HP 64746

MC68302 Emulator Terminal Interface

User's Guide

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Notice

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Using this Manual

This manual has two main purposes:

- It describes the HP 64746 MC68302 emulator.
- It gives an introduction to using the emulator's Terminal Interface.

This manual also describes specific MC68302 emulator commands which do not appear in the *Terminal Interface Reference.*

This manual does not tell you how to use all of the emulator and analyzer commands. Refer to the *Terminal Interface Reference.*

Conventions Used

Examples in this manual use the following format and conventions:

```
M>cf clk=ext <RETURN>
```

M>	This represents one of the prompts shown on screen.
cf clk=ext	This represents an entry that you make.
<RETURN>	This instructs you to press **<RETURN>**.
bold	Bold type highlights commands and options.

<RETURN> versus <ENTER>

This manual instructs you to press the **<RETURN>** key to execute commands. Depending on whether you are using a terminal or personal computer (PC), you will use either the **<RETURN>** or **<ENTER>** key to execute the commands. The **<RETURN>** key on a terminal and the **<ENTER>** key on a PC both perform a carriage return, which is necessary to execute most of the HP 64700-Series commands.

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1

Introducing the MC68302 Emulator

Introduction

The topics in this chapter include:

- Function of the MC68302 Emulator
- Features of the MC68302 Emulator
- How the Components Communicate
- Tips for Operating the Emulator
- Connecting the emulator to the target system
  - Connecting the probe to a PGA socket
  - Connecting using a 132-pin QFP Probe Adapter Assembly
  - Connecting using the 144-pin HP Wedge Probing System
- Other Sources of Information

Function of the MC68302 Emulator

The MC68302 emulator is designed to replace the MC68302 microprocessor in your target system so you can control operation of the microprocessor in your application hardware (usually referred to as the *target system*). The emulator performs just like the MC68302 microprocessor, but is a device that allows you to control the MC68302 directly. The MC68302 emulator features allow you to easily debug software before any hardware is available, and ease the process of integrating hardware and software.

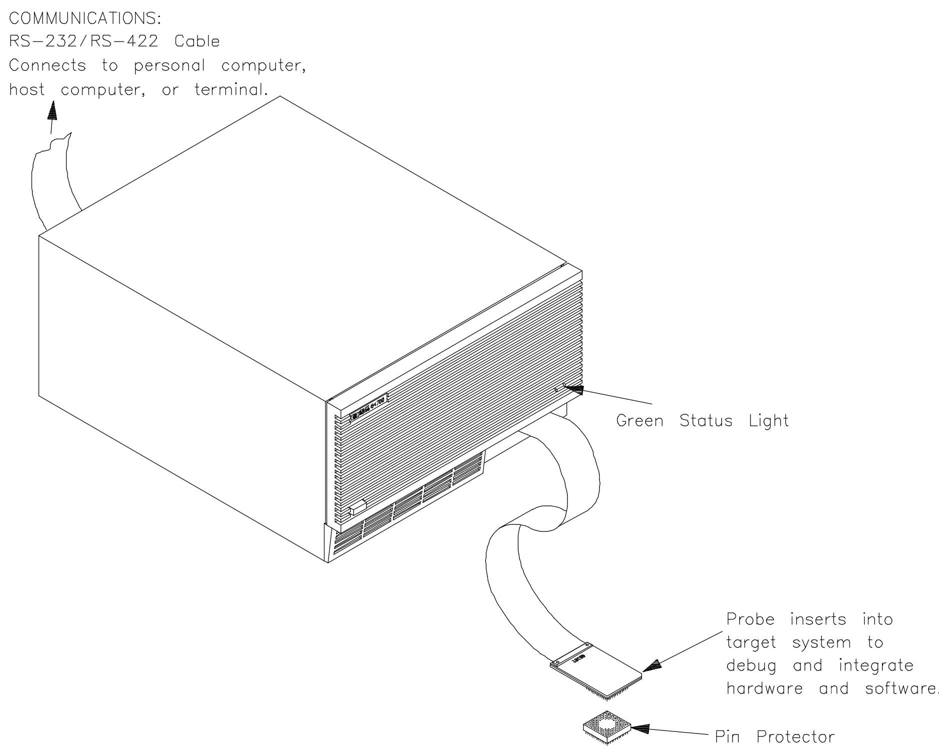

Figure 1-1. HP 64746 Emulator for the MC68302

Versions of the HP 64746

Previous versions of the MC68302 emulator (HP 64746A/AL, HP 64746B/BL, HP 64746G, and HP 64746H) came with fixed amounts of memory. The HP 64746J emulator uses the HP 64170 memory board, which supports up to 2 Mbytes of emulation memory.

When you use the HP 64170 memory board, you will notice changes in the memory block size, memory mapping resolution, and the elimination of coverage measurements.

Features of the MC68302 Emulator

Supported Microprocessors

The HP 64746 emulator contains a Motorola 68302 microprocessor revision B or greater.

Clock Speeds

The internal clock speed of the HP 64746 emulator is at least 16.67 MHz. Your emulator may use a faster clock speed.

Emulation Memory

The HP 64170 memory board provides 256 Kbytes, 512 Kbytes, 1 Mbyte, or 2 Mbytes of emulation memory. The emulator operates with no wait states to emulation or target memory.

Up to seven ranges of memory may be configured as emulation RAM, emulation ROM, target system RAM, target system ROM, or guarded memory.

Analysis

The analyzer (HP 64704A) supplied with the MC68302 emulator monitors the emulation processor using an emulation analysis bus. This analyzer performs only state analysis, and is referred to as the *emulation analyzer*.

The optional *external analyzer* (HP 64703A) allows you to probe 16 individual lines in your target system. Thus you will have a total of 64 analysis channels (or 48 channels if you have upgraded from a HP 64742 M68000 emulator). The external analyzer lets you, for example, to watch the chip select lines, and to distinguish internal from external direct memory accesses. You can configure the external analyzer to perform state or timing analysis measurements. Refer to the *Analyzer Terminal Interface User's Guide* for a complete list of analyzer features.

Registers

You can display or modify the MC68302 internal register contents. This includes the ability to modify the program counter (PC) value so you can control where the emulator starts a program run.

Single-Step

You can direct the emulation processor to execute a single instruction or a specified number of instructions.

Breakpoints

You can set the emulator/analyzer interaction so the emulator will break to the monitor program when the analyzer finds a specific state or states, allowing you to perform post-mortem analysis of the program execution.

You can also set software breakpoints in your program. With the MC68302 emulator, setting a software breakpoint inserts a TRAP instruction into your program at the desired location.

Reset Support

The emulator can be reset from the emulation system under your control, or your target system can reset the emulation processor.

Real-Time Operation

Real-time signifies continuous execution of your program at full rated processor speed without interference from the emulator. (Such interference occurs when the emulator needs to break to the monitor to perform an action you requested, such as displaying target system memory.) Emulator features performed in real-time include running and analyzer tracing.

Emulator features not performed in real-time include displaying or modifying target system memory, loading or dumping any memory, and displaying or modifying registers.

Limitations

- The emulator does not support the CPU disable mode.
- Direct memory access (DMA) to emulation memory is not permitted.
- Memory coverage measurements are not supported by the HP 64746J emulator.

How the Components Communicate

The MC68302 emulation components communicate with each other as shown in figure 1-2. The arrows show the direction of communication. Refer to the *HP 64700-Series Emulators Hardware Installation And Configuration* manual for details on components that make up an HP 64700-Series emulation and analysis system.

Knowledge of the MC68302

If you are designing an MC68302 target system, you probably understand how the MC68302 microprocessor works. If you do not have a working knowledge of this processor, you should become familiar with this processor before continuing.

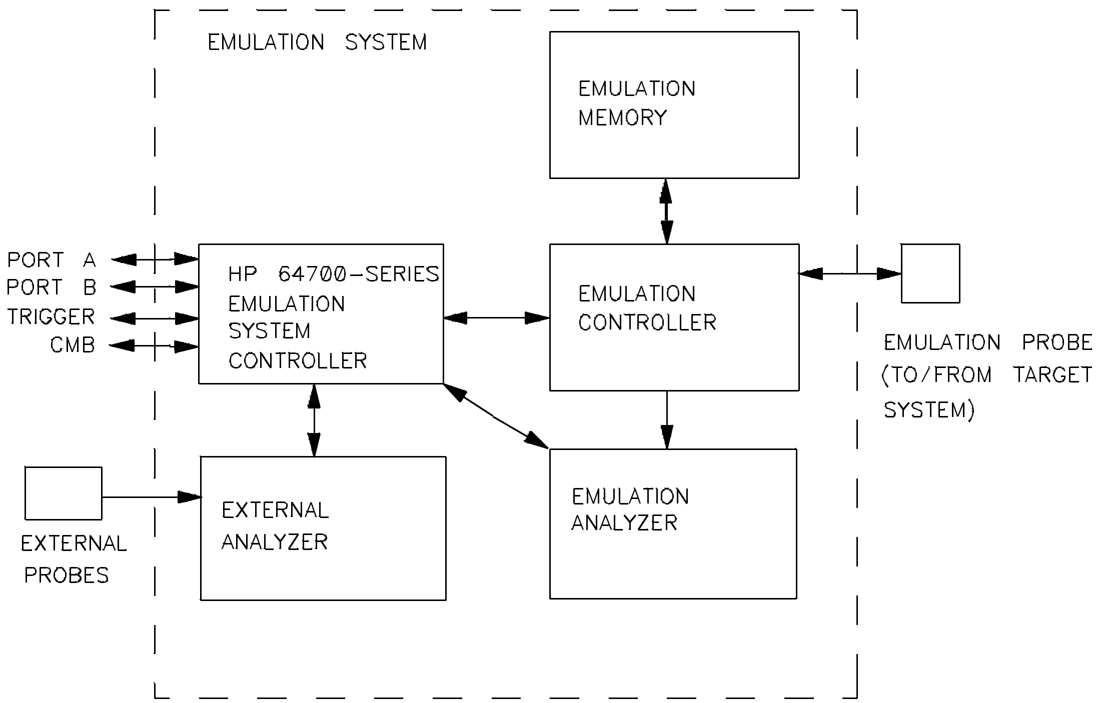

Figure 1-2. How the Components Communicate

Tips for Operating the Emulator

Note To operate the MC68302 emulator efficiently, read this section!

Don't Write to Low Memory

Remember that addresses $0 through $FF in the supervisor space are reserved for the MC68302 vector table.

In particular, address $0F2 is the BAR (base address) register and $0F4 is the SCR (system control) register. If you map these addresses as part of a data area, they may get overwritten, causing unpredictable processor behavior.

Be especially careful not to place the stack where it could grow into this area. For example, *never* place the stack at 100 hex.

Commands Which Stop the Processor

If your target system circuitry is dependent on constant execution of program code, you should set **cf rrt=en**. This will help insure that target system damage doesn't occur. You may also use **cf dbc=en** to drive the address, data, and control strobes while the background monitor is executing. However, remember that you can still execute the **rst**, **b** and **s** commands. You should use caution in executing these commands.

MC68302 Vector Table

All MC68302 emulation systems require a vector table to process system conditions, such as divide by zero or trace traps. You need to provide such a vector table to manage these conditions. Exception processing attempted without a vector table will cause unpredictable results. Most of the examples shown in this manual were created without a vector table to simplify the examples.

Remember not to map internal memory space to 0, thus overwriting the vector table. The internal space must be mapped as target RAM (tram). The BAR and SCR may be mapped as emulation RAM (eram), but you should use the **reg** (not **m**) command to modify or examine these locations.

Refer to the Motorola documentation for the MC68302 microprocessor for additional information about vector tables and exception processing.

Memory Access Mode

When in 8-bit mode, byte access is always used. In 16-bit mode, either byte or word access can be used. Use byte access mode (the default) unless a larger size is needed. See chapter 5, "Concepts," for a discussion of target system memory access.

Pin Protector

Do not use the probe without a pin protector installed. See chapter 5, "Concepts," for more information on protecting the emulator probe.

Chip Selects

The MC68302 chip selects can be configured either to generate the DTACK signal interally or to use an externally supplied DTACK. The emulator looks at two things to decide which source of the DTACK it should look for when a given chip select is active:

- The chip select lines (programmed using registers BR0-BR3). The source of DTACK for the chip select lines is determined by the corresponding DTACK field bits (programmed using OR0-OR3). The order in which you write these registers is significant.

- The emulator configuration (set using **cf cs0_dtk** through **cf cs3_dtk**). The effects of the emulator configuration are described in chapter 4.

Note

Be sure that the emulator configuration and the configuration of the chip select lines are consistent. Remember that the order in which you write the chip select registers BR0-BR3 and OR0-OR3 is significant.

Registers OR0-OR3 contain, among other things, a base address mask field. The base address mask is used to set the block size of the corresponding chip select line. The emulator assumes that this register will be programmed to map one contiguous block for the chip select line. The MC68302 processor does not enforce this rule, so you should be careful not to map several ranges for a specific chip select.

DTACK Interlock

Use the **cf dti** configuration item to select whether the emulator will look for or generate the DTACK signal. See chapter 4 for details.

SCR Register

The emulator does not set any bits in the System Control Register (SCR). You should set the FRZW bit in the SCR to avoid problems when breaking into the monitor via a watchdog timer RESET.

Connecting the emulator to the target system

The emulator supports connections to PGA sockets, 132-pin PQFP, and 144-pin TQFP package types for the Motorola MC68302.

Connecting the probe to a PGA socket

To avoid having to replace the entire probe because of a bent or broken pin, use a pin protector (that is, an extra PGA socket) between the probe and the target.

PGA sockets are available from Hewlett-Packard as HP part number 1200-1318. A MacKenzie Technology PGA-100M-003B1-1324 socket should also be suitable.

See chapter 5 for some important suggestions about using the emulator in-circuit.

Note

The emulator probe requires a PGA (pin grid array) socket. Be sure to use a PGA socket in your target system.

Follow these steps to install the probe in your target system:

1. Turn off power to the emulator and the target system.

2. Take any necessary precautions to avoid static discharge.

3. Remove the MC68302 processor from the target system PGA socket.

4. Plug the probe into a pin protector, if you have not already done so.

5. Plug the probe into your target system.

   Be sure to orient the probe correctly. Pin A1 of the PGA matrix is at the notched corner of the probe. (Note that pin "A1" of the PGA matrix is signal "A14." Pin numbers *do not* correspond to signal numbers for the MC68302.)

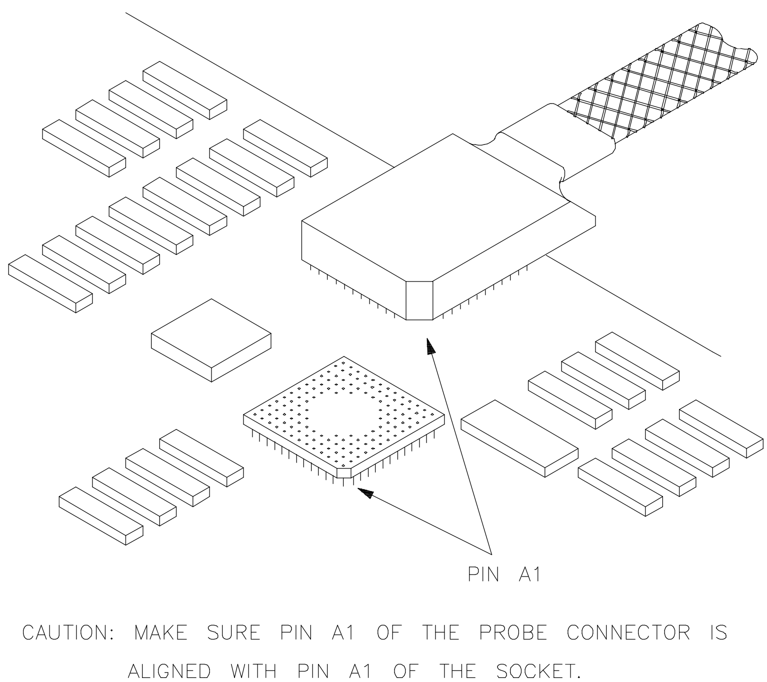

Figure 1-3. Connecting the Probe to a PGA Socket.

6. Turn on the emulator.

7. Turn on power to the target system.

   Turning on the emulator before the target system will prevent damage to sensitive components in the target system.

Connecting using a 132-pin QFP Probe Adapter Assembly

If your target system uses the MC68302FE surface mount (CQFP) or the MC68302FC surface mount (PQFP) package, you should order the following parts:

- HP E3408A PQFP/CQFP Adapter Kit which includes:
  - One HP E2414A QFP Probe Adapter Assembly (includes an HP E2414-63201 transition socket)
  - Two HP 64748-87608 Motorola MC22901PQFP132 dummy parts. Additional dummy parts can be ordered.

Caution

Equipment damage. The connections between the emulator probe, probe adapter assembly, and microprocessor (dummy part) on the target board are delicate and must be done with care. Refer to the Operating Note supplied with the probe adapter assembly for specific instructions when making the connection.

1. Install the "dummy" part in place of the microprocessor on your target system. The QFP Probe Adapter Assembly connects the dummy part to the emulator's PGA probe.

   Before connecting the emulator, a 132-pin PQFP "dummy part" (a mechanical sample with no internal connections) must be soldered onto the target system in place of the microprocessor. This is necessary because the MC68302 has no facility to three-state all of its signals. It is best to solder the dummy part onto the target system using automated surface mounting equipment to give more reliable probing. Hand soldering may result in solder wicking up the leads, which can prevent the probe adapter cable assembly from making good contact.

2. Select an orientation using the following illustration.

   A QFP Probe Adapter can be installed in one of four orientations as shown in the following illustration. This allows flexibility in attaching the emulator probe when target system components interfere. Select the orientation that best suits your target system, and note the position of Pin 1 on the microprocessor (dummy part) on your target board.

   There are two labels with color coding and bar coding on the QFP Probe Adapter; use these to ensure correct orientation when the probe adapter is connected to the emulator. Note the color or count the bars on the edge of the probe adapter that is placed over the Pin 1 side of the dummy part. (For example, Pin 1 of the dummy part may be along the side that is color coded yellow, or along the side that has three bars.) There is a corresponding edge on the PGA end of the probe adapter; it has the same color code and bar code. Connect the PIN 1 SIDE of the emulator probe into the PGA end of the probe adapter that has the same color code/bar code as is on the Pin 1 side of the microprocessor (dummy part).

3. Follow the instructions in the QFP Probe Adapter Assembly Operating Note to install the adapter assembly.

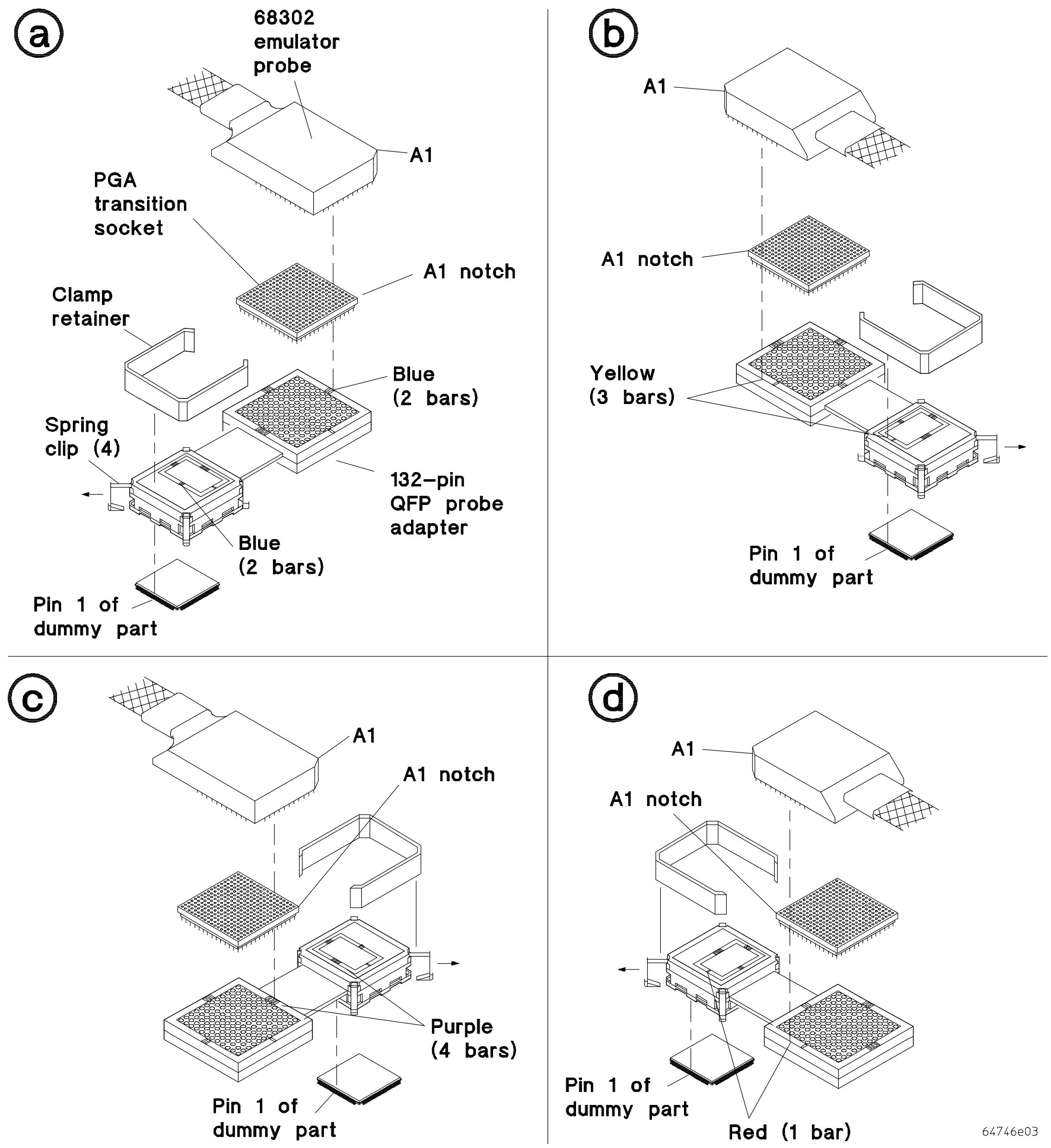

Figure 1-4. Connecting Using a QFP Adapter Assembly.

Connecting using the 144-pin HP Wedge Probing System

If your target system uses a 144-pin TQFP (thin quad flat pack) surface-mounted integrated circuit, you should order:

- HP E3438A Wedge Adapter Kit
  - HP E3435A Wedge
  - HP E3441A General-purpose Flexible Adapter
  - HP E5347-87601 Male-to-male Header
  - HP E3439A Transition Socket
  - HP E3435-97001 HP Wedge Probing System User’s Guide
  - Two HPE3435-87601 144-pin TQFP dummy parts

Caution

Equipment damage. Ensure that the emulator probe is aligned with the proper pins when connecting to the general-purpose flexible adapter. Serious equipment damage can result from improper connection. Refer to the User’s Guide supplied with the HP Wedge Probing System for instructions on installing the 144-pin HP Wedge probe adapter, male-to-male header, general-purpose flexible adapter, and transition socket.

---

1. Install the "dummy" part in place of the microprocessor on your target system. The QFP Probe Adapter Assembly connects the dummy part to the emulator’s PGA probe.

   Before connecting the emulator, a 144-pin TQFP "dummy part" (a mechanical sample with no internal connections) must be soldered onto the target system in place of the microprocessor. This is necessary because the MC68302 has no facility to three-state all of its signals. It is best to solder the dummy part onto the target system using automated surface mounting equipment to give more reliable probing. Hand soldering may result in solder wicking up the leads, which can prevent the probe adapter cable assembly from making good contact.

2. Select an orientation using the following illustration.

   The HP Wedge Probing System can be installed in one of four orientations as shown in the following illustration. This allows flexibility in attaching the emulator probe when target system components interfere. Select the orientation that best suits your target system, and note the position of Pin 1 on the microprocessor (dummy part) on your target board.

   There are two labels with color coding and bar coding on the general-purpose flexible adapter; use these to ensure correct orientation when the flexible adapter is connected to the emulator. Note the color or count the bars on the edge of the general-purpose flexible adapter that is placed over the Pin 1 side of the dummy part. (For example, Pin 1 of the dummy part may be along the side that is color coded yellow, or along the side that has three bars.) There is a corresponding edge on the other end of the general-purpose flexible adapter; it has the same color code and bar code. Connect the PIN 1 SIDE of the emulator probe into the end of the general-purpsoe flexible adapter that has the same color code/bar code as is on the Pin 1 side of the microprocessor (dummy part).

