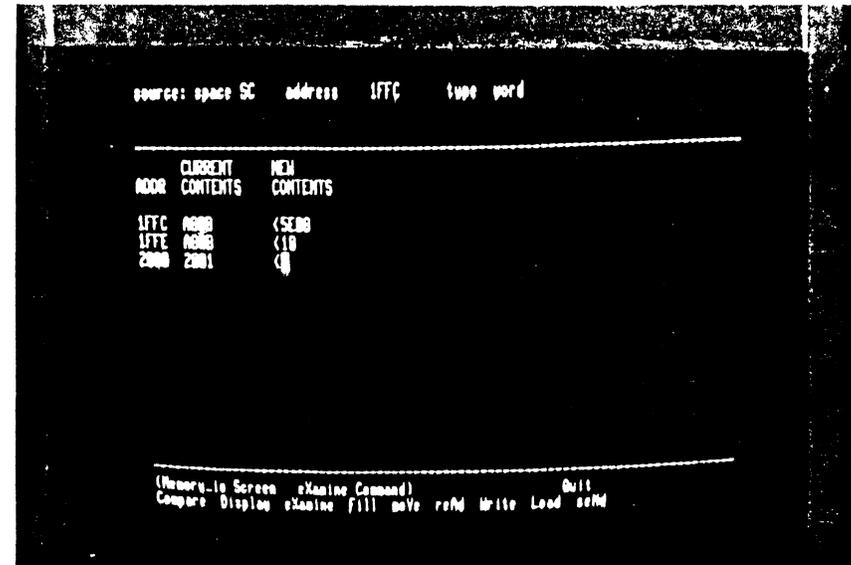


Figure 4-21. Modification of Memory Contents

29. up, RETURN

Cursor up reopens the previous location, showing that the two digits entered in the previous step have been stored right justified in a field of zeros.

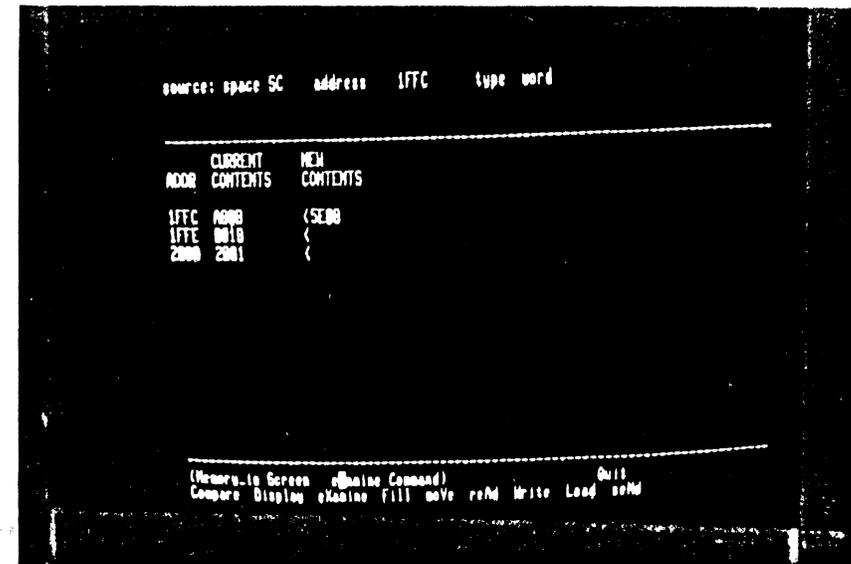


Figure 4-22. Checking Memory Contents

Step	Key Sequence	Commentary
-------------	---------------------	-------------------

30.	C, left, 1, 0, 0, 0 left, 1, RETURN	
-----	--	--

Just to check that everything is set up correctly, the Compare command is used to find the differences between the contents of the top and bottom 4K byte blocks of mappable memory. The byte count field for this command is, like all Z-SCAN monitor numeric fields, hexadecimal (1000 hex = 4096 decimal = 4K). When the command is executed, it should reveal that just four bytes differ between the top and bottom halves of the memory. If it shows anything else, you have probably made a mistake somewhere and not corrected it. Type R, A or, if the cursor is at the bottom right of the screen, RETURN, R, A and repeat the tutorial from step 17.

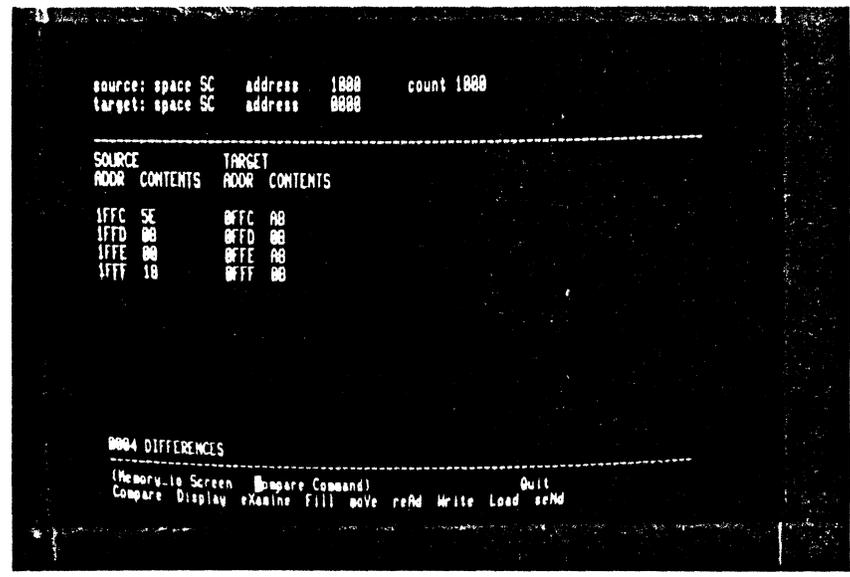


Figure 4-23. Use of the Compare Command

Step Key Sequence Commentary

35. I Emulations can also be run from the Trace screen, which disassembles each instruction before it is executed. The instruction which appears in the center of the screen is the first to be executed when emulation starts. The bottom of the screen displays register and memory contents. The function of these fields will be explored later.

36. down Entering cursor down results in the execution of the number of instructions given in the count field at the bottom left of the screen. PC and FCW values are given for each instruction executed, and the first instruction executed is flagged with an asterisk in column 1. The remaining registers are not redisplayed until all the instructions have been executed. The FCW values at the right of the screen show that the value in RHO has overflowed and become negative.

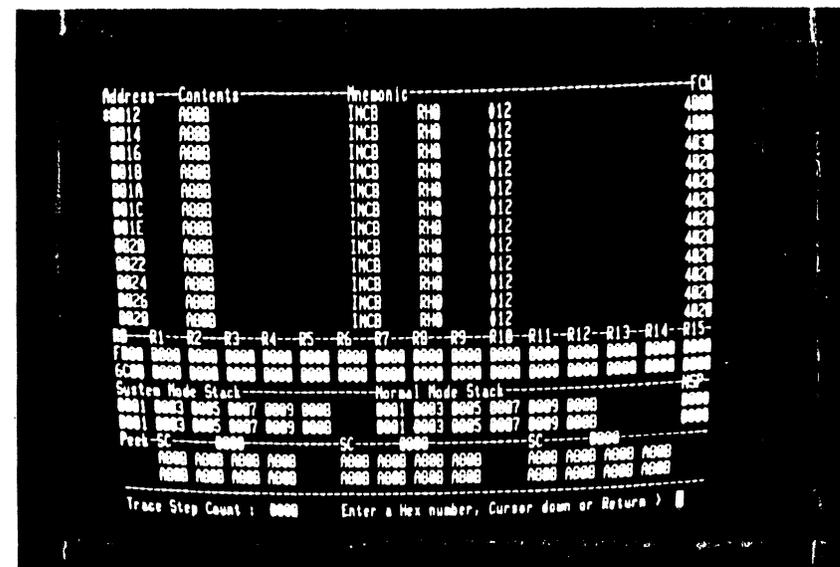


Figure 4-27. Use of the Trace Screen

Step Key Sequence

Commentary

39. M, X, right, space
CTRL R, 0, 0, 1, 8

To explore further facilities offered by Z-SCAN, an instruction which reads and writes memory is required. Use the Memory_io screen eXamine command to insert an instruction at location 0018. Two of the keystrokes in this sequence are redundant. The space restores the address field to its default value and CTRL R cancels any changes made since the cursor entered the field.

40. RETURN, 6, 9, 0, F, 1
0, RETURN

The instruction is "INC %0010,#16" (increment by 16 the word at location 0010). It has a two-word opcode, 690F 0010.

41. C, BREAK, RETURN, left
0, RETURN

Check memory contents again by using the Compare command. Extra keystrokes in this sequence show that the BREAK key moves the cursor back to the menu area without executing the active command and that the monitor does not allow you to enter an illegal value in a numeric field: the previous value of the field is restored. When the command is executed it should show eight differences.

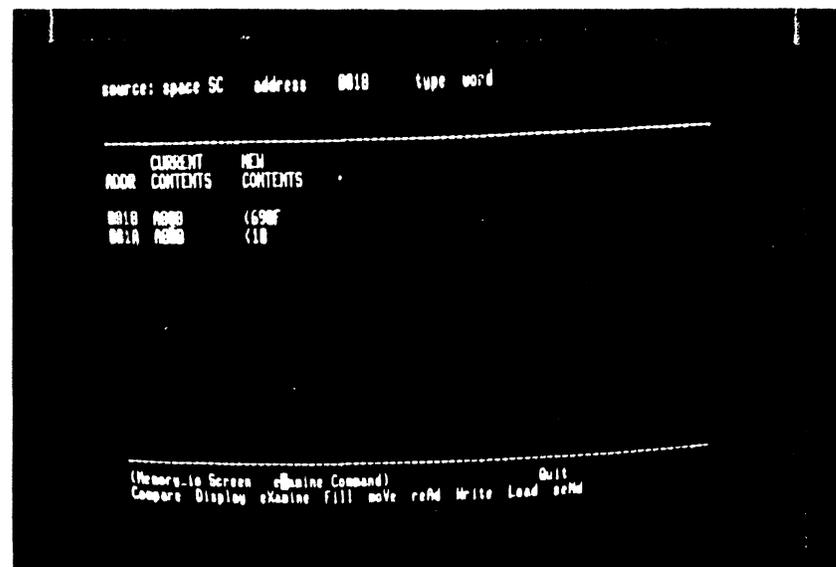


Figure 4-30. Insertion of New Instruction

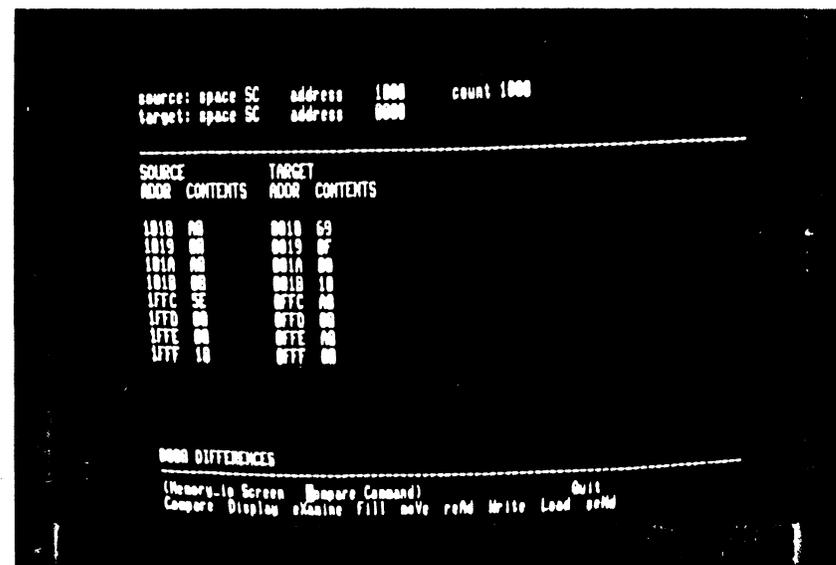


Figure 4-31. Check of Change with Compare Command

Step	Key Sequence	Commentary
42.	D, RETURN, RETURN	Display disassembled memory to show the new instruction at location 0018.

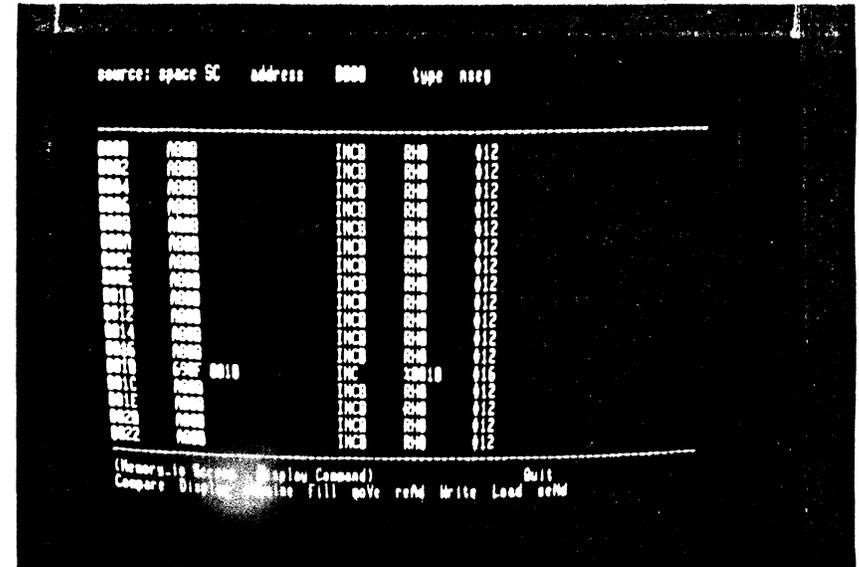


Figure 4-32. Display of Change

Step	Key Sequence	Commentary
43.	R, P, right, >, >, I, RETURN	The added instruction modifies the contents of location 0010 each time it is executed, so it is desirable to know how they have changed after each emulation is run. Z-SCAN displays the contents of selected locations on the Execution and Trace screens. The monitored addresses are set up by the Peek command on the Resources screen. Modify the first of the three addresses to 0010.

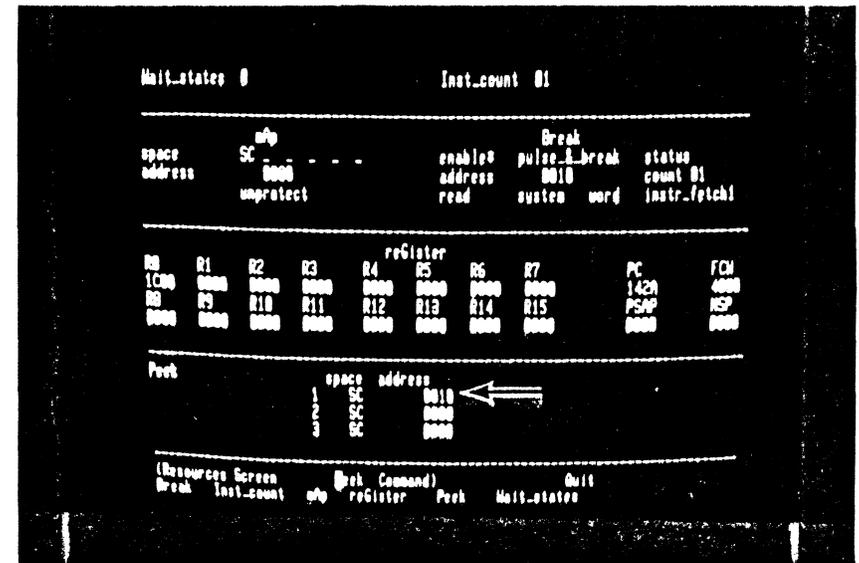


Figure 4-33. Setting Peek Parameters

Step Key Sequence Commentary

44. E, G Now call up the Execution screen and start an emulation. The top line of the first Peek field shows the contents of word locations 0010 through 0016 as they were before the emulation started.

45. monitor NMI You might think that this emulation should stop with a trigger break, because location 0010 is being read by the new instruction. The trigger logic does not fire because the break parameters are set up for an instruction fetch, not a data read, so the emulation must be terminated with a manual break. Looking at the Peek memory areas, you see that the contents of location 0010 have not changed during the emulation. Remember that the mappable memory has been set to respond only to system code space accesses. This explains why the system data accesses made by the new instruction do not affect it.

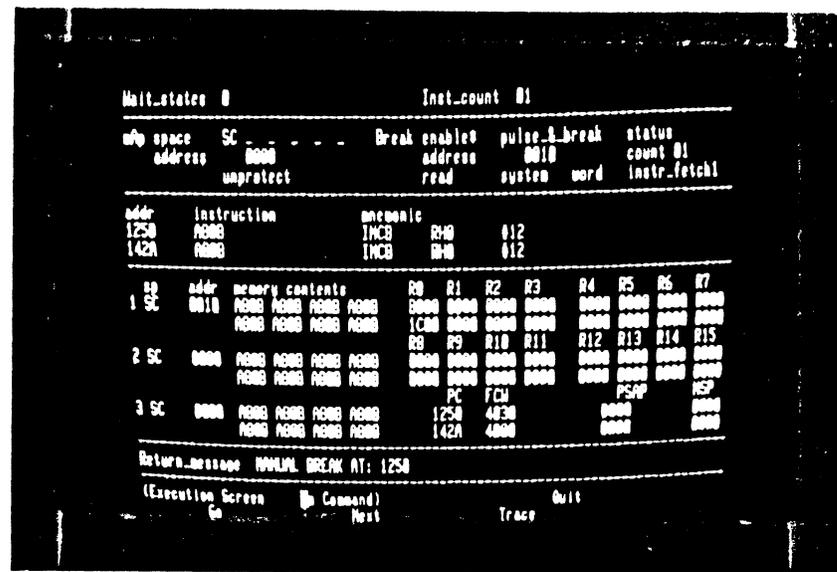


Figure 4-34. Second Manual Break

Step	Key Sequence	Commentary
46.	R, B, up, left, >, >, F, <, space, 1, 2, 9, RETURN	To fix these two problems, leave the Execution screen, which, though it displays data about mappable memory and the break condition, does not allow you to modify the parameters. Use the Resources screen Break command to set up a breakpoint on a data memory request. This is one of 16 possible values in the bus cycle type field. As usual, you can select a choice either by stepping through the table of possible values or by entering a number that corresponds to the required choice. The space character selects the default value.

Step	Key Sequence	Commentary
47.	A, right, 1, RETURN	The second field in the mAp sub-screen determines whether or not the mappable memory responds to system data accesses. Entering a 1 sets the field to "SD". The mappable memory now responds to two types of accesses. For this reason, it is not necessary to modify the memory space parameters of Peek. System code location 0010 is the same memory word as system data location 0010.

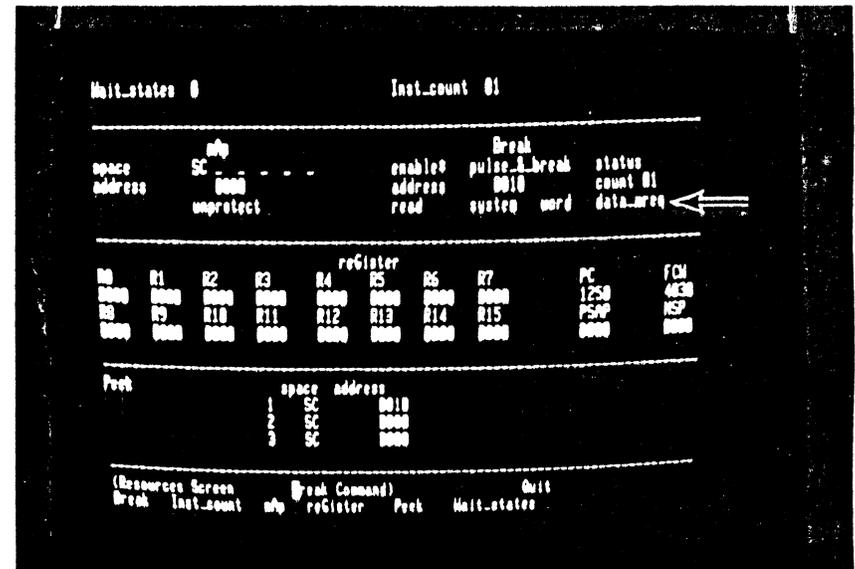


Figure 4-35. Modification of Break Parameters

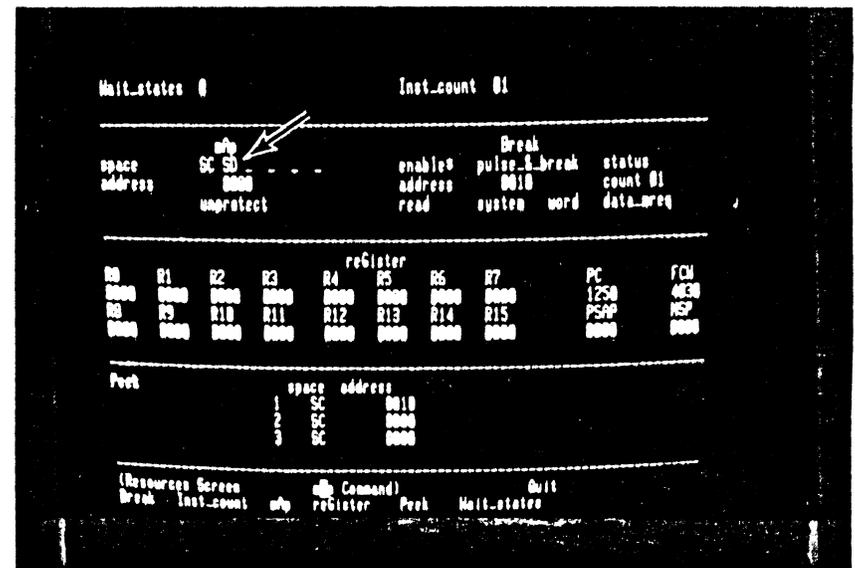


Figure 4-36. Modification of mAp Parameters

Step Key Sequence

Commentary

48. G, A, B, RETURN

The last action on this screen is to set up a new starting value for R0 with the reGister command.

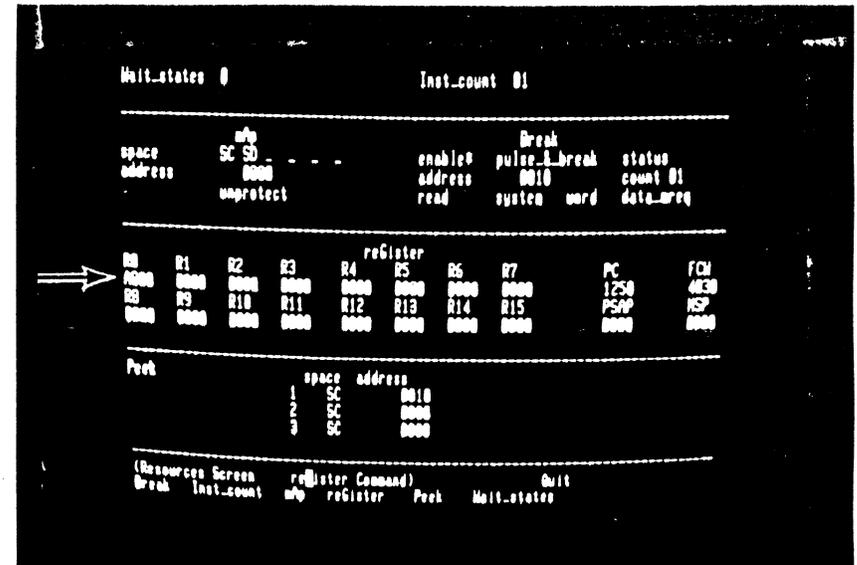


Figure 4-37. Modification of R0 Value

49. E, G

Start a new emulation. This time, the trigger fires almost immediately, and when the execution screen is redisplayed, you see that the contents of location 0010 have indeed changed from A80B to A81B. The Program Counter points to location 001C, the word after the instruction that caused the break condition to be met. The condition flags in the FCW reflect the fact that location 0010 holds a negative 2's complement number.

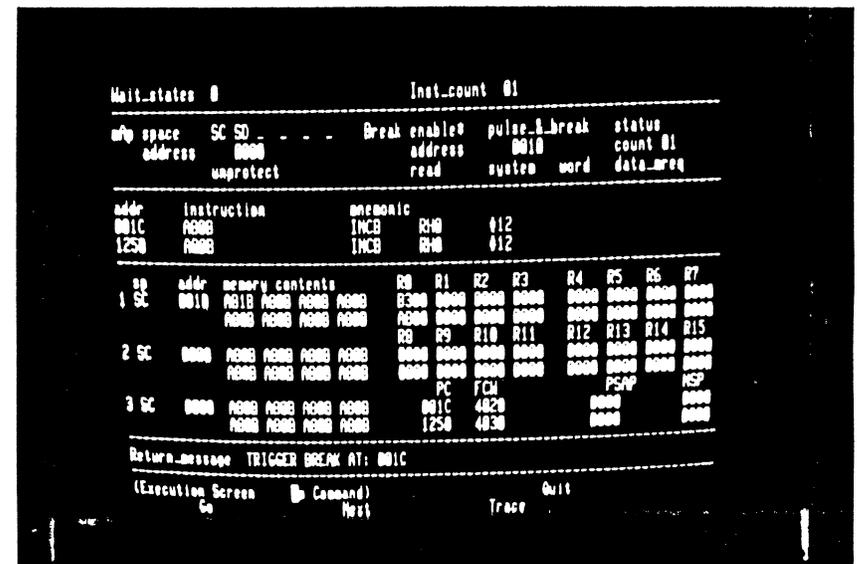


Figure 4-38. Trigger Break on Data Read

Step	Key Sequence	Commentary
50.	R, B, down, left, 5 RETURN	Associated with the breakpoint logic is a pass counter . If you load it with 51 hex (that is 81 decimal), the program loop is executed that number of times on the next emulation.

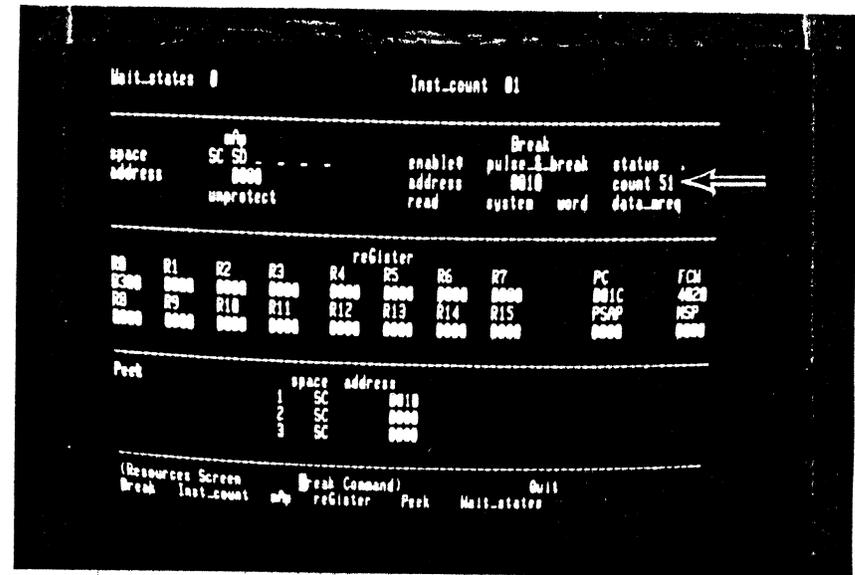


Figure 4-39. Adjusting Pass Counter

Step	Key Sequence	Commentary
51.	E, G	After the emulation begins, there is a short delay before the breakpoint is encountered the number of times programmed. When the emulation ends, location 0010 has been incremented by 510 hex (51 x 10), showing that the correct number of passes has been made.

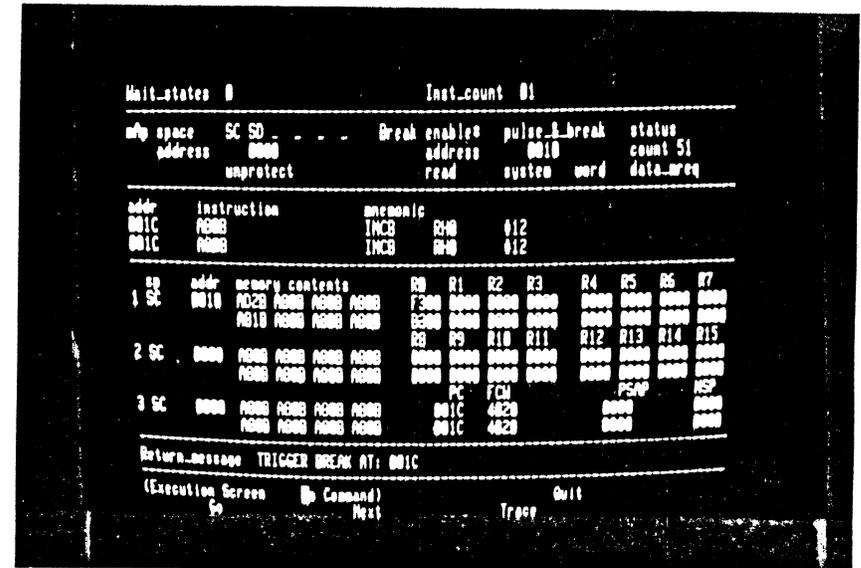


Figure 4-40. Break After Multiple Passes

Step Key Sequence

Commentary

57. T, down

A trace terminates after only two instructions have been executed because a trigger is caused when the instruction at location 0018 performs a data memory read. Emulation stops as this event has precedence over the step count of 000B (11 decimal) instructions. A break message replaces the prompt that normally appears on the bottom screen line. The Peek display shows that the contents of location 0010 have changed.

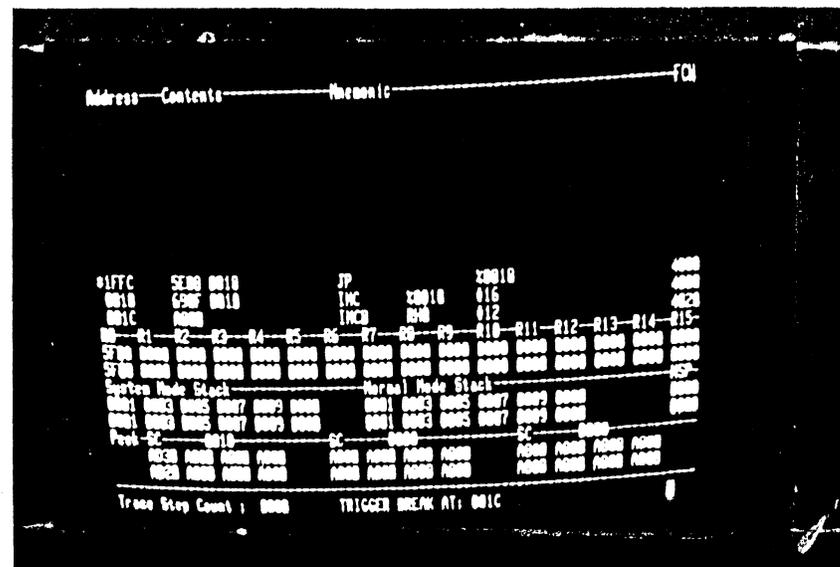


Figure 4-45. Data Read Break on Trace Screen

4.6 HOST SYSTEM USE WITH Z8002

The tutorial script continues on the next page. If your Z-SCAN is connected to a host system that supports the generation and downloading of Z8002 programs, perform steps 59 through 63, then move on to step 65. If the example program already exists on the host file system, you can skip all the steps except 63. If you do not have a suitable host, proceed directly to step 64.

Step Key Sequence Commentary

58. RETURN, R, RETURN, R,
 A, 1, right, 1, right
 1, right, 1, right, 1,
 right, 1, RETURN

The example program that is run in this part of the tutorial generates accesses to all six Z8002 memory spaces. Select the Resources screen and set up the mappable memory to respond to all types of access: code, data and stack references in both system and normal modes.

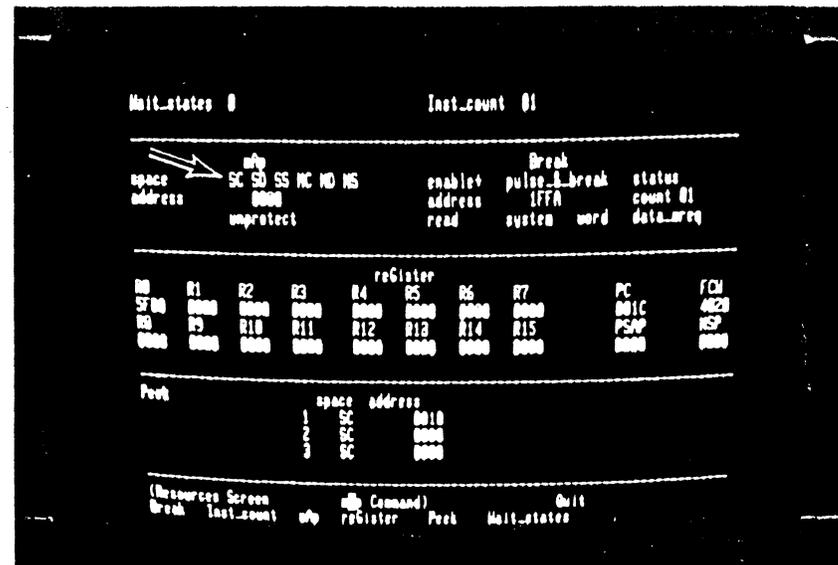


Figure 4-46. Enabling of All mAp Address Spaces

NOTE

If your Z-SCAN is connected to a host system that supports the generation and downloading of Z8002 programs, perform steps 59 through 63, then move on to step 65. If the example program already exists on the host file system, you can skip all the steps except 63. If you do not have a suitable host, proceed directly to step 64.

Step	Key Sequence	Commentary
59. H		Before you can use the Z-SCAN download command, you must have a Z8002 program to load. Your host's utilities and support programs can be used to create it. Type H to enter Transparent mode.
60. Bootstrap your system		Unless it is already up and running, load the operating system of your host. For Zilog PDS 8000 systems, press the reset button on the front panel of the system, then enter RETURN at the terminal keyboard. For ZDS/1 systems, press wait, then enter two returns. An operating system diskette must be present in drive zero or, for hard disk systems, the disks must be spinning. If you have a non-Zilog host, follow the bootstrap procedure described in its system manual.

Step	Key Sequence	Commentary
61.	Enter, assemble and image the example program	Figure 4-47 shows an example program that is compatible with Zilog's Z8000 PLZ/ASM assembler, version 2.02 or later. The commands needed by the Zilog R10 operating system to create it are listed in Figure 4-48. Assemblers on non-Zilog hosts probably require changes in the syntax of the source. Changes are acceptable provided that the memory image of the final program corresponds to the information at the left of Figure 4-47. Refer to the host documentation for more information. The program appears with expanded commentary in Appendix B of this manual.
62.	BREAK	Return to the Z-SCAN monitor environment.

