HP 64758

70632 Emulator Terminal Interface

User's Guide

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Using This manual

This manual is designed to give you an introduction to the HP 64758G/H 70632 Emulator. This manual will also help define how these emulators differ from other HP 64700 Emulator.

This manual will:

- give you an introduction to using the emulator.
- explore various ways of applying the emulator to accomplish your tasks.
- show you emulator commands which are specific to the 70632 Emulator.

This manual will not:

- tell you how to use each and every emulator/analyzer command (refer to the *User's Reference manual).*

Organization

Chapter 1 **Introduction.** This chapter lists the 70632 emulator features and describes how they can help you in developing new hardware and software.

Chapter 2 **Getting Started.** This chapter shows you how to use emulation commands by executing them on a sample program. The chapter describes the sample program and how to: load programs into the emulator, map memory, display and modify memory, display registers, step through programs, run programs, set software breakpoints, search memory for data, and use the analyzer.

Chapter 3 **Virtual Mode Emulation Topics.** This chapter shows you how to use emulator in virtual mode. The chapter describes a sample program and how to: load programs into the emulator, display on-chip MMU registers, privilege registers and TCB, set software breakpoints, and use the analyzer in virtual mode.

Chapter 4 **Using the Emulator.** This chapter describes emulation topics that are not covered in the "Getting Started" and "Virtual Mode Emulation Topics" chapters (for example, coordinated measurements and storing memory).

Chapter 5 **In-Circuit Emulation.** This chapter shows you how to plug the emulator into a target system, and how to use the "in-circuit" emulation features.

Appendix A **70632 Emulator Specific Command Syntax.** This appendic describes the command syntax which is specific to the 70632 emulator. Included are: emulator configuration items, address syntax, display and access mode

Appendix B **Using the Foreground Monitor.** This appendix describes the advantages and disadvantages of foreground and background monitors and how to use foreground monitors.

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1

Introduction to the 70632 Emulator

Introduction

The topics in the this chapter include:

- Purpose of the emulator
- Features of the emulator

Purpose of the 70632 Emulator

The 70632 emulator is designed to replace the NEC uPD70632 microprocessor in your target system to help you integrate target system software and hardware. The 70632 emulator performs just like the NEC uPD70632 microprocessor, but at the same time, it gives you information about the operation of the processor. The emulator gives you control over target system execution and allows you to view or modify the contents of processor registers and, target system memory.

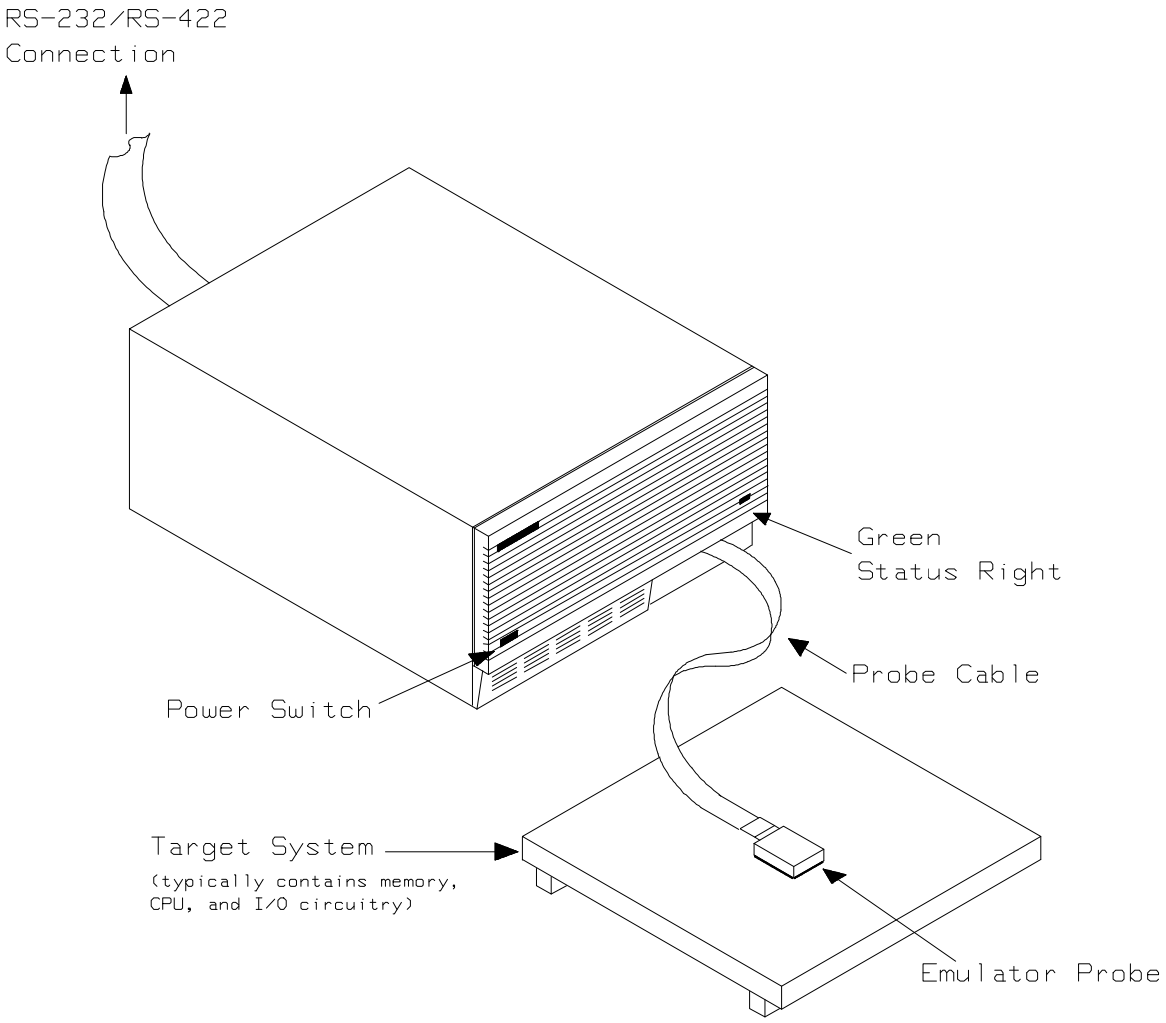


Figure 1-1. HP 64758 Emulator for the 70632

1-2 Introduction

Features of the 70632 Emulator

Supported Microprocessor

The emulator probe has a 132-pin PGA connector. The HP 64758G/H emulator supports the NEC uPD70632 microprocessor.

Clock Speeds

Measurements can be made using the emulator's internal 20 MHz clock or an external clock from 8 MHz to 20 MHz with no wait states added to target memory.

Emulation Memory

Depending on the emulator model number, there are 512K/1M bytes of emulation memory. Memory mapping configuration maps physical memory only. If the MMU is enabled, the user is responsible for knowing user physical memory usage.

Dual-ported memory allows you to display or modify physical emulation memory without stopping the processor. Flexible memory mapping lets you define address ranges over the entire 4 Gbyte address range of the 70632. You can define up to 8 memory ranges (at 4 Kbyte boundaries and at least 4Kbytes in length). The monitor occupies 4K bytes leaving 508K or 1020K bytes of emulation memory which you may use. You can characterize memory ranges as emulation RAM, emulation ROM, target system RAM, target system ROM, or as guarded memory. The emulator generates an error message when accesses are made to guarded memory locations; additionally, you can configure the emulator so that writes to memory defined as ROM cause emulator execution to break out of target program execution. You can select whether the memory accesses honor /READY and /BERR signals from target system for each emulation memory range.

Analysis

The integrated emulation bus analyzer provides real-time analysis of all bus-cycle activity. You can define break conditions based on address and data bus cycle activity. In addition to hardware break, software breakpoints can be used for execution breakpoints.

The 70632 microprocessor has on-chip MMU which provides a 4 Giga-byte virtual space for each task. When you use the on-chip MMU, you will want to analyze either actual or virtual address space. You can configure which address space should be recognized by the emulation analyzer. Analysis functions include trigger, storage, count, and context directives. The analyzer can capture up to 1024 events, including all address, data, and status lines.

FPU

The emulation bus analyzer can capture bus states accessing to a Floating Point Processor.

MMU

The emulator will support development when using the internal Memory Management Unit.

FRM

The emulator supports the master mode of the 70632 FRM function. In the master mode, you can use the analyzer feature of the emulator. If signal is asserted by your target system, the emulator bus signals are held. So the emulator does not work as checker.

Registers

You can display or modify the 70632 internal CPU register contents. This includes the ability to modify the program counter (PC) value so you can control where the emulator starts a program run. You can also display or modify the 70632 MMU register contents.

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 70632 emulator, setting a software breakpoint inserts a 70632 BRK 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.

Software Debugging

The HP 64758G/H Real-Time Emulator for 70632 microprocessors is a powerful tool for both software and hardware designers. Using the HP 64758G/H Emulator's emulation memory (up to 512 Kilo/1 Mega bytes), software debugging can be done without functional target system memory.

Configurable Target System Interface

You can configure the emulator so that it honors target system wait and retry requests when accessing emulation memory. Additionally, the processor signals /READY, /BERR, BFREZ, RT/EP, /NMI, INT, and /HLDRQ may be enabled or disabled independently of the 70632 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: display or modify of target system memory; load/dump of target memory, and display or modification of registers and some virtual related functionality.

Foreground or Background Emulation Monitor

The emulation monitor is a program executed by the emulation processor. It allows the emulation controller to access target system resources. For example, when you display target system memory, the monitor program executes 70632 instructions to read the target memory locations and send their contents to the emulation controller.

The monitor program can execute in *foreground*, the mode in which the emulator operates as would the target processor. The foreground monitor occupies processor address space and executes as if it were part of the target program.

The monitor program also can execute in *background*, the emulator mode in which foreground operation is suspended so the emulation processor can access target system resources. The background monitor does not occupy processor address space.

Out-of-Circuit or In-Circuit Emulation

The 70632 emulator can be used for both out-of-circuit emulation and in-circuit emulation. The emulation can be used in multiple emulation systems using other HP 64700 Series emulators/analyzers.

2

Getting Started

Introduction

This chapter lead you through a basic, step by step tutorial designed to familiarize you with the HP 64758G/H emulator for the 70632 microprocessor in real mode.

This chapter:

- Describes the sample program used for this chapter's examples.
- Shows you how to use the "help" facility.
- Shows you how to map memory.
- Shows you how to enter emulation commands to view execution of the sample program. The commands described in this chapter include:
  - displaying and modifying memory,
  - stepping,
  - displaying registers,
  - defining breaking, using software breakpoints,
  - tracing program execution,
  - copying memory,
  - and testing coverage.

This chapter does not:

- Describe any virtual mode debbugging informations.

The description for virtual mode emulation is shown in the "Virtual Mode Emulation Topics" chapter.

Before You begin

Before beginning the tutorial presented in this chapter, you must have completed the following tasks:

1. Completed hardware installation of the HP 64700 emulator in the configuration you intend to use for your work;
   - Standalone configuration
   - Transparent configuration
   - Remoto configuration
   - Local Area Network configuration

   Reference:*HP 64700 Series Installation/Service* manual

2. 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 xonnected to the emulator. In addition, you must start the termunal emulator program before you can work thr examples in this chapter.

3. If you have properly completed step 1 above, you should be able to hit <RETURN> (or <ENTER> on some keyboards) and get one of the following command prompts on your terminal screen.:

```
U>
R>
M>
```

   If you do not see one of these command prompts, retrace your steps through the hardware installation procedure outlined in the manual referenced above, verifying all connections and procedural steps.

   In any case, you **must** have a command prompt on your terminal screen before proceeding with the tutorial.

A Look at the Sample Program

The sample program used in this chapter is listed in figure 2-1. The program emulates a primitive command interpreter.

```
#cmd_rds.s
D 00000000                                      .file   "cmd_rds.s"

D 00000000                                      .equ    Dest_Size,0x30
D 00000000                                      .equ    Stack_Size,0x100

D 00000000                                      .data   "sbt" (RW) >0x00000000
D 00000000                                      .org    .+0x34
D 00000034 6D000100                             .word   Dummy_Text

T 00010000                                      .text (RX) >0x00010000
T 00010000                                      .align  4

T 00010000 2D3FF434010300       Init:           mov.w   #Stack+Stack_Size,sp
T 00010007 4420F2F9FF0100                       movea.w Command_Input,r0
T 0001000E 4421F2F6FF0100                       movea.w Message_Dest,r1
T 00010015 093AF420                             mov.b   #' ',r26

T 00010019 0980E060             Clear:          mov.b   #0x00,[r0]

T 0001001D 092260               Read_Input:     mov.b   [r0],r2
T 00010020 B822E0                               cmp.b   #0x00,r2
T 00010023 64FA                                 je      Read_Input

T 00010025 B822F441             Process_Comm:   cmp.b   #'A',r2
T 00010029 640A                                 je      Command_A
T 0001002B B822F442                             cmp.b   #'B',r2
T 0001002F 6414                                 je      Command_B
T 00010031 6A22                                 jr      Unrecognized

T 00010033 4423F2CDFF0000       Command_A:      movea.w Message_A,r3
T 0001003A 2D24F411000000                       mov.w   #Message_B-Message_A,r4
T 00010041 6A20                                 jr      Output

T 00010043 4423F2CEFF0000       Command_B:      movea.w Message_B,r3
T 0001004A 2D24F411000000                       mov.w   #Invalid_Input-Message_B,r4
T 00010051 6A10                                 jr      Output

T 00010053 4423F2CFFF0000       Unrecognized:   movea.w Invalid_Input,r3
T 0001005A 2D24F40F000000                       mov.w   #Message_End-Invalid_Input,r4

T 00010061 588A6384F2A3FF01     Output:         movcfu.b [r3],r4,Message_Dest,#Dest_Size
           0030
T 0001006B 6AAE                                 jr      Clear

T 0001006D 00                   Dummy_Text:             halt


D 00020000                                      .data (R) >0x00020000

D 00020000 5448495320495320     Message_A:      .str    "THIS IS MESSAGE A"
           4D45535341474520
           41
D 00020011 5448495320495320     Message_B:      .str    "THIS IS MESSAGE B"
           4D45535341474520
           42
D 00020022 494E56414C494420     Invalid_Input:  .str    "INVALID COMMAND"
           434F4D4D414E44
D 00020031                      Message_End:
```

Figure 2-1. Sample Program Listing

```
B 00030000                              .bss (RW) >0x00030000
B 00030000                              .lcomm  Command_Input,  4,4
B 00030004                              .lcomm  Message_Dest,Dest_Size,4
B 00030034                              .lcomm  Stack,Stack_Size,4
```

Figure 2-1. Sample Program Listing (Cont'd)

System Base Table

The "sbt" section defines 70632 System Base Table containing the vectors for 70632 interrupts and exceptions. The sample program defines BRK instruction vector pointing to an address in the "text" section. This is requirement for emulation software breakpoints feature. Refer to "Using Software Breakpoints" section in this chapter for details.

Data Declarations

The "data" section defines the messages used by the program to respond to various command inputs. These messages are labeled **Message_A**, **Message_B**, and **Message_I**.

The Destination Area

The "bss" section declares memory storage for the command input byte (**Command_Input**), the destination area (**Message_Dest**), and the stack area.

Initialization

The program instructions from the **Init** label to the **Clear** label perform initialization. The stack pointer is set up and the addresses labeled **Command_Input** and **Message_Dest** are loaded into registers; R0 and R1.

Register R26 is set up to 20H for filling remaining locations after transferring a message to the destination area (**Message_Dest**) with blank.

Reading Input

The instruction at the **Clear** label clears any random data or previous commands from the **Cmd_Input** byte. The **Read_Input** loop continually reads the **Cmd_Input** byte to see if a command is entered (a value other than 0H).

Processing Commands

When a command is entered, the instructions from **Process_Comm** to **Command_A** determine whether the command was "A", "B", or an invalid command.

If the command input byte is "A" (ASCII 41H), execution is transferred to the instructions at **Command_A**.

If the command input byte is "B" (ASCII 42H), execution is transferred to the instructions at **Command_B**.

If the command input byte is neither "A" nor "B", an invalid command has been entered, and execution is transferred to the instructions at **Unrecognized**.

The instructions at **Command_A**, **Command_B**, and **Unrecognized** each load register R3 with the starting location of the appropriate message and register R4 with the length of the message to be displayed. Then, execution transfers to **Output** which writes the appropriate message to the destination location, **Message_Dest**. At the same time, the remaining locations are filled with blanks; the content of register R26.

Then, the program jumps back to read the next command.

Using the "help" Facility

The HP 64700 Series emulator's Terminal Interface provides an excellent **help** facility to provide you with quick information on the various commands and their options. From any system prompt, you can enter "**help**" or "**?**" as shown below.

```
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
  *        - all command groups
```

Commands are grouped into various classes. To see the commands grouped into a particular class, you can use the help command with that group. Viewing the group help information in short form will cause the commands or the grammar to be listed without any description. For example, if you want to get some information for group gram, enter "**help gram**". Following help information should be displayed.

```
R>help gram
gram - system grammar
------------------------------------------------------------------------------
--- SPECIAL CHARACTERS ---
  #  - comment delimiter    ;  - command separator    Ctl C - abort signal
  {} - command grouping     "" - ascii string         ''    - ascii string
  Ctl R - command recall    Ctl B - recall backwards

--- EXPRESSION EVALUATOR ---
  number bases:  t-ten   y-binary   q-octal   o-octal   h-hex
  repetition and time counts default to decimal - all else default to hex
  operators:     ()  ~  *  /  %  +  -  <<  <<<  >>  >>>  &  ^  |  &&

--- PARAMETER SUBSTITUTION ---
  &token& - pseudo-parameter included in macro definition
          - cannot contain any white space between & pairs
          - performs positional substitution when macro is invoked
  Example
     Macro definition:  mac getfile={load -hbs"transfer -t &file&"}
     Macro invocation:  getfile MYFILE.o
     Expanded command:  load -hbs"transfer -t MYFILE.o"
```

Help information exists for each command. Additionally, there is help information for each of the emulator configuration items.