3. Follow the instructions in the HP Wedge Probing System User's Guide to install the probing system.

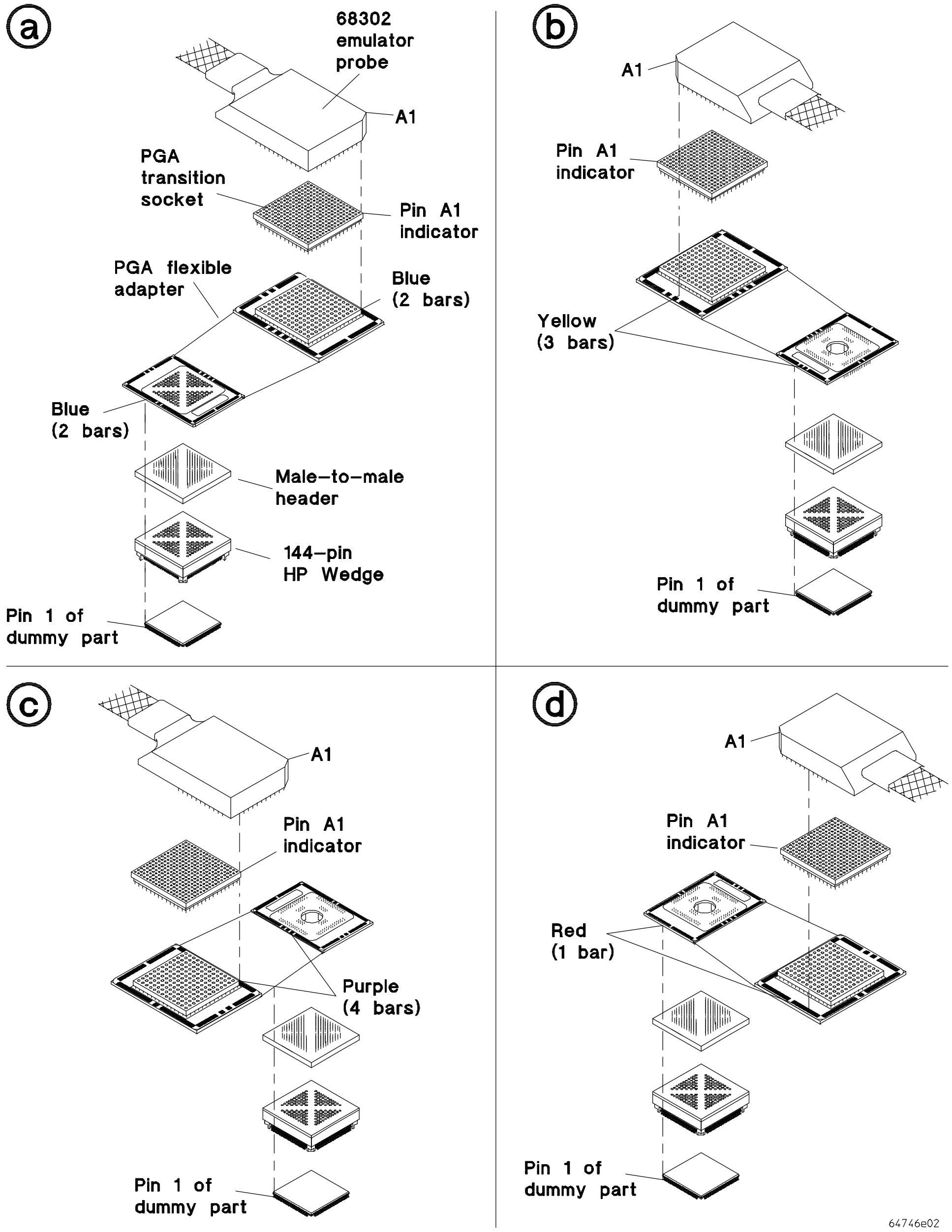

Figure 1-5. Connecting Using the HP Wedge Probing Sys.

Other Sources of Information

If you need other references while operating the emulator, refer to the manuals listed in table 1-1. Note that several manuals may appear in one binder.

Table 1-1. Other Sources of Information

Manual	Description
HP 64700-Series Emulators Terminal Interface Reference	Terminal Interface emulation, analysis, and CMB commands used to control the emulator.
Analyzer Terminal Interface User's Guide	How to use the emulation and external analyzers. Analysis commands are described in the *Terminal Interface Reference.*
CMB User's Guide	How to use the M68302 emulator with the CMB.
M68302 Assembler/Linker User's Guide	How to assemble and link programs using the HP 64870 Cross Assembler/Linker/Librarian.
M68302 PC Interface User's Guide	How to use the emulator with a PC.
M68302 Softkey Interface User's Guide	How to use the M68302 emulator with the Softkey Interface on a Sun or HP workstation.
Graphical User Interface User's Guide	How to use the Graphical User Interface on a Sun or HP workstation.
MC68302 Integraged Multi-Protocol Processor User's Manual	Describes the M68302 microprocessor. (Motorola part MC68302UM/AD).
HP 64700-Series Emulators Support Services	If all else fails, refer to this manual to locate information about support for your product.

2

Getting Started

Before Using the HP 64746

If you haven't already done so, connect the emulator to the host computer. If necessary, refer to the *HP 64700-Series Emulators Hardware Installation And Configuration* manual for details. Then return here.

Things to Know Before You Begin

Before working the examples in this chapter, be sure you know the following:

Know Your System Configuration

Determine which system configuration you will use (either standalone, transparent, or remote). Refer to the *HP 64700-Series Emulators Hardware Installation And Configuration* manual for additional information.

If you are using the Remote Configuration, you must have completed installation and configuration of a terminal emulator program which will allow your host to act as a terminal connected to the emulator. In addition, you must start the terminal emulator program before you can work the examples in this chapter. Refer to the *HP 64700-Series Emulators Hardware Installation And Configuration* manual and the appropriate terminal emulator software manual (such as that for HP AdvanceLink).

Know the Basic Concepts of Emulation

You should read and understand the concepts of emulation presented in the *HP 64700-Series Emulators System Overview* manual. A brief understanding of these concepts may help avoid questions later.

Apply Power

Caution

POSSIBLE DAMAGE TO TARGET SYSTEM!

The emulator power must be turned on **before** the target system power. An excess amount of current may be drawn out of the target system and the target system may be damaged if the order is reversed. Likewise, the target system should be turned off first and then the emulator.

Apply power to the emulator if you haven't already done so. After power is applied, the following information should be displayed.

```
                  Copyright (c) Hewlett-Packard Co. 1987
All Rights Reserved.  Reproduction, adaptation, or translation without prior
written permission is prohibited, except as allowed under copyright laws.

  HP64700 Series Emulation System
    Version:   A.03.00 13Dec90

  HP64746A (PPN: 64746A) Motorola 68302 Emulator
    Version:   A.00.03  24Jun91
    Control:   HP64170A Memory Control Board
```

You will also see information about the amount of memory installed in each bank on the memory control board.

If a message like the one above is not displayed, refer to the *Support Services* manual.

About the Prompts

Press **<RETURN>** to display one of these prompts:

U> (emulator is running user code)
R> (emulation processor is reset - in normal mode)
M> (emulator is running in monitor)

Upon powerup the prompt should be R>.

If No Prompt is Displayed

If one of the prompts (U>, R>, or M>) is not displayed, cycle power on the emulator. The prompt character should be an R> at this point.

If the emulator still doesn't respond, toggle data communication switch 4 (refer to the *HP 64700-Series Emulators Installation And Configuration* manual). Cycle power on the emulator. Then press **<RETURN>** again.

If one of the prompts still does not appear after you have done this, refer to the *HP 64700-Series Emulators Support Services* manual for information about how to resolve this problem. The *Support Services* manual contains a list of Hewlett-Packard Sales and Service Offices that you can use to contact your HP Representative.

Note

One of these prompts must appear before you can continue.

Note

All HP 64700-Series commands must be entered using lower case letters. Follow each of the commands by pressing **<RETURN>** on your terminal (or **<ENTER>** on your personal computer) unless instructed otherwise.

Do not place spaces before or after ".." and "="; doing so will result in an "Invalid option or operand" error.

Description of the Prompts

The prompts for the emulator are:

c> The c> prompt means that the emulator is in external clock mode (set using **cf clk=ext**) and is waiting for a clock signal from the target system. If the target power has not been applied do so now. Then press **<RETURN>**. The R> prompt should be present now.

R>	The processor is being held reset from the emulator.
r>	The processor is being held reset, but not from the emulator.
h>	The processor is halted.
g>	The bus has been granted for direct memory access (DMA).
w>	A memory cycle has started but has not completed. This is caused when no device has issued a termination signal (DTACK or BERR) to the processor.
W>	This indicates the emulator is waiting for the CMB ready signal.
M>	The emulator is executing in the monitor.
b>	No external bus cycles are occurring. Usually the emulator can determine why this is the case and will display the prompt such as w>, c>, or r> to indicate the cause of no bus cycles. If no reason can be determined, the b> prompt will be displayed. One possibility is that a STOP instruction was executed.

Initialize the Emulator

If you plan to use the MC68302 emulator to follow the exercises in this chapter, verify that no one else is using the emulator.

Caution

POSSIBLE LOSS OF INFORMATION!

It is important that you verify that no one else is using the emulator at this time. If you or someone else is operating the MC68302 emulator in a standalone configuration controlled by a data terminal, and have entered a program into memory by manually modifying the memory locations, this information will be lost during the initialization process.

To display the available initialization options, enter:

```
M>help init
  init - reinitialize system

    init      - limited initialization; resets emulation and analysis products
                but not environment (macros, equates, date & time, etc.)
    init -c   - complete initialization; does not run system memory
                integrity tests
    init -p   - powerup initialization; run from reset with complete
                system verification tests
```

Notice that the **init** command performs the following:

- Resets the emulation configuration items.
- Resets the break conditions.
- Clears software breakpoints.

The **init** command does not clear macros or equates (logical expressions).

To initialize the emulator, enter:

```
M>init
  #Limited initialization completed
```

Other Initialization Options

The **-c** and **-p** options to the **init** command allow you to perform a more complete initialization of the emulator. The **init -c** command performs a cold-start initialization, except that performance verification tests are not executed. The **init -p** command performs a powerup initialization, which is also referred to as a cold-start initialization. This process includes emulator, analyzer, system controller, communications port, and performance verification initialization.

Using the Help Facility

If you need quick reference information about a command or a set of commands, you can use the built-in **help** facilities. For example, to display the **help** menu, enter:

```
R>help

  help  - display help information

    help <group>         - print help for desired group
    help -s <group>      - print short help for desired group
    help <command>       - print help for desired command
    help                 - print this help screen

  --- VALID <group> NAMES ---
    gram     - system grammar
    proc     - processor specific grammar

    sys      - system commands
    emul     - emulation commands
    trc      - analyzer trace commands
    xtrc     - external trace analysis commands
    *        - all command groups
```

You can enter the **?** symbol in place of the word "**help**." If you want to display information about the emulation command group, enter:

```
R>? emul

  emul - emulation commands
  -----------------------------------------------------------------------------
  b......break to monitor  cp.....copy memory       mo.....modes
  bc.....break condition   dump...dump memory       r......run user code
  bp.....breakpoints       es.....emulation status  reg....registers
  cf.....configuration     io.....input/output      rst....reset
  cim....copy target image load...load memory       rx.....run at CMB execute
  cmb....CMB interaction   m......memory            s......step
                           map....memory mapper     ser....search memory
```

To display information for a single command, type **help** (or **?**) and the command name. For example:

```
R>help load

  load - download absolute file into processor memory space

    load -i          - download intel hex format
    load -m          - download motorola S-record format
    load -t          - download extended tek hex format
    load -S          - download symbol file
    load -h          - download hp format (requires transfer protocol)
    load -a          - reserved for internal hp use
    load -e          - write only to emulation memory
    load -u          - write only to target memory
    load -o          - data received from the non-command source port
    load -s          - send a character string out the other port
    load -b          - data sent in binary (valid with -h option)
    load -x          - data sent in hex ascii (valid with -h option)
    load -q          - quiet mode
    load -p          - record ACK/NAK protocol (valid with -imt options)
    load -c <file>   - data is received from the 64000. file name format is:
                       <filename>:<userid>:absolute
```

Configure the Emulator

You may want to change the default emulator configuration items before proceeding. To do this, refer to chapter 4 for detailed information. When you are finished, return here.

Software

Supported Absolute Files

Supported absolute file formats that you can download into the target system include, HP, Intel hex, Motorola S-records, and Tektronix hex. To download executable code in HP format you must use the HP 64700-Series MC68302 Emulator PC Interface or Softkey Interface.

Assembler/Linker

Assembly language support for the MC68302 includes:

- HP 64870 HP 9000-based M68000 Assembler/Linker/Librarian . (This assembler generates code for the M68000, M68008, M68010, MC68302, M68332, and M68020 processors. The product number for Apollo computers is HP B1423 .)

C Compiler

High-level language support for the MC68302 includes:

- HP 64902 HP 9000-based M68000 C Compiler (Product number B1421 for Apollo computers)

Branch Validator

Branch analysis support includes:

- HP B1419 HP Branch Validator

About the Other Interfaces

HP provides easy-to-use emulator interfaces for the following host computers:

- Personal computers
- HP 9000 Series 300 workstations
- HP 9000 Series 700 workstations
- Sun workstations

These interfaces provide menu-driven access to emulator commands, disassembly, high-level source code debugging, and many other features to make your job easier.

Example Program

The rest of this chapter will lead you through a basic, step by step tutorial designed to familiarize you with the use of the HP 64700 emulator for the 68302 microprocessor. When you have completed this chapter, you will be able to perform these tasks:

- Set up an emulation configuration for out of circuit emulation use.
- Map memory.
- Transfer a small program into emulation memory.
- Use run/stop controls to control operation of your program.
- Use memory manipulation features to alter the program's operation.
- Use analyzer commands to view the real time execution of your program.

A Look at the Sample Program

The sample program "COMMAND_READER" used in this chapter is shown in figure 2-1. The program is a primitive command interpreter.

Data Declarations

INPUT_POINTER and OUTPUT_POINTER define the address locations of an input area and an output area to be used by the program. MESSAGE_A, MESSAGE_B and INVALID_INPUT are the messages used by the program to respond to various command inputs.

Initialization

The locations of the input and output areas are moved into address registers for use by the program. Next, the CLEAR routine clears the command byte (the first byte location pointed to by the input area address - 3000 hex).

```
Command line: as68k -Lh newprog.s
Line Address
                                             CHIP    68000
                                             SECTION DATA,,D
     00000000 0000 3000         INPUT_POINTER  DC.L 00003000H
     00000004 0000 4000         OUTPUT_POINTER DC.L 00004000H
     00000008 5448 4953 2049    MESSAGE_A     DC.B     'THIS IS MESSAGE A'
              5320 4D45 5353
              4147 4520 41
     00000019 5448 4953 2049    MESSAGE_B     DC.B     'THIS IS MESSAGE B'
              5320 4D45 5353
              4147 4520 42
     0000002A 494E 5641 4C49    INVALID_INPUT DC.B     'INVALID COMMAND'
              4420 434F 4D4D
              414E 44
                                             SECTION PROG,,C,P
     00000000 2479 0000 0000  R INIT          MOVE.L INPUT_POINTER,A2
     00000006 2679 0000 0004  R               MOVE.L OUTPUT_POINTER,A3
     0000000C 14BC 0000         CLEAR         MOVE.B #00H,(A2)
     00000010 1012              READ_INPUT    MOVE.B (A2),D0
     00000012 0C00 0000                       CMP.B #00h,D0
     00000016 67F8                            BEQ READ_INPUT
     00000018 0C00 0041         PROCESS_COMM  CMP.B #41H,D0
     0000001C 6700 000E                       BEQ COMMAND_A
     00000020 0C00 0042                       CMP.B #42H,D0
     00000024 6700 0014                       BEQ COMMAND_B
     00000028 6000 001E                       BRA UNRECOGNIZED
     0000002C 103C 0011         COMMAND_A     MOVE.B #11H,D0
     00000030 207C 0000 0008  R               MOVE.L #MESSAGE_A,A0
     00000036 6000 001A                       BRA OUTPUT
     0000003A 103C 0011         COMMAND_B     MOVE.B #11H,D0
     0000003E 207C 0000 0019  R               MOVE.L #MESSAGE_B,A0
     00000044 6000 000C                       BRA OUTPUT
     00000048 103C 000F         UNRECOGNIZED  MOVE.B #0FH,D0
     0000004C 207C 0000 002A  R               MOVE.L #INVALID_INPUT,A0
     00000052 224B              OUTPUT        MOVE.L A3,A1
```

Figure 2-1. Listing of newprog.s.

```
Line Address
00000054 123C 0020         CLEAR_OLD     MOVE.B #20H,D1

00000058 2A4B                            MOVE.L A3,A5
0000005A 1AFC 0000         CLEAR_LOOP    MOVE.B #00H,(A5)+
0000005E 0441 0001                       SUBI #01H,D1
00000062 66F6                            BNE CLEAR_LOOP

00000064 12D8              LOOP          MOVE.B (A0)+,(A1)+
00000066 0440 0001                       SUBI #01H,D0
0000006A 66F8                            BNE LOOP
0000006C 4EFA FF9E                       JMP CLEAR


                                         END
```

Figure 2-2. Listing of newprog.s (continued).

Read_Input

This routine continuously reads the byte at location 3000 hex until it is something other than a null character (00 hex); when this occurs, the PROCESS_COMM routine is executed.

Process_Comm

Compares the input byte (now something other than a null) to the possible command bytes of "A" (ASCII 41 hex) and "B" (ASCII 42 hex), then jumps to the appropriate set up routine for the command message. If the input byte does not match either of these values, a branch to a set up routine for an error message is executed.

Command_A, Command_B, Unrecognized

These routines set up the proper parameters for writing the output message: the number of bytes in the message is moved to the D0 register and the base address of the message in the data area is moved to address register A0.

Output

First the base address of the output area is copied to A1 (this preserves A3 for use in later program passes). Then the CLEAR_OLD routine writes nulls to 32 bytes of the output area (this serves both to initialize the area and to clear old messages written during previous program passes).

Finally, the proper message is written to the output area by the LOOP routine. When done, LOOP jumps back to CLEAR and the command monitoring process begins again.

Using the various features of the emulator, we will show you how to load this program into emulation memory, execute it, monitor the program’s operation with the analyzer, and simulate entry of different commands utilizing the memory access commands provided y the HP 64700 command set.

Initialize the Emulator to a Known State

To initialize the emulator to a known state for this tutorial:

Note

It is especially important that you perform the following step if the emulator is being operated in a standalone mode controlled by only a data terminal. The only program entry available in this mode is through memory modification; consequently, if the emulator is reinitialized, emulation memory will be cleared and a great deal of tedious work could be lost.

1. Verify that no one else is using the emulator or will have need of configuration items programmed into the emulator.

2. Initialize the emulator by typing the command:

R> init -p

Set Up the Proper Emulation Configuration

Set Up Emulation Conditions

To set the emulator's configuration values to the proper state for this tutorial, do this:

1. Type:

R> cf

You should see the following configuration items displayed:

```
R>cf
  cf ba=en
  cf trc_dma=dis
  cf bbk=0
```

```
cf bfc=sp
cf be=dis
cf clk=int
cf dbc=en
cf dti=dis
cf lfc=x
cf mon=bg
cf rrt=dis
cf rssp=9
cf swtp=0
cf ti=dis
cf im=nor
cf int7=lev
cf iack7=pb0
cf pdw=16
cf cs0_dtk=int
cf cs1_dtk=ext
cf cs2_dtk=ext
cf cs3_dtk=ext
```

Note

The individual configuration items won’t be explained in this example; refer to chapter 4 of this manual and the Reference manual for details.

2. If the configuration items displayed on your screen don’t match the ones listed above, here is how to make them agree:

   For each configuration item that does not match, type:

```
R> cf <config_item>=<value>
```

   For example, if you have the following configuration items displayed (those in bold indicate items different from the list above):

cf ba=en
cf bat=dis
cf bbk=0
cf be=dis
cf bfc=sp
cf clk=ext
cf dbc=dis
.
.
.

   To make these configuration values agree with the desired values, type:

```
R> cf clk=int
R> cf dbc=en
```

3. Let’s go ahead and set up the proper break conditions.

Type:

R> bc

You will see:

```
bc -d bp #disable
bc -d rom #disable
bc -d bnct #disable
bc -d cmbt #disable
bc -d trig1 #disable
bc -d trig2 #disable
```

For each break condition that does not match the one listed, use one of the following commands:

To enable break conditions that are currently disabled, type:

R> bc -e <breakpoint type>

To disable break conditions that are currently enabled, type:

R> bc -d <breakpoint type>

For example, if typing bc gives the following list of break conditions:

(items in bold indicate improper values for this example)

bc -d bp #disable
bc -d rom #disable
bc -d bnct #disable
bc -d cmbt #disable
bc -e trig1 **#enable**
bc -e trig2 **#enable**

Type the following commands to set the break conditions correctly for this example:

R> bc -e rom

(this enables the write to ROM break)

R> bc -d trig1 trig2

(this disables break on triggers from the analyzer)

4. To avoid problems later while modifying and displaying memory locations, type:

R> mo -ab -db

This sets the access and display modes for memory operation to byte. (If they are left at the default mode of word, the memory modification and display examples will not function correctly.)

Map Memory

The high-speed emulation memory can be mapped at a resolution of 1 kilobyte.

Emulation memory allows you to store programs and data used in development before target system memory is available. For this example, you will need to map some of the memory blocks to various type designators. Do the following:

Type:

```
R> map 1000..1fff eram
R> map 2000..2fff erom
R> map 3000..5fff eram
R> map 0fff000..0ffffff tram
```

Set Up the Stack Pointer

After emulator initialization, the "reset supervisor stack pointer" configuration item (cf rssp) and the supervisor stack pointer are set to an odd value. Since you cannot run the emulator when the supervisor stack pointer is odd, you must set up the supervisor stack pointer register to contain an even value. You can do this by using the reg command to modify the supervisor stack pointer, or you can change the reset supervisor stack pointer configuration item (as shown below). The value you assign to the rssp configuration item is placed into the supervisor stack pointer on the entrance to the emulation monitor from an emulation initiated RESET state (the R> prompt).

For this example, we will define the stack pointer within one of the areas mapped earlier.

Type:

```
R>cf rssp=5000
R>b
```

This defines register A7 (the supervisor stack pointer) as 5000 hex. The stack will grow downward in memory from this location; for purposes of our example, it will not grow far enough to interfere with the output area for the program defined at 4000 hex. (The 68302 emulator does not provide stack checking hardware or software to guard against program destruction from an overgrown stack; your program must provide such protection.)

To get the "M>" prompt shown in the next section, type:

```
R>b
M>
```

Transfer Code into Memory

From a Terminal in Standalone Configuration

To transfer code into memory from a data terminal running in standalone mode, you must use the modify memory commands. This is necessary because you have no host computer transfer facilities to automatically download the code for you (as you would if you were using the transparent configuration or the remote configuration.)

To minimize the effects of typing errors, you will modify only one row of memory at a time in this example. Do the following:

Note

Make sure that you have modified the memory access mode default to byte as instructed earlier, before you proceed with memory modification. If you are in doubt, type mo at the prompt. If you see mo -ab -db, your setup is fine. Otherwise, type **mo -ab -db** at the prompt to set the memory display and modification modes.

1. Enter the data information for the program by typing the following commands:

```
M> m 1000..100f=00,00,30,00,00,00,40,00,54,48,49,53,20,49,53,20
M> m 1010..101f=4d,45,53,53,41,47,45,20,41,54,48,49,53,20,49,53
M> m 1020..102f=20,4d,45,53,53,41,47,45,20,42,49,4e,56,41,4c,49
M> m 1030..1038=44,20,43,4f,4d,4d,41,4e,44
```

If you make a mistake, enable command line editing by typing:

```
M> cl -e
```

The commands for command line editing are described in the "Command Entry" chapter of the *Terminal Interface Reference.* You can see a summary of the editing commands by typing:

```
M> help cl
```

1. You should now verify that the data area of the program is correct by typing:

M> m 1000..1038

You should see:

```
001000..00100f     00 00 30 00 00 00 40 00 54 48 49 53 20 49 53 20
001010..00101f     4d 45 53 53 41 47 45 20 41 54 48 49 53 20 49 53
001020..00102f     20 4d 45 53 53 41 47 45 20 42 49 4e 56 41 4c 49
001030..001038     44 20 43 4f 4d 4d 41 4e 44
```

If this is not correct, you can correct the errors by re-entering only the modify memory commands for the particular rows of memory that are wrong.

For example, if row 1000..100f shows these values:

```
001000..00100f     00 30 00 00 00 40 00 54 48 49 53 20 49 53 20 20
```

you can correct this row of memory by typing:

```
M> m 1000..100f=00,00,30,00,00,00,40,00,54,48,49,53,20,49,53,20
```

Or, you might need to modify only one location, as in the instance where address 100f equals 32 hex rather than 20 hex. Type:

M> m 100f=20

2. Enter the program information by typing the following commands:

```
M> m 2000..200f=24,79,00,00,10,00,26,79,00,00,10,04,14,0bc,00,00
```

(note the third from last term **--** hex letters must be preceded by a digit)

```
M> m 2010..201f=10,12,0c,00,00,00,67,0f8,0c,00,00,41,67,00,00,0e
M> m 2020..202f=0c,00,00,42,67,00,00,14,60,00,00,1e,10,3c,00,11
M> m 2030..203f=20,7c,00,00,10,08,60,00,00,1a,10,3c,00,11,20,7c
M> m 2040..204f=00,00,10,19,60,00,00,0c,10,3c,00,0f,20,7c,00,00
M> m 2050..205f=00,2a,22,4b,12,3c,00,20,2a,4b,1a,0fc,00,00,04,41
M> m 2060..206f=00,01,66,0f6,12,0d8,04,40,00,01,66,0f8,4e,0f9,00,00-
M> m 2070..2071=20,0c
```

You should now verify that the program area is correct by typing:

`M> m 2000..2071`

You should see:

```
002000..00200f      24 79 00 00 10 00 26 79 00 00 10 04 14 bc 00 00
002010..00201f      10 12 0c 00 00 00 67 f8 0c 00 00 41 67 00 00 0e
002020..00202f      0c 00 00 42 67 00 00 14 60 00 00 1e 10 3c 00 11
002030..00203f      20 7c 00 00 10 08 60 00 00 1a 10 3c 00 11 20 7c
002040..00204f      00 00 10 19 60 00 00 0c 10 3c 00 0f 20 7c 00 00
002050..00205f      00 2a 22 4b 12 3c 00 20 2a 4b 1a fc 00 00 04 41
002060..00206f      00 01 66 f6 12 d8 04 40 00 01 66 f8 4e f9 00 00
002070..002071      20 0c
```

If this is not correct, you can correct the errors by re-entering only the modify memory commands for the particular rows of memory that are wrong.

For example, if row 2000..200f shows the values

```
002000..00200f      24 79 00 10 00 26 79 00 00 10 04 14 bd 00 00 00
```

you can correct this row of memory by typing:

```
M> m 2000..200f=24,79,00,00,10,00,26,79,00,00,10,04,14,0bc,00,00
```

From a Host in Transparent Configuration

The method provided in this example assumes that you are using the Hewlett-Packard’s 68000 Cross Assembler/ Linker/Loader (HP product number 64870 if you are using an HP Series 9000 computer). In addition, you must have the HP 64000 transfer software running on your host.

If you are using another assembler, you may be able to adapt the methods below to load your code into the emulator (refer to the HP 64700 Terminal Interface User’s Reference manual for help).

If you are not able to transfer code from your host to the emulator using one of these methods, use the method described previously under "From a Terminal in Standalone Mode", as it will work in all cases. However, transferring code using host transfer facilities is easier and faster than modifying memory locations, especially for large programs.

1. First, you must establish communications with your host computer through the transparent mode link provided in the HP 64700. Enable the transparent mode link by typing:

```
M> xp -e
```

   If you then press <RETURN> a few times, you should see:

```
login:
login:
login:
```

   This is the login prompt for the host system. (Your prompt may differ depending on how your system manager has configured your system.)

2. Log in to your host system and start up an editor such as "vi". You should now enter the source code for the sample program shown at the beginning of the chapter. When finished, save the program to filename "newprog.s".