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```

C      OBJ CODE      1 EXAMNSG MODULE
                      2     $SECTION      EXAMNSG_P      ! Make imaging easy
                      3     $REL          %0000
                      4 INTERNAL
                      5 NEW_STATUS_AREA:      ! Most entries unusec
                      6     $REL          %0002      ! Reset status
02 4000 002A'      7     RESET      ARRAY [ 2 WORD ] := [ %4000, INIT ]
                      8     $REL          %0008      ! Privileged instr.
08 4004 002A'      9     PRIV_VECTOR ARRAY [ 2 WORD ] := [ %4004, INIT ]
                      10    $REL          %000C      ! System call
0C 4000 003C'     11     SC_VECTOR  ARRAY [ 2 WORD ] := [ %4000, BREAKER
                      12    $REL          %0014      ! Non-Maskable Int.
14 4008 002A'     13     NMI_VECTOR ARRAY [ 2 WORD ] := [ %4008, INIT ]
                      14
18 0000 0000     15     PASS, LAST WORD := 0      ! Data and stack area
1C 0000 ...      16     NML_STK   ARRAY [ 4 WORD ] := 0
24 0000 0000     17     SYS_STK   RECORD [ ID OLD_FCW OLD_PC WORD ] :=
28 0000
2A
                      18 GLOBAL INIT PROCEDURE      ! Set up control reg'
                      19 ENTRY                      ! and both stacks.
2A 7600 0000'     20     LDA      RO,NEW_STATUS_AREA
2E 7D0D           21     LDCTL   PSAP,RO
30 210F 002A'     22     LD      R15,#SYS_STK + SIZEOF SYS_STK
34 7600 0024'     23     LDA      RO,NML_STK + SIZEOF NML_STK
38 7D0F           24     LDCTL   NSP,RO
3A 7F12           25     SC      %%12      ! Trap into BREAKER
3C
                      26 END INIT
                      27
3C
                      28 INTERNAL BREAKER PROCEDURE      ! Demonstrate bus
                      29 ENTRY                      ! cycle types.
3C A9F5           30     INC      R15,#SIZEOF SYS_STK ! Fix up system stack
3E 670E 0026'     31     BIT      SYS_STK.OLD_FCW,#14 ! Check previous mode
42 E604           32     JR      Z,ELSE_      ! If mode was system
44 7D02           33     LDCTL   RO,FCW      ! set normal mode by
46 A30E           34     RES      RO,#14      ! clearing bit 14
48 7D0A           35     LDCTL   FCW,RO      ! of FCW;
4A E808           36     JR      FI_      ! else do I/O.
4C 2101 ABCD      37 ELSE_: LD      R1,%%ABCD      ! Dummy port address.
50 3D12           38     IN      R2,@R1      ! I/O read
52 3F13           39     OUT     @R1,R3      ! I/O write
54 3B05 1234      40     SIN     RO,%1234      ! Special I/O read
58 3B37 1234      41     SOUT    %1234,R3      ! Special I/O write
                      42 FI_:      ! Memory op's follow:
5C 7602 0018'     43     LDA      R2,PASS      ! Internal operation
60 2124           44     LD      R4,@R2      ! Data read
62 93F4           45     PUSH    @R15,R4      ! Stk write
64 29F0           46     INC     @R15      ! Stk read, stk write
66 57F0 0018'     47     POP     PASS,@R15      ! Stk read, data writ
6A 3304 FFAC      48     LDR     LAST,R4      ! Code write
6E 7FEF           49     SC      %%EF      ! Trap sequence
70
                      50 END BREAKER
                      51
                      52 END EXAMNSG

```

Figure 4-47. Z8002 Program Example

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the express written consent of ZILOG, INC.

URSDAY, NOVEMBER 1, 1979
O REL 2.2
ATE 810424
IDAY, APRIL 24, 1981
;SET TABSIZE=4;EDIT EXAMNSG.S

IT 2.1
W FILE
PUT
AMNSG MODULE
\$SECTION EXAMNSG_P ! Make imaging easy !
\$REL %0000
TERNAL

.

SC #EF ! Trap sequence !
D BREAKER
D EXAMNSG

IT
UIT
8000ASM EXAMNSG
000ASM 2.02
ss 1 complete

0 errors
sembly complete
MAGER EXAMNSG.OBJ (\$=0000 EXAMNSG_P) {0000 0080} E=002A O=EXAMNSG
AGER 2.0
BYTES LOADED
XTRACT EXAMNSG
CORD COUNT = 0001 RECORD LENGTH = 0200 NO. OF BYTES IN LAST RECORD = 008
TRY POINT = 002A LOW ADDRESS = 0000 HIGH_ADDRESS = 0080 STACK SIZE = 000
GMENTS:
00 007F

NOTE
If the file EXAMSEG is created on a diskette, the
record length shown by the EXTRACT command will be
0080.

Figure 4-48. Z8002 Program Creation with RIO

Step	Key Sequence	Commentary
63.	M, L, down, E, X, A, M, N, S, G, RETURN	<p>Set up and execute the Memory-io screen Load command. The program name is EXAMNSG (nonsegmented example), and it is to be loaded into system code memory. As the file is loaded, an incrementing number field appears toward the top left of the screen. This is a count of the number of records transferred from the host to target memory. Each record carries 30 or fewer bytes. When the loading is complete, the entry address of the program is displayed. If any error message appears, enter H and check the following:</p> <ul style="list-style-type: none"> o Does the program file EXAMNSG exist? o Is its name correct? o Does the download utility LOAD exist?

If no message appears when the command is executed, the host has not responded to the Load command sent by Z-SCAN. Terminate the load by entering BREAK, then type H and establish why this happened. When you have fixed the fault, return to the Z-SCAN monitor environment and type M, L, return.

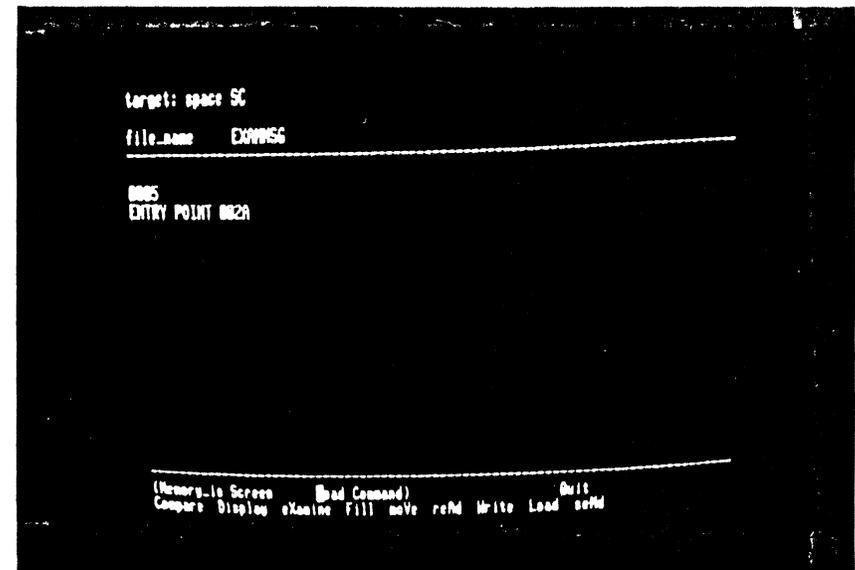


Figure 4-49. Loading of Z8002 Example Program

Step	Key Sequence	Commentary
------	--------------	------------

If you have completed the four previous steps, skip the next one.

64. M, V, 6, right, 5, F,
8, 0, right, 0, 0, 7,
0, RETURN

A copy of the example program shown in Figure 4-47 exists in the Z-SCAN monitor ROM. Use the Memory_io screen moVe command to copy it into the mappable memory.

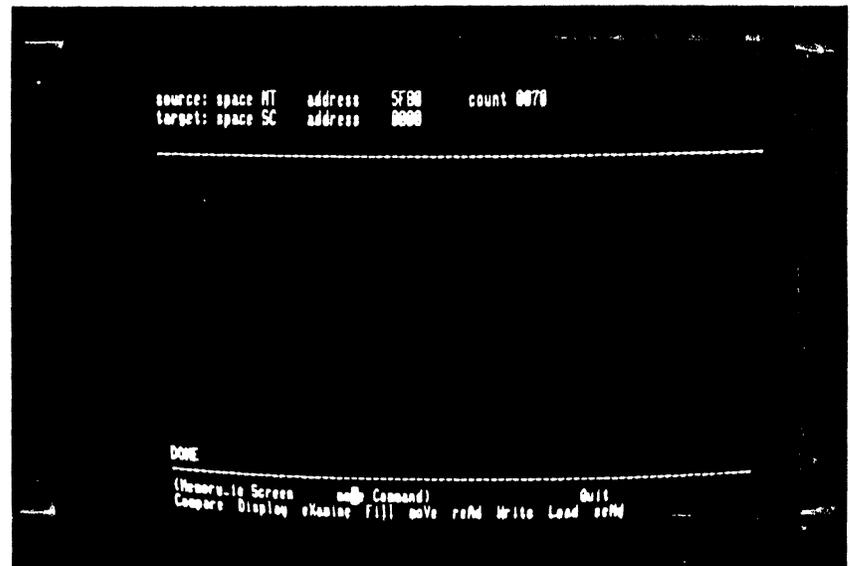


Figure 4-50. Copying Program with moVe Command

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Step	Key Sequence	Commentary
65.	R, G, space, left 4, 0, 0, 0, left, 0, 0, 2, A, RETURN	Set up the PC and FCW so that the program starts at location 002A in system mode. At the same time, restore R0 to its default value.

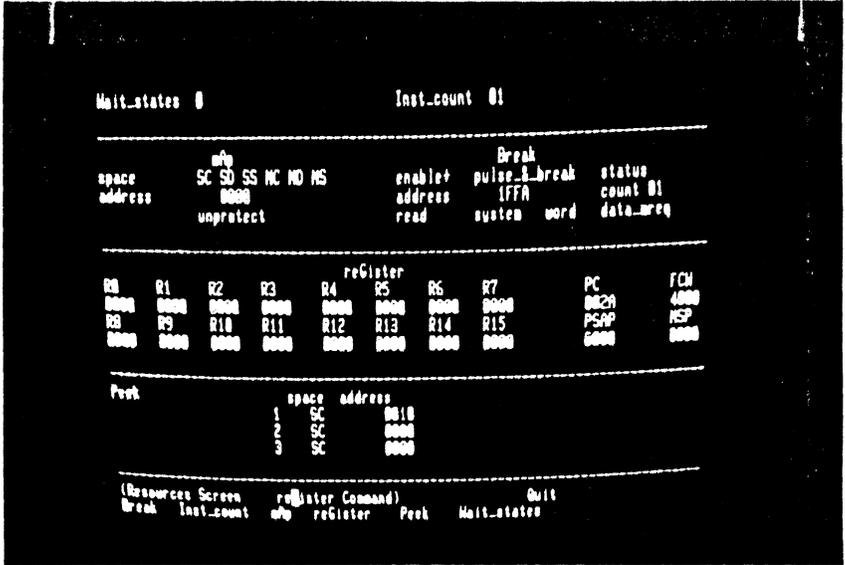


Figure 4-51. reGister Initialization

66.	P, 1, right, 0, 0, 1, 8, down, 0, 0, 1, C, left, 5, down, 2, right, 0, 0, 2, 4, RETURN	The program has data, normal stack and system stack areas. Set up the Peek fields to monitor their contents before and after each emulation is run.
-----	--	---

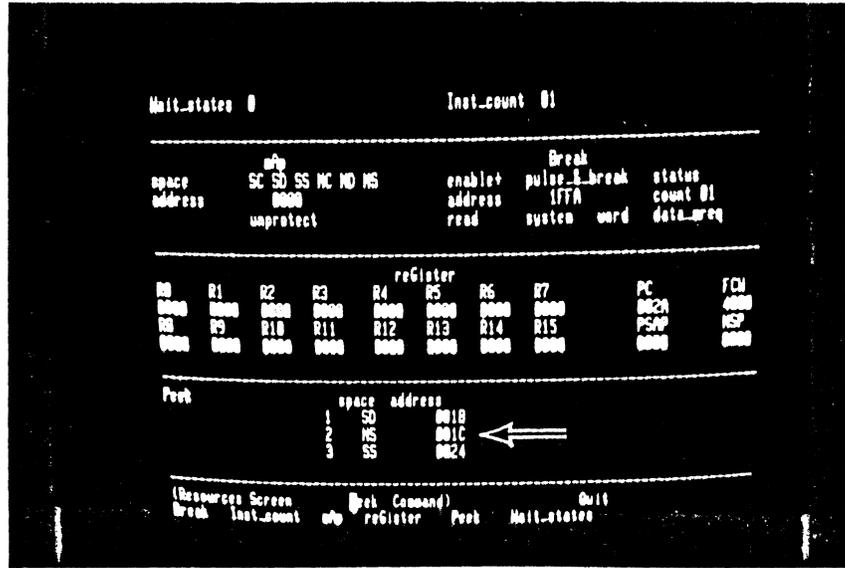


Figure 4-52. Set-up of Peek Parameters

Step Key Sequence

Commentary

67. B, 2, up, left, space,
up, left, 0, 0, 2, A,
RETURN

Finally, set up a breakpoint on the first instruction of the initialization routine of the example program.

68. E, G

The Z-SCAN is now ready to run the program. There is a trigger break after the first instruction is executed. At this point, the only change is in the PC value.

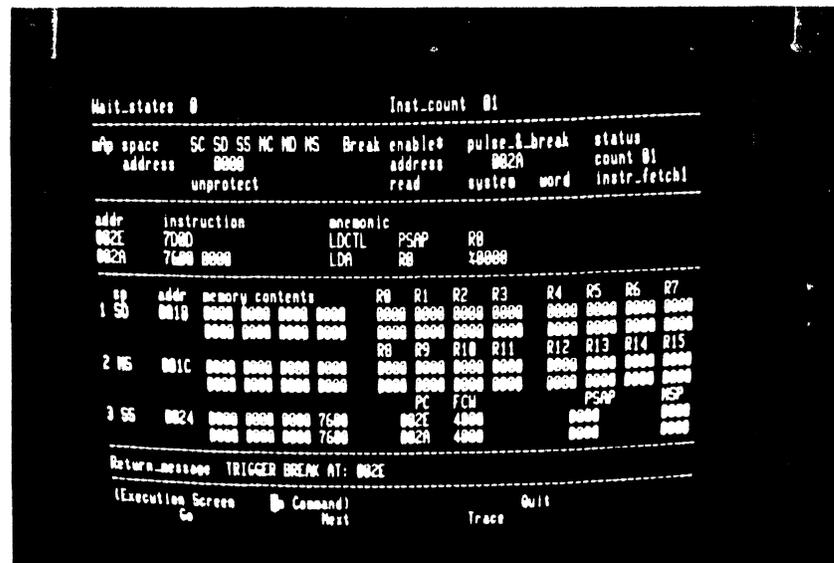


Figure 4-53. Emulation and Breakpoint

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69. T, 4, down, 1, down

Trace the next five instructions, entering numbers to change the default Trace step count. At the end of the sequence, both system and normal stack pointers have been set up, changing the displays for the two **stack areas**. The final instruction, a System Call, pushes three words of data onto the system stack, producing a further change. The data also appears in the third Peek area.

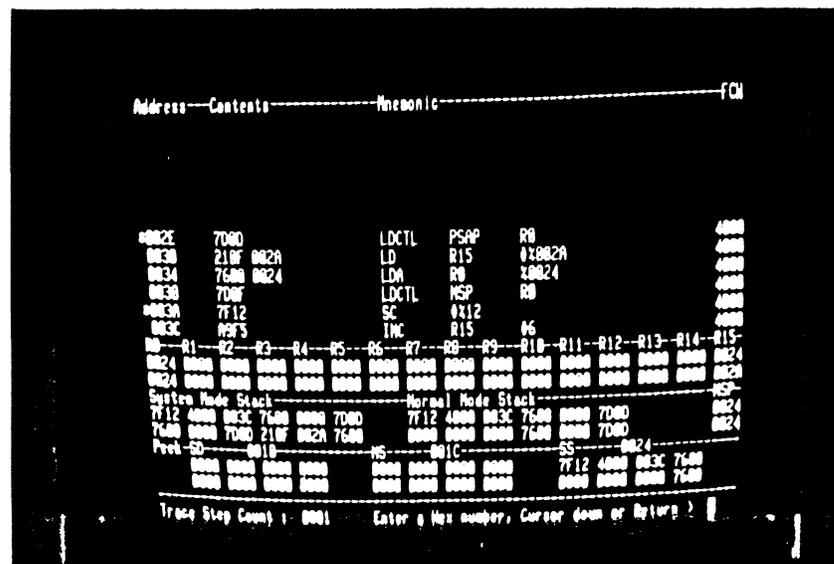


Figure 4-54. Tracing Initialization Routine

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Step Key Sequence

70. 1, 0, 0, 0, BREAK

Commentary

A large number of instructions can be traced with a single command. Let the display run for awhile and observe that the program loops, alternately setting and clearing bit 14 of the FCW to move in and out of system mode. Tracing can be stopped at any time by entering the terminal break key. The redisplayed memory content fields show that the contents of the data area and of both stacks have changed.

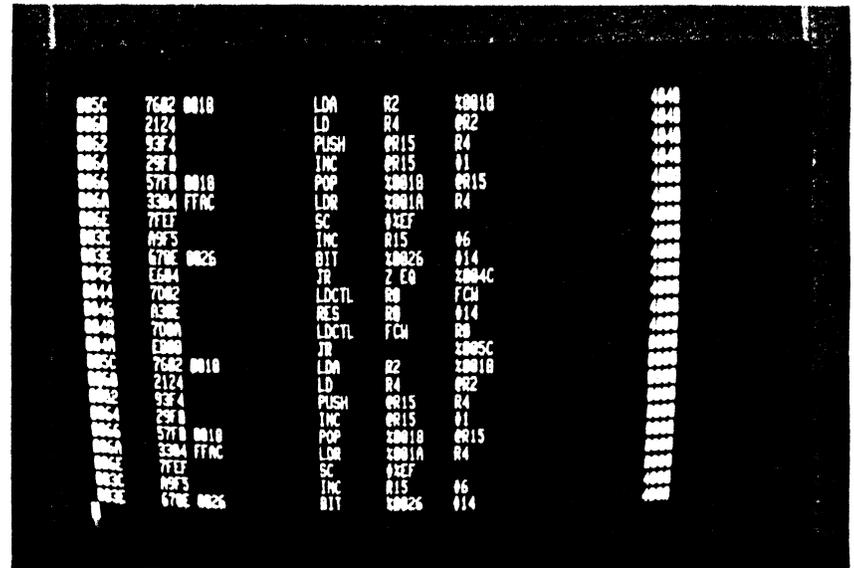


Figure 4-55. Trace of Main Routine

71. RETURN, G, target RESET

Run the program. The emulation can be terminated with a target RESET because the status loaded from locations 0002 and 0004 in response to the input makes the CPU execute the instruction on which the breakpoint is set. The initial conditions of the program are not fully restored by the RESET because the data and stack areas may no longer be zero.

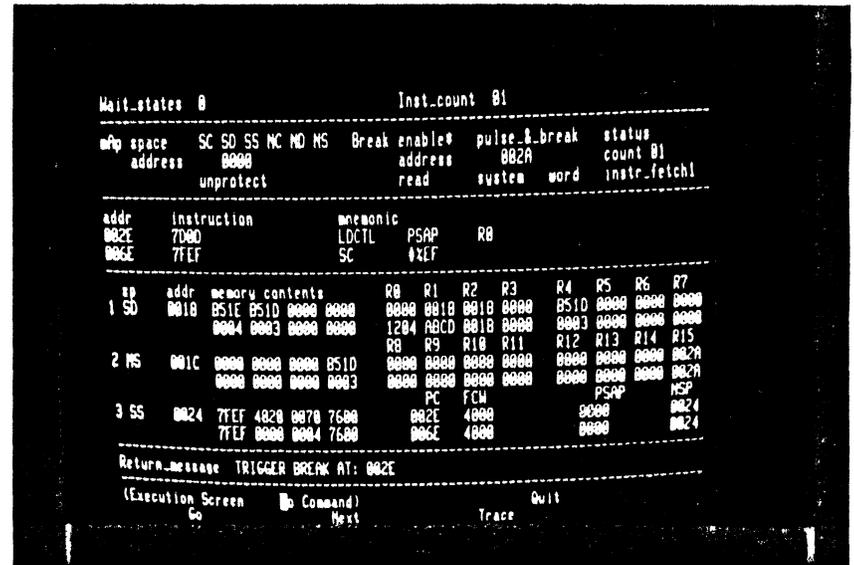


Figure 4-56. Trigger Due to Target Reset

Step Key Sequence Commentary

72. RETURN, target NMI

A target NMI also terminates an emulation. Again, the initialization routine is entered in response to the input. The cause of the entry can be distinguished because the reset and NMI flag register values differ.

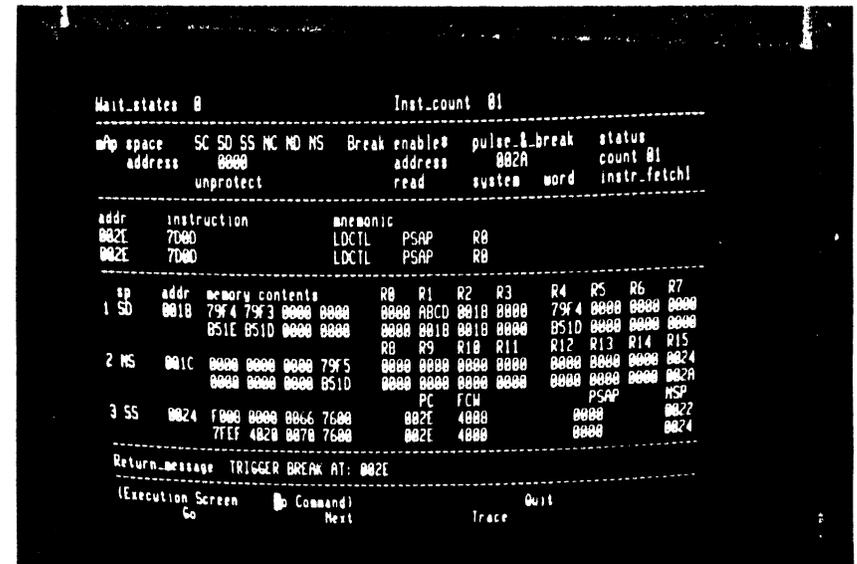


Figure 4-57. Trigger Due to Target NMI

73. R, B, down, 1, down, 1, left, A, RETURN

This tutorial does not explore the full possibilities of the program, which can generate a wide variety of bus cycle types in both system and normal modes. Experiment with it if you want to explore the Z-SCAN's features in more depth. As a start, set up a breakpoint on a system stack write of data pattern 002A.

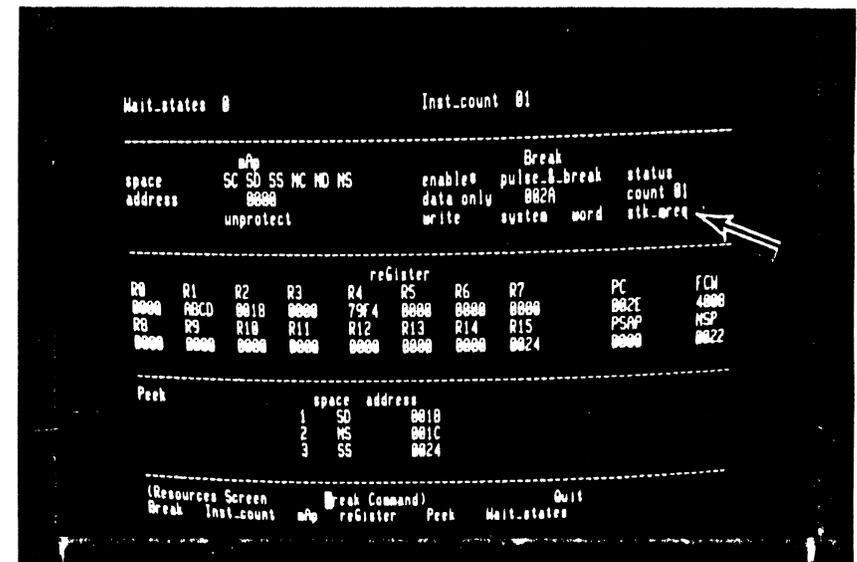


Figure 4-58. Set-up of Stack Write Break

Step	Key Sequence	Commentary
74.	E, G	This last emulation can run for as long as four seconds before the instruction at address 0064 writes the data pattern matching the programmed break condition. Z-SCAN may not stop the emulation before the next instruction is executed because the data match is detected only at the end of the last bus cycle of the INC instruction. Because of this, the next instruction, POP, is executed before the emulation terminates. This leaves the PC pointing to the LDR instruction.

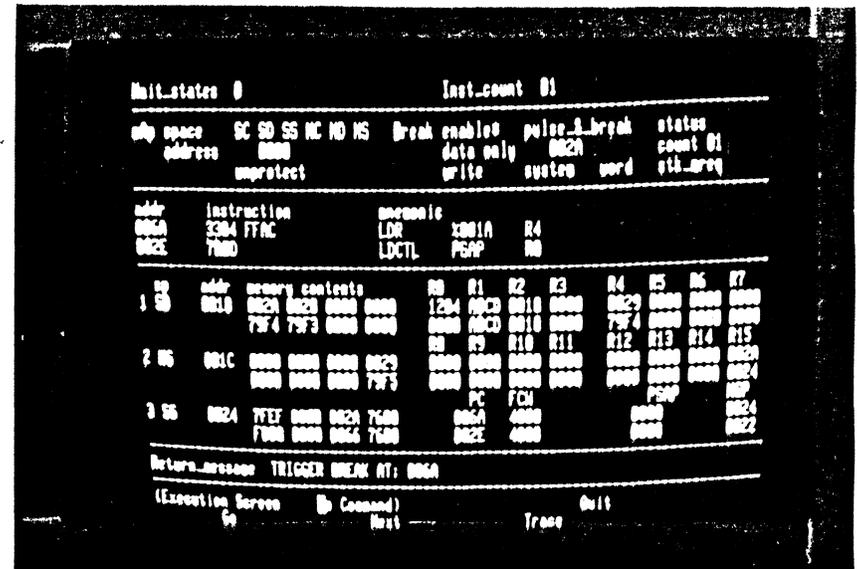


Figure 4-59. Break Following Stack Write

4.7 TUTORIAL SCRIPT FOR Z8001

The tutorial script for the Z8001 begins on the following page. If your unit has a Z8002 installed, turn back to the script in Section 4.5. Be sure not to type the commas or spaces shown throughout the key sequence.

Step	Key Sequence	Commentary
1.	Monitor RESET, RETURN	Z-SCAN is RESET. All information about the previous state of the hardware and software is lost. The monitor software uses the RETURN character to set up a baud rate generator, then it displays a menu of the CRT terminal types supported by the software. The cursor (a steady or flashing bright square on most terminals) appears in the center of the bottom screen line.
2.	Terminal selection digit	To configure the monitor for your terminal, enter one of the digits listed in the menu. If your terminal is not one of those listed on the menu, consult Appendix A and the documentation for the terminal. Pick a digit that corresponds to a protocol supported by the terminal.
3.	RETURN	The CRT screen is cleared, and the System screen is displayed. The cursor rests on the name of the screen, which is in parentheses on line 23, part of the menu area . This screen gives information about the status of the Z-SCAN hardware, for example, the installed CPU type and software revision level. The displayed baud rates and revision levels may differ from those shown in the figure, but the CPU type must be the same. If it is not, follow the alternative tutorial of Section 4.5. If the display is corrupted, the digit entered in step 2 is incorrect and you must repeat the tutorial from step 1.

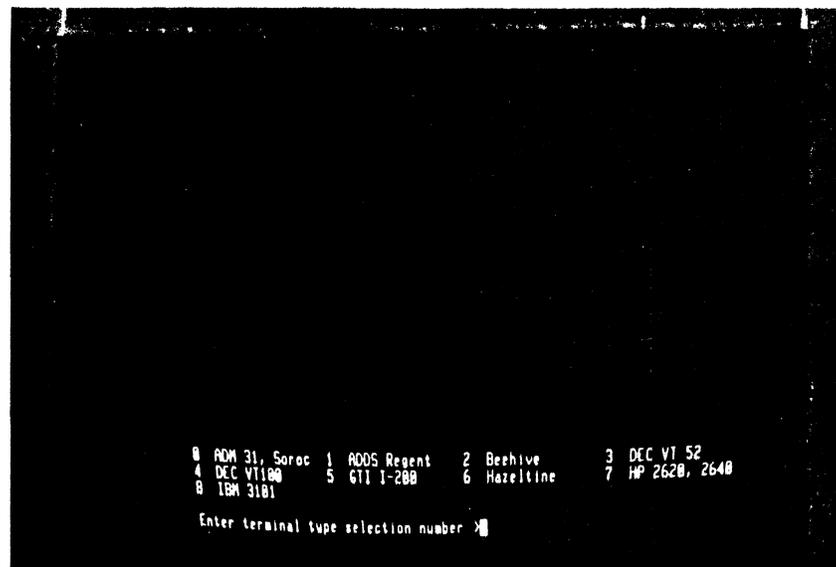


Figure 4-60. Z8001 Terminal Selection Screen

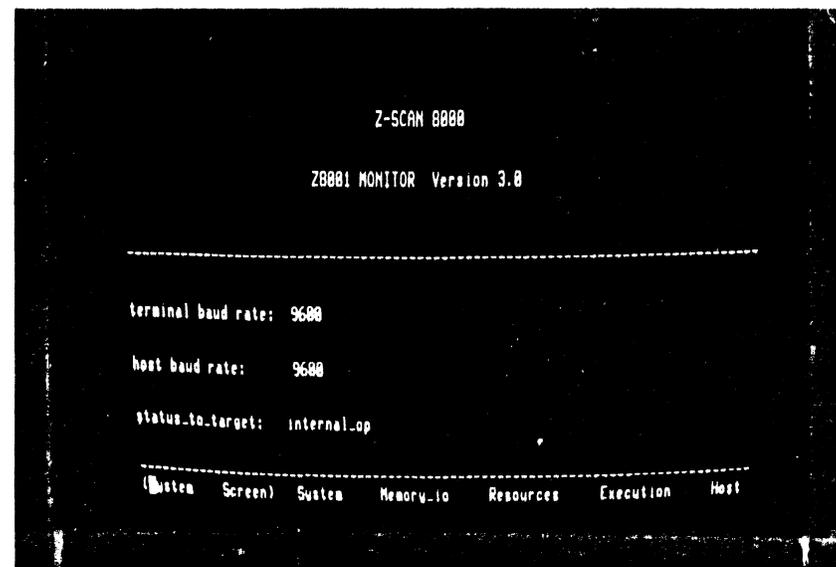


Figure 4-61. Z8001 Monitor System Screen

Step Key Sequence Commentary

4. M The single-keystroke commands you are allowed to enter appear as upper-case letters in the words outside the parentheses in the menu area. The command M calls up the Memory_io screen. Again, the cursor rests on the name of the screen, which appears on line 23 in the menu area.

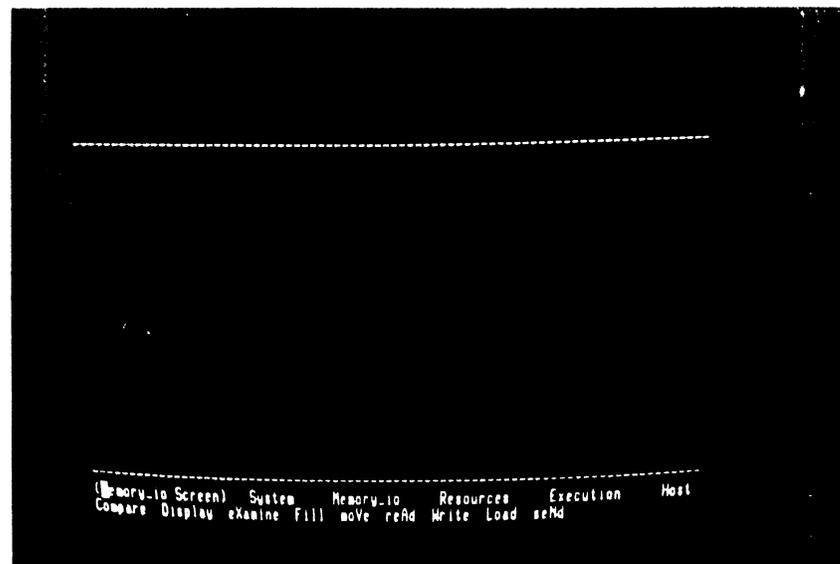


Figure 4-62. Z8001 Monitor Memory_io Screen

5. S, R Among the valid commands shown in the menu area is S. Entering the command **reactivates** the system screen. A third screen, the Resources screen, can be called up by entering R. As usual, the cursor rests on the screen name, and legal commands are listed in the rest of the menu area.

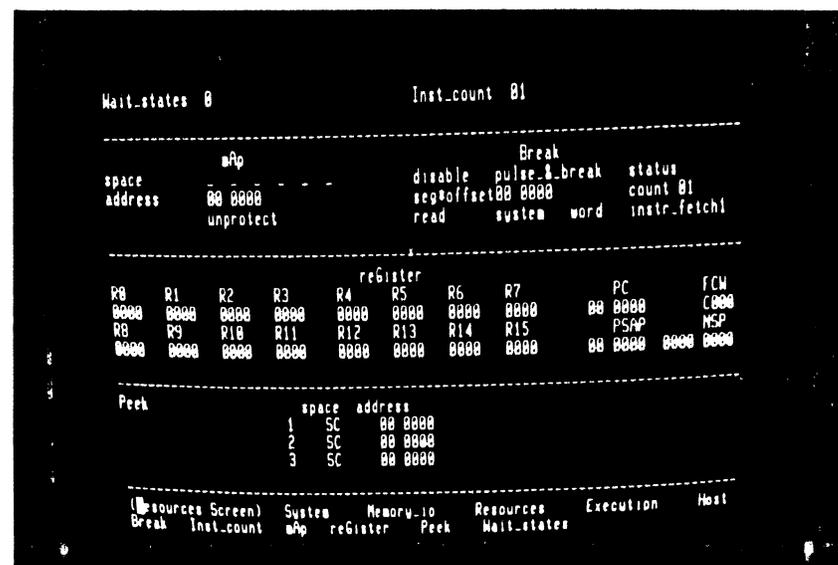


Figure 4-63. Z8001 Monitor Resources Screen

Step Key Sequence Commentary

6. E In step 5, you went from one screen to another by way of the System screen. However, it is usually possible to move from one screen to another with a single keystroke. The Execution screen is activated by the command E.

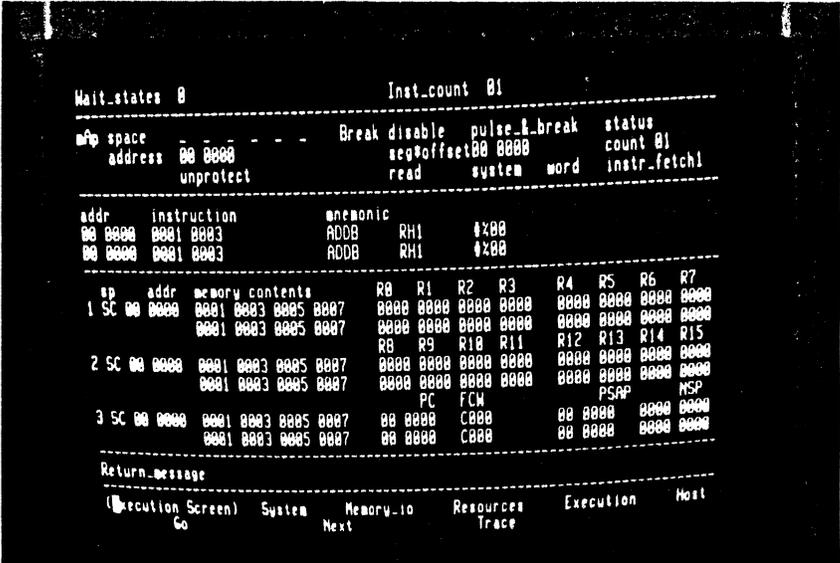


Figure 4-64. Z8001 Monitor Execution Screen

7. T One display, the Trace screen, is accessible only from the Execution screen. Notice that there is no menu area because this screen does not support a variety of commands. It is dedicated to providing a detailed picture of program execution.

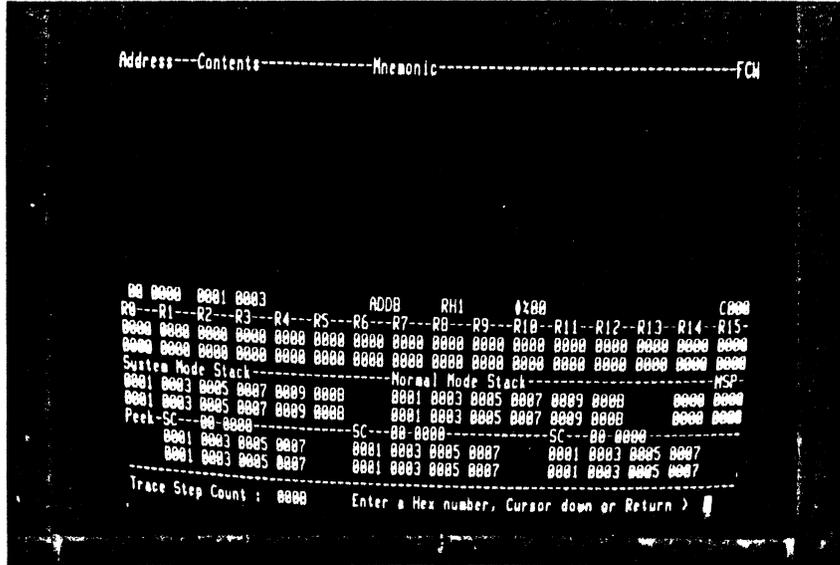


Figure 4-65. Z8001 Monitor Trace Screen

Step Key Sequence

Commentary

8. RETURN, H

Enter a RETURN to exit from the Trace screen to the Execution screen, then enter H. The Host command selects **Transparent** mode, allowing the terminal to communicate with a host system through Z-SCAN. You can enter the command even if no host is connected.

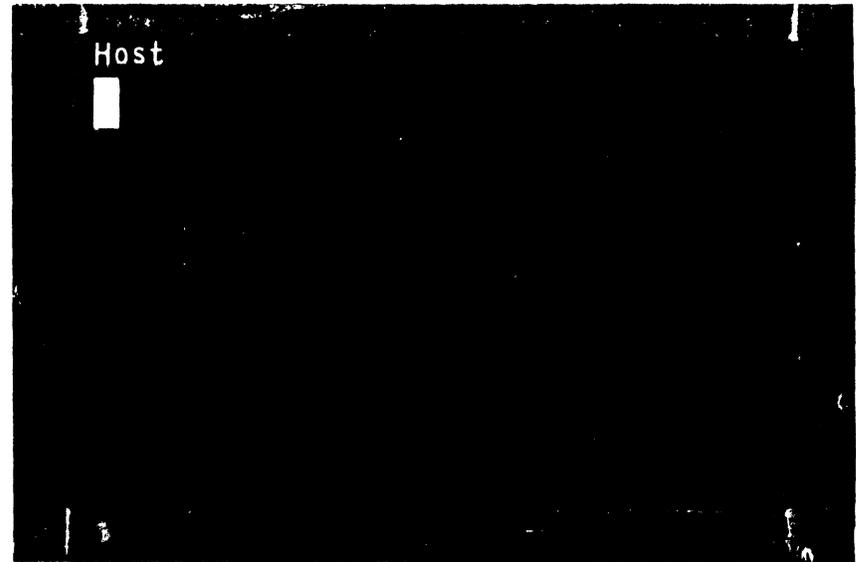


Figure 4-66. Host Screen, Transparent Mode

Step	Key Sequence	Commentary
------	--------------	------------

9.	BREAK	Transparent mode is terminated when the BREAK key is entered. If the System screen does not reappear, consult your terminal documentation -you may have to press another key at the same time as break, or the key may be disabled by an option setting inside the terminal. A monitor RESET can be used to end Transparent mode, but its use is not recommended because it destroys any information that was set up inside the Z-SCAN.
----	-------	---

10.	R, A	So far the cursor has remained at the bottom of the screen except when the Host command was used. All of the user-modifiable fields on the Z-SCAN screens are outside the menu area. The fields are divided into groups, known as subscreens . Each subscreen is associated with a particular command and can be entered by keying the capital letter in the command name as it appears in the menu area. Note that as soon as you enter the A command, the first menu line changes to reflect the selected command (Resources screen, mAp command), and the cursor moves to the top left field in the mAp subscreen.
-----	------	---

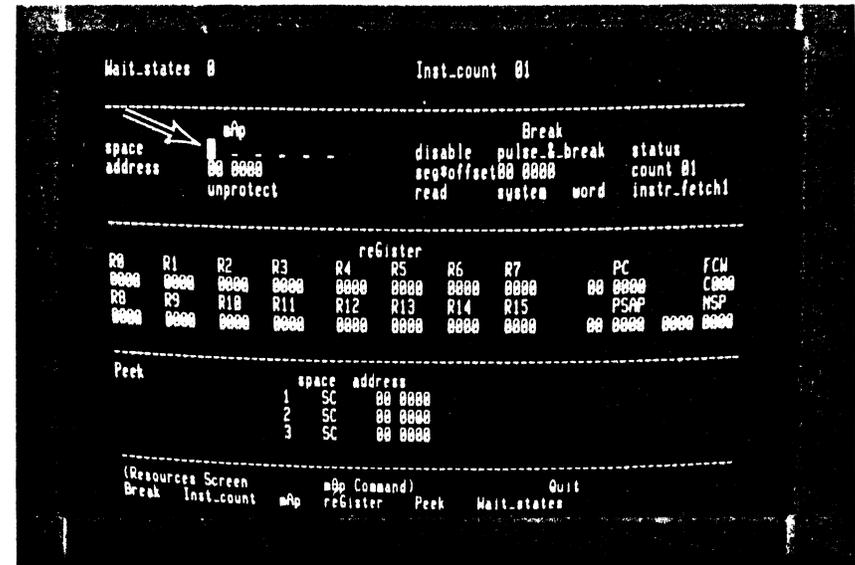


Figure 4-67. Cursor in mAp Subscreen

Step Key Sequence

Commentary

11. RETURN, B

To move the cursor back to the menu area, enter a RETURN. The menu display does not change because the mAp command is still active. It is altered when a new command, Break, is activated. The cursor moves to the top left field in the Break subscreen.

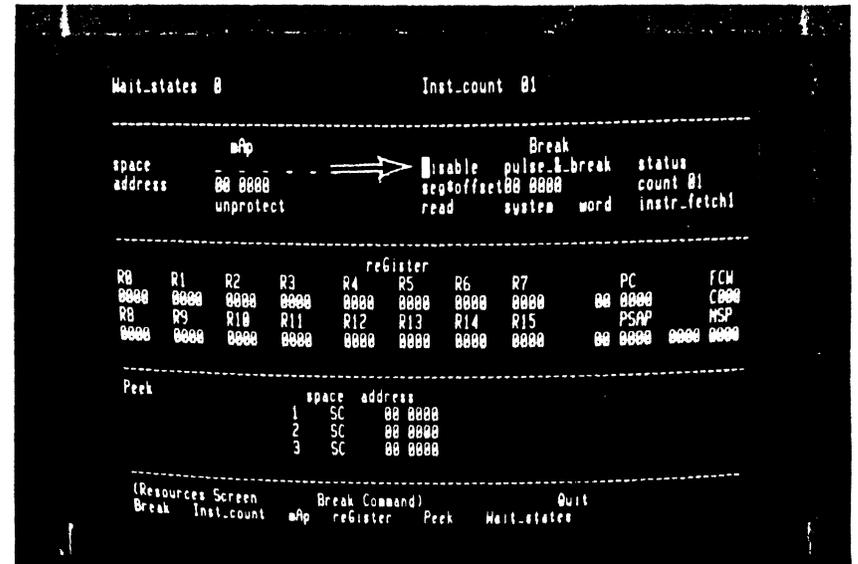


Figure 4-68. Cursor in Break Subscreen

Step Key Sequence

Commentary

16. RETURN, RETURN

The RETURN key moves the cursor back to the menu area. Because the command remains active, a second RETURN moves the cursor to the top left field in its subscreen: there is no need to re-enter the command name.

17. >, >, <, 0, 1, space
G, F, H, CTRL R, >

Each of the six fields on the first line of the mAp subscreen corresponds to one of the Z8001's address spaces, and each has just two possible values. In the default state, an underbar is displayed, indicating that the 8K bytes of **mappable memory** will not respond to CPU accesses made to a particular address space during an emulation. In the alternative state, a two-letter abbreviation for the name of the address space (for example, SC for System Code) shows that the mappable memory will respond. You can step forward or backward through the possible values with the > and < keys or you can access them directly by entering 0 for the first choice and 1 for the second. Alternatively, space and F select the default and final values. CTRL R restores the field to the value it held when the cursor entered it. Other printable characters that are not hexadecimal digits do not affect the field.

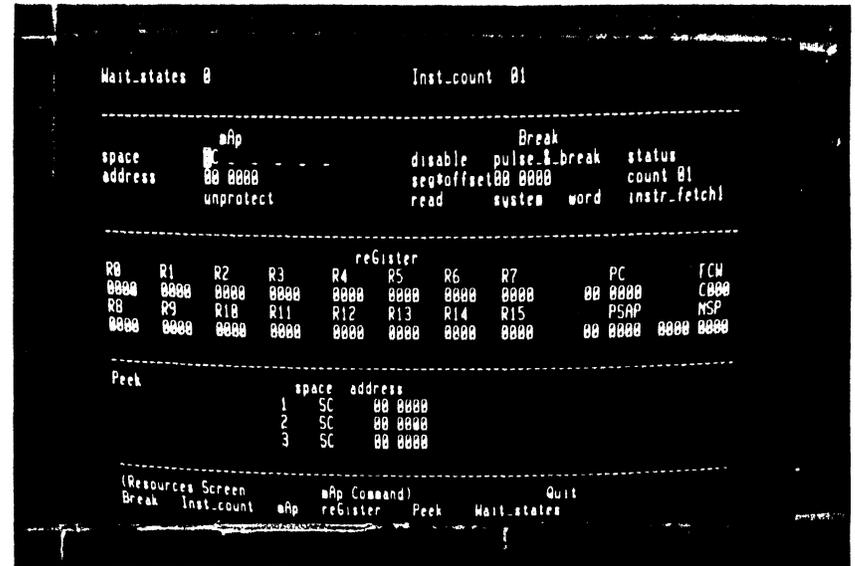


Figure 4-71. Enabling Mappable Memory

Step Key Sequence Commentary

18. RETURN, B, 2

The emulation you are going to run requires a **breakpoint**, so you must enable the breakpoint logic by setting the first field of the Break subscreen to "enable*"*****. This tells the logic to search for a simultaneous match in the segment field, the offset field and the various status fields.

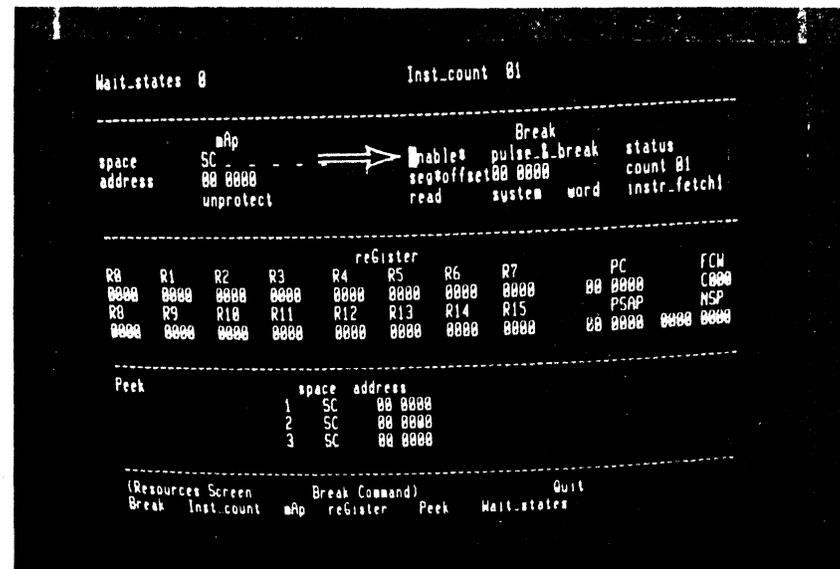


Figure 4-72. Enabling Break Logic

19. down, right, right, >, >, >, <, 1, RETURN

The breakpoint segment number is correct but the offset must be changed. The address field contains four hexadecimal digits and can hold any value between 0000 and FFFF. Use > and < to move the cursor within the field, and enter new hex digits to change the value. You have now set a breakpoint which will be triggered when the first word of an instruction is read from system code location 0010 in segment 00.

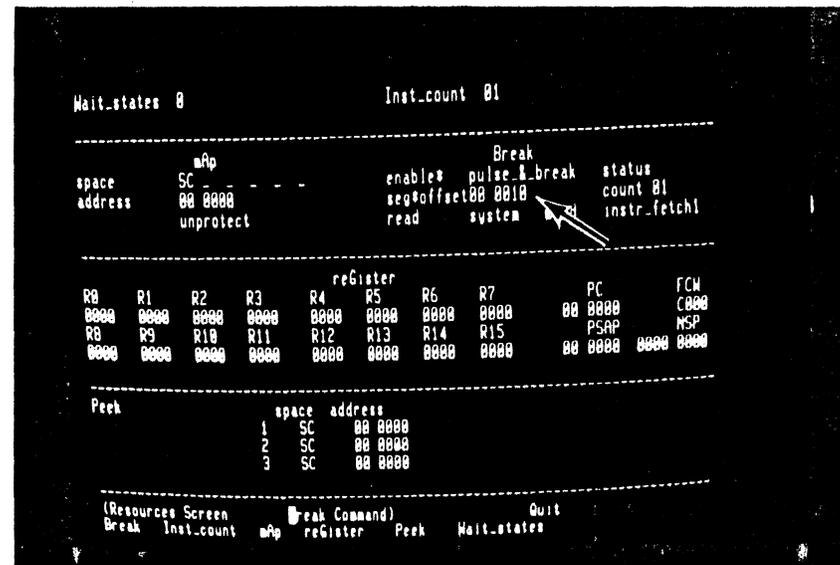


Figure 4-73. Setting Break Address

Step	Key Sequence	Commentary
------	--------------	------------

20. M		Move to the Memory-io screen. When it is displayed, notice that the top three lines are blank.
-------	--	--

21. F		Fill is listed as a valid command in the menu area. As soon as the command is activated, the cursor moves to the first field of the Fill sub-screen which appears at the top of the screen.
-------	--	---

22. left, 1, F, F, F, down A, 8, 0, B		Use the Fill command to fill mappable memory, which currently extends from address 0000 to 1FFF in the first segment of system code space, with increment byte register instructions (opcode A80B, mnemonic INCB RHO, #12). In order to do this, you must change the contents of some of the fields on the sub-screen. The Fill string can be up to 16 hex digits long, but only four are required in this case.
--	--	--

23. RETURN		After the parameters have been set up, the command must be executed by entering a RETURN. Before execution starts, the cursor moves to the bottom of the central window area. The message "DONE" is displayed when execution is complete.
------------	--	---

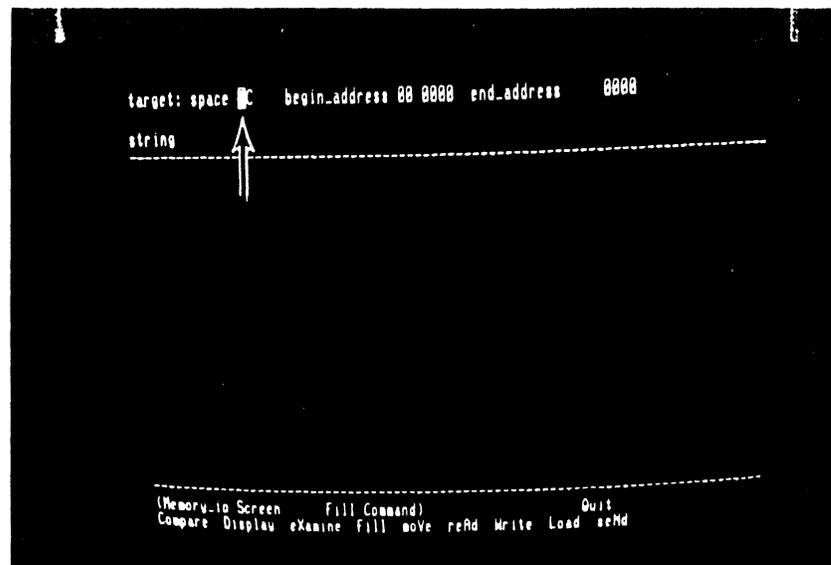


Figure 4-74. Default Fill Command Display

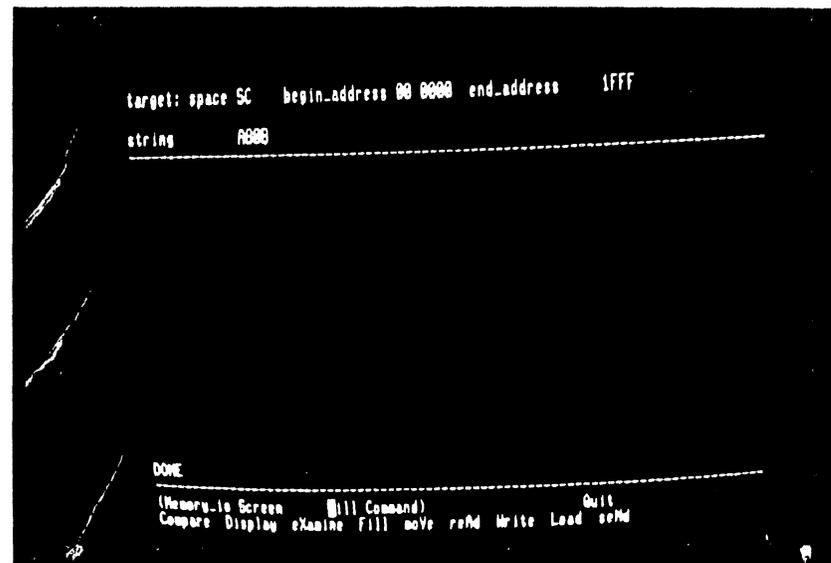


Figure 4-75. Execution of Fill Command

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Step	Key Sequence	Commentary
28.	5, E, F, <, 0, 8, 1, 8 down	This step replaces the two INCB instructions at the top of mappable memory with an unconditional jump to location segment 00 0018 (opcode 5E08 0018, mnemonic JP <<00>> %0018). Short offset addressing is used to save bytes. The < key can be used to backspace over incorrect input. When sufficient digits have been entered to fill the open location, the new value is stored and the next location is opened automatically. The cursor down key opens the next location immediately, storing any digits which have been entered. The data seen in location 2000 may vary because no memory responds at that address.
29.	up, RETURN	Cursor up reopens the previous location, showing that the two digits entered in the previous step have been stored right justified in a field of zeros.

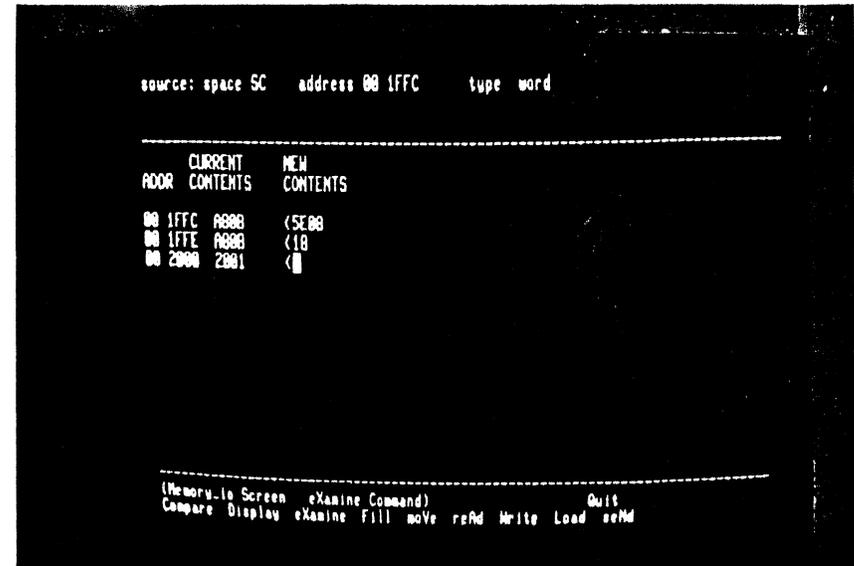


Figure 4-79. Modification of Memory Contents

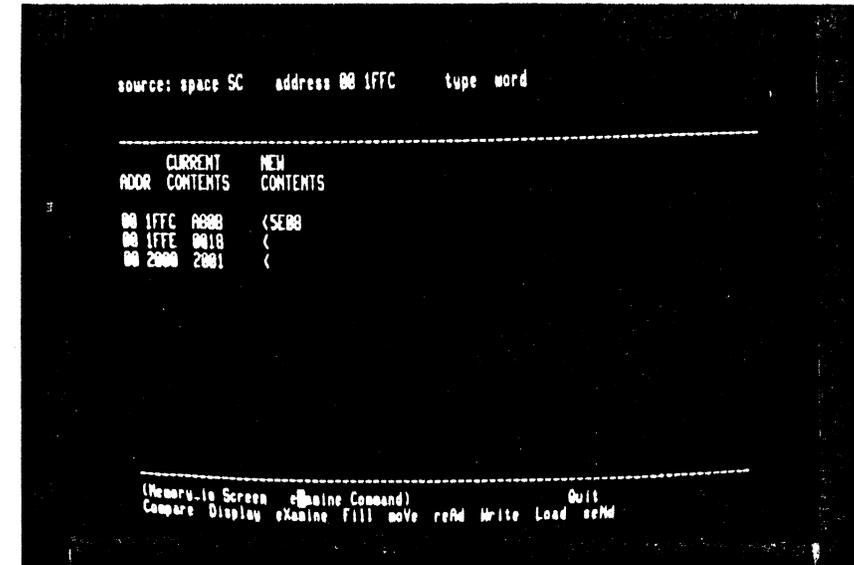


Figure 4-80. Checking Memory Contents

Step Key Sequence Commentary

31. E The program in the mappable memory consists of 4,094 (decimal) INCB instructions and an unconditional jump. It can be run from the Execution screen. The default values of the Program Counter (PC) and Flag and Control Word (FCW) are suitable for running this first emulation. The emulation will run in system mode because bit 14 of the FCW is set. Bit 15 selects segmented mode and is also set in the default FCW value provided by the monitor.

32. N The Next command **steps** through the number of instructions displayed in the `Instruction_count` field at the top right of the screen. In this case, the count is one. After the single instruction has been executed, the whole screen is redisplayed, updating the emulation status. Two registers are affected: RHO, the high byte of R0 has been incremented by 12 (decimal) and the PC offset has moved to next instruction. The top row of the instruction and register values reflect the state of the program after the emulation. The bottom row values reflect the state of the program at the end of the previous emulation.

Wait_states		Inst_count		Break enables		pulse_&_break		status							
space	SC	seg_offset	read	system	word	instr_fetch	count	01							
00	0000	00	0000												
00	0000		unprotect												
addr		instruction		mnemonic											
00	0002	A000		INCB	RHO	#12									
00	0000	A000		INCB	RHO	#12									
sp	addr	memory contents				R0	R1	R2	R3	R4	R5	R6	R7		
1	SC 00	0000	A000	A000	A000	A000	0C00	0000	0000	0000	0000	0000	0000		
			A000	A000	A000	A000	0000	0000	0000	0000	0000	0000	0000		
			A000	A000	A000	A000	R0	R9	R10	R11	R12	R13	R14	R15	
2	SC 00	0000	A000	A000	A000	A000	0000	0000	0000	0000	0000	0000	0000		
			A000	A000	A000	A000	0000	0000	0000	0000	0000	0000	0000		
			A000	A000	A000	A000		PC	FCW		PSWP		NSP		
3	SC 00	0000	A000	A000	A000	A000	00	0002	C000		00	0000	0000		
			A000	A000	A000	A000	00	0000	C000		00	0000	0000		
Return_message STEP BREAK AT: 0002															
(Execution Screen Next Command)															
Go										Next		Trace		Quit	

Figure 4-82. Instruction Step with Next Command

Step Key Sequence Commentary

33. RETURN Now that the Next command is active, it may be repeated by entering RETURN. Again, the PC value changes and RHO is incremented.

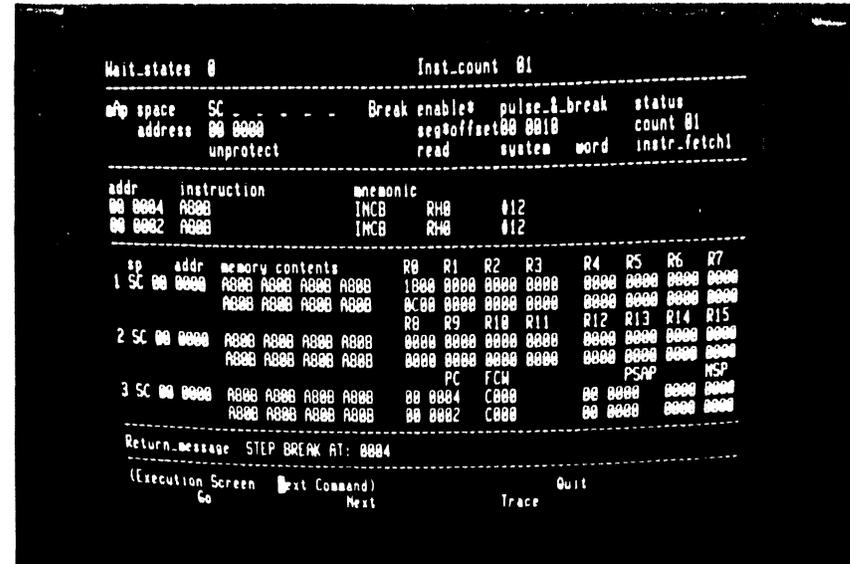


Figure 4-83. Second Instruction Step

34. G The Go command starts an emulation which does not stop until a break condition is encountered. Your program should trigger the breakpoint logic when an instruction is fetched from location 0010. The breakpoint is honored after the instruction has been executed so that the emulation ends with the Program Counter pointing to the instruction at location 0012. Note that the termination message is different from that of the Next command.

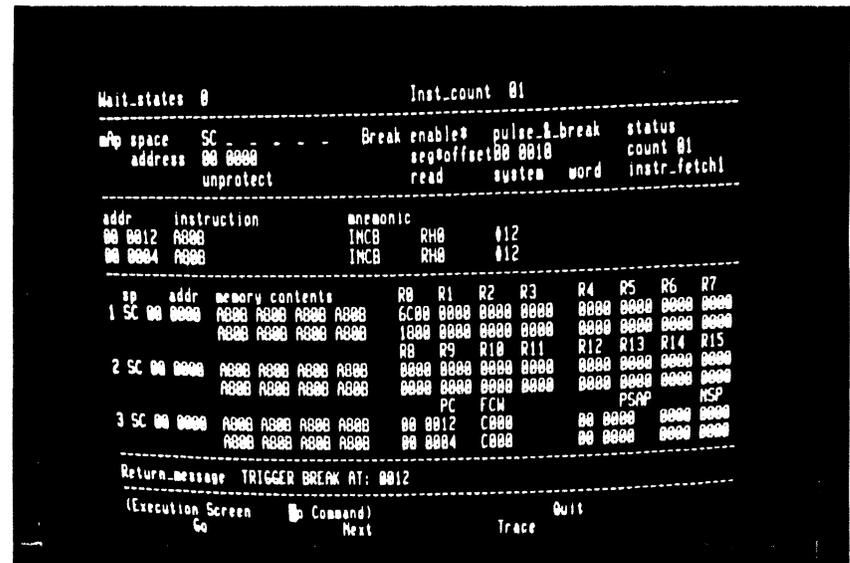


Figure 4-84. Running to Breakpoint with Go Command

Step Key Sequence Commentary

35. T Emulations can also be run from the Trace screen, which disassembles each instruction before it is executed. The instruction which appears in the center of the screen is the first to be executed when emulation starts. The bottom of the screen displays register and memory contents. The function of these fields will be explored later.

36. down Entering cursor down results in the execution of the number of instructions given in the count field at the bottom left of the screen. PC and FCW values are given for each instruction executed, and the first instruction executed is flagged with an asterisk in column 1. The remaining registers are not redisplayed until all the instructions have been executed. The FCW values at the right of the screen show that the value in RHO has overflowed and become negative.

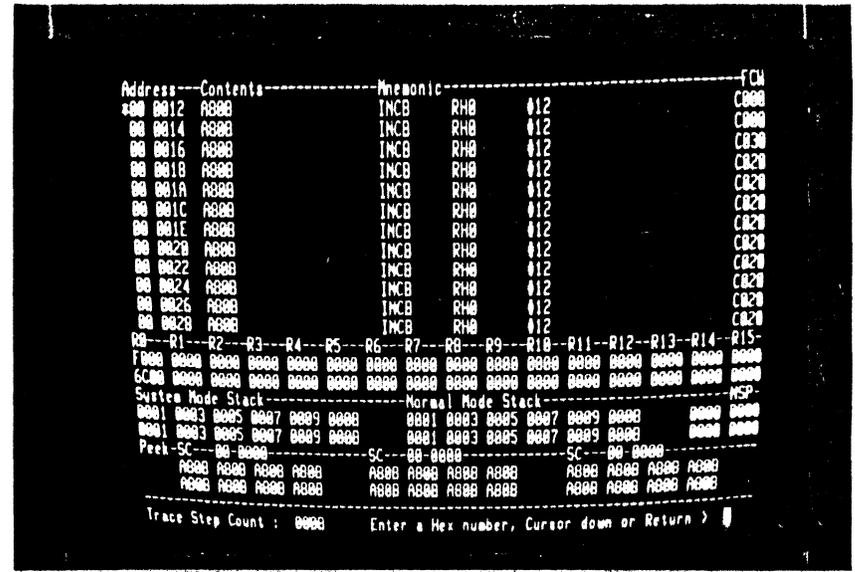


Figure 4-85. Use of the Trace Screen

Step Key Sequence

Commentary

37. RETURN, G

Return from the Trace screen to the Execution screen and start another emulation with the Go command. This time the breakpoint is not encountered - the program loops in the address range 0018 to 1FFC, avoiding location 0010. While the emulation is running, the cursor rests in the blanked return message line and the terminal keyboard is disabled.