Becoming Familiar with the System Prompts

A number of prompts are used by the HP 64700 Series emulators. Each of them has a different meaning, and contains information about the status of the emulator before and after the commands execute. These prompts may seem cryptic at first, but there are two ways you can find out what a certain prompt means if you are not familiar with it.

Using "help proc" to View Prompt Description

The first way you can find information on the various system prompts is to look at the proc help text.

```
R>help proc
```

```
--- Address format ---
 32 bit address for memory with optional function code.
 An address is usually interpreted as real unless the function
 code contains a 'v' specifying a virtual or real address.
 Address format is either XXXXXXXX or XXXXXXXX@fc where
 XXXXXXXX is a 32 bit address and fc is any of the following:

   r - real    v - virtual

--- Address range format ---
 32 bit address thru 32 bit address with optional function codes.
 Address range format is any of the following:

 XXXXXXXX..XXXXXXXX   XXXXXXXX..XXXXXXXX@fc   XXXXXXXX@fc..XXXXXXXX@fc

--- Emulation Status Characters ---
 R - emulator in reset state            c - no target system clock
 U - running user program               r - target system reset active
 M - running monitor program            h - halt or machine fault
 W - waiting for CMB to become ready    w - waiting for target ready
 T - waiting for target reset           b - no bus cycles
 g - frozen or held or in checker mode  i - invalid virtual cpu
 ? - unknown state

--- Equates for Analyzer Label stat ---
 base     - system base table     coproc   - co processor cycle
 coprd    - co processor read     copwr    - co processor write
 data     - data cycle            datard   - data read
 datawr   - data write            exe      - instruction execution
 fetch    - instruction fetch     fetchbr  - fetch after branch
 fault    - machine fault         grd      - guarded access
 halt     - halt acknowledge      hold     - hold tag
 int      - interrupt acknowledge io       - io cycle
 iord     - io read               iowr     - io write
 lock     - bus lock              mon      - background cycle
 retry    - retry cycle           short    - data short cycle
 shortrd  - data short read       shortwr  - data short write
 trans    - translation table     transrd  - trans. table read
 transwr  - trans. table write    wrrom    - write to rom
```

Using the Emulation Status Command (es) for Description of Current Prompt

When using the emulator, you will notice that the prompt changes after entering certain commands. If you are not familiar with a new prompt and would like information about that prompt only, enter the es (emulation status) command for more information about the status of the emulator.

```
U>es
N70632--Running user program
```

Initializing the Emulator

If you plan to follow this tutorial by entering commands on your emulator as shown in this chapter, verify that no one else is using the emulator. To initialize the emulator, enter the following command:

```
R>init
# Limited initialization completed
```

The init command with no options causes a limited initialization, also known as a warm start initialization. Warm start initialization does not affect system configuration. However, the init command will reset emulator and analyzer configurations. The init command:

- Resets the memory map.
- Resets the emulator configuration items.
- Resets the break conditions.
- Clears software breakpoints.

The init command does not:

- Clear any macros.
- Clear any emulation memory locations; mapper terms are deleted, but if you respecify the mapper terms, you will find that the emulation memory contents are the same.

Other Types of Initialization

There are two options to the init command which specify other types of initializations. The **-p** option specifies a powerup initialization, also known as a cold start initialization. The cold start initialization sequence includes the emulator, analyzer, system controller, and communications port initialization; additionally, performance verification tests are run.

The **-c** option also specifies a cold start initialization, except that performance verification tests are not run.

Using The Default Emulation Configuration

Emulation configuration is needed adapting to your specific development. To view the items of emulation configuration, enter:

```
R>help cf
```

You will see:

```
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 ---
  clk  - select internal/external clock source
  rrt  - enable/disable restriction to real time runs
  mil  - selection of memory inverse assembler
  mon  - selection of a foreground or background monitor
  dbc  - en/dis drive of background cycles to the target system
  bbk  - select memory block during background operation
  th   - en/dis Target /HLDRQ signal
  tbf  - en/dis Target /BFREZ signal
  ti   - en/dis Target INT signal
  tn   - en/dis Target /NMI signal
  trh  - en/dis emulation analyzer tag of the bus hold handshake
  tre  - en/dis emulation analyzer trace execution cycles
  tra  - select virtual / real address trace
  loa  - select virtual / real address for file loading
```

To view the current emulation configuration, enter:

```
R>cf
```

As you have initialized the emulator, the emulation configuration items have the default value. So you should see the default configuration values as follows.

```
cf clk=int
cf rrt=dis
cf mil=v70
cf mon=bg
cf dbc=dis
cf bbk=0
cf th=en
cf tbf=en
cf ti=en
cf tn=en
cf trh=en
cf tre=en
cf tra=real
cf loa=real
```

Since the default configuration is sufficient to execute the sample program, you don't have to change any configuration items in this tutorial.

Loading Firmware Sample Programs

For convenience of demonstration, two sample programs are included in the emulator, one for this chapter and the other for next chapter. Usually, you need to map memory and load program into the memory after configuring the emulator.

You don't have to enter the commands in the following two sections ("Mapping Memory" and "Loading the Sample Program into Emulation Memory" sections).

Enter the following command instead.

```
R>demo 1
```

The "demo" command performs the same as the commands will do. However, you should read through the sections to learn how to map memory and load program for debugging your development.

Mapping Memory

Depending on the emulator model number, emulation memory consists of 512K or 1M bytes, mappable in 4K byte blocks. The monitor occupies 4K bytes, leaving 508K or 1020K bytes of emulation memory which you may use. You can examine the emulation memory size of your emulator, type:

```
R>ver
```

The resulting display includes the information of emulation memory size. If your emulator's model number is:

- HP64758G, you'll find:

```
Memory:    508 KBytes Emulation Memory
```

- HP64758H, you'll find:

```
Memory:    1020 KBytes Emulation Memory
```

By default, the emulation memory system does not introduce wait states. The memory mapper allows you to characterize memory locations. It allows you specify whether a certain range of memory is present in the target system or whether you will be using emulation memory for that address range. You can also specify whether the target system memory is ROM or RAM, and you can specify that emulation memory be treated as ROM or RAM. If you are using the emulator in in-circuit, additionally; you can choose whether the emulation accesses honor /READY or /BERR signals from the target system (wait or retry cycles are inserted if requested).

Note

Target system access to emulation memory is not allowed. Target system devices that take control of the bus (for example, coprocessors or external DMA controllers) cannot access emulation memory.

Blocks of memory can also be characterized as guarded memory. Guarded memory accesses will generate "break to monitor" requests. Writes to ROM will generate "break to monitor" requests if the rom break condition is enabled. Memory is mapped with the map command. To view the memory mapping options, enter:

```
R>help map
```

```
map - display or modify the processor memory map

  map                 - display the current map structure
  map <addr>..<addr> <type> <attrib> - define address range as memory type
  map other <type>    - define all other ranges as memory type
  map -d <term#>      - delete specified map term
  map -d *            - delete all map terms

--- VALID <type> OPTIONS ---
  eram - emulation ram
  erom - emulation rom
  tram - target ram
  trom - target rom
  grd  - guarded memory

--- VALID <attrib> OPTIONS ---
  <none> - do not see /READY and /BERR signal during emulation memory cycles
  lock   - see READY , BERR and RT/EP signal during emulation memory cycles
```

Enter the **map** command with no options to view the default map structure.

```
R>map
# remaining number of terms   : 8
# remaining emulation memory  : 7f000h bytes
map  other tram
```

If your emulator's model number is HP64758B, the size of remaining emulation memory will be displayed "0ff000h bytes" instead of "7f000h bytes".

Mapping the Appropriate Memory Location

The sample program consists of four sections; the system base table area named "sbt", the program area named "text", the data area named "data", the destination area named "bss".

The sbt area which contains 70632 System Base Table occupies locations 0 through 4ffH. The program area ("text" section), which contains the opcodes and operands which make up the sample program, occupies locations 10000H through 1006dH. The data area ("data" section), which contains the ASCII values of the messages the program transfers, occupies locations 20000H through 20031H. The destination area ("bss" section), which contains the command input byte and the locations of the message destination, occupies locations 30000H through 30117H.

Since the program writes to the destination locations, the mapper block of destination area should not be characterized as ROM memory. Enter the following commands to map memory for the sample program.

```
R>map 0..4ff erom
R>map 10000..1006c erom
R>map 20000..20031 erom
R>map 30000..30117 eram
```

By default, unmapped area attribute is defined as target RAM. However, when emulation without plugging the emulator into your target system, unmapped area should be defined as "guarded" to detect the illegal accesses to the area.

```
R>map other grd
```

To confirm the memory map you've just done.

```
R>map
```

```
# remaining number of terms   : 4
# remaining emulation memory  : 7b000h bytes
map  000000000..000000fff@r   eram        # term 1
map  000010000..000010fff@r   erom        # term 2
map  000020000..000020fff@r   erom        # term 3
map  000030000..000030fff@r   eram        # term 4
map  other  grd
```

As you can see, the mapper rounded up the second term to 4 Kbytes blocks, since those are minimum size blocks supported by the 70632 emulator.

When mapping memory for your target system programs, you may wish to characterize emulation memory locations containing programs and constants (locations which should not be written to) as ROM. This will prevent programs and constants from being written over accidentally, and will cause breaks when instructions or commands attempt to do so (if the **rom** break condition is enabled).

Note

Software breakpoints should be removed before altering the memory map. If they are **NOT**, BRK instructions will be left at unknown locations.

Loading the Sample Program into Emulation Memory

This section assumes you are using the emulator in one of three configurations:

1. Connected only to a terminal, which is called the standalone configuration. In the *standalone* configuration, you must modify memory to load the sample program.

2. Connected between a terminal and a host computer, which is called the *transparent* configuration. In the transparent configuration, you can load the sample program by downloading from the "other" port.

3. Connected to a host computer and accessed via a terminal emulation program (for example, the terminal window of the PC Interface). Configurations in which the emulator is connected to, and accessed from, a host computer are called *remote* configurations. In the remote configuration, you can load the sample program by downloading from the same port.

Standalone Configuration

If you are operating the emulator in the standalone configuration, the only way to get the sample program into emulation memory is by modifying emulation memory locations with the **m** (memory display/modification) command. You can enter the sample program into memory with the **m** command.

Transparent Configuration

If your emulator is connected between a terminal and a host computer, you can download programs into memory using the load command with the **-o** (from other port) option. The load command will accept absolute files in the following formats:

- HP absolute.
- Intel hexadecimal.
- Tektronix hexadecimal.
- Motorola S-records.

The examples which follow will show you the methods used to download HP absolute files and the other types of absolute files.

HP Absolutes Downloading HP format absolute files requires the **transfer** protocol. The example below assumes that the transfer utility has been installed on the host computer (HP 64884 for HP 9000 Series 500, or HP 64885 for HP 9000 Series 300).

Note

Notice that the transfer command on the host computer is terminated with the <ESCAPE>**g** characters; by default, these are the characters which temporarily suspend the transparent mode to allow the emulator to receive data or commands.

```
R>load -hbo <RETURN> <RETURN>
$ transfer -rtb cmd_rds.X <ESCAPE>g

#####
R>
```

Other Supported Absolute Files The example which follows shows how to download Intel hexadecimal files, but the same method (and a different **load** option) can be used to load Tektronix hexadecimal and Motorola S-record files as well.

```
R>load -io <RETURN> <RETURN>
$ cat ihexfile <ESCAPE>g

#####
Data records = 00003  Checksum error = 00000
R>
```

Remote Configuration

If the emulator is connected to a host computer, and you are accessing the emulator from the host computer via a terminal emulation program, you can also download files with the **load** command. However, in the remote configuration, files are loaded from the same port that commands are entered from. For example, if you wish to download a Tektronix hexadecimal file from a Vectra personal computer, you would enter the following commands.

```
R>load -t <RETURN>
```

After you have entered the load command, exit from the terminal emulation program to the MS-DOS operating system. Then, copy your hexadecimal file to the port connected to the emulator, for example:

```
C:\copy thexfile com1: <RETURN>
```

Now you can return to the terminal emulation program and verify that the file was loaded.

For More Information

For more information on downloading absolute files, refer to the load command description in the *HP 64700 Emulators Terminal Interface: User's Reference* manual.

Displaying Memory In Mnemonic Format

Once you have loaded a program into the emulator, you can verify that the program has indeed been loaded by displaying memory in mnemonic format.

```
R>m -dm 10000..1006c
000010000@r  -          MOV.W      #00030134H,SP
000010007@r  -          MOVEA.W    00030000H,R0
00001000e@r  -          MOVEA.W    00030004H,R1
000010015@r  -          MOV.B      #20H,R26
000010019@r  -          MOV.B      #0H,[R0]
00001001d@r  -          MOV.B      [R0],R2
000010020@r  -          CMP.B      #0H,R2
000010023@r  -          BE/Z       0001001dH
000010025@r  -          CMP.B      #41H,R2
000010029@r  -          BE/Z       00010033H
00001002b@r  -          CMP.B      #42H,R2
00001002f@r  -          BE/Z       00010043H
000010031@r  -          BR         00010053H
000010033@r  -          MOVEA.W    00020000H,R3
00001003a@r  -          MOV.W      #00000011H,R4
000010041@r  -          BR         00010061H
000010043@r  -          MOVEA.W    00020011H,R3
00001004a@r  -          MOV.W      #00000011H,R4
000010051@r  -          BR         00010061H
000010053@r  -          MOVEA.W    00020022H,R3
00001005a@r  -          MOV.W      #0000000fH,R4
000010061@r  -          MOVCFU.B   [R3],R4,00030004H,#30H
00001006b@r  -          BR         00010019H
```

To display in processor mnemonics, the **-dm** option was used. You can specify one of display modes with the option like this; **-d** followed by one character. It allows you to display contents of memory in various formats. The following display modes are available in the memory display command.

- **b** ... byte
- **h** ... half word (2 bytes)
- **w** ... word (4 bytes)
- **d** ... double word (8 bytes)
- **s** ... short float
- **l** ... long float
- **m** ... processor mnemonic

The display mode option, which is used last except for '**s**' or '**l**', is registered as current default display mode. The current default display mode is used when you don't specify display mode with this option. To view the current default display command, type:

```
R>mo
mo -ab -dm
```

Stepping Through the Program

The emulator allows you to execute one instruction or a number of instructions with the **s** (step) command. Enter the **help s** to view the options available with the step command.

```
R>help s
s - step emulation processor

  s                     - step one from current PC
  s <count>             - step <count> from current PC
  s <count> $           - step <count> from current PC
  s <count> <addr>      - step <count> from <addr>
  s -q <count> <addr>   - step <count> from <addr>, quiet mode
  s -w <count> <addr>   - step <count> from <addr>, whisper mode

--- NOTES ---
  STEPCOUNT MUST BE SPECIFIED IF ADDRESS IS SPECIFIED!
  If <addr> is not specified, default is to step from current PC.
  A <count> of 0 implies step forever.
```

A step count of 0 will cause the stepping to continue "forever" (until some break condition, such as "write to ROM", is encountered, or until you enter <CTRL>**c**). The following command will step from the first address of the sample program.

```
R>s 1 10000
000010000@r  -              MOV.W      #00030134,SP
PC = 000010007@r
```

Displaying Registers

The step command shown above executed a MOV.W #00030118,SP instruction. Enter the following command to view the contents of the registers.

```
M>reg
```

The resulting display will be similar to the following.

```
 reg   pc=00010007  psw=10000000 sycw=00000070
 reg   r0=000000ff   r1=00000000   r2=00000000   r3=00000000   r4=00000000
 reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
 reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
 reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
 reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
 reg  r25=00004040  r26=00000000  r27=00000000  r28=00000000  r29=04420010
 reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
```

Combining Commands

More than one command may be entered in a single command line if the commands are separated by semicolons (**;**). For example, you could execute the next instruction(s) and display the registers by entering the following.

```
M>s;reg
```

```
000010007@r  -               MOVEA.W    00030000H,R0
 PC = 00001000e@r
 reg   pc=0001000e  psw=10000000 sycw=00000070
 reg   r0=00030000   r1=00000000   r2=00000000   r3=00000000   r4=00000000
 reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
 reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
 reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
 reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
 reg  r25=00004040  r26=00000000  r27=00000000  r28=00000000  r29=04420010
 reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
```

Using Macros

Suppose you want to continue stepping through the program, displaying registers after each step. You could continue entering **s** commands followed by **reg** commands, but you may find this tiresome. It is easier to use a macro to perform a sequence of commands which will be entered again and again.

Macros allow you to combine and store commands. For example, to define a macro which will display registers after every step, enter the following command.

```
M>mac st={s;reg}
```

Once the **st** macro has been defined, you can use it as you would any other command.

```
M>st
```

```
# s ; reg
00001000e@r  -                MOVEA.W    00030004H,R1
PC = 000010015@r
reg   pc=00010015  psw=10000000 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000000   r3=00000000   r4=00000000
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000000  r27=00000000  r28=00000000  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
```

Command Recall

The command recall feature is yet another, easier way to enter commands again and again. You can press <CTRL>**r** to recall the commands which have just been entered. If you go past the command of interest, you can press <CTRL>**b** to move forward through the list of saved commands. To continue stepping through the sample program, you could repeatedly press <CTRL>**r** to recall and <RETURN> to execute the **st** macro.