Note

If you need help learning how to log in to your host system or use other features of the system, such as editors, refer to the host documentation (for an HP-UX host, read the **HP-UX Concepts and Tutorials** guides) or ask your system administrator.

---

3. Assemble your code with the 68000 Cross Assembler using the command:

```
$ as68k -Lh newprog.s  newprog.lis
```

   This will generate an expanded listing with cross reference table of all the symbols used. If any assembly errors were reported, re-edit your file and verify that the code was entered correctly (compare to the listing at the beginning of the chapter).

4. Link the program to the correct addresses.

Using your editor, create a linker command file called "newprog.cmd":

```
NAME newprog
LIST C,D,O,P,S,T,X
ORDER PROG,DATA
SECT DATA=1000H
SECT PROG=2000H
LOAD newprog.o
END
```

Now link using the command using the command:

$ ld68k -c newprog.cmd -Lh

Now it's time to transfer your code into the emulator. Do the following:

1. Disable the transparent mode so that your terminal will talk directly to the emulator. Type:

$ <ESC>g xp -d

The "<ESC>g" sequence temporarily toggles the transparent mode so that the emulator will accept commands; "xp -d" then fully disables the transparent mode.

2. Load code into the emulator by typing:

M> load -hbo
transfer -tb newprog.X<ESC>g (NOTE: DO NOT TYPE CARRIAGE RETURN!)

The system will respond:

##
M>

load -hbo tells the emulator to load code expected in HP binary file format and to expect the data from the other port (the one connected to the host). It then puts you in communication with the host; you then enter the transfer command to start the HP 64000 transfer utility. Typing "<ESC>g" tells the system to return to the emulator after transferring the code. The "##" marks returned by the system indicates that the emulator loaded two records from the host.

3. At this point you should examine a portion of memory to verify that your code was loaded correctly. Type:

M> m 1000..1038

You should see:

```
001000..00100f      00 00 30 00 00 00 40 00 54 48 49 53 20 49 53 20
001010..00101f      4d 45 53 53 41 47 45 20 41 54 48 49 53 20 49 53
001020..00102f      20 4d 45 53 53 41 47 45 20 42 49 4e 56 41 4c 49
001030..001038      44 20 43 4f 4d 4d 41 4e 44
```

If your system does not match, verify that you entered the source code and linker command file correctly.

Looking at Your Code

Now that you have loaded your code into memory, you can display it in mnemonic format. Type:

```
M> sym start=2000
M> m -dm 2000..206d
```

You will see:

```
0002000  start         MOVEA.L 0001000,A2
0002006  -             MOVEA.L 0001004,A3
000200c  -             MOVE.B  #000,[A2]
0002010  -             MOVE.B  [A2],D0
0002012  -             CMPI.B  #000,D0
0002016  -             BEQ.B   0002010
0002018  -             CMPI.B  #041,D0
000201c  -             BEQ.W   000202c
0002020  -             CMPI.B  #042,D0
0002024  -             BEQ.W   000203a
0002028  -             BRA.W   0002048
000202c  -             MOVE.B  #011,D0
0002030  -             MOVEA.L #000001008,A0
0002036  -             BRA.W   0002052
000203a  -             MOVE.B  #011,D0
000203e  -             MOVEA.L #000001019,A0
0002044  -             BRA.W   0002052
0002048  -             MOVE.B  #00f,D0
000204c  -             MOVEA.L #00000102a,A0
0002052  -             MOVEA.L A3,A1
0002054  -             MOVE.B  #020,D1
0002058  -             MOVEA.L A3,A5
000205a  -             MOVE.B  #000,[A5]+
000205e  -             SUBI.W  #00001,D1
0002062  -             BNE.B   000205a
0002064  -             MOVE.B  [A0]+,[A1]+
0002066  -             SUBI.W  #00001,D0
000206a  -             BNE.B   0002064
000206c  -             JMP     000200c[PC]
```

Familiarize Yourself with the System Prompts

Note

The following steps are not intended to be complete explanations of each command; the information is only provided to give you some idea of the meanings of the various command prompts you may see and reasons why the prompt changes as you execute various commands.

You should gain some familiarity with the HP 64700 emulator command prompts by doing the following:

1. Ignore the current command prompt. Type:

```
M> rst
```

You will see:

```
R>
```

The rst command resets the emulation processor and holds it in the reset state. The "R>" prompt indicates that the processor is reset.

2. Type:

```
R> r 2000
```

You will see:

```
U>
```

The **r** (run) command causes the emulation processor to begin executing from the current program counter address or from the specified address.

The "U>" prompt indicates that the emulation processor is running in foreground, rather than in the monitor. When you have a program loaded into memory, this prompt indicates that the processor is running a user program.

Note

This prompt (U>) will be displayed if there is user code to run, or if you try to run the processor and no breaks occur.

3. To cause the emulator to begin executing in the monitor, enter:

```
U> b
```

You will see:

```
M>
```

The **b** (break) command causes the emulation processor to stop execution of whatever it is doing and begin executing in the emulation monitor. The newly displayed "M>" prompt indicates that the emulator is running in the monitor.

To view all of the possible emulator prompts (emulation status characters), enter:

```
M>help proc
```

Running the Sample Program

1. Type:

M> r 2000

The emulator changes state from background to foreground and begins running the sample program from location 2000 hex.

Note

The default number base for address and data values within HP 64700 is hexadecimal. Other number bases may be specified. Refer to the "Expressions" chapter of the *HP 64700 Terminal Interface Reference* manual for further details.

---

2. Let's look at the registers to verify that the address registers were properly initialized with the pointers to the input and output areas. Type:

U> reg

You will see:

```
reg pc=00000000 st=2700 d0=00000000 d1=00000000 d2=00000000 d3=00000000
reg d4=00000000 d5=00000000 d6=00000000 d7=00000000 a0=00000000 a1=00000000
reg a2=00000000 a3=00000000 a4=00000000 a5=00000000 a6=00000000 a7=00005000
reg usp=00000000 ssp=00005000 bar=bfff scr=00000f00
```

Notice that A2 contains 3000 hex; A3 contains 4000 hex.

3. Verify that the input area command byte was cleared during initialization.

Type:

U> m -db 3000

You will see:

```
003000..003000     00
```

The input byte location was successfully cleared.

4. Now we will use the emulator features to make the program work. Remember that the program writes specific messages to the output area depending on what the input byte location contains. Type:

```
U> m 3000=41
```

This modifies the input byte location to the hex value for an ASCII "A". Now let's check the output area for a message.

```
U> m 4000..401f
```

You will see:

```
004000..00400f     54 48 49 53 20 49 53 20 4d 45 53 53 41 47 45 20
004010..00401f     41 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

These are the ASCII values for MESSAGE_A.

Repeat the last two commands twice. The first time, use 42 instead of 41 at location 3000 and note that MESSAGE_B overwrites MESSAGE_A. Then try these again, using any number except 00, 41, or 42 and note that the INVALID_INPUT message is written to this area.

Tracing Program Execution

Now let's use the emulation analyzer to trace execution of the program. Suppose that you would like to start the trace when the analyzer begins writing data to the message output area. You can do this by specifying an analyzer trigger upon encountering the address 4000 hex. Furthermore, you might want to store only the data written to the output area. This can be accomplished by modifying what is known as the "analyzer storage specification".

Note

For this example, you will be using the analyzer in the easy configuration, which simplifies the process of analyzer measurement setup. The complex configuration allows more powerful measurements, but requires more interaction from you to set up those measurements. Such examples will be covered in later chapters. For more information on easy and complex analyzer configurations and the analyzer, refer to the HP 64700 Analyzer User's Guide and the User's Reference.

Now, let's set the trigger specification. Type:

```
M> tg addr=4000
```

Do you remember how to get the "M>" prompt? Type "b" to break from the running prompt "U>" to the monitor prompt "M>". The commands in this section will also work if you type them at the "U>" prompt.

To store only the accesses to the address range 4000 through 4011 hex, type:

```
M> tsto addr=4000..4011
```

Let's change the data format of the trace display so that you will see the output message writes displayed in ASCII format:

```
M> tf addr,h data,A count,R seq
```

Start the trace by typing:

```
M> t
```

You will see:

```
Emulation trace started
```

To start the emulation run, type:

```
M> r 2000
```

Now, you need to have a "command" input to the program so that the program will jump to the output routines (otherwise the trigger will not be found, since the program will never access address 4000 hex). Type:

```
U> m 3000=41
```

To display the trace list, type:

```
U> tl 0..34
```

You will see:

```
 Line  addr,H  data,A    count,R  seq
-----  ------  ------  ---------  ---
    0  004000  ..            ---   +
    1  004001  ..       1.880 uS   .
    2  004002  ..       1.880 uS   .
    3  004003  ..       1.840 uS   .
    4  004004  ..       1.880 uS   .
    5  004005  ..       1.880 uS   .
    6  004006  ..       1.880 uS   .
    7  004007  ..       1.880 uS   .
    8  004008  ..       1.880 uS   .
    9  004009  ..       1.880 uS   .
   10  00400a  ..       1.880 uS   .
   11  00400b  ..       1.840 uS   .
   12  00400c  ..       1.880 uS   .
   13  00400d  ..       1.880 uS   .
   14  00400e  ..       1.880 uS   .
   15  00400f  ..       1.880 uS   .
   16  004010  ..       1.880 uS   .
   17  004011  ..       1.880 uS   .
   18  004000  TT       28.00 uS   .
   19  004001  HH       1.880 uS   .
   20  004002  II       1.840 uS   .
   21  004003  SS       1.880 uS   .
   22  004004  ..       1.880 uS   .
   23  004005  II       1.880 uS   .
   24  004006  SS       1.880 uS   .
   25  004007  ..       1.880 uS   .
   26  004008  MM       1.880 uS   .
   27  004009  EE       1.880 uS   .
   28  00400a  SS       1.840 uS   .
   29  00400b  SS       1.880 uS   .
   30  00400c  AA       1.880 uS   .
   31  00400d  GG       1.880 uS   .
   32  00400e  EE       1.880 uS   .
   33  00400f  ..       1.880 uS   .
   34
```

If you look at the last lines of the trace listing, you will notice that the analyzer seems to have stored only part of the output message, even though you specified more than the full range needed to store all of the message. The reason for this is that the analyzer has a storage pipeline, which holds states that have been acquired but not yet written to trace memory. To see all of the states, halt the analyzer by typing:

U> th

You will see:

```
Emulation trace halted
```

Now display the trace list:

U> tl 0..34

You will see:

```
 Line  addr,H  data,A    count,R  seq
-----  ------  ------  ---------  ---
    0  004000  ..            ---   +
    1  004001  ..      1.880 uS    .
    2  004002  ..      1.880 uS    .
    3  004003  ..      1.840 uS    .
    4  004004  ..      1.880 uS    .
    5  004005  ..      1.880 uS    .
    6  004006  ..      1.880 uS    .
    7  004007  ..      1.880 uS    .
    8  004008  ..      1.880 uS    .
    9  004009  ..      1.880 uS    .
   10  00400a  ..      1.880 uS    .
   11  00400b  ..      1.840 uS    .
   12  00400c  ..      1.880 uS    .
   13  00400d  ..      1.880 uS    .
   14  00400e  ..      1.880 uS    .
   15  00400f  ..      1.880 uS    .
   16  004010  ..      1.880 uS    .
   17  004011  ..      1.880 uS    .
   18  004000  TT      28.00 uS    .
   19  004001  HH      1.880 uS    .
   20  004002  II      1.840 uS    .
   21  004003  SS      1.880 uS    .
   22  004004  ..      1.880 uS    .
   23  004005  II      1.880 uS    .
   24  004006  SS      1.880 uS    .
   25  004007  ..      1.880 uS    .
   26  004008  MM      1.880 uS    .
   27  004009  EE      1.880 uS    .
   28  00400a  SS      1.840 uS    .
   29  00400b  SS      1.880 uS    .
   30  00400c  AA      1.880 uS    .
   31  00400d  GG      1.880 uS    .
   32  00400e  EE      1.880 uS    .
   33  00400f  ..      1.880 uS    .
   34  004010  AA      1.880 uS    .
```

As you can see, all of the requested states have been captured by the analyzer. By the way, you may be wondering why the analyzer has "doubled up" the message written on both bytes of the data bus. This occurred because we were using byte write accesses to the requested address; the output data was repeated on both the lower and upper bytes of the data bus.

For More Information

Chapter 3 contains additional information about using the emulator. If you want detailed information about emulation commands, refer to the *Terminal Interface Reference.*

3

Advanced Example

In the previous chapter, "Getting Started", you learned how to load code into the emulator, how to modify memory and view a register, and how to perform a simple analyzer measurement. This chapter will discuss in more detail how to use the emulator. Some of the topics discussed discussed in this chapter build upon others; therefore, proceed through the chapter by working through each topic sequentially and not by jumping randomly from topic to topic.

The Sample Programs

The last chapter looked at a primitive command interpreter; that is, it wrote various messages to an output buffer depending on the character you inserted in the input buffer. That program executed only in the 68302 processor's supervisor state.

This chapter uses a modified version of the program from chapter 2. It performs exactly the same function; however, the program now changes between supervisor and user states.

- The supervisor program performs most of the initialization routines and reads the input buffer, looking for a command. When a command is entered, the program changes to the user state.

- The user program determines which command was entered and writes the appropriate output message. A software trap then returns execution to the supervisor program.

The programs are listed and described on the following pages.

Notice that the supervisor and user programs are assembled and linked separately; this is necessary in order to load the programs correctly.

Supervisor Program

The supervisor program used in the following examples is shown in figure 3-1.

Variable Declaration

```
Command line: as68k -Lh supprog.s
Line Address
1                                              CHIP 68000
2
3                                ;SUPERVISOR SECTION
4                                              SECT DATA ,,D,D
5                                              ORG 2000H
6
7    00002000 0000 0400          INPUT_POINTER  DC.L 00000400H
8    00002004 0000 1000          USER_LOCATION  DC.L 00001000H
9    00002008 0000 00BC          TRAP_POINTER   DC.L 000000BCH
10   0000200C 0000 0FF0          STACK_POINTER  DC.L 00000FF0H
11
12                                             SECT PROG,,C,P
13                                             ORG 1000H
14
15   00001000 2478 2000          INIT          MOVE.L INPUT_POINTER,A2
16   00001004 2E78 200C                        MOVE.L STACK_POINTER,A7
17   00001008 2C78 2008                        MOVE.L TRAP_POINTER,A6
18   0000100C 2CBC 0000 1028                   MOVE.L #RETURNTOSUP,(A6)
19
20   00001012 14BC 0000          CLEAR         MOVE.B #00H,(A2)
21
22   00001016 1012               READ_INPUT    MOVE.B (A2),D0
23   00001018 0C00 0000                        CMP.B #00h,D0
24   0000101C 67F8                             BEQ READ_INPUT
25
26   0000101E 2F38 2004          JUMPTOUSER    MOVE.L USER_LOCATION,-(A7)
27   00001022 3F3C 0000                        MOVE.W #0000H,-(A7)
28   00001026 4E73                             RTE
29
30   00001028 2F3C 0000 1012     RETURNTOSUP   MOVE.L #CLEAR,-(A7)
31   0000102E 3F3C 2000                        MOVE.W #2000H,-(A7)
32   00001032 4E73                             RTE
33                                             END
```

Figure 3-1. Supervisor program listing.

The supervisor program declares the following pointers:

- Pointer to the input area at location 400 hex.
- First location of the user program (1000 hex).

- Trap pointer, which is the location of the trap vector used to return to the supervisor state (0bc hex).

- Supervisor stack pointer (0ff0 hex).

INIT

The initialization routine moves the input area pointer to a register for future use in addressing the input port. The stack pointer register is initialized. Then, the trap vector 0BC hex is loaded with the address of the RETURNTOSUP routine.

CLEAR

The CLEAR routine prepares the program for input by initializing the input port value to a null character (00 hexadecimal).

READ_INPUT

This routine continuously reads the input port until a non-zero value is read, indicating the presence of a command value.

JUMPTOUSER

As soon as a non-zero value is read from the input port, the JUMPTOUSER routine pushes onto the stack the location of the user program and a status register value that indicates a user program state. The RTE instruction is then executed, which loads the status register and program counter with the values on the stack and begins execution at the new program counter value. With the values just pushed on, the processor will be executing in the user program after this routine completes.

RETURNTOSUP

This routine is executed whenever the user program terminates by executing a TRAP #0FH instruction. Specifically, when the user program executes the TRAP #0FH, the address of RETURNTOSUP is loaded into the program counter from the trap vector at 0BC hex, and execution begins in the RETURNTOSUP routine. In the RETURNTOSUP routine, the address of the CLEAR routine is pushed onto the stack, along with an appropriate status register value. The RTE instruction is executed, causing the values pushed onto the stack to be loaded into the status register and program counter. This causes execution to continue in the CLEAR routine (described above).

User Program

The user program used in the following examples is shown in figure 3-2.

```
Command line: as68k -Lh usrprog.s
Line Address
1                                            CHIP 68000
2
3                              ;USER PROGRAM SECTION
4
5                                            SECT DATA,,D,D
6                                            ORG 2000H
7
8     00002000 0000 0500         OUTPUT_POINTER DC.L 00000500H
9
10    00002004 5448 4953 2049    MESSAGE_A     DC.B      'THIS IS MESSAGE A'
               5320 4D45 5353
               4147 4520 41
11
12    00002015 5448 4953 2049    MESSAGE_B     DC.B      'THIS IS MESSAGE B'
               5320 4D45 5353
               4147 4520 42
13
14    00002026 494E 5641 4C49    INVALID_INPUT DC.B      'INVALID COMMAND'
               4420 434F 4D4D
               414E 44
15
16
17                                           SECT PROG,,C,P
18                                           ORG 1000H
19
20    00001000 2678 2000         INIT          MOVE.L OUTPUT_POINTER,A3
21
22    00001004 0C00 0041         PROCESS_COMM  CMP.B #41H,D0
23    00001008 6700 000E                       BEQ COMMAND_A
24    0000100C 0C00 0042                       CMP.B #42H,D0
25    00001010 6700 0014                       BEQ COMMAND_B
26    00001014 6000 001E                       BRA UNRECOGNIZED
27
28    00001018 103C 0011         COMMAND_A     MOVE.B #11H,D0
29    0000101C 207C 0000 2004                  MOVE.L #MESSAGE_A,A0
30    00001022 6000 001A                       BRA OUTPUT
```

Figure 3-2. User program listing.

```
00001026 103C 0011          COMMAND_B     MOVE.B #11H,D0
0000102A 207C 0000 2015                   MOVE.L #MESSAGE_B,A0
00001030 6000 000C                        BRA OUTPUT
00001034 103C 000F          UNRECOGNIZED  MOVE.B #0FH,D0
00001038 207C 0000 2026                   MOVE.L #INVALID_INPUT,A0
0000103E 224B               OUTPUT        MOVE.L A3,A1
00001040 123C 0020          CLEAR_OLD     MOVE.B #20H,D1
00001044 2A4B                             MOVE.L A3,A5
00001046 1AFC 0000          CLEAR_LOOP    MOVE.B #00H,(A5)+
0000104A 0441 0001                        SUBI #01H,D1
0000104E 66F6                             BNE CLEAR_LOOP
00001050 12D8               LOOP          MOVE.B (A0)+,(A1)+
00001052 0440 0001                        SUBI #01H,D0
00001056 66F8                             BNE LOOP
00001058 4E4F               TRAPTOSUP     TRAP #0FH
                                          END
```

Figure 3-2. User program listing (continued).

Variable Declaration

The user program declares one pointer, which is the pointer to the output port base location at 500 hex. Three strings are also declared; these are the messages that will be written to the output port whenever a command input is processed.

INIT

This routine moves the output pointer value to an address register for future use in the program.

PROCESS_COMM

When the routine arrives here, the non-zero value read into the input port is still available in the D0 data register. PROCESS_COMM performs a series of comparisons to determine whether the command in register D0 is "A", "B" or an unrecognized command. Once this is resolved, the routine branches to one of the setup routines to prepare for message output.

COMMAND_A, COMMAND_B, UNRECOGNIZED

One of these routines will be executed, depending on the comparisons made in PROCESS_COMM. Each routine moves the length of the appropriate message into the D0 register (which will be used as a counter for the number of bytes to be moved). Also, each routine moves the location of the appropriate message into the A0 register.

OUTPUT

This routine begins the output by first setting up some pointer values and an output buffer length (20 hex, resident in D1). The CLEAR_LOOP routine then writes null characters to all of the output buffer locations. This insures that previous messages are erased from the output buffer.

LOOP then performs byte moves using the values of the A0 (message source pointer) and the A1 register (output buffer pointer) to determine the locations of the source and destination. When all of the bytes have been moved (indicated by the value of D0), the loop terminates.

TRAPTOSUP

When LOOP is complete, execution should return to the supervisor program and resume reads of the input buffer. TRAPTOSUP does this by simply executing a TRAP #0F instruction. The processor will fetch the new execution address from the trap vector region, switch to the supervisor state, and begin execution. (The specific return location is the RETURNTOSUP routine in the supervisor module.)

Note

This set of programs should not be construed as a complete example of user/supervisor state switching for the 68302. It relies on simplicity, and the fact that various pointer and data values are retained during the state switch. In an actual programming example, you would probably want to push the values of all registers onto a stack before making a state switch, then recover those values after the switch.

Mapping Memory

For this example, you will need to specify more information in the memory map to allow correct loading of the program. The information required tells the memory mapper that a certain range resides within supervisor memory space or user memory space. To map memory for this program, type the following commands:

```
R> map -d *
R> map 100..0fff@d eram
R> map 1000..2fff@s erom
R> map 1000..2fff@u erom
```

The first command deletes all currently defined mapper terms.

The second command defines an emulation RAM data area (to be used by either the supervisor or user program) from 100 to fff hexadecimal. Notice that this data area was not placed at 0--supervisor writes in the range 0 to ff could change the exception vector table and the SCR and BAR registers.

The third and fourth commands define supervisor (**@s**) and user (**@u**) program/data areas as emulation ROM from address 1000 to 2fff hexadecimal. The emulation memory mapper can differentiate between the supervisor and user address spaces. Now, whenever you specify an address in the range 1000 to 2fff hex, you must also include the function code; otherwise, the address will be ambiguous. Refer to chapter 4 of this manual for further information on specifying function codes as part of the memory map.

You will usually need to map an area of memory for the 68302's internal dual-port RAM. Be sure to map this space above the vector table. Map this space as target RAM:

```
R> map 0fff000..0ffffff@s tram
```

To help you find accidental accesses to other parts of memory, map all other addresses to guarded memory:

```
R> map other grd
```

You can specify even more detailed load information. For example, you might wish to define 1000 to 1fff as a supervisor program space, and 2000 to 2fff as a supervisor data space. To enter such a map, you would type (do **not** type this right now):

```
R> map 1000..1fff@sp erom
R> map 2000..2fff@sd erom
```

However, if you do this, the supervisor data and program modules will need to be separated, modified (to declare symbols defined in one module and used in the other as globals and externals, respectively), linked, and loaded separately. The **cf lfc** command specifies the function code area where each module is loaded.

Note

When memory ranges are overlaid using function code specifiers, you need to have a separately linked module for each different function code specifier. (This is because linkers do not typically understand function codes and overlapping address errors would occur when attempting to link modules to the same address range.)

When different address ranges are mapped with different function code specifiers (no overlapping ranges), your program modules may exist in one absolute file; however, you will have to use multiple load commands - one for each function code specifier. This is necessary to load the various sections of the absolute file into the appropriate function code qualified mapper ranges. When you do this, be sure that "other" is mapped as target RAM. (If "other" is mapped as guarded, guarded memory access errors, from the attempt to load the absolute file sections that are outside the function code specified range, can prevent the absolute file sections that are inside the function code specified range from being loaded.)

For details on all of the different possible function code specifiers, refer to Appendix A, which contains syntax information specific to the 68302 emulator.

Loading the Sample Program

Assembly and Linking

You are now ready to load the sample program. You must first assemble and link it using the available host tools.

If you are using the transparent configuration, connect to your host by typing:

```
xp -e
```

If you are using the HP 64870 68000 Assembler/ Linker/Librarian, assemble and link using the following commands:

```
$ as68k -Lh userprog.s
$ as68k -Lh supprog.s
$ ld68k -c userprog.cmd -Lh
$ ld68k -c supprog.cmd -Lh
```

Use the following linker command files:

```
$ cat userprog.cmd
NAME userprog
LIST C,D,O,P,S,T,X
ORDER PROG,DATA
SECT DATA=1000H
SECT PROG=2000H
LOAD userprog.o
END

$ cat supprog.cmd
NAME supprog
LIST C,D,O,P,S,T,X
ORDER PROG,DATA,A5
SECT PROG=1000H
SECT DATA=2000H
SECT A5=2000H
LOAD supprog.o
END
$
```

Loading the Code

Now to load your files. The example in this chapter uses the HP 9000/HP-UX based transfer utility. You can use this method or any that fits your situation; refer to Chapter 2 and the load command information in the *Reference* for examples of other file load methods. The important difference in this load procedure is that you need to properly configure the emulator so that each module will end up in the proper supervisor or user space.

If you need to change directories to get to your program files, do so now.

Otherwise, type:

```
<ESC>g xp -d
```

to return to the emulator command prompt.

Now, load the supervisor module by typing:

```
M> cf lfc=s
```

This command (configure load function code) tells the emulator that subsequent load commands should load code into memory ranges mapped as supervisor.

Now type:

```
M> load -hbo
transfer -tb supprog.X<ESC>g (do NOT press
return)
```

You will see:

```
##
M>
```

To load the user module, type the following:

```
M> cf lfc=u
```

This tells the emulator that subsequent load commands should load code into memory ranges mapped as user space.

Type:

```
M> load -hbo
transfer -tb userprog.X<ESC>g (again, do NOT
press return)
```

You will see:

```
##
M>
```

Your code is now loaded into memory and is ready to use. To log off the host computer, type:

```
M> xp -e
```

Hit return until you see a prompt and type:

```
$  <CTRL>d
```

Now type:

```
<ESC>g xp -d
```

which will return you to the emulator command prompt.

Note

If you see the message "hpuadownload in_HP64000_format," you pressed <RETURN> after entering the transfer command. Repeat the load and transfer commands exactly as shown above.

Building a Command File

If you are using a computer with a terminal emulator, find out if the terminal emulator has the ability to log displays to a disk file and upload ASCII disk files to the datacomm port. If your terminal emulator has this ability, you can easily build a command files to save a considerable amount of time whenever you need to reload the emulator’s code, data, or configuration information.

Note

The HP 64700 Terminal Interface also supports command files from a host in transparent mode using the po -f command. That command is not described here; refer to the *Reference* for an example.

Now, follow the steps below to build a command file which will load your emulator’s code by modifying memory.

First, you need to get the memory contents into a disk file so that you can manipulate them. Enable the file logging capability of your terminal emulator to create a file called comfile.txt. (If you need help with this function, refer to the manual for your terminal emulator.) Then, type the following commands:

M> m -dl 2000..200f@s

```
0002000..000200f@s   00000400 00001000 000000bc 00000ff0
```

M> m -dl 1000..1033@s

```
0001000..000100f@s   24782000 2e78200c 2c782008 2cbc0000
0001010..000101f@s   102814bc 00001012 0c000000 67f82f38
0001020..000102f@s   20043f3c 00004e73 2f3c0000 10123f3c
0001030..0001033@s   20004e73
```

M> m -dl 2000..2034@u

```
0002000..000200f@u   00000500 54484953 20495320 4d455353
0002010..000201f@u   41474520 41544849 53204953 204d4553
0002020..000202f@u   53414745 2042494e 56414c49 4420434f
0002030..0002037@u   4d4d414e 44000000
```

M> m -dl 1000..1059@u

```
0001000..000100f@u   26782000 0c000041 6700000e 0c000042
0001010..000101f@u   67000014 6000001e 103c0011 207c0000
0001020..000102f@u   20046000 001a103c 0011207c 00002015
0001030..000103f@u   6000000c 103c000f 207c0000 2026224b
0001040..000104f@u   123c0020 2a4b1afc 00000441 000166f6
0001050..000105b@u   12d80440 000166f8 4e4f4e4f
```

Now you can close the disk log file. Your disk log file contains the code for the supervisor data, supervisor program, user data, and user program regions. Note that to enter the proper address ranges, you will need to know the starting and ending addresses of each block you want to manipulate. Your linker output listing should contain this information.

You will need to edit the disk file so that all of the memory dump information is actually expressed as a memory modification command. Use an ASCII text editor (or a word processor with ASCII import/export capability) to create the file shown below from the file comfile.txt.