```

Wait_states 0                               Inst_count 01
-----
wfp space SC - - - Break enabled pulse_&_break status
address 00 0000 unprotect read segoffset00 0010 system word count 01
instr_fetch1
-----
addr instruction mnemonic
00 0020 A000 INCB R#0 #12
00 0012 A000 INCB R#0 #12
-----
sp addr memory contents R0 R1 R2 R3 R4 R5 R6 R7
1 SC 00 0000 A000 A000 A000 A000 F000 0000 0000 0000 0000 0000 0000 0000
  A000 A000 A000 A000 6C00 0000 0000 0000 0000 0000 0000 0000 0000
  R0 R1 R10 R11 R12 R13 R14 R15
2 SC 00 0000 A000 A000 A000 A000 0000 0000 0000 0000 0000 0000 0000 0000
  A000 A000 A000 A000 0000 0000 0000 0000 0000 0000 0000 0000 0000
  PC FCW PSAP HSP
3 SC 00 0000 A000 A000 A000 A000 00 0020 C020 00 0000 0000 0000
  A000 A000 A000 A000 00 0012 C000 00 0000 0000 0000
-----
Return_message
(Execution Screen Go Command) Trace Quit

```

Figure 4-86. Indefinite Emulation with Go Command

38. monitor NMI

The monitor NMI signal acts as a manual break request during emulations run from the Execution screen.

The emulation terminates when execution of the current instruction is complete. The break address and register contents which you see will probably be different from those in the photograph, but this does not matter.

```

Wait_states 0                               Inst_count 01
-----
wfp space SC - - - Break enabled pulse_&_break status
address 00 0000 unprotect read segoffset00 0010 system word count 01
instr_fetch1
-----
addr instruction mnemonic
00 0302 A000 INCB R#0 #12
00 0020 A000 INCB R#0 #12
-----
sp addr memory contents R0 R1 R2 R3 R4 R5 R6 R7
1 SC 00 0000 A000 A000 A000 A000 1400 0000 0000 0000 0000 0000 0000 0000
  A000 A000 A000 A000 F000 0000 0000 0000 0000 0000 0000 0000 0000
  R0 R1 R10 R11 R12 R13 R14 R15
2 SC 00 0000 A000 A000 A000 A000 0000 0000 0000 0000 0000 0000 0000 0000
  A000 A000 A000 A000 0000 0000 0000 0000 0000 0000 0000 0000 0000
  PC FCW PSAP HSP
3 SC 00 0000 A000 A000 A000 A000 00 0302 C000 00 0000 0000 0000
  A000 A000 A000 A000 00 0020 C020 00 0000 0000 0000
-----
Return_message MANUAL BREAK AT: 0302
(Execution Screen Go Command) Trace Quit

```

Figure 4-87. Manual Break with NMI Switch

- | Step | Key Sequence | Commentary |
|------|--|---|
| 39. | M, X, right, right,
space, CTRL R, 0, 0, 1, 8 | To explore further facilities offered by Z-SCAN, an instruction which reads and writes memory is required. Use the Memory_io screen eXamine command to insert an instruction at location 0018. Two of the keystrokes in this sequence are redundant. The space restores the address field to its default value and CTRL R cancels any changes made since the cursor entered the field. |
| 40. | RETURN, 6, 9, 0, F, 1
0, RETURN | The instruction is INC <<00>> %0010 , #16 in segment 00 (increment by 16 the word at location 0010). If short offset addressing is used, it has a two-word opcode, 690F 0010. |
| 41. | C, BREAK, RETURN, left
0, RETURN | Check memory contents again by using the Compare command. Extra keystrokes in this sequence show that the BREAK key moves the cursor back to the menu area without executing the active command and that the monitor does not allow you to enter an illegal value in a numeric field: the previous value of the field is restored. When the command is executed it should show eight differences. |

```

source: space SC   address 00 0018   type word
-----
      CURRENT      NEW
ADDR  CONTENTS   CONTENTS
00 0018  A000    <690F
00 001A  A000    <10
-----
(Memory-to Screen  eXamine Command)      Quit
Compare Display eXamine Fill moVe reAd Write Load seM

```

Figure 4-88. Insertion of New Instruction

```

source: space SC   address 00 1000   count 1000
target: space SC   address 00 0000
-----
SOURCE          TARGET
ADDR  CONTENTS  ADDR  CONTENTS
00 1018  A0      00 0010  69
00 1019  00      00 0019  0F
00 101A  A0      00 001A  00
00 101B  00      00 001B  10
00 101C  5E      00 001C  A0
00 101D  00      00 001D  00
00 101E  00      00 001E  A0
00 101F  10      00 001F  00
-----
0008 DIFFERENCES
(Memory-to Screen  Compare Command)      Quit
Compare Display eXamine Fill moVe reAd Write Load seM

```

Figure 4-89. Check of Change with Compare Command

Step	Key Sequence	Commentary
42.	D, RETURN, RETURN	Display disassembled memory to show the new instruction at location 0018.

```

source: space SC  address 00 0000  type seq
-----
00 0000 A000          INCB  RHO  012
00 0002 A000          INCB  RHO  012
00 0004 A000          INCB  RHO  012
00 0006 A000          INCB  RHO  012
00 0008 A000          INCB  RHO  012
00 000A A000          INCB  RHO  012
00 000C A000          INCB  RHO  012
00 000E A000          INCB  RHO  012
00 0010 A000          INCB  RHO  012
00 0012 A000          INCB  RHO  012
00 0014 A000          INCB  RHO  012
00 0016 A000          INCB  RHO  012
00 0018 690F 0010      INC   <<<00>>0010: 016
00 001C A000          INCB  RHO  012
00 001E A000          INCB  RHO  012
00 0020 A000          INCB  RHO  012
00 0022 A000          INCB  RHO  012
-----
(Memory to Screen) (Display Command)  Quit
Compare Display eXamine Fill noVe reAd Write Load setd

```

Figure 4-90. Display of Change

43.	R, P, left, >, >, 1, RETURN	The added instruction modifies the contents of location 0010 each time it is executed, so it is desirable to know how they have changed after each emulation is run. The Z-SCAN displays the contents of selected locations on the Execution and Trace screens. The monitored addresses are set up by the Peek command on the Resources screen. Modify the first of the three addresses to 0010.
-----	-----------------------------	--

```

Wait_states 0          Inst_count 01
-----
space SC  - - - -      Break
address 00 0000      enables pulse_t_break status
unprotect          segoffset 00 0010  count 01
read              system word  instr_fetch
-----
R0  R1  R2  R3  R4  R5  R6  R7  PC  FCW
1400 0000 0000 0000 0000 0000 0000 0000 00 0302 0000
R8  R9  R10 R11 R12 R13 R14 R15 PSAP MSP
0000 0000 0000 0000 0000 0000 0000 0000 00 0000 0000 0000
-----
Peek          space address
1 SC 00 0010 ←
2 SC 00 0000
3 SC 00 0000
-----
(Resources Screen) (Break Command)  Quit
Break Inst_count noP reGister Peek Wait_states

```

Figure 4-91. Setting Peek Parameters

Step Key Sequence Commentary

44. E, G
 Now call up the system screen and start an emulation. The top line of the first Peek field shows the contents of word locations 0010 through 0016 as they were before the emulation started.

45. monitor NMI
 You might think that this emulation should stop with a trigger break, because location 0010 is being read by the new instruction. The trigger logic does not fire because the break parameters are set up for an instruction fetch, not a data read, so the emulation must be terminated with a manual break. Looking at the Peek memory areas, you see that the contents of location 0010 have not changed during the emulation. Remember that the mappable memory has been set to respond only to system code space accesses. This explains why the system data accesses made by the new instruction do not affect it.

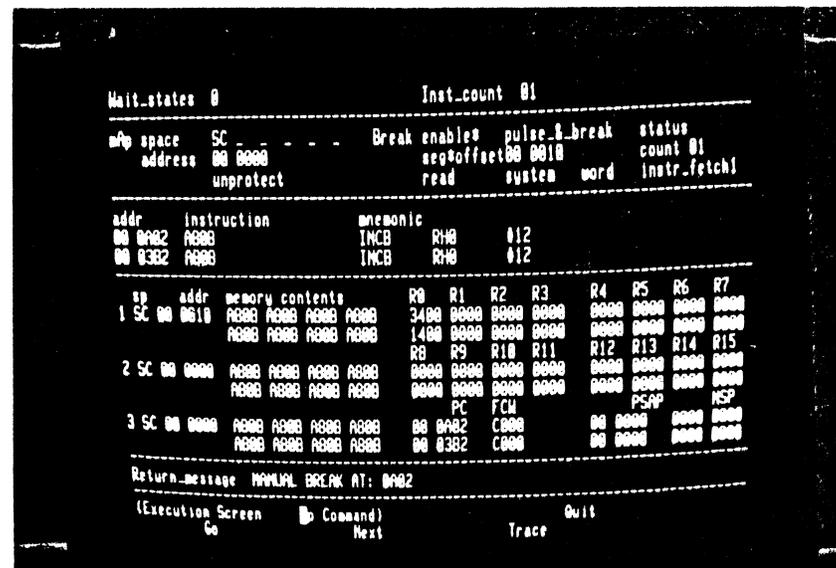


Figure 4-92. Second Manual Break

Step Key Sequence

46. R, B, up, left, >, >, F
 <, space, 1, 2, 9, RETURN

Commentary

To fix these two problems, leave the Execution screen, which, though it displays data about mappable memory and the break condition, does not allow you to modify the parameters. Use the Resources screen Break command to set up a breakpoint on a data memory request. This is one of 16 possible values in the bus cycle type field. As usual you can select a choice either by stepping through the table of possible values or by entering a number that corresponds to the required choice. The space character selects the default value.

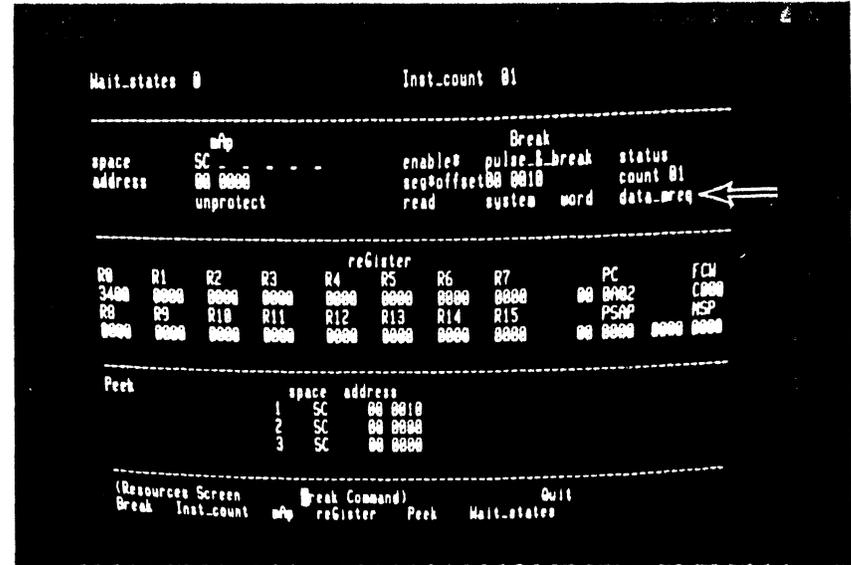


Figure 4-93. Modification of Break Parameters

47. A, right, 1, RETURN

The second field in the mAp sub-screen determines whether or not the mappable memory responds to system data accesses. Entering a 1 sets the field to "SD". The mappable memory now responds to two types of accesses. For this reason, it is not necessary to modify the memory space parameters of Peek. System code location 0010 is the same memory word as system data location 0010.

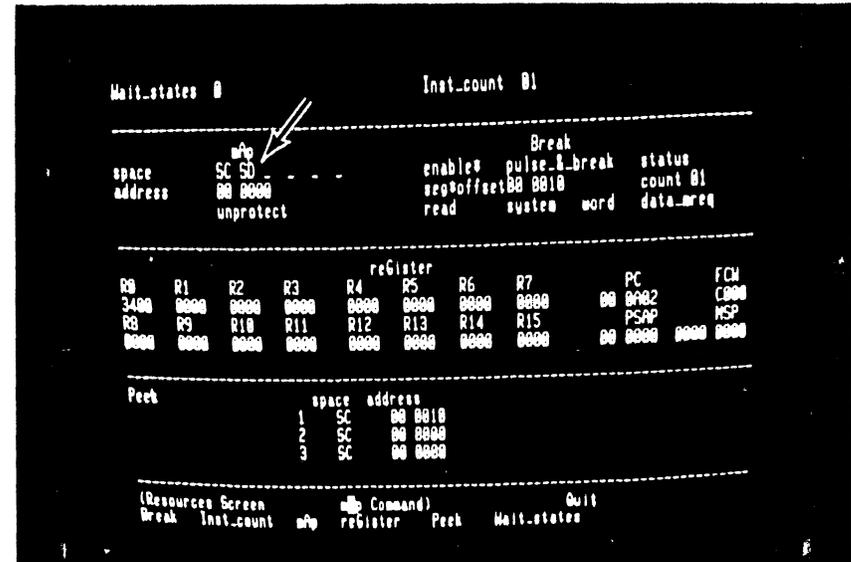


Figure 4-94. Modification of mAp Parameters

Step Key Sequence Commentary

48. G, A, B, RETURN
 The last action on this screen is to set up a new starting value for R0 with the reGister command.

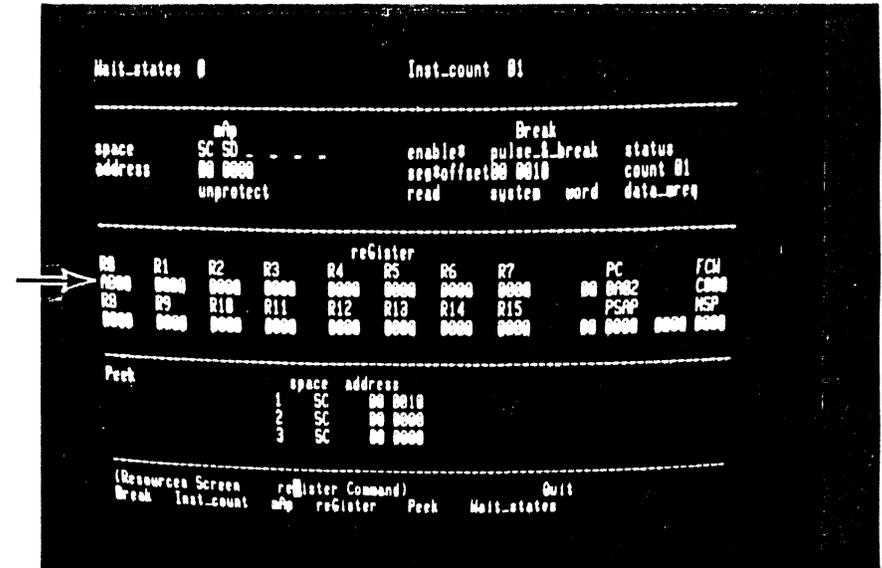


Figure 4-95. Modification of R0 Value

49. E, G
 Start a new emulation. This time, the trigger fires almost immediately, and when the execution screen is redisplayed, you see that the contents of location 0010 have indeed changed from A80B to A81B. The Program Counter points to location 001C, the word after the instruction that caused the break condition to be met. The condition flags in the FCW reflect the fact that location 0010 holds a negative 2's complement number.

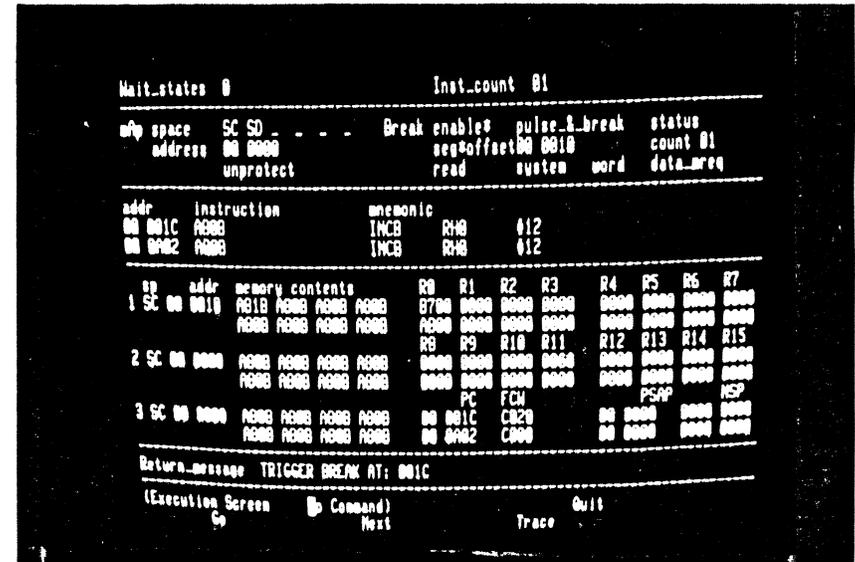


Figure 4-96. Trigger Break on Data Read

Step Key Sequence

Commentary

50. R, B, down, left, 5
RETURN

Associated with the breakpoint logic is a **pass counter**. If you load it with 51 hex (that is 81 decimal), the program loop is executed that number of times on the next emulation.

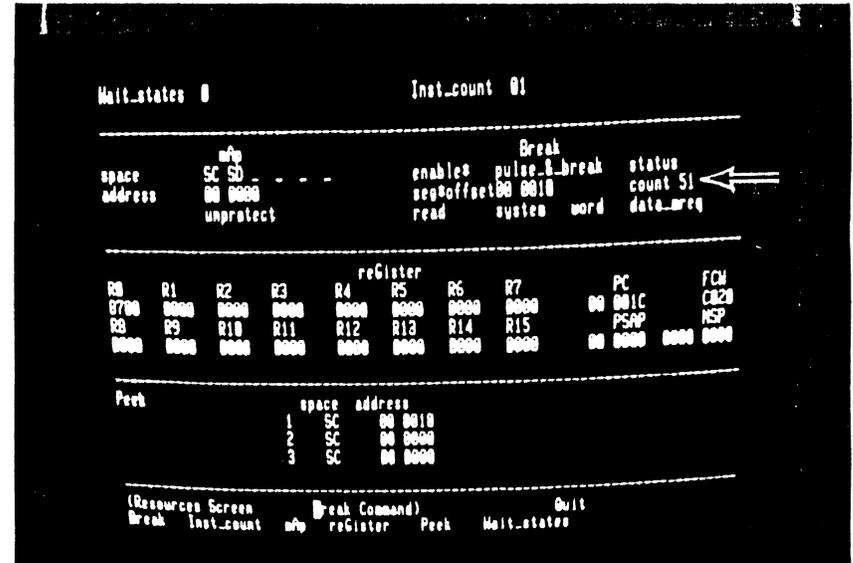


Figure 4-97. Adjusting Pass Counter

51. E, G

After the emulation begins, there is a short delay before the breakpoint is encountered the number of times programmed. When the emulation ends, location 0010 has been incremented by 510 hex (51 x 10), showing that the correct number of passes has been made.

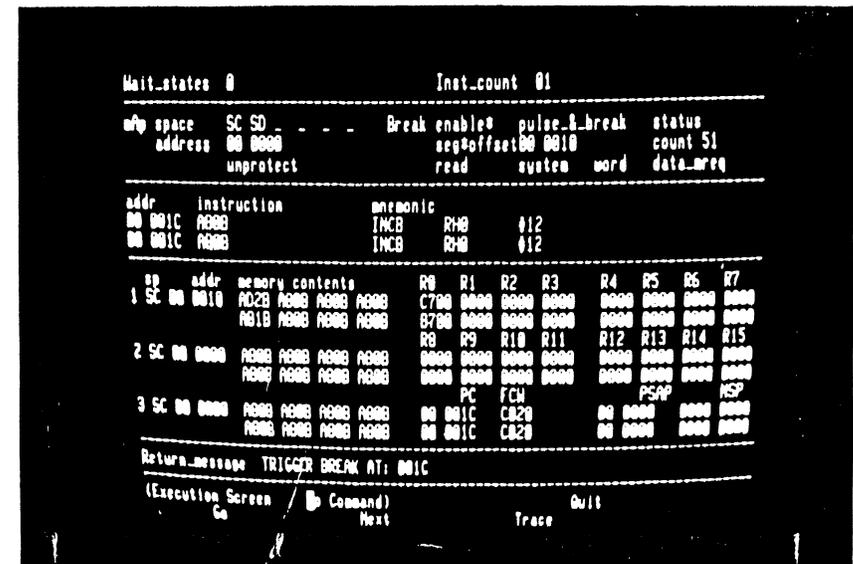


Figure 4-98. Break After Multiple Passes

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Step	Key Sequence	Commentary
52.	R, A, up, 2, RETURN, B, space, RETURN	The INC instruction writes memory and can be used to show the Z-SCAN's write protect feature. To do this, disable the breakpoint and enable a write protect break.

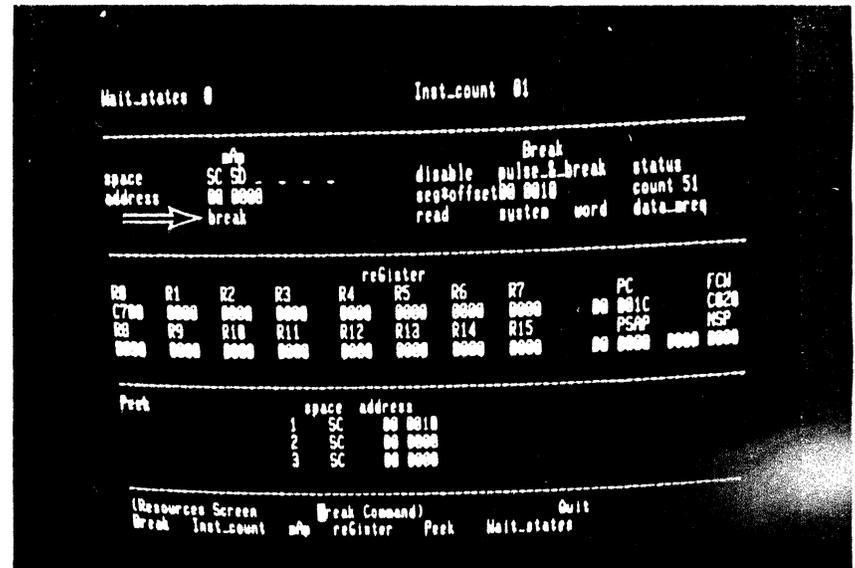


Figure 4-99. Selection of Write-Protect Break

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53.	E, G	The next emulation terminates with a message warning of a write protect violation. Although the offending instruction has been executed, the contents of mappable memory remain unchanged and the data that the CPU attempted to write into memory is lost.
-----	------	---

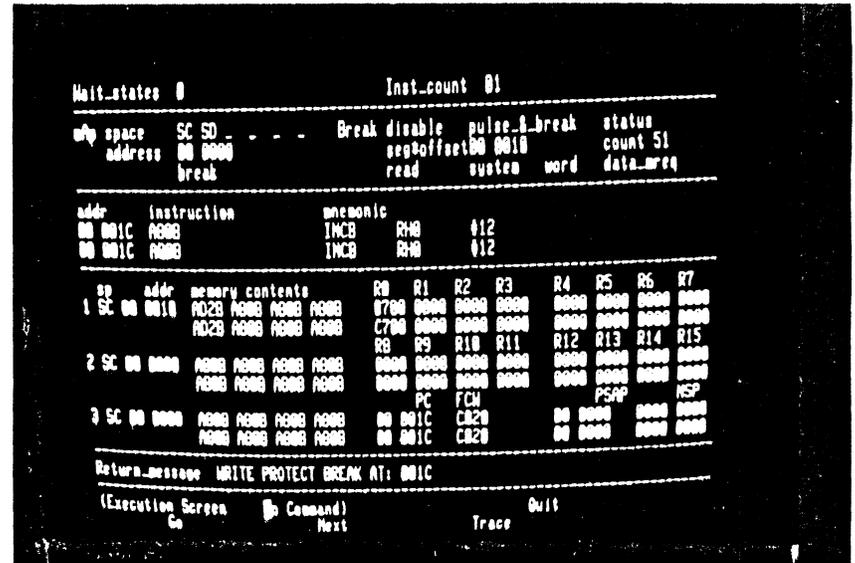


Figure 4-100. Break After Violation

Step	Key Sequence	Commentary
54.	R, A, up, space, RETURN	Clear the write protect break.

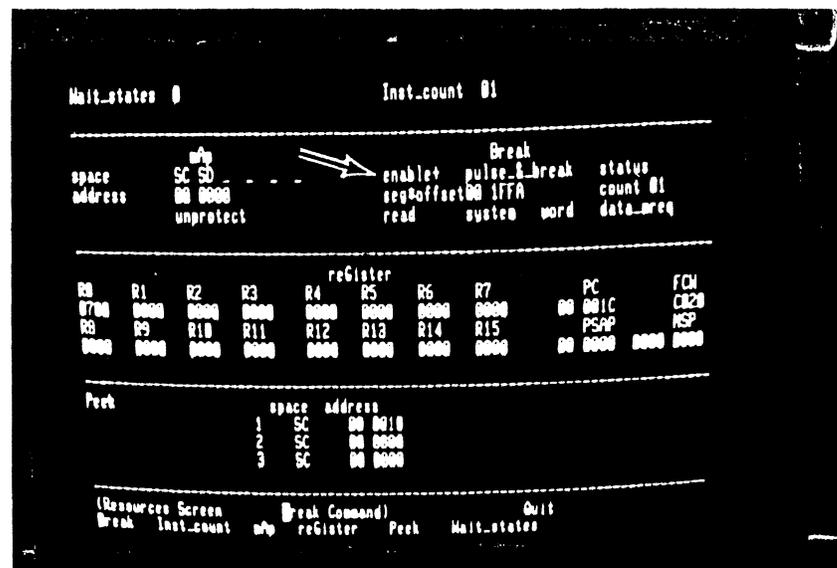


Figure 4-101. Set-up of Multiple Condition Break

55.	B, 1, down, left, space, left, 1, F, F, A, RETURN	Now select a break on the first occurrence of either any reference to segment 00, location 1FFA (in any address space) or any word read from system data memory. "enable+" designates this mode of operation.
-----	---	---

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Step	Key Sequence	Commentary
56. E, G		Return to the Execution screen and run an emulation. It stops at location 1FFC because the address of the previous instruction has fired the trigger. The contents of location 0010 are unchanged, indicating that the instruction at location 0018 was not executed during the emulation.

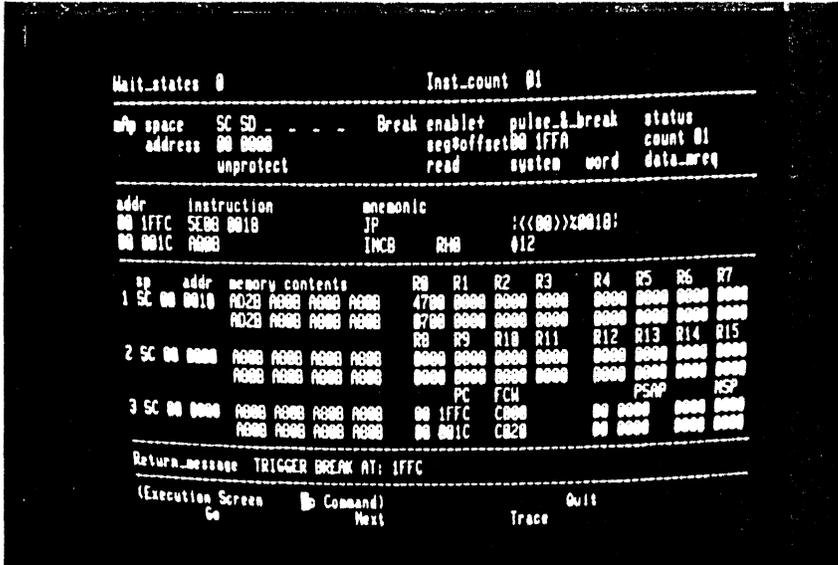


Figure 4-102. Break on Address Match

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57. I, down		A trace terminates after only two instructions have been executed because a trigger is caused when the instruction at location 0018 performs a data memory read. Emulation stops as this event has precedence over the step count of 000B (11 decimal) instructions. A break message replaces the prompt that normally appears on the bottom screen line. The Peek display shows that the contents of location 0010 have changed.
-------------	--	---

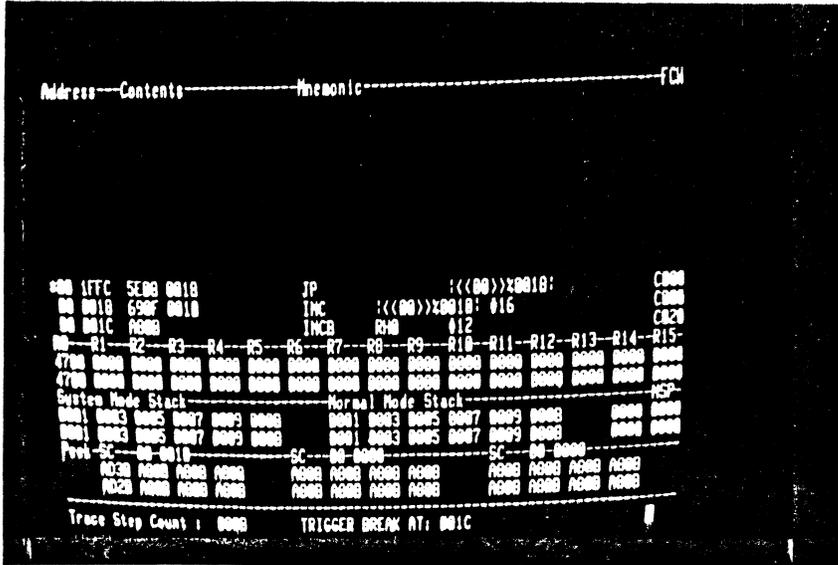


Figure 4-103. Data Read Break on Trace Screen

4.8 HOST SYSTEM USE WITH Z8001

The tutorial script continues on the next page. If your Z-SCAN is connected to a host system that supports the generation and downloading of Z8001 programs, perform steps 59 through 63, then move on to step 65. If the example program already exists on the host file system, you can skip all the steps except 63. If you do not have a suitable host, proceed directly to step 64.

Step	Key Sequence	Commentary
58.	RETURN, R, RETURN, R, A, 1, right, 1, right, 1, right, 1, right, 1, right, 1, right, 1, RETURN	The example program that is run in this part of the tutorial generates accesses to all six Z8001 memory spaces. Select the Resources screen and set up the mappable memory to respond to all types of access: code, data and stack references in both system and normal modes.

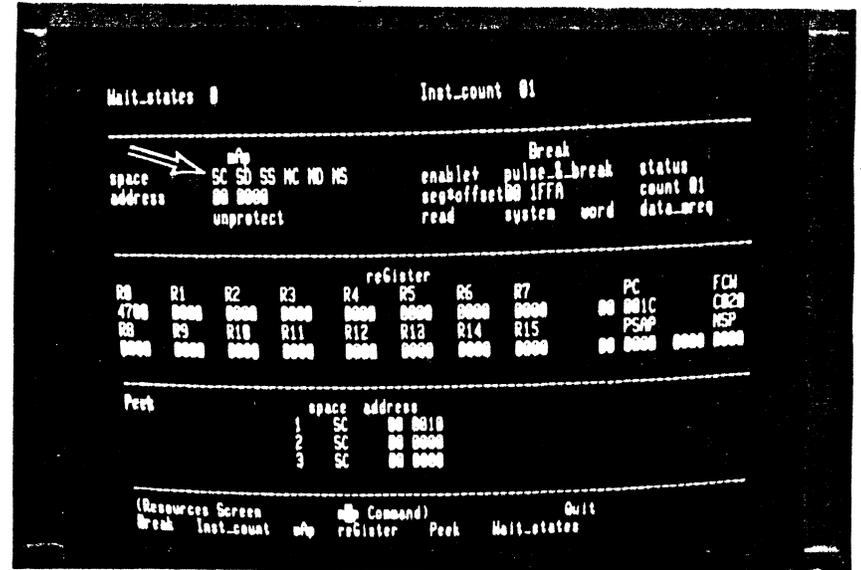


Figure 4-104. Enabling of All mAp Address Spaces

NOTE

If your Z-SCAN is connected to a host system that supports the generation and downloading of Z8001 programs, perform steps 59 through 63, then move on to step 65. If the example program already exists on the host file system, you can skip all the steps except 63. If you do not have a suitable host, proceed directly to step 64.

Step	Key Sequence	Commentary
59.	H	Before you can use the Z-SCAN down-load command, you must have Z8001 program to load. Your host's utilities and support programs can be used to create it. Type H to enter Transparent mode.
60.	Bootstrap your system	Unless it is already up and running, load the operating system of your host. For Zilog PDS 8000 systems, press the reset button on the front panel of the system, then enter RETURN at the terminal keyboard. For ZDS/1 systems, press wait, then enter two returns. An operating system diskette must be present in drive zero or, for hard disk systems, the disks must be spinning. If you have a non-Zilog host, follow the bootstrap procedure described in its system manual.
61.	Enter, assemble and image the example program	Figure 4-105 shows an example program that is compatible with Zilog's Z8000 PLZ/ASM assembler, version 2.02 or later. The commands needed by the Zilog R10 operating system to create it are listed in Figure 4-106. Assemblers on non-Zilog hosts probably require changes in the syntax of the source. Changes are acceptable provided that the memory image of the final program corresponds to the information at the left of Figure 4-105. Refer to the host documentation for more information. The program appears with expanded commentary in Appendix B of this manual.



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```

0C      OBJ CODE      1 EXAMSEG MODULE
                                2 $SEGMENTED
                                3 $SECTION      EXAMSEG_P      ! Make imaging easy
                                4 $REL      %0000
                                5 INTERNAL
00 0000  C000      6 NEW_STATUS_AREA:      ! Most entries unusec
04 8000' 0044'      7 RESET      ARRAY [ 2 LONG ] := [ %C000, INIT ]
                                8 $REL      %0010      ! Privileged instr.
10 0000  C004      9 PRIV_VECTOR ARRAY [ 2 LONG ] := [ %C004, INIT ]
14 8000' 0044'
                                10 $REL      %0018      ! System call
18 0000  C000     11 SC_VECTOR  ARRAY [ 2 LONG ] := [ %C000, BREAKER
1C 8000' 005A'
                                12 $REL      %0028      ! Non-Maskable Int.
28 0000  C008     13 NMI_VECTOR  ARRAY [ 2 LONG ] := [ %C008, INIT ]
2C 8000' 0044'
30 0000  0000     14 PASS, LAST WORD := 0      ! Data and stack area
34 0000  ...     15 NML_STK    ARRAY [ 4 WORD ] := 0
3C 0000  0000     16 SYS_STK RECORD [ID OLD_FCW WORD OLD_PC LONG] := (
40 0000  0000
44
                                17 GLOBAL INIT PROCEDURE      ! Set up control reg'
                                18 ENTRY      ! and both stacks.
44 7600  00' 00'  19 LDA      RRO, |NEW_STATUS_AREA|
48 7D0C      20 LDCTL   PSAPSEG, R0
4A 7D1D      21 LDCTL   PSAPOFF, R1
4C 760E  00' 44'  22 LDA      RR14, |SYS_STK + SIZEOF SYS_STK|
50 7600  00' 3C'  23 LDA      RRO, |NML_STK + SIZEOF NML_STK|
54 7D0E      24 LDCTL   NSPSEG, R0
56 7D1F      25 LDCTL   NSPOFF, R1
58 7F12      26 SC      #%12      ! Trap into BREAKER
5A
                                27 END INIT
                                28
5A
                                29 INTERNAL BREAKER PROCEDURE      ! Demonstrate bus
                                30 ENTRY      ! cycle types.
5A A9F7      31 INC      R15, #SIZEOF SYS_STK      ! Fix up system stack
5C 670E  00' 3E'  32 BIT      |SYS_STK.OLD_FCW|, #14 ! Check previous mode
60 E604      33 JR      Z, ELSE_      ! If mode was system
62 7D02      34 LDCTL   RO, FCW      ! set normal mode by
64 A30E      35 RES      RO, #14      ! clearing bit 14
66 7D0A      36 LDCTL   FCW, RO      ! of FCW;
68 E808      37 JR      FI_      ! else do I/O.
6A 2101  ABCD   38 ELSE_: LD      R1, #%ABCD      ! Dummy port address.
6E 3D12      39 IN      R2, @R1      ! I/O read
70 3F13      40 OUT     @R1, R3      ! I/O write
72 3B05  1234   41 SIN     RO, %1234      ! Special I/O read
76 3B37  1234   42 SOUT    %1234, R3      ! Special I/O write
                                43 FI_:      ! Memory op's follow
7A 7602  00' 30'  44 LDA      RR2, |PASS|      ! Internal operation
7E 2124      45 LD      R4, @RR2      ! Data read
80 93E4      46 PUSH    @RR14, R4      ! Stk write
82 29E0      47 INC     @RR14      ! Stk read, stk write
84 57E0  00' 30'  48 POP     |PASS|, @RR14      ! Stk read, data write
88 3304  FFA6    49 LDR     LAST, R4      ! Code write
8C 7FEF      50 SC      #%EF      ! Trap sequence
8E
                                51 END BREAKER
                                52 END EXAMSEG

```

Figure 4-105. Z8001 Example Program

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the express written consent of ZILOG, INC.

```
THURSDAY, NOVEMBER 1, 1979
RIO REL 2.2
%DATE 810424
FRIDAY, APRIL 24, 1981
%B;SET TABSIZE=4;EDIT EXAMSEG.S
3
EDIT 2.1
NEW FILE
INPUT
EXAMSEG MODULE
    $SEGMENTED
    $SECTION    EXAMSEG_P      ! Make imaging easy    !
    $REL        %0000
INTERNAL
    . . . . .
    SC          #%EF          ! Trap sequence      !
END BREAKER
END EXAMSEG

EDIT
QUIT
%Z8000ASM EXAMSEG
%8000ASM 2.02
Pass 1 complete

0 errors
Assembly complete
%IMAGER EXAMSEG.OBJ 0=(%=0000 EXAMSEG_P) {0000 0090} E=0044 O=EXAMSEG
IMAGER 2.0
%E BYTES LOADED
%EXTRACT EXAMSEG
RECORD COUNT = 0001  RECORD LENGTH = 0200  NO. OF BYTES IN LAST RECORD = 00
ENTRY POINT = 0044  LOW ADDRESS = 0000  HIGH_ADDRESS = 0080  STACK SIZE = 00
%SEGMENTS:
)000 008F
;
```

NOTE

If the file EXAMSEG is created on a diskette, the first
line of information output by the EXTRACT command will
read as follows:

```
RECORD COUNT = 0002  RECORD LENGTH = 0080  NO. OF BYTES IN LAST RECORD = 00
```

Figure 4-106. Z8001 Program Creation with RIO

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Step	Key Sequence	Commentary
62.	BREAK	Return to the Z-SCAN monitor environment.

Step	Key Sequence	Commentary
63.	M, L, down, E, X, A, M, S, E, G, return	Set up and execute the Memory-io screen Load command. The program name is EXAMSEG (segmented example), and it is to be loaded into system code memory, segment 00. As the file is loaded, an incrementing number field appears toward the top left of the screen. This is a count of the number of records transferred from the host to target memory. Each record carries 30 or fewer bytes. When the loading is complete, the entry address of the program is displayed. If any error message appears, enter H and check the following:

- o Does the program file EXAMSEG exist?
- o Is its name correct?
- o Does the download utility LOAD exist?

If no message appears when the command is executed, the host has not responded to the Load command sent by Z-SCAN. Terminate the load by entering BREAK, then type H and establish why this happened. When you have fixed the fault, return to the Z-SCAN monitor environment and type M, L, return.

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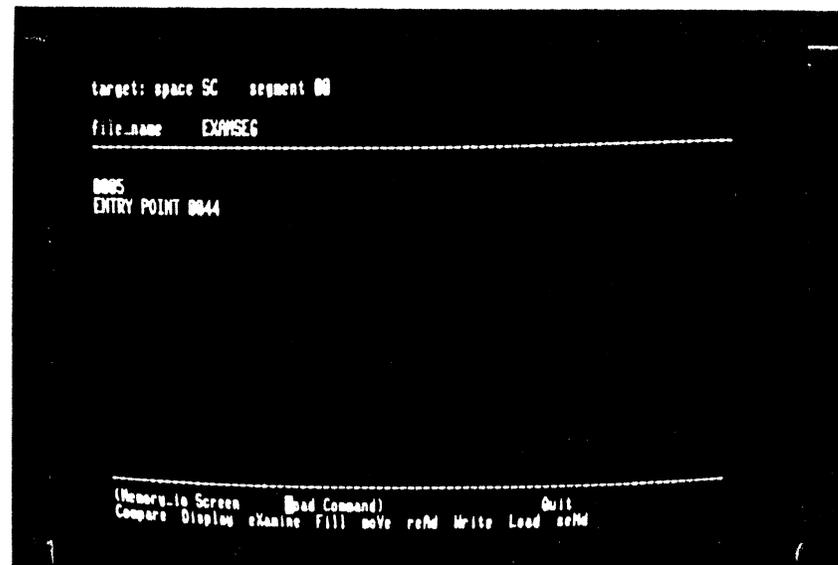


Figure 4-107. Loading of Z8001 Example Program

Step	Key Sequence	Commentary
------	--------------	------------

If you have completed the four previous steps, skip the next one.

4-81

64.	M, V, 6, left, 0, 0, 9, 0, left, 5, E, 7, 0, RETURN	
-----	---	--

A copy of the example program shown in Figure 4-105 exists in the Z-SCAN monitor ROM. Use the Memory_io screen moVe command to copy it into the mappable memory.