Repeating Commands

The **rep** command is also helpful when entering commands repetitively. You can repeat the execution of macros as well commands. For example, you could enter the following command to cause the st macro to be executed four times.

```
M>rep 4 st
```

```
# s ; reg
0000010015@r  -               MOV.B      #20H,R26
PC = 0000010019@r
reg   pc=00010019  psw=10000000 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000000   r3=00000000   r4=00000000
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000020  r27=00000000  r28=00000000  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
# s ; reg
0000010019@r  -               MOV.B      #0H,[R0]
PC = 00001001d@r
reg   pc=0001001d  psw=10000000 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000000   r3=00000000   r4=00000000
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000020  r27=00000000  r28=00000000  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
# s ; reg
00001001d@r  -                MOV.B      [R0],R2
PC = 0000010020@r
reg   pc=00010020  psw=10000000 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000000   r3=00000000   r4=00000000
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000020  r27=00000000  r28=00000000  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
# s ; reg
0000010020@r  -               CMP.B      #0H,R2
PC = 0000010023@r
reg   pc=00010023  psw=10000001 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000000   r3=00000000   r4=00000000
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000020  r27=00000000  r28=00000000  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
```

Command Line Editing

The terminal interface supports the use of HP-UX **ksh**(1)-like editing of the command line. The default is for the command line editing feature to be disabled to be compatible with earlier versions of the interface. Use the **cl** command to enable command line editing.

```
M>cl -e
```

Refer to "Command Line Editing" in the *HP 64700-Series Emulators Terminal Interface Reference* for information on using the command line editing feature.

Modifying Memory

The preceding step and register commands show the sample program is executing **Read_Input** loop, where it continually reads the command input byte to check if a command had been entered. Use the **m** (memory) command to modify the command input byte.

```
M>m -db 30000=41
```

To verify that 41H has been written to 30000H, enter the following command.

```
M>m 30000
```

```
000030000@r  41
```

The display mode described in the above "Display Memory In Mnemonic Format" section also functions when modifying memory contents.

When memory was displayed in byte format earlier, the current display mode was changed to "byte". The display and access modes from previous commands are saved and they become the defaults.

In "mnemonic" current display mode, last display mode in '**b**', '**h**', '**w**' and '**d**' is used when modifying memory command with no display mode option.

Specifying the Access and Display Modes

There are a couple of different ways to modify the display and access modes. One is to explicitly specify the mode with the command you are entering, as with the command **m -db 30000**. The **mo** (display and access mode) command is another way to change the default mode. For example, to display the current modes, display 20000H in the current

mode "byte", define the display mode as "word", and redisplay 20000H, enter the following commands.

```
M>mo
mo -ab -db

M>m 20000
  000020000@r  54

M>mo -dw
M>m 20000
  000020000@r  53494854
```

To continue the rest of program ..

```
M>r
U>
```

Display the **Message_Dest** memory locations (destination of the message, 30004H) to verify that the program moved the correct ASCII bytes. At this time we want to see correct byte value, so "**-db**" option (display with byte) is used.

```
U>m -db 30004..30023
  000030004@r  54 48 49 53 20 49 53 20 4d 45 53 53 41 47 45 20
  000030014@r  41 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
```

Searching Memory for Data

The **ser** (search memory for data) command is another way to verify that the program did what it was supposed to do.

```
U>ser 30000..3003f="THIS IS MESSAGE
A"
 pattern match at address: 000030004@r
```

If any part of the data specified in the **ser** command is not found, no match is displayed (No message displayed).

Breaking into the Monitor

You can use the break (**b**) command to generate a break to the background monitor. While the break will occur as soon as possible, the actual stopping point may be many cycles after the break request (depend on the type of instruction being executed and whether the processor is in a hold state).

```
U>b
M>
```

Using Software Breakpoints

Software breakpoints are realized by the 70632 BRK instruction. When you define or enable a software breakpoint (with the **bp** command), the emulator will replace the opcode at the software breakpoint address with a breakpoint interrupt instruction (BRK).

If the BRK interrupt was generated by a software breakpoint, execution breaks to the monitor, and the breakpoint interrupt instruction (BRK) is replaced by the original opcode. A subsequent run or step command will execute from this address.

Note

When using software breakpoints feature of the emulator, you must define the BRK instruction vector to point to an address where instruction fetches is allowed; typically in the program code area. In this sample program, the BRK instruction vector points to a "HALT" instruction. When a software breakpoint occurs, the emulator reads the BRK interrupt vector, push the next PC, PSW and a word of exception code to stack, fetch one word of instruction pointed by the vector same as the actual CPU. And then, break occurs but the instruction, "HALT" in this example, will never be executed.

There are some notices to use the software breakpoints features. Refer to the "Software Breakpoints" section of the "Using the Emulator" chapter.

Displaying and Modifying the Break Conditions

Before you can define software breakpoints, you must enable software breakpoints with the **bc** (break conditions) command. To view the default break conditions and change the software breakpoint condition, enter the **bc** command with no option. This command displays current configuration of break conditions.

```
M>bc
```

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

To enable the software breakpoint feature enter

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

To confirm modified break condition, enter:

```
M>bc
```

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

Defining a Software Breakpoint

Now that the software breakpoint feature is enabled, you can define software breakpoints. Enter the following command to break on the address of the **Command_A** (address 10033H) label.

```
M>bp 10033
M>bp
```

```
### BREAKPOINT FEATURE IS ENABLED ###
bp 000010033@r #enabled
```

Run the program, and verify that execution broke at the appropriate address.

```
M>r 10000
U>m -db 30000=41
```

```
!ASYNC_STAT  615! Software breakpoint: 000010033@r
```

```
M>st
```

```
# s ; reg
000010033@r  -                MOVEA.W    00020000H,R3
PC = 00001003a@r
reg   pc=0001003a  psw=10000001 sycw=00000070
reg   r0=00030000   r1=00030004   r2=00000041   r3=00020000   r4=00000011
reg   r5=00000000   r6=00000000   r7=00000000   r8=00000000   r9=00000000
reg  r10=00000000  r11=00000000  r12=00000000  r13=00000000  r14=00000000
reg  r15=00000000  r16=00000000  r17=00000000  r18=00000000  r19=00000000
reg  r20=00000000  r21=00000000  r22=00000000  r23=00000000  r24=00000000
reg  r25=00004040  r26=00000020  r27=00030034  r28=00020011  r29=04420010
reg  r30=00000000  r31=00030134   ap=04420010   fp=00000000   sp=00030134
```

When a breakpoint is hit, it becomes disabled. You can use the **-e** option to the **bp** command to re-enable the software breakpoint.

```
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
bp 000010033@r #disabled
M>bp -e 10033
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
bp 000010033@r #enabled
M>r
U>m -db 30000=41
!ASYNC_STAT  615! Software breakpoint: 000010033@r
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
bp 000010033@r #disabled
```

Predefined Trace Labels

Three trace labels are predefined in the 70632 emulator. You can view these labels by entering the **tlb** (trace label) command with no options.

```
M>tlb
#### Emulation trace labels
tlb addr 32..63
tlb data 0..31
tlb stat 64..79
```

Predefined Status Equates

Common values for the 70632 status trace signals have been predefined. You can view these predefined equates by entering the **equ** command with no options.

```
M>equ
### Equates ###
equ base=0xxxxxxxxxxxx0100y
equ coprd=0x1xxxxxxxxxx1000y
equ coproc=0xxxxxxxxxxxx1000y
equ copwr=0x0xxxxxxxxxx1000y
equ data=0xxxxxxxxxxxx0011y
equ datard=0x1xxxxxxxxxx0011y
equ datawr=0x0xxxxxxxxxx0011y
equ exe=0xxxxxxxxxxxx0000y
equ fault=0xxxxxxxxxxxx1100y
equ fetch=0x1xxxxxxxxxx011xy
equ fetchbr=0x1xxxxxxxxxx0111y
equ grd=0xxxxxxxxxx0x0xxxy
equ halt=0xxxxxxxxxxxx1101y
equ hold=0xxxxxxxxxxxx0001y
equ int=0xxxxxxxxxxxx1110y
equ io=0xxxxxxxxxxxx1011y
equ iord=0x1xxxxxxxxxx1011y
equ iowr=0x0xxxxxxxxxx1011y
equ lock=0xxxxxxxx0xxxxxxxy
equ mon=0xxxxxxxxxx0xxxxy
equ retry=0xxxxxxxxxxxxxxxy
equ short=0xxxxxxxxxxxx0010y
equ shortrd=0x1xxxxxxxxxx0010y
equ shortwr=0x0xxxxxxxxxx0010y
equ trans=0xxxxxxxxxxxx0101y
equ transrd=0x1xxxxxxxxxx0101y
equ transwr=0x0xxxxxxxxxx0101y
equ wrrom=0x0xxxxxxx0xx0xxxy
```

These equates may be used to specify values for the stat trace label when qualifying trace conditions.

For the description of these equates, refer to the "Analyzer Topics" section of the "Using the Emulator" chapter.

Specifying a Simple Trigger

The **tg** analyzer command is a simple way to specify a condition on which to trigger the analyzer. Suppose you wish to trace the states of the program after the read of a "B" (42H) command from the command input byte. Enter the following commands to set up the trace, run the program, issue the trace, and display the trace status. (Note that the analyzer is to search for a lowest byte read of 42H because the address is a multiple of four.)

```
M>tg addr=30000 and data=0xxxxxx42
M>t

Emulation trace started

U>r
U>ts

  --- Emulation Trace Status ---
  NEW User trace running
  Arm ignored
  Trigger not in memory
  Arm to trigger ?
  States ? (0) ?..?
  Sequence term 1
  Occurrence left 1
```

The trace status shows that the trigger condition has not been found. You would not expect the trigger to be found because no commands have been entered. Modify the command input byte to "B"(42H) and display the trace status again.

```
U>m -db 30000=42
U>ts

  --- Emulation Trace Status ---
  NEW User trace complete
  Arm ignored
  Trigger in memory
  Arm to trigger ?
  States 1024 (1024) 0..1023
  Sequence term 2
  Occurrence left 1
```

The trace status shows that the trigger has been found, and that 1024 states have been stored in trace memory. Enter the following command to display the first 20 states of the trace.

```
U>tl 0..19
```

```
 Line   addr,H    data,H    uPD70632 Mnemonic,H                      count,R
-----   --------  --------  ---------------------------------------  ---------
    0   00030000  ffffff42     ......42H data  read                 *********
    1   00010020  64226a14   No fetch cycle found                   *********
    2   00010030  44226a14              fetch                       *********
    3   00010023  44226a14   No fetch cycle found                   *********
    4   00010034  ffcdf223              fetch                       *********
    5   00010025  ffcdf223   No fetch cycle found                   *********
    6   00010029  ffcdf223   No fetch cycle found                   *********
    7   00010038  242d0000              fetch                       *********
    8   0001002b  242d0000   No fetch cycle found                   *********
    9   0001003c  000011f4              fetch                       *********
   10   0001002f  44ffffff   No fetch cycle found                   *********
   11   00010043  44ffffff              fetch aft br                *********
   12   00010044  ffcef223              fetch                       *********
   13   00010048  242d0000              fetch                       *********
   14   0001004c  000011f4              fetch                       *********
   15   00010050  44106a00              fetch                       *********
   16   00010054  ffcff223              fetch                       *********
   17   00010043  242d0000   MOVEA.W   00020011H,R3                 *********
   18   00010058  242d0000              fetch                       *********
   19   0001004a  00000ff4   MOV.W     #00000011H,R4                *********
```

Line 0 in the trace list above shows the state which triggered the analyzer. The trigger state is always on line 0. To list the next lines of the trace, enter the following command.

```
U>tl
```

```
 Line   addr,H    data,H    uPD70632 Mnemonic,H                      count,R
-----   --------  --------  ---------------------------------------  ---------
   20   0001005c  00000ff4              fetch                       *********
   21   00010061  638a58ff              fetch aft br                *********
   22   00010051  ffa3f284   BR        00010061H                    *********
   23   00010064  ffa3f284              fetch                       *********
   24   00010068  6a300001              fetch                       *********
   25   0001006c  000000ae              fetch                       *********
   26   00010070  fffffff3              fetch                       *********
   27   00010074  dfffabff              fetch                       *********
   28   00010061  dfffabff   MOVCFU.B  [R3],R4,00030004H,#30H       *********
   29   00010078  55555557              fetch                       *********
   30   00020011  ffff54ff     ....54..H data  read                 *********
   31   00020012  ff48ffff     ..48....H data  read                 *********
   32   00030004  00000054     ......54H data  write                *********
   33   00020013  49ffffff     49......H data  read                 *********
   34   00030005  00004800     ....48..H data  write                *********
   35   00020014  ffffff53     ......53H data  read                 *********
   36   00030006  00490000     ..49....H data  write                *********
   37   00020015  ffff20ff     ....20..H data  read                 *********
   38   00030007  53000000     53......H data  write                *********
   39   00020016  ff49ffff     ..49....H data  read                 *********
```

Trigger Position

You can specify where the trigger state will be positioned with in the emulation trace list. The following three basical trigger positions are defined.

- **s** start
- **c** center
- **e** end

When **s** (start) trigger position is selected, the trigger is positioned at the start of the trace list. You can trace the states after the trigger state.

When **c** (center) trigger position is selected, the trigger is positioned at the center of the trace list. You can trace the states around the trigger state.

When **e** (end) trigger position is selected, the trigger is positioned at the end of the trace list. You can trace the states before the trigger.

In the above section, you have traced the states of the program after a certain state, because the default trigger position was **s** (start). If you want to trace the states of the program around a certain state, you need to change the trigger position.

For example, if you wish to trace the transition to the command A process, change the trigger position to "center" and specify the trigger condition.

To specify the trigger position, issue the **tp** command like this:

```
U>tp c
```

Specify the trigger condition by typing:

```
U>tg addr=10033 and stat=exe
```

Issue the trace command to start the trace.

```
U>t
Emulation trace started
```

Modify the command input byte to "A" and display the trace status again.

```
U>m -db 30000=41
U>ts
--- Emulation Trace Status ---
NEW User trace complete
Arm ignored
Trigger in memory
```

```
Arm to trigger ?
States 1024 (1024) -512..511
Sequence term 2
Occurrence left 1
```

The trace status shows that the trigger has been found. Enter the following command to display the states about the execution state of the address 10033H.

```
U>tl -10..13
```

Line	addr,H	data,H	uPD70632 Mnemonic,H		count,R
-10	00010023	44226a14	BE/Z	0001001dH	*********
-9	00010034	ffcdf223		fetch	*********
-8	00010025	ffcdf223	CMP.B	#41H,R2	*********
-7	00010029	44fdffff	BE/Z	00010033H	*********
-6	00010033	44ffffff		fetch aft br	*********
-5	00010034	ffcdf223		fetch	*********
-4	00010038	242d0000		fetch	*********
-3	0001003c	000011f4		fetch	*********
-2	00010040	44206a00		fetch	*********
-1	00010044	ffcef223		fetch	*********
0	00010033	242d0000	MOVEA.W	00020000H,R3	*********
1	00010048	242d0000		fetch	*********
2	0001003a	000011f4	MOV.W	#00000011H,R4	*********
3	0001004c	000011f4		fetch	*********
4	00010061	638a58ff		fetch aft br	*********
5	00010041	ffa3f284	BR	00010061H	*********
6	00010064	ffa3f284		fetch	*********
7	00010068	6a300001		fetch	*********
8	0001006c	000000ae		fetch	*********
9	00010070	78ef4120		fetch	*********
10	00010074	ffff1028		fetch	*********
11	00010061	ffff1028	MOVCFU.B	[R3],R4,00030004H,#30H	*********
12	00010078	015d0aaa		fetch	*********
13	00020000	ffffff54	......54H data	read	*********

The transition states to the process for the command A are displayed.

For a Complete Description

For a complete description of the HP 64700 Series analyzer, refer to the *HP 64700 Emulators Terminal Interface: Analyzer User's Guide*.

Copying Memory

The **cp** (copy memory) command gives you the ability to copy the contents of one range of memory to another. This is a handy feature to test things like the relocatability of programs, etc. To test if the sample program is relocatable within the same segment, enter the following command to copy the program to an unused, but mapped, area of emulation memory. After the program is copied, run it from its new start address to verify that the program is indeed relocatable.

```
U>cp 10800=10000..1006d
U>cp 20800=20000..20031
U>r 10800
U>
```

The prompt shows that the emulator is executing user code, so it looks as if the program is relocatable. You may want to issue a simple trace to verify that the program works while running from its new location.

```
U>tg any
U>t
Emulation trace started

U>tl
```

Testing for Coverage

For each 4 bytes of emulation memory, there is an additional bit of emulation RAM used by the emulator to provide coverage testing. When the emulator is executing the target program and an access is made to a byte in emulation memory, the corresponding bit of coverage memory is set. With the **cov** command, you can see which bytes in a range of emulation memory have (or have not) been accessed.

For example, suppose you want to determine how extensive some test input is in exercising a program (in other words, how much of the program is covered by using the test input). You can run the program with the test input and then use the **cov** command to display which locations in the program range were accessed.

Before coverage testing, break the emulator into monitor, by typing:

```
U>b
```

The examples which follow use the **cov** command to perform coverage testing on the sample program. Before performing coverage tests, reset all coverage bits to non-accessed by entering the following command.

```
M>cov -r
```

Run the program from the start address (10000H) and use the **cov** command to display how much of the program (instructions and data) is accessed before any commands are entered.

```
M>r 10000
U>cov -a 10000..1006c 20000..20030
# coverage list  -  list of address ranges accessed
000010000..000010033@r

percentage of memory accessed:  % 32.9
```

Now enter the sample program commands "A", "B", and an invalid command ("C" will do); display the coverage bits for the address range of the sample program after each command. You can see that more of the sample program address range is covered after each command is entered.

```
U>m 30000=41
U>cov -a 10000..1006c 20000..20030
# coverage list  -  list of address ranges accessed
000010000..00001004f@r
000010060..00001006c@r
000020000..000020013@r

percentage of memory accessed:  % 71.5
```

As you have entered command "A", the memory access for the command A process is added to the address ranges. Each term of the address ranges displayed is rounded to 4 byte boundaries because the coverage resolution is 4 byte.

```
U>m 30000=42
U>cov -a 10000..1006c 20000..20030
# coverage list  -  list of address ranges accessed
000010000..00001006c@r
000020000..000020023@r

percentage of memory accessed:  % 91.7
```

The address range 10000H through 1006cH contains all instructions in the sample program. Although you have never enter the invalid command "C", the report shows that all instructions including the instructions for the invalid command process have been accessed. This

reason is because the 70632 microprocessor prefetched the instructions for the invalid command. Note this when you use the coverage tester for the purpose of measuring memory locations of instructions executed.

```
U>m 30000=43
U>cov -a 10000..1006c 20000..20030
# coverage list  -  list of address ranges accessed
000010000..00001006c@r
000020000..000020030@r

percentage of memory accessed:  % 100.0
```

Resetting the Emulator

To reset the emulator, enter the following command.

```
U>rst
R>
```

The emulator is held in a reset state (suspended) until a **b** (break), **r** (run), or **s** (step) command is entered. A CMB execute signal will also cause the emulator to run if reset.