```
m -dl 0002000..000200f@s=00000400,00001000,000000bc,00000ff0
m -dl 0001000..000100f@s=24782000,2e78200c,2c782008,2cbc0000
m -dl 0001010..000101f@s=102814bc,00001012,0c000000,67f82f38
m -dl 0001020..000102f@s=20043f3c,00004e73,2f3c0000,10123f3c
m -dl 0001030..0001033@s=20004e73
m -dl 0002000..000200f@u=00000500,54484953,20495320,4d455353
m -dl 0002010..000201f@u=41474520,41544849,53204953,204d4553
m -dl 0002020..000202f@u=53414745,2042494e,56414c49,4420434f
m -dl 0002030..0002037@u=4d4d414e,44000000
m -dl 0001000..000100f@u=26782000,0c000041,6700000e,0c000042
m -dl 0001010..000101f@u=67000014,6000001e,103c0011,207c0000
m -dl 0001020..000102f@u=20046000,001a103c,0011207c,00002015
m -dl 0001030..000103f@u=6000000c,103c000f,207c0000,2026224b
m -dl 0001040..000104f@u=123c0020,2a4b1afc,00000441,000166f6
m -dl 0001050..000105b@u=12d80440,000166f8,4e4f4e4f
```

Notice that you do not have to modify the "load function code" configuration item. This method is completely different than loading memory with the load command. Instead, the function code is explicitly specified in memory modification commands.

Now you can execute your command file. Make sure that the emulator is running in the monitor ("M>" prompt), or is running. To get to the monitor, type **b**.

Note

If the emulator is reset, it will not be able to display or modify target system memory. Although that does not affect this particular example, you should keep this information in mind when you build command files which access target system memory.

To load your command file, simply use the ASCII upload feature of your terminal emulator and specify comfile.txt as the file to upload. You will see each line read in by the emulator and executed as a command.

You can do this with virtually any command that prints the current settings when executed. The output of many commands, such as **map** and **tpat**, can be used in a command file without any modification.

You can avoid error messages by using the appropriate "clear" command at the beginning of a command file. For example, if your command file contains **map** commands, include the command **map -d *** to delete any existing mapper terms.

Again, you can use your terminal emulator’s ASCII upload facilities to load this file into the emulator.

To build a command file to completely configure your emulator, you would simply enable disk logging as you start configuration and turn it off when you’re finished. Then you can edit the command file. However, be sure to completely understand the procedure you will use; otherwise, you might spend a lot of time editing a command file because of logged mistakes.

Note

We strongly recommend that you use your terminal emulator's logging feature to record the commands you enter in the example which follows. Doing so will save you a lot of work if for any reason you need to start over.

Set Mode and Stack Pointer

Set the memory display mode to byte to avoid problems later in the examples:

```
M> mo -db
```

Also, the supervisor stack pointer must be modified to be able to run the emulator. Type:

```
M> rst
R> cf rssp=00000ff0
R> b
```

Now the supervisor stack pointer will be initialized to the value 00000ff0 hex.

You could also modify the supervisor stack pointer as follows:

```
M> reg ssp=0ff0
```

This modifies the supervisor stack pointer register directly to the value 00000ff0. However, by using the **cf rssp** command, you will automatically set the stack pointer every time the emulator enters the monitor from an emulation reset.

Complex Configuration Trace Example

This example will make a more sophisticated trace measurement using the analyzer's complex configuration capabilities. In this example, the sequencer will be used to look for execution of several of the routines in the two programs and to trigger the analyzer finding the last routine.

The analyzer will be set up so that execution between certain states is stored until the trace list is filled.

This example will be using several different analyzer and emulator commands to make a complete measurement. This is intended to give you a complete context for the use of each command, rather than presenting the commands independently.

Note This example will not explain all of the analyzer's sequencer capabilities. Instead, refer to the Analyzer User's Guide for a complete tutorial on analyzer operation.

When setting up complex analyzer measurements, you will generally use the following procedure to draw a sequencer diagram.

- First, draw a sequencer diagram which shows all eight of the analyzer sequencer terms.
- Next, fill in the primary and secondary branch qualifiers.
- Finally, write down the analyzer storage qualifiers for each sequencer level.

With the completed diagram, you can set up the analyzer measurement quickly and accurately.

In the sequencer diagram shown in figure 3-3, several branches and store conditions are set up.

The analyzer always enters the sequencer at term 1.

It will branch from term 1 to term 2 when data of any value except zero is read from the INPUT_POINTER location while in the supervisor state. Notice that the expression is additionally qualified with the supervisor data status. This is done because the analyzer does not allow you to specify function codes in addresses; the additional status qualifier makes sure that the sequencer searches for the supervisor access to the INPUT_POINTER location and not a user access. No states are stored before or after the branch; however, any expression

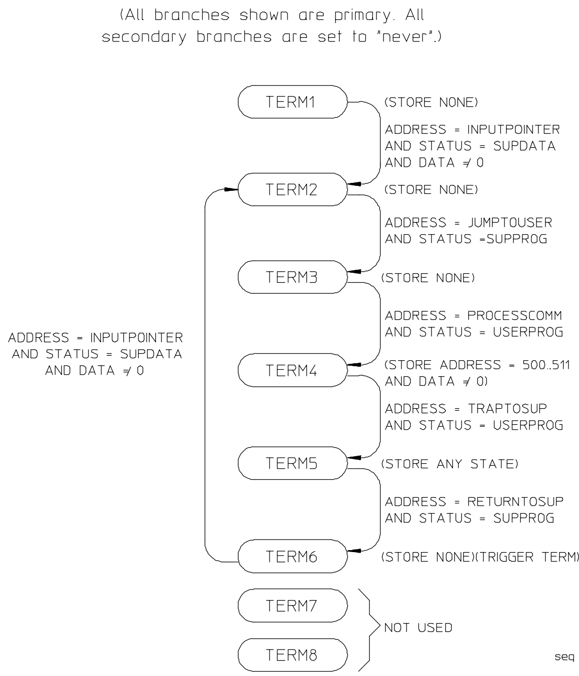

Figure 3-3. Sequencer Diagram.

which satisfies a branch will always store, regardless of the storage qualifier.

A branch from term 2 to term 3 will happen when the analyzer sees execution of the JUMPTOUSER routine. Notice that the address is qualified with a status of supervisor program space. Again, no states are stored except the branch condition.

A branch from term 3 to term 4 will happen when the analyzer sees execution of the PROCESSCOMM routine. The address is qualified with a status of user program space. After the branch, the analyzer will store all states in the range 500 through 511 hex with data not equal to zero. (The sequencer will specifically look for the message writes to the output area.)

A branch from term 4 to term 5 occurs when the analyzer sees the TRAPTOSUP routine. Now all states are stored because the trace should contain the states that show the processor pick up the exception vector information.

A branch from term 5 to term 6 (the trigger term) happens when the analyzer sees the execution of the RETURNTOSUP routine. No states are stored.

Finally, the sequencer branches back to term 2 when a non-zero value is read from the input port by the supervisor program. The sequencer process is repeated from this point onward.

Terms 7 and 8 are not used in this example. Also, there are no secondary branch conditions, so they are left at the default of telif never.

Defining Equates

Use the **equ** command to assign names to specific patterns. This should aid you in setting up the analyzer specification. First, look at the default equate list. Type:

```
M> equ
```

You can see that several "equates" have been predefined. This occurred during emulator initialization. These equates allow you to specify various processor status qualifiers without having to remember the specific bit patterns associated with each status. For example, you can specify a status qualifier of "supervisor program" with stat=supprog.

Now set up the equates for the input port address, the program routine names, and a "null data" value of 00 hex. Type:

```
M> equ inputpointer=400
M> equ nulldata=00
M> equ jumptouser=101e
```

Verify the new equates by typing:

```
M> equ
```

Symbols are can be used like equates for addresses, but they also are shown by name in the trace listings.

```
M> sym processcomm=1004@u
M> sym traptosup=1058@u
M> sym returntosup=1028@s
```

Verify the symbols by typing:

```
M> sym
```

Set the Analyzer to Complex Configuration

Before you set up the analyzer qualifiers, you need to set the analyzer to the complex configuration. Type:

```
M> tcf -c
```

(For specific information on the capabilities of the analyzer's complex configuration, refer to the *Analyzer User's Guide* and the *Reference* manuals.)

Define a New Analyzer Signal Label

Now you need to set up an analyzer label for the lower byte of the data bus. Type:

```
M> tlb lowerdata 40..47
```

This enables you to qualify byte operations (such as the input port read or the output port writes) without concern about what the patterns are on the upper byte of the bus.

Assign Analyzer Patterns to Expressions

Now, since the analyzer is in complex configuration, you need to assign pattern numbers to the specific analyzer expressions you want to use for branching. (The complex configuration does not allow you to specify these expressions directly in the branch (tif command); instead, you assign pattern names to expressions, then use the pattern names in the tif command to form more complex expressions.) Type:

```
M> tpat p1 addr=inputpointer and stat=supdata
M> tpat p2 addr=jumptouser and stat=supprog
M> tpat p3 addr=processcomm and stat=userprog
M> tpat p4 addr=traptosup and stat=userprog
M> tpat p5 addr=returntosup and stat=supprog
```

Use the range variable to qualify storage of data written to the output area. Assign a range to this variable using the trng command. Type:

```
M> trng addr=500..511
```

Finally, one pattern is needed that has data not equal to zero. Set this pattern not equal to the nulldata equate defined earlier. Type:

```
M> tpat p6 lowerdata!=nulldata
```

You can verify all of the pattern assignments by typing:

```
M> tpat
```

```
tpat p1 addr=inputpointer and stat=supdata
tpat p2 addr=jumptouser and stat=supprog
tpat p3 addr=processcomm and stat=userprog
tpat p4 addr=traptosup and stat=userprog
tpat p5 addr=returntosup and stat=supprog
tpat p6 lowerdata!=nulldata
tpat p7 any
tpat p8 any
```

Set the Primary Branch Qualifiers

Now you can set up the primary branch qualifiers which specify how the analyzer sequencer will branch from term to term when certain expressions are found. Type:

```
M> tif 1 p1 and p6 2
M> tif 2 p2 3
M> tif 3 p3 4
M> tif 4 p4 5
M> tif 5 p5 6
M> tif 6 p1 and p6 2
```

Now you can specify the trigger term. Type:

```
M> tsq -t 6
```

You can check all of the primary branch qualifiers by typing:

```
M> tif
```

```
tif 1 p1 and p6 2
tif 2 p2 3
tif 3 p3 4
tif 4 p4 5
tif 5 p5 6
tif 6 p1 and p6 2
tif 7 any 8
tif 8 never
```

Specifying What to Store

As you can see from the sequencer diagram, you only want to store certain items depending on the state of the sequencer. The analyzer's complex configuration allows you to specify different storage qualifiers for each trigger state. Since nothing is to be stored for the majority of the sequencer terms, you can use one command to set all storage qualifiers to none. Then, you can redefine the storage qualifiers for the individual terms during which trace states are to be stored. For example, type:

```
M> tsto none
```

View this by typing:

```
M> tsto
```

```
tsto 1 none
tsto 2 none
tsto 3 none
tsto 4 none
tsto 5 none
tsto 6 none
tsto 7 none
tsto 8 none
```

Now you can set the storage qualifiers for the terms that need to change. Type:

```
M> tsto 4 r and p6
M> tsto 5 all
```

Check the storage qualifier changes:

```
M> tsto
```

```
tsto 1 none
tsto 2 none
tsto 3 none
tsto 4 r and p6
tsto 5 all
tsto 6 none
tsto 7 none
tsto 8 none
```

Counting the Output Writes

You can set the analyzer's trace tag counter to count the number of writes to the output area. Since a range variable was defined for the storage qualifier, you can use this to count the number of writes to the output range. Type:

```
M> tcq r
```

Set the Trace Display Format

To display the trace with address and mnemonic information, along with the data (output writes), in ASCII format, and the output write count, type:

```
M> tf addr,h mne lowerdata,A count,A
```

The trace list display will have address displayed in hex, data disassembled into 68302 mnemonic instructions, the lower byte of the data bus displayed in ASCII, and the state count displayed absolute (relative to the beginning of the trace rather than the previous state).

Make the Measurement

Now you can make the measurement. First, start the trace by typing:

```
M> t
Emulation trace started
```

Then, start the emulation run:

```
M> r 1000@s
```

Notice that you need to specify the function code specifier since two different function code ranges (user and supervisor) share the same numeric addresses.

Note

If you see any error messages at this point, check that you entered all of the code, data, equates, and analyzer expressions correctly.

You will need to provide some input to the input port; otherwise, the analyzer will never trigger (because the sequencer will never pass term 1). Type:

```
U> m 400@d=41
U> m 400@d=42
U> m 400@d=43
```

This puts an "A" command, a "B" command, and an unrecognized command into the input port. Now display the trace list:

```
U> tl -etd 30
```

```
 Line   addr,H  68302 Mnemonic,H                     lowerdata,A    count,A
-----   ------  ----------------------------------  -----------  ---------
    0   000400    41    sdata rd byte                A                   0
    1   00101e  MOVE.L  ******,-[A7]          ROM    /                   0
    2   sscomm  CMPI.B  #**,D0                ROM    .                   0
    3   000500    54    udata wr byte                T                  19
    4   ptosup  TRAP    #f                    ROM    N                  19
    5   001050  MOVE.B  [A0]+,[A1]+           ROM    .                  19
    6   001052  SUBI.W  #00001,D0             ROM    .                  19
    7   002005      48  udata rd byte         ROM    .                  19
    8   000501      48  udata wr byte                H                  20
    9   001054    0001  uprog rd word         ROM    .                  20
   10   001056  BNE.B   0001050               ROM    f                  20
   11   ptosup  TRAP    #f                    ROM    N                  20
   12   001050  MOVE.B  [A0]+,[A1]+           ROM    .                  20
   13   001052  SUBI.W  #00001,D0             ROM    .                  20
   14   002006    49    udata rd byte         ROM    I                  20
   15   000502    49    udata wr byte                I                  21
   16   001054    0001  uprog rd word         ROM    .                  21
   17   001056  BNE.B   0001050               ROM    f                  21
   18   ptosup  TRAP    #f                    ROM    N                  21
   19   001050  MOVE.B  [A0]+,[A1]+           ROM    .                  21
   20   001052  SUBI.W  #00001,D0             ROM    .                  21
   21   002007      53  udata rd byte         ROM    .                  21
   22   000503      53  udata wr byte                S                  22
   23   001054    0001  uprog rd word         ROM    .                  22
   24   001056  BNE.B   0001050               ROM    f                  22
   25   ptosup  TRAP    #f                    ROM    N                  22
   26   001050  MOVE.B  [A0]+,[A1]+           ROM    .                  22
   27   001052  SUBI.W  #00001,D0             ROM    .                  22
   28   002008    20    udata rd byte         ROM    .                  22
   29   000504    20    udata wr byte                .                  23
```

This isn’t what you would expect to see. (You expect to see the lowerdata column with unbroken strings of each message, and you also expect to see the TRAP vector pickup.) If you look carefully at the trace listing, you will see that the TRAP #f instruction is repeated several times, but the processor keeps repeating instructions from the LOOP routine in the program and doesn’t switch states to supervisor when the TRAP is encountered.

The reason for the repeated TRAP instruction is the prefetch feature of the 68302 processor. The processor is continually prefetching the TRAP #f instruction, but not executing it because of the BNE.B back to location 1050 hex. The reason this instruction keeps appearing in the trace list is because the HP 64700’s emulation analyzer does not provide "de-queuing" of the instruction pipeline; that is, it records all instructions that appear on the bus and cannot differentiate between a prefetched instruction and one which was actually executed. Many more states are stored than expected, because the first prefetch of the TRAP #f instruction causes the sequencer to increment to term 5, which has a storage qualifier of tsto all. So, as a result of the prefetch, many side effects have occurred which present a different trace list than expected.

One of the easiest ways to fix this problem, at least during the debugging and integration stages of your project, is to insert a NOP instruction at the end of each routine in your code. Then, if you set up the sequencer branch for the first instruction of the next routine, the NOP is the instruction prefetched at the end of the previous routine and therefore won't cause a sequencer branch (unless, of course, you set up the sequencer to branch on the NOP or its address in memory). To do this with the sample program, first display the end of the user program routine:

U> m 1050..1059@u

```
0001050..0001059@u   12 d8 04 40 00 01 66 f8 4e 4f
```

Now, insert a NOP instruction where the TRAP #f is and move TRAP #f to the next higher memory location. (NOP is 4e71 hex; TRAP #f is 4e4f hex.)

U> m -dw traptosup=4e71,4e4f

Now verify the change:

U> m -db 1050..105b@u

```
0001050..000105b@u   12 d8 04 40 00 01 66 f8 4e 71 4e 4f
```

You need to modify the traptosup symbol to reflect the new location of the TRAPTOSUP routine. Type:

U> sym traptosup=105a

You must also reenter the commands where the symbol is used! This is because an equate is translated at the time of command entry, rather than at the time of measurement.

U> tpat p4

```
tpat p4 addr=traptosup and stat=userprog
```

U> tpat p4 addr=traptosup and stat=userprog

Repeat the measurement:

U> t

```
Emulation trace started
                              U> m 400@d=41
                              U> m 400@d=42
                              U> m 400@d=43
                              U> tl -etd 30
 Line   addr,H  68302 Mnemonic,H                    lowerdata,A    count,A
-----   ------  ----------------------------------  -----------  ---------
   -1   0000be    1028  sdata rd word               .                    0
    0   ntosup  MOVE.L  #********,-[A7]       ROM   /                    0
    1   000400    42    sdata rd byte               B                    0
    2   00101e  MOVE.L  ******,-[A7]          ROM   /                    0
    3   sscomm  CMPI.B  #**,D0                ROM   .                    0
    4   000500    54    udata wr byte               T                   19
    5   000501      48  udata wr byte               H                   20
    6   000502    49    udata wr byte               I                   21
    7   000503      53  udata wr byte               S                   22
    8   000504    20    udata wr byte               .                   23
    9   000505      49  udata wr byte               I                   24
   10   000506    53    udata wr byte               S                   25
   11   000507      20  udata wr byte               .                   26
   12   000508    4d    udata wr byte               M                   27
   13   000509      45  udata wr byte               E                   28
   14   00050a    53    udata wr byte               S                   29
   15   00050b      53  udata wr byte               S                   30
   16   00050c    41    udata wr byte               A                   31
   17   00050d      47  udata wr byte               G                   32
   18   00050e    45    udata wr byte               E                   33
   19   00050f      20  udata wr byte               .                   34
   20   000510    42    udata wr byte               B                   35
   21   ptosup  TRAP    #f                    ROM   N                   35
   22   00105c    07e1  unused prefetch       ROM   .                   35
   23   000fd6    105c  sdata wr word               .                   35
   24   000fd2    0004  sdata wr word               .                   35
   25   000fd4    0000  sdata wr word               .                   35
   26   0000bc    0000  sdata rd word               .                   35
   27   0000be    1028  sdata rd word               .                   35
   28   ntosup  MOVE.L  #********,-[A7]       ROM   /                   35
```

Now the desired states seem to have been captured, including the pickup of the TRAP vector from 0bc hex (states 26 and 27 in the trace list). However, the message written from the first command entry ("MESSAGE A") is missing. The sequencer trigger was actually the last term in the sequence (term 6); and since the trigger position in the trace list was the first state in trace memory, states occurring previous to the trigger were discarded. You can modify the trigger position in memory and run another trace so these states will be retained.

Type:

```
U> tp -b 30
U> t
Emulation trace started
U> m 400@d=41
```

Are you getting tired of typing this information over and over? Use command line editing to enter the data this time:

```
cl -e
```

Now type **<ESC> k k** to see the line you just entered. Type **$** to move the cursor to the end of the line. Type **r2** to replace the 1 with a 2:

```
U> m 400@d=42
```

Press <RETURN> to enter that line. Type **<ESC> k $ r 3** to get:

```
U> m 400@d=43
```

Now type:

```
U> tl -etd
```

```
 Line   addr,H  68302 Mnemonic,H                      lowerdata,A   count,A
-----   ------  ---------------------------------    -----------  ---------
  -27   000400    41    sdata rd byte                 A                 -35
  -26   00101e  MOVE.L  ******,-[A7]           ROM    /                 -35
  -25   sscomm  CMPI.B  #**,D0                 ROM    .                 -35
  -24   000500    54    udata wr byte                 T                 -16
  -23   000501      48  udata wr byte                 H                 -15
  -22   000502    49    udata wr byte                 I                 -14
  -21   000503      53  udata wr byte                 S                 -13
  -20   000504    20    udata wr byte                 .                 -12
  -19   000505      49  udata wr byte                 I                 -11
  -18   000506    53    udata wr byte                 S                 -10
  -17   000507      20  udata wr byte                 .                  -9
  -16   000508    4d    udata wr byte                 M                  -8
  -15   000509      45  udata wr byte                 E                  -7
  -14   00050a    53    udata wr byte                 S                  -6
  -13   00050b      53  udata wr byte                 S                  -5
  -12   00050c    41    udata wr byte                 A                  -4
  -11   00050d      47  udata wr byte                 G                  -3
  -10   00050e    45    udata wr byte                 E                  -2
   -9   00050f      20  udata wr byte                 .                  -1
   -8   000510    41    udata wr byte                 A                   0
   -7   ptosup  TRAP    #f                     ROM    N                   0
   -6   00105c    07e1  unused prefetch        ROM    .                   0
   -5   000fca    105c  sdata wr word                 .                   0
   -4   000fc6    0004  sdata wr word                 .                   0
   -3   000fc8    0000  sdata wr word                 .                   0
   -2   0000bc    0000  sdata rd word                 .                   0
   -1   0000be    1028  sdata rd word                 .                   0
    0   ntosup  MOVE.L  #********,-[A7]        ROM    /                   0

    1   000400    42    sdata rd byte                 B                   0
    2   00101e  MOVE.L  ******,-[A7]           ROM    /                   0
```

Now you see the first message; but, you don't have the entire message set.

To see the full symbol name in the "addr" column of the trace display, change the trace format by typing:

U> tf addr,h,14 mne lowerdata,A

This increases the width of the address column, and eliminates the count column to make room on an 80-column display.

Display a greater range of the trace list by typing:

U> tl -ed -30..100

```
 Line   addr,H          68302 Mnemonic,H                      lowerdata,A
-----   --------------  -----------------------------------   -----------
  -28
  -27   000400            41    sdata rd byte                 A
  -26   00101e          MOVE.L  ******,-[A7]           ROM    /
  -25   processcomm     CMPI.B  #**,D0                 ROM    .
  -24   000500            54    udata wr byte                 T
  -23   000501              48  udata wr byte                 H
  -22   000502            49    udata wr byte                 I
  -21   000503              53  udata wr byte                 S
  -20   000504            20    udata wr byte                 .
  -19   000505              49  udata wr byte                 I
  -18   000506            53    udata wr byte                 S
  -17   000507              20  udata wr byte                 .
  -16   000508            4d    udata wr byte                 M
  -15   000509              45  udata wr byte                 E
  -14   00050a            53    udata wr byte                 S
  -13   00050b              53  udata wr byte                 S
  -12   00050c            41    udata wr byte                 A
  -11   00050d              47  udata wr byte                 G
  -10   00050e            45    udata wr byte                 E
   -9   00050f              20  udata wr byte                 .
   -8   000510            41    udata wr byte                 A
   -7   traptosup       TRAP    #f                     ROM    N
   -6   00105c            07e1  unused prefetch        ROM    .
   -5   000fca            105c  sdata wr word                 .
   -4   000fc6            0004  sdata wr word                 .
   -3   000fc8            0000  sdata wr word                 .
   -2   0000bc            0000  sdata rd word                 .
   -1   0000be            1028  sdata rd word                 .
    0   returntosup     MOVE.L  #********,-[A7]        ROM    /
    1   000400            42    sdata rd byte                 B
    2   00101e          MOVE.L  ******,-[A7]           ROM    /
    3   processcomm     CMPI.B  #**,D0                 ROM    .
    4   000500            54    udata wr byte                 T
    5   000501              48  udata wr byte                 H
    6   000502            49    udata wr byte                 I
    7   000503              53  udata wr byte                 S
    8   000504            20    udata wr byte                 .
    9   000505              49  udata wr byte                 I
   10   000506            53    udata wr byte                 S
   11   000507              20  udata wr byte                 .
   12   000508            4d    udata wr byte                 M
   13   000509              45  udata wr byte                 E
   14   00050a            53    udata wr byte                 S
```