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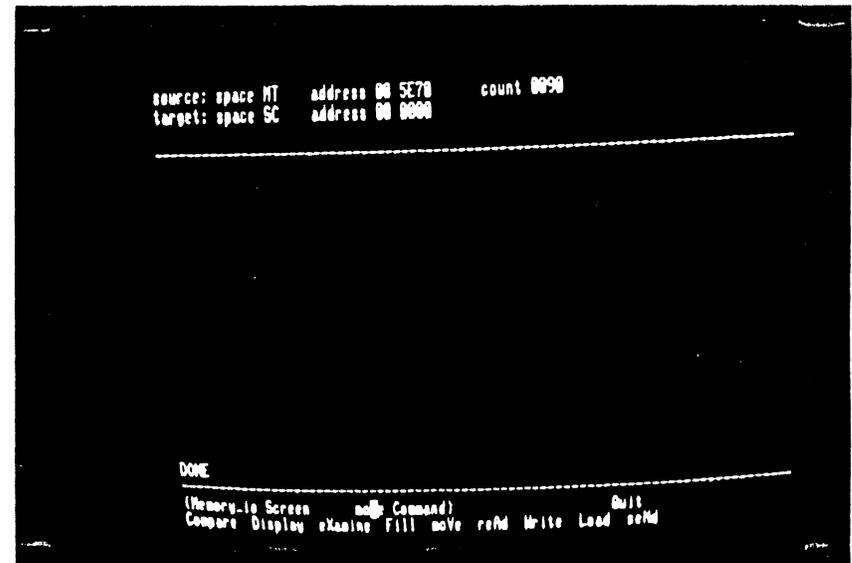


Figure 4-108. Copying Program with moVe

Step	Key Sequence	Commentary
65.	R, G, space, left space, left, 0, 0, 4, 4, RETURN	Set up the PC and FCW so that the program starts at location 0044 in system mode. At the same time, restore R0 to its default value.

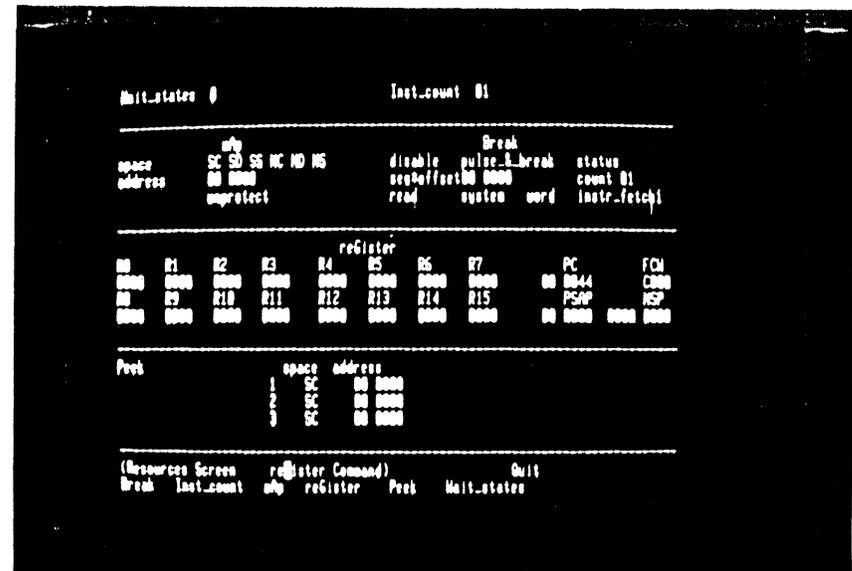


Figure 4-109. reGister Initialization

66.	P, 1, left, 0, 0, 3, 0, down, 0, 0, 3, 4, right, 5, down, 2, left, 0, 0, 3, C, RETURN	The program has data, normal stack and system stack areas. Set up the Peek fields to monitor their contents before and after each emulation is run.
-----	---	---

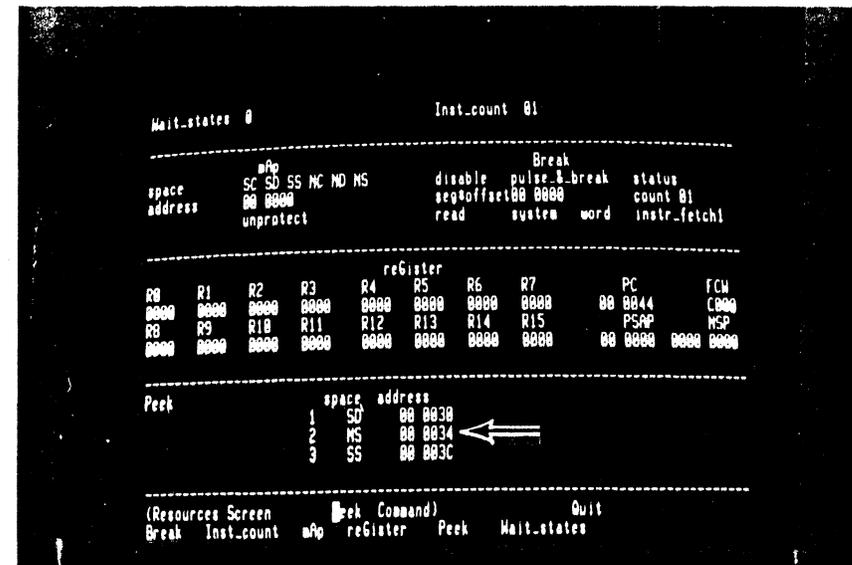


Figure 4-110. Set-up of Peek Parameters

Step	Key Sequence	Commentary
67.	B, 2, up, left, space, up, left, 0, 0, 4, 4, RETURN	Finally, set up a breakpoint on the first instruction of the initialization routine of the example program.

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68.	E, G	The Z-SCAN is now ready to run the program. There is a trigger break after the first instruction is executed. At this point, the only change is in the PC value.
-----	------	--

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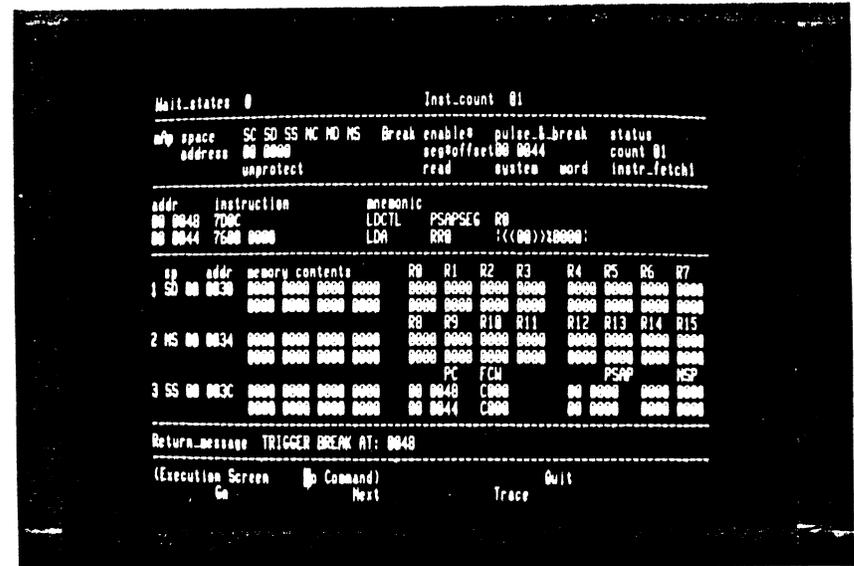


Figure 4-111. Emulation and Breakpoint

Step	Key Sequence
------	--------------

69.	T, 6, down, 1, down
-----	---------------------

Commentary

Trace the next five instructions, entering numbers to change the default Trace step count. At the end of the sequence, both system and normal stack pointers have been set up, changing the displays for the two stack areas . Notice that when the LDA instruction is used with a short offset address, the low byte of the address is loaded into both halves of the long word destination register. This is acceptable because the low eight bits of the segment register are ignored. Also, bit 7 of the PC segment number is a don't care. The final instruction, a System Call, pushes four words of data onto the system stack, producing a further change. The data also appears in the third Peek area.

```

Address-----Contents-----Mnemonic-----FCN
000 0040 700C          LDCTL  PSWPSEG  R0          C000
00 0040 7010          LDCTL  PSWPOT7  R1          C000
00 0040 701E 0044      LDA     R0R      (((00))0044:  C000
00 0050 7020 003C      LDA     R0R      (((00))003C:  C000
00 0054 702E          LDCTL  PSPSEG   R0          C000
00 0056 701F          LDCTL  PSPOT7   R1          C000
00 0050 7712          SC      0112          C000
00 0050 00F7          INC     R15           00          C000
R0--R1--R2--R3--R4--R5--R6--R7--R8--R9--R10--R11--R12--R13--R14--R15-
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0044 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0044 0044
System Mode Stack-----Normal Mode Stack-----
7712 C000 0000 005A 7020 0000      7712 C000 0000 005A 7020 0000      0000 0000
7020 0000 700C 701D 701E 0044      0000 0000 0000 0000 7020 0000      0000 0000
Peek--00--00--0000-----05--00--0034-----05--00--003C-----
0000 0000 0000 0000      0000 0000 0000 0000      7712 C000 0000 005A
0000 0000 0000 0000      0000 0000 0000 0000      0000 0000 0000 0000
Trace Step Count : 0001      Enter # Hex number, Cursor down or Return )
  
```

Figure 4-112. Tracing Initialization Routine

Step Key Sequence

Commentary

70. 1, 0, 0, 0, BREAK

A large number of instructions can be traced with a single command. Let the display run for a while and observe that the program loops, alternately setting and clearing bit 14 of the FCW to move in and out of system mode. Tracing can be stopped at any time by entering the terminal break key. The redisplayed memory content fields show that the contents of the data area and of both stacks have changed.

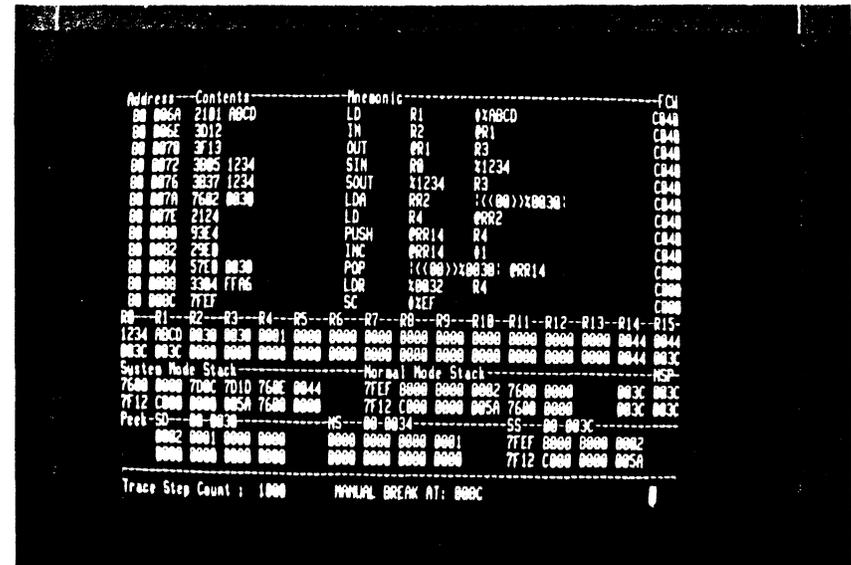
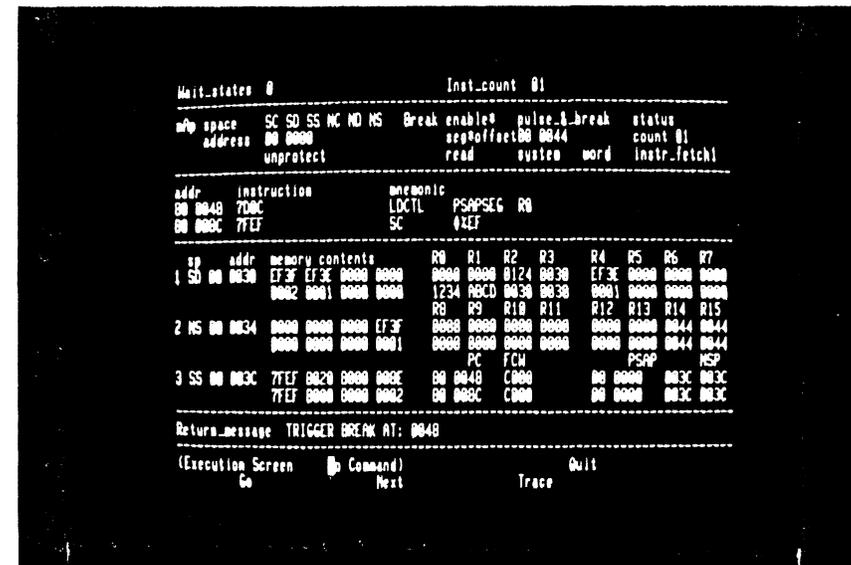


Figure 4-113. Trace of Main Routine

71. RETURN, G, target RESEI

Run the program. The emulation can be terminated with a target RESEI because the status loaded from locations 0002 through 0006 in response to the input makes the CPU execute the instruction on which the break-point is set. The initial conditions of the program are not fully restored by the RESEI because the data and stack areas may no longer be zero.



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Step Key Sequence

Commentary

72. RETURN, target NMI

A target NMI also terminates an emulation. Again, the initialization routine is entered in response to the input. The cause of the entry can be distinguished because the reset and NMI flag register values differ.

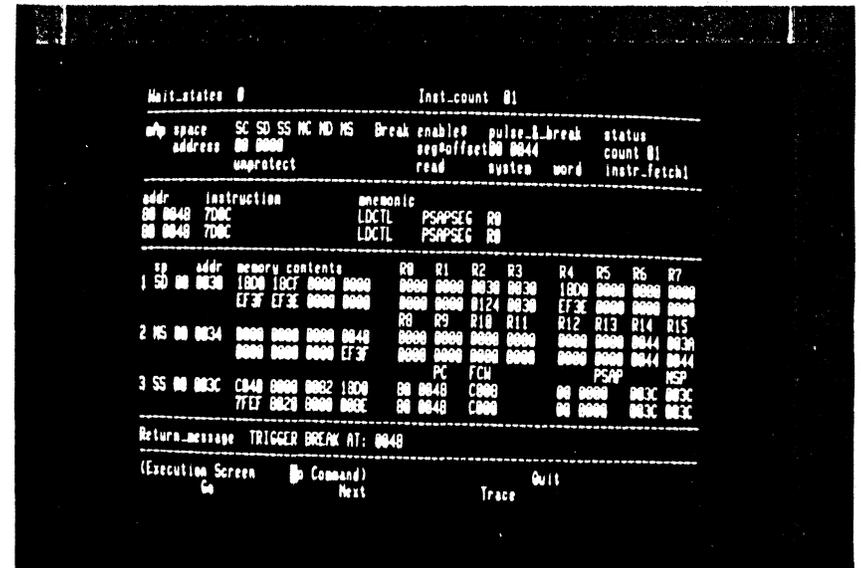


Figure 4-115. Trigger Due to Target NMI.

73. R, B, down, 3, down, 1, left, A, RETURN

This tutorial does not explore the full possibilities of the program, which can generate a wide variety of bus cycle types in both system and normal modes. Experiment with it if you want to explore the Z-SCAN's features in more depth. As a start, set up a breakpoint on a system stack write of data pattern 0044.

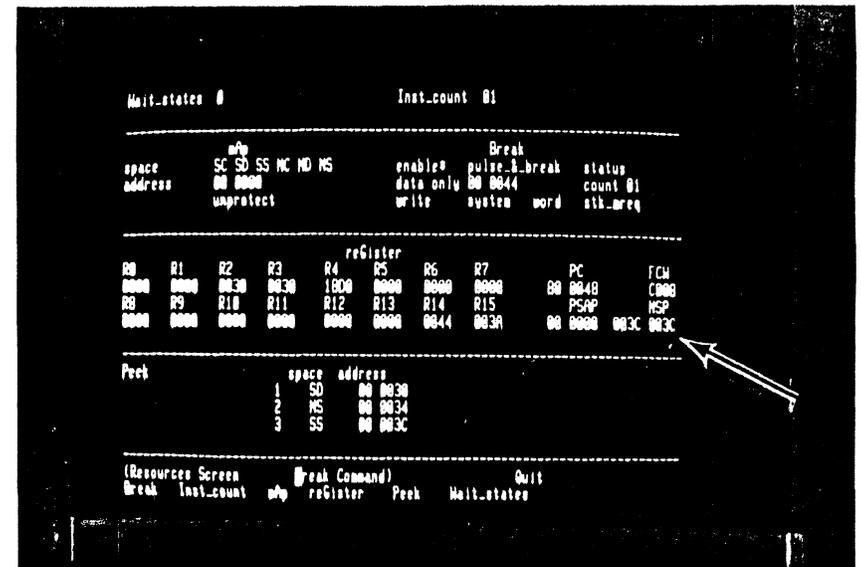


Figure 4-116. Set-up of Stack Write Break

Step Key Sequence

Commentary

74. E, G

This last emulation can run for as long as four seconds before the instruction at address 0082 writes the data pattern matching the programmed break condition. The Z-SCAN may not stop the emulation before the next instruction is executed because the data match is detected only at the end of the last bus cycle of the INC instruction. Because of this, the next instruction, POP, is executed before the emulation terminates. This leaves the PC pointing to the LDR instruction.

Muit_states 0		Inst_count 01	
why space	SC SD SS RC RD RG	Break enabled	status
address	00 0000	data only 00 0044	count 01
	unprotect	write system word	stk_mrg
addr	instruction	memoin	
00 0000	3E04 77A6	LDR 30E32 R4	
00 0040	70AC	LOCTL PRAPSEG R0	
00	addr	memory contents	R0 R1 R2 R3 R4 R5 R6 R7
1 SD 00 00E0	0044 0042 0000 0000	1234 00C0 00E0 00E0	0043 0000 0000 0000
	1000 10C7 0000 0000	0000 0000 00E0 00E0	1000 0000 0000 0000
2 RS 00 00E4	0000 0000 0000 0043	R0 R1 R10 R11	R12 R13 R14 R15
	0000 0000 0000 0040	0000 0000 0000 0000	0000 0000 0044 00C4
		PC FCH	PSW
3 SS 00 00E8	77E7 0000 0000 0044	R0 0000 C000	R0 0000 00C0 00C0
	C040 0000 0002 1000	R0 0040 C000	R0 0000 00C0 00C0
Return_message TRIGGER BREAK AT: 0000			
(Execution Screen		Command	Quit
Go		Next	Trace

Figure 4-117. Break on Stack Write

4.9 CONCLUSION

This concludes the Z-SCAN monitor tutorials. They have shown many of Z-SCAN's features and most of its displays. A few commands have not been explored; these are discussed in Section 6. New users should now proceed to Section 5 which describes the connection of target hardware to Z-SCAN.

SECTION 5

TARGET HARDWARE CONNECTION

5.1 INTRODUCTION

The Z-SCAN 8000's major function is to replace a Z8001 or Z8002 microprocessor in a target system with an in-circuit emulator. This section details the method of connection. Readers are assumed to have some familiarity with the Z-SCAN monitor software. New users are advised to work through the tutorial in Section 4 before proceeding to the connection of a target system.

While Z-SCAN is designed to mimic the Z8000 processors as accurately as possible, the characteristics of any microprocessor emulator inevitably differ slightly from those of the CPU it replaces. These differences and their impact on the behavior of Z-SCAN in certain types of target hardware are discussed. Designers of Z8000-based hardware should read this material. Users debugging existing designs may find that this section explains certain aspects of Z-SCAN's behavior in their target systems.

The combination of a Z-SCAN and a logic analyzer forms a powerful tool capable of real-time recording of logic signals in the target during emulations. The way Z-SCAN's break pulse output can be used to trigger the analyzer, or an oscilloscope, is described in the final part of the section.

5.2 USE OF THE EMULATOR CABLE

5.2.1 Clock Source

Z-SCAN is capable of operating either from its own 3.3 MHz internal clock or from an external clock supplied through the emulator cable from the target hardware. The external clock can have any frequency from 0.5 to 4.0 MHz.

If Z-SCAN is used without a target, as might be the case during the debugging of a non-hardware-dependent software module no larger than the 8K bytes of mappable memory, the internal clock source must be used. When Z-SCAN is connected to a target that has its own clock source, Z-SCAN must use the target's clock to ensure that its CPU operates at the same speed as synchronous logic elements in the target and to ensure successful emulation.

Changeover from internal to external clock is accomplished by moving a single jumper on the Z-SCAN printed circuit board. The jumper, designated E10, E11, E12, is located towards the front left of the board, as shown in Figure 5-1. The jumper is the only one on the board the user should alter, and it selects clock source as listed in Table 5-1.

Table 5-1. Clock Source Selection

Connection	Clock Source
E10 to E11	Internal
E11 to E12	External

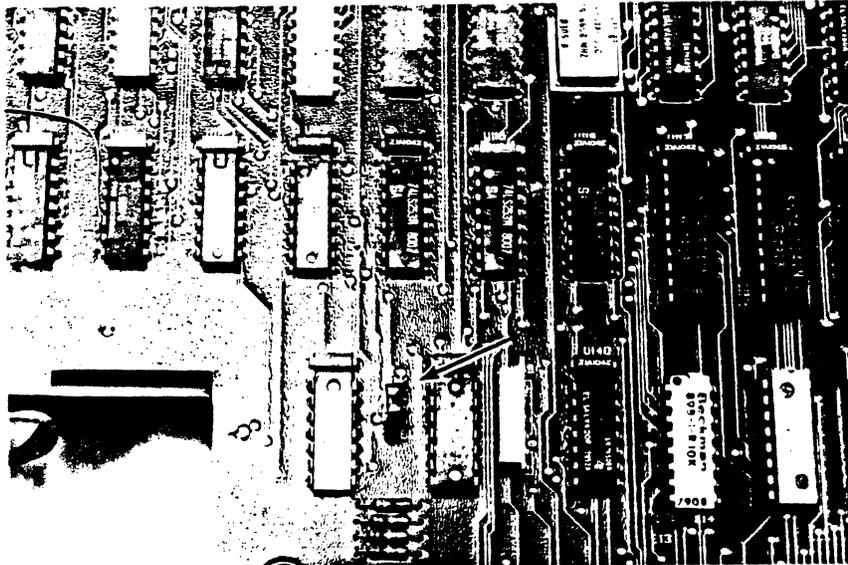


Figure 5-1. Clock Jumper Location

In order to select a new clock source, proceed as follows:

1. Switch the Z-SCAN power off by toggling the red power switch, located on the front panel, to the OFF position.
2. Remove the power cord from the socket on the rear of the unit.

--DANGER--

Failure to remove power from the unit prior to removal of the cover may result in exposure to hazardous voltages.

3. Remove the three screws and washers that secure the top cover of the unit at the top left, center, and right of the rear panel, as shown in Figure 5-2. Store the screws and washers in a safe place.
4. Grasping the rear of the top cover, lift it upwards and move it to the rear to release it from the front panel.

5. Locate the clock source jumper (see Figure 5-1) and move to the required position (see Table 5-1).
6. To replace the top cover, locate the front flange under the front bezel and swing the rear down. Make sure that the rear flange is inside the rear panel of the unit.

--DANGER--

Do not reconnect power to the unit until the top cover has been replaced and secured.

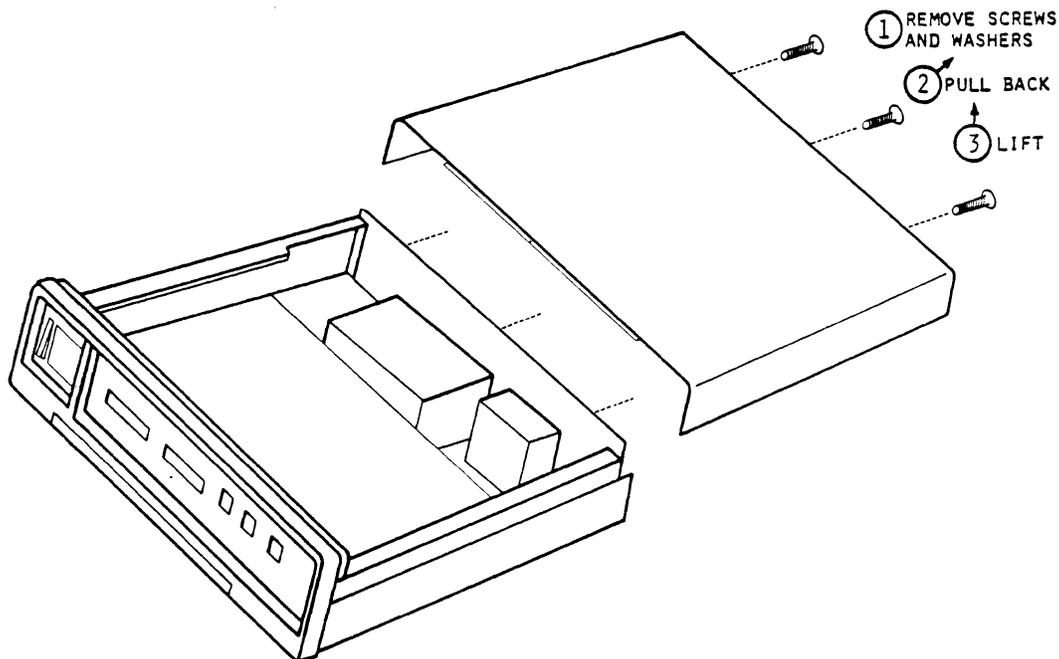


Figure 5-2. Z-SCAN Top Cover Removal

7. Replace the three screws and washers removed in step 3.
8. Reconnect the power cord to the rear of the unit, but **do not switch power on at this stage.**
9. If the external clock was selected in step 5, proceed to Section 5.2.2 below, which describes the connection of the emulator cable. Z-SCAN requires the connection of a target in order to function when the external clock has been selected.
10. If the internal clock was selected in step 5, the unit can now be powered on by moving the front panel power switch to the on position. Correct operation can be verified by following the procedure described in Section 3.6.

5.2.2 Connection of the Emulator Cable

Two emulator cables are shipped with each Z-SCAN. The 40-way cable is used for Z8002 emulation and the 48-way for emulation of the Z8001. Before connecting either of the cables to the Z-SCAN, check that the correct processor is installed. The processor type is displayed on the System screen. Section 3.9 describes how to change the processor.

When the correct processor is installed, the target system can be connected to Z-SCAN with the emulator cable. To do this, procede as follows:

1. If Z-SCAN is not already switched OFF, switch it OFF using the front panel POWER/OFF switch.
2. Turn the target system OFF.
3. If the Z-SCAN unit is equipped with a Z8002 CPU, plug the 40-pin flat cable connector into the right-hand socket marked Z8002 on the front panel of the Z-SCAN. If a Z8001 is installed, plug the 50-pin flat cable connector into the left-hand socket marked Z8001. **The stripe indicating Line 1 should be to the right of the cable.**

--CAUTION--

It is possible to insert either connector upside-down. Incorrect connection can result in damage both to Z-SCAN and to the target system.

4. Remove the plastic pin protector from the DIL header and store it in a safe place.
5. Plug the header into the CPU socket in the target system, making sure that the pin marked "1" on the header is mated with pin 1 of the socket. Figure 5-3 shows the Z-SCAN unit correctly connected to a target system.

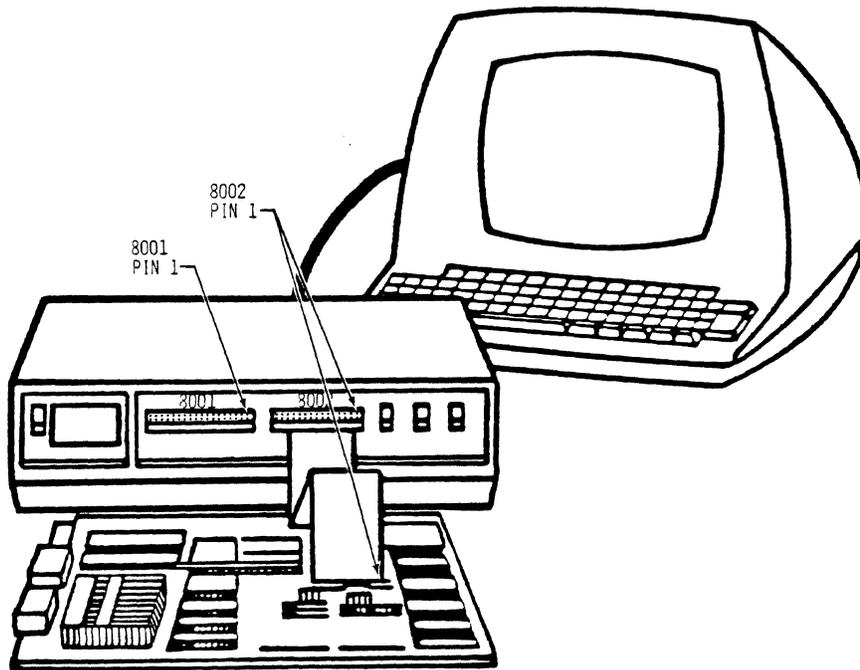


Figure 5-3. Z-SCAN and Z8002 Target System Connections

5.2.3 Checkout of Z-SCAN with Target System

To check that Z-SCAN can operate with the newly connected target system, the following test should be carried out. Note that this simple procedure only verifies that the target is correctly connected and is providing an adequate clock signal to the unit. It does not verify that the target is functional in any other respect.

1. Turn on the target system.
2. Power the Z-SCAN by moving the front panel Power/OFF switch to the POWER position.
3. Place the TARGET/MONITOR switch in the MONITOR position.
4. Toggle the RESET switch.
5. On the keyboard, enter RETURN once. The Z-SCAN sets its baud rate and displays the terminal menu.

If the terminal menu does not appear, check the following:

- Emulator cable is correctly connected.
- Target system is powered.
- Target clock circuitry is functioning properly.

- Target clock rate is within Z8000 specification (0.5 - 4.0 MHz).
- Target clock meets minimum high- or low-time requirements of Z8000 CPU (105 ns) and has proper rise time (less than 20 ns).
- Clock source selection jumper is correctly installed (see Section 5.2.1).
- Emulator cable assembly is not damaged (see Section 5.2.4).

After the problem has been identified and corrected, the Terminal Selection screen should appear after the checkout procedure. If problems persist despite the availability of an adequate clock from the target system, the Z-SCAN may require maintenance. In this event, the user should contact the nearest Zilog sales office.

6. Select a terminal number, then enter return. If the target system contains dynamic memory components, enter the key sequence:

RETURN, cursor down, 1, RETURN

This updates the status to target field on the System screen from internal_op to refresh. For further details see Section 5.4.3.

5.2.4 Care of the Emulator Cable

The emulator cable assembly is 18 inches (45.7 cm) long and is constructed from a special high-quality flat cable that has a ground wire adjacent to each signal wire for optimum transmission characteristics. Standard flat cable connectors cannot be used with this type of cable. If the assembly is damaged during use, a replacement must be obtained from Zilog. Z-SCAN's performance will be degraded if a substitute is constructed with standard cable and connectors.

While the assembly is quite sturdy, it can be damaged by incorrect handling. Observe the following precautions to minimize the possibility of damage:

- **Never pull on the cable. Use the procedures detailed below to remove the connectors from the Z-SCAN or from the target system.**
- When the cable is not plugged into a target system, cover the exposed pins on the emulator plug with the pin protector supplied with the unit. If the protector is lost, a small pad of conductive foam or styrofoam is an acceptable substitute.
- Once the cable has been connected to the Z-SCAN, do not remove it unless absolutely necessary. When removal is required, grip both sides of the cable and the connector between the thumbs and forefingers of both hands. Move the connector up and down slightly while gently pulling until it is free.
- To remove the emulator plug from the target system CPU socket, use a small screwdriver as a lever to lift each end of the Augat header from the socket in the target a little at a time. When the plug is free, cover the exposed pins with the pin protector supplied with the unit.

- If target hardware modifications are made, remove the cable from the target system to avoid contact with a hot soldering iron.

5.3 FRONT PANEL SWITCHES

The three switches at the right of the Z-SCAN front panel were described in Sections 3 and 4. This section describes the exact effect of each of the four types of input that these switches can generate to Z-SCAN. See Table 4-2 for details of how to generate each type. Z-SCAN's response to a particular input is determined primarily by the operating mode at the time the input is received (see Tables 5-2 through 5-5).

At no time does Z-SCAN drive the target system's RESET- or NMI- signals. Thus, while the Z-SCAN CPU responds correctly to a target RESET or NMI generated with the Z-SCAN front panel switches, circuitry in the target hardware that relies on these signals' being active does not respond. This makes it possible that the behavior of the target following a front panel reset or NMI will differ from that which occurs when either signal is generated by the target itself.

Table 5-2. Response to Monitor RESET Input

Operating Mode Before Monitor RESET	Operating Mode After Monitor RESET	Notes
Monitor	Monitor	The CPU and Z-SCAN hardware is RESET to its initial state. All information about the previous state of Z-SCAN is lost. Type RETURN to set baud rate.
Host	Monitor	
Target	Monitor	

Table 5-3. Response to Monitor NMI Input

Operating Mode Before Monitor NMI	Operating Mode After Monitor NMI	Notes
Monitor	Monitor	The input is ignored.
Host	Monitor	The input is ignored.
Target	Monitor	This is the Z-SCAN's manual BREAK.

Table 5-4. Response to Target RESET Input

Operating Mode Before Target RESET	Operating Mode After Target RESET	Notes
Monitor	Monitor	Returns Z-SCAN to its initial condition.
Host	Monitor	Has same effect as Monitor reset.
Target	Target	Has the same effect as the target system's RESET- input to Z-SCAN. The Z8000 CPU in Z-SCAN is reset. All other Z-SCAN hardware is unaffected. See Section 7.4 of the <u>Z8000 CPU Technical Manual</u> .

Table 5-5. Response to Target NMI Input

Operating Mode Before Target NMI	Operating Mode After Target NMI	Notes
Monitor	Monitor	The input is ignored.
Host	Host	The input is ignored.
Target	Target	Has the same effect as the target system's NMI- input to the Z-SCAN. The Z8000 CPU in Z-SCAN will respond to an NMI-. All other Z-SCAN hardware is unaffected. See Section 7.6 of the <u>Z8000 CPU Technical Manual</u> .

5.4 HARDWARE DESIGN AND DEBUGGING WITH Z-SCAN

The Z-SCAN 8000 has been designed to emulate the Z8000 CPUs faithfully in both new and existing hardware designs. This means that any target that operates correctly when a CPU chip is installed should also operate correctly when a Z-SCAN emulator is used in place of the CPU. The converse is also true. However, the ac and dc characteristics of Z-SCAN, and under certain circumstances, its bus signal sequences differ slightly from those of an actual CPU. These differences arise from the buffering required to isolate the Z-SCAN CPU from possible faults in the target system and from the need to prevent execution of the Z-SCAN monitor software from affecting the target system.

The remainder of this subsection details the areas in which differences exist and describes their possible effects on emulation and debugging. Hints to designers allow potential problems to be avoided before they arise. The hints in general reflect conservative design practices and ensure that equipment can be produced reliably and repeatably once the design has been finalized. Additionally, each paragraph suggests ways in which small problems in existing target hardware designs can be overcome or circumvented.

5.4.1 Emulator DC Characteristics

The dc characteristics of the Z-SCAN emulator differ from those of an actual CPU in three respects:

- **Input Loading:** Z8000 CPUs load inputs very lightly (no more than 10 uA and, except in the case of CLK, less than 10 pF). The Z-SCAN, in contrast, loads each input with 30 pF and a low-power Schottky TTL buffer (200 uA). In addition, the NMI-, NVI-, SEGT-, WAIT-, RESET-, DS- and VI- inputs have 10k pullups for an additional load of 500 uA.
- **Output Drive:** Z8000 CPUs are specified with a load of 100 pF and 2 mA. Because it has low-power Schottky TTL drivers, Z-SCAN can drive a much greater load.
- **Input Levels:** The majority of Z8000 inputs are completely TTL compatible. Two are not: CLK has more stringent high- and low-level requirements, and RESET- requires a slightly greater input high level. In contrast, all inputs to Z-SCAN are TTL compatible.

The electrical differences between a Z-SCAN and the Z8000 CPUs make it possible (though unlikely) that a target system could work with Z-SCAN but not with a CPU, or vice-versa. Such problems can easily be avoided at the design stage by adopting a few simple standards:

- **Clock Driver:** Never attempt to drive the CLK pin of the CPU directly from a TTL output. A special drive circuit capable of meeting the stringent requirements of the Z8000 is required. The Zilog application note A Small Z8000 System (document #03-8060) details a suitable design. A TTL output with a pullup resistor is not a satisfactory alternative.
- **Reset Driver:** If RESET- is driven by a TTL output, add a pullup resistor. The value is not critical: 4.7 K will do.

- **Bus Loading:** Do not attach too many loads directly to the bus signal pins of the CPU. As a rule of thumb, Z8000 processors can accommodate up to ten NMOS loads plus one low-power Schottky TTL load on each bus signal line, provided that the total length of the line is not greater than 8 in (20 cm) of printed circuit track. Greater loading is likely to exceed the capacitive drive capability of the CPU, even if dc loading limits are not exceeded. If there is any doubt about loading levels, or if bus signals are to be carried between circuit boards, use buffers.

Emulation problems arising from the differences between the dc characteristics of Z-SCAN and those of a Z8000 CPU are likely to show one or more of the following symptoms:

- **Intermittency:** The symptoms appear and disappear unpredictably.
- **Temperature Sensitivity:** The symptoms are seen only when Z-SCAN or the target system is warm and can be removed by cooling a particular component in the target system.
- **Voltage Sensitivity:** Raising or lowering the supply voltage in the target system affects the symptoms.
- **Locality:** Z-SCAN is able to access all features of the target system except those associated with a particular component or logic block.

If it is established that the Z-SCAN capacitive loading is increasing access times in the target to an unacceptable level, and that the target is capable of meeting the worst case ac specification of the Z8000, a temporary solution is to replace the target memory or I/O components with faster parts. Alternatively, provided that full-speed emulation is not required, the Z-SCAN Wait states command can be used to relax access time requirements. Section 6.10.6 gives more details.

In general, quick fix solutions to such problems are not recommended because they probably indicate a marginal hardware design which, even if it works correctly with a CPU in prototype form, could suffer from repetitive or reliability problems when it is moved into production. The user is urged to determine the source of the problem and incorporate a permanent solution into the target hardware.

5.4.2 Emulator AC Characteristics

The ac characteristics of Z-SCAN differ from those of a Z8000 CPU because of delays introduced by signal buffering. The differences are minimized by using a factory-selected CPU in Z-SCAN.

Problems might also occur in synchronous logic in the target. Typically, such logic uses the system clock to latch signals coming from the CPU. For example, a dynamic memory controller might latch MREQ- on the rising edge of CLK-. The Z8000 has been designed to allow comparatively long set-up times in such cases, so it is unlikely that the slight reduction of time that results when Z-SCAN is used will cause problems. If a problem does occur because the timing skew introduced by the Z-SCAN is unacceptable to the target, it can usually be solved by introducing extra delay in the clock path to the synchronous logic

in the target. Designers should be aware that such a solution may affect the access time requirements of memory or I/O components controlled by the synchronous logic.

5.4.3 Dynamic Memory Refresh

Z8000 microprocessors have a feature that allows them to refresh dynamic memory components automatically with a minimum of external logic. This is described in Chapter 8 of the Z8000 CPU Technical Manual (document #00-2010-C). Zilog's application note A Small Z8000 System suggests a suitable logic design and shows the relationship between the contents of the upper byte of the refresh register and refresh rate.

Z-SCAN supports automatic refresh before, during, and after emulations to preserve the integrity of the contents of dynamic memory in the target system. Z-SCAN itself contains no dynamic memory and so does not require refresh to be enabled in order to operate correctly.

Refresh is controlled by the Z8000 refresh register. Z-SCAN does not exercise as close control over the contents of this register as it does over those of others, partly because changes in its contents are largely independent of the code which is being executed, and also because some of its bits are write-only bits. For these reasons it does not appear on the Resources or Execution screens (Sections 6.10 and 6.11). Z-SCAN only alters the contents of the refresh register when the status_to_target field on the System screen is changed by the user. When refresh is selected, the register is loaded with %9E00; when internal_op is selected, a value of %0000 is loaded. The System screen is described in Section 6.8.

The hexadecimal value %9E00 causes the CPU to perform a refresh operation every 60 clock cycles. At a 4 MHz clock rate, this results in 128 refresh cycles every 1.92 ms, sufficient to satisfy the worst case requirements of typical dynamic RAM components. For targets in which the clock rate is significantly lower or in which a higher refresh rate is required, the user must change the value in the refresh register if worst case requirements are to be met. The alteration can be accomplished in one of two ways:

- Run an emulation of the initialization portion of the target application software. This should contain code that loads the refresh register with the value required by the target.
- Using the eXamine command on the Memory_io screen, load the opcode %7D0B (LDCTL REFRESH,RO) into any available RAM location. Use mappable memory if all the target memory is dynamic. Then use the Resources screen reGister command to load the required refresh register value into RO, the location of the instruction into PC, and %4000 into FCW. Finally, step through the instruction with the Execution screen Next command.

It is worthwhile to consider the exact effects of the two possible status_to_target values on the bus signals in the target system (Table 5-6).

Table 5-6. Monitor Mode Target Signals

status_to_target	ST ₀₋₃	AD ₀₋₁₅	AS-	MREQ-	DS-
internal_op	internal op (0000)	active	active	3-stated	inactive*
refresh	internal op (0000) or refresh (0001)	active	active	active	inactive*

*DS- is held high by a 10 kilo ohm pullup resistor

When `internal_op` is selected, every bus transaction generated by the monitor appears to be an internal operation to the target system. Because AS- is still active, self-refreshing (pseudo-static) memories in the target retain their contents provided that they use AS- and not MREQ- as a clocking signal.

When `refresh` is selected, most Z-SCAN monitor bus transactions appear as internal operations to the target system. They differ from the internal operations generated by an actual CPU because MREQ- may be active. Refresh cycles, generated when the CPU refresh rate counter times out, present refresh status to the target.

5.4.4 Target Memory and I/O Access

When Z-SCAN accesses target memory during emulations, the transactions it generates are identical to those that would be generated by a Z8000 CPU. However, when such accesses are made by the Z-SCAN monitor software, there may be differences. All the commands available on the `Memory_io` screen (see Section 6.9) cause Z-SCAN to perform memory or I/O operations in the target system. The Peek and current instruction fields on the Execution screen also require target memory accesses in order to be updated.

The `Memory_io` screen `reAd` and `Write` commands access target byte and word standard and special I/O ports using operations exactly like those produced when I/O instructions are executed by a program running under emulation. For target memory accesses, however, Z-SCAN always uses the same width of data (word or byte) for each type of operation, independent of the width (long word, word, or byte) selected by the user for the display of information. Table 5-7 lists the operation types, together with the transactions generated by Z-SCAN.

Table 5-7. Z-SCAN Target Memory Access Transactions

Operation	Transaction	Notes
Memory read	Byte read	
Memory write	Byte read, word write	A read-modify-write sequence for each byte to be written accommodates memories that do not support byte writes.

Z-SCAN's choice of transaction types should cause no problems in most target systems. There are, however, some unusual design configurations where target accesses may produce unexpected results:

- **Memory that does not support byte reads:** A correctly designed Z8000 memory control circuit does not need to distinguish between byte and word reads and hence implicitly supports both (see A Small Z8000 System). If, for any reason, a target's memory does not respond to byte read transactions, the Z-SCAN monitor will not be able to access that memory.
- **Systems using B/W- as a memory bank select signal:** The Z-SCAN monitor expects the same memory space to be accessed by both byte and word transactions. The Z-SCAN memory modification commands cannot be used in unorthodox target systems that use the B/W- (Byte/Word) signal to choose between two separate memory banks.
- **Word-wide, memory-mapped I/O:** The Z-SCAN memory modification commands cannot operate on write-only, word-wide memory-mapped I/O, nor do they give correct results on memory-mapped ports that require all 16 bits to be written or read in a single operation.

5.4.5 Interrupts and Traps

Z-SCAN terminates all emulations by giving the CPU a non-maskable interrupt. This interrupt has a higher priority than the three other external interrupts supported by the Z8000--segment trap, vectored and non-vectored. This means that all break conditions--step, manual, trigger and write protect --have priority over interrupts generated by the target hardware, including target NMI (see Section 6.10.1).

The Trace command (see Section 6.12.3) and the Next command (see Section 6.12.2), if used with an instruction count of one, give the CPU an NMI after each user instruction. This prevents the acknowledgement of any target interrupt, even though the target program is being executed. This does not prevent interrupt service routines from being traced, but it does mean that they cannot be entered while another part of the program is being traced.

The Z8000 CPU always fetches one instruction that it does not execute after it has accepted an interrupt or trap. See Section 9.4.5 of the Z8000 CPU Technical Manual for further details. The aborted operation is indistinguishable from any other instruction fetch, first word, bus cycle, and so can trigger the Z-SCAN breakpoint logic if suitable conditions have been set up. When this happens, the state of the user program following the breakpoint will differ from the state expected.

Unexpected breaks of this type do not corrupt the target program: if emulation is resumed, the instruction is fetched and executed normally after the target handler interrupt is executed.

5.4.6 Memory Management Considerations

Many applications use a Z8001 CPU in conjunction with a Z8010 Memory Management Unit, or some other memory management hardware. These external components increase system reliability and flexibility by serving two functions:

- Translation of logical address information from the CPU to physical addresses for memory components.
- Protection of memory from invalid access by the CPU.

When the Z-SCAN mappable memory is used in conjunction with a target system that has a memory manager, the user should be aware that the mappable memory is fixed in logical address space during emulations. It responds directly to the untranslated addresses output by the CPU. It cannot be relocated or protected by the action of the memory manager.

The protection attributes of target system memory may be violated by a program running under emulation. In such cases, the MMU activates the SEGT- signal and the user's trap handler is entered to deal with the problem. It is also possible for target memory accesses generated when Z-SCAN is in monitor mode to violate protection attributes. For example, the user could use the Fill command on a write protected memory area. An external memory manager responds to these violations by asserting SEGT-, but the monitor does not acknowledge the signal, and so it remains outstanding until the next emulation starts. The user's trap handler is then entered to deal with a violation that is not caused by the user program.

A message displayed at the lower right of the System and Trace screens warns the user if SEGT- is asserted before an emulation is started (see Section 6.12). If the user does not want the trap routine to be entered, the Memory_io screen Write command must be used to reset the memory management hardware before emulation.

5.4.7 Direct Memory Access

Z-SCAN fully supports Direct Memory Access (DMA) in the target system while emulations are running. Note that if a trigger or manual break condition occurs during a DMA operation, emulation does not stop until the DMA controller releases the bus, because the CPU cannot service the break request until it has regained control of the bus. Also, because BUSACK- is not a term in the breakpoint equation, Z-SCAN cannot distinguish between transactions generated by the CPU and those generated by another bus master.

DMA controllers (or any other types of bus masters) are able to read and write the Z-SCAN mappable memory once they have gained control of the bus during an emulation. A prerequisite for such operations is that the alternative bus master and the CPU socket must be connected to the same bus. Any buffering between the socket and the alternative bus master probably prevents access to mappable memory because the buffers may be 3-stated during DMA operations.

Z-SCAN does not acknowledge bus requests from the target when no emulation is in progress. This means that DMA devices that repeatedly request the bus once it is enabled (for example, CRT refresh controllers) do not have their requests honored after an emulation has terminated. For problem-free operation with Z-SCAN, such controllers should be designed to accommodate the possibility that the bus may not be granted an indefinite period following a request. Designs that abort or shut down if a request is not honored within a certain time may not restart correctly when emulation is resumed.

5.4.8 Termination of Emulation

The previous section mentioned that a breakpoint, whether manual or programmed, is not activated until the end of a bus acknowledge state. The same is true of wait and stop states: an emulation cannot terminate unless RESET-, BUSACK-, WAIT-, and STOP- are all inactive. The only certain method of returning control to the Z-SCAN monitor if any of these signals is stuck in the active state is to apply a monitor reset using the Z-SCAN front panel switches. This action, which must be followed by RETURN, reinitializes the monitor, meaning that the Z-SCAN must be completely reprogrammed. This can be avoided by first resetting the target with its own reset logic (a Target mode reset from Z-SCAN front panel switches may not have the required effect; see Section 4.3) and then entering a manual break with a Monitor mode non-maskable interrupt (NMI).