The **-m** option to the **rst** command specifies that the emulator begin executing in the monitor after reset instead of remaining in the suspended state.

```
R>rst -m
M>
```

Notes

3

Virtual Mode Emulation Topics

Introduction

The on-chip Memory Management Unit (MMU) of the 70632 microprocessor translates virtual addresses to physical (actual) addresses that are placed on the processor address bus. This chapter shows you how to use the emulator when the 70632 MMU is active.

This chapter:

- Describes the sample program used for this chapter's examples.
- Shows you how to enter emulation commands to view execution of the sample program. The commands described in this chapter include:
  - using virtual address expression in command lines.
  - displaying on-chip MMU registers and privilege registers.
  - displaying address translation tables.
  - displaying TCB.
  - using software breakpoint.
  - using XMMU function.
  - using the analyzer.

Sample Program for Virtual Mode Emulation

The sample program listed in figure 3-1 is a multi-task system which consists of a simple operating system and two tasks. Each of two tasks transfers its own message from an independent area to a common area.

System Base Table

The "sys_sbt" part located at address range 00000000H through 00000fffH defines the 70632 Break-point instruction trap vector and

```
#mul_task.s
D 00000000                                      .file   "mul_task.s"

D 00000000                                      .equ    isp,0
D 00000000                                      .equ    l0sp,1
D 00000000                                      .equ    l1sp,2
D 00000000                                      .equ    l2sp,3
D 00000000                                      .equ    l3sp,4
D 00000000                                      .equ    sbr,5
D 00000000                                      .equ    tr,6
D 00000000                                      .equ    sycw,7
D 00000000                                      .equ    tkcw,8
D 00000000                                      .equ    pir,9
D 00000000                                      .equ    psw2,15
D 00000000                                      .equ    atbr0,16
D 00000000                                      .equ    atlr0,17
D 00000000                                      .equ    atbr1,18
D 00000000                                      .equ    atlr1,19
D 00000000                                      .equ    atbr2,20
D 00000000                                      .equ    atlr2,21
D 00000000                                      .equ    atbr3,22
D 00000000                                      .equ    atlr3,23
D 00000000                                      .equ    trmod,24
D 00000000                                      .equ    adtr0,25
D 00000000                                      .equ    adtr1,26
D 00000000                                      .equ    adtmr0,27
D 00000000                                      .equ    adtmr1,28

D 00000000                                      .equ    Stack_Size,0x1000
D 00000000                                      .equ    Dest_Size,0x20

D 00000000                                      .data   "sys_sbt" (RW) >0x00000000
D 00000000                              Sys_SBT:
D 00000000                                      .org    0x34
D 00000034 C1500000                             .word   Dummy_Text
D 00000038                                      .org    0xc0
D 000000C0 88500000                             .word   Sys_Trap


D 000000C4                                      .data   "sys_tcb" (RW) >0x00001000
D 00001000 00000000                     Current_Task:   .word   0
D 00001004 02000000                     Num_Of_Task:    .word   2

D 00001008 38100000                     TCB_Entry:      .word   TCB_A
D 0000100C 0000007F                                     .word   0x7f000000
D 00001010 00000000                                     .word   0x00000000
D 00001014 00000040                                     .word   0x40000000
D 00001018 00200040                                     .word   0x40002000
D 0000101C 00000000                                     .word   0


D 00001020 64100000                                     .word   TCB_B
D 00001024 0000007F                                     .word   0x7f000000
D 00001028 00000000                                     .word   0x00000000
D 0000102C 00000040                                     .word   0x40000000
D 00001030 00200040                                     .word   0x40002000
D 00001034 00000000                                     .word   0
```

Figure 3-1. Sample Program Listing

3-2 Virtual Mode Emulation Topics

```
D 00001038 00E00000                TCB_A:          .word   0x0000e000
D 0000103C                                         .space  8*4
D 0000105C 0920000000000000                        .word   0x00002009,0x00000000

D 00001064 00E00000                TCB_B:          .word   0x0000e000
D 00001068                                         .space  8*4
D 00001088 1120000000000000                        .word   0x00002011,0x00000000


D 00001090                                         .data   "sys_ate" (RW) >0x00002000
D 00002000 0330000000050000        ATE0:           .word   0x00003003,0x00000500

D 00002008 0331000000030000        ATE1_A:         .word   0x00003103,0x00000300
D 00002010 0332000000030000        ATE1_B:         .word   0x00003203,0x00000300

D 00002018                                         .data   "sys_pte" (RW) >0x00003000
D 00003000 050E0000                PTE0:           .word   0x00000e05
D 00003004 051E0000                                .word   0x00001e05
D 00003008 052E0000                                .word   0x00002e05
D 0000300C 053E0000                                .word   0x00003e05
D 00003010 054E0000                                .word   0x00004e05
D 00003014 055E0000                                .word   0x00005e05

D 00003018                                         .org    0x100
D 00003100 056E0000                PTE1_A:         .word   0x00006e05
D 00003104 058E0000                                .word   0x00008e05
D 00003108 05AE0000                                .word   0x0000ae05
D 0000310C 05CE0000                                .word   0x0000ce05

D 00003110                                         .org    0x200
D 00003200 057E0000                PTE1_B:         .word   0x00007e05
D 00003204 059E0000                                .word   0x00009e05
D 00003208 05BE0000                                .word   0x0000be05
D 0000320C 05CE0000                                .word   0x0000ce05

B 00004000                                         .bss    "sys_stk" (RW) >0x00004000
B 00004000                                         .lcomm  Sys_Stack,Stack_Size,4


T 00005000                                         .text   "sys_text" (RX) >0x00005000
T 00005000                                         .align  4

T 00005000 2D3FF400500000          Sys_Init:       mov.w   #Sys_Stack+Stack_Size,sp
T 00005007 1280F400000000E5                        ldpr    #Sys_SBT,#sbr

T 0000500F 1280F401200000F4                        ldpr    #0x2001,#atbr0
           10000000
T 0000501B 1280E0F411000000                        ldpr    #0x00000000,#atlr0
T 00005023 1280E0F412000000                        ldpr    #0,#atbr1
T 0000502B 1280E0F414000000                        ldpr    #0,#atbr2
T 00005033 1280E0F416000000                        ldpr    #0,#atbr3

T 0000503B 1280F471210000E7                        ldpr    #0x2171,#sycw

T 00005043 2D20F2C1BFFFFF          Setup_Task:     mov.w   Num_Of_Task,r0
T 0000504A 2D21F408100000                          mov.w   #TCB_Entry,r1
```

Figure 3-1. Sample Program Listing (Cont'd)

```
T 00005051 0180010461              Setup_Task_0:   ldtask  4[r1],[r1]
T 00005056 2D220110                                mov.w   0x10[r1],r2
T 0000505A 2DA0E0A2                                mov.w   #0,[-r2]
T 0000505E 2DA00108A2                              mov.w   8[r1],[-r2]
T 00005063 2DA0010CA2                              mov.w   12[r1],[-r2]
T 00005068 2D42010004                              mov.w   r2,4[[r1]]
T 0000506D 8421F418000000                          add.w   #0x18,r1
T 00005074 C6A0DDFF                                dbr     r0,Setup_Task_0

T 00005078 0180F294BFFFFFF2                        ldtask  TCB_Entry+4,TCB_Entry
           90BFFFFF
T 00005084 FAE4                                    retis   #4

T 00005086                                         .align  4
T 00005088 2D20F278BFFFFF          Sys_Trap:       mov.w   Current_Task,r0
T 0000508F 2D4062                                  mov.w   r0,r2
T 00005092 8522E6                                  mul.w   #0x6,r2
T 00005095 2D21F408100000                          mov.w   #TCB_Entry,r1
T 0000509C FDC20104                                sttask  4[r1](r2)
T 000050A0 DD60                                    inc.w   r0
T 000050A2 BC00F262BFFFFF                          cmp.w   r0,Num_Of_Task
T 000050A9 6505                                    jnz     Sys_Trap_0
T 000050AB B44060                                  xor.w   r0,r0
T 000050AE 2D00F252BFFFFF          Sys_Trap_0:     mov.w   r0,Current_Task
T 000050B5 8520E6                                  mul.w   #0x6,r0
T 000050B8 01E0C00104C061                          ldtask  4[r1](r0),[r1](r0)
T 000050BF FAE4                                    retis   #4

T 000050C1 00                      Dummy_Text:     halt

T 000050C2                                         .text   "text_a" (RW) >0x00006000
T 00006000 2D3AF420000000          Transfer_A:     mov.w   #' ',r26
T 00006007 2D38F417000000                          mov.w   #Message_A_End-Message_A,r24
T 0000600E 588AF30020004098                        movcfu.b /0x40002000,r24,
                                                            /0x40003000,#Dest_Size
           F30030004020
T 0000601C F8F4A0                                  trap    #0xa0
T 0000601F D6F2E1FFFFFF                            jmp     Transfer_A

T 00006025                                         .text   "text_b" (RW) >0x00007000
T 00007000 2D3AF420000000          Transfer_B:     mov.w   #' ',r26
T 00007007 2D38F413000000                          mov.w   #Message_B_End-Message_B,r24
T 0000700E 588AF30020004098                        movcfu.b /0x40002000,r24,
                                                            /0x40003000,#Dest_Size
           F30030004020
T 0000701C F8F4A0                                  trap    #0xa0
T 0000701F D6F2E1FFFFFF                            jmp     Transfer_B

B 00008000                                         .bss    "stack_a"  (RW) >0x00008000
B 00008000                                         .lcomm  Stack_A,Stack_Size,4

B 00009000                                         .bss    "stack_b"  (RW) >0x00009000
B 00009000                                         .lcomm  Stack_B,Stack_Size,4

D 0000A000                                         .data   "data_a" (RW) >0x0000a000
D 0000A000 5448495320495320        Message_A:      .str    "THIS IS TASK A MESSAGE."
           5441534B2041204D
           4553534147452E
```

Figure 3-1. Sample Program Listing (Cont'd)

3-4 Virtual Mode Emulation Topics

```
D 0000A017                          Message_A_End:
D 0000A017                                        .data   "data_b" (RW) >0x0000b000
D 0000B000 5461736B2042203A         Message_B:    .str    "Task B : Running..."
           2052756E6E696E67
           2E2E2E
D 0000B013                          Message_B_End:
B 0000C000                                        .bss    "dest"  (RW) > 0x0000c000
B 0000C000                                        .lcomm  Message_Dest,Dest_Size,4
```

Figure 3-1. Sample Program Listing (Cont'd)

the Software trap 0 vector. The break-point instruction vector is required for the software breakpoint feature of the emulator. The software trap 0 vector is used for aborting task and transfering execution to the operating system.

Task Context Block

The "sys_tcb" part at address range 00001000H through 00001fffH defines task context block. The operating system manages tasks with this block.

The address labeled **Current_Task** contains a task number which is currently executed. Tasks are numbered from 0. This address initialized to 0 when the program is started. First, the task numbered 0 will be executed.

The address labeled **Num_Of_Task** contains the number of tasks the operating system manages. This program has two tasks, which are alternately executed. So this address contains the value "2".

The address labeled **TCB_Entry** contains task control blocks for each task. Each block consists of pointer and register list of TCB managed under the 70632 processor, and the initial values of registers PSW, PC and SP, and a word of flags.

The address labeled **TCB_A** contains the TCB, managed under the processor, for one of the tasks. This task will be called as "*Task A*" in this example. The task number mentioned above is "0".

The address labeled **TCB_B** contains the TCB for the other task, which will be called as "*Task B*". The task number is "1".

Area Table Entry

The "ate" part at address range 00002000H through 00002fffH defines the 70632 Area Table Entry.

The address labeled **ATE0** contains Area Table Entry (ATE) in Section 0. In this example, Section 0 is a common part between *Task A* and *Task B.* Section 0 has one area.

The address labeled **ATE1_A** and **ATE1_B** contains ATE in Section 1 for each task. Section 1 is independent between *Task A* and *Task B.* **ATE1_A** is for *Task A,* and **ATE1_B** is for *Task B.* Section 1 has one area each other.

Page Table Entry

The "pte" part at address range 00003000H through 00003fffH defines the 70632 Page Table Entry.

The address labeled **PTE0** contains Page Table Entry (PTE) in Section 0, Area 0. This area has six pages.

The addresses labeled **PTE1_A** and **PTE1_B** contains PTE in Section 1, Area 0 for each task. **PTE1_A** is for *Task A,* and **PTE1_B** is for *Task B.* Each area has four pages.

System Stack

The "sys_stk" part at address range 00004000H through 00004fffH defines a stack for the operating system. The stack is pointed by the register ISP.

System Program Code

The "sys_text" part at address range 00005000H through 00005fffH defines program codes for the operating system.

The program instructions from the **Sys_Init** label to the **Setup_Task** perform initialization of the operating system. The privilege registers are set up and the processor address mode is switched to virtual mode.

The instructions from the **Setup_task** to **Start_Ini_Task** perform initialization for the tasks. The stack for each task is set up with initial PC and PSW.

The instructions from **Start_Ini_Task** transfer the execution to initial task (*Task A*).

The instructions from **Sys_Trap** perform switching task. When a task aborts the execution, the processor executes from the address labeled **Sys_Trap**. The instructions store the task execution environment of the aborted task to corresponding TCB, update the **Current_Task** to the another task number to be switched, load the TCB, and switch the execution.

Task A Program Code

The "text_a" part defines program codes of *Task A*. This part located at 00006000H through 00006fffH of actual memory address. However, when *Task A* is running, this part is executed as it is located at 40000000H through 40000fffH by using the on-chip MMU.

Task A transfers a message of character string data from the address labeled **Message_A** to the address labeled **Message_Dest**. After the transfer, the processor executes trap instruction. The trap instruction causes the execution aborting into the operating system. At this time, the execution of *Task A* is stopped until next dispatch by the operating system.

Task B Program Code

The "text_b" part defines program codes of *Task B*. This part is at 00007000H through 00007fffH of actual memory address. Under the *Task B* virtual space, this part is executed as it is at 40000000H through 40000fffH as same as *Task A*.

Task B does same as *Task A* except for the message data, which is located at address labeled **Message_B**.

Task A Data

The "data_a" part defines the message transferred by *Task A*.

This part located at 0000a000H through 0000afffH of actual memory address. Under the *Task A* virtual space, location of this part is recognized as 40002000H through 40002fffH.

Task B Data

The "data_b" part defines the message transferred by *Task B*.

This part located at 0000b000H through 0000bfffH of actual memory address. Under the *Task B* virtual space, location of this part is recognized as 40002000H through 40002fffH as same as *Task A*.

Task A Stack

The "stack_a" part at 00008000H through 00008fffH of actual memory address defines stack of *Task A*. The location of the *Task A* virtual space is at 40001000H through 40001fffH.

Task B Stack

The "stack_b" part at 00009000H through 00009fffH of actual memory address defines stack of *Task B*. The location of the *Task B* virtual space is at 40001000H through 40001fffH as same as *Task A*.

Common Destination Area

The "common" part defines common destination of message from both *Task A* and *Task B* tasks.

This part is located at 0000c000H through 0000cfffH of actual memory address. Both locations of the *Task A* and *Task B* virtual space are at the same address range 40003000H through 40003fffH.

Multiple Virtual Space of the Sample Program

The sample program is a multi-tasking program. There are two tasks and each task has an independent virtual space.

Figure 3-2 shows the virtual spaces of each task. Section 0 which contains the operating system resources is 1:1 mapping at the same address between real address and virtual address. The mapping of

section 1 is different between each virtual space, for *Task A* and *Task B*, except for the destination area.

Figure 3-3 shows the detail of the operating system locations.

Figure 3-4 shows the detail of the virtual space of each task in Section 1.