```
15   00050b           53  udata wr byte             S
16   00050c          41   udata wr byte             A
17   00050d           47  udata wr byte             G
18   00050e          45   udata wr byte             E
19   00050f           20  udata wr byte             .
20   000510          42   udata wr byte             B
21   traptosup      TRAP  #f                  ROM   N
22   00105c         07e1  unused prefetch     ROM   .
23   000fc4         105c  sdata wr word             .
24   000fc0         0004  sdata wr word             .
25   000fc2         0000  sdata wr word             .
26   0000bc         0000  sdata rd word             .
27   0000be         1028  sdata rd word             .
28   returntosup    MOVE.L  #********,-[A7]   ROM   /
29   000400         43    sdata rd byte             C
30   00101e         MOVE.L  ******,-[A7]      ROM   /
31   processcomm    CMPI.B  #**,D0            ROM   .
32   000500         49    udata wr byte             I
33   000501           4e  udata wr byte             N
34   000502         56    udata wr byte             V
35   000503           41  udata wr byte             A
36   000504         4c    udata wr byte             L
37   000505           49  udata wr byte             I
38   000506         44    udata wr byte             D
39   000507           20  udata wr byte             .
40   000508         43    udata wr byte             C
41   000509           4f  udata wr byte             O
42   00050a         4d    udata wr byte             M
43   00050b           4d  udata wr byte             M
44   00050c         41    udata wr byte             A
45   00050d           4e  udata wr byte             N
46   00050e         44    udata wr byte             D
47   traptosup      TRAP  #f                  ROM   N
48   00105c         07e1  unused prefetch     ROM   .
49   000fbe         105c  sdata wr word             .
50   000fba         0004  sdata wr word             .
51   000fbc         0000  sdata wr word             .
52   0000bc         0000  sdata rd word             .
53   0000be         1028  sdata rd word             .
54   returntosup    MOVE.L  #********,-[A7]   ROM   /
55
```

Even though you asked for display of states -30 through 100 in the trace list, only states -28 through 54 were displayed, because the analyzer has not captured any more data satisfying the storage specifications. You can try modifying location 400 in the data space with several values; display the trace after each modify. The trace display memory will fill up with additional states every time the complete sequencer branch specification is satisfied.

Refer to the *Analyzer User's Guide* for more information regarding analyzer measurements.

Setting up an Automatic Break to Monitor

By using the bc command, you can set the emulator to break to the monitor upon finding certain conditions, such as a write to ROM, a software breakpoint, or a specific condition found by the analyzer.

Break on Measurement Complete

Suppose you have found that the first value input to the input port is handled correctly by the sample program, but the next value input causes the program to "run away" and destroy memory. You can modify the measurement set up from the complex configuration trace example to capture only one trace, then break the emulator to monitor so that memory contents are not destroyed by the runaway program. (Note: the program does not actually have such a bug; assume it might for purposes of this example.)

First, set up the analyzer to drive the trig1 signal (internal to the HP 64700 emulator) upon finding the trigger condition:

U> tgout trig1

Now, set the emulator break conditions such that the emulator will break to monitor upon receiving the trig1 signal:

U> bc -e trig1

Start the measurement:

U> t

```
Emulation trace started
```

U> r 1000@s
U> m 400@d=41

```
!ASYNC_STAT  618! trig1 break
```

M>

The analyzer finds the trigger condition and asserts the trig1 signal; the emulator then recognizes that the break condition is true and breaks the emulator to monitor execution.

You may also have the emulator break upon receiving the trig2 signal, a trigger signal from the CMB (Coordinated Measurement Bus), or the BNC trigger line (allowing you to break the emulator when an external instrument finds its trigger condition.) Refer to the **HP 64700 Terminal Interface Reference** and the *CMB User's Guide* for more information on using the various trigger signals to break emulator execution.

Setting a Software Breakpoint

Another way to stop program execution is to set a software breakpoint. Using the bc and bp commands, you can insert TRAP instructions into your code and have the emulator break to the monitor upon execution of the inserted TRAP. Selection of one of the 16 different TRAP instructions for insertion is managed by the cf swtp command; see Chapter 4 of this manual. Once the breakpoint is found, you can examine memory locations, registers, and so on, without worry that further program execution will destroy the state of the machine.

First, you must enable the software breakpoint feature:

```
M> bc -e bp
```

Now, insert a breakpoint at the location of the RETURNTOSUP routine in the supervisor program:

```
M> bp returntosup
```

The emulator controller saves the state of the instruction at location 1028 (returntosup) and overwrites the information there with a TRAP instruction. Now, start the program run:

```
M> r 1000@s
U> m 400@d=41
!ASYNC_STAT  615! Software breakpoint: 0001028@sp
M>
```

When the breakpoint is executed, the status message shown above is displayed. At this time, the emulator restores the original contents of the breakpoint location and disables the breakpoint in the breakpoint list. You can reenable the breakpoint using the command bp -e returntosup. Refer to the *Reference* manual for further information on software breakpoints.

Note

In the 68302 emulator, all read accesses to the software breakpoint TRAP vector location preceded by a supervisor data write will cause the emulator to break into background. However, only the read associated with the TRAP instruction will cause a proper transfer to monitor. All other accesses will result in undefined execution. Therefore, if software breakpoints are enabled, the TRAP vector should not be accessed by any instruction other than a TRAP. Note that this includes boot-up code that attempts to perform a checksum over the vector table area. The status of the emulator may become undefined, and the monitor program may become unusable.

Write to ROM

You can also have the emulator break to the monitor upon attempts to write to memory space mapped as ROM. Simply enter the command bc -e rom. All current HP 64700 emulators will prevent the processor from actually writing to memory mapped as emulation ROM; however, they cannot prevent writes to target system RAM locations which are mapped as ROM, even though the write to ROM break is enabled.

Prefetching and Effect on Break Conditions

Since the 68302 emulator prefetches instructions, it is possible that an additional instruction may execute after the one which originally caused the break condition. If this does occur, the additional instruction was already in the processor's instruction pipeline; the emulator has no way of aborting the execution of that instruction.

Step, Register Display, and Memory Display Example

Suppose you would like to set up a measurement that displays information for each execution of the sample program's LOOP routine. You want to step through the routine so that each pass of the loop is executed, then the processor's registers are displayed, and the output buffer area is displayed. You also want to label each display, and you do not want the display to scroll.

Note

This example assumes that you are using an HP 2392A data terminal or any HP data terminal which uses equivalent control escape sequences. If you are not using such a terminal, you can modify the escape sequences in the example to work with your terminal. Refer to the reference manual for your data terminal.

Defining Macros

To set up this measurement, you'll define several different macros, then assemble them into one macro which runs the entire measurement and display sequence. The mac command allows you to assemble several HP 64700 commands under one name and store them away for later execution.

The first macro you define will set up initial conditions for the looping sequence by inserting a breakpoint at the LOOP routine location, then running the processor to that breakpoint by supplying a "command" to the input area. Type:

```
M> mac runtoloop={bc -e bp;bp 1050@u;r
1000@s;m 400@d=41}
```

You must also define an equate which predefines a value used for numbering iterations through the LOOP routine on the output display:

```
M> mac defcount={equ loopcount=0}
```

Using Echo to Send Escape Sequences to a Terminal

Before you display the first measurement, you want to clear the terminal screen. Type:

```
M> mac clrscreen={echo \1b "H" \1b "J"}
```

This macro will echo the sequence <ESC>H<ESC>J to the terminal, which will home the cursor and clear display memory.

You can echo any hex character between 0 and 255 decimal by using \nn, where nn is the hex representation of that character. Any printing ASCII characters can be echoed by enclosing them in single or double quote marks.

Using the Step Command

The step command allows you to step the emulation processor through individual instructions or groups of instructions.

Now, define a macro which steps the processor through the loop. Since there are three instructions in the loop, use 3 as the step count for the s (step) command. Type:

```
M> mac steploop={s 3 1050@u}
```

The step count is always the value immediately after the command. If no other parameters are specified, the processor is stepped from the current program counter value. In this case, you want to step from the beginning of the loop routine, so supply that address as the second parameter.

Note

You need to be careful not to confuse the step count and the step address; if you happen to supply an address as a step count, the emulator will attempt to step through that many instructions.

Displaying Memory

One of the things you want is a display of the output memory area. Set this up as follows:

```
M> mac dispoutput={m -db 500..51f@d}
```

Now you can set up the full combination of displays. You want the step display at the top of the screen, the register display in the middle, and the output area display at the bottom. Set up the step display as follows:

```
M> mac dispstep={echo \1b "H";echo "LOOP # "
loopcount;equ loopcount=loopcount+1;
steploop}
```

The dispstep macro homes the cursor, then echoes the words "LOOP # " along with the current value of the loopcount (defined by defcount as zero). Then, the loopcount is incremented, and you step through the loop.

Displaying Registers

You can display processor registers in groups or individually. You want to display the entire register set, so use the reg command without any parameters.

To define the register display, type:

```
M> mac dispreg={echo \1b "&a8r0C";echo
"PROCESSOR REGISTERS";reg}
```

Here, the cursor is moved to row 8, column 0 of the display. The words "PROCESSOR REGISTERS" are echoed on the display; then, the register set is displayed.

To define the memory display, type:

```
M> mac dispmem={echo \1b "&a16r0C";echo
"OUTPUT PORT DISPLAY";dispoutput}
```

With this macro, the cursor is moved to row 16, column 0; the words "OUTPUT PORT DISPLAY" are echoed to the display; then the memory is displayed.

Now, you need a macro to assemble these into one. Type:

```
M> mac runit={runtoloop; defcount;
clrscreen;rep 17 {dispstep;dispreg; dispmem}}
```

The initial loop counter value is defined, then the screen is cleared. Next, the step/register/memory display sequence is repeated 17 times (which happens to be the number of bytes written by the loop).

Verify all of the macros by typing:

```
M> mac
```

```
  mac  runtoloop={bc -e bp;bp 1050@u;r 1000@s;m 400@d=41}
  mac  defcount={equ loopcount=0}
  mac  clrscreen={echo \1b "H" \1b "J"}
  mac  steploop={s 3 1050@u}
  mac  dispoutput={m -db 500..51f@d}
  mac  dispstep={echo \1b "H";echo "LOOP # " loopcount; equ loopcount=loopcount+1;
steploop}
  mac  dispreg={echo \1b "&a8r0C";echo "PROCESSOR REGISTERS";reg}
  mac  dispmem={echo \1b "&a16r0C";echo "OUTPUT PORT DISPLAY";dispoutput}
  mac runit={defcount;clrscreen;rep 17 {dispstep;dispreg;dispmem}}
```

Your macros should match the ones defined here (unless you needed to modify the escape sequences to work with a terminal incompatible with the HP 2392A).

To run the macros, type:

```
M>runtoloop
  # bc -e bp ; bp 1050@u ; r 1000@s ; m
400@d=41
!ASYNC_STAT  615! Software breakpoint:
0001050@up
M>runit
```

As the macros execute, you can watch the processor instruction steps, the changing register values, and the changing output memory region.

Searching Memory for Strings or Numeric Expressions

The HP 64700 emulator provides you with tools that allow you to search memory for data strings or numeric expressions. For example, you might want to know exactly where a string is located, so that you can define an equate pointing to that string. To locate the position of the string "THIS IS MESSAGE A" in the user data area of the sample program, type:

```
M> ser 1000..2fff@u="THIS IS MESSAGE A"
```

```
pattern match at address: 0002004@u
```

You can also find numeric expressions. For example, you might want to find all of the TRAP instructions in the user code. Since a TRAP instruction begins with 4e hex, you can search for that value:

```
M> ser -db 1000..105b@u=4e
```

```
pattern match at address: 0001050@u
pattern match at address: 0001058@u
pattern match at address: 000105a@u
```

(Note: this search assumes that all of the breakpoints inserted during the tutorials in this chapter were enabled with bp -e *.)

You can then use the memory display to narrow down the selection:

```
M> m 1050..105f@u
```

```
0001050..000105f@u   4e 40 04 40 00 01 66 f8 4e 71 4e 4f 00 00 00 00
```

Two TRAP instructions are here; one at location 1050 hex, the other at location 105a hex. The instruction at location 1058 hex is actually a NOP.

What Next?

For more tutorial information:

- On the analyzer, refer to the *Analyzer User's Guide.*
- On coordinated measurements using the CMB, refer to the *CMB User's Guide.*

For reference information, with examples showing command context, refer to the *Reference* manual.

Notes

4

Configuring the Emulator

This chapter shows how you can configure the HP 64746 MC68302 emulator for your particular measurement needs.

Emulation Commands

Emulator commands fall into several groups. To fully understand the emulator configuration, you need to understand the different command groups and how they relate to the emulator configuration. See table 4-1 for the list of commands in each group while you read about these groups.

Configuration Commands

These commands are generally referred to as "configuration items," and are used to configure the emulator. The emulator response to certain processor actions can also be configured. These commands are described in this chapter.

Commands Used to Make a Measurement

Several of the emulator commands do not configure the emulator. They either simply start an emulator program run or other measurement, begin or halt an analyzer measurement, or allow you to display the results of such measurements. Some of these commands are used in the examples in chapters 2 and 3. The *Terminal Interface Reference* contains detailed information about all of these commands.

Table 4-1. Command Groups

Configuration	Make a Measurement	Coordinated Measurements	Analyzer	System
bc	b	bnct	ta	cim
cf	bp	cmb	tarm	cl
map	cov	cmbt	tcf	cp
	es	rx	tck	dt
	io	tx	tcq	dump
	m	x	telif	echo
	r		tf	equ
	reg		tg	help
	rst		tgout	init
	s		tif	lcd
	t		tinit	load
	th		tlb	mac
	tl		tp	mo
			tpat	po
			tpq	pv
			trng	rep
			ts	ser
			tsck	stty
			tsq	sym
			tsto	ver
			xttd	w
			xteq	xp
			xtgq	
			xtm	
			xtmo	
			xtsp	
			xtt	
			xttq	
			xtv	

Coordinated Measurement Commands

These commands determine how the emulator interacts with other measurement instruments, such as external analyzers, or other HP 64700-Series emulators connected together by the coordinated measurement bus (CMB). These commands are described in the *CMB User's Guide* and in the *Terminal Interface Reference*.

Analyzer Commands

The analyzer configuration commands are those commands which specify the type of measurement the analyzer is to make. Some of the analyzer commands are described earlier in this manual. You can refer to the *Analyzer Terminal Interface User's Guide* and the *Terminal Interface Reference* for more information.

System Commands

The system commands are used to set the emulator data communications protocol, load or dump contents of emulation memory, and set up command macros. These commands are described earlier in this manual and in the *Terminal Interface Reference.*

Displaying MC68302 Configuration Items

Use the **cf** command to configure the MC68302 emulator. To view the current emulator configuration settings, enter:

```
M>cf
  cf ba=en
  cf trc_dma=dis
  cf bbk=0
  cf bfc=sp
  cf be=dis
  cf clk=int
  cf dbc=en
  cf dti=dis
  cf lfc=x
  cf mon=bg
  cf rrt=dis
  cf rssp=9
  cf swtp=0
  cf ti=dis
  cf im=nor
  cf int7=lev
  cf iack7=pb0
  cf pdw=16
```

```
cf cs0_dtk=int
cf cs1_dtk=ext
cf cs2_dtk=ext
cf cs3_dtk=ext
```

Using the Built-in Help Facility

To display information about the **cf** command, enter:

```
M>help cf

  cf - display or set emulation configuration

    cf                  - display current settings for all config items
    cf <item>         - display current setting for specified <item>
    cf <item>=<value> - set new <value> for specified <item>
    cf <item> <item>=<value> <item> - set and display can be combined

  help cf <item>    - display long help for specified <item>

 --- VALID CONFIGURATION <item> NAMES ---
    ba       - en/dis bus arbitration
    trc_dma  - en/dis/tag emulation analysis of the bus arbitration cycles
    bbk      - select memory block during background operation
    bfc      - select function codes during background operation
    be       - en/dis /BERR to/from target system
    clk      - select int/ext clock source
    dbc      - en/dis drive of background cycles to the target system
    dti      - en/dis /DTACK interlock
    lfc      - select function codes for file loading
    mon      - selection of a foreground or background monitor
    rrt      - en/dis restriction to real time runs
    rssp     - set SSP when monitor is entered from emulation reset
    swtp     - select trap for software breaks
    ti       - en/dis of target system interrupts
    im       - nor/ded mode of target system interrupts
    int7     - lev/edge mode of IRQ7 interrupt
    iack7    - pb0/iack7 iack7 pin is pb0 or iack 7
    pdw      - 8/16 processor configuration for data bus width
    cs0_dtk  - int/ext internal or external /DTACK for chip selects 0
    cs1_dtk  - int/ext internal or external /DTACK for chip selects 1
    cs2_dtk  - int/ext internal or external /DTACK for chip selects 2
    cs3_dtk  - int/ext internal or external /DTACK for chip selects 3
```

Detailed information about each of these configuration items can be obtained by specifying the name of the item. For example, to learn about the **ba** item, type the following:

```
R>help cf ba

  Bus Arbitration configuration
```

```
cf ba=en      enable
cf ba=dis     disable

When bus arbitration is enabled the /BR and /BGACK
  signals driven from the target system to the emulator
  will respond in the same manner as they would respond
  if the CPU were present.
When bus arbitration is disabled the /BR signal
  driven from the target system will be ignored
  by the emulator.  The emulator will not drive an
  active level on /BG and the address, data and control
  signals will not be placed in a tristate condition.
```

Bus Arbitration (cf ba)

The **ba** (bus arbitration) configuration item defines how your emulator responds to bus request signals from the target system.

M> cf ba=en

When bus arbitration is enabled, the /BR (bus request) and /BGACK (bus grant acknowledge) signals from the target system are responded to exactly as they would be if the target processor was present. In other words, if the emulation processor receives a /BR from the target system, it will respond by asserting /BG and will set the various processor lines to tri-state at the end of the current cycle. The target system should then assert /BGACK to complete acquisition of the processor bus. /BR is then released by the target; /BG is negated by the processor. When /BGACK is negated by the target, the emulation processor restarts execution.

Note

You cannot perform DMA (direct memory access) transfers between your target system and emulation memory at any time; the 68302 emulator does not support such a feature. You may, however, do accesses to the processor's internal memory.

M> cf ba=dis

When you disable bus arbitration by entering the above command, the emulator ignores the /BR and /BGACK signals from the target system. The emulation processor will never drive the /BG line true; nor will it place the address, data and control signals into the tri-state mode.

Enabling and disabling bus master arbitration can be useful to you in isolating target system problems. For example, you may have a situation where the processor never seems to execute any code. You can disable bus arbitration using **cf ba=dis** to check and see if faulty arbitration circuitry in your target system is contributing to the problem.

See also the section on **cf trc_dma**.

Background Block (cf bbk)

The **bbk** (background block) configuration item allows you to specify what memory address will be driven to the target system on address lines A23-A16 during emulation background monitor accesses. These lines will only be driven if you have configured the emulator to drive upper addresses during background monitor operation using the **cf dbc=en** option.

If you have set the emulator to use a foreground monitor using the **cf mon=fg..xxxxxx@f** option, the **bbk** configuration option is still valid because the emulation processor executes a few bus cycles in the background monitor before the transition to the foreground monitor.

For example you might want your target system to see that accesses are occurring in the range 05xxxx hexadecimal while the emulator is operating in background. By typing

```
M> cf bbk=05
```

the emulator will drive the value 05 hex on the upper address lines during every background monitor access.

You should use the address block configuration option to set up an address which will not interfere with your target system circuitry, such as memory management units or cache memory. Note that this is still important even when using a foreground monitor, since the emulator does spend a few cycles in the background monitor during the transition to the foreground monitor.

Bus Error (cf be)

The **be** (bus error) configuration item allows you to define how the emulator will respond to a /BERR (low bus error) signal asserted by the target system during an emulation memory cycle.

be=en connects the target system /BERR to the emulator /BERR signal so that the emulation processor will terminate the current emulation memory cycle and will begin executing your bus error handler if your target system asserts the /BERR signal during an emulation memory cycle.

Note

You must interlock the target system /DTACK (data transfer acknowledge) with the emulation system /DTACK using the **cf dti=en** configuration option; otherwise, the emulator will not respond correctly to the /BERR signal from the target system.

be=dis disconnects the emulator /BERR from the target.

Background Function Codes (cf bfc)

The **bfc** (background function codes) configuration option lets you select the function code state that will be driven to your target system during emulator background monitor cycles. These function codes will only be driven to the target system if you set the **cf dbc** option to **cf dbc=en**. If you have elected to use a foreground monitor with the **cf mon=fg** option, this option is still valid because the emulator spends a few cycles in the background before the transition to the foreground.

You can select one of four possible function code states to be driven to the target system during background monitor cycles. These are:

```
M> cf bfc=sp
```

The function code for supervisor program cycles will be driven to the target system. This is function code 110 binary (FC2-FC0, respectively).

```
M> cf bfc=sd
```

The function code for supervisor data access cycles will be driven to the target system. This is function code 101 binary (FC2-FC0, respectively).

```
M> cf bfc=up
```

The function code for user program cycles will be driven to the target system. This is function code 010 binary (FC2-FC0, respectively).

```
M> cf bfc=ud
```

The function code for user data access cycles will be driven to the target system. This is function code 001 binary (FC2-FC0, respectively).

The setting you choose for your situation is dependent on your particular system. Generally, you want to choose a function code that will not cause target system hardware such as memory management units to behave in an unpredictable manner.

Clock Selection (cf clk)

The **clk** (clock) option allows you to select either the external target system clock or the emulator's internal clock as the emulator clock source.

```
M> cf clk=int
```

You can select the emulator's internal 16 MHz oscillator using the above command.

```
M> cf clk=ext
```

You can specify that the emulator use the emulator probe's clock input as the clock source. This clock must conform to the specifications for the 68302 microprocessor. The maximum clock speed with the HP 64746 emulator is 16.67 MHz.

You should always select the external clock option when using the emulator in-circuit to ensure that the emulator is properly synchronized with your target system.

Note

Executing the **cf clk=int** command (even if already using the internal clock) will drive the emulator into the reset state and hold it in that state (R> prompt).

Chip Selects (cf cs[0-3]_dtk)

The MC68302 chip selects can be configured either to generate the DTACK signal internally or to use an externally supplied DTACK. The emulator looks at two things to decide which source of the DTACK it should look for when a given chip select is active:

- The chip select lines (programmed using registers BR0-BR3). The source of DTACK for the chip select lines is determined by the corresponding DTACK field bits (programmed using OR0-OR3). The order in which you write these registers is significant.

- The emulator configuration (set using **cf cs0_dtk** through **cf cs3_dtk**).

Note

Be sure that the emulator configuration and the configuration of the chip select lines are consistent. Remember that the order in which you write the chip select registers BR0-BR3 and OR0-OR3 is significant.

If **cs***x***_dtk=int**, an active signal on chip select *x* causes the /DTACK signal to be driven to the target system and the emulator will not drive /DTACK to the processor.

If **cs***x***_dtk=ext**, an active signal on chip select *x* causes the /DTACK signal to be driven to the processor. The source of this /DTACK signal is determined by the /DTACK interlock configuration.

See also the section on /DTACK interlock in this chapter.

Drive Background Cycles (cf dbc)

The **dbc** (drive background cycles) option allows you to select whether or not the emulator will drive the target system bus on all background monitor cycles.

If you have elected to use a foreground monitor with the **cf mon=fg** command, emulator foreground monitor cycles will appear at the target interface exactly as if they were bus cycles caused by any target system program.

```
M> cf dbc=en
```

You can enable background cycle drive to the target system by entering the above command. All of the emulation processor's address, data and control strobes are driven during background cycles.

The value driven on the upper 8 bits (A23-A16) of the address bus is selected by the configuration command **cf bbk=xx**; the value driven on the function code lines is selected by the configuration command **cf bfc=xx** (see above for descriptions of these two configuration items).

Background write cycles will appear as read cycles to the target system if the **dbc** option is enabled.

```
M> cf dbc=dis
```

If you specify the above command, background monitor cycles are not driven to the target system. When you select this option, the emulator will appear to the target system as if it is between bus cycles while it is operating in the background monitor.

The **dbc** option is used to avoid target system interaction problems. For example, your target system memory refresh scheme may depend on the constant repetition of bus cycles, or you may be using a watchdog timer (which resets the system after no bus cycles occur in a specified time period). Using the **dbc** option will help avoid problems in either case.

/DTACK Interlock (cf dti)

The **dti** (/DTACK interlock) option allows you to specify the source of the /DTACK (cycle termination) signal. /DTACK interlock applies only to situations where the MC68302 does not provide an internal /DTACK.

When /DTACK interlock is enabled (**dti=en**), the target system (if there is one) is expected to provide a /DTACK signal. Accesses to emulation memory will not be terminated until the target system provides a /DTACK. If background cycles are being driven to the target system, then the target system *must* provide a /DTACK signal to terminate background memory cycles.

When /DTACK interlock is disabled (**dti=dis**), emulation memory and background memory accesses are terminated by a /DTACK signal generated by the emulator.

When the emulator is not operating in a target system, all externally provided /DTACK cycles are terminated by an emulator-generated /DTACK signal.

If a /BERR signal occurs during an emulation memory cycle when **cf be=en** (bus error response enabled), then the cycle will be terminated and the emulation processor will begin executing the bus error handler.

If you have enabled background monitor drive to the target system with the **cf dbc=en** configuration option, and if /DTACK is interlocked (**cf dti=en**), then the target system must provide a /DTACK signal as if it were a normal user program access to emulation memory.

See also the section on chip selects in this chapter.

Note

If you are not operating the emulator in-circuit, all emulation and background monitor accesses are completed by the emulator generated DTACK signal, regardless of the setting of the **cf dti** configuration option.

PB0/IACK7 Configuration (cf iack7)

When the PB0/IACK7 pin is used as an interrupt acknowledge line (**cf iack7=iack7**), the emulator blocks emulator-generated level 7 interrupt acknowledges to the target system.

When the PB0/IACK7 pin is used as a port B peripheral pin (**cf iack7=pb0**), the emulator does not affect the pb0 line.

Interrupt Mode (cf im)

In normal mode (**cf im=nor**), the interrupt inputs to the processor are encoded on IPL2, IPL1, and IPL0.

In dedicated mode (**cf im=ded**), IPL2 becomes IRQ7, IPL1 becomes IRQ6, and IPL0 becomes IRQ1. Use **cf int7** to choose whether to interrupt on a falling edge or on a low level.

IRQ7 Mode (cf int7)

This configuration item only applies when **cf im=ded**.

In level mode (**cf int7=lev**), interrupt 7 will happen when IRQ7 is low. In edge mode (**cf int7=edge**), a change from high to low on IRQ7 causes an interrupt 7.

Load Function Codes (cf lfc)

The **lfc** (load function codes) configuration item determines how the emulator will interact with the **load** command when loading your program files.