There are occasions when it appears that a programmed breakpoint should have been encountered--execution has proceeded past the point at which the breakpoint was expected to occur--but emulation continues. This is likely to happen when the bus transaction on which the breakpoint was set does not completely match the conditions set up with the Breakpoint command. The mismatch can arise from the fact that the Z-SCAN address/data bus breakpoint comparator is a full 16 bits wide and so does not detect byte data or interrupt vector matches (eight bits) or refresh address matches (nine bits). Problems can often be circumvented either by eliminating the offending term from the break condition or by choosing an alternative bus transaction as the trigger condition. This topic is discussed in more detail in Section 6.10.1.

Unless one or more of the signals mentioned in the first paragraph is active, it should always be possible to stop an emulation with a front panel monitor NMI. If emulation cannot be stopped this way, it is possible that the CPU has entered an illegal state as a result of being driven by target-generated signals that are out of specification. The most likely culprit is the clock. Another possibility is that substantial ground currents are flowing in the emulator cable and disrupting dc levels. This can happen when Z-SCAN and the target system are connected to different power ground distributions. For this reason it is recommended that Z-SCAN and the target system are both connected to the same power receptacle.

5.5 USE OF THE HARDWARE TRIGGER

The rear panel BNC connector which carries the Z-SCAN break pulse output signal allows the unit to be used in conjunction with other test instruments such as oscilloscopes and logic analyzers. Section 6.10.1 details the programming of the break pulse logic. This section discusses the use of the break pulse in general terms only because of the wide variety of equipment with which Z-SCAN can be used.

5.5.1 Break Pulse Characteristics

The pulse from the rear panel is positive going. This means that the rising edge of the pulse signals the time when the programmed bus condition is detected. Detection occurs shortly after the rising edge of clock in T2, and the pulse is one clock cycle long. The pulse appears in the same cycle that

causes the match when the programmed condition is address, control/status, or control/status with address. For data or control/status with data, the pulse is output during the bus cycle that follows the programmed condition causing the match. A separate pulse is produced for each cycle which results in a match, even when a number of consecutive cycles all match the programmed condition.

The pass counter logic can be used in conjunction with the pulse feature. For a pass count of n, a pulse is output every nth time the programmed condition is satisfied. There is no output at any other time.

The Z-SCAN pulse logic is inhibited when no emulation is in progress, so there is no danger of spurious triggering of external equipment, even if the programmed match condition is satisfied during the execution of the monitor software.

5.5.2 Connection of External Equipment

Connection of an oscilloscope or logic analyzer to the Z-SCAN break pulse output is a simple matter, typically accomplished with a coaxial cable terminated with BNC connectors.

--CAUTION--

The break pulse output is driven directly by the output of a low-power Schottky TTL gate, which may be damaged if subjected to a sustained short circuit.

Due to its short duration, the pulse should be used as an external trigger when Z-SCAN is used in conjunction with a logic analyzer. It is not suitable for use as a gating, qualifying, or enabling signal. The analyzer should be set to expect a positive-going TTL-level trigger pulse.

The pulse can also be used as an external trigger for an oscilloscope. The time base should be set to trigger on the positive edge of the dc-coupled input signal. AC coupling is not recommended because the mean level of the signal--and hence the trigger point--changes according to the frequency of the pulses. If the break pulse is displayed on an oscilloscope for any reason, it may have a slight but inconsequential ringing on transitions, because the output is not terminated.

5.5.3 Choice of Logic Analyser Recording Window

When a logic analyzer receives a trigger, one of three things happens:

- **The logic analyzer stops recording**, and its memory holds information about events prior to the trigger.
- **It starts recording**, stopping when its memory is full. Here, events after the trigger are recorded.
- **It continues recording** but stops after a certain number of sample clock cycles. Information about events before and after the trigger is recorded.

All three options can be used in conjunction with the Z-SCAN break pulse output when the pulse_only option is selected with the Break command (see Section 6.11.1).

Z-SCAN also outputs a break pulse when the pulse & break option is selected. This allows a logic analyzer to be used to record events in the target system prior to the break if the analyzer is set to stop recording when it receives a trigger pulse.

5.5.4 Clocking of Logic Analyzers

With most logic analyzers, users have a choice of two sources for the clock that determines the rate at which logic inputs are sampled. The analyzer's internal clock, which typically allows sampling rates of between tens of nanoseconds and milliseconds, can be used. Alternatively, the user can provide an external clock signal from the system under test.

Both sources have their uses in the development of Z8000-based designs. The internal clock is used both for simplicity of set-up and for maximum resolution. The sample rate should be such that the sample period is shorter than the duration of the shortest pulse being monitored; this avoids the possibility of pulses being missed. The shortest pulse generated by the Z8000 is Address Strobe (AS-), which has a minimum duration of 20 ns less than the CPU's clock high width (85 ns with a 4 MHz clock). In order to reliably capture AS-, a sample period of 50 ns is required in a 4 MHz system with an internally clocked logic analyzer. Still shorter periods may be required to capture glitches of short duration in the target hardware.

The disadvantage of internal clocking is that the analyzer must sample the input signals at a higher rate than is strictly necessary to record events occurring in a system that is driven synchronously by its own clock source. As a result, the number of events that can be recorded by the analyzer before its memory becomes saturated is less than optimal. For example, with a 50 ns sample period it takes only about 50 Z8000 bus cycles to saturate a 1024-word sample memory. A greater number of cycles could be accommodated if a clocking signal precisely matched to the Z8000 system were used. Of course, such a signal is readily available in the CPU clock signal.

When the CPU clock is used as an external clock for a logic analyzer, its negative edge (high-to-low transition) should be treated as active. It is on this edge that Address Strobe is active, that address and status are valid in T1 of any bus cycle, that WAIT- is sampled during T2, and that data is sampled in T3 during read operations. For further details, see Section 9.4 of the Z8000 CPU Technical Manual. Using the clock, a 1024-word sample memory in an analyzer can record about 250 Z8000 bus cycles, five times more than is possible with the analyzer's own clock.

In certain situations it may be desirable to use a more selective clock source than the clock signal. For example, the user may wish to record only I/O transactions or only refresh cycles. This can be accomplished in one of two ways, depending on the amount of information required about the transactions:

- **Address and Status Only:** When just one sample occurring shortly after Address Strobe is sufficient, the break pulse output of Z-SCAN can be used directly as a positive-going clock signal. Use the Break command (see Section 6.11.1) to select pulse only on the selected status condition, with ignore_AD and a count of 01.
- **Full Record:** When complete information about each transaction is required, the analyzer should be clocked either from its internal clock source or from the target clock, as described above, but the clock must be qualified by the Z8000 status signals in order to select particular types of transactions. Most analyzers have a clock qualifier input that can be used to gate the clock in this way. The qualifying signal must come from the target, from a proprietary qualifying probe pod available from the supplier of the analyzer, or from a temporary circuit constructed from logic components and attached to the target system. Most Z8000 systems fully decode the status lines ST₀₋₃. An output of the decoder can often be used directly as a clock qualifier, avoiding the requirement for additional logic.

5.5.5 Break Pulse Demonstration

The wide variety of equipment that can be used with Z-SCAN makes it impossible to give a step-by-step tutorial. It is suggested that users having logic analyzers and wishing to become familiar with the break pulse should proceed as follows:

1. Connect the emulator cable to the Z-SCAN as described in Section 5.2.2, steps 1 through 4.
2. Attach logic analyzer signal probes to signal pins of interest on the header at the target end of the cable. Suggested signals are ST₀₋₃ (pins 21-18 on the Z8002, 23-20 on the Z8001), AS- (pins 29-34), DS- (pins 17-19), MREQ- (pins 16-18), and R/W- (pins 25-30). Consult the logic analyzer manual to find out how to arrange these so ST₀₋₃ can be interpreted as a hex digit with ST₃ as the most significant bit.

--WARNING--

Take care not to bend or break the pins on the header.

3. Connect the Z-SCAN rear panel break pulse output to the external trigger input of the analyzer. On analyzers without such an input, connect the break pulse to an unused signal input. The position of the connector is shown in Figure 3-2.
4. Ensure that the analyzer is on, then turn on the Z-SCAN.
5. Set up the analyzer for pre-trigger recording with an internal clock period of 50 ns. Select a positive-going trigger from the external trigger input rather than from the analyzer's internal word recognizer. For analyzers without an external trigger, select the signal input

carrying the break pulse as the only significant term in the trigger equation: all other inputs should be "don't cares." Consult the logic analyzer manual for its set-up procedure.

6. Prime the analyzer manually so that it starts to record information.
7. Work through the tutorial of Section 4 of this manual. Experienced users can ignore some of the redundant keystrokes in arriving at the steps that perform emulations.

Each time an emulation terminating with a trigger break is run, the analyzer should capture information about the transactions preceding the break. If it does not, it is probably not set up or primed properly. Check the manual again. Once the error has been corrected, use the Z-SCAN Register command (see Section 6.10.4) to reset the PC register to the value it held before emulation, then rerun the emulation with the Go command (Section 6.11.1). Before each emulation, reprime the analyzer so that it can record the new information.

The format in which the recorded information is displayed depends both on the particular analyzer used and on the display mode selected. The signals suggested above in step 2 are best suited to the Timing Diagram Display mode supported by most analyzers. These signals give insight into the way the processor uses the bus while executing programs.



SECTION SIX

MONITOR SOFTWARE DESCRIPTION

6.1 INTRODUCTION

The main functions of the monitor program software are to monitor the interaction between the Z-SCAN system and the target system during emulation, to supervise the changeover from Target mode to Monitor mode, and to control the passing of program files between a host system and Z-SCAN. A secondary but more visible aspect of the program is its user interface, which controls, monitors, and acts upon user input from the terminal keyboard. Section 6.2 describes the Z-SCAN operating modes in more detail.

The user interface controls the commands available to the user throughout the set-up and execution phases of emulation. It also checks the syntax and sequence of user input and acts upon correct sequences by updating the screen display and, if necessary, the values of operating parameter fields. The Z-SCAN screen displays are introduced in Section 6.3. If user input is invalid, the monitor ignores it completely. Valid inputs are discussed in Sections 6.4 through 6.7.

Table 6-1 is an alphabetical summary of the software commands available in the monitor program and the keys that must be entered to access them. Sections 6.8 through 6.12 describe each command, its parameters, and its usage in detail.

Table 6-1. Software Monitor Commands

Command	Key	Command	Key	Command	Key
Break	B	Inst_count	I	reAd	A
Compare	C	Load	L	reGister	G
Display	D	mAp	A	Resources	R
eXamine	X	Memory_io	M	seNd	N
Execution	E	moVe	V	System	S
Fill	F	Next	N	Trace	T
Go	G	Peek	P	Wait_states	W
Host	H	Quit	Q	Write	W

6.2 Z-SCAN 8000 OPERATING MODES

The Z-SCAN 8000 system can operate in any of three modes: Monitor mode, Transparent mode and the Target Mode. One of these can be used only in configurations that include a host system for software development. The three modes are:

1. Monitor Mode

- The Z-SCAN terminal is logically connected to the Z-SCAN unit, giving the user access to the monitor's commands.
- In this mode, the user has access to five distinct displays on the terminal's CRT. These screens allow the examination, enabling, and modification of resources belonging to the Z-SCAN or to the target system.
- If the Z-SCAN system configuration includes a host system, program files can be passed between the host file system and Z-SCAN's memory when the Z-SCAN Monitor mode is in effect.

2. Transparent Mode

- This mode logically connects the Z-SCAN terminal to the host system, giving the user unrestricted access to host system resources.
- The user has no access to the Z-SCAN monitor commands during Transparent mode, but can enter host system commands just as if the terminal were directly connected to the host.
- Transparent mode can be entered from Monitor mode at any time and does not affect any parameters the user has set up to control the debugging process.

3. Target Mode

- This mode dedicates Z-SCAN resources to running either Z8001 or Z8002 emulation on the target system, depending on the CPU installed in the Z-SCAN unit.
- While Target mode is in effect, the user cannot enter keyboard commands either for Z-SCAN or for the host system.

Following a RESET and baud rate synchronization (see Section 3.5), the Z-SCAN software enters Monitor mode. Transition to either Transparent mode or Target mode occurs in response to specific commands entered on the terminal keyboard. The reverse transitions take place in response to generation of the Z-SCAN break signals. Alternatively, transition from Target mode to Monitor mode can take place if the program running during emulation generates a condition that triggers the Z-SCAN breakpoint logic.

Figure 6-1 diagrams the allowed transitions and their causes. Note that direct transitions between Transparent and Target modes are not allowed.

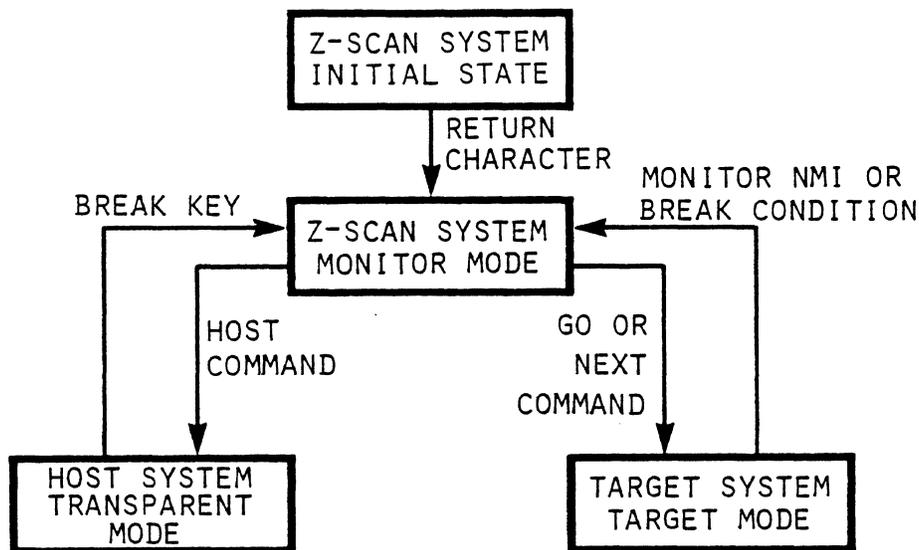


Figure 6-1. Z-SCAN 8000 Operating Modes

6.3 MONITOR MODE OVERVIEW

Almost all interaction between the user and Z-SCAN monitor software occurs in Monitor mode. During Transparent and Target modes, the user cannot give commands to the monitor. For this reason, the remainder of this section describes Monitor mode commands and displays.

The commands available while Z-SCAN is in Transparent mode are determined by the host system and its operating software and are not described here. Refer to the host system's documentation for further details.

While operating in Target mode, Z-SCAN 8000 emulates either the Z8001 or the Z8002, so its behavior is described in the Z8000 CPU Technical Manual (document #00-2010-C). Further information can be found in Section 5.4 of this manual.

In Monitor mode, Z-SCAN gives the user access to five screens, each allowing the user to select from a menu of commands and other screens in order to set up and control the emulation process. The basic functions of each screen are listed below. In keeping with the format used by the Z-SCAN CRT terminal displays, the capital letter in each screen or command name indicates the key entered to activate the screen or command. Sections 6.8 through 6.13 give a complete description of each screen and how its associated commands can be used.

The seven screens available in Monitor mode and the functions of each are:

1. Terminal Selection screen

- o Displayed following monitor reset and entry of RETURN.
- o Allows the user to select from a choice of terminal cursor control protocols.

- Provides access to the System screen.

2. System screen

- Informs the user of the monitor software release level and of the baud rate selected for communications between the terminal, Z-SCAN's monitor and the target system.
- Allows the user to select the appropriate baud rate for the host system communication link.
- Allows the user to select one of two values, internal operation or refresh, for the CPU status that is sent to the target system while the monitor software is running.
- Allows other screens to be selected.

3. Memory_io screen

- Presents a choice of commands that allow manipulation of target system memory: Compare, Display, eXamine, Fill and moVe.
- Allows target system input and output ports to be manipulated with the reAd and Write commands.
- Permits program files to be loaded from the host system into memory. This function is controlled by the Load command.
- Permits program files or information to be sent to the host system from Z-SCAN via the seNd command.
- Allows other screens to be selected.

4. Resources screen

- Gives the user access to the Z-SCAN emulation control resources through the Break, Inst_count, mAp, reGister, Peek and Wait_states commands.
- Allows other screens to be selected.

5. Execution screen

- Displays the conditions selected for the execution and control of emulations and the state of the processor before and after each emulation.
- Allows emulations to be started with the Go and Next commands.
- Upon termination of each emulation begun by either the Go or Next commands, displays a message stating the reason for termination.

- Allows access to the Trace screen.
- Allows other screens to be selected.

6. Trace screen

- Accessible from Execution screen.
- Provides an instruction-by-instruction analysis of the execution of the user program and its effect on registers and memory.
- Allows return to the Execution screen.

7. Host screen

- Displayed when Z-SCAN enters the Transparent mode.
- Indicates that control of the display has passed from the Z-SCAN monitor to the host system's software.
- Does not allow access to Z-SCAN monitor commands or to other screens.

6.4 Z-SCAN SCREEN LAYOUTS AND COMMAND DISPLAYS

With the exception of the Terminal Selection screen and the Host screen, each of the Z-SCAN displays is divided into two or more areas by horizontal rows of dashes. Each area has one of three distinct functions:

- **Menu area.** This area appears below the bottom row of dashes on the System, Memory_io, Resources and Execution screens. It lists the name of the screen, the commands available on the screen, and the active command. If no command is active, the names of alternative screens are listed.
- **Window area.** This type of area appears on the Memory_io screen only, directly above the menu area. It displays variable amounts of information during the execution of commands available on the Memory_io screen.
- **Command area.** Any area above both the menu area and (on the Memory_io screen only) the window area is a command area. These areas display fixed amounts of information. Much of the information displayed in command areas is invariant, consisting of headings or of Z-SCAN parameters that cannot be changed on the particular screen displayed. The contents of certain fields in command areas can be altered by the user. This process is described in Sections 6.5, Cursor Manipulation, and Section 6.6, Variable Fields.

Command areas are divided into subscreens. Each subscreen is controlled by one of the Z-SCAN monitor commands. On the Memory_io screen, only the subscreen associated with the active command is displayed, whereas on other screens, all subscreens are displayed at all times.

6.4.1 The Menu Area

The menu area appears on all screens except the Terminal Selection screen and the Host screen. The format and content of other areas varies from screen to screen and is discussed in following sections that relate to specific screens.

Examples of menu displays can be found at the bottoms of Figures 4-5 and 4-9. Moving through the two lines of the menu area from left to right and top to bottom, the first items encountered are enclosed in parentheses. The item on the far left is the name of the screen itself--for example "Resources screen." If there is another item inside the parentheses, it is the name of an active command, which is a command the user has selected from those displayed on the lower line of the menu.

Outside the parentheses, the contents of the upper line vary according to whether or not a command has been selected. If no command is active, the line names alternative screens. To select another screen the user enters the initial letter of the desired screen name. When a command is active, the only information outside the parentheses is the name of any command supplementary to the active command. To execute a supplementary command, the user enters the letter in its name that is capitalized. The only supplementary command is Quit, which deactivates the current command.

The contents of the lower line of the menu area are fixed for each particular screen; they do not change in response to user input. The lower line lists the commands available on a particular screen. The user can activate any one of these commands by entering the letter in its name that is capitalized, for example, "A" for the mAp command.

6.5 CURSOR MANIPULATION

When a screen is first displayed, the cursor rests on the initial letter of the name of the screen, which is inside the parentheses at the top left of the menu area. When a command is activated, its name is added to the information inside the parentheses, and the cursor automatically moves to the first variable field associated with the active command. For commands controlling more than one field, the "first" field is that nearest the top left of the subscreen associated with the command.

Once the cursor has been positioned on the first variable field in a subscreen, the contents of that field can be altered by user input. This process is described in Section 6.6. To allow other fields on the same subscreen to be altered, the cursor must be moved into those fields. The four cursor control keys, ↑, ↓, ←, and → (cursor up, cursor down, cursor left, and cursor right) are used for this purpose.

Each cursor control key moves the cursor into a variable field that is logically adjacent to the current field. Logical adjacency requires the destination field to be part of the subscreen associated with the active command. A field that is physically adjacent (for example, on the same display line as the current field) but is not part of the subscreen associated with the active command cannot be entered through the use of the cursor control keys alone.

For consistency, the top and bottom variable fields in a given subscreen column are considered to be logically adjacent, as are the far left and far right fields on a given subscreen line. This means that if, for example, the cursor is moved up from the top field, it appears on the bottom field. Sometimes there is only one variable field in a particular subscreen row. In such cases, the cursor left and cursor right keys cannot move the cursor out of the field, because there is no field logically adjacent to it in those directions (in fact, the implementation considers the field to be logically adjacent to itself). Similar reasoning applies to fields without a logically adjacent field above or below them.

After the values held by the fields in a given subscreen are updated, the cursor must be returned to the menu area before a new command be activated or an alternative screen selected. Entering RETURN achieves this, moving the cursor from the current field to the name of the active command. The command itself is not deactivated until a new command is selected or the Quit command is executed.

Table 6-2 shows how the cursor can be manipulated to access parameter fields in a typical subscreen. The example shows the effect of the cursor movement keys when the Resources screen is active. The cursor position in each step is at the left of the field shown in boldface type. Refer to Section 6.10.5 for further details of the Peek command.

Table 6-2. Effect of Cursor Control Keys
(Peek command, Resources screen)

Step	Display	Keystroke	Notes
1.	SC 00 0000 SC 00 0000 SC 00 0000	P	Cursor is on screen name (Resources screen) prior to selecting Peek command. The Peek command is activated by keying P. This moves the cursor to the first variable item in the Peek command area. (Cursor position is indicated by bold characters of the following display.)
2.	SC 00 0000 SC 00 0000 SC 00 0000	-->	Move right. This key positions the cursor at the beginning of the second variable item in this command area.
3.	SC 00 0000 SC 00 0000 SC 00 0000	↓	Move down to vertically adjacent field.
4.	SC 00 0000 SC 00 0000 SC 00 0000	<--	Move left.
5.	SC 00 0000 SC 00 0000 SC 00 0000	↑	Move up to vertically adjacent field.
6.	SC 00 0000 SC 00 0000 SC 00 0000	↑	Move directly down to bottom row of this field.
7.	SC 00 0000 SC 00 0000 SC 00 0000	RETURN	Remove cursor from subscreen.

6.6 VARIABLE FIELDS

As mentioned above, command areas display information the user is allowed to alter. There are two main types of modifiable fields: hexadecimal and multiple choice. The next two subsections discuss these in detail. A third subsection mentions two additional types of fields, the file name and memory content fields.

6.6.1 Hexadecimal Fields

A hexadecimal field may contain two, four or 16 hexadecimal digits and can be modified, once the cursor has been positioned in the field, by entering new digits (0-9 and upper case A-F). A space restores the default value of a hex field whereas entering the control (CTRL) and R keys returns it to the value it held when the cursor was last moved into it. CTRL R is entered by holding down the control key while pressing the R key.

If the user does not want to modify the particular digit on which the cursor rests, "<" or ">" can be entered to move the cursor left or right within the field. The SHIFT key must be held down while these characters (< or >) are entered.

None of the keys mentioned above is able to move the cursor out of the variable field. When the cursor is moved to the right of the far-right character, it wraps around to the far-left character. The reverse is also true. The cursor can be moved out of the field by using the cursor control functions described in the previous section.

Table 6-3 gives examples of the effects of valid keys on a four-digit hexadecimal field. Although the count field in the Compare command (Memory_io screen) has been used for this example, the effects of keystrokes as shown in Table 6-3 apply to all similar hexadecimal fields. The position of the cursor is shown in Table 6-3 by a vertical arrow.

Step 7 of the key sequence shown in the table gives the result shown only if the field holds the value 0018 when the cursor is moved into it. If you wish to examine the effect of the sequence yourself, you must first set up the field by selecting the Memory_io screen, then enter the following keystrokes:

C, left, 0, 0, 1, 8, left, right

Table 6-3. Effect of User Entry on Hexadecimal Field
(Compare command, Memory_io screen)

Step	Keystroke	Contents	Notes
1.	(see note)	0018 ↑	Not default value. Use instructions in previous paragraph to start with 0018 in the count field and with the cursor on the first 0.
2.	1	1018 ↑	Changes digit that cursor is on to 1.

Table 6-3. Effect of User Entry on Hexadecimal Field--Continued
(Compare command, Memory_io screen)

Step	Keystroke	Contents	Notes
3.	SHIFT >	1018 ↑	Moves cursor right one position. (Repeated use of the SHIFT and > keys steps the cursor forward through each position. This is useful in moving the cursor to a particular position without having to rekey any of the other digits.)
4.	G	1018 ↑	Z-SCAN ignores this input because it is not a valid hex digit.
5.	F	10F8 ↑	Hex digit "F" is inserted and the cursor automatically moves to the next position.
6.	SHIFT >	10F8 ↑	These keys are used to move forward through each position in the field. If the cursor is on the last position of a hexadecimal field, SHIFT > moves the cursor back to the first position of the field.
7.	space	000C ↑	Entering a space always restores the field to the default value. Also, the cursor returns to the first position of the field each time a space is used.
8.	SHIFT <	000C ↑	These keys (SHIFT and <) move the cursor backwards through each position of the field. If the cursor was on the first position before using these keys, then the use of these keys moves the cursor to the last position of this field.
9.	CTRL R	0018 ↑	CTRL R is used to restore the contents of a field to the value it held when the cursor first moved into the field.

All hexadecimal fields are initialized to meaningful default values by a monitor reset or power-up sequence. The range of values that can be held in some hexadecimal fields is constrained: for example, a count field cannot contain zero. If the user attempts to move the cursor out of a field that contains an illegal value, the monitor automatically restores the contents of the field to what it held when the cursor last entered it.

6.6.2 Multiple-Choice Fields

The other main type of modifiable field is the multiple-choice field. As the name suggests, such fields allow the user to choose a value from a fixed number of alternatives.

An example of such a field is the data type associated with the Display command (see Section 6.10.2). It has five valid values: word, byte, long (for 32-bit long words), nseg (for nonsegmented disassembly) and seg (for segmented disassembly). Rather than displaying the value selected as a single-digit code, the monitor displays a descriptive string. Single digit codes are used internally by Z-SCAN as indexes into tables of possible values for each multiple-choice field. Consequently, when the cursor is positioned on a multiple-choice field, the user can select a particular value (table entry) by entering the single hexadecimal digit that indexes that choice. Valid indexes range from zero to one less than the number of entries in the table. If the user inputs a digit outside the allowed range, the last entry in the table is used.

It is unreasonable to expect all users to learn the index numbers for each possible value in each of the Z-SCAN multiple choice fields. Consequently, an alternative method of selecting values is provided: when the cursor rests on a multiple choice field, SHIFT and > can be entered to select and display the next possible value. The preceding table entry is selected by entering SHIFT and <. As previously indicated, the SHIFT key must be depressed during the entry of either of these characters (< or >). This feature allows the user to step forward or backward through the list of available values until the desired value is found. Stepping forward from the last available value re-selects the first possible value. The reverse is also true.

Besides the hexadecimal digits, the "greater than" and the "less than" keys, two other keys are accepted as valid inputs for multiple choice fields. The space character is considered equivalent to zero, and so it selects the first of the possible choices. Entering the CTRL and R keys returns the contents of a multiple choice field to what it held when the cursor last entered it.

Like hexadecimal fields, multiple choice fields are initialized to meaningful default values by a monitor reset or power-up sequence. The default corresponds to the first entry in the table of possible values. This makes it possible to restore the default value with a single keystroke: zero or space, either of which selects the first value in the table.

Table 6-4 lists the hexadecimal digits that can be used to make particular choices in one of the multiple choice fields; this particular field is the "type" field of the Memory_io Screen's Display command.

Table 6-4. Multiple Choice Field Indexes
(Display command, Memory_io screen)

Index	Choice	Selected by
0	word	0, space, Monitor reset
1	byte	1
2	long	2
3	nseq	3
4	seg	4, or any of the hex digits greater than 4 (i.e., 5 thru F)

Entering an F always selects the last possible choice in any of the multiple choice fields, whereas entering a 0 or space always selects the first possible choice in any multiple-choice field.

Table 6-5 shows the effect of user input including some key sequences other than Index entries on the same example field. These examples show how user input is handled on all multiple choice fields by the Z-SCAN monitor. If you wish to perform the sequential steps in this table, select the Memory_io screen, then enter the following keystrokes:

D, left, 4, left, right

Table 6-5. Effect of User Input on Multiple Choice Field
(Display command, Memory_io screen)

Step	Keystroke	Contents	Index	Notes
1.	(none)	seg	4	The field holds this value when the cursor is moved into it. Step 6 recalls the same value.
2.	1	byte	1	Select second table entry by the index value of 1.
3.	SHIFT <	word	0	Step back to preceding table entry via SHIFT and < keys.
4.	SHIFT >	byte	1	Step forward to next table entry via SHIFT and > key.
5.	2	long	2	Move directly to third entry of table using index value.

Table 6-5. Effect of User Input on Multiple Choice Field
(Display command, Memory_io screen)

Step	Keystroke	Contents	Index	Notes
6.	CTRL R	seg	4	Restore field to value that existed at the time the cursor was moved into the field. This is the value shown in step 1 above.
7.	F	seg	4	Move directly to last entry in table.
8.	SHIFT >	word	0	Step forward and loop back to first entry in table.
9.	6	seg	4	Any hex number larger than number of items in table always selects the last table entry.
10.	3	nseg	3	Selects fourth entry in table.
11.	space	word	0	Restores field to the default value.

6.6.3 Other Field Types - File Name and Memory Content

In addition to hexadecimal and multiple choice fields, the Z-SCAN monitor uses two other types of fields. Each is used in only one situation.

- o The file name field appears only in the Load and seNd command subscreens (see Sections 6.10.8 and 6.10.9). This field can hold up to 32 non-space characters. Z-SCAN makes no check on input because it has no knowledge of the file-naming conventions of the host system. It is the responsibility of the host system's LOAD command to check the file name for validity. For further details see Section 7, Interface to Non-Zilog Hosts.

The SHIFT >, SHIFT <, and control (CTRL) and R keys are used in the same way in the file name field as in a hexadecimal field (see Section 6.6.1). Hence, Z-SCAN does not allow these characters to be sent to the host as part of a file name. If you put a space in a file name, Z-SCAN treats it as a terminator and shows this by erasing all input to the right of the inserted space.

- o The Memory Content field is used exclusively by the eXamine command and is tailored to the special requirements of that command. Its behavior is similar to that of a hexadecimal field with two, four or eight digits. The differences are summarized in paragraph seven of the next section.

6.7 SUMMARY OF VALID USER INPUT SEQUENCES

The three preceding sections discussed the keystrokes used to achieve the following objectives:

- Moving from one screen display to another.
- Activating commands available on the current screen.
- Moving the cursor into and out of modifiable fields in parameter areas.
- Updating the contents of modifiable fields.

This section summarizes the keys that can be entered, which generally depend on the position of the cursor on the screen. Refer to Section 6.8 for complete information on executing commands.

Many of the terminals supported by the Z-SCAN monitor offer features which are not needed by the monitor. In many cases, Z-SCAN ignores data received when keys associated with such features are entered. Some keys, however, may send data that is considered to be valid. The function keys on some terminals do this, while others affect the display on the terminal screen without sending data to the Z-SCAN. Local editing keys such as line delete and character insert have this effect.

If the display is corrupted by the entry of an incorrect key, the user should activate another screen (the following paragraphs explain how to do this), then reactivate the corrupted screen. If any of the variable fields on the screen contains an incorrect value, they should be corrected before the user continues.

1. Following a power-up or monitor reset from front panel:

- To synchronize Z-SCAN's baud rate with that of your terminal, enter RETURN. The terminal selection screen is displayed. Entry of an incorrect character may result in garbage being displayed. To correct this, RESET Z-SCAN, then enter RETURN.
- To select a terminal type, enter one of the numbers listed on the screen. Invalid entries are ignored. Incorrect entries can be replaced by entering another selection. Appendix A details the terminals supported by the Z-SCAN monitor.
- When the terminal type has been selected, enter RETURN to activate the System screen. If the display is corrupted, the terminal selection is incorrect. RESET Z-SCAN and repeat the steps above.

2. Cursor on current screen name inside menu area parentheses:

- To select another of the five screen displays, enter the appropriate capital letter from the screen name.

- To activate a command on the current screen, enter the appropriate capital letter from the command name. This automatically moves the cursor to the first position of the first item in the associated command area.
- System screen only: Enter RETURN to move cursor into the host baud rate field.

All other input is considered invalid and does not change the state of the monitor software. Screen editing keys must not be used as they can cause unpredictable results.

3. Cursor on a hexadecimal variable field in a command area:

- Enter hex digits (0-9, capital A-F) or spaces to modify the value in the field.
- Enter SHIFT > or SHIFT < to move the cursor forward or backward inside the current field without modifying its contents.
- Enter space to change the contents of the field to the default value.
- Enter CTRL R to restore the field to the value it held when the cursor was moved into it.
- Use the cursor control keys (cursor up, cursor down, cursor right or cursor left) to move the cursor to other fields in the subscreen associated with the active command.
- To return the cursor to the menu area (state six below) without executing the active command, enter BREAK.
- To execute the current command, enter RETURN.

Any other key is considered invalid and is ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

4. Cursor on a multiple choice, variable field in a command area:

- Enter a single hexadecimal digit (0-9, A-F) to select a corresponding value to a particular entry in the Z-SCAN internal table of choices.
- Enter SHIFT > or SHIFT < to select the next or previous value from the Z-SCAN internal table of choices.
- Enter CTRL R to restore the field to the value it held when the cursor was moved into it.
- Enter space to restore the field to the default value.

- Use the cursor control keys (cursor up, cursor down, cursor left or cursor right) to move the cursor to other fields in the subscreen associated with the active command.
- To return the cursor to the menu area (state six below) without executing the active command, enter BREAK.
- To execute the current command, enter RETURN.

Any other key is considered invalid and is ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

5. **Cursor on file name field (Memory_io screen Load and seNd commands only):**

- Enter any keys not mentioned below to update the value of the field
- Enter SHIFT > or SHIFT < to move the cursor forward or backward inside the current field without modifying its contents.
- Enter CTRL R to restore the field to the value it held when the cursor was moved into it.
- Enter space to terminate the file name.
- Use the cursor control keys (cursor up or cursor down) to move the cursor to other fields in the subscreen associated with the active command.
- To return the cursor to the menu area without executing the command, enter BREAK.
- To execute the command, enter RETURN.

Any other key is considered invalid and is ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

6. **Cursor on active command name inside menu area parentheses:**

- To move the cursor to the first variable field associated with the active command, enter RETURN.
- To select another command on the same screen, enter the appropriate capital letter from the command name. The cursor moves automatically from the command name to the first position of the first field associated with the new command.
- To deactivate the current command, enter Q. The upper menu line is rewritten to display the names of alternative screens.

- To display another screen, enter the appropriate capital letter from the screen name. It is not necessary to enter Q prior to displaying another screen when the cursor is on an active command name inside the menu area parentheses. (The Terminal Selection screen cannot be called up in this manner and the Trace screen can only be selected from the Execution screen.)

Any other key is considered invalid and is ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

7. Cursor in window area (Memory_io screen eXamine command only):

- Enter hex digits (0-9, A-F) to modify the value in the memory location currently open. After sufficient digits are entered to fill the current location, the next location is automatically opened.
- Use the <-- (cursor left) key or SHIFT < to backspace over and delete incorrectly entered digits.
- The and (cursor up and cursor down) keys can be used to open the previous and next locations respectively.
- To return the cursor to the menu area, enter RETURN.

Any other key is considered invalid and is completely ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

8. Cursor resting in window area (Memory_io screen only):

- Enter cursor down to clear the window area and display the next block of data.
- Enter cursor up to clear the window and display the previous block of data (Display command only).
- Enter BREAK to abort the Load or seNd command.
- Enter RETURN to move the cursor to the menu area.

Any other key is considered invalid and is completely ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

9. Cursor resting at bottom right of Trace screen:

- Enter cursor down to execute the number of instructions shown in the step count field.
- Enter hex digits (0-9, A-F) to alter the value in the step count field. Execution begins after four digits have been entered. Use cursor left or SHIFT < to backspace over and delete incorrect entries.

- Enter RETURN to move to the Execution screen.

Any other key is considered invalid and is completely ignored by the Z-SCAN monitor software. Screen editing keys must not be used as they can cause unpredictable results.

10. Cursor writing data onto screen:

- Enter CTRL S to force a temporary pause in data output to the terminal. Enter CTRL Q to resume output. Some terminals have a scroll control key which sends CTRL S and CTRL Q alternately.
- Enter BREAK to ensure that output stops when the screen is full and before any part of the screen is overwritten with new data. Break achieves this by aborting execution on the Trace screen and by flushing the type ahead input buffer. Any commands entered but not yet executed are lost.

Any other key (with the exception of screen editing keys) can be entered while the Z-SCAN is sending data to the terminal or while output is paused. The input is buffered and is not acted upon until output is complete.

11. Cursor resting in Execution screen return message area (Z-SCAN in Target mode):

- To force a return to Monitor mode, use the Z-SCAN front panel switches to enter a Monitor NMI.

Input from the keyboard is not accepted while Z-SCAN is in Target mode.

12. Transparent mode (all cases not mentioned above):

- Enter data in the format required by the host system.
- To return to Monitor mode from Transparent mode, use the BREAK key. If the host and terminal baud rates differ, the user is prompted to set the baud rate of the terminal to the Monitor mode value. The System screen is displayed when the terminal baud rate is correctly set up.

6.8 THE TERMINAL SELECTION SCREEN

Following a power-up or monitor RESET sequence, Z-SCAN must establish two characteristics of the terminal being used:

- Baud rate.
- Cursor addressing protocol.

To set up the baud rate, the user enters a RETURN. Z-SCAN measures the width of the start bit of the character, then programs a baud rate generator to match the calculated speed. Fourteen rates, listed in Table 6-7, are supported.

When the terminal baud rate is established, the Terminal Selection screen shown in Figure 6-2 is displayed. If the terminal is running at a baud rate not supported by Z-SCAN or if an incorrect character is entered, the display will be corrupted or will not appear. Z-SCAN must be RESET before the baud rate can be set up correctly.

The display prompts the user to enter a terminal selection digit. Valid choices are listed on the screen. Invalid entries are ignored. If an incorrect choice is entered, it can be replaced by entering the correct choice.

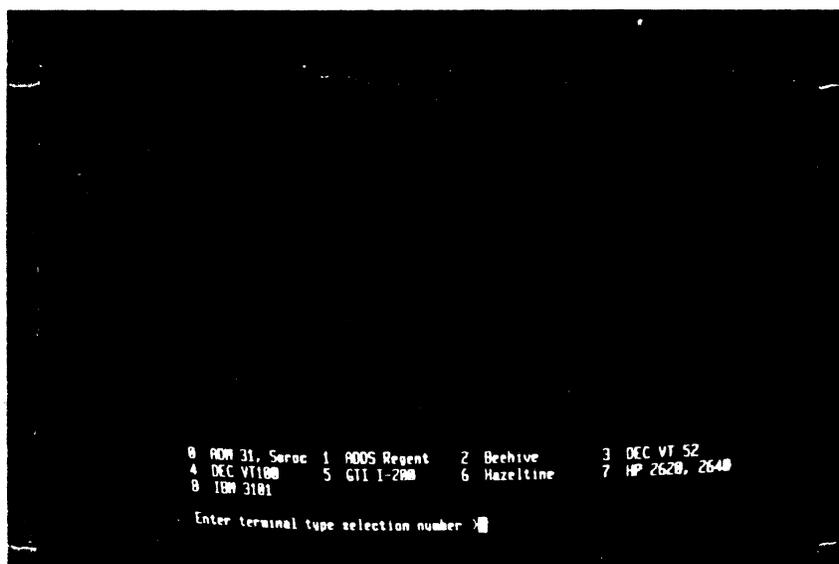


Figure 6-2. The Terminal Selection Screen

Table 6-6 lists a number of terminals supported by the Z-SCAN monitor and the corresponding selection digits. Appendix A gives further information about the supported terminals and describes how to find out whether an unlisted type can work with Z-SCAN.

After the selection digit has been entered, the user must enter RETURN to move to the System screen (Section 6.9). If garbage appears instead of the System screen, the terminal selection digit is incorrect. Z-SCAN must be RESET and baud rate synchronization re-established before the correct digit can be entered.

Table 6-6. Terminals and Terminal Type Selection Numbers

Supplier	Model	Selection Number
ADDS	Regent 20, 40 or 60	1
Beehive	B-100 or Bee-1	2
DEC	VT52	3
DEC	VT100	4
General terminals	I-200, I-400	5
Hazeltine	1420 or 1500 series	6
Hewlett Packard	2620 or 2640 series	7
IBM	3101	8
Lear Siegler	ADM 31	0
Soroc	IQ 120 or IQ 135	0
Televideo	TVI 912 or TVI 920	0
Zentec	Zephyr	0

6.9 THE SYSTEM SCREEN

Figure 6-3 shows the System screen in the default state. The display area is divided into three parts by rows of dashes. The bottom is a Menu area (see Section 6.4.1) and the other two are Command areas. Since there is no choice of commands on this Screen, the second line of the menu area is blank.

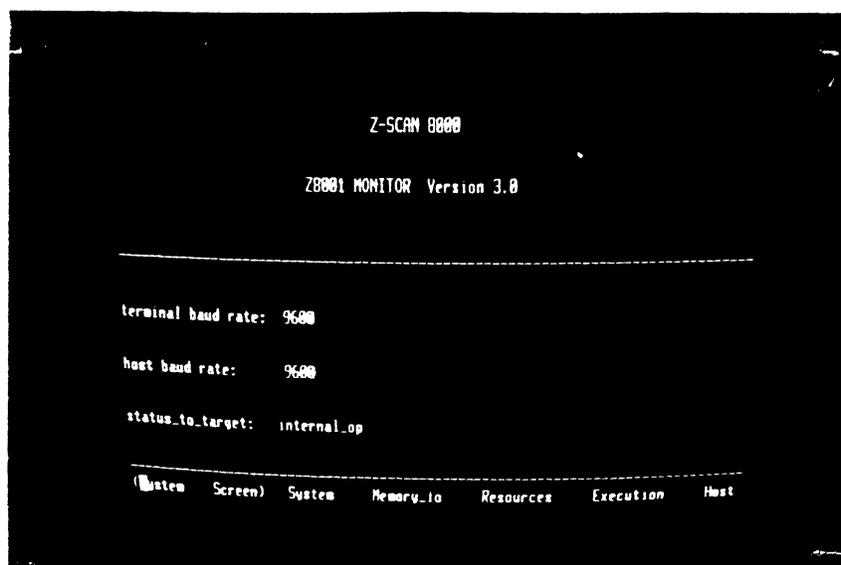


Figure 6-3. The System Screen

The top Command area identifies the Z-SCAN monitor software. It shows the release level of the software and identifies the CPU type (Z8001 or Z8002) installed. It does not contain any user modifiable fields. The release level may differ from that shown in Figure 6-3.

The first field in the center command area specifies the terminal baud rate. This is not a variable field (as discussed in Section 6.6) and cannot be changed by the user on the System screen. The terminal baud rate is used between Z-SCAN and the terminal during Monitor mode.

The second field in the center command area specifies the host baud rate. This variable field allows the user to select the baud rate used between the terminal and a host system (if connected). Following a RESET, its value defaults to the same value as the terminal baud rate.

- o To move the cursor to the host baud rate field from the menu area, enter RETURN.
- o To step forward through the 14 selections available for the host baud rate use SHIFT >.
- o To step backward through the various selections available for this field, use SHIFT <.

Table 6-7 lists the Host baud rates supported by Z-SCAN. Many terminals do not support all the rates supported by Z-SCAN. Some terminals support rates not available on Z-SCAN. These speeds must not be used. The effects of the terminal baud rate selection are discussed in Section 6.13.

Table 6-7. Host Baud Rate Values

Field name	Type	Values (M-C) Range (hex)	Index/ Default	Notes
Host baud rate	mult choice	19200	0	See text
		9600	1	
		4800	2	
		2400	3	
		1800	4	
		1200	5	
		600	6	
		300	7	
		200	8	
		150	9	
		134.5	A	134.5 baud
		110	B	
		75	C	
		50	D	

--NOTE--

In this and subsequent tables, mult choice stands for multiple choice. Hex-N, where N is 2, 4 or 16, indicates a hexadecimal field with the given number of digits. The fourth column lists indexes for multiple-choice fields. The default is always the choice with an index of zero. A default value is given for hexadecimal fields.

The third field in the center command area specifies the status_to_target. This variable field determines the status code sent to the target system during Monitor mode and Transparent mode. It is a multiple-choice field with two possible values: internal op (internal operation, the default value) or refresh. The implications of each possible status are covered in Section 5.4.3.

- To move the cursor from the host baud rate field to the status_to_target field, enter cursor down (↓).
- To move the cursor back to the host baud rate field, enter cursor up (↑).
- To move the cursor to the menu area from either of the two variable fields, enter RETURN.

Table 6-8 summarizes the behavior of the status_to_target field.

Table 6-8. Status_to_target Values

Field Name	Type	Values (m-c) Range (hex)	Index/ Default	Notes
status_to_target	mult choice	internal_op refresh	0 1	see Section 5.4.3

6.10 THE MEMORY_IO SCREEN

The Memory_io screen (Figure 6-4) supports nine commands that can manipulate the contents of memory and I/O ports in the target system. The memory commands can also operate on the Z-SCAN mappable memory (see Section 6.11.3) and on the Z-SCAN monitor memory. Monitor commands and emulations are prohibited from operating on the Z-SCAN I/O ports.

--NOTE--

To set up conditions for emulation, it should not be necessary for the user to operate on the contents of monitor memory with Memory_io screen commands. If the commands are used to operate on monitor memory, the user should exercise great care, since changes to the contents of the memory could prevent the monitor from functioning correctly.

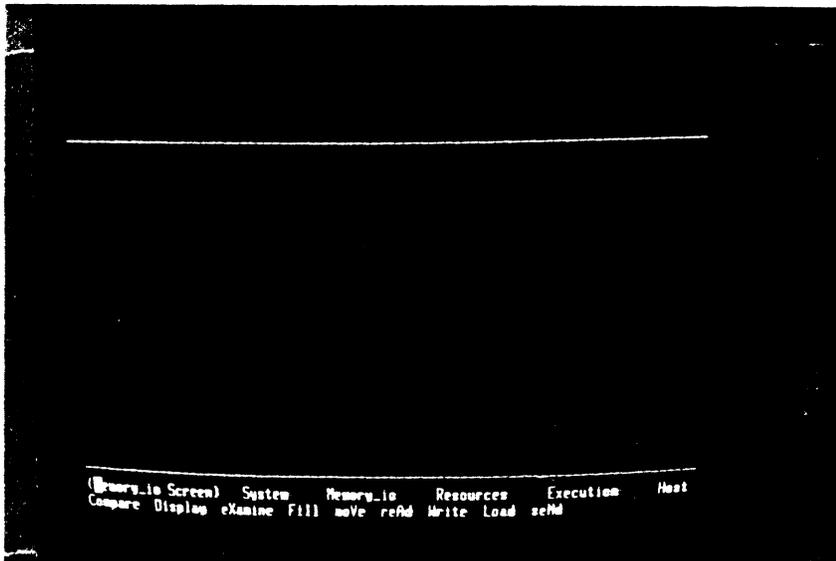


Figure 6-4. The Memory_io Screen

The Memory_io screen display is divided into three areas by lines of dashes. The bottom area is the menu area. Above it is a window area, used primarily for the display of data during the execution of commands. The window is initially empty and remains so until a command is executed. The command area at the top of the screen is also initially blank but is used to display a subscreen associated with the command as soon as any command is activated. Refer to Section 6.4 for further information on screen layouts and command displays.

Once a command has been activated, the cursor automatically moves up into the first variable field in the newly displayed subscreen, allowing the contents of the various fields to be updated as described in Section 6.6.

Simply updating the values held by variable fields does not result in the actual performance of an active command. For example, changing the start address field in the memory display command does not result in the immediate display of the contents of the newly addressed block of memory. In order for the action defined by the command and its parameters to be performed, the command must be executed. Execution is accomplished by entering a RETURN after all the command parameters are set to the desired values. The cursor is in the command parameter area just before execution takes place.