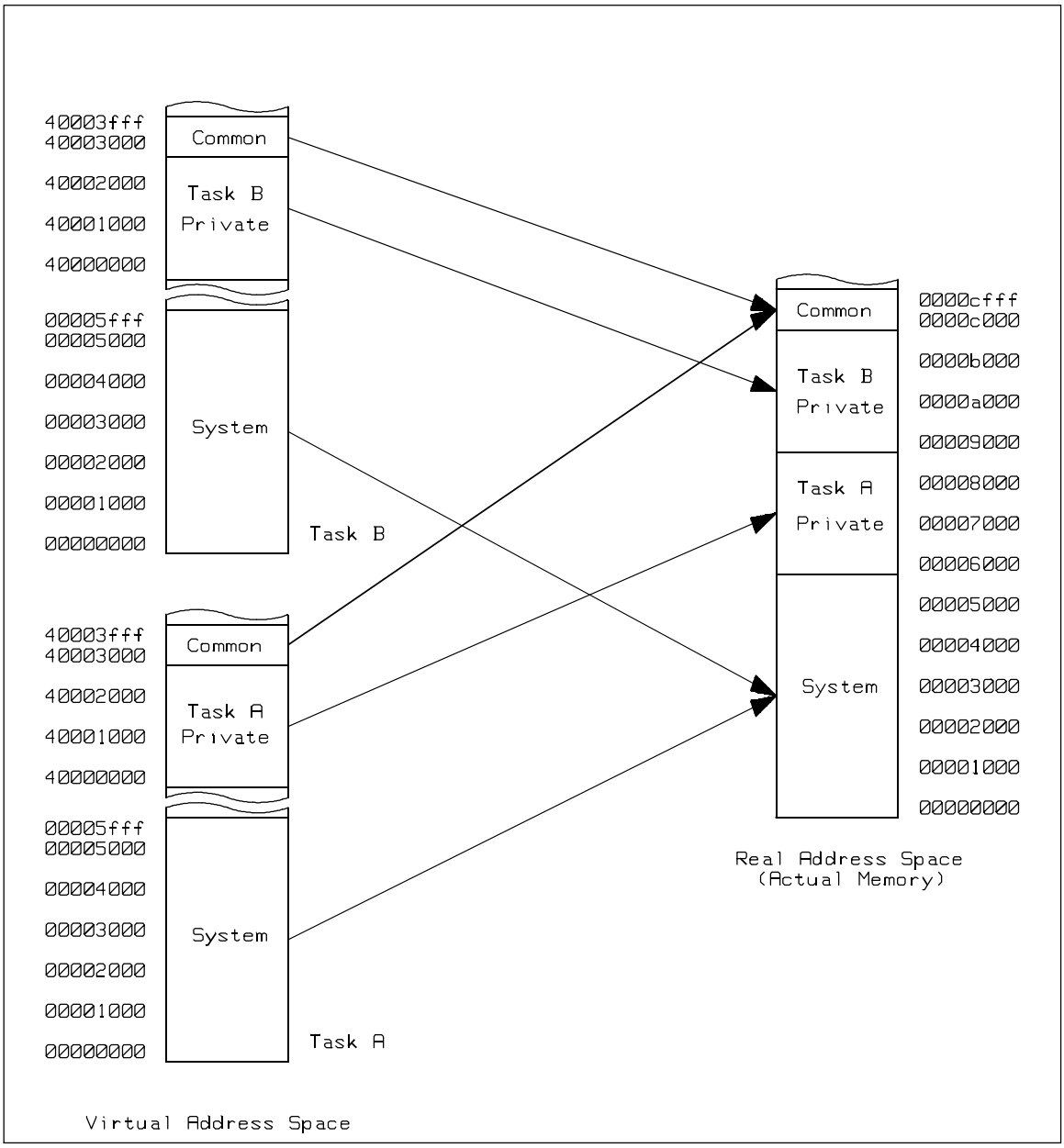


Figure 3-2. Virtual Address Space for Sample Program

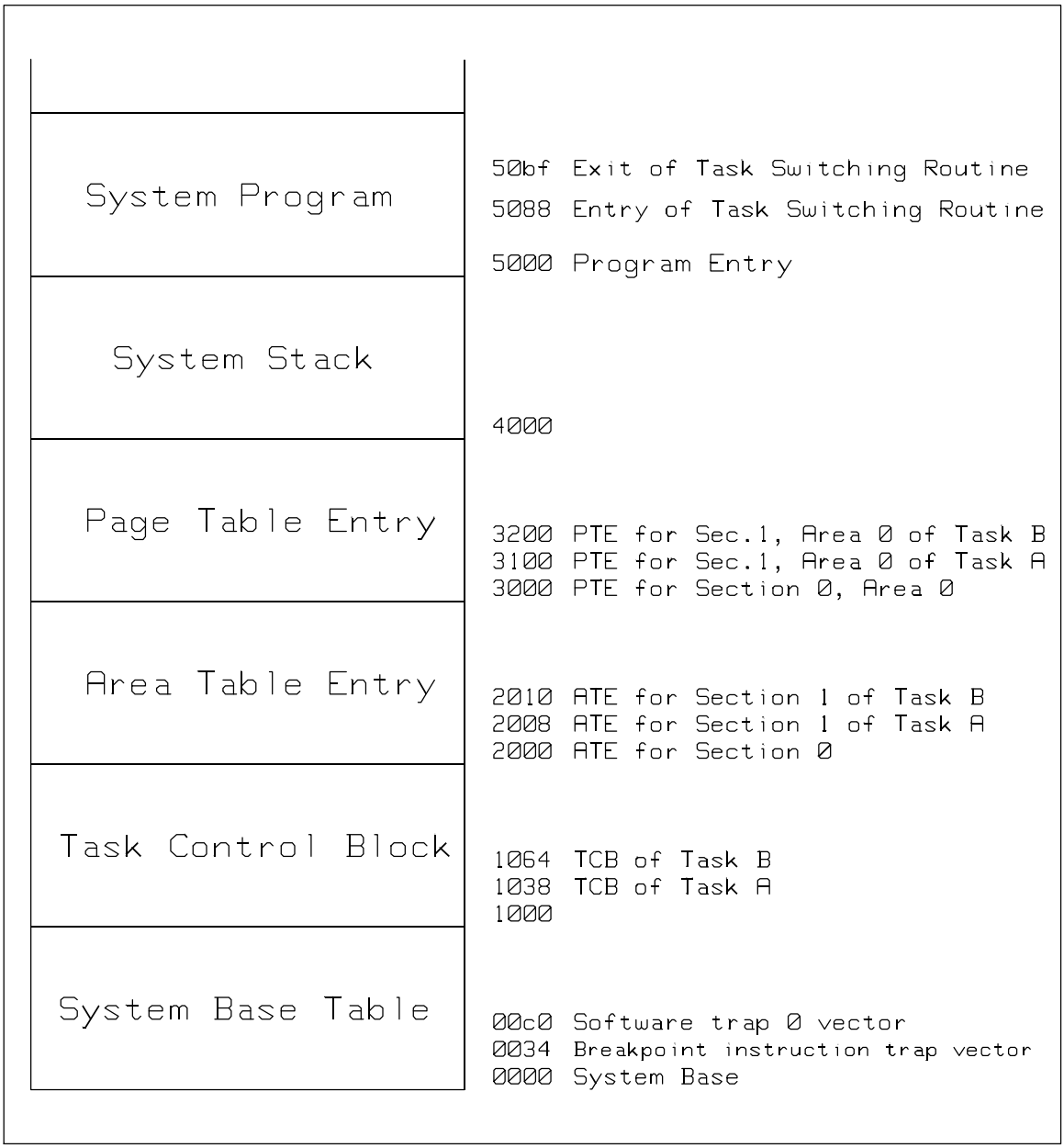


Figure 3-3. Mapping of the Sample Operating System

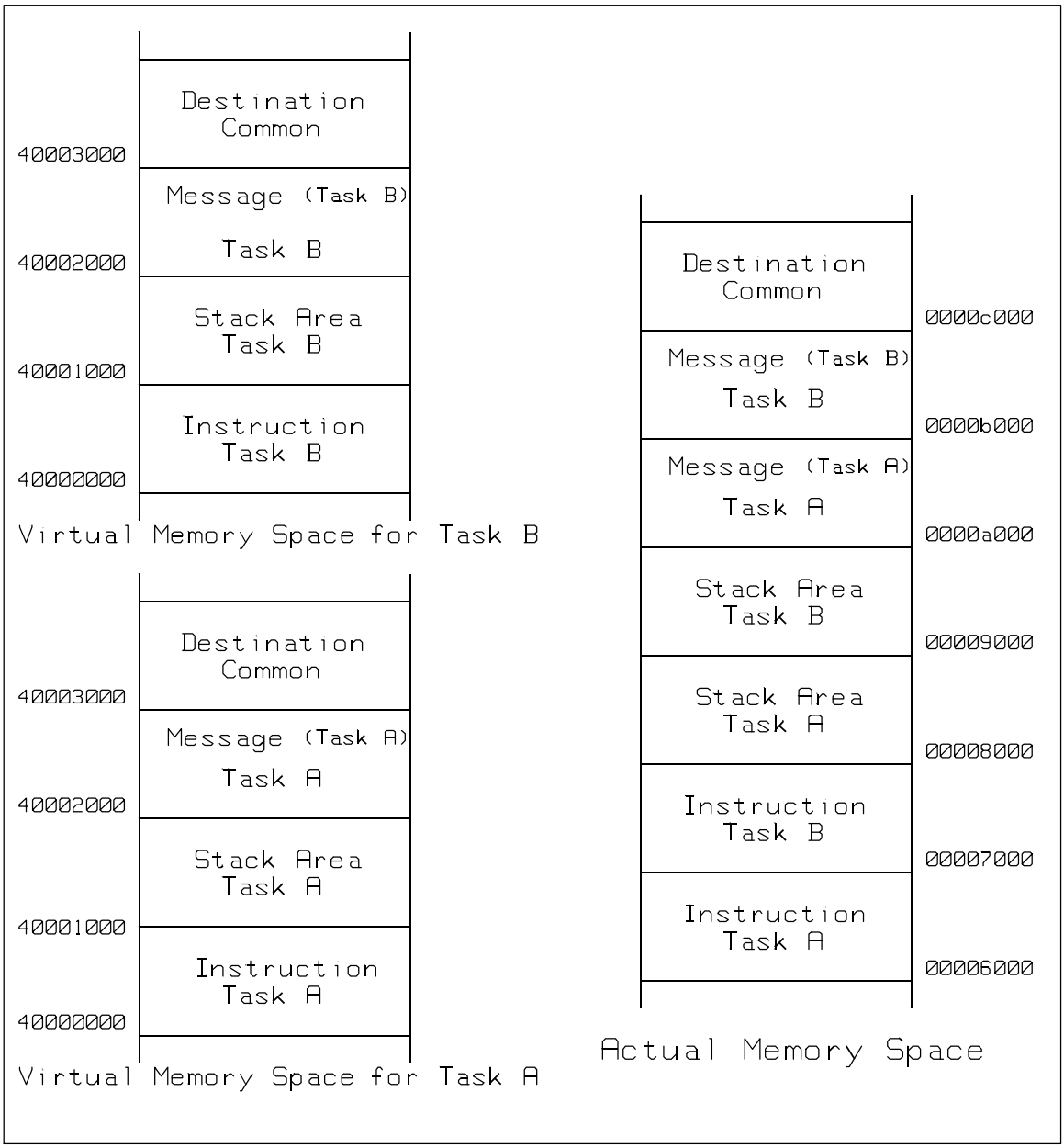


Figure 3-4. Mapping of the Tasks

Sample Program Flow

Figure 3-5 shows the flow of the sample program.

1. The initialization of the operating system is executed, and the execution is switched to *Task A*.

2. *Task A* reads the characters from address **Message_A** and writes to address **Message_Dest**.

3. When the trap instruction of *Task A* is executed, the execution of *Task A* is stopped, and the task dispatcher of the operating system stores environment of *Task A* and loads the *Task B*'s one.

4. The execution of the operating system is exited, then the execution is switched to *Task B*. *Task B* reads the characters from address **Message_B** and writes to address **Message_Dest**.

5. After the transfer, the execution is returned to the operating system by the trap instruction of *Task B.*

6. *Task A* is executed via the operating system again. The next instruction which has made abort to the operating system restarts the execution from address **Transfer_A**. The transfer of the *Task A* message is executed again.

The procedures numbered from 2 to 6 are repeated infinitely. As a result, the address **Message_Dest** is written the messages of *Task A* and *Task B* alternately, because the address **Message_Dest** is same actual memory.

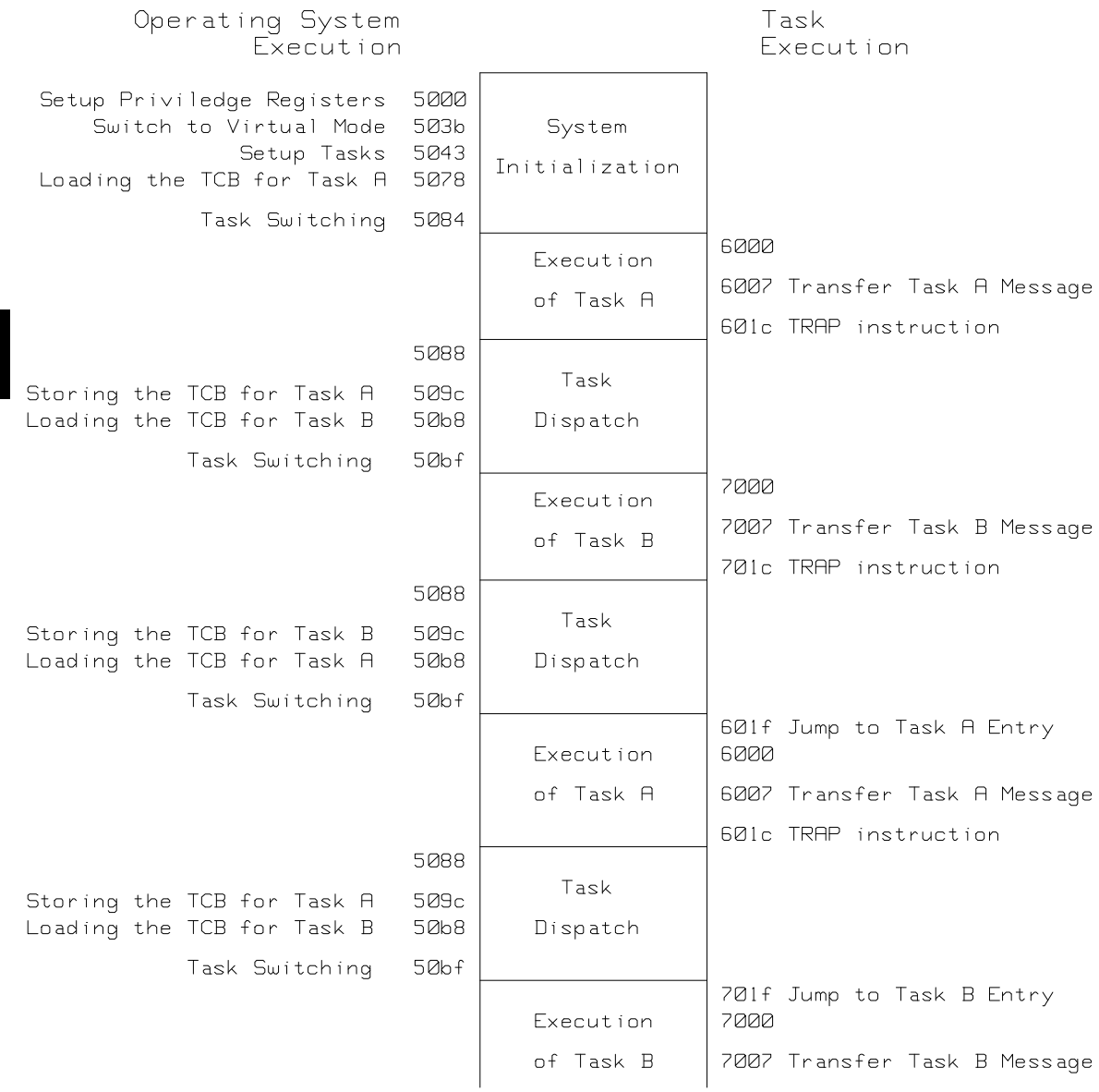


Figure 3-5. The Execution Flows of the Sample Program

Setting Up the Emulator

To set up the emulator, the **demo** command is provided for this example. The **demo** command performs the following tasks.

- Limited initialization of the emulator.
- Mapping memory for this example.
- Loading the sample program into the emulator.

Enter the following command.

```
R>demo 2
```

Using The Emulator In Virtual Mode

This section shows a example usage of the emulator in virtual mode.

Address Mode suffixes

When you issue a command, the emulator displays the result of the command. According to circumstance, the resulting display includes address information such as "00004000@r" or "00008000@v".

The suffix "@r" indicates that the address is displayed in real address space. The suffix "@v" indicates that the address is displayed in virtual address space. When the emulator displays an address information, the address space mode will be different as the case may be.

Specifying An Address Mode

When you designate addresses, you can select either real or virtual address by adding a suffix with a few exceptions such as **map** and **cov** commands. These exceptions are shown in "ADDRESS" section in the "70632 Emulator Specific Command Syntax" appendixa. The following suffixes are allowed.

- "@r" real address
- "@v" virtual address

You can also designate addresses with no suffix. In this case, the address mode, which is required to evaluate the addresses, is determined as follows.

1. When the processor is reset, the addresses are evaluated as real address.
2. When the processor never runs in virtual mode after reset, the addresses are evaluated as real address.
3. Once the processor has run in virtual mode after reset, the addresses are evaluated as virtual address.

Note

If the processor has ever run in virtual mode since the processor was reset, the address expression without suffix is evaluated as virtual address, even if the processor is running in real mode.

If you specify a virtual address in a command, the emulator has to translate the virtual address, which you have specified,to the real address. The method of the address translation is same as the actual 70632 microprocessor. In this case, the emulator use the current value of the 70632 address table register pairs, ATBR0, ATLR0, ATBR1 ...., to translate the address by default. The details of the address translation are shown in chapter 4.

Setting Breakpoints in Real Address

First, set the software breakpoints at the entry of both tasks. The real address of *Task A* entry is 00006000H, and *Task B* is 00007000H. Enter the following commands.

```
R>bc -e bp
R>bp 6000
R>bp 7000
```

The address expressions used in the above commands have no suffix. The emulator recognized the address as real because the processor is reset. You could also enter the addresses using the "@r" suffixes such as "6000@r" and "7000@r".

To confirm the breakpoints set, type:

```
R>bp
```

```
### BREAKPOINT FEATURE IS ENABLED ###
bp 000006000@r #enabled
bp 000007000@r #enabled
```

Running the Sample Program

Start the program from address 00005000H by typing the following command.

```
R>r 5000
```

```
!ASYNC_STAT  615! Software breakpoint: 040000000@v
M>
```

You will see the execution has stopped at virtual address 40000000H which is one of the breakpoints you set. Because the processor ran in virtual mode, the address which caused breaking into monitor was displayed in virtual address.

Displaying the CPU Address Mode

You can confirm the CPU is in virtual mode, type:

```
M>reg sycw
```

```
reg sycw=00002171
```

You can find the bit 0 of SYCW register is set. This bit indicates the CPU is in virtual mode.

Which Breakpoint Has Hit ?