```
R>help cf lfc

  Selection of function code for file loading

    cf lfc=x      function codes unmapped
    cf lfc=s      load file in supervisor space
    cf lfc=u      load file in user space
    cf lfc=p      load file in program space
    cf lfc=d      load file in data space
    cf lfc=sp     load file in supervisor program space
    cf lfc=sd     load file in supervisor data space
    cf lfc=up     load file in user program space
    cf lfc=ud     load file in user data space

    Select the function code pattern that specifies
      the function code range that the 'load' command
      uses to load files.
    This configuration must be used if 68302 function
      codes are part of the memory map.
```

Parameter Descriptions

cf lfc=x — No function codes are mapped. This is the default.

cf lfc=s — This configures the emulator so that subsequent **load** commands will address only terms specified as supervisor space.

cf lfc=u — This configures the emulator so that subsequent **load** commands will address only terms specified as user space.

cf lfc=p — When you enter a **load** command, the file will be loaded into memory ranges designated as "program" space.

cf lfc=d	When you enter a **load** command, the file will be loaded into memory ranges designated as "data" space.
cf lfc=sp	When you enter a **load** command, the file will be loaded into memory ranges designated as "supervisor program" space.
cf lfc=sd	When you enter a **load** command, the file will be loaded into memory ranges designated as "supervisor data" space.
cf lfc=up	When you enter a **load** command, the file will be loaded into memory ranges designated as "user program" space.
cf lfc=ud	When you enter a **load** command, the file will be loaded into memory ranges designated as "user data" space.

Monitor Selection (cf mon)

The **mon** (monitor) configuration item allows you to choose between a foreground monitor, which you must load into the emulator, or the background monitor, which resides in the emulator.

The emulation monitor is the program that handles communication between the emulation controller and the emulation processor. For example, when you ask for a register display, the emulator execution breaks out of the user program into the monitor, where 68302 instructions store the register contents in an array of memory locations. When all register contents are stored, emulator execution returns to your program.

The background monitor provided with the emulator offers the greatest degree of transparency to your target system (that is, your target system should generally be unaffected by monitor execution). However, in some cases you may require an emulation monitor tailored to the requirements of your system. In this case, you will need to use a foreground monitor linked into your program modules. See chapter 5 of this manual for more information on foreground monitors.

```
M> cf mon=bg
```

The command above selects the use of the built-in background monitor. A memory overlay is created and the background monitor is loaded into that area. You can use the configuration items **cf dbc**, **cf bbk**, and **cf bfc** to specify how the emulator will drive the target system during background monitor execution.

Note

When stepping through program execution and an interrupt occurs while the emulator is executing in background, another step command looks as though it causes the same instruction to execute. Actually, the instruction does not execute because the interrupt occurs before the instruction is executed.

```
M> cf mon=fg..XXXXXX@f
```

The command above selects the use of your foreground monitor, where

- **XXXXXX** defines an hexadecimal address where the monitor will be located. (Note: this will not load the monitor, it only specifies its location). Choose the address as follows:
  - If you are not using the HP 64170 memory board, the address should be on a 2-kbyte boundary.
  - If you are using the HP 64170 with 256-kbyte memory modules, the address should be on a 2-kbyte boundary.
  - If you are using the HP 64170 with 1-Mbyte memory modules, the address should be on an 8-kbyte boundary.
- **@f** defines an optional function code specifier to further qualify the monitor location. You may only use **x** (no function code) or **s** (supervisor space). If you do not specify a function code, the default is **x**.

Remember that you must assemble and link your foreground monitor starting at the 2 kilobyte boundary specified in the command above. If you specified a function code in the monitor location specifier, you need to use the **cf lfc=s** or **cf lfc=x** command before loading the monitor to ensure that it is loaded at the correct location.

Note

If you intend to use a foreground monitor, the monitor must be loaded before attempting to load any information into target system memory.

A memory mapper term is automatically created when you execute the **cf mon=fg** command to reserve 2 kilobytes of memory space for the monitor.

The memory map is reset any time **cf mon=fg** is entered. It is only reset when the **cf mon=bg** command is entered if the emulator is not already configured to use the background monitor.

Bus Width (cf pdw)

When out of circuit, this configuration item sets the processor bus width. The two possibilities are **cf pdw=8** and **cf pdw=16**.

When in circuit, the target system BUSW pin overrides this configuration item.

Restrict to Real-Time (cf rrt)

The **rrt** (restrict to real-time) option lets you configure the emulator so that commands which temporarily cause the emulator to break to the monitor will be rejected by the emulator command interpreter.

```
M>help cf rrt

  Restrict to Real Time Runs

    cf rrt=en       enable
    cf rrt=dis      disable

  When enabled and while the emulator is running the user program, any
    command that requires a break to the monitor will be rejected except
    'rst', 'b', 'r' or 's'.
  When disabled, commands that require a break to the monitor will
    always be accepted.
```

When you enable the "restrict to real-time" option with the command **cf rrt=en**, you can restrict the emulator to accept only commands that don't cause temporary breaks to the monitor.

Only the following emulator run/stop commands will be accepted:

rst (Resets the emulation processor.)

b (Breaks processor to background monitor until you enter another command.)

r (Runs the emulation processor from a given location.)

s (Steps the processor through a section of code, and returns to monitor after each step.)

Commands which cause the emulator to temporarily break to the monitor and return, such as **reg**, **m** (for target memory display), and others, will be rejected by the emulator.

Caution

POSSIBLE DAMAGE TO TARGET SYSTEM!

IF COMMANDS THAT STOP THE PROCESSOR WILL DISRUPT TARGET SYSTEM OPERATION, READ THIS!

If your target system circuitry is dependent on constant execution of program code, you should set this option to **cf rrt=en**. This will help insure that target system damage doesn't occur. However, remember that you can still execute the **rst**, **b** and **s** commands. You should use caution in executing these commands.

Also consider using **cf dbc=en** to drive the address, data, and control strobes while the background monitor is executing.

When the "restrict to real-time" option is disabled, all commands, regardless of whether or not they require a break to the emulation monitor, are accepted by the emulator.

Supervisor Stack Pointer on Reset (cf rssp)

The **rssp** (register supervisor stack pointer) configuration item allows you to specify a value to which the supervisor stack pointer will be set upon the first transition from emulation reset into the emulation monitor.

```
R> cf rssp=XXXXXXXX
```

Where **XXXXXXXX** is a 32-bit hexadecimal even address. The supervisor stack pointer will be set to this value upon entry to the emulation monitor after an emulation reset. This address should reside in an otherwise unused emulation or target system RAM area.

Note

We recommend that you use this method of configuring the supervisor stack pointer. Without a stack pointer, the emulator is unable to make the transition to the run state, step, or perform many other emulation functions. However, using this option **does not** preclude you from changing the stack pointer value or location within your program; it just sets the initial conditions to allow a run to begin.

For example, to set the stack pointer to 000000ff0 hex, type:

```
R> cf rssp=00000ff0
```

Now, if you break the emulator to monitor using the **b** command, the stack pointer will be modified to the value 00000ff0 hex.

Note

A target system reset which occurs during background monitor operation will not affect the supervisor stack pointer value.

Note

When a foreground monitor is used, the reset value of the supervisor stack pointer must be at least six bytes away from a guarded memory area. If the reset value of SSP is not six bytes away from a guarded area, a "Stack is in guarded memory" error will occur when you attempt to run the program.

Software Breakpoint Trap (cf swtp)

The **swtp** (software trap) configuration item allows you to specify which of 16 software trap instructions implemented by the 68302 should be used when you insert a software breakpoint with the **bp** command.

```
M> cf swtp=xx
```

Executing the above command with **xx** as one of the values 00 through 0f specifies the particular software trap instruction to be used for the software breakpoints feature.

For example, suppose **cf swtp=0f**; when you define a software breakpoint at some address, the opcode at that address is replaced by the TRAP #0FH instruction.

When a TRAP #0FH instruction is executed, the emulator breaks into the monitor. Since the system controller knows the locations of defined software breakpoints, it can determine whether the TRAP #0FH was generated by an enabled software breakpoint or a TRAP #0FH instruction in the user program.

If the TRAP #0FH instruction was inserted as a software breakpoint, the TRAP #0FH instruction is replaced by the original opcode. A subsequent run or step command will execute from this address.

If the TRAP #0FH instruction is part of the user program, an "undefined breakpoint" message is displayed. To continue program execution, you must run or step from the user program's TRAP #0FH vector address.

When you change the value assigned to the **swtp** configuration item, any software breakpoints currently defined with the **bp** command are disabled (since the software trap instructions currently in memory may differ from the new value you have specified).

Target System Interrupts (cf ti)

The **ti** (target system interrupts) configuration item allows you to specify whether or not the emulation processor responds to interrupts generated by the target system.

```
M> cf ti=en
```

When you enable target system interrupts with the above command, all target system interrupts generated when the processor is executing your user program are recognized by the emulation processor.

If you are using the built-in background monitor, target system interrupts are always ignored during background execution. If you are using a foreground monitor, whether or not target system interrupts are recognized during monitor execution is dependent on the implementation of your monitor. See chapter 5 for further information on foreground monitors.

```
M> cf ti=dis
```

You can disable the recognition of all target system interrupts by the emulator by entering the above command.

DMA Tracing (cf trc_dma)

When DMA tracing is enabled (**cf trc_dma=en**), the analyzer will capture analyzer states during external or internal DMA bus cycles. The analyzer state can be generated only if the processor states are actually being driven on the external DMA cycle.

When DMA tracing is disabled (**cf trc_dma=dis**), the analyzer will not capture any external or internal DMA, bus cycles.

When DMA tagging is enabled (**cf trc_dma=tag**), a single emulation analyzer state will be generated each time an external bus arbitration sequence occurs.

Where to Find More Information

Due to the architecture of the HP 64700-Series Emulators, there are a wide variety of items that affect how the emulator interacts with your system, controller, and other measuring instruments. If you need more information, refer to the following:

- *Analyzer Terminal Interface User's Guide*

  This manual describes how to use the analyzer in the Terminal Interface.

- *CMB User's Guide*

  This manual describes how to use the Coordinated Measurement Bus.

- *Terminal Interface Reference*

  This manual contains detailed descriptions and syntax diagrams for all HP 64700-Series Terminal Interface commands. Also included are error messages and other pertinent information.

- The built-in help messages for each configuration item

Configuring Other Features

Some other emulator features that you can configure (not using the **cf** command) include:

- Memory
- Access and Display Modes
- Break Conditions
- Software Breakpoints
- Coordinated Measurement Bus Operation

5

Concepts

Topics Covered

- MC68302 Vector Table
- Access and Display Modes
- Target System Memory Access
- Break Conditions
- Macros
- Coordinated Measurement Bus Operation
- Software Products
- In-Circuit Emulation
- Using the Analyzer
- Equates
- Replacing Firmware in the Emulator
- Foreground and Background Monitors

MC68302 Vector Table

All MC68302 emulation systems require a vector table to process system conditions, such as divide by zero or trace traps. You need to provide such a vector table to manage these conditions. Exception processing attempted without a vector table will cause unpredictable results. Most of the examples shown in this manual were created without a vector table to simplify the examples.

The MC68302 vector table is different from the M68000 vector table in that it includes the processor's BAR and SCR registers at $0F2 and $0F4.

Refer to the Motorola documentation for the MC68302 microprocessor for additional information about vector tables and exception processing.

Access and Display Modes

When using the HP 64746 emulator, you can set the access mode to bytes, or words. The display mode can be set to mnemonics, bytes, words, or long words (4 bytes).

To display the current access and display modes, enter:

```
M>mo
  mo -ab -dm
```

If the result shown above appears, the access mode is set to "bytes" and the display mode is set to "mnemonics."

To change the access mode to word format, enter:

```
M>mo -aw -dm
```

To change the display mode to byte format, you can either use the **mo** command to modify the current setting, or execute a "memory display" command in the form:

```
M>m -db 300
```

The display mode is then automatically set to "byte." All successive commands will be displayed in byte format.

You should always do accesses in byte mode when the processor is running in 8 bit mode (set by **cf pdw=8** when out of circuit, or by the BUSW pin when in circuit).

To display additional information about the mode command, enter:

```
M>help mo
```

Target System Memory Access

Target memory accesses by the emulator are accomplished by causing the monitor to read target memory, then placing the data so that it is accessible by the emulation controller. When the emulator is executing in the monitor, the target system is "locked out." Because of this, special hardware is used to access the target system at the appropriate time.

The choice of an access mode is provided by the emulator to accommodate memory devices which must be accessed using a particular bus size. The emulator access mode to target system memory can be bytes, or words. The default access mode is bytes. The emulator will access target system memory using whatever mode is currently set.

When using word access mode, if the target system bus requires a smaller bus width, an error message will be displayed. However, since target system bus widths for a particular memory range cannot be determined until the bus cycle occurs, target system memory write operations may disrupt the monitor, causing the emulator to be put in an unknown state. If this happens, resetting the emulator (using the **rst** command) should restore the monitor.

Because of the restraints listed here, Hewlett-Packard recommends that you use byte access mode unless a larger size is needed. If you need to write to devices that require a larger bus size, use word mode. However, performance increases are hardly noticeable when using a larger access mode.

Break Conditions

If break conditions are enabled, when a specified break condition occurs the emulator will break to the monitor. If break conditions are disabled, when a specified break condition occurs the emulator will not break into the monitor. The **bc** command is used to set break conditions.

Possible break conditions include:

- bp (software breakpoints)
- rom (write to ROM)
- bnct (BNC trigger signal)
- cmbt (CMB trigger signal)
- trig1 (trig1 signal)
- trig2 (trig2 signal)

Some examples follow. The *Terminal Interface Reference* contains additional information about break conditions.

To display current break conditions, enter:

```
M>bc
```

The **bc** command lets you configure the emulator's response to various emulation system and external events.

Software Breakpoints

The **bp** command allows you to insert software traps in your code which will cause a break to the emulation monitor when encountered during program execution. To enable the insertion and use of software breakpoints by the **bp** command, enter:

```
M>bc -e bp
```

Note that any breakpoints that existed before you entered this command are not reenabled. You must do that explicitly by using the **bp** (breakpoint) command.

To disable use of software breakpoints, enter:

```
M>bc -d bp
```

Any breakpoints which previously existed in memory are disabled, but are not removed from the breakpoint table.

Note

Software breakpoints should not be set, cleared, enabled, or disabled while the emulator is running user code. If any of these commands are entered while the emulator is running user code, and the emulator is executing code in the area where the breakpoint is being modified, program execution may be unreliable.

Break on Trigger Signals

Each HP 64700-Series emulator provides four different trigger signals which allow you to selectively start or stop measurements depending on the signal state. These are the **bnct** (rear panel BNC input), **cmbt** (CMB trigger input), and **trig1** and **trig2** signals (provided by the analyzer).

You can configure the emulator to break to the monitor upon receipt of any of these signals. For example, to have the emulator break to monitor upon receipt of the **trig1** signal from the analyzer, enter:

```
M>bc -e trig1
```

(In this situation, you must also configure the analyzer to drive the **trig1** signal upon finding its trigger by entering **tgout trig1**).

To enable the breakpoint and BNC trigger conditions, enter:

```
M>bc -e bp bnct
```

To disable the BNC trigger break condition, enter:

```
M>bc -d bnct
```

To display additional information about break conditions, refer to the *Terminal Interface Reference*. You can also enter:

```
M>help bc
```

Macros

To create your own macros, follow this syntax:

```
mac <macro_name>={command 1;command 2}
```

You can use more than two commands in a macro definition. Refer to the *HP 64700-Series Emulators Terminal Interface Reference* for details about the **mac** command.

For example, with a program already loaded in memory, you could define a macro to:

- Display the MC68302 emulator status.
- Display registers.
- Start the emulator running the program.
- Trace program activity.
- Halt the trace.
- Display the trace list.
- Observe the trace status.

All of these functions would be performed automatically when you execute the macro. For example (enter the brackets also):

```
M>mac go302={es;t;r;reg;th;tl;ts}
```

While the emulator is executing in the monitor (the prompt is M>), to execute the macro, enter:

```
M>go302
```

Observe the commands execute as you defined them in the macro.

To display additional information about the mac command, enter:

```
M>help mac
```

Coordinated Measurement Bus Operation

The Coordinated Measurement Bus (CMB) connects multiple emulators together and allows you to make synchronous measurements between those emulators. You can determine whether the MC68302 emulator will participate in a coordinated measurement using the **cmb** command. For example:

To display the current setting of the CMB, enter:

```
M>cmb
```

To enable CMB interaction, enter:

```
M>cmb -e
```

To disable CMB interaction, enter:

```
M>cmb -d
```

The **cmb** command does not affect operation of the HP 64700 emulation analyzer cross-triggering. Refer to the *CMB User's Guide* for additional information about operating the emulator with the CMB and making measurements.

To display additional information you can enter:

```
M>help cmb
```

Software Products

Assembler/Linker

HP 64870 HP 9000-based M68000 Assembler/Linker/Librarian . (This assembler generates code for the M68000, M68008, M68010, MC68302, M68332, and M68020 processors. Also available for Apollo computers as B1423.)

C Cross Compiler

The HP 64902 68000 C Cross Compiler can be used to compile high-level C programs, and operates on the HP 9000 Series 300 and Series 800 host computers. (Also available for Apollo computers as B1421.)

HP Branch Validator

The HP Branch Validator operates on the HP 9000 Series 300 host computer, and can be used to analyze and quantify the level of testing on your product.

User Interfaces

At least two other interfaces are available for using the HP 64746 emulator, depending on what type of host computer you are using.

Softkey Interface

The HP 64746 MC68302 Softkey Interface allows you to operate your HP 64746 emulator using a softkey-driven interface on the HP 9000 Series 300 or Sun SPARCsystem host computer. You can also configure your HP 64700-Series emulator into a measurement system to make coordinated measurements with HP 64000-UX emulators.

PC Interface

The HP 64746 MC68302 PC Interface allows you to operate your HP 64746 emulator on a personal computer using a menu-driven interface. The PC Interface allows you to transfer (download) absolute files from a PC into the emulator in standalone mode.

Protecting the Emulator Probe

The HP 64746 MC68302 emulator can be operated in-circuit (connected to a target system) or out-of-circuit.

Note

The emulator probe requires a PGA (pin grid array) socket. Connecting the emulator is much easier if you use a PGA socket in your target system.

If you would like to use a PQFP package, see chapter 1.

Pin Protector

The emulation probe has a pin protector that prevents damage to the probe when inserting and removing the probe from the target system microprocessor socket. **Do not use the probe without a pin protector installed.** If the probe is installed on a densely populated circuit board, there may not be enough room to accommodate the plastic shoulders of the probe socket. If this occurs, another pin protector may be stacked onto the existing pin protector.

To order additional pin protectors, contact your local HP Sales and Service Office listed in the *Support Services* manual. You may also use a socket such as the McKenzie Technology PGA-100M-003B1-1324 for a pin protector.

Conductive Pin Guard

HP emulators are shipped with a conductive plastic or conductive foam pin guard over the target system probe pins. This guard is designed to prevent impact damage to the pins and should be left in place while you are not using the emulator. However, when you do use the emulator, either for normal emulation tasks, or to run performance verification on the emulator, you must remove this conductive pin guard to avoid intermittent failures due to the probe lines being shorted together.

Caution

POSSIBLE DAMAGE TO EMULATOR PROBE!

Always use the pin protectors and guards as described above. Failure to use these devices may result in damage to the probe pins. Replacing the probe is expensive. If damage occurs, the entire probe and cable assembly must be replaced because of the wiring technology employed.

Using the Analyzer

Your MC68302 emulator can use either an emulation analyzer (Model 64704A), and or an external analyzer (Model 64703A).

The emulation analyzer captures emulator bus cycle information synchronously with the processor clock signal. When a trace is taken, a collection of the captured states is stored in the analyzer.

The external analyzer captures activity on signals that are external to the emulator. This typically includes signals in a target system. The external analyzer provides 16 external trace signals and two external clock inputs. The external analyzer can be used as an extension to the emulation analyzer. In addition, it can be used independently as a state analyzer, or as a timing analyzer. However, to use the external analyzer as a timing analyzer, you must have either a personal computer running the HP 64746 MC68302 PC Interface or an HP 9000 Series 300 host computer running the HP 64746 Softkey Interface.

For additional information about operating the analyzer terminal interface, refer to the *Analyzer Terminal Interface User's Guide.*

Analyzer Clock Speed

To display the current analyzer clock speed setting, enter:

```
M>tck
  tck -r L -u -s S
```

You can configure the analyzer to operate at various clock speeds using the following commands:

```
M>tck -s VF  (for speeds greater than 20 MHz)
```

```
M>tck -s F  (for speeds greater than 16 MHz but less than 20MHz)
M>tck -s S  (for speeds less than 16 MHz)
```

For the MC68302, the analyzer speed should always be **tck -s S**.

If you try to execute one of these commands, and the system displays an error message indicating the clock speed is not available with the current count qualifier, enter:

```
M>tcq none
```

Then try executing the command again.

The analyzer clock runs at one-fourth of the processor clock speed. Thus if the processor is running at 16 MHz, the analyzer will run at 4 MHz. The analyzer state counter cannot be used at analyzer clock speeds greater than 20 MHz. The analyzer time counter is turned off by default because it cannot be used at clock speeds greater than 16 MHz.

If you want to use the analyzer counter, you can:

- Cut the clock speed in half.
- Slow the bus clock using an external clock.

Equates

Equates are logical expressions. The **equ** command allows you to equate arithmetic values to names that you choose. Names can be used in other commands when referencing the value. Equates are commonly used to define trigger patterns for the emulation or external analyzers (as trace qualifiers). Equates for common status values are predefined.

For the MC68302 emulator, the following equates are defined when the emulator is powered up.

```
M>equ
### Equates ###
  equ bclr=0xxxxxxxxxxxxxx0xy
  equ berr=0xxxxxxxxx0xxxxxxy
  equ bgd=0xxxxxxxy
  equ byte=0xxxxxxx0y
  equ cs0=0xxxxxxxxxx0xxxxxy
  equ cs1=0xxxxxxxxxxx0xxxxy
  equ cs2=0xxxxxxxxxxxx0xxxy
  equ cs3=0xxxxxxxxxxxxx0xxy
  equ data=0xxx01xxxy
  equ ded_int1=0xx0xxxxxxxxxxxxxy
  equ ded_int6=0x0xxxxxxxxxxxxxxy
  equ ded_int7=0xxxxxxxxxxxxxxxy
  equ dma=0x1xxxxxxy
  equ ext_cyc=0xxxxx0xxy
  equ ext_dma=0xxxxxxxxxxxxxxx0y
  equ fgd=1xxxxxxxy
  equ grd=0xxxxxxx0xxxxxxxxxy
  equ int_cyc=0xxxxx1xxy
  equ int_dma=0xxxxxxxxxxxxxxx1y
  equ intack=0xx111xxxy
  equ nor_int1=110xxxxxxxxxxxxxy
  equ nor_int2=101xxxxxxxxxxxxxy
  equ nor_int3=100xxxxxxxxxxxxxy
  equ nor_int4=11xxxxxxxxxxxxxy
  equ nor_int5=10xxxxxxxxxxxxxy
  equ nor_int6=1xxxxxxxxxxxxxy
  equ nor_int7=0xxxxxxxxxxxxxy
  equ nor_no_int=111xxxxxxxxxxxxy
  equ not_dma=0x0xxxxxxy
  equ pb10_h=0xxxx1xxxxxxxxxxxy
  equ pb10_l=0xxxx0xxxxxxxxxxxy
  equ pb11_h=0xxx1xxxxxxxxxxxxy
  equ pb11_l=0xxx0xxxxxxxxxxxxy
  equ pb8_h=0xxxxxx1xxxxxxxxxy
  equ pb8_l=0xxxxxx0xxxxxxxxxy
  equ pb9_h=0xxxxx1xxxxxxxxxxy
  equ pb9_l=0xxxxx0xxxxxxxxxxy
  equ prog=0xxx10xxxy
  equ read=0xxxxxx1xy
  equ rom=0xxxxxxxx0xxxxxxxxy
  equ sup=0xx1xxxxxy
  equ supdata=0xx101xxxy
  equ supprog=0xx110xxxy
  equ user=0xx0xxxxxy
  equ userdata=0xx001xxxy
  equ userprog=0xx010xxxy
```

```
equ word=0xxxxxxx1y
equ write=0xxxxxx0xy
```

You can add, observe, delete and modify logical expressions using the **equ** command. How to use the **equ** command is described in the following paragraphs.

These logical expressions are used to define values for the emulation analyzer label "stat" (for 8-bit equates) and "extra" (for 16-bit equates). For example, the following two equations are equal:

```
stat=data
stat=0xxxxxxxxxxxx0xy
```

The "y" indicates the number is binary.

Note

Use the label **stat** for 8-bit equates. Use the label **extra** for 16-bit equates.

Note

The 16-bit equates and **extra** label will not exist on 48-channel analyzers. If you upgraded an M68000 emulator to the MC68302 emulator, you have a 48-channel analyzer.

You can see a summary of which equates apply go with "stat" and which go with "extra" by typing:

```
help proc
```

You can define other expressions using the **equ** command. Some examples of using the **equ** command are shown in the following paragraphs.

To define a logical expression for running from the start of a program located at address 0, enter:

```
M>equ start=0
```

Verify that the start equate was added to the list of equates.