Execution of any command clears the window area (which may contain data resulting from a previous execution) and then performs the command. As execution proceeds, data or messages are displayed in the window. If a command requires the display of more data than will fit in the window, the window is repeatedly filled from top to bottom as many times as are necessary to display all the data. The user is given the opportunity to abort or continue with the command after each block of data is displayed.

Execution of commands that operate on large areas of memory may take a long time because Z-SCAN runs one or two separate emulations for each byte in the block. Section 5.4.4 discusses the hardware implications of these memory accesses.

Execution can be suspended temporarily by entering CTRL S to stop the display of further data. CTRL Q terminates the suspension.

When execution is complete, all commands except Display and eXamine give a closing message, usually DONE. The cursor returns to the menu area, and the command is still active. The state of the software is as described in state seven of Section 6.7.

In summary:

- To abort the current command, enter BREAK. This moves the cursor to the menu area without executing the command.
- To execute the current command, enter RETURN.
- To temporarily stop the execution process, enter CTRL S. To continue, enter CTRL Q.
- To continue when the window is full, enter (cursor down); to abort the execution, enter RETURN.

6.10.1 The Compare Command

This command performs a byte-by-byte comparison of the contents of two areas. Any differences between corresponding bytes in the source and target blocks are reported. The terms source and target have no significance; the result of comparing two blocks of memory does not depend on which is named in the source field and which is in the target.

Execution of the command clears the window area and displays a heading at its top left. Bytes from the source and target areas are then compared. Each time a difference is found the two bytes and their addresses are displayed on a new line. This continues either until the examination is complete or until the window area is full. In the first case, a count of differences is displayed at the bottom left of the window, and the cursor returns to the menu area. When the window is full no message is displayed. The cursor rests at the bottom right of the area. Two user input characters are valid:

- Cursor down clears the window and redisplayes the heading, allowing more data to be displayed.
- RETURN terminates the command, moving the cursor to the menu area. The message ABORTED appears, indicating that not all the differences between the blocks were displayed.

If there are no differences between the source and target areas, the headings and the message NO DIFFERENCES appear before the cursor returns to the menu area.

Figure 6-5 is an example of a display produced by the Compare command.

```
source: space SC   address 00 1000   count 1000
target: space SC   address 00 0000

SOURCE            TARGET
ADDR CONTENTS    ADDR CONTENTS
00 1010 AB        00 0010 69
00 1019 00        00 0019 0F
00 101A 00        00 001A 00
00 101B 00        00 001B 10
00 1FFC SE        00 0FFC AB
00 1FFD 00        00 0FFD 00
00 1FFE 00        00 0FFE AB
00 1FFF 10        00 0FFF 00

0000 DIFFERENCES
(Press: to Screen (Compare Command) Quit
Compare Display eXamine Fill move read Write Load send
```

Figure 6-5. The Compare Command

Additional examples of the Compare command are included in the tutorials in Section 4.

Table 6-9 summarizes the Compare command's fields and parameters.

Table 6-9. Compare Command Fields

Field name	Type	Values (M-C) Range (hex)	Index/ Default	Notes
source space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
source address (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	Does not appear if Z8002 is installed This is the only address field on the Z8002
count	Hex-4	0001-FFFF	000C	This is a byte count
target space	mult choice	--same as for source space--		
target address (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	See notes for source address

6.10.2 The Display Command

The Display command allows the contents of blocks of memory to be displayed on the screen. It does not allow the user to modify those contents; that function is handled by the eXamine command, described in Section 6.10.3. The Display command has two operating modes: memory dump and disassembly. In the first, sixteen bytes are displayed per screen line. The hexadecimal representation of their contents follows the address of the first byte, which appears at the left of the screen. The data can be formatted on the display as bytes, words, or long words (two, four or eight hex digits per data item, respectively). The right of the screen is used to display an ASCII representation of the same data, delimited at each end by asterisks (*). Non-printing characters (00-1F and 7E-FF) are represented by periods (.). There are 17 (decimal) display lines giving a total of 110 hex bytes per display.

The Display command can also disassemble the contents of memory in segmented or nonsegmented mode. The format of the disassembled instruction mnemonics and operands is as described in the Z8000 PLZ/ASM Assembly Language Programming Manual (document # 03-3055-02). Addresses and most immediate operands are presented as hexadecimal values. Decimal representation is used for immediate values represented by four or fewer bits.

The display is presented in listing format with addresses at the left of the screen, mnemonics in the center and operands at the right. The memory words disassembled from the decoded instructions appear between the address and the mnemonic.

If the disassembler encounters one of the Z8000's extended instructions, the message * * UNIMPLEMENTED INSTRUCTION * * is displayed in the place of the mnemonic and operands, but the correct number of disassembled words appear to the right of the address. Extended instructions, which may be two, three or four words in length depending on addressing mode and address format, are described in Section 6.8 of the Z8000 CPU Technical Manual (document # 00-2010-C).

When the disassembler finds that the first word of an instruction does not correspond to an operation available on the Z8000, the message * * INVALID OPCODE * * appears and just one word appears to the right of the address. The same message is shown if an illegal register designator--for example, an odd valued long word designator--appears anywhere in the instruction. The number of words disassembled is determined by the opcode and addressing mode of the first instruction word. No error message is generated if invalid constant or opcode fields appear in the second word of an instruction. The invalid instruction message is likely to appear when data areas are disassembled, or when an incorrect disassembly mode (segmented or nonsegmented) is used.

Seventeen instructions are displayed in the window area by disassembly. The number of bytes displayed depends on the instructions disassembled.

--NOTE--

The Z-SCAN memory target access method allows the Display command to address words at odd memory addresses. Individual Z8000 instructions address words only at even addresses. See Section 5.4.4 for more details.

After 110 (hex) bytes or 17 (decimal) instructions have been decoded, the cursor rests at the bottom right of the window area. One of three characters must be entered:

- **Cursor down** clears the screen, then displays the next block of memory. For word, byte and long display types, the next block starts at the address shown at the bottom left of the display before the screen is cleared, giving an overlap of 16 (decimal) bytes. For disassembly, the next block starts at the address following that of the last word displayed before the screen is cleared.

- **Cursor up** clears the screen, then displays the previous block of memory. For word, byte and long display types, the final line of the block is the same as the first line of data on the screen just erased. Again, this gives an overlap of 16 (decimal) bytes. For disassembly, the first word disassembled is fetched from an address 44 hex bytes below that which follows the last word displayed before the screen is cleared.
- **Return** moves the cursor to the menu area. The command remains active and the window area is not cleared.

Figure 6-6 shows a display produced by the execution of the Display command.

```

source: space 5C   address 00 0000   type seg
-----
00 0000  A000          INCB  R00  #12
00 0002  A000          INCB  R00  #12
00 0004  A000          INCB  R00  #12
00 0006  A000          INCB  R00  #12
00 0008  A000          INCB  R00  #12
00 000A  A000          INCB  R00  #12
00 000C  A000          INCB  R00  #12
00 000E  A000          INCB  R00  #12
00 0010  A000          INCB  R00  #12
00 0012  A000          INCB  R00  #12
00 0014  A000          INCB  R00  #12
00 0016  A000          INCB  R00  #12
00 0018  5000 0010      INC   <<<00>>0010: #16
00 001C  A000          INCB  R00  #12
00 001E  A000          INCB  R00  #12
00 0020  A000          INCB  R00  #12
00 0022  A000          INCB  R00  #12
-----
(Reset to Screen) (Display Command)      Quit
Compare Display eXamine Fill moVe reAd Write Load seNd

```

Figure 6-6. The Display Command

Table 6-10 details the variable fields in the Display Command.

Table 6-10. Display Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
source space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
source address (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	Segment number does not appear if Z8002 is installed This is the only address field on the Z8002. It should be even except when the type field is set to byte.
type	mult choice	word byte long nseg seg	0 1 2 3 4	Non-segmented disassembly Segmented disassembly

6.10.3 The eXamine Command

The function of this command is to allow the user to examine, and optionally to modify, the contents of individual bytes, words, or long words in memory. When the eXamine command is executed, the contents of the location specified in the command area at the top of the screen are displayed in the window area, and the user is prompted for a new value that will replace those contents.

Figure 6-7 shows the initial screen obtained by the eXamine command. Additional examples of this command are included in the tutorials of Section 4.

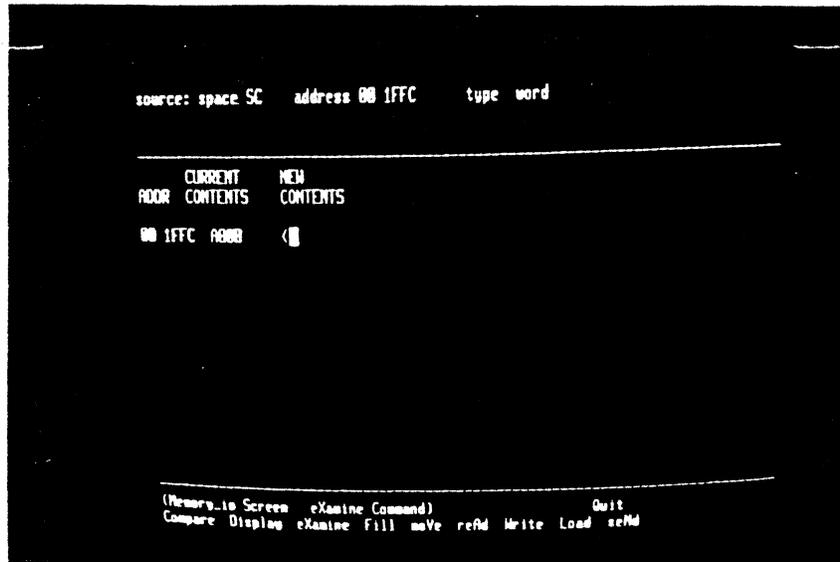


Figure 6-7. The eXamine Command

Table 6-11 lists the parameters of the eXamine command. After setting up the parameters, one of two keys must be entered:

- BREAK returns the cursor to the menu area without executing the command. The command remains active.
- RETURN clears the window area then displays the address of the location selected by the parameters, its contents, and a prompt for a new value.

At this stage, the following keys are valid:

- Hex digits can be used to alter the value held in the open location.
- Cursor up and cursor down keys open the previous and the next memory locations, respectively.
- The next location (in the new contents field) is automatically opened after enough hex digits have been entered to fill the location.
- Erroneous input can be deleted with the cursor left or SHIFT < keys.
- Execution of this command is terminated by entering RETURN. The cursor moves to the menu area and the command remains active.

The eXamine command is capable of writing into the Z-SCAN mappable memory. A write protection feature is available that protects the contents of this memory (see Section 6.11.3). Write protection applies only during Target mode; Memory_io screen commands can still write to the memory. The user should exercise caution to avoid overwriting data that should be preserved.

Table 6-11. eXamine Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
source space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
source address (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	Segment number does not appear if Z8002 is installed This is the only address field on the Z8002. It should be even except when the type field is set to byte.
type	mult choice	word byte long	0 1 2	

6.10.4 The Fill Command

The Fill command allows the user to replicate a specified string one to eight bytes in length throughout a specified memory area. If the length of the memory area in bytes is not exactly divisible by the length of the string in bytes, the final copy of the string is truncated. The length of the memory area is defined as $\text{end_address} - (\text{begin_address} + 1)$. This implies that the last byte filled is the one located at the end address. If end_address is less than begin_address, filling continues from the bottom of memory after the top of memory has been passed.

The string is specified as a sequence of up to 16 (decimal) hex digits. The string used to fill memory always consists of a whole number of bytes. Thus, if the user enters a string that has an odd number of digits, a leading zero is assumed. For example, a user input of 12345 is interpreted as a three-byte string: 01, 23, 45.

The default string is empty; that is, it has no digits and its length is zero. It is equivalent to a field of spaces. Z-SCAN automatically aborts the Fill command if it is executed with such a fill string.

The area to be filled may include the Z-SCAN mappable memory, which is described in Section 6.10.3. The Fill command can alter its contents even if it is write protected.

The only display produced by this command in the window area is the termination message DONE. See Figure 4-20 for an example. Table 6-11 lists the command's variable fields.

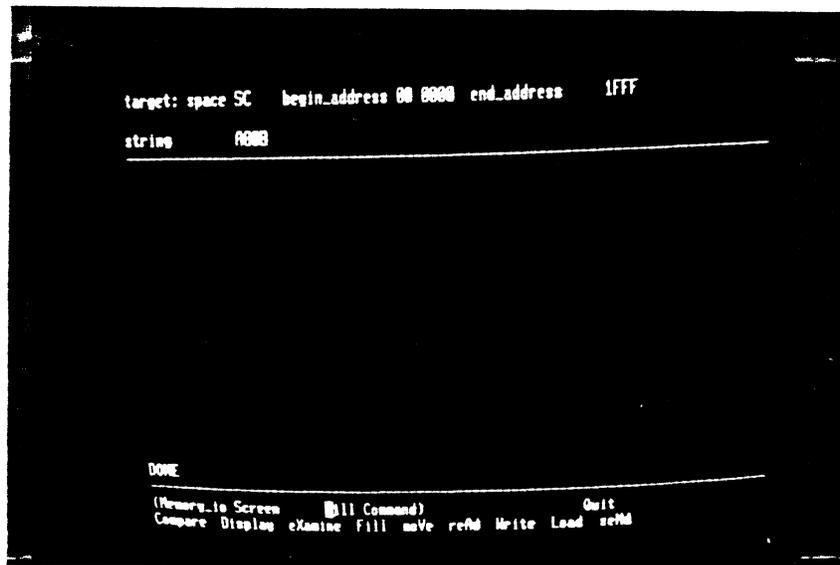


Figure 6-8. The Fill Command

Table 6-12 lists the variable fields for the Fill command.

Table 6-12. Fill Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
target space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
begin_address (segment number) (offset)	Hex-2 Hex-4	00-FF 0000-FFFF	00 0000	Segment number does not appear if Z8002 is installed This is the only address field on the Z8002.
end_address	Hex-4	0000-FFFF	0000	On the Z8001, the same segment number is used for both address fields.
string	Hex-16	empty - FFF...FFF	empty	Leading zero is implied if length is odd.

6.10.5 The moVe Command

The moVe command allows the user to copy the contents of one area of memory into another area. The contents of the source area are not altered by this command. The source and target areas can be in the same or in different address spaces, and they can overlap. Thus, it is possible for the target address to be within the block specified by the start address and by the length. Similarly, the source address can be within the block specified by the target address and the length. Note that the length is always specified in bytes.

As with the eXamine and Fill commands, the target memory area for the moVe command may include the Z-SCAN mappable memory (see Section 6.11.3). The moVe command can alter its contents even if it is write protected.

Figure 6-9 shows an example of the moVe command. This display results from setting parameters to move the contents of 10 bytes starting at location 0000 in system code space to the 10 bytes starting at location 2000 in system code space. A RETURN is entered after setting up the parameters. This executes the command and displays the DONE message when complete.

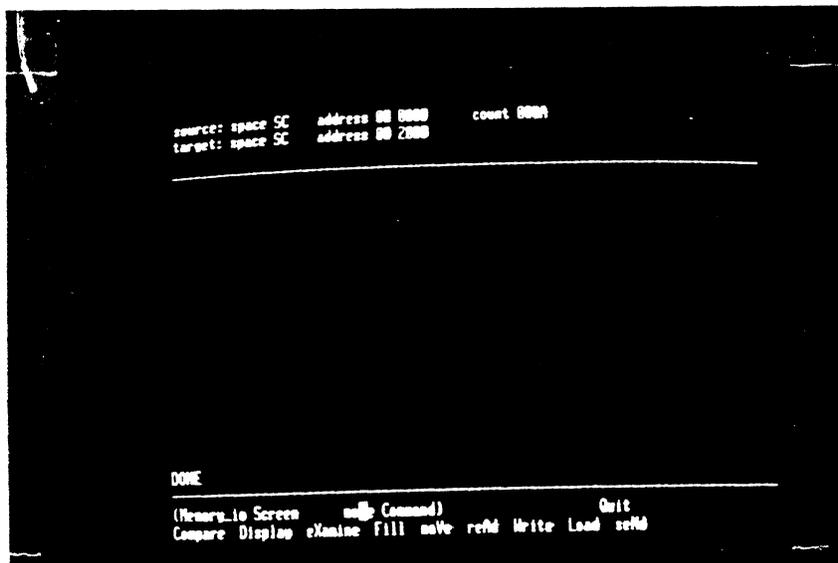


Figure 6-9. The moVe Command

Table 6-13 summarizes the moVe command's parameters.

Table 6-13. moVe Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
source space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
source address (segment number) (offset)	Hex-2 Hex-4	00-FF 0000-FFFF	00 0000	Segment number does not appear if Z8002 is installed This is the only address field on the Z8002.
count	Hex-4	0001-FFFF	0001	This is a byte count.
target space	mult choice	--same as for source space--		
target address (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	See notes for source address.

6.10.6 The reAd Command

The user can read byte- or word-wide ports in the target system through the use of this command. Up to FFFF read operations can be performed and their results displayed. Both standard and special operations are supported by the reAd command.

Note that Z-SCAN's own ports cannot be accessed by this command, just as they cannot be accessed during emulations.

Execution of the reAd command first clears the window area, then displays the data read, one word or byte per line. An ordinal number appears to the left of each value.

If the number of operations specified by the count field in the command area is not complete when the bottom of the window is reached the cursor waits at the bottom right of the area. Two keys are valid in this context:

- Cursor down clears the screen and displays more data.
- Return aborts the command, moving the cursor to the menu area. The message ABORT is displayed.

The message DONE is displayed when the requested number of reads has taken place.

Figure 6-10 is an example of a display following execution of the reAd command.

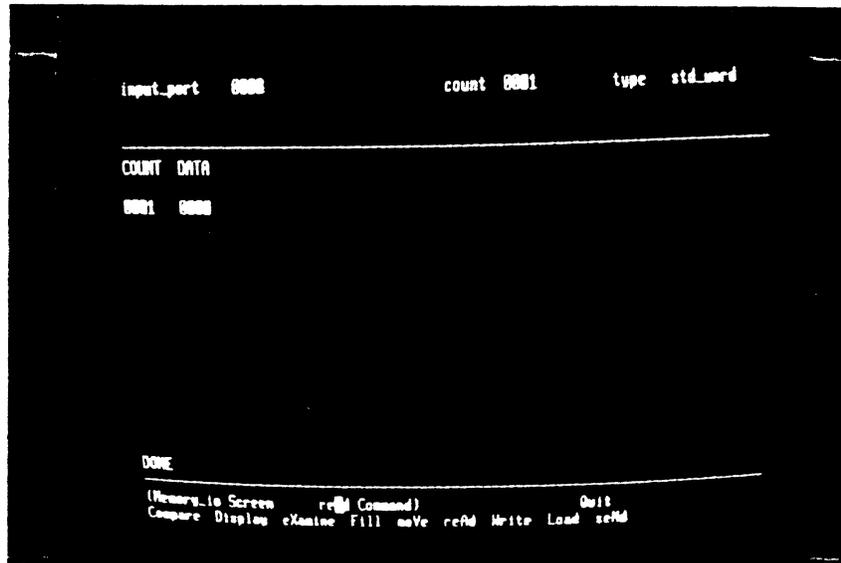


Figure 6-10. The reAd Command

Table 6-14 details the reAd command parameters.

Table 6-14. reAd Command Fields

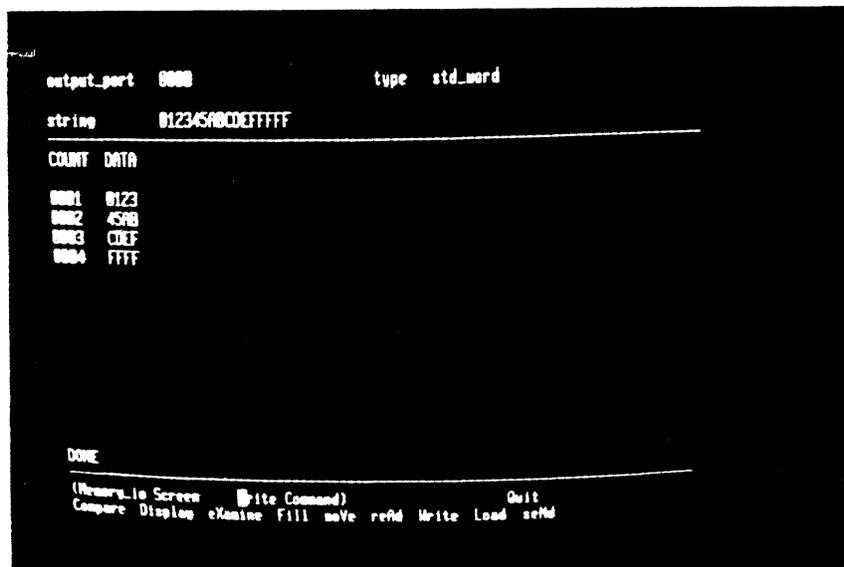
Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
input_port	Hex-4	0000-FFFF	0000	See Section 5.4.4.
count	Hex-4	0001-FFFF	0001	Counts words or bytes.
type	multi choice	std_word std_byte spl_word spl_byte	0 1 2 3	Reads whole bus. Reads bits 0-7 of bus if address is odd, or bits 8-16 of bus if address is even. Reads whole bus. Reads bits 0-7 of bus if address is odd, or bits 8-16 of bus if address is even.

6.10.7 The Write Command

With this command, a string of up to eight bytes can be written to a single byte or word-wide I/O port in the target system. The Write command also supports both standard and special operations. The output string can contain up to 16 hex digits. If the string contains an odd number of digits and the destination is a byte port, a leading zero is assumed. Thus, the high nibble of the first byte transmitted is zero. Similarly, if the destination is a word port, up to three leading zeros can be assumed to ensure that the string fills a whole number of words. For example, the user input 12345 could be interpreted as three bytes (01, 23, 45) or as two words (0001 and 2345).

As each word or byte is output, it is displayed in the window area to the right of an ordinal number. No output occurs if the command is executed with the default string, which is empty (equivalent to a user input of spaces). Note that this command cannot access Z-SCAN's own output ports. The message DONE indicates completion.

An example of the Write command's default screen display is shown in Figure 6-11.



```
output_port 0000          type std_word
string 012345ABCDEF
-----
COUNT DATA
0001 0123
0002 45AB
0003 CDEF
0004 FFFF

DONE
-----
(Home) to Screen  Write Command)  Quit
Compare Display examine Fill move read Write Load send
```

Figure 6-11 The Write Command

Table 6-15 lists the parameters for the Write command.

Table 6-15. Write Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
output_port	Hex-4	0000-FFFF	0000	
type	mult	std_word	0	16 bits of data appear on bus
	choice	std_byte	1	Data duplicated on high and low halves of bus
		spl_word	2	16 bits of data appear on bus
		spl_byte	3	Data duplicated on high and low halves of bus
string	Hex-16	empty - FFF...FFF	empty	Leading zeros may be implied See above.

6.10.8 The Load Command

The Load command allows the downloading of executable files (procedure files) from a host system into memory controlled by Z-SCAN. This section describes the user interface to the command. Section 7 of this manual details the down-load transactions between Z-SCAN and the host system.

Z-SCAN requires three items of information in order to load a program. It needs to know which address space it will be loaded into. A load address is not required, since the file itself contains this information. If Z-SCAN is using the Z8001 CPU, the second item of information needed is the segment number. The last item of information required is the file name, which may contain up to 32 arbitrary characters. Refer to Section 6.6.3 for further information on file names.

When the Load command is executed, Z-SCAN requests the host system's load utility to open the requested file. It is possible that the host cannot run the load utility or that the requested file cannot be opened for some reason. In either of these cases, an error message is displayed in the window area and execution is terminated. If the host does not respond to the request at all, Z-SCAN waits indefinitely for a response. In this case, the user must abort the command by entering a BREAK.

More often, the load utility runs successfully and the contents of the file are loaded into the target memory area. As this happens, a record count is displayed at the top left of the window area. Each record contains about 30 (decimal) bytes of data. When loading is complete, the entry point of the program just loaded is displayed before execution of the command terminates. The user can abort loading at any time by entering BREAK.

Load can be used to write the contents of a program file into the Z-SCAN mappable memory, which is described in Section 6.11.3. As with other monitor commands that can write to this memory, Load is able to alter its contents even if it is write protected.

Figure 6-12 shows an example screen for the Load command. The tutorials in Section 4 include other examples of the Load command.

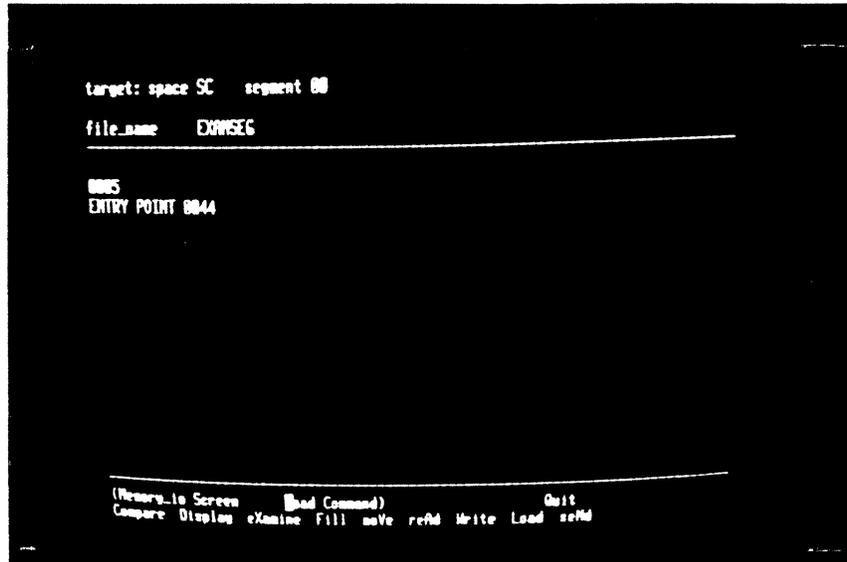


Figure 6-12 The Load Command

Table 6-15 lists the parameters for the Load command.

Table 6-16. Load Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
segment number	Hex-2	00	00-7F	Segment number does not appear if Z8002 is installed
file_name	file name	any	blank	32 arbitrary characters terminated by space.

6.10.9 The seNd Command

The seNd command allows the uploading of information or procedure files contained in memory controlled by Z-SCAN. This section describes the interface to the command. Section 7 of this manual details the upload transactions between Z-SCAN and the host system.

Z-SCAN requires several items of information in order to seNd (upload) information or files to the host system. The begin_address and end_address identify the block of data to be sent from the source address space. The Z8001 requires the segment number to be stated. Both begin address and end_address are offsets in the same segment. The number of bytes sent is (end_address - begin_address + 1), so that the last byte in the block is that at end_address.

The seNd command is intended mainly for saving patched programs. For this reason, it has an entry point field to define the address at which execution of the program should begin. The entry point must be greater than or equal to the begin address and less than the end address. seNd can be used to save the contents of data areas provided that a dummy entry point is supplied.

When the command is executed, the validity of the addresses is checked. If the check fails, INVALID ADDRESS is displayed and the command aborts. If the parameters are acceptable, the host's SEND utility is activated. An error message is displayed if the host cannot load the utility or if the file name is unacceptable--for example, the file already exists with the same file name as the one given in the seNd command. More normally, the host program is activated without error and records are sent to the host by Z-SCAN. An incrementing number at the top left of the screen counts the records, which each contain 30 or fewer bytes. Execution terminates when the transfer is complete.

Figure 6-13 shows an example of the initial display obtained by accessing the seNd command.

Table 6-17. seNd Command Fields

Field Name	Type	Values (M-C) Range (hex)	Index/ Default	Notes
source space	mult choice	SC SD SS NC ND NS MT	0 1 2 3 4 5 6	System code space System data space System stack space Normal code space Normal data space Normal stack space Monitor memory space
begin_address (segment number) (offset)	Hex-2	00-7F	00	Segment number does not appear if Z8002 is installed. This is the only field on the Z8002. Must be less than end_address.
	Hex-4	0000-FFFF	0000	
end_address	Hex-4	0000-FFFF	0000	Must be greater than begin_address.
entry_address	Hex-4	0000-FFFF	0000	Must be in range of begin_address to end_address -1.
file_name	file_name	any	blank	32 non-blank characters

6.11 RESOURCES SCREEN

Before an emulation can be run, a number of parameters must be set up to define the emulation starting conditions, its environment and the constraints placed on it. Without such controls, the emulator would have little advantage over a CPU for debugging purposes.

The Resources screen allows the user to enter control information of this type. A set of six commands is available on this screen. Some of these configure the Z-SCAN resources, for example, its mappable memory and breakpoint logic, whereas others affect the CPU's state and behavior during emulations.

The Resources screen is shown in Figure 6-14. Above the Menu area there are three command areas which are further divided into six subscreens, one for each command. Unlike the Memory_io screen, the Resources screen displays all its subscreens continually, whether the associated command has been activated or not. Commands are activated by entering the capital letter from their names when the cursor is in the menu area.

Once a command has been activated, the cursor automatically moves into the first variable field in the associated subscreen, which allows the contents of the fields to be updated as described in Section 6.6. Entering a RETURN or BREAK moves the cursor back to the menu area.

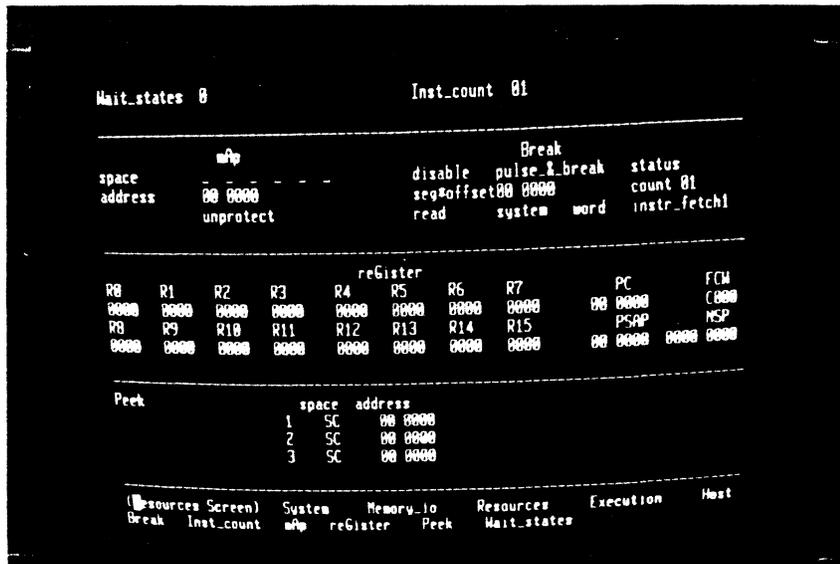


Figure 6-14. The Resources Screen

Each of the following subsections describes one of the six commands available from the Resource screen (Break, Inst_count, mAp, reGister, Peek and Wait_states).

6.11.1 The Break Command

The Z-SCAN breakpoint logic is very flexible, allowing BREAKs to be set or pulses to be output in response to a wide variety of conditions. Consequently, the monitor must maintain a large number of variables in order to control its functions. The Break command provides a comprehensive and comprehensible interface to those functions. The default parameters for the Break command fields are included in the Resources Screen, Figure 6-14.

One of the two main inputs to the Z-SCAN breakpoint logic is the address/data bus and, in the case of the Z8001 only, the segment number. The logic can be programmed to search for address matches or data matches, but not both at once. Hence, it is possible to request a break to occur when a particular location is read, but it is not possible to simultaneously request that the break take place only when a particular data pattern is read from that location. Instead, a break can be programmed when that data pattern is read from any location. On the Z8002, the only address field is the 16-bit address/data bus contents. On the Z8001, it may be the segment number, the offset, or both. The segment field is ignored when searching for data matches.

The Z-SCAN address/data comparator is 16 bits wide. This must be taken into account when setting up breaks conditioned on byte data. With byte write operations, the user can take advantage of the fact that the Z8001 duplicates the eight bits of data on the upper and lower halves of the bus during all such operations. For example, to break when an ASCII A (code 41 hex) is written, load the match field with 4141. During byte read operations, it is difficult to predict the data that will be seen on the unused part of the bus (upper byte for odd addresses, lower byte for even), so it is seldom possible to program a break conditioned on byte read data. For similar reasons, the user is cautioned against the setting of breakpoints on specific 8-bit interrupt vectors or 9-bit refresh addresses.

The other input to the breakpoint logic is the set of seven signals that constitute the Z8000's status: read/write, normal/system, byte/word and the four status code lines, ST0_3. Users can select any of 128 possible combinations, although some of these are meaningless because the CPU never generates them. An example of such a meaningless status is a normal mode I/O operation, a transaction that is specifically prohibited by the processor architecture.

The design of the breakpoint logic makes it possible to break following a non-maskable interrupt acknowledge cycle. However, because the logic that controls the change of mode from Target to Monitor traps this particular status code, an NMI acknowledge that triggers the breakpoint is prevented from reaching the target system. This is likely to prevent the target's service routine from being entered correctly, even when emulation is resumed. For this reason, breaks on NMI acknowledges are not allowed and the corresponding status code appears as "reserved".

When some characteristic of either Z-SCAN or the target system makes it undesirable to select a certain set of breakpoint conditions, it is almost always possible to program an alternative condition that ends the emulation under identical or very similar circumstances. Such alternatives take advantage either of program flow or of CPU characteristics. In the case of NMI acknowledge, the operating sequence of the CPU ensures that the new program status area in system code space is referenced soon after such a cycle. Thus, a breakpoint placed on the NMI status entry is an acceptable substitute for a break on NMI acknowledge. Similarly, it may be possible to pick out a certain instruction that will be executed if and only if a particular byte data value is read.

The outputs of the address/data and status comparators feed the trigger logic. Either of these inputs can be masked out (a "don't care" condition). The trigger logic can be fired either when both of its inputs are true (the logical AND condition represented by enable*) or when either of the inputs is true (the logical OR condition, enable+). If either of the inputs is a "don't care" when a logical OR trigger is selected, the break condition is always satisfied, and any emulation stops at once if the trigger logic is enabled (pulse_&_break selected).

The trigger can be further conditioned by a pass counter, which can count up to FF pulses (255 decimal) before providing a trigger output. Values other than 01 should not be used in conjunction with the Execution screen Trace command (Section 6.12.3) because this command loads the pass counter with the count value before each instruction is emulated. This usually prevents a multiple pass break condition from being satisfied.

Figure 6-15 is a conceptual diagram of the breakpoint logic chain. It is provided to help users visualize the action of the logic, not to illustrate the actual implementation. The instruction counter shown on the diagram is discussed in connection with the Inst_count command in the Section 6.11.2.

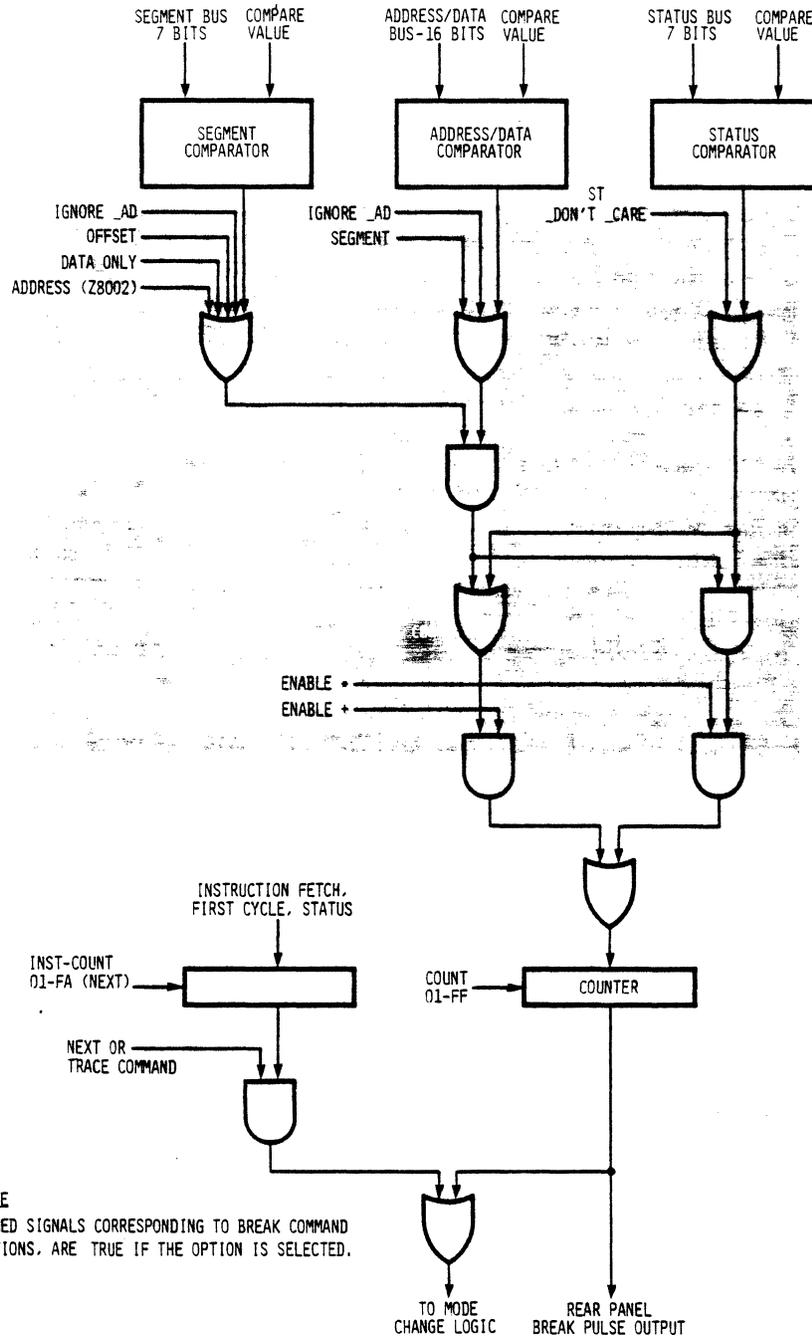


Figure 6-15. Z-SCAN Breakpoint Logic (Conceptual Diagram)

Table 6-16 lists the Break command fields and their possible values. Steps 19 and 20 of the tutorial in Section 4.5, together with their associated Figures 4-14 and 4-15, show the setting of a breakpoint that uses the enable* option. The alternative, enable+, is shown in step 55 and Figure 4-43.

Table 6-18. Break Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
master enable	mult choice	disable enable+ enable*	0 1 2	Inhibit pulse and break Enable, OR condition Enable, AND condition
effect	mult choice	pulse_&_break pulse_only	0 1	Trigger ends emulation Trigger does not stop emulation
status select	mult choice	status SI_dontcare	0 1	Status affects break Status ignored
address/data select (Z8002 installed)	mult choice	address data ignore_AD	0 1 1	Address affects break Data affects break Address/data ignored
address/data select (Z8001 installed)	mult choice	seg*offset offset segment data ignore_AD	0 1 2 3 4	Segment and offset must match for break Offset affects break Segment affects break Data affects break Address/data and segment ignored
segment number		00-7F	00	Used for address matches only with Z8001
match pattern	Hex-4	0000-FFFF	0000	See above notes
count	Hex-2	01-FF	01	Pass count field
read/write	mult choice	read write	0 1	
normal/system	mult choice	system normal	0 1	
byte/word	mult choice	word byte	0 1	

Table 6-18. Break Command Fields--Continued

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
status code	mult choice	instr_fetch1	0	Instruction fetch, 1st word
		internal_op	1	Internal operation
		mem_refresh	2	Memory refresh
		io_reference	3	Standard I/O
		special_io	4	Special I/O
		seg_trap_ack	5	Not produced by Z8002
		reserved	6	NMI acknowledge. See above
		nvi_ack	7	Non-vectorized int. ack.
		vi_ack	8	Vectorized interrupt ack.
		data_mreq	9	Data memory access
		stk_mreq	A	Stack memory access
		EPU_data_mrq	B	Extended Processing Unit
		EPU_stk_mrq	C	Memory operations
		code_sp_access	D	Code space access, Nth word
		EPA_transfer	E	CPU to EPU transfer
reserved	F	Not used by CPU		

6.11.2 The Inst_count Command

As well as the breakpoint logic described in the previous section, Z-SCAN contains an instruction counter that can be programmed to stop an emulation after a given number of instructions have been executed. The user must start the emulation with the Execution screen Next command (see Section 6.12.2) if the instruction counter is to affect the trigger condition. Figure 6-5 shows the relationship between the instruction counter and the breakpoint logic.

The instruction counter can be used in conjunction with a programmed break condition to run emulations that stop either when a specified number of instructions is executed or when a particular condition is detected on the bus. This feature further increases the flexibility of Z-SCAN.

Up to FB (251 decimal) instructions can be counted. The difference between this maximum and that of the breakpoint pass counter (FF) arises because four instructions are fetched between the time that the instruction counter is enabled and the time at which the next emulation actually begins. Table 6-19 summarizes the range of values for the field.

Table 6-19. Inst_count Command Field

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
Inst_count	Hex-2	01-FB	01	

6.11.3 The mAp Command

Z-SCAN contains an 8K byte (8192 decimal bytes) block of mappable memory. This feature facilitates the development and debugging of target hardware, because the mappable memory can be used as a substitute for memory in the target system. This feature is generally used in one of two situations:

- **Target memory not implemented.** Often, when a prototype is made, it does not include as much memory as is provided by the final design. Alternatively, it may be found that the preliminary memory design does not function correctly. In either of these cases, Z-SCAN mappable memory can substitute for the missing or faulty memory, allowing software debugging to proceed even before the target hardware is fully functional. The memory can also be used for the loading of test programs that exercise the target hardware, thus speeding hardware development.
- **Target memory is read-only.** Many applications, particularly those addressed by small, dedicated systems, require software that is totally ROM (Read-Only Memory) based. This non volatile method of program storage allows systems to operate without requiring backup storage devices (floppy disks, for example) to save and protect the software when power is removed from the equipment. The production advantages of ROM-based software (also known as firmware) are balanced by a development disadvantage: it is difficult to make changes in firmware in order to debug applications programs. The non volatile nature of the memory means that it must be removed from the prototype in order to modify its contents--if they can be modified at all. Z-SCAN circumvents such problems by allowing the mappable memory to substitute for target system ROM. Because the memory can be written as well as read, the user can easily make changes to its contents as debugging proceeds. An additional feature protects the mappable memory against write accesses, permitting it to simulate read-only memory.

The mAp command allows the user to define the types of memory accesses to which the mappable memory responds. The address space (or spaces) in which the memory appears must be selected, then the ranges of addresses within those spaces. Finally, write protection can be enabled or disabled, as required.

Mappable memory can appear in any combination of the Z8000's six memory address spaces (system code, system data, ..., normal stack) and can be mapped as a single block onto any 8K byte boundary within those spaces. Such boundaries are multiples of 2000 hex. It is not possible for the memory to appear at different addresses in different spaces, nor is it possible for it to be write-enabled in one space and write-protected in another. When the memory is mapped at a particular address in a particular block, it responds to all CPU accesses in the range between the base address and base address + 1FFF hex. Memory in the target may respond in the same address range. Even so, CPU read accesses read data from the mappable memory, not from the target. CPU writes are to both the mappable memory and the target memory.

The user may sometimes want to develop ROM-based applications that require more memory than is provided by the Z-SCAN mapping feature. The recommended approach in such cases is to develop and debug the software as a number of separate pieces, consigning each piece to ROM when it is considered fully functional. This allows the amount of code in the mappable memory to be kept

within the allowed limits. The Z8000 support software available on many host systems permits newly written routines to be linked to existing procedures in ROM.

Table 6-20 details the mAp command's parameter fields. The tutorials in Section 4 include examples of operations using the mAp command.

Table 6-20. mAp Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
system code select	mult choice	-	0	Mappable memory does not respond to system code accesses.
		SC	1	Mappable memory responds to system code accesses.
system data select	mult choice	\overline{SD}	0	Similar to first field
			1	
system stack select	mult choice	\overline{SS}	0	Similar to first field
			1	
normal code select	mult choice	\overline{NC}	0	Similar to first field
			1	
normal data select	mult choice	\overline{ND}	0	Similar to first field
			1	
normal stack select	mult choice	\overline{NS}	0	Similar to first field
			1	
segment	Hex-2	00-7F	00	Segment number does not appear if Z8002 is installed.
address	mult choice	0000	0	This is NOT a hex field , because the index required by the choice table.
		2000	1	
		C000	6	
		E000	7	
protection	mult choice	unprotect	0	Mappable memory can be written.
		protect	1	Mappable memory cannot be written, but emulation continues if an attempt is made to do so.
		break	2	Mappable memory cannot be written, and emulation terminates if an attempt is made to do so.

6.11.4 The reGister Command

By default, Z-SCAN saves the contents of the CPU registers at the end of each emulation and restores the same values at the start of the next emulation. The reGister command allows the user to alter register contents between emulations so that the next emulation starts with modified values. For example, the Program Counter's contents can be changed so that the next emulation does not start where the previous one finished, or in order to set up the entry point of a newly loaded file.

Changes made to register contents on the Resources screen are reflected in the upper rows of register values on the Execution screen (see Section 6.12). Table 6-21, parts 1 and 2, details the reGister command's variable fields. The tutorials in Section 4 demonstrate the use of the reGister command.

Some of the control registers are used only on the segmented Z8001. They do not appear when a Z8002 is installed in Z-SCAN. These registers are the Program Counter and new program status area segment numbers and normal mode register 14 (NSPSEG).

Table 6-21. reGister Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/Default	Notes
R0	Hex-4	0000-FFFF	0000	Word register zero. High byte is byte register R0H, low byte is R0L. Can be used as more significant part of long word reg. R0R or as most significant part of quad reg. R0Q.
R1	Hex-4	0000-FFFF	0000	Also R0H, R0L, R0R, R0Q
R2	Hex-4	0000-FFFF	0000	See notes above
R3	Hex-4	0000-FFFF	0000	See notes above
R4	Hex-4	0000-FFFF	0000	See notes above
R5	Hex-4	0000-FFFF	0000	See notes above
R6	Hex-4	0000-FFFF	0000	See notes above
R7	Hex-4	0000-FFFF	0000	See notes above
PC Seg. no.	Hex-2	00-FF	00	Segment number for Program Counter. This does not appear if Z8002 CPU installed. MSB may be set as a result of program execution, but cannot be set by user.

Table 6-21. reGister Command Fields
(continued)

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
PC (offset for Z8001)	Hex-4	0000-FFFF	0000	Program Counter. Action of CPU undefined if contents are odd.
FCW	Hex-4	0000-FFFF	C000	Flag and Control Word. See Z8000 Technical Manual to determine legal values. Default is segmented system mode with interrupts disabled. The Z8002 ignores the fact that the segmentation flag is set.
R8	Hex-4	0000-FFFF	0000	Also RR8, RQ8
R9	Hex-4	0000-FFFF	0000	See notes above
R10	Hex-4	0000-FFFF	0000	See notes above
R11	Hex-4	0000-FFFF	0000	See notes above
R12	Hex-4	0000-FFFF	0000	See notes above
R13	Hex-4	0000-FFFF	0000	See notes above
R14	Hex-4	0000-FFFF	0000	See notes above. Also segment number of system stack pointer for Z8001.
R15	Hex-4	0000-FFFF	0000	System mode Stack Pointer, must contain an even value if used for this function. Also less significant half of RR14 in system mode only
PSAP Segment no.	Hex-2	00-7F	0000	Program Status Area Pointer segment number. Not displayed if Z8002 is installed.
PSAP (offset for Z8001)	Hex-4	0000-FFFF	0000	Program Status Area Pointer. Low byte is ignored by CPU.
NSP Segment Segment no.	Hex-4	0000-FFFF	0000	Normal mode Stack Pointer Segment no. (R14). Not dis- played if Z8002 is installed.
NSP offset	Hex-4	0000-FFFF	0000	Normal mode stack pointer (offset on Z8001) R15.