You will be unable to find which breakpoint has been hit in this information because the virtual address 40000000H corresponds to both real addresses 00006000H and 00007000H.

To show the breakpoint status, type:

```
M>bp
```

```
### BREAKPOINT FEATURE IS ENABLED ###
bp 000006000@r #disabled
bp 000007000@r #enabled
```

Now, you can find the breakpoint is the real address 00006000H because it is disabled. The address is the entry of the program *Task A*.

Displaying MMU Registers

To display the on-chip MMU registers, enter:

```
M>reg mmu
```

```
reg  atbr0=00002001  atlr0=00000000  atbr1=00002009  atlr1=00000000
reg  atbr2=00000000  atlr2=00000000  atbr3=00000000  atlr3=00000000
```

You will verify the CPU is in *Task A* address space from the value of atbr1 displayed.

Displaying Address Translation Tables

You can display the 70632 Area Table Entry (ATE). To display the ATE corresponding with address 40000000, enter:

```
M>ate 40000000
```

```
1:000 at 000002008  Present
      PTB=000003100  Limit=003  Growth=positive
      Execute level=0  Write level=0  Read level=0
```

You can also display the 70632 Page Table Entry (PTE). To display the PTE corresponding with address 40000000, enter:

```
M>pte 40000000
```

```
1:000:000 at 000003100  Present
          Page base=000006000  Executable  Writable  Readable
          Not modified  Accessed  User=0  Not locked
```

The display shows the page base address is 00006000H. The addition of this base address and the offset of virtual address "000H" is 00006000H. The address is the real address corresponding with the virtual address 40000000H

You could also use section, area and page number with **-i** option instead of address.

To display the ATE of Section 1, Area 0, enter:

```
M>ate -i 1:0
```

To display the PTE of Section 1, Area 0, Page 0, enter:

```
M>pte -i 1:0:0
```

Continuing the Execution

To continue the execution, enter:

```
M>r
!ASYNC_STAT  615! Software breakpoint: 040000000@v
```

The breakpoint hits at the virtual address 40000000H again. The real address should be 00007000H. To show the breakpoint status, type:

```
M>bp
```

You can find the breakpoint of the real address 00007000H is disabled. The address is the entry of program *Task B.*

To display the on-chip MMU registers, the ATE and PTE corresponding with address 40000000H, enter:

```
M>reg mmu
  reg  atbr0=00002001  atlr0=00000000  atbr1=00002011  atlr1=00000000
  reg  atbr2=00000000  atlr2=00000000  atbr3=00000000  atlr3=00000000
```

```
M>ate 40000000
1:000 at 000002010  Present
      PTB=000003200  Limit=003  Growth=positive
      Execute level=0  Write level=0  Read level=0
```

```
M>pte 40000000
1:000:000 at 000003200  Present
          Page base=000007000  Executable  Writable  Readable
          Not modified  Accessed  User=0  Not locked
```

A few differences can be found from the results of the commands in *Task A* virtual space which you entered. This is the another virtual space for *Task B.*

Let's look at the execution of *Task B.*

The Program Counter (PC) points to the entry of *Task B. Task B* will transfer its message to the destination area.

To display the destination area, enter:

```
M>m -db 40003000..4000301f
  040003000@v  54 48 49 53 20 49 53 20 54 41 53 4b 20 41 20 4d
  040003010@v  45 53 53 41 47 45 2e 20 20 20 20 20 20 20 20 20
```

The message of *Task A* remains here.

Step the three instructions by typing:

```
M>s 3
040000000@v  -                MOV.W      #00000020H,R26
040000007@v  -                MOV.W      #00000013H,R24
04000000e@v  -                MOVCFU.B   /40002000H,R24,/40003000H,#
PC = 04000001c@v
```

To display the destination area once again. Type:

```
M>m -db 40003000..4000301f
040003000@v  54 61 73 6b 20 42 20 3a 20 52 75 6e 6e 69 6e 67
040003010@v  2e 2e 2e 20 20 20 20 20 20 20 20 20 20 20 20 20
```

You will find the message of *Task B* is transferred.

Enabling Breakpoints in Virtual Address

You can enable or disable the software breakpoints, which was set with real addresses, by using virtual addresses. Enter the following command.

```
M>bp -e 40000000
```

To display the breakpoint enabled, enter:

```
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
bp 000006000@r #disabled
bp 000007000@r #enabled
```

As the virtual address 40000000H in the current virtual space corresponds to the real address 00007000H, the 7000@r is enabled.

To enable or disable the breakpoint with real address, add the suffix "@r". Enter:

```
M>bp -e 6000@r
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
bp 000006000@r #enabled
bp 000007000@r #enabled
```

Setting Breakpoints in Virtual Address

Remove the all breakpoints, enter:

```
M>bp -r *
```

Verify that the all breakpoints are removed by typing:

```
M>bp
### BREAKPOINT FEATURE IS ENABLED ###
```

Set the breakpoint at the address 40000000@v, and verify it.

Enter:

```
M>bp 40000000
M>bp
  ### BREAKPOINT FEATURE IS ENABLED ###
  bp 040000000@v #enabled
```

Run the program from current PC, enter:

```
M>r
!ASYNC_STAT  615! Software breakpoint: 040000000@v
```

The emulator displays that the breakpoint hit.

To display the MMU registers to examine the address space.

```
M>reg mmu
  reg  atbr0=00002001  atlr0=00000000  atbr1=00002011  atlr1=00000000
  reg  atbr2=00000000  atlr2=00000000  atbr3=00000000  atlr3=00000000
```

The address space is for *Task B.* No break occurs at the address 40000000@v at *Task A.* You should note this when dealing breakpoints with virtual address.

Display Privilege registers

The 70632 microprocessor has several privilege registers which can be accessed only if the execution level is "0". The level is known as the privilege level. You can display the privilege registers by typing:

```
M>reg priv
  reg  isp=00005000 l0sp=40002000 l1sp=00000000 l2sp=00000000 l3sp=00000000
  reg  sbr=00000000   tr=00001064 sycw=00002171 tkcw=0000e000  pir=00007006
  reg psw2=0000f002
```

The current values of the privilege registers are displayed.

Displaying TCB

You can display the register SYCW and stack pointers of each level in current TCB. Type:

```
M>tcb
  tkcw ATT=7 OTM=0 FIT=0 FZT=0 FVT=0 FUT=0 FPT=0 RDI=0 RD=0
  l0sp=40001ff4
```

You must designate the register list to display the complete TCB contents of current task with **-l** option. The register list specifies registers to be stored to or loaded from TCB when the task is switched. The format of the register list is same as the 70632 processor's LDTASK or STTASK instruction operand. Since the register list of current task is 7f000000H, enter:

```
M>tcb -l 7f000000
tkcw ATT=7 OTM=0 FIT=0 FZT=0 FVT=0 FUT=0 FPT=0 RDI=0 RD=0
l0sp=40001ff4
r24=00000013  r25=00000000  r26=00000020  r27=40003020  r28=40002013
r29=00000000  r30=00000000
atrp1 ATB=000002010  Limit=000  Growth=positive  Valid
```

To display the TCB which is not current, specify the base address of the TCB. Enter:

```
M>tcb -l 7f000000 1038
tkcw ATT=7 OTM=0 FIT=0 FZT=0 FVT=0 FUT=0 FPT=0 RDI=0 RD=0
l0sp=40001ff4
r24=00000017  r25=00000000  r26=00000020  r27=40003020  r28=40002017
r29=00000000  r30=00000000
atrp1 ATB=000002008  Limit=000  Growth=positive  Valid
```

Using the XMMU Function

As described in the previous section, the emulator uses the current value of the 70632 address table register pairs by default when you specify an address in virtual address in a command.

Suppose that you would like to debug a certain task executed in multiple virtual space without stopping the execution. You will be unable to specify the virtual address in desired virtual space, because the address space is dynamically changed.

The XMMU function provides you to specify a desired virtual address space. Regardless of the current virtual space, you can specify the address space you want to note to. The emulator has the optional XMMU class registers. These registers consist of eight XMMU register pairs and one XMMU mode register. The XMMU register pairs correspond to the actual 70632 area table register pairs. You can specify a virtual address space by modifying the XMMU class registers. These registers are not actual registers of the 70632 processor.

When you set the contents of the XMMU class registers and activate the XMMU function, the XMMU class registers are used for the address translation of the virtual address you specify in a command, instead of the actual area table register pairs of the 70632 microprocessor.

The XMMU class registers consist of the following registers.

XMMU class registers	corresponded actual registers
xatbr0	atbr0
xatlr0	atlr0
xatbr1	atbr1
xatlr1	atlr1
xatbr2	atbr2
xatlr2	atlr2
xatbr3	atbr3
xatlr3	atlr3
mmumod	--None--

If you set the value of the **mmumod** register in the above table to "1", the emulator translates the virtual address in a command line with the contents of the XMMU class registers instead of the actual area table register pairs. Oppositely, if you want to make the emulator to translate the virtual address in a command line with the actual table register pairs, in other words the virtual address in the current address space, reset the value of the **mmumod** register to "0".

Displaying the XMMU Class Registers

Assuming that you want to note to the current task, *Task B*. Display the XMMU class registers by typing:

```
M>reg xmmu
reg  mmumod=00000000
reg  xatbr0=00000000  xatlr0=00000000  xatbr1=00000000  xatlr1=00000000
reg  xatbr2=00000000  xatlr2=00000000  xatbr3=00000000  xatlr3=00000000
```

Also display the MMU registers to refer the value of area table register pairs for the current task.

```
M>reg mmu
reg  atbr0=00002001  atlr0=00000000  atbr1=00002011  atlr1=00000000
reg  atbr2=00000000  atlr2=00000000  atbr3=00000000  atlr3=00000000
```

Modifying the XMMU Class Registers

Modify the XMMU class registers to the current area table register pairs by typing:

```
M>reg xatbr0=2001
M>reg xatbr1=2011
```

There is another way to modify the XMMU class registers, as far as you want to modify the registers to the value of the current area table register pairs by using the "**cpmmu**" command.

In the above case, you didn't have to type the **reg** command two times because of modifying the registers for the current task. You could type the only one command as follows.

```
M>cpmmu
```

To confirm the XMMU class registers modified, enter:

```
M>reg xmmu
```

```
reg  mmumod=00000000
reg  xatbr0=00002001  xatlr0=00000000  xatbr1=00002011  xatlr1=00000000
reg  xatbr2=00000000  xatlr2=00000000  xatbr3=00000000  xatlr3=00000000
```

To make the emulator use the configured address space when you enter a virtual address, enter:

```
M>reg mmumod=1
```

Restart the program from the current PC which is the address the emulator has been broken.

```
M>r
U>
```

Display the memory at the **Message_B** with the virtual address 40002000H.

```
U>m -db 40002000..4000201f
```

You should see:

```
040002000@v  54 61 73 6b 20 42 20 3a 20 52 75 6e 6e 69 6e 67
040002010@v  2e 2e 2e 00 9f eb b5 5f 54 5c 60 41 55 55 15 5c
```

Display the translation tables at the virtual address 40000000H by typing:

```
U>ate 40000000
```

```
1:000 at 000002010  Present
      PTB=000003200  Limit=003  Growth=positive
      Execute level=0  Write level=0  Read level=0
```

```
U>pte 40000000
```

```
1:000:000 at 000003200  Present
          Page base=000007000  Executable  Writable  Readable
          Not modified  Accessed  User=0  Not locked
```

The contents of the tables displayed should be the execution environment of *Task B*.

The XMMU function also allows you to specify breakpoints with virtual addresses in a desired address space by using the XMMU function, even though the processor is executed in the other virtual address space.

Besides by using the **reg** command, the **mmumod** register is reset when the emulator breaks into monitor in the following causes.

- Break by software breakpoint
- Break by single-stepping
- Break by writing to ROM
- Break by access to guarded memory

In these case, the **mmumod** register is reset to "0". As the result, the address translation of the virtual address in a command uses the actual area table register pairs.

Using the Analyzer

Regardless of address mode, addresses which the analyzer captures are real addresses by default. You can select which address the analyzer should capture by changing the configuration item "**cf tra**". If you want to make the analyzer capture the virtual address, enter:

```
U>cf tra=vir
```

Or, if you want to make the analyzer capture the real address, enter:

```
U>cf tra=real
```

Before setting a trace specifications, initialize the any trace specifications you had changed.

```
U>tinit
```

To trace from the real address 00006000H which is the entry of *Task A,* enter:

```
U>cf tra=real
U>tg addr=6000
U>t
Emulation trace started
```

To display the trace list, type:

```
U>tl 0..24
```

```
 Line   addr,H    data,H    uPD70632 Mnemonic,H                          count,R
-----   --------  --------  ---------------------------------------  ---------
    0   00006000  20f43a2d              fetch aft br                 *********
    1   0000601f  2d000000   No fetch cycle found                     *********
    2   00006004  2d000000                fetch                      *********
    3   00006008  0017f438                fetch                      *********
    4   0000600c  8a580000                fetch                      *********
    5   00006000  8a580000   MOV.W     #00000020H,R26                *********
    6   00006010  002000f3                fetch                      *********
    7   00006014  00f39840                fetch                      *********
    8   00006007  20400030   MOV.W     #00000017H,R24                *********
    9   00006018  20400030                fetch                      *********
   10   0000601c  d6a0f4f8                fetch                      *********
   11   00006020  ffffe1f2                fetch                      *********
   12   00006024  000000ff                fetch                      *********
   13   00006028  777e5558                fetch                      *********
   14   00002008  00003103     00003103H trans table  read           *********
   15   0000200c  00000300     00000300H trans table  read           *********
   16   00003108  0000ae85     0000ae85H trans table  read           *********
   17   00002008  00003103     00003103H trans table  read           *********
   18   0000200c  00000300     00000300H trans table  read           *********
   19   0000310c  0000cf85     0000cf85H trans table  read           *********
   20             0000cf85   MOVCFU.B  /40002000H,R24,/40003000H,    *********
        0000600e                        #20H
   21   0000a000  ffffff54      ......54H data  read                 *********
   22   0000a001  ffff48ff      ....48..H data  read                 *********
   23   0000c000  00000054      ......54H data  write                *********
   24   0000a002  ff49ffff      ..49....H data  read                 *********
```

The trace list shows the execution from the read address 00006000H.

To trace from the virtual address 40000000H which is the entry of both *Task A* and *Task B*, enter:

```
U>cf tra=vir
U>tg addr=40000000
U>t
```

The trace list will be stored from whether the entry of *Task A* or *Task B*.

View the trace list by typing:

```
U>tl 0..24
```

You will see:

```
 Line   addr,H    data,H    uPD70632 Mnemonic,H                        count,R
-----   --------  --------  -----------------------------------------  ---------
    0   40000000  20f43a2d              fetch aft br                  *********
    1   4000001f  2d000000   No fetch cycle found                      *********
    2   40000004  2d000000              fetch                         *********
    3   40000008  0013f438              fetch                         *********
    4   4000000c  8a580000              fetch                         *********
    5   40000000  8a580000   MOV.W     #00000020H,R26                 *********
    6   40000010  002000f3              fetch                         *********
    7   40000014  00f39840              fetch                         *********
    8   40000007  20400030   MOV.W     #00000013H,R24                 *********
    9   40000018  20400030              fetch                         *********
   10   4000001c  d6a0f4f8              fetch                         *********
   11   40000020  ffffe1f2              fetch                         *********
   12   40000024  000000ff              fetch                         *********
   13   40000028  5750875d              fetch                         *********
   14   00002010  00003203     00003203H trans table  read            *********
   15   00002014  00000300     00000300H trans table  read            *********
   16   00003208  0000be85     0000be85H trans table  read            *********
   17   00002010  00003203     00003203H trans table  read            *********
   18   00002014  00000300     00000300H trans table  read            *********
   19   0000320c  0000cf85     0000cf85H trans table  read            *********
   20             0000cf85   MOVCFU.B  /40002000H,R24,/40003000H,     *********
        4000000e                        #20H
   21   40002000  ffffff54     ......54H data  read                   *********
   22   40002001  ffff61ff     ....61..H data  read                   *********
   23   40003000  00000054     ......54H data  write                  *********
   24   40002002  ff73ffff     ..73....H data  read                   *********
```

Or:

```
 Line   addr,H    data,H    uPD70632 Mnemonic,H                        count,R
-----   --------  --------  -----------------------------------------  ---------
    0   40000000  20f43a2d              fetch aft br                  *********
    1   4000001f  2d000000   No fetch cycle found                      *********
    2   40000004  2d000000              fetch                         *********
    3   40000008  0017f438              fetch                         *********
    4   4000000c  8a580000              fetch                         *********
    5   40000000  8a580000   MOV.W     #00000020H,R26                 *********
    6   40000010  002000f3              fetch                         *********
    7   40000014  00f39840              fetch                         *********
    8   40000007  20400030   MOV.W     #00000017H,R24                 *********
    9   40000018  20400030              fetch                         *********
   10   4000001c  d6a0f4f8              fetch                         *********
   11   40000020  ffffe1f2              fetch                         *********
   12   40000024  000000ff              fetch                         *********
   13   40000028  777e5558              fetch                         *********
   14   00002008  00003103     00003103H trans table  read            *********
   15   0000200c  00000300     00000300H trans table  read            *********
   16   00003108  0000ae85     0000ae85H trans table  read            *********
   17   00002008  00003103     00003103H trans table  read            *********
   18   0000200c  00000300     00000300H trans table  read            *********
   19   0000310c  0000cf85     0000cf85H trans table  read            *********
   20             0000cf85   MOVCFU.B  /40002000H,R24,/40003000H,     *********
        4000000e                        #20H
   21   40002000  ffffff54     ......54H data  read                   *********
   22   40002001  ffff48ff     ....48..H data  read                   *********
   23   40003000  00000054     ......54H data  write                  *********
   24   40002002  ff49ffff     ..49....H data  read                   *********
```

Note

In a analyzer command, you can not specify a address with a address mode suffix such as "@r" or "@v". Additionally, the XMMU class registers do not effect. You should configure which address mode the analyzer should capture and you will specify in with "**cf tra**" command, before starting trace.