```
M>equ *
```

You could put the analyzer in complex mode, then use the "start" equate in defining a trigger pattern for the emulation analyzer. For example:

```
M>tcf -c
M>tpat p1 addr=start
```

This command defines pattern 1 to be the address equal to the value of "start." You could then have the analyzer trigger on p1 using the command **tg p1**.

In "easy" mode, you could just specify **tg addr=start**.

Note

You should not delete any of the predefined equates unless you know they are not going to be needed. Each time you cycle power on the emulator, or execute an **init** command, any predefined equates that were deleted will be automatically defined again.

To delete a defined equate (for example, "start"), enter:

```
M>equ -d start
```

To verify that the "start" equate was deleted from the list of equates, enter:

```
M>equ
```

For additional information about equates and using the emulation or external analyzer, refer to the *Terminal Interface Reference* (for command descriptions) and the *Analyzer Terminal Interface User's Guide*.

Symbols

Symbols, like equates, are logical expressions. If you use a symbol in place of an equate for an address, the symbol name will be displayed in the address column of the trace list.

For example, you can define a symbol "EntryPoint":

```
M>sym EntryPoint=1050
```

You can display the values of all currently defined symbols by typing:

```
M>sym
   sym EntryPoint=0001050
```

To display a trace list with symbols, use the **-e** option:

```
M>tl -e
```

Any access to location 1050 hex will now be shown with the address "EntryPoint" rather than "1050."

Emulator Firmware

This emulator uses flash ROMs, which can be reprogrammed from an appropriately equipped personal computer. Instructions on how to reprogram the ROMs will accompany the firmware update.

If you need to determine what version of firmware is loaded into the emulator, type:

```
M>ver

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written permission is prohibited, except as allowed under copyright laws.

  HP64700 Series Emulation System
    Version:   A.02.02 24Jan90

  HP64746A (PPN: 64746A) Motorola 68302 emulator
    Version:   A.02.02 05Jul90
    Speed:     16.67 MHz
    Memory:    126 KBytes

  HP64740 Emulation Analyzer with External State/Timing Analyzer
    Version:   A.02.00 29Jun89
```

Monitor Description

The monitor program is the interface between the emulation system controller and the target system. The emulation system controller contains a microprocessor which accepts and executes emulation, system, and analysis commands. The monitor operates in the background emulator mode.

The monitor program allows emulation commands to access target system resources. Access to the target system can only be accomplished through the emulation processor. For example, if you enter a command to modify target system memory, the monitor program will execute instructions that write the new value into target system memory.

When the emulation system controller recognizes that an emulation command needs to access target system resources, it writes a command code to the communications area, then breaks into the monitor. The monitor reads the command code (and any associated parameters), then executes the appropriate MC68302 instructions to access target system resources.

By using and modifying the optional foreground monitor, you can provide an emulation environment which is customized to the needs of a particular target system.

Comparison of Foreground and Background Monitors

An emulation monitor is required to service certain requests for information about the target system and the emulation processor. For example, when you request a register display, the emulation processor is forced into the monitor. The monitor code has the processor dump its registers into certain emulation memory locations, which can then be read by the emulator system controller without further interference.

Background Monitors

A *background* monitor is an emulation monitor which overlays the processor's memory space with a separate memory region. Entry into the monitor is normally accomplished by jamming the monitor addresses onto the processor's address bus during an INT7 vector fetch.

Usually, a background monitor will be easier to work with in starting a new design. The monitor is immediately available upon powerup, and you don't have to worry about linking in the monitor code or allocating space for the monitor to use the emulator. No assumptions are made about the target system environment; therefore, you can test and debug hardware before any target system code has been written. All of the processor's address space is available for target system use, since the monitor memory is overlaid on processor memory, rather than subtracted from processor memory. Processor resources such as interrupts are not taken by the background monitor.

However, all background monitors sacrifice some level of support for the target system. For example, when the emulation processor enters the monitor code to display registers, it will not respond to target system interrupt requests. This may pose serious problems for complex applications that rely on the microprocessor for real-time, non-intrusive support. Also, the background monitor code resides in emulator firmware and can't be modified to handle special conditions. Likewise, entrance to the background monitor pulls on the MC68302 fr2 pin and thus stops processor DMA and processor-internal DRAM refresh.

Foreground Monitors

A *foreground* monitor may be required for more complex debugging and integration applications. A foreground monitor is a block of code that runs in the same memory space as your program. You link this monitor with your code so that when control is passed to your program, the emulator can still service real-time events, such as interrupts or watchdog timers. For most multitasking, interrupt intensive applications, you will need to use a foreground monitor.

You can tailor the foreground monitor to meet your needs, such as servicing target system interrupts. However, the foreground monitor does use part of the processor's address space, which may cause problems in some target systems. You must also properly configure the emulator to use a foreground monitor (see chapter 4); and, you must link the monitor with your other program code. Note that the first part of the monitor should not be modified.

Using a Foreground Monitor

You will need to follow several steps to use a foreground monitor:

- Modify the ORG statement to piont to the base address where the monitor will be loaded. Load the monitor at any 2-Kbyte boundary (except 0, which is the vector table location). If you are using an HP 64170 memory board with 1-Mbyte SIMMs, use an 8-Kbyte boundary.
- Assemble and link the monitor to your program.
- Configure the emulator with **cf mon=fg..***XXXXX*. This will create a memory map entry for the monitor.
- Set up a stack pointer for the monitor using **cf rssp**.
- Load the monitor and program into the emulator.
- If you will be using the **s** command to single step through your code, you must modify the TRACE exception vector at 24 hex to point to the TRACE_ENTRY routine in the monitor.

Sample Foreground Monitor Listing

This sample foreground monitor program is written to be used with the HP 64870 or B1423A 68000 Cross Assembler. This is the same monitor program used with the HP 64742 68000 Emulator.

The sample foreground monitor program is just a place to start; you will need to modify it to meet your special needs.

```
SECT 14

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
;    EMULATION FOREGROUND MONITOR FOR 64746 EMULATOR.
;    THIS MONITOR VERSION IS USED WITH THE MICROTEC LANGUAGE
;    SYSTEM.
;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
; @(mktid) Product_Numb Product_Description..................... A.00.00 DDMMMYY
HH:MM:SS status....
;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;    THE EMULATION FOREGROUND MONITOR IS THE VEHICLE BY WHICH THE
;    FOLLOWING EMULATOR FUNCTIONS ARE EFFECTED IF THE 64746
;    EMULATOR IS CONFIGURED TO OPERATE WITH A FOREGROUND MONITOR:
;        READ/WRITE TARGET SYSTEM MEMORY
;        DISPLAY/MODIFY 68302 REGISTERS
;        EXECUTE USER PROGRAM
;        BREAK AWAY FROM USER PROGRAM
;
;    THE 64746 FOREGROUND MONITOR MUST START ON A 2K BYTE BOUNDARY
;    OTHER THAN 0H.  THE DESIRED 2K BYTE BOUNDARY SHOULD BE SPECIFIED
;    IN THE "ORG" STATEMENT AT THE START OF THE MONITOR.  THE SAME
;    24 BIT ADDRESS MUST BE SPECIFIED IN THE EMULATOR CONFIGURATION
;    QUESTION "cf mon=fg..XXXXXX".  IN THIS MANNER, COMMUNICATION
;    BETWEEN THE FOREGROUND MONITOR AND THE EMULATOR OPERATING SOFTWARE
;    CAN BE ESTABLISHED.
;
;    THE FIRST FEW SECTIONS OF THE FOREGROUND MONITOR CANNOT BE
;    MODIFIED AND THEIR LOCATION WITH RESPECT TO THE START OF THE
;    FOREGROUND MONITOR CANNOT BE ALTERED. THESE INCLUDE THE FOLLOWING:
;        MONITOR VECTOR TABLE
;        MONITOR VARIABLES
;        KEY MONITOR ENTRY ROUTINES
;
;    THE MONITOR VECTOR TABLE IS USED EXCLUSIVELY BY THE EMULATOR
;    TO TRANSITION INTO THE FOREGROUND MONITOR FROM RESET, FROM
;    SOFTWARE BREAKPOINTS, OR FROM EMULATION GENERATED BREAKS LIKE
;    THE BREAK COMMAND OR A WRITE TO ROM.  THE MONITOR VECTOR IS NOT
;    A REPLACEMENT FOR THE TARGET SYSTEM'S EXCEPTION VECTOR TABLE.
;
;    THE MONITOR VARIABLES SECTION CONTAINS FOUR PARTS.
;    THE FIRST PART IS A GROUP OF VARIABLES THAT ACT AS THE
;    COMMUNICATIONS PATH BETWEEN THE FOREGROUND MONITOR AND THE
;    EMULATOR CONTROLLER.  THE SECOND SECTION HOLDS A COPY OF THE
;    68302 REGISTERS WHICH ARE STORED WHEN ENTERING THE FOREGROUND MONITOR.
;    THE THIRD SECTION IS THE XFER_BUF WHICH IS A BUFFER TO HOLD DATA
;    WHICH IS TRANSFERRED BETWEEN THE EMULATOR CONTROLLER AND TARGET
;    SYSTEM MEMORY.  THE BK_STACK IS A STACK USED BY THE MONITOR
;    WHEN IT IS IN A BACKGROUND STATE FOR A FEW BUS CYCLES UPON
;    TRANSITION TO THE FOREGROUND MONITOR.  THE STAT(1:4) VARIABLES
```

```
;    ARE A HOLDING AREA FOR THE EXTRA STACK INFORMATION THAT OCCURS
;    WHEN A BUS ERROR OR ADDRESS ERROR HANDLER IS DIRECTED INTO THE MONITOR.
;
;    THE KEY MONITOR ENTRY ROUTINES ARE BK_RESET_ENTRY, INT_ENTRY,
;    SW_ENTRY, INMON_INT_ENTRY, AND INMON_TRACE_ENTRY.  THESE ROUTINES INVOLVE
;    A BRIEF STOP IN THE BACKGROUND MONITOR AND THEREFORE CANNOT BE
;    MODIFIED OR MOVED WITH RESPECT TO THE START OF THE MONITOR.
;
;

;    TO PERFORM SINGLE STEPPING WITH THE FOREGROUND MONITOR, THE
;    "TRACE" VECTOR IN THE EXCEPTION VECTOR TABLE MUST POINT TO
;    "TRACE_ENTRY" IN THE FOREGROUND MONITOR.
;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


; ORG XXXXX   ; START MONITOR ON 2K BOUNDARY OTHER THAN ZERO

MONITOR_START

;;;;;;;;;;;;;;;;;;;;;;;;
; MONITOR VECTOR TABLE ;
;;;;;;;;;;;;;;;;;;;;;;;;

;    ---RESET---
   DC.L    BK_STACK
   DC.L    0258H

;    --- MARK SPACE ---
     DC.L  0
     DC.L  0
     DC.L  0
     DC.L  0
     DC.L  0
     DC.L  0
     DC.L  0
     DC.L  02B2H      ;TRACE ENTRY AFTER STEP
     DC.L  0
     DC.L  0


MONITOR_REGISTERS

CURRENT_PC
PCH           DC.W            0
PCL           DC.W            0
PSTAT         DC.W            0
              DC.W            0           ;ALIGNMENT SPACER
PREGS
PD0            DC.L            0
PD1            DC.L            0
PD2            DC.L            0
PD3            DC.L            0
PD4            DC.L            0
PD5            DC.L            0
PD6            DC.L            0
PD7            DC.L            0
PA0            DC.L            0
PA1            DC.L            0
PA2            DC.L            0
PA3            DC.L            0
PA4            DC.L            0
```

```
PA5             DC.L            0
PA6             DC.L            0
PA7             DC.L            0
PUSP            DC.L            0

; END OF MONITOR_REGISTERS ;

;    --- INTERRUPT MONITOR ENTRY ---
     DC.L  266H


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; TRAP VECTORS ( SOFTWARE BREAKPOINT VECTOR ) ;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH
   DC.L    029EH

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; END OF MONITOR VECTOR TABLE ;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


;;;;;;;;;;;;;;;;;;;;;
; MONITOR VARIABLES ;
;;;;;;;;;;;;;;;;;;;;;

STADJVAR        DC.W    0       ;ALIGNMENT SPACER
                DC.W    0       ;ALIGNMENT SPACER

CMD_CONTROL     DC.W    3       ;VARIABLE TO TELL WHO IS IN CONTROL MONITOR OR EMULATOR
                                ;'1' INDICATES COMMAND PENDING
                                ;'2' INDICATES COMMAND IN PROGRESS
                                ;'3' INDICATES COMMAND COMPLETE
CMD_RESULT      DC.W    0       ;'0' INDICATES NO PROBLEM
                                ;'1' INDICATES ILLEGAL SR ON ENTRY
CMD_TYPE        DC.W    0       ;'1' INDICATES 'ARE-YOU-THERE'
                                ;'2' INDICATES MONITOR EXIT
                                ;'4' INDICATES TARGET MEMORY WRITES
                                ;'8' INDICATES TARGET MEMORY READS
TARG_START      DC.L    0       ;START ADDRESS TO LOAD EMULATION MEMORY
TARG_BYTES      DC.W    0       ;NUMBER OF BYTES TO TRANSFER
                                ;IF BIT 15 HIGH, DO WORD TRANSFERS
STEP_ENTRY      DC.W    0
LAST_ENTRY      DC.W    0
STEP_MODE       DC.W    0
```

```
;     --- MARK SPACE ---
      DC.W  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0
      DC.L  0

XFR_BUF         DS.W          136
                DS.W           16
BK_STACK

STAT1           DC.W            0
STAT2           DC.W            0
STAT3           DC.W            0
STAT4           DC.W            0


;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; END OF MONITOR VARIABLES ;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; KEY MONITOR ENTRY ROUTINES ;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

BK_RESET_ENTRY
   MOVE.W       #01H,0D2H
   DC.W         04EF9H
   DC.L         BK_RESET_PROCESS
   NOP

INT_ENTRY
   MOVE.B       #008H,0F4H        *CLEAR SCR IPA BIT
   MOVE.L       D0,PD0
   MOVE.B       STEP_ENTRY+1,D0   *POLL IOB REGISTER, BG CONTROL BIT
   AND.B        #0FH,D0           *CHECK IF SWBK ENTRY
   BTST         #03H,D0
   BEQ          NO_SWBK_ENTRY
   MOVE.L       PD0,D0
   ADDQ.L        #6,A7             *FIX THE SYSTEM STACK POINTER
   DC.W         04EF9H
   DC.L         SW_ENTRY-MONITOR_START
NO_SWBK_ENTRY
   MOVE.L       PD0,D0
   MOVE.W       #02H,0D2H
   DC.W         04EF9H
   DC.L         MON_ENT
```

```
   NOP

SW_ENTRY
   NOP
   NOP
   NOP
   NOP
   MOVE.L       D0,PD0
   MOVE.W       0D4H,D0
   BEQ          NO_STEP_FIX
   MOVE.L       PD0,D0
   ADDQ.L        #6,A7            *FIX THE SYSTEM STACK POINTER
NO_STEP_FIX
   MOVE.L       PD0,D0
   MOVE.W       #03H,0D2H
   DC.W         04EF9H
   DC.L         MON_ENT
   NOP

INMON_TRACE_ENTRY
   ADDQ.L  #6,A7        ;ADJUST STACK POINTER TO IGNORE STACKING FOR TRACE
   MOVE.W #0BH,0D0H    ;INDICATES A STEP HAS OCCURRED.
   JMP    SW_ENTRY

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; END OF KEY MONITOR ENTRY ROUTINES ;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;; MONITOR OPERATING ROUTINES ;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; SOFTWARE IN MONITOR AND OPERATING VERIFICATION
;   THIS ROUTINE IS USED TO TELL THE EMULATOR CONTROLLER
;   IF THE EMULATOR IS OPERATING IN THE MONITOR AND IS
;   READY TO ACCEPT COMMANDS.

SW_IN_MON
   MOVE.W       #3,CMD_CONTROL
   BRA          MON_LOOP


; MONITOR EXIT ROUTINE
;   THE MONITOR EXIT ROUTINE PERFORMS THE TRANSITION FROM FOREGROUND
;   MONITOR OPERATION TO EXECUTION OF THE USERS PROGRAM

START_EXIT
   MOVE         SR,D0                 ;CHECK THAT 68302 IS IN
   BTST         #13,D0                ;SUPERVISOR MODE
   BNE          EXIT_OK
   MOVE.W       #0FH,LAST_ENTRY       ;FLAG THE PROBLEM
   BRA          MON_LOOP              ;GO BACK TO MONITOR LOOP
EXIT_OK
   MOVE.L       PUSP,A0
   MOVE.L       A0,USP                ;RESTORE USER STACK POINTER
   MOVEM.L      PREGS,D0-D7/A0-A7     ;RESTORE REGISTERS
   MOVE         PCL,-(SP)             ;PUSH PCL
   MOVE         PCH,-(SP)             ;PUSH PCH
   MOVE         PSTAT,-(SP)           ;PUSH STATUS
   MOVE         #3,CMD_CONTROL
   RTE                                ;RETURN TO USERS PROGRAM
```

```
; END OF THE MONITOR EXIT ROUTINE


; WRITE TARGET MEMORY ACCESS ROUTINE
;   THIS ROUTINE WRITES DATA TO TARGET SYSTEM MEMORY.
;   THE DATA WAS LOADED INTO THE 'XFER_BUF' BY THE EMULATION CONTROLLER.
;   THE STARTING ADDRESS OF THE WRITE PROCESS WAS LOADED INTO
;   'TARG_START' BY THE EMULATION CONTROLLER.  THE LOWER BYTE OF THE
;   'TARG_BYTES' VARIABLE CONTAINS THE NUMBER OF BYTES OF DATA WHICH
;   WILL BE WRITTEN TO TARGET MEMORY.  IF BIT 11 OF THE 'TARG_BYTE'
;   FIELD IS SET THEN THE ACCESS MODE TO TARGET MEMORY IS WORDS.  IF
;   BIT 11 IS NOT SET THEN THE ACCESS MODE IS BYTES. THE 'TARG_BYTE'
;   VARIABLE WAS SET BY THE EMULATION CONTROLLER.
;

TARG_MEM_WR
   MOVE.L       TARG_START,A0
   MOVE.L       #XFR_BUF,A1
   MOVE.W       TARG_BYTES,A2
   CMP.W        #00800H,A2
   BPL          TARG_WORD_WR

TARG_BYTE_WR
   AND.W        #007FFH,TARG_BYTES
T_BYTE_LP_WR
   MOVE.B       (A1)+,D0
   MOVE.B       D0,(A0)+
   NOP
   SUB.W        #1,TARG_BYTES
   BEQ          TARG_WR_ACC_DONE
   BRA          T_BYTE_LP_WR


TARG_WORD_WR
   AND.W        #007FFH,TARG_BYTES
T_WORD_LP_WR
   MOVE.W       (A1)+,A2
   MOVE.W       A2,(A0)+
   SUB.W        #2,TARG_BYTES
   BEQ          TARG_WR_ACC_DONE
   BRA          T_WORD_LP_WR
TARG_WR_ACC_DONE
   MOVE.W       #3,CMD_CONTROL
   BRA          MON_LOOP

; END OF WRITE TARGET MEMORY ACCESS ROUTINE


; READ TARGET MEMORY ACCESS ROUTINE
;   THIS ROUTINE READS DATA FROM TARGET SYSTEM MEMORY.
;   THE DATA IS STORED IN THE 'XFER_BUF'.
;   THE STARTING ADDRESS OF THE READ PROCESS WAS LOADED INTO
;   'TARG_START' BY THE EMULATION CONTROLLER.  THE LOWER BYTE OF THE
;   'TARG_BYTES' VARIABLE CONTAINS THE NUMBER OF BYTES OF DATA WHICH
;   WILL BE READ FROM TARGET MEMORY.  IF BIT 11 OF THE 'TARG_BYTE'
;   FIELD IS SET THEN THE ACCESS MODE TO TARGET MEMORY IS WORDS.  IF
;   BIT 11 IS NOT SET THEN THE ACCESS MODE IS BYTES. THE 'TARG_BYTE'
;   VARIABLE WAS SET BY THE EMULATION CONTROLLER.
;

TARG_MEM_RD
```

```
   MOVE.L       TARG_START,A0
   MOVE.L       #XFR_BUF,A1
   MOVE.W       TARG_BYTES,A2
   CMP.W        #00800H,A2
   BPL          TARG_WORD_RD

; PROCESS IN BYTES

TARG_BYTE_RD
   AND.W        #007FFH,TARG_BYTES
T_BYTE_LP_RD
   MOVE.B       (A0)+,D0
   MOVE.B       D0,(A1)+
   SUB.W        #1,TARG_BYTES
   BEQ          TARG_RD_ACC_DONE
   BRA          T_BYTE_LP_RD

;; PROCESS IN WORDS

TARG_WORD_RD
   AND.W        #007FFH,TARG_BYTES
T_WORD_LP_RD
   MOVE.W       (A0)+,D0
   MOVE.W       D0,(A1)+
   SUB.W        #2,TARG_BYTES
   BEQ          TARG_RD_ACC_DONE
   BRA          T_WORD_LP_RD

TARG_RD_ACC_DONE
   MOVE.W       #3,CMD_CONTROL
   BRA          MON_LOOP

; END OF READ TARGET MEMORY ACCESS ROUTINE


;;;;;;;;;;;;;;;;;;;
;; MONITOR ENTRY ;;
;;;;;;;;;;;;;;;;;;;

MON_ENT
                                      ;LOOK FOR BREAK WHILE
                                      ;ALREADY IN THE MONITOR
   CMP.L        #MONITOR_START,2(A7)  ;STACK ADDRESS LESS THAN
   BMI          BREAK_OK              ;MONITOR_START
   CMP.L        #MONITOR_END,2(A7)    ;STACK ADDRESS GREATER THAN
   BPL          BREAK_OK              ;MONITOR_END
   RTE                                ;ALREADY IN THE MONITOR

BREAK_OK
   MOVE         (SP)+,PSTAT          ;SAVE STATUS REGISTER PRIOR TO ENTRY
   MOVE         (SP)+,PCH            ;SAVE PC PRIOR TO ENTRY
   MOVE         (SP)+,PCL            ;STACK IS AS IT WAS BEFORE
INT_JUMP_ENTRY
   MOVEM.L      D0-D7/A0-A7,PREGS    ;SAVE REGISTERS
   MOVE         SR,D0                ;VERIFY SUPERVISOR MODE OPERATION
   BTST         #13,D0
   BNE          MODE_OK
   MOVE.W       #10H,LAST_ENTRY      ;FLAG THE PROBLEM
   BRA          MON_LOOP             ;GO TO MONITOR LOOP

MODE_OK
   MOVE.L       USP,A0               ;SAVE USER STACK POINTER
```

```
   MOVE.L       A0,PUSP
   MOVE.W       #3,CMD_CONTROL
;                                     SET STATUS REGISTER AS IT WAS
;                                     PRIOR TO MONITOR ENTRY
;  MOVE.W       PSTAT,D0
;  OR           #0F8FFH,D0
;  MOVE.W       SR,D1
;  AND          D1,D0
;  MOVE.W       D0,SR
   JMP          MON_LOOP

; MONITOR CONTROL LOOP
;   THE FOREGROUND MONITOR WAITS IN THIS LOOP UNTIL THE EMULATOR
;   CONTROLLER REQUESTS AN ACTION BY SETTING CMD_CONTROL TO 1
;

MON_LOOP
   MOVE.W       CMD_CONTROL,D0
   CMP.W        #1,D0             ;COMMAND HAS BEEN REQUESTED
   BEQ          COMMAND_REQUEST
   BRA          MON_LOOP

; COMMAND_REQUEST
;   WHEN A COMMAND HAS BEEN REQUESTED, THIS ROUTINE DETERMINES THE
;   TYPE OF COMMAND REQUESTED AND INITIATES THE APPROPRIATE ACTION

COMMAND_REQUEST
   MOVE.W       #0,CMD_RESULT     ;CLEAR OUT RESULT VARIABLE
   MOVE.W       #2,CMD_CONTROL    ;SET TO INDICATE COMMAND PROCESSING STARTED
   MOVE.W       CMD_TYPE,D0
   CMP.W        #1,D0             ;IN MONITOR OPERATION VERIFICATION
   BEQ          SW_IN_MON
   CMP.W        #2,D0             ;START MONITOR EXIT PROCESS
   BEQ          START_EXIT
   CMP.W        #4,D0             ;PERFORM TARGET MEMORY ACCESS WRITES
   BEQ          TARG_MEM_WR
   CMP.W        #8,D0             ;PERFORM TARGET MEMORY ACCESS READS
   BEQ          TARG_MEM_RD
   BRA          ILL_CTRL_REQ

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; COMMAND ERROR LOOP
ILL_CTRL_REQ
                BRA ILL_CTRL_REQ
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; FG_RESET_ENTRY IS THE ENTRY ROUTINE THAT A RESET: INITITAL PC
;   IN THE USERS EXCEPTION VECTOR TABLE SHOULD POINT TO IF THE
;   USER WANTS THE EMULATOR TO VECTOR TO THE FOREGROUND MONITOR
;   FROM TARGET SYSTEM RESETS.
;   THIS ROUTINE CLEARS OUT THE REGISTERS D7-D0 AND A6-A0.
;   THE STATUS REGISTER IS SET TO 2700H.
;   THE PC IS SET TO JUMP_ENTRY
;   THE A7 REGISTER, THE SUPERVISOR STACK POINTER AND THE USER
;   STACK POINTER ARE SET TO THE VALUE OF THE SSP AS THE EMULATOR
;   IS RELEASED FROM TARGET RESET.