6.11.5 The Peek Command

Z-SCAN automatically captures and displays the contents of the CPU registers at the end of an emulation. This information appears on the Execution screen (Section 6.12) and can be updated with the reGister command (Section 6.11.4). Often, the user wants to know the contents of selected areas of memory at the end of each emulation as well as register contents. In order to satisfy this request, Z-SCAN provides three windows, each four words in length, into target memory and displays the contents of these windows alongside the register information. Note that this usage of the word window is different from that used in connection with the window area on the Memory_io screen.

The Peek command allows the user to select the memory space and start address for each of the three windows. Table 6-22 lists its variable fields. An example of its use is given in step 66 of the tutorial, Section 4.6.

Table 6-22. Peek Command Fields

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
space #1	mult choice	SC SD SS NC ND NS	0 1 2 3 4 5	System code space System data space System stack space Normal code space Normal data space Normal stack space
address #1 (segment number)	Hex-2	00-7F	00	Window segment number. Segment number does not appear if Z8002 is installed. This is the only address field on the Z8002.
(offset)	Hex-4	0000-FFFF	0000	
space #2	mult choice	--same as space #1--		
address #2 (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	See notes for address #1.
space #3	mult choice	--same as space #1--		
address #3 (segment number) (offset)	Hex-2 Hex-4	00-7F 0000-FFFF	00 0000	See notes for address #1

6.11.6 The Wait_states Command

Not all memory components meet the maximum access time requirement of 350 ns required by the Z8000 to run at full speed with a 4 MHz clock frequency. A common example of such a memory component is the EPROM (Erasable Programmable Read Only Memory), which has a typical access time of 450 ns. If the Z8000 is used with slow memory or with slow I/O, its access time requirement must be increased. This function is handled by the WAIT- input to the CPU, which must be driven by an external wait state generator in systems that cannot meet full speed access time requirements.

To eliminate the need for each user to implement a wait state generator at an early stage in development, Z-SCAN provides its own generator. This can insert between zero and eight wait states in each memory transaction. It also affects I/O and interrupt acknowledge cycles, as detailed in Table 6-23. The differences between the three types of transactions arise because the CPU samples the WAIT- signal at a different time, relative to Address Strobe, in each type of transaction. Note that refresh operations are not affected because the CPU does not sample the WAIT- line during these cycles. Table 6-24 summarizes the choice of values available in the single variable field controlled by this command.

Table 6-23. Effect of Wait States

Wait_states Field Value	Memory Reference		I/O Reference		Interrupt Acknowledge	
	Cycles Added	Total Length	Cycles Added	Total Length	Cycles Added	Total Length
0	0	3	0	4	0	10
1	1	4	0	4	0	10
2	2	5	1	5	0	10
3	3	6	2	6	0	10
4	4	7	3	7	1	11
5	5	8	4	8	2	12
6	6	9	5	9	3	13
7	7	10	6	10	4	14
8	8	11	7	11	5	15

Table 6-24. Wait_states Command Field

Field name	Type	Values (M-C) Range (Hex)	Index/ Default	Notes
Wait_states	mult choice	0	0	No waits
		1	1	
		2	2	
		3	3	
		4	4	
		5	5	
		6	6	
		7	7	
		8	8	

6.12 THE EXECUTION SCREEN

The Execution screen differs from those discussed previously in that it has no variable fields. Instead, it performs the following functions:

- Display of Z-SCAN parameters pertinent to emulation--for example, the setting of the breakpoint logic.
- Display of information on the status of the processor and selected target memory areas before and after each emulation.
- Display of a message that indicates the reason for termination of each emulation.
- Provision of commands to start emulations (Go and Next).
- Access to the Trace screen for detailed program analysis.

Figure 6-16 shows the screen as it appears between emulations. It is shown in this state rather than in its default state to better illustrate the functions of the various fields. Note that the screen is divided into five command areas (although they are not used for the entry of command parameters) and a menu area.

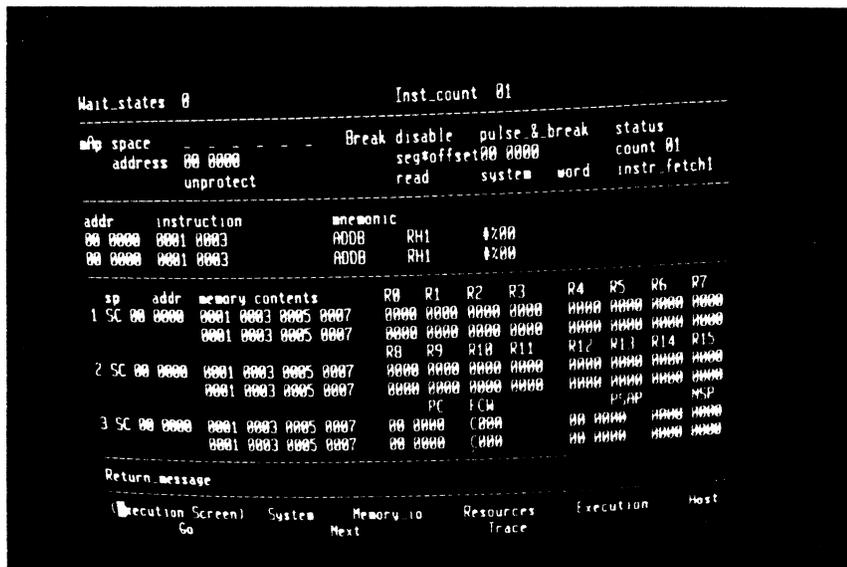


Figure 6-16. The Execution Screen

The two top command areas contain Z-SCAN status information that describes the state of the Wait_states, Inst_count, map and Break variable fields. These displays are for reference only, since the fields can be modified only by Resources screen commands. For further details, see Sections 6.11.1 through 6.11.3 and 6.11.6.

Moving toward the bottom of the screen, the next command area contains two lines of data that correspond to the Program Counter contents before and after the last emulation and to the instructions at those locations. The current information, captured after the emulation stopped, appears as the upper row of data, and the status from before the emulation is displayed on the lower line. The display lines are generated by the disassembler described in Section 6.10.2. Disassembly is always nonsegmented if a Z8002 is installed in Z-SCAN. For the Z8001, the segmentation bit (bit 15) of the FCW controls disassembly segmentation mode.

Below the instruction information is a large command area that contains information about register and memory contents. The memory locations displayed to the left of this area are selected by the Resources screen Peek command (see Section 6.11.5). There are two rows of data for each location, again corresponding to the status before (lower row) and after (upper row) the last emulation.

To the right of the memory trace information is a display of register contents. As with the instruction and trace fields, the two rows of data represent the status before and after the last emulation. As with the Resources screen reGister command, three control registers do not appear if a Z8002 is installed in Z-SCAN. Refer to Table 6-21 for details. It is possible for bit seven of the Program Counter segment number to be set by program execution on the Z8001, for example, when a long offset direct address mode call instruction is executed. This has no consequence: a segment number of 80 is equivalent to 00, 81 to 01 and so on.

Register contents and traced addresses can be changed using the Resources screen reGister and Peek commands, respectively (see Sections 6.11.4 and 6.11.5). Any such change is reflected in the top entry for the corresponding field on the Execution screen. In other words, it is the status captured after the last emulation that is modified. It is this status that is used when the next emulation begins.

The bottom Command area on the Execution screen is headed Return message. It is here that the monitor writes a short message stating where (PC contents) and why (cause of transition from Target to Monitor mode) the previous emulation terminated. This field is blank when the Execution screen is first displayed unless a segment trap is outstanding on the Z8001. Section 5.4.6 discusses this situation. Table 6-25 lists the four possible causes of break conditions. One or more of these messages appears each time an emulation terminates.

Table 6-25. Termination Messages

Message	Notes
TRIGGER BREAK	The condition set up by the Break command was satisfied.
MANUAL BREAK	The user generated a monitor NMI with the Z-SCAN front panel switches.
WRITE PROTECT BREAK	The executing program attempted to write into the Z-SCAN mappable memory when a write-protect break was enabled.
STEP BREAK	The number of instructions defined by the Inst_count field was executed during an emulation started with the Next command.

The menu area of the Execution screen lists two commands that are specific to the screen: Go and Next. These are described in Sections 6.12.1 and 6.12.2. There is a third command, Trace, which generates its own screen. The Trace command is described in Section 6.12.3.

6.12.1 The Go Command

This command starts an emulation at the address held in the PC register. The emulation continues until one of three conditions occur:

- The breakpoint condition selected with the Break command is met.
- The user generates a Monitor NMI with the Z-SCAN front panel switches.
- The program running under emulation attempts to write into the Z-SCAN mappable memory when a break is set on write protect violation.

If any of the above conditions is detected, the emulation either stops at once or executes a maximum of one more instruction in Target mode before Z-SCAN switches back to Monitor mode. This implies that the CPU must be executing instructions so that the transition between modes can occur. This topic is discussed in Section 5.4.8. The tutorials in Section 4 include examples of the Go command.

6.12.2 The Next Command

The Next command allows the user to start an emulation that executes a given number of instructions before it is automatically terminated. The number of instructions is determined by the contents of the Inst count field, which can be modified on the Resources screen (see Section 6.11.2). This command is useful for stepping through programs one or more instructions at a time.

It is possible for an emulation started by the Next command to terminate before the instruction count is exhausted if an alternative break condition arises. The Next command can terminate when:

- The programmed instruction count is exhausted.
- The breakpoint condition selected with the Break command is met.
- The user generates a monitor NMI with the Z-SCAN front panel switches.
- The program running under emulation attempts to write into the Z-SCAN mappable memory when a break has been set on write-protect violation

If any of the above conditions is detected, the emulation either stops at once or executes a maximum of one more instruction in Target mode before Z-SCAN switches back to Monitor mode. This implies that the CPU must be executing instructions so that the transition between modes can occur. This topic is discussed in Section 5.4.8 (Termination of Emulation). The tutorials in Section 4 include examples of the use of the Next command.

The user should be aware of the effect of stepping through the Z8002's block instructions, for example LDIR or OTDRB. When Inst_count is set to one, each step results in a single operation on one word or byte, and the Program Counter value is not changed by the operation unless the Block Count register named in the instruction is decremented to zero. If, on the other hand, Inst_count has a value greater than one, the block instruction executes in

entity and counts as just one instruction as far as the Z-SCAN instruction counting logic is concerned. This is a consequence of the interaction between the interruptable block instructions and Z-SCAN's use of non-maskable interrupts to terminate emulation (see Section 5.4.6). The Z8000 CPU Technical Manual provides more information about the operation of block instructions.

6.12.3 The Trace Command

The Trace command provides a more detailed picture of program execution than either the Go or Next command because it disassembles and displays each instruction before it is executed. Disassembly incurs a time penalty, so unlike Go or Next, Trace cannot run emulations in real time. The monitor traces the user program by forcing a non-maskable interrupt after each instruction. This prevents acceptance of any interrupts or traps generated by the target hardware. Section 5.4.6 discusses this behavior in detail.

Figure 6-17 shows the Trace screen in its default state. The contents of all memory data fields in the figure is arbitrary and has no significance in the following discussion.

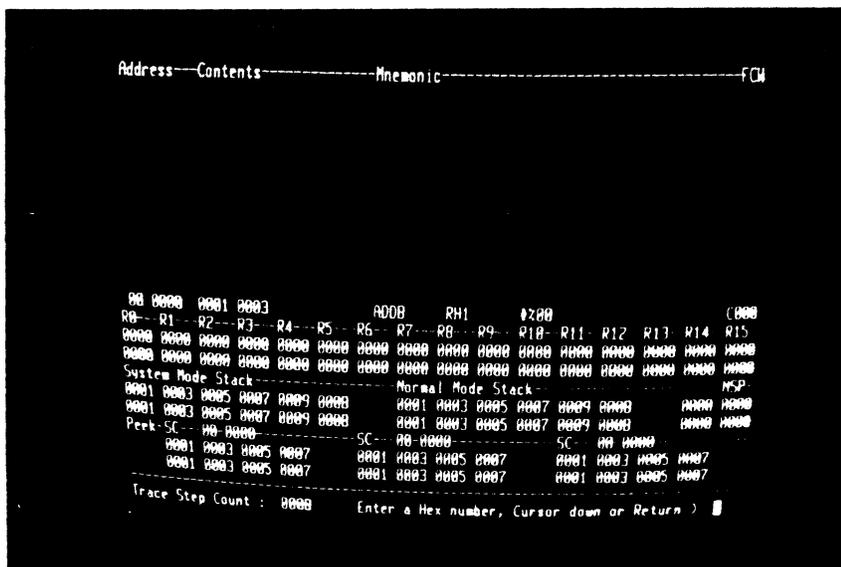


Figure 6-17. Default Trace Display

In its default state, the screen displays a heading followed by ten blank lines. Below these, a single disassembled instruction appears in the format described in Section 6.10.2, followed by the FCW value. Disassembly mode is always nonsegmented if a Z8002 is installed in Z-SCAN. The segmentation bit (bit 15) of the FCW controls the mode on the Z8001. The instruction will be executed when emulation starts.

Below the instruction, two lines of general-purpose register contents are shown. The values in the top line are loaded before the next emulation starts; those in the lower line were used when the last emulation started. Space limitations prevent the display of the normal mode stack pointer (NSP) in this area. It appears elsewhere on the screen. The program status area pointer (PSAP) is not shown on the Trace screen.

Two stack area displays appear below the register contents. Again there are two lines of data, corresponding to the current and previous stack states. The left hand area displays the 12 (decimal) bytes at the top of the system stack, which starts at the address in RR14 (Z8001 segmented mode) or R15 (Z8001 nonsegmented mode or Z8002). Thus, the address of the first byte displayed varies as data is added to or removed from the system stack.

To the right, the normal stack is displayed in a similar format. The normal stack pointer register contents appear at the far right. The segment number register (NSPSEG) is not displayed if a Z8002 is installed in Z-SCAN.

The final data area displays the contents of the memory areas defined by the Resources screen Peek command (Section 6.11.5). Current and previous contents appear on the upper and lower lines respectively.

The field at the left of the bottom line defines a step count; that is the number of instructions to be executed when emulation starts. The default value is 000B (11 decimal), sufficient to fill the upper half of the screen with disassembled instructions. The value can be changed as described below. A prompt filling the remainder of the line invites the user to enter hex digits, cursor down or RETURN. The effect of these keys are as follows:

- Enter cursor down to execute the number of instructions shown in the step count field.
- Enter hex digits (0-9, A-F) to alter the value in the step count field. Execution begins after four digits have been entered. Use cursor left or SHIFT < to backspace over and delete incorrect entries.
- Enter RETURN to move to the Execution screen.

When tracing starts, the bottommost instruction on the screen is redisplayed. An asterisk in column one shows that it is the first instruction executed in the series of traced instructions.

Tracing can be stopped by four events:

- The number of instructions defined by the step count has been traced. This is the normal termination. The prompt is redisplayed on the bottom screen line.
- The condition set up by the Resources screen Break command (Section 6.11.1) is satisfied. Tracing terminates at once and the message TRIGGER BREAK replaces the prompt.

- o A traced instruction attempts to write to write protected mappable memory. Tracing terminates at once and the message WRITE PROTECT BREAK replaces the prompt.
- o The user enters the terminal keyboard BREAK key. Tracing terminates at once and the message MANUAL BREAK replaces the prompt.

When tracing terminates, the register, stack and peek memory contents fields are updated. All instructions shown in the top half of the screen have been executed except the bottommost. The next emulation starts by executing this instruction. The FCW values at the right of the screen show the state of the CPU **before** the execution of the instruction to the left. Figure 6-18 shows the Trace screen after execution.

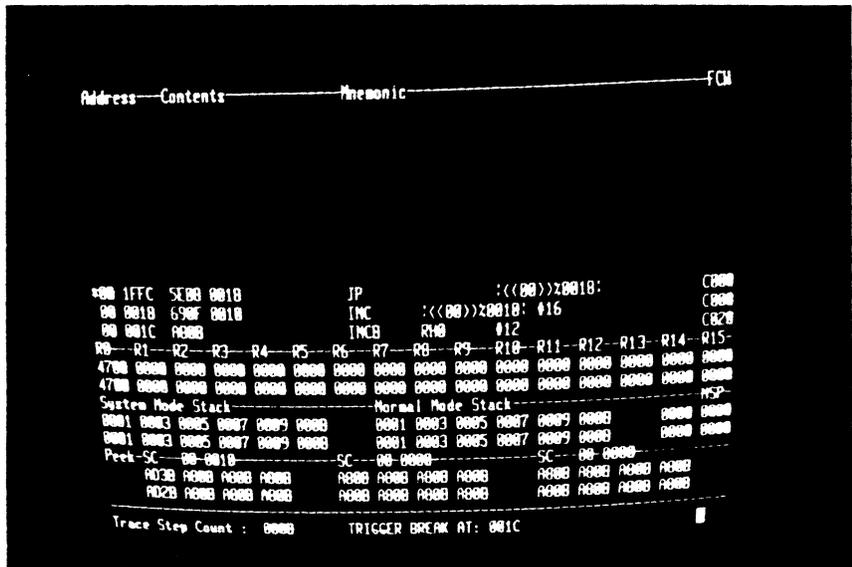


Figure 6-18. Trace Screen after Execution

Three termination conditions described above replace the prompt on the bottom screen line with an informative message. The user input required is not changed: hex digits, cursor down and RETURN are still valid keys.

As discussed in Section 5.4.7, the Z-SCAN monitor may violate protection attributes set up in the memory manager of a Z8001-based target system. The user is warned of this condition by the appearance of a warning message at the bottom right of the screen. The message overwrites the previous contents of the area. Segment traps cannot be serviced during tracing for the reasons outlined at the beginning of this section. Other screens and commands must be used to correct the condition.

6.13 The Host Screen

The characteristics of the host screen are defined almost entirely by the host system rather than by Z-SCAN. The initial screen, which is displayed in response to the Host command, is shown in Figure 6-19. It is clear, except for the message "Host" at the top left. When the contents of the host baud rate and terminal baud rate fields set up on the System screen (Section 6.9) differ, a supplementary message, "Set baud rate of terminal to (speed), then enter RETURN and ">", appears. The speed is taken from the host baud rate field. The monitor waits until a RETURN character is received at the host baud rate before enabling communication between the terminal and the host system. Consult the terminal documentation for details of its baud rate setting procedure.

When the baud rate is correct, Transparent mode is entered. This mode is terminated when the user enters BREAK. If the System screen host and terminal baud rates are the same, the System screen is displayed at once. If they differ, the procedure described in the previous panel is repeated, telling the user to set the baud rate of the terminal to that required by the monitor. The System screen is displayed after a RETURN has been entered at the correct baud rate.



Figure 6-19. The Host Screen

SECTION SEVEN

INTERFACE TO NON-ZILOG HOSTS

7.1 INTRODUCTION

This section describes the overall communications protocol of the Z-SCAN monitor so that custom host software can be designed to interact successfully with the Load/seNd utility built into Z-SCAN.

Load/send communication between a Zilog (or other) host system and the Z-SCAN monitor is accomplished by exchanging messages containing printable ASCII characters. Message types are:

- o Single-character, data-block acknowledgement
- o Error text
- o Data block

All messages exchanged during a Load or seNd command are text lines, each ending in RETURN (carriage return). Memory and other data are converted into hexadecimal numerals for transmission, and the resultant message is readable left-to-right, high-order digit first, as it is transmitted over the RS-232 link.

The following illustrates a simplified form of Z-SCAN's Load/seNd transmission protocol:

Mode	Host Message	Message Path	Z-SCAN Message
either mode	-- acknowledge	<---- ---->	start command --
Load	data --	----> <----	-- acknowledge
seNd	-- acknowledge	<---- ---->	data --

In this illustration, data/acknowledge message pairs are continually sent until the desired amount of data is transmitted successfully, or a fatal error or user abort occurs.

7.2 DATA ACKNOWLEDGEMENT MESSAGES

Of the three types of Load/seNd messages, data-block acknowledgements are the simplest. A data-block acknowledgement must be sent each time a data message is received. It consists of exactly one of three characters--0, 7, or 9--followed by a RETURN. The characters have the following meaning:

- 0 Data block received with valid checksums.
- 7 Transmission error, please resend last block
- 9 Bad load address or error message received, abort process.

Thus, the sender (either the host system or Z-SCAN) simply places a data message on the RS-232 link and after one echoed line, receives one of these three characters. If the host does not echo the input characters, it must at least precede any acknowledgement with RETURN or RETURN and linefeed. This happens if, for example, the host is half duplex.

If a 7 is persistently returned to the host system because of checksum errors, the sender must decide when to stop trying to send a message. In the Z-SCAN seNd command, this occurs after a total of 10 tries. A custom host Load command can use some other value, if desired. In any case, once the sender stops re-sending data, it notifies the receiver that it is giving up the whole communication effort by sending one of the error messages (// RETURN) described below.

Z-SCAN Load/seNd acknowledgement logic allows for don't-care regions in acknowledgement lines, such as:

```
xxxx 0 xxxx RETURN xxxx ...
```

Here, Z-SCAN's seNd command examines all characters returning from the host after a data message has been sent. It throws out all data until a 0, 7 or 9 is found. The data preceding the acknowledgement character must not contain 0, 7 or 9. It also throws away the rest of the line. Z-SCAN does not currently use these regions, so the host receives 0, 7 or 9 and RETURN in unadulterated form, even if it chooses to send "dirty" acknowledgements.

7.3 DATA TRANSMISSION MESSAGES

All memory or other numerical data sent over the host/Z-SCAN link is formatted as ASCII characters that represent each data byte as two hexadecimal digits. Error-message text can also be sent. Since each transmission is terminated by a RETURN, it appears to the host as if the source were simply a standard ASCII terminal. This formatting allows Z-SCAN to be connected to a standard terminal port on the host, which, in turn, makes possible its transparent (user-to-host) mode of operation.

Data and error messages begin with a slash (/) to distinguish them from acknowledgements. The basic format for a message is:

```
/ printable_ASCII_characters RETURN
```

7.3.1 Error Messages

To distinguish error messages from data blocks, an error message has the form:

```
// error_text RETURN
```

where the degenerate case, //, is used by the Z-SCAN seNd command to respond to the last 7 in a failed sequence of sending retries (see Section 7.2). Z-SCAN thus signals the host to abort the entire communication process. When sent by the host, error messages cause the Z-SCAN Load and seNd commands to abort, but any error text is first copied to the user's terminal to indicate that an error has occurred.

The error-message facility thus allows the sender to force the receiver to abort, while optionally providing an informative message of up to 40 characters. Error messages can only be sent in place of a data message--that is, only when a data message might otherwise be sent. The appropriate acknowledgement of any error message is 9. Z-SCAN supplies but does not expect such closure, since all error messages from Z-SCAN correspond to abort conditions.

7.3.2 Data Messages

A data message begins with /, ends with RETURN, and contains printable characters that are translated from hexadecimal numerals into memory bytes, checksum bytes, or address words. The sender's message encoding proceeds byte by byte, nibble-by-nibble, building a string of hexadecimal text digits 0 through F. The receiver must then reverse the translation to obtain binary byte values. The basic format of a data message is:

```

      /  address byte_count checksum1 data      checksum2      RETURN
char:1  2 3 4 5   6 7           8 9   10... 2xbyte_count+10  2xbyte_count+11

```

where the items sent are defined as:

- address** 4-digit hexadecimal (0-F) representation of a 16-bit destination address for data, highest-order digit first. If the byte count is zero, it corresponds to a program file's entry address and must be even.
- byte_count** 2-digit hexadecimal, 8-bit count of the physical memory bytes to be constructed from data numerals. 00 indicates the final record in the transmission and that the program's entry address was sent in this message. For the Z-SCAN seNd command, the maximum count is 30 (decimal). For Load, the byte_count is limited by the Z-SCAN input buffer size.
- checksum1** 2-digit hexadecimal, 8-bit sum of address and byte-count values, nibble-by-nibble, done prior to conversion to ASCII 0 to F. Data nibbles are simply added successively into an 8-bit register to produce the checksum, which is then translated into the two numerals sent.
- data** 2-digit hexadecimal, 8-bit memory bytes, starting with numerals for the byte at the address sent--30 bytes (60 numerals) maximum length for seNd.
- checksum2** 2-digit hexadecimal, 8-bit sum of data-byte nibbles with the overflow ignored. The ability of this checksum to trap errors decreases once the sum of all data nibbles exceeds 255, which also depends on the byte_count.

During reception of data messages, all ASCII control characters (codes below 32 decimal) are ignored except for RETURN. Furthermore, all characters following RETURN up to the beginning of the next message (/) are ignored. In combination with the fact that only sufficient numerals are used to exhaust the byte count and checksum2, identification of don't-care regions within a stream of data messages is possible:

```
xxxx / address... data checksum2 xxxx RETURN xxxx /...
```

The xxxx regions could conceivably be used to transmit any information that does not conflict with the basic format used. As with the acknowledgement message, Z-SCAN does not use this feature, though a custom host program can do so, with the limitation that during Load operations, any host should not send more message characters than can fit in Z-SCAN's input buffer (currently 128).

Note that the only characters that have meaning in data messages are /, RETURN, 0 to 9 and A to F, and the overall transmission format corresponds to one originally developed by Tektronix. Each data message must be acknowledged before the next can be sent.

7.4 COMMAND TRANSMISSION

Both the Load and seNd commands initiated in Z-SCAN by the user at the terminal rely on the host to run the appropriate program (LOAD or SEND) to complete the communications link and to transfer the desired data. To begin the process, Z-SCAN sends a command line to the host. This line includes a file name taken from the corresponding field on the Load or seNd command subscreen. The seNd command line also includes the start address, end address and entry point for the file, encoded as four-digit hex numbers. The host program may choose to ignore this information since it is also contained in the data records sent to the host by Z-SCAN. Thus, the host operating system must be able to receive either of two commands from Z-SCAN:

```
B;LOAD filename RETURN
```

or:

```
B;SEND filename start_address end_address entry_point RETURN
```

The host operating system should then run the appropriate program, passing the parameters, which may be followed by trailing blanks, to the program for parsing.

The "B;" prefix instructs the Zilog RIO operating system to cease verbose mode re-echoing of commands after RETURN. If no such feature exists in the host being used, these two characters must be ignored. In any case, Z-SCAN ignores echoing of the command line and the next line too if it begins with B; and awaits activation of the corresponding program.

The user can enter BREAK to abort command transmission. If this is not done, Z-SCAN does one of three things once the command line has been sent to the host and any echo(s) have been ignored:

host failure 0, 7, or 9 RETURN not received: pass what was received to user's terminal as host error diagnostic and abort.

file unopened 7 or 9 RETURN received: desired file not found or can't be opened: display error message and abort.

proceed 0 received: LOAD/SEND running and ready to send or receive data.

Note that in host failure, the host's response is passed directly to the user's terminal regardless of its structure. The transmission or reception of data by the host begins as soon as the host LOAD/SEND program issues its initial 0 response.

Once Z-SCAN has ignored command echoing, any text beginning with B is skipped until the next RETURN:

B;SEND...RETURN... B xxxx RETURN xxxx 0 xxxx RETURN

This feature is not used by Zilog's host software, though it may be implemented by a custom host.

7.5 USER ABORT

The Z-SCAN software monitors terminal activity and break keystrokes during Load/seNd activities. In this way it can abort data transfers entirely. Whenever an abort occurs after successful command transmission, the host is sent either 9 or //, depending on the context (Z-SCAN receiving or sending, respectively), and is expected to abort the LOAD/SEND program immediately. The Z-SCAN never waits for acknowledgement of the degenerate error message (//) and terminates seNd activity at once. BREAK aborts Z-SCAN Load/seNd regardless of the host program's current state, functional or not. During Load activity, the 9 is sent just after the last acknowledge, allowing the host to send an extra data block that is acknowledged by the waiting 9 but is never received by the already aborted Z-SCAN.

7.6 DETAILED TRANSMISSION PROTOCOL

The following sections describe the assumptions of the sequential details of host/Z-SCAN Load/seNd transactions and data transmission currently made by the Z-SCAN monitor.

Load/seNd communication is always initiated by Z-SCAN because it responds to commands from the user terminal. Whether Z-SCAN issues a Load or seNd command, the initial sequence of messages is the same:

Z-SCAN Sends	Host Sends
B; command RETURN	normal_echo RETURN line feed (of command)
	verbose_echo RETURN line feed (possible)
	0 RETURN (file found and ready)

where the command sent by Z-SCAN always begins with either B;LOAD or B;SEND, and where the host operating system (RIO on Zilog systems) determines the nature and existence of command echoing. Z-SCAN assumes that there is one echo line, and that if B starts the second line received, the host was in verbose mode and acknowledgement will be found in the next line (0...). Thus, the first one or two lines received from the host are completely ignored by Z-SCAN. For custom hosts or host programs, this means that if no echoing occurs (for example, if normal, full-duplex echoing is turned off), all messages sent to Z-SCAN must be preceded by RETURN, since Z-SCAN assumes that each message sent to the host is echoed. The acknowledgement above would then be RETURN 0 RETURN.

Just before sending the host command, Z-SCAN also checks to see if the user has entered BREAK. If so, Z-SCAN sends 9 RETURN to the host, as it does during data transmission, but does not send the command. Typically, the host operating system does not understand this meaningless message and, in turn, generates a meaningless error message.

Note that every message line sent to the host by Z-SCAN is echoed by the host if echoing is on. For simplicity, this is not shown in subsequent examples except for command transmission. Z-SCAN automatically skips one received line for each line it sends.

It is, however, possible that communication is not successfully established. In fact, once Z-SCAN has sent the Load or seNd command line to the host and received and ignored normal and verbose echoes, three possibilities exist:

1. The command contains an error that prevents the operating system from running the load or send program. In this case, a 0 is not transmitted, but any response or error message the operating system chooses is sent. Whatever is returned is passed directly to the user's terminal to indicate the failure of the command.
2. The command is correct, and the load or send program runs but cannot find or open the desired file. In this case, either a 7 or a 9 (no preference) is returned by the host program to Z-SCAN, generating an error message on the user's terminal.
3. The command is correct, the LOAD/SEND program runs, and the desired file is opened. In this case, a 0 is returned to signify that data transmission will (Load), or may begin (seNd).

Samples of successful command transmission appear in the data transmission examples in subsequent sections. Listed here are some failure possibilities:

Z-SCAN Sends	Host Sends
1. B;LOAD X RETURN	CAN'T FIND PROGRAM: LOAD RETURN line feed
2. B;LOAD X RETURN	7 RETURN (LOAD can't open X)
3. 9 RETURN	ILLEGAL FILENAME: 9 RETURN line feed (user entered BREAK)

In the first case, Z-SCAN copies the host message to the user's terminal, while in the second case, Z-SCAN generates its file-error message. In all cases, Z-SCAN aborts the Load/seNd activity, and in the second case, the host program does the same.

7.6.1 Load Protocol

After command transmission to the host, the message-exchange protocol for down-loading a program into Z-SCAN is:

Host Message	Path	Z-SCAN Message	Notes
data message	-->	--	Skip until /, then wait for RETURN. Check first message character for error flag (/), validate checksums, and load data into memory.
--	<--	0	Acknowledge valid data so next block can be sent. Done if final block. Check for BREAK by user.
--	<--	7	Request re-sending of block due to checksum error. Check for BREAK by user.
--	<--	9	Acknowledge error message or indicate that BREAK was typed, and transmission must be aborted. Done.

Possible message sequences between the Z-SCAN and the host might be:

Z-SCAN Sends	Host Sends
B;LOAD X RETURN	B;LOAD X RETURN line feed (normal echo)
0 RETURN	0 RETURN (LOAD acknowledgement)
7 RETURN	/ data1 RETURN
0 RETURN	/ data2 RETURN (data re-sent)
.	/ data3 RETURN
.	.
.	.
0 RETURN	/ dataend RETURN (0-count data message with entry point address)

Here, both Z-SCAN and the host system reach normal completion after the final acknowledge.

An error transmission might be:

Z-SCAN Sends	Host Sends
B;LOAD X RETURN	B;LOAD X RETURN line feed (from host OS) O RETURN (from LOAD program)
7 RETURN	/ data1 RETURN (checksum bad)
.	.
.	.
7 RETURN	// error RETURN (retries exhausted)
9 RETURN	

Here, both Z-SCAN and the host program abort the transmission attempt after error-message acknowledgement.

An example of a user-induced abort during data transmission might be:

Z-SCAN Sends	Host Sends
B;LOAD X RETURN	B;LOAD X RETURN line feed
	O RETURN
	/ data1 RETURN (user enters BREAK)
O RETURN 9 RETURN	(host sees O)
	/ data2 RETURN (sends next data)
	(then sees 9)

The BREAK is entered during data1 transmission, but Z-SCAN acknowledges the data anyway and then immediately sends its abort signal. The host, operating line by line on Z-SCAN messages, sends data2, sees the abort acknowledgement waiting in its input buffer, and then terminates. Z-SCAN terminated earlier, upon sending the 9.

7.6.2 Send Protocol

In the seNd protocol, as in Load, command transmission takes place first. Subsequent protocol elements are:

Host Message	Path	Z-SCAN Message	Notes
--	<--	data message	See Section 7.7, Message Syntax
0 RETURN	-->	--	Acknowledge valid data
7 RETURN	-->	--	Request to re-send data
		:	
--	<--	//	Error - re-send count exhausted
9 RETURN	-->	--	Acknowledge error and abort

A message sequence might look like:

Z-SCAN Sends	Host Sends
B;SEND W start end entry RETURN	B;SEND W RETURN line feed
/ data1 RETURN	0 RETURN
/ data2 RETURN	0 RETURN
.	.
.	.
.	.
/ dataend RETURN	0 RETURN

As a result of this sequence, the Z-SCAN command and the host program simply terminate.

An error transmission might be:

Z-SCAN Sends	Host Sends
B;SEND W start end entry RETURN	B;SEND W RETURN line feed
/ data1 RETURN	0 RETURN
.	7 RETURN
.	.
.	.
// RETURN	9 RETURN

Again both programs terminate, but in failure.

A user abort might take place before command transmission (see Section 7.5, User Abort) or during data transmission:

Z-SCAN Sends	Host Sends
B;SEND W start end entry RETURN	B;SEND W start end entry RETURN line feed
/ data1 RETURN	0
//	0 (user enters BREAK)
	9

Here, BREAK was struck after Z-SCAN began sending data1 and the error-abort message was sent instead of data2.

7.7 MESSAGE SYNTAX

The three types of messages symmetrically exchanged over the host-Z-SCAN link can be described in Backus-Nauer form:

```

<Z-SCAN message> ::= <message string> RETURN
<message string> ::= <acknowledgement> | <data string> | <end string> |
                    <error string>
<acknowledgement> ::= "0" | "7" | "9"
<data string>     ::= "/" <address> <count> <sum> <data> <sum>
<end string>     ::= "/" <address> "00" <sum>
<address>        ::= <digit> <digit> <digit> <digit>
<count>          ::= <digit> <digit>
<sum>            ::= <digit> <digit>
<data>           ::= <digit> | <data> <digit>
<error string>   ::= "//" <error string> <ASCII char>
<digit>          ::= "0" | "1" | ... | "9"
                  "A" | "B" | ... | "F"

```

A valid data message must have twice the value of <count> data digits in the <data> string. The end string is a special case of the data string and is the last message to be sent by the sender. In this case, <address> is the entry (starting) point of the procedure (program) file being transferred and must be even for Z8000 programs.

The two checksum (<sum>) values are computed by adding all nibbles of the data they are to check. This is done in an 8-bit accumulator, which generally overflows for the <data> portion of the transmission. Note that the addition occurs before the data is translated into ASCII numerals. Thus the host SEND program must translate the received Z-SCAN data before computing the checksum for comparison with the value of either <sum>.

For any of the three message types, Z-SCAN ignores control characters (except RETURN) and any characters between those needed to decode the message and the end of the line sent (RETURN). Z-SCAN also ignores characters between the last RETURN and the next / when receiving data/error messages.

Command transmission syntax is defined by Z-SCAN, and because it describes unidirectional communication, it is of interest only to the host:

```

<Z-SCAN command> ::= "B;" <name> sp <body> sp* RETURN
<name>           ::= "LOAD" | "SEND"
<body>           ::= <filename> [<parameter>]*
<parameter>     ::= start_address | end_address | entry_point

```

where sp denotes ASCII space, filename is the name entered by the user, and * indicates an item that occurs zero or more times.

7.8 HOST PROGRAM CONTROL FLOW

The following outlines the sequential behavior of a host LOAD or SEND program that successfully interacts with Z-SCAN. It is an alternative way of stating the protocol definition already discussed from the host program's point of view. An example of such a program, the LOAD utility for Zilog's Z80 RIO operating system, is given in Appendix A.

7.8.2 seNd Program

The host SEND program flow is shown in Figure 7-2.

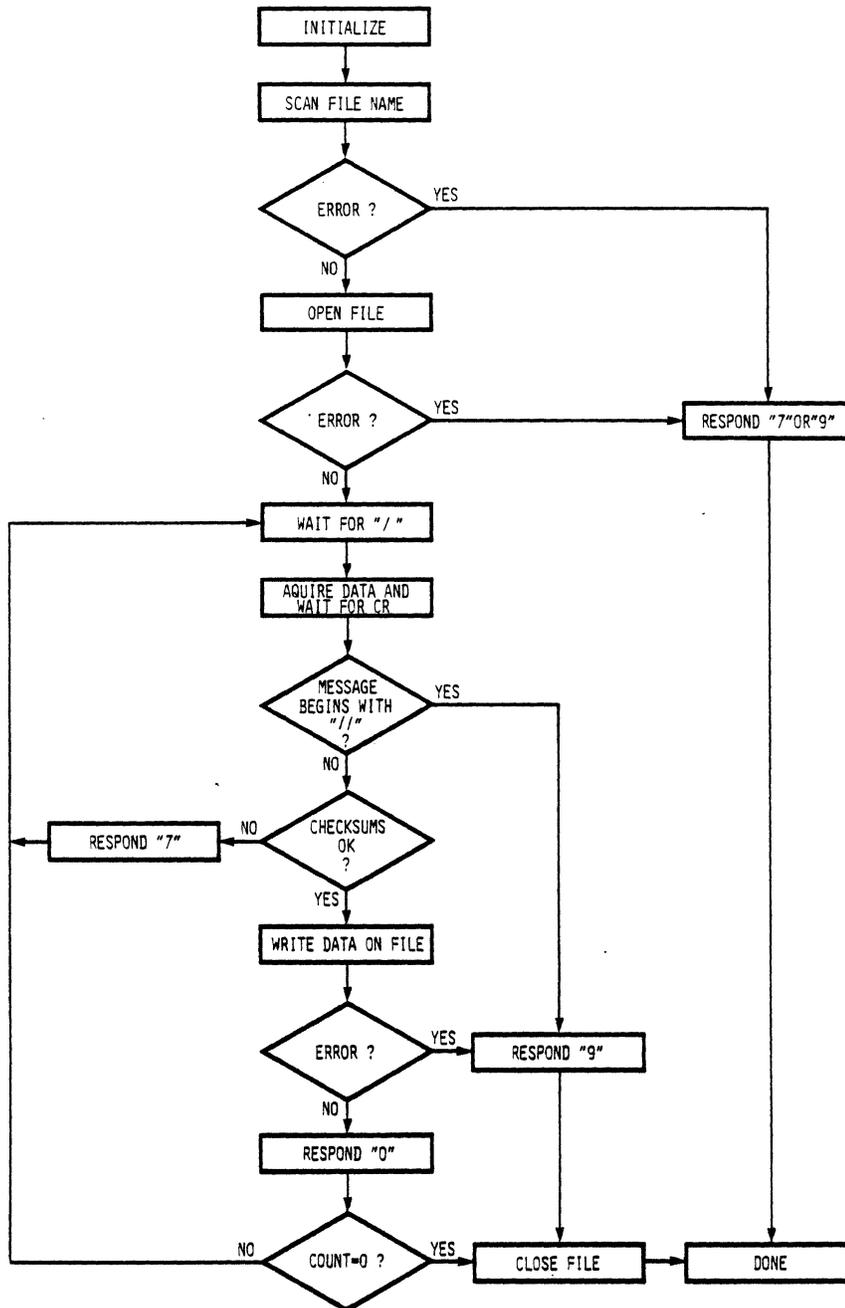


Figure 7-2. Flowchart for SEND Program

APPENDIX A
TERMINALS SUPPORTED BY Z8000



APPENDIX A

Terminals Supported by Z-SCAN

A.1 INTRODUCTION

The two-dimensional user interface of the Z-SCAN monitor software requires a CRT terminal with a 24-line by 80-column display. In addition, the monitor software requires the following functions:

- Clear screen
- Clear to end of line
- Position cursor
- Cursor control keys (move cursor up, down, left or right)

Most terminals offer these features, but the character sequences that distinguish them vary according to the terminal manufacturer.

The monitor software supports nine distinct CRT control protocols, allowing Z-SCAN to be used in conjunction with terminals from many different manufacturers. The user must select the terminal type by entering a hex digit during the initialization of the software. See Section 3.5 for further details. Table A-1 summarizes the terminal types that are supported.

A.2 TERMINAL DETAILS

The Z-SCAN can be used with a terminal not listed in Table A-1 provided that the terminal is compatible with one of those which is listed. The following paragraphs detail the control sequences generated by the monitor for each supported control protocol. Table A-2 lists the symbols used to describe the protocols. Commas and spaces that appear in the descriptions are simply separators: they are not part of the transmitted sequences.

Table A-1. Terminals Supported by the Z-SCAN Monitor

Selection Digit	Manufacturer	Model
0	Lear Siegler Televideo Zentec Soroc	ADM 31 TVI 912 TVI 920 Zephyr IQ 120 IQ 135
1	ADDS	Regent series
2	Beehive	Bee 100 Bee 107 Micro-B 1
3	DEC	VT52
4	DEC (any)	VT100 ANSI A3.64 or ISO DP 6429 compatible
5	General Terminals Inc.	I-200 I-400
6	Hazeltine	1420 1500 Exec 80
7	Hewlett Packard	2620 2640
8	IBM	3101

Table A-2. Control Sequence Protocol Symbols

Symbol Type	Representation	Notes
escape (hex 1B) other control chars. (codes 00 to 1F)	esc ^ char	This code is that transmitted when the control key and the given character key are pressed together.
tilde (hex 7E)	tilde	This character, ~, does not display on some terminals.
cursor row (binary)	rb	This is a single character giving the row number, 1-24 decimal, offset by 31 decimal unless otherwise stated.
cursor column (binary)	cb	This is a single character giving the column number, 1-80 decimal, offset by 31 decimal unless otherwise stated.
cursor row (decimal)	rd	This is the row number sent as two printable characters. The range is 00 to 23 for HP terminals and 01 to 24 for the ANSI compatible DEC VT100.
cursor column (decimal)	cd	This is the column number sent as two printable characters. The range is 00 to 79 for HP terminals and 01 to 80 for the ANSI compatible DEC VT100.
all others	as displayed	

Many terminals offer options that can be selected by entering commands at the keyboard when the terminal is in a special set-up mode, or by setting concealed switches. The Z-SCAN monitor is not able to function correctly when certain options are selected. The option settings required on each major terminal type are listed. The monitor is not sensitive to the setting of any option that is not mentioned. Refer to the manufacturer's documentation if further information is required about any particular terminal.

Special considerations apply when certain terminals are used with Z-SCAN. For example, some low-cost terminals do not have cursor movement keys, so the user must enter control characters manually in order to achieve the desired effect. Such considerations are mentioned when they apply.

A.2.1 Lear Sielger ADM 31 and Soroc Terminals

Table A-3 lists the control sequences used with the ADM 31 and compatible terminals:

Table A-3. ADM 31 Control Sequences

Clear Screen Sequence	Clear Line Sequence	Move Cursor Sequence	Cursor Up	Cursor Down	Cursor Left	Cursor Right
^^ ,esc, Y	esc, T	esc, =, rb, cb	^ K	^ J	^ L	^ H

The following internal switch settings are required when an ADM-31 is used in conjunction with Z-SCAN. It should not be necessary to check these settings unless problems are experienced during use:

Table A-4. ADM 31 Option Settings

Switch Bank	Switch	Setting	Function
1	1	On	Break enable
	5	Off	8 bits, no parity
	7	Off	Conversational mode
	8	On	Full duplex
3	8	On	Disable polling
4	4	Off	Current loop disable
	6	On	Display nulls as nulls

The following ADM 31 baud rates may be used in conjunction with the Z-SCAN monitor. Note that, because some of the features of the terminal do not function at 19200 baud, this speed should not be used. The baud rate selection switch is at the left rear of the terminal.

Table A-5. ADM 31 Baud Rates Supported by Z-SCAN

Baud Rate	Switch Setting	Baud rate	Switch Setting
75	1	1200	7
110	2	1800	8
134.5	3	2400	10
150	4	4800	12
300	5	9600	14
600	6		

The sequences used to control the ADM 31 are compatible with the Soroc IQ 120 and IQ 135 terminals. Z-SCAN supports all baud rates available on these terminals except 1000, 2000, 3600 and 7200 baud. Users of the IQ 135 should be aware that either of the SHIFT keys must be pressed at the same time as BREAK in order for a break to be transmitted. Switch bank K8 switch, 8 must be in the up position. Parity should be disabled when a Soroc terminal is used with Z-SCAN.

A.2.2 ADDS (Applied Digital Data Systems) Regent Series

The Z-SCAN monitor supports the protocol used by the Regent 40 and other compatible terminals in the ADDS range. Table A-6 lists the control sequences used.

Table A-6. Regent 40 Control Sequences

Clear Screen Sequence	Clear Line Sequence	Move Cursor Sequence	Cursor Up	Cursor Down	Cursor Left	Cursor Right
^ L	esc, K	esc, Y, rb, cb	^ Z	^ J	^ F	^ U

Because of the wide variety of terminals in the Regent series, it is not possible to list the options and baud rates required for compatibility with the Z-SCAN monitor in each case. If difficulties are experienced, refer to the terminal documentation and check that each of the following statements is true:

- Line mode is full duplex.
- Parity bit is spacing.
- Baud rate is supported by Z-SCAN (See Table 6-7).
- Termination character is CR.
- Auto scroll is on.
- Interface is EIA (not current loop).
- Z-SCAN is connected to EAI/CURRENT LOOP connector.

A.2.3 Beehive Terminals

The protocol used by the Bee 100, Bee 107 and Micro B 1 terminals is given in Table A-7.

Table A-7. Beehive Control Sequences

Clear Screen Sequence	Clear Line Sequence	Move Cursor Sequence	Cursor Up	Cursor Down	Cursor Left	Cursor Right
esc,E	esc, K	esc, F, rb, cb	esc, A	esc, B	esc, C	esc, D
alternative sequences - see below -->			^ K	^ J	^ L	^ H

The cursor up, down, left and right keys on the Bee 100 operate locally: they move the cursor on the screen but do not transmit codes on the serial link. They are thus unsuitable for use with the Z-SCAN monitor. The user must enter the sequences manually. The single control characters listed above may be used to save keystrokes. As a further alternative, Beehive's service organization can arrange for incorporation of the field change that transforms a Bee 100 into a Bee 107. The Bee 107 cursor control keys transmit escape sequences on the serial link. Cursor control sequence transmission is a switch-selectable option on the Micro B1. The option should be enabled.

A.2.4 DEC (Digital Equipment Corporation) VT52

Table A-8 lists the control sequences used with the DEC VT 52 terminal.