The sample program transfers the character string data. Suppose that you would like to trace the character translation by *Task A*.

Change the data format of the trace display so that you will see the output message writes displayed in ASCII format:

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

To specify the analyzer trace address mode to real.

```
U>cf tra=real
```

To set the trigger point at the entry address of *Task A*, 00006000H.

```
U>tg addr=6000
```

To store only the accesses to the addresses which are stored message of *Task A*, range 0000a000H through 0000a01fH.

```
U>tsto addr=0a000..0a01f
```

Start the trace by typing:

```
U>t
```

You will see:

```
Emulation trace started
```

To view the trace listing, enter:

```
U>tl 0..24
```

```
 Line  addr,H    data,A    count,R  seq
-----  --------  ------  ---------  ---
    0  00006000  ..:-    *********   +
    1  0000a000  ...T    *********   .
    2  0000a001  ..H.    *********   .
    3  0000a002  .I..    *********   .
    4  0000a003  S...    *********   .
    5  0000a004  ....    *********   .
    6  0000a005  ..I.    *********   .
    7  0000a006  .S..    *********   .
    8  0000a007  ....    *********   .
    9  0000a008  ...T    *********   .
   10  0000a009  ..A.    *********   .
   11  0000a00a  .S..    *********   .
   12  0000a00b  K...    *********   .
   13  0000a00c  ....    *********   .
   14  0000a00d  ..A.    *********   .
   15  0000a00e  ....    *********   .
   16  0000a00f  M...    *********   .
   17  0000a010  ...E    *********   .
   18  0000a011  ..S.    *********   .
   19  0000a012  .S..    *********   .
   20  0000a013  A...    *********   .
   21  0000a014  ...G    *********   .
   22  0000a015  ..E.    *********   .
   23  0000a016  ....    *********   .
   24  0000a017  ....    *********   .
```

The trace listing shows that the processor reads characters to transfer the message of *Task A*.

To view the continuation of the trace listing, type:

```
U>tl
```

```
 Line  addr,H    data,A    count,R  seq
-----  --------  ------  ---------  ---
   25  0000a000  ...T    *********   .
   26  0000a001  ..H.    *********   .
   27  0000a002  .I..    *********   .
   28  0000a003  S...    *********   .
   29  0000a004  ....    *********   .
   30  0000a005  ..I.    *********   .
   31  0000a006  .S..    *********   .
   32  0000a007  ....    *********   .
   33  0000a008  ...T    *********   .
   34  0000a009  ..A.    *********   .
   35  0000a00a  .S..    *********   .
   36  0000a00b  K...    *********   .
   37  0000a00c  ....    *********   .
   38  0000a00d  ..A.    *********   .
   39  0000a00e  ....    *********   .
   40  0000a00f  M...    *********   .
   41  0000a010  ...E    *********   .
   42  0000a011  ..S.    *********   .
   43  0000a012  .S..    *********   .
   44  0000a013  A...    *********   .
   45  0000a014  ...G    *********   .
   46  0000a015  ..E.    *********   .
   47  0000a016  ....    *********   .
   48  0000a017  ....    *********   .
   49  0000a000  ...T    *********   .
```

You will find the transfer of the *Task A* message is done continuously.

Contrary, specify the address in virtual address.

```
U>cf tra=vir
```

To set the trigger point at 40000000H

```
U>tg addr=40000000
```

To store only the accesses to the address range 40002000H through 4000201fH.

```
U>tsto addr=40002000..4000201f
```

Start the trace by typing:

```
U>t
```

You will see:

```
Emulation trace started
```

To view the trace listing, enter:

```
U>tl
```

```
 Line  addr,H    data,A    count,R  seq
-----  --------  ------  ---------  ---
    0  40000000  ..:-    *********   +
    1  40002000  ...T    *********   .
    2  40002001  ..H.    *********   .
    3  40002002  .I..    *********   .
    4  40002003  S...    *********   .
    5  40002004  ....    *********   .
    6  40002005  ..I.    *********   .
    7  40002006  .S..    *********   .
    8  40002007  ....    *********   .
    9  40002008  ...T    *********   .
   10  40002009  ..A.    *********   .
   11  4000200a  .S..    *********   .
   12  4000200b  K...    *********   .
   13  4000200c  ....    *********   .
   14  4000200d  ..A.    *********   .
   15  4000200e  ....    *********   .
   16  4000200f  M...    *********   .
   17  40002010  ...E    *********   .
   18  40002011  ..S.    *********   .
   19  40002012  .S..    *********   .
   20  40002013  A...    *********   .
   21  40002014  ...G    *********   .
   22  40002015  ..E.    *********   .
   23  40002016  ....    *********   .
   24  40002017  ....    *********   .
```

To view the continuation of the trace listing, type:

```
U>tl
 Line  addr,H    data,A    count,R  seq
-----  --------  ------  ---------  ---
   25  40002000  ...T    *********   .
   26  40002001  ..a.    *********   .
   27  40002002  .s..    *********   .
   28  40002003  k...    *********   .
   29  40002004  ....    *********   .
   30  40002005  ..B.    *********   .
   31  40002006  ....    *********   .
   32  40002007  :...    *********   .
   33  40002008  ....    *********   .
   34  40002009  ..R.    *********   .
   35  4000200a  .u..    *********   .
   36  4000200b  n...    *********   .
   37  4000200c  ...n    *********   .
   38  4000200d  ..i.    *********   .
   39  4000200e  .n..    *********   .
   40  4000200f  g...    *********   .
   41  40002010  ....    *********   .
   42  40002011  ....    *********   .
   43  40002012  ....    *********   .
   44  40002013  ....    *********   .
   45  40002000  ...T    *********   .
   46  40002001  ..H.    *********   .
   47  40002002  .I..    *********   .
   48  40002003  S...    *********   .
   49  40002004  ....    *********   .
```

Because the locations of both *Task A* and *Task B* messages are the same address in virtual, the message which is stored in the beginning of the trace listing may be of *Task B*.

Anyway, you will find the messages of *Task A* and *Task B* are alternately read from the same address range 40002000H through 4000201fH.

Notes

4

Using The Emulator

Introduction

Many of the important topics described in this chapter involve the commands or features which relate to using the emulator. The "Getting Started" and "Virtual Mode Emulation Topics" chapters shows you how to use the basic features of the 70632 emulator. This chapter describes more information or notices of the 70632 emulator.

This chapter contains the following topics.

- Register Manipulation
  - Stack Pointer and Program Status Word Modification.
  - Floating-Point Format Display or Modification
- Analyzer Topics
  - Analyzer Status Labels
  - Analyzer Trigger Condition
  - Trace Listing Disassembler
  - Execution States
  - Analyzer Data Bus Condition
  - Analyzer Clock Speed
  - Cause of Monitor Break
- Hardware Breakpoints
- Software Breakpoints
- Target Memory Access
- FPU Support
- MMU Support
- Coordinated Measurement
- Unfamiliar Prompts
- 70118/70116 Emulation Mode
- FRM Support
- Real-time Emulation Memory Access
- Virtual Address Translation
- Restrictions and Considerations

Prerequisites

Before performing the tasks described in this chapter, you should be familiar with how the emulator operates in general. Refer to the *Concepts of Emulation and Analysis* manual and the "Getting Started" and "Virtual Mode Emulation Topics" chapters of this manual.

Register Manipulation

Stack Pointer Modification

In the 70632 microprocessor, one of the five privileged registers (L0SP, L1SP, L2SP, L3SP, ISP) is selected as stack pointer according to the EL and IS flags of the PSW, and the stack pointer is cached by SP. The contents of the stack pointer corresponding to the execution level are not always the same as the stack pointer (SP). The stack pointer corresponding to the execution level is updated only when the execution level is changed.

The emulation monitor is executed in execution level 0. When the emulator returns from emulation monitor to user program, for example when you issue **r** (run) command, the emulator changes execution level from 0 to user program's execution level which is determined by the IS flag and EL field in the program status word (PSW).

For this reason, in emulation monitor, the stack pointer (SP) and the stack pointer corresponding to the execution level need to have the same value. The monitor intends to keep the stack pointer (SP) and the current level stack pointer to have the same value.

When breaking into monitor, the current level stack pointer is modified to the value of SP.

If you modify registers PSW, L0SP, L1SP, L2SP, L3SP or SP in monitor, note the following.

- When you modify the EL or IS flag of the PSW, the SP is modified to the value of the stack pointer corresponding to the execution level which is determined by the EL or IS flag of the PSW you have modified.
- When you modify the stack pointer corresponding to the current execution level (L0SP, L1SP, L2SP, L3SP, ISP), the stack pointer SP is modified to the same value.
- When you modify the stack pointer SP, the stack pointer corresponding to the execution level (L0SP, L1SP, L2SP, L3SP or ISP; the one selected depending on the contents of the PSW) is modified with the same value.

Displaying/Modifying Registers In Floating-Format

You can display/modify general purpose registers (R0 through R31) in floating-point format with **freg** command. The IEEE-754 standard data type is supported.

To display all general purpose registers in short real format, enter:

```
freg
```

You can specify register(s) to be displayed.

```
freg r0 r1
```

To display two consecutive registers R0 and R1 in long real format, enter:

```
freg -l r0
```

Modify register R0 to the value 12345.678, by typing:

```
freg r0=12345.678
```

Verify the value of the R0 you have modified.

```
freg r0
```

For more informations, refer to the "**freg**" syntax pages in this chapter.

Analyzer Topics

Analyzer Status Qualifiers

The following are the analyzer status labels which may be used in the "**tg**" and "**tsto**" analyzer commands.

```
base            0xxxxxxxxxxx0100    system base table access
coprd           0x1xxxxxxxxx1000    co-processor access read
coproc          0xxxxxxxxxxx1000    co-processor access(read/write)
copwr           0x0xxxxxxxxx1000    co-processor access write
data            0xxxxxxxxxxx0011    data access (read/write)
datard          0x1xxxxxxxxx0011    data access read
datawr          0x0xxxxxxxxx0011    data access write
exe             0xxxxxxxxxxx0000    execution state
fault           0xxxxxxxxxxx1100    machine fault acknowledge
fetch           0x1xxxxxxxxx011x    code fetch
fetchbr         0x1xxxxxxxxx0111    code fetch after branch
grd             0xxxxxxxxx0x0xxx    guarded memory access
halt            0xxxxxxxxxxx1101    halt acknowledge
hold            0xxxxxxxxxxx0001    bus hold
int             0xxxxxxxxxxx1110    interrupt acknowledge
io              0xxxxxxxxxxx1011    i/o access (read/write)
iord            0x1xxxxxxxxx1011    i/o access read
iowr            0x0xxxxxxxxx1011    i/o access write
lock            0xxxxxxx0xxxxxxx    bus lock
mon             0xxxxxxxxxx0xxxx    background monitor cycle
retry           00xxxxxxxxxxxxxx    retry
short           0xxxxxxxxxx0010     data access (read/write) with short path
shortrd         0x1xxxxxxxxx0010    data access read with short path
shortwr         0x0xxxxxxxxx0010    data access write with short path
trans           0xxxxxxxxxxx0101    translation table access (read/write)
transrd         0x1xxxxxxxxx0101    translation table access read
transwd         0x0xxxxxxxxx0101    translation table access write
wrrom           0x0xxxxxx0xx0xxx    write to ROM
```

Specifying Trigger Condition at Desired Instruction Execution

In the "Using the Analyzer" section of the "Getting Started" chapter, you used the analyzer to trace the states of the program after that the instruction located at address 10033H was executed. Then the following command was issued to specify trigger condition.

```
tg addr=10033 and stat=exe
```

As you know, the 70632 processor has the prefetch unit (PFU) to prefetch the instruction string to be executed.

If you had issued the following command instead, unexpected trigger would have occurred at the prefetch state of the address 10033H.

```
tg addr=10033
```

This discussion is significant when you specify the trigger condition at the execution of the instruction which follows a branch instruction like:

```
000020012@r   -                 CMP.B       #00H,R2
000020016@r   -                 BZ          00020000H
000020018@r   -                 MOV.W       #0000000fH,R0
```

Assume that the processor executes instructions at address range 20000H through 20016H normally, and the instruction at address 20018H is executed at long intervals.

If you wish to trigger the analyzer at the execution of the address 20018H, you should specify trigger condition as follows.

```
tg addr=20018 and stat=exe
```

If you would type the following, the trigger will always occur at the prefetch of the address 20018H whether or not the branch condition at address 20016H is satisfied.

```
tg addr=20018
```

Disassembles In Trace Listing

As you can see disassembles in analyzer trace listing, the emulator has disassemble capability in trace listing. When the emulator disassembles instructions in stored trace information, the prefetch cycles of each instruction are required.

In the "Using the Analyzer" section of the "Getting Started" chapter, you configured the analyzer to trace the states of the program after the read states of address 30000H and data=0xxxxxx42H by typing:

```
U>tp s
U>tg addr=30000 and data=0xxxxxx42
U>t
```

When you displayed the results of analyzer trace, some lines which include "**No fetch cycle found**" messages were displayed. Each line was instruction execution cycle at the address in the left side of the line. However, the disassembles of these instructions were not displayed because the prefetch states for the instructions were not stored by the analyzer.

To display complete disassembles in trace listing, you should modify location of trigger state in trace list, referred to as the "trigger position", with "**tp**" command. (See the "**tp**" command syntax in the *HP 64700 Emulators Terminal Interface Reference* manual.)

The trigger position was at the start of the trace listing, because you wished to trace the states of the program after the triggered state. ("**tp s**" command)

For complete disassembles, specify the trigger point that ten states will be stored before the trigger point by typing the following command instead of "**tp s**".

```
tp -b 10
```

To display the trace listing from the triggered state, enter.

```
tl 0
```

You will see complete disassembles in trace listing.

In this example, the trigger position was specified to store the 10 states before the trigger. According to your program, more states may be required for complete disassembles.

Execution States Location in Trace Listing

The emulation analyzer stores execution states of the program in addition to actual bus cycles, if configuration item "**cf tre**" is enabled.

When the processor executes an instruction, the execution state of the instruction is generated before its bus state(s) by the execution of the instruction.

However, it is possible that the execution states are inserted after or between the actual bus states of these activities, since the clock rate of bus sampling is high-speed.

The following trace listing shows the example that the execution state, numbered 64, falls behind its bus activity.

```
61   00003004  00001e05     00001e05H trans table  read          *********
62   00003004  00001e85     00001e85H trans table  write         *********
63   00001004  00000002     00000002H data  read                 *********
64   00005043  00000002   MOV.W     00001004H,R0                 *********
65   0000504a  00000002   MOV.W     #00001008H,R1                *********
66   00005060  2da20801               fetch                      *********
```

Specifying Data For Trigger Condition or Store Condition

The analyzer captures the data bus of the 70632 microprocessor. When you specify a data in the analyzer trigger condition or store condition, the ways of the analyzer data specifications differ according to the data size and the address. Suppose that you wish to trigger the analyzer when the processor accesses to the byte data 41H in the address 1000H. You should not specify the trigger condition like this.

```
tg addr=1000 and data=41
```

The data condition will be considered as 00000041H. The bit 31 through bit 8 of data bus is unpredictable because of the byte data. You will unable to trigger as you desire. You should have entered as follows.

```
tg addr=1000 and data=0xxxxxx41
```

Where **x**'s are "don't care" bits.

When the address that you want to trigger is not a multiple of 4, the data bus specification is different from the above. If you trigger the analyzer at the address 1001H instead of the address 1000H, the data 41H will be output to the bit 7 through bit 4 of the data bus. You should enter:

```
tg addr=1001 and data=0xxxx41xx
```

In case of halfword or word access to the data bus, it will be more complex, if two bus states are required to access the data because the data is across 4 byte boundary.

In this case, you need to use the analyzer sequential trigger capabilities. We do not describe the detail about the sequential trigger feature. Only how to trigger the analyzer at some example cases is described in this section.

To trigger the analyzer when the processor accesses the word data 12345678H at the address 1003H. The data bus activity of this cycles will be as follows.

```
Sequencer level    Address bus        Data bus
           1        00001003           78xxxxxx
           2        00001004           xx123456
```

To specify the condition of sequencer level 1, enter:

```
tif 1 addr=1003 and data=78xxxxxx
```

To specify the condition of sequencer level 2, enter:

```
tif 2 addr=1004 and data=xx123456
```

To restart sequencer when any states except for exe state are generated between sequencer term 1 and 2.

```
telif stat!=exe
```

Start trace by typing:

```
t
```

Analyzer Clock Speed

The emulation analyzer can capture both the exe states and bus states.

Bus states show actual processor's bus activity.

Exe states indicate the address of the first byte of an executed opcode. Only the address and processor status fields are valid during these states.

The analyzer has a counter which allows to count either time or occurrence of bus states.

Tracing both bus cycles and exe states, effectively doubles the clock rate to the analyzer. If the system clock speed is 20 MHz, the analyzer will be collecting states at a rate in maximum 20 MHz.

By default, the analyzer time counter is turned off. This is because the analyzer time counter cannot be used at clock speeds greater than 16 MHz. The internal emulator clock is 20 MHz when clocking both bus cycles and execution states. In addition, the analyzer state counter cannot be used at speeds greater than 20 MHz. If it is desired to use the analyzer counter, one of the following ways can be done.

- The clock speed can be effectively halved if execution states are NOT traced. This is accomplished using the configuration item "**cf tre=dis**".
- The other method is to slow the bus clock using an external clock. The internal clock is fixed and is NOT easily changed.

To trace both bus cycles and exe states, the configuration item "**cf tre**" should be enabled. Issue the following command.

```
cf tre=en
```

By default, the analyzer time tagging or # of states counter field in trace listing will be displayed as "*********".

If you wish to trace both bus cycles and exe states and also wish to use the analyzer tag counter. you have the following two alternatives according to the system clock speed.