FG_RESET_ENTRY
   MOVE.W       #01H,LAST_ENTRY            ;SET ENTRY CAUSE
   MOVE.L       #JUMP_ENTRY,CURRENT_PC     ;SET COPY OF PC
   MOVE.W       #2700H,PSTAT               ;SET STATUS
   CLR.L        PD0                        ;CLEAR REGISTERS
```

```
   CLR.L        PD1
   CLR.L        PD2
   CLR.L        PD3
   CLR.L        PD4
   CLR.L        PD5
   CLR.L        PD6
   CLR.L        PD7
   CLR.L        PA0
   CLR.L        PA1
   CLR.L        PA2
   CLR.L        PA3
   CLR.L        PA4
   CLR.L        PA5
   CLR.L        PA6
   MOVE.L       A7,PA7                      ;SET EMULATOR COPY OF SSP
   MOVE.L       A7,USP                      ;SET USP TO SAME AS SSP
   MOVE.L       A7,PUSP                     ;SET EMULATOR COPY OF USP
   BRA          MON_LOOP

BERR_ENTRY
   MOVE.W       #04H,LAST_ENTRY
   BRA          SPECIAL_ENTRY
ADDR_ERR_ENTRY
   MOVE.W       #05H,LAST_ENTRY
   BRA          SPECIAL_ENTRY
ILL_INST_ENTRY
   MOVE.W       #06H,LAST_ENTRY
   BRA          MON_ENT
ZERO_D_ENTRY
   MOVE.W       #07H,LAST_ENTRY
   BRA          MON_ENT
CHK_I_ENTRY
   MOVE.W       #08H,LAST_ENTRY
   BRA          MON_ENT
TRAPV_ENTRY
   MOVE.W       #09H,LAST_ENTRY
   BRA          MON_ENT
PRIV_V_ENTRY
   MOVE.W       #0AH,LAST_ENTRY
   BRA          MON_ENT
TRACE_ENTRY
   MOVE.W       #0BH,STEP_ENTRY
   MOVE.W       #0BH,LAST_ENTRY
   BRA          MON_ENT
EMUL_1010_ENTRY
   MOVE.W       #0CH,LAST_ENTRY
   BRA          MON_ENT
EMUL_1111_ENTRY
   MOVE.W       #0DH,LAST_ENTRY
   BRA          MON_ENT
JUMP_ENTRY
   MOVE.W       #0EH,LAST_ENTRY
   BRA          INT_JUMP_ENTRY

BK_RESET_PROCESS
   MOVE.W       #0,CMD_RESULT
   MOVE.W       #2700H,PSTAT                ;SET STATUS
   BRA          MON_LOOP

; SPECIAL ENTRY IS EXECUTED WHEN THE MONITOR IS ENTERED FROM A BERR
;   OR AN ADDRESS ERROR.  INFORMATION STACKED AS A RESULT OF THE
;   BERR OR ADDRESS ERROR IS SAVED IN STAT1, STAT2, STAT3 AND STAT4.
```

```
SPECIAL_ENTRY
     MOVE      (SP)+,STAT1         ;PULL & SAVE EXCEPTION STATUS.
     MOVE      (SP)+,STAT2         ;PULL & SAVE ACCESS ADDRESS HIGH.
     MOVE      (SP)+,STAT3         ;PULL & SAVE ACCESS ADDRESS LOW.
     MOVE      (SP)+,STAT4         ;PULL & SAVE INSTRUCTION REGISTER.
     BRA       MON_ENT

MONITOR_END
```

Notes

A

Syntax for the MC68302 Emulator

The *Terminal Interface Reference* describes the syntax for commands which are common to all HP 64700-series emulators.

This chapter contains information about syntax items that are specific to the MC68302 emulator. These include:

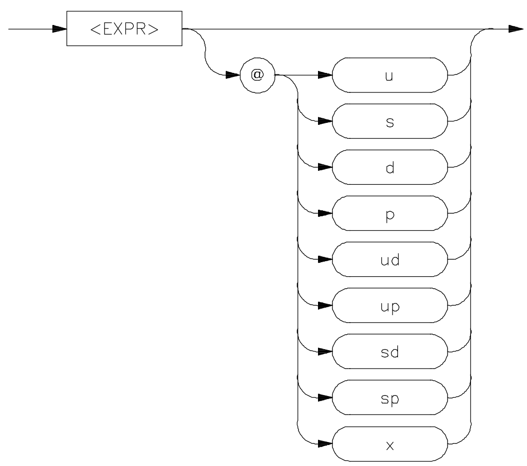
- ADDRESS
- CONFIGURATION ITEMS
- MODE
- REGISTERS
- ANALYZER INPUTS

Notes

ADDRESS

Summary **Address specifications in run and memory modification**

Syntax



Description The MC68302 emulator provides the capability to specify function code information in addition to the numerical address. This allows you to specify separate regions of memory for user and supervisor program and data space.

All address specifications are of the form:

<EXPR>@FC

Expressions are defined in the *Terminal Interface Reference*. For address specifications, any number specified in the expression defaults to hexadecimal unless specifically identified as another base.

The **@** symbol is required if you specify a function code. Otherwise, it must be omitted.

The function code (**FC**) may be any one of the following:

Function Code	Description
u	User
s	Supervisor
d	Data
p	Program
ud	User Data
up	User Program
sd	Supervisor Data
sp	Supervisor Program
x	don't care

Examples

These are some examples of correct address specifications, both with and without function codes, shown in the context of the **m** (memory) command:

```
M>m 400..40f@sd
  0000400..000040f@sd  08 08 08 01 08 00 0c 01 00 00 08 01 00 08 01 01


M>m 200..20f@d
  0000200..000020f@d   00 00 00 00 04 08 0c 01 08 00 00 00 08 00 0d 01


M>m 400..40f@up
  0000400..000040f@up  08 00 08 00 09 00 00 01 00 00 0c 00 09 08 01 00


M>m 000..00f
  0000000..000000f     00 00 80 00 11 08 88 09 08 00 08 00 0c 00 0d 00
```

In the last memory display, we can specify part of the range 0 through 1ffh without specifying a function code, because no other range numerically overlaps this range.

Related Commands

Refer to the **<EXPR>** command in the *Terminal Interface Reference* for additional information about specifying expressions.

Notes

CONFIG_ITEMS

Summary **Emulator configuration items**

Syntax **cf** *<item name>***=***<value>*

Description The MC68302 emulator has several dedicated configuration items which allow you to specify the emulator interaction with the target system and the rest of the emulation system. These items are:

ba	Enables or disables bus arbitration.
bbk	Use with dbc to define A23-A16 during background monitor execution.
be	Enables or disables emulation processor response to target system /BERR signal.
bfc	Defines function code values during background monitor execution.
clk	Selects the internal or external emulation clock.
cs0_dtk-cs3_dtk	Selects internal or external /DTACK for chip select.
dbc	Enables or disables driving signals to the target system during background monitor execution.
dti	Enables or disables /DTACK interlock.
iack7	Selects configuration for IACK7 pin.
im	Selects normal (IPL) or dedicated (IRQ) interrupt mode.
int7	When im=ded, selects level mode or edge mode for IRQ7 interrupts.

lfc	Selects a function code for file loading.
mon	This selects a foreground or background monitor.
pdw	Selects 8/16-bit processor data bus width.
rrt	Restricts the emulator to real-time runs.
rssp	Sets SSP value upon reset.
swtp	Selects which trap instruction to use.
ti	Enables or disables target system interrupts.
trc_dma	Enables or disables tracing of DMA cycles, or enables generation of an analyzer state for each bus arbitration sequence.

Explanations of selected configuration items are included in chapter 4.

Examples

To display the current configuration item settings, enter:

```
M>cf
```

To select an external clock source, enter:

```
M>cf clk=ext
```

Related Commands

help cf

Refer to the **cf** command in the *Terminal Interface Reference.* Also, refer to chapter 4 of this manual for information about each configuration item.

MODE

Summary

Memory access/display modes

Syntax

Description

Each emulator allows you to access memory in several different ways for memory display and modification. The size of the access is set using the **mo** command. There are two types of mode settings.

Display Mode

Display mode defines how the emulator displays or modifies memory. The MC68302 emulator allows the following access modes:

l	long word (four bytes)
w	word (two bytes) display mode
b	byte display mode
m	mnemonic display mode

The mnemonic display mode allows you to display memory disassembled into processor instruction mnemonics using the **m** command. If you specify mnemonic display mode and then perform a memory modification, search for a value, or execute any other command that references the display mode, the command will behave as if "byte" display mode were in effect.

Access Mode

Access mode defines how the emulator accesses target system memory. The MC68302 emulator allows the following access modes:

w	word (double byte) access mode
b	byte access mode

The emulation monitor uses the access mode to determine whether to use byte or word instructions during target system memory accesses, such as for memory modification or display. (It does **not** affect how that data is displayed on screen. That is controlled by the display mode.)

Defaults

At powerup or after **init**, the default access and display modes are set to **w** (word).

Examples

These are some examples of the different display modes using the memory display command:

```
R>m -dm 1000..101f@u
  0001000@u  init             MOVEA.L 0002000,A3
  0001004@u  process_comm     CMPI.B  #041,D0
  0001008@u  -                BEQ.W   0001018
  000100c@u  -                CMPI.B  #042,D0
  0001010@u  -                BEQ.W   0001026
  0001014@u  -                BRA.W   0001034
  0001018@u  -                MOVE.B  #011,D0
  000101c@u  -                MOVEA.L #000002004,A0

R>m -db 1000..101f@u
  0001000..000100f@u   26 78 20 00 0c 00 00 41 67 00 00 0e 0c 00 00 42
  0001010..000101f@u   67 00 00 14 60 00 00 1e 10 3c 00 11 20 7c 00 00

R>m -dw 1000..101f@u
  0001000..000100f@u   2678 2000 0c00 0041 6700 000e 0c00 0042
  0001010..000101f@u   6700 0014 6000 001e 103c 0011 207c 0000

R>m -dl 1000..101f@u
  0001000..000100f@u   26782000 0c000041 6700000e 0c000042
  0001010..000101f@u   67000014 6000001e 103c0011 207c0000
```

Related Commands

help mo

Refer to the **mo** command in the *Terminal Interface Reference* for additional information about using the "mode" command.

REGISTERS

Summary **MC68302 register designators**

Description The **reg** command allows you to display individual processor registers or groups of registers defined by a **<REG_CLASS>** identifier.

The MC68302 emulator supports the display and modification of these register classes:

*	This represents all of the MC68302 registers.
302	This class represents various MC68302 (BAR, SCR, CR) and serial interface registers.
idma	This represents the IDMA controller registers.
interrupt	This class represents the interrupt controller registers.
pio	These represent the port data and control registers.
chip_sel	These represent the chip select registers.
tmr	These represent the timer registers.
scc	These represent all of the serial communication controllers.
scc*n*	These represent the registers for each serial communication controller.

Examples To display the basic set of MC68302 registers, enter:

```
M>reg
  reg pc=00000000 st=2700 d0=00000000 d1=00000000 d2=00000000 d3=00000000
  reg d4=00000000 d5=00000000 d6=00000000 d7=00000000 a0=00000000 a1=00000000
  reg a2=00000000 a3=00000000 a4=00000000 a5=00000000 a6=00000000 a7=00000009
  reg usp=00000000 ssp=00000009 bar=bfff scr=00000f00
```

To display the MC68302 interrupt registers, enter:

```
M>reg interrupt
  reg gimr=0000 ipr=0000 imr=0000 isr=0000
```

Related Commands

help reg

Type **help reg** to see a list of the registers you may display.

Refer to the **reg** command in the *Terminal Interface Reference* for additional information about displaying and modifying registers.

ANALYZER INPUTS

Analyzer Input Line (address field)	Signal Name	Description
AD0	A(0)	Address Lines 1-23
AD1	A(1)	
AD2	A(2)	
AD3	A(3)	
AD4	A(4)	
AD5	A(5)	
AD6	A(6)	
AD7	A(7)	
AD8	A(8)	
AD9	A(9)	
AD10	A(10)	
AD11	A(11)	
AD12	A(12)	
AD13	A(13)	
AD14	A(14)	
AD15	A(15)	
AD16	A(16)	
AD17	A(17)	
AD18	A(18)	
AD19	A(19)	
AD20	A(20)	
AD21	A(21)	
AD22	A(22)	
AD23	A(23)	

Analyzer Input Line (status field)	Signal Name or Equate Name	Description
AD24 stat(0)	byte/word	6800 (8-bit) mode
AD25 stat(1)	read/write	Processor read/write
AD26 stat(2)	in_cyc/ext_cyc	Processor IAC
AD27 stat(3)	FC0	Function code bit 0
AD28 stat(4)	FC1	Function code bit 1
AD29 stat(5)	FC2	Function code bit 2
AD30 stat(6)	dma	Internal or external DMA (low)
AD31 stat(7)	bgd/fgd	Background/foreground monitor. Becomes analyzer qualifier FG_H.
AD32	D0	Processor data lines 0-15
AD33	D1	
AD34	D2	
AD35	D3	
AD36	D4	
AD37	D5	
AD38	D6	
AD39	D7	
AD40	D8	
AD41	D9	
AD42	D10	
AD43	D11	
AD44	D12	
AD45	D13	
AD46	D14	
AD47	D15	

Analyzer Input Line (extra field)	**Equate Name**	**Description**
		These bits are available only on 64-channel analyzers. They are not available on 48-channel analyzers. Note that these inputs are accessed via the "extra" label.
AD48	int_dma/ext_dma	External DMA_L
AD49	bclr	Processor BCLR_L
AD50	cs3	Processor CS3
AD51	cs2	Processor CS2
AD52	cs1	Processor CS1
AD53	cd0	Processor CS0
AD54	berr	Processor BERR_L
AD55	grd	GRDAC_L
AD56	rom	ROMAC_L
AD57	pb8_l/pb8_h	Processor PB8
AD58	pb9_l/pb9_h	Processor PB9
AD59	pb10_l/pb10_h	Processor PB10
AD60	pb11_l/pb11_h	Processor PB11
AD61		Target IPL0
AD62		Target IPL1
AD63		Target IPL2
	-	

Notes

B

Messages

These messages may appear while using the HP 64746 MC68302 emulator. Messages are listed in numerical order.

Error messages numbered 200 and above are common to all HP 64700-Series emulators and are listed in the *Terminal Interface Reference.*

1 I/O port access not supported

See *Terminal Interface Reference.*

2 Invalid word access for odd address

Word accesses are allowed only for even addresses.

3 Invalid word access for odd number of bytes

Specify an even number of bytes for a word access, or use byte access instead (use **mo -ab**).

20 Attempt to change foreground monitor map term

See *Terminal Interface Reference.*

21 Insufficient emulation memory

You need to map a smaller area of emulation memory.

40 Restricted to real time runs

See *Terminal Interface Reference.*

61 Emulator is in the reset state

See *Terminal Interface Reference.*

62 Reset encountered while in monitor

The emulator encountered a target system reset while running in the motor.

80 Stack pointer is odd

See *Terminal Interface Reference*.

81 Stack is in guarded memory

See *Terminal Interface Reference*.

82 Stack is in target ROM

See *Terminal Interface Reference*.

83 Stack is in emulation ROM

See *Terminal Interface Reference*.

84 Program counter is odd

See *Terminal Interface Reference*.

107 Monitor failure; bus error

See *Terminal Interface Reference*.

140 Supervisor stack pointer not initialized

Use **reg ssp=***value* to set the SSP. If you type **cf rssp=***value*, the SSP will be re-initialized automatically whenever the emulator is reset.

141 Foreground monitor operating in USER mode

The foreground monitor must be run in supervisor mode.

142 Supervisor stack in guarded memory at *xxxxxxxx*

You need to map the supervisor stack to emulator or target RAM. Remember to place the supervisor stack where it will not collide with the vector table.

143 Supervisor stack is in ROM at *xxxxxxxx*

You need to map the supervisor stack to emulator or target RAM. Remember to place the supervisor stack where it will not collide with the vector table.

145 BERR occurred during background operation

One possible cause is that you are not driving background cycles to the target system, and a watchdog timer went off.

146 BERR during background access to supervisor stack

A BERR occurred while the monitor was looking at the stack to determine the PC value (this happens just after breaking into the monitor).

147 RESET during background operation

The target was reset while the emulator was operating in background mode.

148 cf int7 must be lev if cf im=nor

The target system interrupt mode is set to normal, so there is no such thing as IRQ7. Either set **cf int7=lev** or **cf im=ded**.

149 register modify would cause chip select address decode conflict

The chip select register modify you just attempted would cause two or more chip selects to be enabled and overlapping.

150 bar register must not map internal memory to 0

If internal memory were mapped to 0, the vector table along with the BAR and SCR registers would be overwritten.

151 HP 64170A has missing memory module: bank <bank number>

Make sure the HP 64170 memory board has at least one memory module installed in bank 0. It is not required for bank 1 to have a memory module. This must be corrected for the emulator to function correctly.

An example showing an empty bank (bank 1), viewed with the **ver** command, is:

```
HP 64746 (PPN: 64746A) Motorola 68302 Emulator
  Version:   A.00.03 24Jun91
  Control:   HP64170A Memory Control Board
  Memory:    0 KBytes
    Bank 0:  HP64171A/C 256 KByte Memory Module
    Bank 1:  Empty
    Bank 2:  Empty
    Bank 3:  Empty
```

152 HP 64170A has mixed memory modules: banks 0, <bank number>

The memory modules loaded on the memory board can be 256 Kbyte modules or 1 Mbyte modules, but not a combination of both types. Mixing the two types of memory modules is not allowed. This must be corrected for the emulator to function correctly.

An example showing an invalid mixing of modules, viewed with the **ver** command, is:

```
HP 64746 (PPN: 64746A) Motorola 68302 Emulator
  Version:   A.00.03 24Jun91
  Control:   HP64170A Memory Control Board
  Memory:    0 KBytes
    Bank 0:  HP64171A/C 256 KByte Memory Module
    Bank 1:  HP64171B/D 1024 KByte Memory Module
    Bank 2:  Empty
    Bank 3:  Empty
```

153 HP 64170A has unrecognized memory module: bank <bank number>

The HP 64170 memory board has detected an unusable memory module. Verify that a memory module is installed in the bank in question. If the correct memory module is installed, or if there is no memory module installed, a hardware fault may be present. This must be corrected for the emulator to function properly.

An example showing an unrecognized memory module, viewed with the **ver** command, is:

```
HP 64746 (PPN: 64746A) Motorola 68302 Emulator
  Version:   A.00.03 24Jun91
  Control:   HP64170A Memory Control Board
  Memory:    0 KBytes
    Bank 0:  HP64171A/C 256 KByte Memory Module
    Bank 1:  Unrecognized Memory Module
    Bank 2:  Empty
    Bank 3:  Empty
```

154 Unable to find emulation memory

The emulator cannot determine which emulation memory board is installed. This is a hardware fault, and must be corrected for the emulator to function correctly. Contact your HP Representative.

Error messages numbered 200 and above are common to all HP 64700-Series emulators and are listed in the *Terminal Interface Reference.*

Notes

C

MC68302 Specifications and Characteristics

General Specifications

This chapter lists the specifications and characteristics for the HP 64746 MC68302 emulator/analyzer with external analyzer, and for the HP 64746 emulator probe.

Processor Compatibility

The HP 64746 is compatible with the Motorola 68302 microprocessor with clock speeds up to 20.0 MHz, and any other microprocessors that comply with the specifications of the Motorola 68302. The HP 64746 supports the MC68302 in either 8 or 16 bit mode. CPU disable mode is not supported.

Electrical

Maximum Clock Speed

The maximum external clock speed is at least 20 MHz for the HP 64746 emulator. No wait states are required for emulation or target system memory. (The internal clock speed is 16 MHz.)

Power

The emulator draws an additional 40 milliamps from the target system when operating at 16.67 MHz.

Inputs/Outputs

The emulator loads the processor lines with an additional 50 picofarads, except for the clockout signal, which is 20 picofarads.

Physical

Emulator Dimensions

325 mm width x 125 mm height x 354 mm depth (12.8 in. x 4.9 in. x 14 in.).

Note

Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP sales representative.

Emulator Weight

HP 64746: 6.7 kg (14.7 lb). With external analyzer: 7.2 kg (15.9 lb). (Any component used in suspending the emulator must be rated for 65 lb capacity.)

Cable Length

Emulator to target system, approximately 600 mm (2 feet).

Environmental

Temperature

Operating, 0 to +40 C (+32 F to +131 F); nonoperating, -40 C to +70 C (-40 F to +158 F).

Altitude

Operating, 4600 m (15 000 ft); nonoperating, 15 300 m (50 000 ft).

Relative Humidity

15% to 95%.

Regulatory Compliance

Safety Approvals

Self-certified to UL 1244, IEC 348, CSA 556B.

BNC (labeled TRIGGER IN/OUT)

Output Drive

Driven active high only = +2.4 V into a 50 ohm load.

Input

Input signal must drive approximately 4 mA at 2 V. Edge sensitive. Minimum pulse width is approximately 25 ns.

Communications

Host Port

- 25-pin female type "D" subminiature connector.
- RS-232-C DCE or DTE to 38.4 kbaud.
- RS-422 DCE only to 460.8 kbaud.

Auxiliary Port

- 25-pin female type "D" subminiature connector.
- RS-232-C DCE only to 19.2 kbaud.

CMB Port

- 9-pin female type "D" subminiature connect.

Emulator Probe Characteristics

These specifications are for an emulator with a clock speed of 16.67 MHz.

Unbuffered Signals

The following signals are unbuffered to the target system: /RESET, /HALT, PB1-PB11, PA0-PA15, RXD1, TXD1, RCLK1, TCLK1, /CD1, /CTS1, /RTS1, BRG1, BCLR, /RMC, IAC.

Data Inputs

One 74FCT245A load per bit plus 50 pf capacitance.

Address and Function Codes

One 74FCT245A load per bit plus 50 pf capacitance.

Clocks

One 74ACT load per bit plus 20 pf capacitance.

Chip Selects

One 74FCT244A load per bit plus 50 pf capacitance.

Interrupts

One F load per bit plus a 3.3K pullup and 50 pf capacitance.

Other Signals

/FRZ, /AVEC, BUSW are 74ALS inputs plus 50 pf capacitance.

/DTACK, /BR, /BG, /BGACK have a 5 ns pal path to the processor.

/UDS, /LDS, /AS, R/W have a 5 ns pal path to the processor plus a 3.3K pullup and 50 pf capacitance.

Bus Error is either connected to the target system unbuffered or totally disconnected from the target.

The emulator specifications for "worst case" and "typical" are a function of loading in the target system. Actual performance may be worse than "worst case" if the loading is above Motorola specifications for the processor.

				Processor		Emulator Worst		Typical	
Num	**Description**	**Unit**	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
1	Clock Period	MHz	f	8	16.7	8	16.7	-	-
2,3	Clock Pulse Width	ns	Tcvc	60	125	60	125	-	-
4,5	Clock Rise and Fall times	ns	Tcr,Tcf	-	5	-	5	-	-
5a	EXTAL to CLK0 Delay	ns	Tcd	2	11	16	29	18	-
6	Clock High to FC, Addr valid	ns	Tchfcadv	-	45	9	59	5	40
7	Clock High to addr, data - Z	ns	Tchadz	-	50	-	-	-	-
8	Clock High to addr, fc invalid	ns	Tchafi	0	-	0	-	0	-
9	Clock High to AS, DS asserted	ns	Tchsl	3	30	5	50	8	23
11	Addr, FC valid to AS,DS (READ) AS (WRITE) asserted	ns	Tafcvsl	15	-	13	-	20	-
12	Clock low to AS,DS negated	ns	Tslsh	-	30	-	35	-	20
13	AS,DS negated - Addr,FC invalid	ns	Tshafi	15	-	12	-	20	-
14	AS,(DS read) width asserted	ns	Tsl	120	-	110	-	-	120
14A	DS width asserted (write)	ns	Tdsl	60	-	50	-	60	-
15	AS,DS width Negated	ns	Tsh	60	-	55	-	65	-
16	Clock High to Control Bus Z	ns	Tchcz	-	50	-	50	-	50
17	AS,DS negated to R/W invalid	ns	Tshrh	15	-	5	-	10	-

18	Clock High to RW high	ns	Tchrh	-	30	-	40	-	30
20	Clock High to RW low	ns	Tchrl	-	30	-	40	-	30
21	Addr, FC valid to RW low	ns	Tafcvfl	15	-	10	-	20	-
22	RW low to DS asserted write	ns	Trlsl	30	-	25	-	32	-
23	Clock low to Data Out valid	ns	Tcldo	-	30	-	40	-	35
25	AS,DS negated to data invalid	ns	Tshdoi	15	-	10	-	16	-
26	Data Out to DS asserted write	ns	Tdosl	15	-	10	-	16	-
27	Data Valid to Clock low (setup)	ns	Tdicl	7	-	21	-	15	-
28	AS,DS negated to DTACK negated	ns	Tshdah	0	110	0	90	0	100
29	AS,DS negated to Data in (hold)	ns	Tshdii	0	-	0	-	0	-
30	AS,DS negated to BERR negated	ns	Tshdeh	0	-	0	-	0	-
31	DTACK asserted to data in-setup	ns	Tdaldi	-	50	43	-	49	-
32	Halt, Reset input transition	ns	Trhr, Trhf	-	150	-	150	-	<150
33	Clock High to BG asserted	ns	Tchgl	-	30	-	45	-	40
34	Clock High to BG negated	ns	Tchgh	-	30	-	60	-	40
35	BR asserted to BG asserted	clks	Tbrlgl	2.5	4.5	2.5	4.5	2.5	4.5
36	BR negated to BG negated	clks	Tbrhgh	1.5	2.5	1.5	2.5	1.5	2.5
37	BGACK asserted to BG negated	clks	Tgalgh	2.5	4.5	2.5	4.5	2.5	4.5
37A	BGACK asserted to BR negated	ns/ clks	Tgalbrh	10	1.5	20	1.5	10	1.5
38	BG asserted to high Z	ns	Tglz	-	50	-	50	-	50

39	BG width negated	clks	Tgh	1.5	-	1.5	-	1.5	-
44	AS,DS negated to AVEC negated	ns	Tshvph	0	50	0	30	0	40
46	BGACK width low	clks	Tgal	1.5	-	1.5	-	1.5	-
47	Async input setup time	ns	Tasi	10	-	20	-	15	-
48	BERR asserted to DTACK asserted	ns	Tbeldal	10	-	20	-	15	-
53	Data Out hold from clock high	ns	Tchdoi	0	-	0	-	0	-
55	RW asserted to Data bus change	ns	Trldbd	0	-	0	-	0	-
56	HALT,RST pulse width	clks	Thrpw	10	-	10	-	10	-
57	BGACK negated to AS,DS,RW drive	clks	Tgasd	1.5	-	1.5	-	1.5	-
57A	BGACK negated to FC driven	clks	Tgafd	1	-	1	-	1	-
58	BR negated to AS,DS,RW driven	clks	Trhsd	1.5	-	1.5	-	1.5	-
58A	BR negated to FC driven	clks	Trhfd	1	-	1	-	1	-
60	Clock high to BCLR asserted	ns	Tchbcl	-	30	-	45	-	35
61	Clock high to BLCR negated	ns	Tchbch	-	30	-	45	-	35
62	Clock low to RMC asserted	ns	Tclrml	-	30	-	45	-	35
63	Clock high to RMC negated	ns	Tchrmh	-	30	-	45	-	35
64	RMC negated to BG asserted	ns	Trmhgl	-	30	-	45	-	35

"High Z" or "Z" means high impedance.

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