Table A-8. VT 52 Control Sequences

Clear Screen Sequence	Clear Line Sequence	Move Cursor Sequence	Cursor Up	Cursor Down	Cursor Left	Cursor Right
esc, H, esc, J	esc, K	esc, Y, rb, cb	esc, A	esc, B	esc, C	esc, D

A.2.5 DEC (Digital Equipment Corporation) VT 100

The VT 100 terminal control sequences are compatible with those specified by ANSI standard A 3.64 and ISO standard DP 6429 and so can be used with any terminal that supports either standard. The standards allow some flexibility in implementation, so users should check that any alternative terminal is compatible with the VT 100 for the small number of functions required. The

SYSTEM CALL VECTOR LOAD
 LOC OBJ CODE M STMT SOURCE STATEMENT

```

02C5 0000          523          DEFW 0
02C7 0000          524          DEFW 0
02C9 00           525          DEFB 0
                    526
                    527 ;CONSOLE READ AND WRITE
                    528
02CA 01           529 CONVEC: DEFB CONIN
02CB 0C           530          DEFB ZDREDA
02CC 0000          531 CONDTA: DEFW 0
02CE 0000          532 CONLEN: DEFW 0
02D0 0000          533          DEFW 0
02D2 0000          534          DEFW 0
02D4 00           535          DEFB 0
                    536
02D5 02           537 STRVEC: DEFB CONOUT
02D6 0E           538          DEFB ZDWRTB
02D7 0000          539 STRDTA: DEFW 0
02D9 0000          540 STRLEN: DEFW 0
02DB 0000          541          DEFW 0
02DD 0000          542          DEFW 0
02DF 00           543          DEFB 0
                    544
02E0 1B           545 NOOPEN: DEFB B0-NOOPEN
02E1 2F2F554E     546          DEFM '//UNABLE TO OPEN FILE ('
02F8 3830          547 ERADR:  DEFW 3038H
02FA 29           548          DEFB ') '
02FB 0D           549          DEFB 0DH
                    550 B0 EQU $-1
                    551
                    552
02FC 11           553 ERFILE: DEFB B1-ERFILE
02FD 2F2F4649     554          DEFM '//FILENAME ERROR'
030D 0D           555          DEFB 0DH
                    556 B1 EQU $-1
                    557
030E 15           558 NOPROC: DEFB B2-NOPROC
030F 2F2F4E4F     559          DEFM '//NOT PROCEDURE FILE'
0323 0D           560          DEFB 0DH
                    561 B2 EQU $-1
                    562
0324 1D           563 RDBAD:  DEFB B3-RDBAD
0325 2F2F4552     564          DEFM '//ERROR IN READING FILE ('
033E 3830          565 ERRADR: DEFW 3038H
0340 29           566          DEFB ') '
0341 0D           567          DEFB 0DH
                    568 B3 EQU $-1
                    569
0342 15           570 TRYMCH: DEFB B4-TRYMCH
0343 2F2F5245     571          DEFM '//RECORD CKSUM ERROR'
0357 0D           572          DEFB 0DH
                    573 B4 EQU $-1
                    574
0358 02           575 ACKMSG: DEFB 2
0359 30           576          DEFB '0 '
035A 0D           577          DEFB 0DH
                    578
035B 0000          579 RECBYTE: DEFW 0 ; RECORD BYTE COUN
035D 0000          580 SEGPTR: DEFW 0 ; SEGMENT TABLE PO

```


CROSS REFERENCE

LOAD

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SYMBOL	VAL	M	DEFN	REFS									
ACKMSG	0358	R	575	50									
ACKOK	00FE	R	229	220									
30	02FB	R	550	545									
B1	030D	R	556	553									
B2	0323	R	561	558									
B3	0341	R	568	563									
B4	0357	R	573	570									
CHMORE	001D	R	62	58									
CHRBUF	0369	R	587	315	439								
CLSF	014E	R	284	221	273	275							
COMSY1	000D	R	49	46									
CONDTA	02CC	R	531	440									
CONIN	0001	R	9	529									
CONINP	01E0	R	438	310									
CONLEN	02CE	R	532	442									
CONOUT	0002	R	10	537									
CONVEC	02CA	R	529	443									
CORADR	035F	R	581	174	232	234	366	368					
CURBUF	0363	R	584	186	217	379							
ERADR	02F8	R	547	88									
ERFILE	02FC	R	553	96	553								
ERRADR	033E	R	565	198									
FILASV	0202	R	470	118									
FILBFR	03E9	R	588	185	521								
FILCLS	023F	R	495	79	285								
FILDEV	0005	R	8	470	484	495	519						
FILERR	0057	R	96	63	65	67							
FILOPN	0232	R	484	126									
FILPRM	024B	R	503	75	486								
FILPRP	0252	R	508										
FILPTR	0204	R	472	117									
FILRDV	02BF	R	519	188									
FILRL	024E	R	506										
FILSA	0253	R	509	264	266								
FILSMT	0267	R	511	146									
FILSPV	020F	R	479	125	477	491							
FINL	0121	R	257	161									
GENCKS	01C5	R	412	90	200	372	382						
GENHEX	01C6	R	413	265	267	269	367	369	371	377			
HIGADR	02BB	R	513										
LOWADR	02B9	R	512										
MAXRTY	000A	R	16	214	258								
NACK	0170	R	329	320									
NIBBLE	01CF	R	420	418									
NIBDIG	01DB	R	428	426									
NOOPEN	02E0	R	545	91	545								
NOPROC	030E	R	558	94	558								
NPROC	0052	R	94	81									
NXTBFR	009C	R	177	248									
NXTLIN	00D5	R	206	193	238								
NXTSEG	0084	R	149	250									
OPNB	0044	R	87	71									
OPNFIL	005E	R	116	70									
OPNINP	0000	R	15	124									
OUTBUF	08E9	R	589	260	362	384	388						
PROC	0080	R	14	77									
PROCF	0040	R	83	78									
PUTCLS	014B	R	282	202									

LOSS REFERENCE
 SYMBOL VAL M DEFN REFS

LOAD

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SYMBOL	VAL	M	DEFN	REFS	LOAD								
ITS	005A	R	97	92	95								
ITSTR	01F3	R	458	52	97	282							
DBAD	0324	R	563	201	563								
DFILE	007E	R	145	84									
DVLEN	02C3	R	522	184	191	245							
ECBYE	035B	R	579	212	230								
EMCNT	0365	R	585	206	211	235							
FRY	0179	R	336	332									
FCYNT	0367	R	586	215	259	330							
EGCNT	0361	R	582	177	183	244							
EGPTR	035D	R	580	147	149	158							
CLPSP	0015	R	56	60									
FRDTA	02D7	R	539	389	460								
FRLEN	02D9	R	540	387	461								
FRVEC	02D5	R	537	337	390	462							
ZSTEM	0000	X	3	80	119	127	189	286	338	391	444	463	
EKLIN	0182	R	362	218									
CLNLP	019F	R	374	378									
CMSPN	01AA	R	381	270									
CSWAT	0156	R	309	219	272	322	339						
MUCH	0148	R	278	223									
RYMCH	0342	R	570	279	570								
BIG1	00AB	R	184	182									
BIG2	00E4	R	212	210									
DASGN	0002		20	471									
DCLOS	0006		22	496									
DOPEN	0004		21	485									
DRDST	0040		26										
DREDA	000C		24	530									
DREDB	000A		23	520									
DWRTB	000E		25	538									

```
1  *HEADING MAIN ROUTINE
2
3          EXTERNAL          SYSTEM
4
5  ;PREDEFINED DEVICES
6
7
8  FILDEV  EQU 5              ;DEVICE FOR FILES
9  CONIN   EQU 1              ;CONSOLE INPUT
10 CONOUT  EQU 2              ;CONSOLE OUTPUT
11
12 ; CODE FOR OPEN NEW FILE
13
14 OPNEWF  EQU      2          ; OPEN NEW FILE
15
16
17 ;DEVICE FUNCTION CODES
18
19 ZDASGN  EQU 2              ;ASSIGN
20 ZDOPEN  EQU 4              ;OPEN
21 ZDCLOS  EQU 6              ;CLOSE DEVICE
22 ZDREDB  EQU 0AH           ;READ BINARY
23 ZDREDA  EQU 0CH           ;READ ASCII LINE
24 ZDWRTB  EQU 0EH           ;WRITE BINARY
25
```

```

26 *HEADING MAIN PROGRAM
27
28
29 ; *****
30 ; *
31 ; * THIS PROGRAM IS USED TO CREATE A FILE WITH DATA
32 ; * RECEIVING FROM THE Z8000 EVALUATION BOARD.
33 ; * IF THE FILE HAS ALREADY EXISTED OR UNABLE TO OPEN
34 ; * FILE, THIS PROGRAM WILL SEND AN ASCII 9 TO THE
35 ; * CONSOLE OUTPUT, AND PROGRAM WILL BE ABORTED.
36 ; * IF DATA RECORD WITH TWO LEADING '/' IS RECEIVED
37 ; * THIS PROGRAM WILL ALSO BE ABORTED.
38 ; * IF THE CHECKSUM OF THE DATA RECORD RECEIVING FROM
39 ; * THE CONSOLE INPUT ARE VERIFIED, AN ASCII 0 WILL
40 ; * SEND TO THE CONSOLE OUTPUT. AN ASCII 7 WILL BE
41 ; * IF CHECKSUM DOES NOT VERIFY.
42 ; *
43 ; *****
44
45
000 180B 46 JR COMSY1
002 44415445 47 DEFM 'DATE:790629'
48
49 COMSY1:
00D E1 50 POP HL ; RIO RETURN
00E E3 51 EX (SP),HL ; GET COMMAND POINT
52
00F 7E 53 SKIPSP: LD A,(HL)
010 FE20 54 CP ' ' ; SKIP OVER SPACE
012 2003 55 JR NZ, CHMORE
014 23 56 INC HL
015 18F8 57 JR SKIPSP
58
017 FE3B 59 CHMORE: CP ';' ; CHECK FOR DELIMIT
019 2819 60 JR Z,SEND9
01B FE2C 61 CP ','
01D 2815 62 JR Z,SEND9
01F FE0D 63 CP ODH
021 2811 64 JR Z,SEND9
65
66
023 CD3800 R 67 CALL OPNFIL ; OPEN FILE FOR INP
026 200C 68 JR NZ,SEND9 ; UNABLE TO OPEN FI
69
70
028 CD5800 R 71 CALL STRFIL ; GET DATA FROM CON
72 ; & STORE IN FILE
02B C8 73 RET Z ; FILE CLOSE,EVERYT
74
75 ; RECEIVE ABORT MESSAGE OR HAVING WRITE FILE PROBLE
76
02C FD213F03 R 77 LD IY,FILCLS
030 CD0000 X 78 CALL SYSTEM ; CLOSE FILE
033 C9 79 RET
80
034 CD8101 R 81 SEND9: CALL ABRCKS ; SEND '9'
037 C9 82 RET

```



```

113 *HEADING STRFIL ROUTINE
114
115
116 ; *****
117 ; *
118 ; * STRFIL RECEIVE DATA RECORD FROM CONSOLE INPUT IN
119 ; * TEKTRONIX FORMAT. VERIFY TWO CHECKSUMS
120 ; * THE RECEIVING DATA, UNPACK DATA TO HEX VALUE
121 ; * AND STORE THEM IN A FILE
122 ; * DATA RECORD WITH ZERO BYTE COUNT INDICATE
123 ; * END OF DATA, THEN THE FILE WILL BE CLOSED
124 ; * IF DATA RECORD WITH TWO LEADING //, ALSO
125 ; * WILL STOP RECEIVING DATA AND CLOSE THE FILE
126 ; * IF ERROR OCCUR WHILE WRITING DATA INTO FILE
127 ; * AN ASCII 9 WILL BE SEND OUT TO ABORT THE
128 ; * DATA TRANSFERING.
129 ; *
130 ; * TEKTRONIX FORMAT:
131 ; * /<CORE ADDRESS(4)><BYTE COUNT(2)><CHECKSUM1(2)>
132 ; * <DATA(2)><DATA(2)> ... <DATA(2)><CHECKSUM2(2)>
133 ; *
134 ; *
135 ; * OUTPUT: RETURN Z FOR SAVING DATA ON FILE
136 ; * RETURN NZ FOR HAVING PROBLEM IN WRITING
137 ; * DATA ON FILE
138 ; *
139 ; *****
140
141 STRFIL:
058 210000 142 LD HL,0
05B 22F603 R 143 LD (SEGPTR), HL ; INIT SEGMENT TABLE
05E 216703 R 144 LD HL,FILSMT
061 116803 R 145 LD DE,FILSMT+1
064 015200 146 LD BC,82 ; INIT SEGMENT TABLE
067 3600 147 LD (HL),0
069 EDB0 148 LDIR
06B CD3B02 R 149 CALL BLKBUF ; BLANK FILBFR WITH
150
151 LODFRO:
06E CD7501 R 152 CALL GODCKS ; SEND ACKNOWLEDGE
153 LODF:
071 CD0201 R 154 CALL LODREC ; GET RECORD OF DATA
074 3A0009 R 155 LD A,(OUTBUF)
077 FE2F 156 CP '/' ; CHECK IF ERROR RECORD
079 287E 157 JR Z,CLSE ; YES, ABORT & CLOSE
158
159
160 ; VERIFY TWO CHECKSUM & UNPACKED DATA
161
07B 210009 R 162 LD HL,OUTBUF ; VERIFY ADDR & COUNT
07E 0603 163 LD B,3
080 CD8701 R 164 CALL CHKCKS
083 380B 165 JR C,CHKBAD ; BAD CHECKSUM
085 78 166 LD A,B ; CHECK BYTE COUNT
086 A7 167 AND A
087 280C 168 JR Z,LODOK ; COUNT=0, NO DATA
169
170 ; BYTE COUNT NOT ZERO, VERIFY DATA CHECKSUM

```

STRFIL ROUTINE SEND
 LOC OBJ CODE M STMT SOURCE STATEMENT

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 ASM 5.9

```

171
J089 C5 172 PUSH BC ; SAVE BYTE COUNT
J08A CD8701 R 173 CALL CHKCKS ; CKSUM DATA,B=BYTE
J08D C1 174 POP BC
J08E 3005 175 JR NC, LODOK
176 CHKBAD:
J090 CD7B01 R 177 CALL BADCKS ; SEND NON-ACKNOWLEDGE
J093 18DC 178 JR LODF ; GET DATA RECORD
179
180 ; CHECKSUM ARE VERIFIED, GENERATE ADDRESS & POINTER
181 ; FILE ATTRIBUTES, FILE RECORD ..ETC
182
J095 78 183 LODOK: LD A, B ; BYTE COUNT=0 INDICATOR
J096 A7 184 AND A ; LAST RECORD
J097 2828 185 JR Z, FINLOD ; YES, LAST RECORD
186
J099 ED43F403 R 187 LD (RECBYTE), BC ; SAVE BYTE COUNT
188
J09D 210009 R 189 LD HL,OUTBUF
J0A0 CD6B01 R 190 CALL GENADL ; GET ADDRESS FROM
J0A3 CD9A01 R 191 CALL BUFADM ; GENERATE BUF ADDRESS
J0A6 2806 192 JR Z, LODCON ; NO ERROR IN WRITING
193
194 SED9:
00A8 CD8101 R 195 CALL ABRCKS ; SEND '9' TO ABORT
00AB F601 196 RETNZ OR 1 ; RETURN NZ FOR FAILURE
00AD C9 197 RET
198
199 ; UNPACK DATA IN OUTBUF TO FILBFR
200 ; HL - FILBFR ADDRESS TO STORE DATA
201
202 LODCON:
00AE D9 203 EXX
00AF ED4BF403 R 204 LD BC, (RECBYTE) ; BYTE COUNT
00B3 210809 R 205 LD HL,OUTBUF+8 ; ADDRESS OF 1ST DATA
00B6 CD3601 R 206 LODFR3: CALL LODBYL ; CONVERT TO HEX VALUE
00B9 D9 207 EXX
00BA 77 208 LD (HL),A ; SAVE IN FILE BUFFER
00BB 23 209 INC HL
00BC D9 210 EXX
00BD 10F7 211 DJNZ LODFR3 ; NEXT BYTE
00BF 18AD 212 JR LODFRO ; DONE WITH CURRENT RECORD
213 ; SEND '0',GET NEXT RECORD
214
215
216 ; RECEIVE LAST DATA RECORD WITH BYTE COUNT=0, SET UP
217 ; DESCRIPTOR RECORD, AND WRITE FILE TO DISK
218
219 FINLOD:
220
221
00C1 210009 R 222 LD HL,OUTBUF
00C4 CD6B01 R 223 CALL GENADL ; GENERATE ENTRY ADDRESS
00C7 225303 R 224 LD (FILSA),HL ; & STORE IN FILE
00CA CDBC02 R 225 CALL SETCNT ; ADJUST CURRENT SECTOR
226 ; ENTRY 2ND WORD
00CD DD360000 227 LD (IX),0 ; CLEAR ONE SEGMENT
00D1 DD360100 228 LD (IX+1),0 ; TO INDICATE END

```

TRFIL	ROUTINE			SEND		PAGE 6
LOC	OBJ CODE	M	STMT	SOURCE	STATEMENT	ASM 5.9
0D5	DD360200		229		LD (IX+2),0	
0D9	DD360300		230		LD (IX+3),0	
0DD	CD4D02	R	231		CALL TSTMXR	; FIX UP HIGH ADDRESS
0E0	2ABB03	R	232		LD HL,(HIGADR)	
0E3	2B		233		DEC HL	; ADDRESS IS 1 TOO H
0E4	22BB03	R	234		LD (HIGADR),HL	
0E7	CD5D02	R	235		CALL WRTDSK	; WRITE CURRENT FILE
0EA	20BC		236		JR NZ,SED9	; WRITE FILE ERROR
0EC	CD6F02	R	237		CALL ADJDSK	; CHECK ANY MORE DA
0EF	3805		238		JR C,CLSS	; NO MORE DATA,CLOS
0F1	CD5D02	R	239		CALL WRTDSK	; MORE DATA TO WRIT
0F4	20B2		240		JR NZ,SED9	; WRITE FILE ERROR
0F6	CD7501	R	241	CLSS:	CALL GODCKS	
			242	CLSE:		
0F9	FD21CA03	R	243		LD IY,FILCLP	;CLOSE PROCEDURE FII
0FD	CD0000	X	244		CALL SYSTEM	
100	AF		245		XOR A	; RETURN Z FOR OK
101	C9		246		RET	
			247			

```

248 *HEADING LODREC ROUTINE
249
250
251 ; *****
252 ; *
253 ; * LODREC RECEIVING AN INPUT LINE FROM CONSOLE INP
254 ; * MAXIMUM READ 128 CHARACTERS TERMINATED
255 ; * CARRIAGE RETURN. ONLY ACCEPT CHARACTERS
256 ; * AFTER A '/', AND IGNORE ALL CONTROL CHAR
257 ; * THE LEADING / WILL BE INCLUDED IN THE BU
258 ; *
259 ; * OUTPUT: OUTBUF - CONTAIN DATA STRING
260 ; *
261 ; *****
262
263
0102 CDE002 R 264 LODREC: CALL CONINP ; GET INPUT LINE 12
0105 3AD903 R 265 LD A,(CONLEN) ; # OF CHAR IN INPU
0108 47 266 LD B,A
0109 218009 R 267 LD HL, CHRBUF ; INPUT LINE BUFFER
268
010C 7E 269 NCHR: LD A, (HL) ; LOOK FOR '/'
010D 23 270 INC HL
010E E67F 271 AND 7FH
0110 FE2F 272 CP '/'
0112 2807 273 JR Z, GOTLSH
274
0114 10F6 275 DJNZ NCHR ; NO '/', CHECK NE
0116 CD7B01 R 276 CALL BADCKS ; CAN'T FIND '/', C
0119 18E7 277 JR LODREC ; INPUT LINE
278
279 GOTLSH:
011B 05 280 DEC B ; CHAR COUNT
011C 110009 R 281 LD DE,OUTBUF ; FILL OUTBUF WITH
011F 7E 282 NXT: LD A,(HL)
0120 23 283 INC HL
0121 E67F 284 AND 7FH
0123 12 285 LD (DE),A ; MOVE CHAR INTO O
0124 FE0D 286 CP 0DH ; CHECK END OF LINE
0126 C8 287 RET Z
288
0127 FE20 289 CP ' ' ; CHECK FOR CONTROL
0129 3004 290 JR NC, CHROK ; CHAR OK
012B 10F2 291 DJNZ NXT ; NEXT CHARACTER
012D 1803 292 JR CEND ; TERMINATE WITH C
293
294 CHROK:
012F 13 295 INC DE
0130 10ED 296 DJNZ NXT
297
298 CEND:
0132 3E0D 299 LD A,0DH ; JUST PUT CR AT E
0134 12 300 LD (DE),A
0135 C9 301 RET
302

```

```

303 *HEADING LODBYL ROUTINE
304
305 ; *****
306 ; *
307 ; * CONVERT THE NEXT TWO ASCII CHARACTERS IN THE INP
308 ; * STREAM TO A 8-BIT HEX VALUE. AFTER EACH ASCII CH
309 ; * IS CONVERTED TO 4-BIT HEX VALUE, THE HEX VALUE I
310 ; * ADDED TO A CHECKSUM ACCUMULATOR.
311 ; *
312 ; * INPUT: HL - POINTER TO CHARACTER STREAM
313 ; * C - CHECKSUM ACCUMULATOR
314 ; *
315 ; * OUTPUT: HL - INCREMENTED BY 2
316 ; * C - UPDATED CHECKSUM ACCUMULATOR
317 ; * A - 8 BIT HEX VALUE OF TWO ASCII CHAR
318 ; *
319 ; * RETURN NC FOR CONVERSION SUCCESSFUL
320 ; * RETURN C FOR NON-ASCII CHAR IN BUFFER
321 ; *
322 ; *****
323
136 CD4D01 R 324 LODBYL: CALL HEXDCD ;GET CHR AND CHECK
139 D8 325 RET C ;BAD
13A F5 326 PUSH AF
13B 81 327 ADD A,C
13C 4F 328 LD C,A
13D F1 329 POP AF
13E 07 330 RLCA
13F 07 331 RLCA
140 07 332 RLCA
141 07 333 RLCA
142 5F 334 LD E,A ;SAVE PARTIAL BYTE
143 CD4D01 R 335 CALL HEXDCD ; NEXT BYTE
146 D8 336 RET C
147 F5 337 PUSH AF
148 81 338 ADD A,C
149 4F 339 LD C,A
14A F1 340 POP AF
14B B3 341 OR E ; MERGE TWO HEX VAL
342 ; OR SET NC FOR OK
14C C9 343 RET
344
345
346
347 ; *****
348 ; *
349 ; * HEXDCD CONVERT A SINGLE ASCII CHARACTER TO A 4-
350 ; * HEX VALUE. ( 41 -> A, 37 -> 7 )
351 ; *
352 ; * INPUT: HL - POINTER TO ASCII CHARACTER
353 ; *
354 ; * OUTPUT: HL - INCREMENTED BY 1
355 ; * A - 4-BITS HEX VALUE
356 ; *
357 ; * RETURN NC FOR CONVERSION SUCCESSFUL
358 ; * RETURN C FOR CHARACTER IS NON-ASCII
359 ; *
360 ; *****

```

```

361
)14D 7E 362 HEXDCD: LD A, (HL) ; GET CHARACTER
)14E 23 363 INC HL
)14F FE5B 364 CP 'Z'+1 ; CHECK FOR LOWER C.
)151 3802 365 JR C, HEXUPR ; NO
)153 CBAF 366 RES 5,A ; FORCE TO UPPER CA
)155 FE30 367 HEXUPR: CP '0'
)157 D8 368 RET C ; NOT 0-9
)158 FE47 369 CP 'F'+1
)15A 300D 370 JR NC, HEXBAD ; NOT A-F
)15C FE3A 371 CP '9'+1
)15E 3806 372 JR C, USEDIG ; IS DIGIT
)160 FE41 373 CP 'A'
)162 3805 374 JR C, HEXBAD
)164 D637 375 SUB 'A'-10
)166 E60F 376 USEDIG: AND OFH
)168 C9 377 RET ; RETURN NC FROM AN
378
)169 37 379 HEXBAD: SCF ; RETURN C FOR BAD
)16A C9 380 RET
381
382
383
384 ; *****
385 ; *
386 ; * GENADL CONVERT 4 ASCII CHARACTERS TO A 16 BIT H
387 ; * VALUE IN HL.
388 ; *
389 ; * INPUT: HL - POINTER TO FIRST ASCII CHARACTER
390 ; *
391 ; * OUTPUT: HL - 16-BIT HEX VALUE
392 ; *
393 ; *****
394
395
)16B CD3601 R 396 GENADL: CALL LODBYL
)16E 57 397 LD D,A
)16F CD3601 R 398 CALL LODBYL
)172 5F 399 LD E,A
)173 EB 400 EX DE,HL
)174 C9 401 RET
402
403
404 ; *****
405 ; *
406 ; * GODCKS SEND ASCII 0 FOLLOWED BY CARRIAGE RETURN
407 ; * ACKNOWLEDGE.
408 ; *
409 ; * BADCKS SEND ASCII 7 FOLLOWED BY CARRIAGE RETURN
410 ; * NON-ACKNOWLEDGE.
411 ; *
412 ; * ABRCKS SEND ASCII 9 FOLLOWED BY CARRIAGE RETURN
413 ; * EITHER ERROR IN OPEN FILE OR ERROR IN WRITE DAT
414 ; * ON DISK FILE.
415 ; *
416 ; *****
417
418

```

DBYL	ROUTINE				SEND		PAGE 10
.OC	OBJ CODE	M	STMT	SOURCE	STATEMENT		ASM 5.9
175	21EB03	R	419	GODCKS:	LD	HL, ACKMSG	; SEND ASCII '0'
178	C3F302	R	420		JP	PUTSTR	
			421				
17B	21EE03	R	422	BADCKS:	LD	HL, NAKMSG	; SEND ASCII '7'
17E	C3F302	R	423		JP	PUTSTR	
			424				
181	21F103	R	425	ABRCKS:	LD	HL, ABRMSG	; SEND ASCII '9'
184	C3F302	R	426		JP	PUTSTR	

```

427 *HEADING CHKCKS ROUTINE
428
429
430 ; *****
431 ;
432 ; CHKCKS VERIFIES RECORD CHECKSUM. FIRST CONVERT T
433 ; CHARACTERS TO THEIR CORRESPONDING HEX VALUE, CAL
434 ; THE CHECKSUM BY ADDING THESE HEX VALUES, THEN CO
435 ; THE ASCII RECORD CHECKSUM WHICH FOLLOWED THE DAT
436 ; HEX VALUES AND COMPARE TO THE CALCULATED CHECKSU
437 ;
438 ; INPUT: HL - POINTER TO ASCII STRING
439 ;         B - # OF CHARACTER PAIR TO BE CHECKSUM
440 ;         ( TOTAL CHARACTERS TO CHECKSUM IS (
441 ;
442 ; OUTPUT: RETURN NC IF CHECKSUM VERIFY
443 ;         RETURN C IF INCORRECT CHECKSUM
444 ;
445 ; *****
446
447
)187 OE00          448 CHKCKS: LD C,0          ;INITIAL CKSUM ACCU
)189 CD3601      R 449 CK1:  CALL LODBYL      ; KEEPS C UPDATED
)18C D8          450          RET C          ;ERROR, NON-ASCII C
)18D 10FA       451          DJNZ CK1
)18F 47         452          LD B,A
)190 C5         453          PUSH BC          ;SAVE ACCUMULATED C
)191 CD3601    R 454          CALL  LODBYL      ; CONVERT STORED CK
)194 C1         455          POP BC
)195 D8        456          RET C          ;ERROR, NON-ASCII C
)196 B9        457          CP          C      ; COMPARE STORED CK
458          ; WITH CALC.CKSUM
)197 C8        459          RET Z          ;OK
)198 37        460          SCF          ;BAD CHECKSUM, FORC
)199 C9        461          RET
  
```

```

462 *HEADING BUFADM ROUTINE
463
464 ; *****
465 ;
466 ; BUFADM BREAKS UP THE LOAD STREAM INTO DISK SEGMENT
467 ;
468 ; INPUT: HL- CORE ADDRESS IN LOAD RECORD
469 ;         B - BYTE COUNT IN LOAD RECORD
470 ;
471 ; OUTPUT: HL - FILBFR ADDRESS TO STORE DATA
472 ;
473 ; OUTPUT: RETURN Z IF NO ERROR IN FILE WRITING
474 ;         RETURN NZ IF PROBLEMS IN FILE WRITING
475 ;
476 ; IT USES FLAG (SEGPTR=0) TO INDICATE THAT THIS IS
477 ; FIRST SEGMENT.
478 ;
479 ; *****
480
481
482 BUFADM:
19A 22F803 R 483 LD (CORADR),HL ; CORE ADDRESS
19D ED5BF603 R 484 LD DE,(SEGPTR) ; CHECK IF FIRST TIME
1A1 7A 485 LD A,D
1A2 B3 486 OR E
1A3 201B 487 JR NZ,NOTFST ; NOT FIRST TIME
488
489
490 ; INIT VARIABLES:
491 ; SEGPTR - SEGMENT TABLE POINTER
492 ; HIGADR - HIGH ADDRESS FOR FILE ATTRIBUTES
493 ; LOWADR - LOW ADDRESS FOR FILE ATTRIBUTES
494 ; BOTRNG - LOW ADDRESS OF CURRENT FILE RECORD
495 ; TOPRNG - TOP ADDRESS OF CURRENT FILE RECORD
496 ; TOPUSD - FILBFR ADDR. WHERE LAST BYTE DATA
497 ;
498 ; ALSO SET UP ENTRY IN SEGMENT TABLE
499 ; 1ST WORD - LOW CORE ADDRESS OF CURRENT SEGM
500 ; 2ND WORD - HIGH CORE ADDRESS OF CURRENT SEG
501 ; (TEMPORARY, SHOULD SET TO SEGMENT)
502
01A5 116703 R 503 LD DE,FILSMT
01A8 ED53F603 R 504 LD (SEGPTR),DE ; SEGMENT TABLE POINTER
505
01AC CDA602 R 506 CALL GENRNG ; SET UP ADDRESSES
507 ; RECORD, SEGMENT
01AF 22BB03 R 508 LD (HIGADR),HL ; ADDRESS FOR FILE
01B2 2AFA03 R 509 LD HL,(BOTRNG)
01B5 22B903 R 510 LD (LOWADR),HL
511
512
513 BLKBFR:
01B8 CD3B02 R 514 CALL BLKBUF ; INIT FILBFR WITH
01BB 210004 R 515 LD HL,FILBFR
01BE 1816 516 JR COMADM ; FIGURE HOW FAR TO
517 ; FILBFR (TOPUSD)
518
519 ; CHECK IF CORE ADDRESS OF RECEIVING DATA IS BEYOND

```


UFADM ROUTINE SEND
 LOC OBJ CODE M STMT SOURCE STATEMENT

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```

)1FF 22FA03 R 578 LD (BOTRNG),HL ; FILE RECORD
)202 ED5B4E03 R 579 LD DE,(FILRL) ; RECORD LENGTH
)206 19 580 ADD HL,DE
)207 22FC03 R 581 LD (TOPRNG),HL ; TOP ADDR FOR NEW
582
583 ; CHECK IF CORE ADDRESS OF RECEIVING DATA IS BEYOND
584 ; RANGE OF THE NEXT NEW FILE RECORD ADDRESSES, IF
585 ; KEEP FILLING DATA IN FILBFR
586

)20A DD2AF603 R 587 LD IX,(SEGPTR)
)20E DD6E02 588 LD L,(IX+2)
)211 DD6603 589 LD H,(IX+3)
)214 19 590 ADD HL,DE ; CORE ADDRESS FOR
591 ; BYTE + 80H

)215 ED5BF803 R 592 LD DE,(CORADR) ; CORE ADDR OF RECI
)219 A7 593 AND A
)21A ED52 594 SBC HL,DE
)21C EB 595 EX DE,HL ; HL = CORE ADDR
)21D 3806 596 JR C, WRTS ; WRITE OUT DATA
597

)21F 08 598 EX AF,AF'
)220 DC3B02 R 599 CALL C,BLKBUF ; BLANK FILBFR IF E
)223 189B 600 JR NOTFST ; USE SAME FILE REC
601
602 ; ADDRESS OF NEXT RECORD DATA IS NOT IN THE RANGE (
603 ; CURRENT FILE RECORD, WRITE OUT DATA IN FILBFR,
604 ; CREATE A NEW SEGMENT
605
606 WRTS:
0225 08 607 EX AF,AF' ;WAS THERE MORE IN
)226 3804 608 JR C,NXTRN2 ;NO
)228 CD5D02 R 609 CALL WRTDSK ;GET RID OF REMAINI
)22B C0 610 RET NZ ; WRITE FILE ERROR
611

022C CDBC02 R 612 NXTRN2: CALL SETCNT ; SET SEGMENT SIZE
613 ; MENT TABLE

022F 2AF803 R 614 LD HL,(CORADR)
0232 CDA602 R 615 CALL GENRNG ; SET FILE RECORD
0235 CD4D02 R 616 CALL TSTMXR ; SET HIGHADDRESS I
617 ; ATTRIBUTES
0238 C3B801 R 618 JP BLKBFR ; BLANK FILBFR & S'
619

```

```

620 *HEADING BLKBUF, TSTMXR, WRTDSK, ADJDSK
621
622 ; *****
623 ;
624 ; BLKBUF FILL THE FILBFR BUFFER WITH DATA FF.
625 ;
626 ; *****
023B E5 627 BLKBUF: PUSH HL
023C C5 628 PUSH BC
023D 210004 R 629 LD HL, FILBFR ; BUFFER ADDR
0240 110104 R 630 LD DE, FILBFR+1
0243 01FF03 631 LD BC, 3FFH ; SIZE OF BUFF
0246 36FF 632 LD (HL), OFFH ; FILL 1ST BYTE WIT
0248 EDB0 633 LDIR
024A C1 634 POP BC
024B E1 635 POP HL
024C C9 636 RET
637
638
639 ; *****
640 ;
641 ; TSTMXR SET THE HIGH ADDRESS FOR THE FILE ATTRIBU
642 ; IF (TOPUSD) TOP ADDRESS OF CURRENT FILE RECORD I
643 ; GREATER THAN THEVALUE IN(HIGADR), THEN SET HIGADR
644 ;
645 ; *****
024D 2ABB03 R 648 TSTMXR: LD HL, (HIGADR)
0250 ED5BFC03 R 649 LD DE, (TOPRNG)
0254 A7 650 AND A
0255 ED52 651 SBC HL, DE
0257 D0 652 RET NC ;OK
0258 ED53BB03 R 653 LD (HIGADR), DE ;RESET
025C C9 654 RET
655
656
657 ; *****
658 ;
659 ; WRTDSK WRITE THE FIRST 80 BYTES OF DATA IN FILBFR
660 ; BUFFER TO THE DISK.
661 ;
662 ; OUTPUT: RETURN NZ FOR WRITE FILE ERROR
663 ; RETURN Z FOR NO ERROR
664 ;
665 ; *****
025D 2A4E03 R 668 WRTDSK: LD HL, (FILRL)
0260 22C303 R 669 LD (FILDL), HL ; FILE RECORD LENG
0263 FD21BF03 R 670 LD IY, FILVEC
0267 CD0000 X 671 CALL SYSTEM ; WRITE DATA TO FII
026A FDCB0A76 672 BIT 6, (IY+10)
026E C9 673 RET ; RETURN Z FOR NO I
674 ; RETURN NZ FOR WR
675
676
677 ; *****

```

```

678 ;
679 ; ADJDSK DELETES THE DATA IN FILBFR THAT HAS BEEN V
680 ; TO FILE, THEN MOVES UP THE REST OF DATA AND BLANK
681 ; THE UNUSED PART OF FILBFR. ALSO RESET (TOPUSD)
682 ; FOR ADDRESS OF FILBFR LAST USED.
683 ;
684 ; OUTPUT: RETURN NC IF THERE IS VALID DATA IN FILE
685 ; RETURN C IF FILBFR EMPTY
686 ;
687 ; *****
688 ;
689 ;
026F 2AFE03 R 690 ADJDSK: LD HL,(TOPUSD)
0272 110004 R 691 LD DE,FILBFR
0275 A7 692 AND A
0276 ED52 693 SBC HL,DE ; # OF BYTE OF DATA IN FILBFR
0278 D8 694 RET C ; NO DATA IN FILBFR
695 ;
0279 ED5B4E03 R 696 LD DE,(FILRL) ;THIS MUCH WAS WRITTEN
027D ED52 697 SBC HL,DE
027F D8 698 RET C ;NOTHING MORE IN FILBFR
699 ;
700 ; MOVE UP DATA
701 ;
0280 23 702 INC HL
0281 44 703 LD B,H
0282 4D 704 LD C,L ;READY FOR LDIR
0283 2A4E03 R 705 LD HL,(FILRL)
0286 110004 R 706 LD DE,FILBFR
0289 19 707 ADD HL,DE ;FROM TOP TO BOTTOM
028A C5 708 PUSH BC ; # OF BYTE GOT MOVE
028B EDB0 709 LDIR
028D C1 710 POP BC
028E 21FF03 711 LD HL,400H-1
0291 A7 712 AND A ; BLANK REST OF FILBFR WITH
0292 ED42 713 SBC HL,BC
0294 44 714 LD B,H
0295 4D 715 LD C,L
0296 D5 716 PUSH DE ; FILBFR ADDRESS FOR NEXT
717 ;
0297 62 718 LD H,D
0298 6B 719 LD L,E
0299 36FF 720 LD (HL),OFFH
029B 13 721 INC DE
029C EDB0 722 LDIR ;CLEAR REMAINDER WITH FF
029E D1 723 POP DE
029F 1B 724 DEC DE
02A0 ED53FE03 R 725 LD (TOPUSD),DE ; DATA ARE FILL UP TO THIS
02A4 A7 726 AND A ;FORCE NO CARRY ON RETURN
02A5 C9 727 RET
728 ;
729 ;
730 ; *****
731 ;
732 ; GENRNG SET UP SEGMENT ADDRESS IN SEGMENT TABLE.
733 ; SET BOTRNG - LOW ADDRESS OF NEW FILE RECORD
734 ; TOPRNG - HIGH ADDRESS OF NEW FILE RECORD
735 ;

```

```

736 ; INPUT: HL - CORE ADDRESS
737 ; SEGPTR - POINTER TO SEGMENT TABLE
738 ;
739 ; *****
740
02A6 22FA03 R 741 GENRNG: LD (BOTRNG),HL
02A9 DD2AF603 R 742 LD IX,(SEGPTR)
02AD DD7401 743 LD (IX+1),H
02B0 DD7500 744 LD (IX),L
02B3 ED5B4E03 R 745 LD DE,(FILRL)
02B7 19 746 ADD HL,DE ;TOP
02B8 22FC03 R 747 LD (TOPRNG),HL
02BB C9 748 RET
749
750
751
752 ; *****
753 ;
754 ; SETCNT COMPUTES THE SEGMENT SIZE IN THE SEGMENT T
755 ; THE SECOND WORD IN THE SEGMENT TABLE HAS BEEN K
756 ; UPDATED WITH THE HIGHEST ADDRESS-1 SO FAR. IT
757 ; REPLACE WITH THE ACTUAL SEGMENT SIZE.
758 ;
759 ; INPUT: SEGPTR - POINTER TO THE SEGMENT TABLE
760 ;
761 ; OUTPUT: SEGPTR - UPDATED BY 4 TO POINT TO NEXT SE
762 ;
763 ; *****
764
02BC DD2AF603 R 766 SETCNT: LD IX,(SEGPTR)
02C0 DD6603 767 LD H,(IX+3)
02C3 DD6E02 768 LD L,(IX+2) ; 1ST WORD OF SEGME
02C6 DD5601 769 LD D,(IX+1)
02C9 DD5E00 770 LD E,(IX) ; 2ND WORD OF SEGME
02CC A7 771 AND A
02CD ED52 772 SBC HL,DE
02CF 23 773 INC HL ; CONVERT TO SIZE
02D0 DD7403 774 LD (IX+3),H
02D3 DD7502 775 LD (IX+2),L
02D6 110400 776 LD DE,4
02D9 DD19 777 ADD IX,DE
02DB DD22F603 R 778 LD (SEGPTR),IX ; UPDATE SEGMENT TB
02DF C9 779 RET

```

```

780 *HEADING SUBROUTINE.S
781
782
783 ; *****
784 ;
785 ; CONINP GET INPUT LINE FROM CONSOLE INPUT
786 ;
787 ; *****
788
789
790 CONINP:
?E0 218009 R 791 LD HL, CHRBUF ; RECEIVE CHARACTER
?E3 22D703 R 792 LD (CONDTA),HL
?E6 218000 793 LD HL, CHRSIZ ; SIZE OF INPUT CHAR
?E9 22D903 R 794 LD (CONLEN),HL ; LENGTH OF BUF
?EC FD21D503 R 795 LD IY, CONVEC
?FO C30000 X 796 JP SYSTEM
797
798
799
800 ; *****
801 ;
802 ; PUTSTR OUTPUT A STRING OF CHARACTER TO CONSOLE OUT
803 ;
804 ; INPUT: HL - POINT TO A MESSAGE IN DEFT FORMAT
805 ;
806 ; *****
807
808
?F3 7E 809 PUTSTR: LD A,(HL) ;GET COUNT
?F4 23 810 INC HL
?F5 22E203 R 811 LD (STRDTA),HL
?F8 32E403 R 812 LD (STRLEN),A ;OTHER PART IS ALWAYS
?FB FD21E003 R 813 LD IY,STRVEC
?FF C30000 X 814 JP SYSTEM
815

```

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      816 *HEADING SYSTEM CALL VECTOR
      817
      818
      819 ; ASSIGN FILE
      820
302   05      821 FILASV: DEFB   FILDEV
303   02      822           DEFB   ZDASGN           ; ASSIGN REQUEST COI
304  0000     823 FILPTR: DEFW   0           ; FILENAME POINTER
306  0000     824           DEFW   0
308  0000     825           DEFW   0
30A  0000     826           DEFW   0
30C   00      827           DEFB   0
30D  0F03     R 828           DEFW   FILSPV           ; SUPPL. PARAMETER VI
      829
30F   00      830 FILSPV: DEFB   0           ; FLAG BYTE
310           831           DEFS   34
      832
      833 ; OPEN FILE
      834
332   05      835 FILOPN: DEFB   FILDEV           ; SAME UNIT AS ASSIC
333   04      836           DEFB   ZDOPEN           ; OPEN REQUEST CODE
334  4B03     R 837           DEFW   FILPRM          ; FILE ATTRIBUTES AI
336  7400     838           DEFW   116           ; LENGTH OF FILE ATI
338  0000     839           DEFW   0
33A  0000     840           DEFW   0
33C   00      841           DEFB   0
33D  0F03     R 842           DEFW   FILSPV           ; SUPPL. PARAMETER VI
      843
      844 ; CLOSE FILE
      845
333F  05      846 FILCLS: DEFB   FILDEV           ; SAME UNIT AS ASSIC
340   06      847           DEFB   ZDCLOS          ; CLOSE REQUEST CODI
341  0000     848           DEFW   0
343  0000     849           DEFW   0
345  0000     850           DEFW   0
347  0000     851           DEFW   0
349  0000     852           DEFW   0
      853
      854 FILPRM:
344B  80      855           DEFB   80H           ; FILE TYPE ( MUST BE PROC.
344C  0000     856           DEFW   0           ; SIZE
344E  0000     857 FILRL:  DEFW   00H           ; RECORD LENGTH, DEFAULT
350  0000     858           DEFW   0           ; BLOCKING
352   00      859           DEFB   0           ; PROPERTIES
353  0000     860 FILSA:  DEFW   0           ; STARTING ADDRESS
355  0002     861           DEFW   200H          ; BYTE IN LAST RECORD
      862
357           863           DEFS   16           ; WILL CHANGE TO 80H IF FLO
367           864 FILSMT: DEFS   82           ; CREATION DATE
3B9  0000     865 LOWADR: DEFW   0           ; SEGMENT POINTER TABLE
3BB  0000     866 HIGADR: DEFW   0           ; LOWEST ADDRESS USED
3BD  8000     867           DEFW   80H           ; HIGHEST ADDRESS UES
      868
      869
      870 ;FILE WRITE VECTOR
      871
3BF   05      872 FILVEC: DEFB   FILDEV
3CO   0E      873           DEFB   ZDWRTB
  
```


CROSS REFERENCE

SEND

SYMBOL	VAL	M	DEFN	REFS				
ABRCKS	0181	R	425	81	195			
ABRMSG	03F1	R	915	425				
ACKMSG	03EB	R	909	419				
ADJDSK	026F	R	690	237	574			
3ADCKS	017B	R	422	177	276			
BLKBFR	01B8	R	513	618				
BLKBUF	023B	R	627	149	514	599		
BOTRNG	03FA	R	923	509	532	578	741	
BUFADM	019A	R	482	191				
CEND	0132	R	298	292				
CHKBAD	0090	R	176	165				
CHKCKS	0187	R	448	164	173			
CHMORE	0017	R	59	55				
CHRBUF	0980	R	930	267	791	931		
CHROK	012F	R	294	290				
CHRSIZ	0080		931	793				
CK1	0189	R	449	451				
CLSE	00F9	R	242	157				
CLSS	00F6	R	241	238				
COMADM	01D6	R	544	516				
COMSY1	000D	R	49	46				
CONDTA	03D7	R	895	792				
CONIN	0001		9	893				
CONINP	02E0	R	790	264				
CONLEN	03D9	R	896	265	794			
CONOUT	0002		10	901				
CONVEC	03D5	R	893	795				
CORADR	03F8	R	922	483	531	554	592	614
FILASV	0302	R	821	101				
FILBFR	0400	R	928	515	534	629	630	691 706 874
FILCLP	03CA	R	882	243				
FILCLS	033F	R	846	77				
FILDEV	0005		8	821	835	846	872	882
FILDL	03C3	R	875	669				
FILOPN	0332	R	835	109				
FILPRM	034B	R	854	837	884			
FILPTR	0304	R	823	100				
FILRL	034E	R	857	579	668	696	705	745
FILSA	0353	R	860	224				
FILSMT	0367	R	864	144	145	503		
FILSPV	030F	R	830	108	828	842		
FILVEC	03BF	R	872	670				
FINLOD	00C1	R	219	185				
GENADL	016B	R	396	190	223			
GENRNG	02A6	R	741	506	615			
GODCKS	0175	R	419	152	241			
GOTLSH	011B	R	279	273				
HEXBAD	0169	R	379	370	374			
HEXDCCD	014D	R	362	324	335			
HEXUPR	0155	R	367	365				
HIGADR	03BB	R	866	232	234	508	648	653
LODBYL	0136	R	324	206	396	398	449	454
LODCON	00AE	R	202	192				
LODF	0071	R	153	178				
LODFRO	006E	R	151	212				
LODFR3	00B6	R	206	211				
LODOK	0095	R	183	168	175			
LODREC	0102	R	264	154	277			

CROSS REFERENCE

SEND

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SYMBOL	VAL	M	DEFN	REFS							
LOWADR	03B9	R	865	510							
IAKMSG	03EE	R	912	422							
ICHR	010C	R	269	275							
IOTFST	01C0	R	524	487	600						
IXT	011F	R	282	291	296						
JXTRN2	022C	R	612	608							
JXTRNG	01F4	R	569	526							
JPNEWF	0002		14	107							
JPNFIL	0038	R	99	67							
JUTBUF	0900	R	929	155	162	189	205	222	281		
JUTSTR	02F3	R	809	420	423	426					
JRECBE	03F4	R	920	187	204	545					
JRETNZ	00AB	R	196								
JSED9	00A8	R	194	236	240						
JSEGPTR	03F6	R	921	143	484	504	556	587	742	766	778
JSEND9	0034	R	81	60	62	64	68				
JSETCNT	02BC	R	766	225	612						
JSKIPSP	000F	R	53	57							
JSTRDTA	03E2	R	903	811							
JSTRFIL	0058	R	141	71							
JSTRLEN	03E4	R	904	812							
JSTRVEC	03E0	R	901	813							
JSYSTEM	0000	X	3	78	102	110	244	671	796	814	
JTOPRNG	03FC	R	925	524	577	581	649	747			
JTOPUSD	03FE	R	927	551	690	725					
JTSTMXR	024D	R	648	231	616						
JUSEDIG	0166	R	376	372							
JWRTDSK	025D	R	668	235	239	570	609				
JWRTS	0225	R	606	596							
ZDASGN	0002		19	822							
ZDCLOS	0006		21	847	883						
ZDOPEN	0004		20	836							
ZDREDA	000C		23	894							
ZDREDB	000A		22								
ZDWRTB	000E		24	873	902						

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