1. If you use the internal system clock or if your target system clock rate is greater than 16 MHz, you can use the analyzer state counter. Change the mode of the analyzer clock speed to First, by entering:

```
tck -s F
```

The First mode allows you to use the analyzer tag counter as the state counter. The analyzer state counter counts occurrences of the states which you specify. Assume that you would like to count occurrences of the states which the processor read a data from the address 123456H.

```
tcq addr=123456 and stat=read
```

Now, specify the trigger condition and start the trace.

2. If your target system clock rate is equal to 16 MHz or less than 16 MHz, you can use the state counter or the time counter of the analyzer. Change the mode of the analyzer clock speed to Slow, by entering:

```
tck -s S
```

The Slow mode allows you to use the analyzer tag counter as either the state counter or the time counter. The analyzer tag counter counts occurrences of the states which you specify or the amount of time between stored states. The following is example of the usage of the analyzer tag counter as the time counter. Assume that you would like to count time between states.

```
tcq time
```

Now, specify the trigger condition and start the trace.

Finding Out the Cause of a Monitor Break

If the emulator breaks into monitor unwillingly, you can examine the cause of the break by using the analyzer. When you issue the following commands, you can capture the behavior of the program just before the monitor break.

Specify the trigger condition that the analyzer is never triggered.

```
tg never
```

Specify the store condition that the analyzer captures any states.

```
tsto any
```

Start the trace.

```
t
```

After starting your program, the unexpected break will occur. To show the cause of the break, stop the trace and display the trace listing.

```
th
tl -19..0
```

The trace listing displays will show the cause of the break. If you cannot find the cause of the break, display the previous states. If the trace listing does not include the fundamental problem, you need to change the trigger condition to capture the problem, and then restart the trace and the program.

This is also useful to detect the causes other than monitor breaks like a processor halt.

Hardware Breakpoints

The analyzer may generate a break request to the emulation processor. To set up a break condition upon an analyzer trigger, follow the steps below.

Specify the Signal Driven when Trigger is Found

Use the **tgout** (trigger output) command to specify which signal is driven when the analyzer triggers. Either the "**trig1**" or the "**trig2**" signal can be driven on the trigger.

```
tgout trig1
```

Enable the Break Condition

Enable the "**trig1**" break condition.

```
bc -e trig1
```

Additionally, you can see the program states before the breakpoint in trace listing. Specify the trigger position at the end of trace listing by typing:

```
tp e
```

After you specify the trigger to drive "**trig1**" and enable the "**trig1**" break condition, set up the trace, issue the **t** (trace) command, and run the program. When the trigger condition is found, emulator execution will break into the emulation monitor. Then you can also see the trace listing mentioned above, enter the following commands.

Stop the trace by typing:

```
th
```

Display the twenty states at the end of the trace listing by typing:

```
tl -19..0
```

The trace listing will show the cause of the break.

Without the trigger condition, the trigger will never occur and will never break.

The break condition on **trig1** that you have enabled should be disabled when you use the analyzer in order to only trace states of your program. If you neglect and issue **t** (trace) command, the execution of the program will break at the trigger you have specified unexpectedly.

Example Configuration for Hardware Breakpoints Features.

The following are example configurations for typical break conditions you will use.

Breaks on Executing an Instruction

If you wish to break the execution when an instruction is executed. To specify the breakpoint when the instruction at address 12345678H is executed.

```
tg addr=12345678 and stat=exe
```

Start the trace by typing:

```
t
```

Breaks on Accessing an Address

If you wish to break the execution when a certain data is written to a certain memory location. To specify the breakpoint when the halfword data 0abcdH is written to the address 87654321H.

```
tg addr=87654321 and data=0xxabcdxxH
and stat=write
```

Start the trace by typing:

```
t
```

The detail of analyzer data specification in the trigger condition is described in "Specifying Data For Trigger Condition or Store Condition" part of this section.

Breaks on 70632 Exceptions

In case that you test a simple program which does not have exception handler, you want to break the emulator on a 70632 exception. It is useful to specify the breakpoint when a 70632 exception is occurred.

There are two way to detect the 70632 exceptions as follows.

- Detect the states of the System Base Table Access at Events.

  To specify the breakpoint when the system base table access occurs by an event (exception or interrupt), enter:

```
tg stat=base
```

- Detect the states of the Address Range of System Base Table.

  To specify the breakpoint when the address range of the system base table access occurs (except for Software Trap and Maskable Interrupt), enter:

```
tg addr=0..0bf
```

If the program to be tested uses the 70632 Software Trap or Maskable Interrupt or any other trap or exceptions on purpose, use the method of "Detect the System Base Table Access".

If the program to be tested accesses the 70632 system base tables which pointed at the SBR register on purpose, use the method of "Detect the Address Range of System Base Table".

Now start the trace by typing:

```
t
```

Software Breakpoints

Software breakpoints are realized by the 70632 BRK instruction. When you define or enable a software breakpoint (with the **bp** command), the emulator will replace the opcode at the software breakpoint address with a breakpoint interrupt instruction (BRK). When the BRK instruction is executed, the emulator breaks into monitor and compares the address that the break occurred.

If the address is defined as software breakpoint, the emulator displays that the breakpoint hit. The emulator disable the breakpoint and replace the BRK instruction with the original opcode.

If the BRK interrupt was generated by a BRK interrupt instruction in the target system, execution still breaks to the monitor, and an "undefined breakpoint" status message is displayed. To continue with program execution, you must run or step from the target program's breakpoint interrupt vector address.

There are some attentions when you use the software breakpoint features.

Software breakpoints should be set at only locations which contain instruction opcodes.

You must only set software breakpoints at memory locations which contain instruction opcodes (not operands or data). If a software breakpoint is set at a memory location which is not an instruction opcode, the software breakpoint instruction will never be executed and the break will never occur.

Software breakpoints should be set when the emulator is running in monitor.

Software breakpoints should not be set, enabled, disabled, or removed 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.

Software breakpoints cannot be set in target ROM.

Because software breakpoints are implemented by replacing opcodes with the BRK instructions, you cannot define software breakpoints in target ROM.
You can, however, copy target ROM into emulation memory (see the "Target ROM Debug Topics" section of the "In-Circuit Emulation" chapter).

BRK instruction vector must be set up

You must define the 70632 break-point instruction trap vector to point to an address which is allowed instruction fetch; typically in the program code area.

When a software breakpoint occurred, the emulator breaks into the monitor after the BRK instruction has been executed. However the instruction which is pointed by the BRK instruction vector is never executed.

If you didn’t set up the vector and a software break has occurred, an access to the address pointed by the vector may drive the emulator into unpredictable state. The 70632 break-point instruction vector is defined in the 70632 system base table. The vector is located at 0XXXXXX34H; where "XXXXXX" is determined by the contents of the privilege register SBR (defaults is "000000").

This table location depends on the content of 70632 SBR register.

More three words of the stack area must be prepared.

When the BRK instruction is executed, the emulator stores the exception information to stack as the same as the 70632 microprocessor does.

So, you should prepare more three words (12 bytes) for stack in addition. The stack, which is used when the breakpoint occurs, is normally the level 0 stack which is pointed by L0SP. When the software breakpoint occurs, if the program uses interrupt stack, the three words of the interrupt stack pointed by ISP is modified by the emulator instead of level 0 stack.

Software Breakpoint Manipulation In Virtual Mode

When you enable, disable or remove a software breakpoint which you have set by using virtual address, you must issue its command in same virtual space when you have set.

The notices related to software breakpoint manipulation in virtual mode are described in chapter 3.

Target Memory Access

Commands Not Allowed when Real-Time Mode is Enabled

When emulator execution is restricted to real-time and the emulator is running in user code, the system refuses all commands that require access to processor registers or target system memory or I/O. The following commands are not allowed when runs are restricted to real-time:

- Register display/modification (except for XMMU class registers).
- Target system memory display/modification. Because the emulator contains dual-port emulation memory, commands which access emulation memory do not require breaks and are allowed while runs are restricted to real-time.
- I/O display/modification.
- Step.
- Area Table Entry display (which is in target system memory).
- Page Table Entry display (when the PTE or the dependent ATE is/are in target system memory).
- Any other commands with virtual address designation (which cause target system memory accesses for address translation).

When you specifies virtual addresses in commands, the emulator will refer to the address translation tables to translate the virtual addresses to the corresponded real addresses. If the address translation tables which are required to translate the specified virtual addresses is in target system memory, the address translation will be failed.

If the real-time mode is enabled, these resources can only be displayed or modified while running in the monitor.

Breaking out of Real-Time Execution

The only commands which are allowed to break real-time execution are:

rst (reset), **r** (run), **b** (break)

FPU Support

The emulation analyzer can capture co-processor cycles. FPU register display and modification are not supported.

There are following considerations to display co-processor mnemonics in trace or memory display.

FMOVCR instruction

FMOVCR instruction will be displayed as follows:

FMOVCTW instead of **FMOVCR 0P1, FCTW**

FMOVPTW instead of **FMOVCR 0P1, FPTW**

FMOVSTW instead of **FMOVCR 0P1, FSTW**

Instructions with no operand

Dummy operands are displayed when dis-assembling instructions without any operand. As a sign, "#" is displayed just after Opcode mnemonics as follows.

```
0000fe86a@r -          FRPUSH #    FR0,FR0
```

Two "FR0"s are dummy operands. The following instructions relate this.

FADD3M.S FADD3M.L FADD4M.S FADD4M.L
FSUB3M.S FSUB3M.L FSUB4M.S FSUB4M.L
FMUL3M.S FMUL3M.L FMUL4M.S FMUL4M.L
FRPUSH FRPOP FAFFECT

Instructions with one operand

Dummy operand is displayed when dis-assembling instructions with only one operand. As a sign, "*****" is displayed just after Opcode mnemonics as follows.

```
0000fe87a@r -          FRREL *     /00000100H,FR0
```

The "FR0" is a dummy operand. The following instructions relate this.

FIPV.S FIPV.L FRPINC FRREL

MMU Support

The **ate** and **pte** commands allow you to display Area Table Entry and Page Table Entry for an address you specified in the commands. These commands are useful to examine in which address space the program are executed, and detect the address translation error of the program. Examples of these command usages are described in "Virtual Mode Emulation Topics" chapter. These command syntax are shown in "70632 Emulator Specific Command Syntax" appendixa.

Making Coordinated Measurements

Coordinated measurements are measurements made between multiple HP 64700 Series emulators which communicate via the Coordinated Measurement Bus (CMB). Coordinated measurements can also include other instruments which communicate via the BNC connector. A trigger signal from the CMB or BNC can break emulator execution into the monitor, or it can arm the analyzer. An analyzer can send a signal out on the CMB or BNC when it is triggered. The emulator can send an EXECUTE signal out on the CMB when you enter the **x** (execute) command.

Coordinated measurements can be used to start or stop multiple emulators, start multiple trace measurements, or to arm multiple analyzers.

As with the analyzer generated break, breaks to the monitor on CMB or BNC trigger signals are interpreted as a "request to break". The emulator looks at the state of the CMB READY (active high) line to determine if it should break. It does not interact with the EXECUTE (active low) or TRIGGER (active low) signals.

For information on how to make coordinated measurements, refer to the *HP 64700 Emulators Terminal Interface: Coordinated Measurement Bus User's Guide* manual.

Unfamiliar Prompts

When you are using the emulator, one of the following prompts is displayed normally.

```
R>      The emulator is in reset state
U>      The emulator is running user program
M>      The emulator is running in monitor
```

If your target system has a defect or you does not configure the emulator appropriately, the following prompts may be displayed.

- **w>** waiting for target ready
- **h>** halt or machine fault

Waiting for Target Ready

The prompt "**w>**" indicates that the emulator is waiting for target ready signal.

If you map the unused memory locations as target memory and your program accesses to these locations by a defect (in case of in-circuit, also if a target memory is accessed by an emulation command), the emulator is waiting for an impossible ready signal infinitely because the /READY signal is internally pulled up. When you encounter the prompt "**w>**", the emulator cannot break into monitor. All you can do is to reset the processor.

If you are using the emulator in in-circuit mode, the reason is that the emulator intends to access to a memory location for which your target system does not generate ready signal.

If you are using the emulator in out-of-circuit mode, the reason is that the emulator intends to access to a target memory location by your program. To prevent this, all of memory locations, which are not used, should be mapped as guarded memory. When you direct the emulator to access a target memory location, the emulator will return an error message.

Halt or Machine Fault

The prompt "**h>**" indicates that the emulator is halted or in machine fault.

In case of machine fault, all you can do will be to reset the processor because the emulator cannot break into monitor.

One of the causes is the exception by a address translation failure. In this case, one of the solution is to use the analyzer. The analyzer will capture states which causes the emulator to halt. Refer to the "Finding out the Cause of a Monitor Break" description of the "Analyzer Topics" section in this chapter, for the analyzer configuration.

70108/70116 Emulation Mode

The 70632 microprocessor has the 70108/70116 emulation mode. In this mode, the 70632 executes instructions as 70108/70116 microprocessor's ones.

The emulator provides the following functions for both 70108/70116 and 70632.

- Display memory contents in processor mnemonic format.
- Single-stepping
- Analyzer trace

Displaying Memory In 70108/70116 Mnemonic Format

The emulator can display contents of memory in mnemonic format for both 70108/70116 and 70632. The emulator provides both inverse assemblers for 70108/70116 and 70632. You can select one of the inverse assemblers to display memory contents by using configuration item "**cf mil**".

To display memory contents in 70108/70116 mnemonic, change the disassembler by typing:

```
cf mil=v20_30
```

Issue the **m** (memory) command.

To display memory contents in 70632 mnemonic (default), enter:

```
cf mil=v70
```

Issue the m (memory) command.

Single-stepping

You can also single-step the instructions in the 70108/70116 emulation mode. When you single-step the instructions, mnemonics of the executed instruction is displayed in corresponded processor's ones.

However, when you modify the contents of PSW to change the mode with the **reg** command, a mnemonic of next one instruction is displayed in wrong processor mnemonic.

Tracing States In Both Mode

You can also trace the bus states and exe states in the 70108/70116 emulation mode. When tracing the execution of the program,

mnemonics of the executed instructions are included in trace listing. The corresponded processor mnemonics are displayed automatically.

Real-time Emulation Memory Access

The dual-port memory for the emulation memory allows emulation displays and modifications of emulation memory without breaking the processor into the monitor during emulation.

This is referred to as the Real-time Emulation Memory Access capability.

If you issue emulation memory display/modification command while the emulation program is running, HP 64700 emulation controller, not the emulation processor, intends to access the dual-port emulation memory with the cycle-stealing method. The emulation memory accesses without breaking the processor into the monitor are accomplished for this reason.

When cycle-stealing to access to the emulation memory, the emulation controller watches for idle cycles in the 70632 bus cycles. When the idle cycles are found, the emulation controller can access to the emulation memory at the interval of the 70632 bus cycles with cycle-stealing.

However, in case that the emulation controller cannot find any idle cycles, the emulation controller holds the 70632 bus cycles (not but breaking into the monitor) in order to access to the emulation memory.

If your target system inserts some wait states to access to memory, no idle cycle may be generated. It is depended on WHAT instructions are executed when the emulation memory access command is issued, or HOW much wait states are inserted.

When there is no idle cycle within 160 mS, the hold request will be generated to the emulation processor except that the emulator is held, bus-frozen or reset.

Virtual Address Translation

When you specify virtual addresses in emulation commands, the emulator intends to translate these virtual addresses to actual memory addresses in order to manipulate contents of these memory locations.

For the address translation, the 70632 microprocessor uses its area table register pairs, which define a virtual address space. Similarly, the emulator requires values which corresponds to the 70632 area table register pairs.

Using the Caches of Area Table Register Pairs

The emulator has the caches of the area table register pairs, which allow the emulator to refer the corresponded area table for the address translations even if the emulator cannot to or is not allowed to break into the monitor.

Each time the emulator breaks into monitor, the caches are updated by the contents of the 70632 area table register pairs.

By default, the emulator uses the caches to translate the addresses which you specify in emulation commands. The caches contain the base addresses and the lengths of the area tables as the same as the 70632 area table register pairs. The emulator refers to the corresponded area table and page table by using the caches.

If the emulator is restricted to real-time runs by the "**cf rrt=en**" configuration command, the caches will keep the values while you do not break the emulator into the monitor intentionally. Only when you issue "**b**", "**s**" or "**rst**" command or a break condition (such as software breakpoint) is satisfied, the caches are updated.

If the emulator is not restricted to real-time runs (default), the caches are updated by the contents of the area table register pairs every time the emulator breaks into monitor whether with or without your intention. When you issue commands with virtual addresses, the emulator breaks into the monitor to access the area table register if possible. As the result, the emulator will use the current virtual address space for address translations.

In the both cases, when the emulator cannot break into monitor, for example the processor is reset, the emulator uses the caches for the address translation.

Specifying Virtual Address Space

When you specify virtual addresses in emulation commands, the emulator translates the virtual address to corresponded real addresses. The translated real addresses depends on a virtual address space. The virtual address space can be defined by the values of area table base and length for each section. In 70632 microprocessor, these informations are stored in its area table register pairs.

In case that the caches mentioned above are used for the address translation, it is difficult to specify an virtual address in your desirable virtual address space during running user program. If your program performs in multiple virtual space, you may want to specify a virtual address space for address translations in order to watch for the execution of a certain task.

This is accomplished by using the XMMU function. The XMMU function allows you to fix a virtual address space for address translations. The emulator has the optional XMMU class registers. These registers consist of eight XMMU register pairs and one XMMU mode register. The XMMU register pairs correspond to the actual 70632 area table register pairs. You can specify a virtual address space by modifying the XMMU class registers. The format of the XMMU class registers is the same as the 70632 actual area table register pairs. The XMMU class registers also include the XMMU mode register (mmumod), which determines whether the caches or the contents of the XMMU register pairs are used for address translations. By default, the caches are selected.

If you activate the XMMU function, the emulator uses the contents of the XMMU register pairs for address translations whether or not the emulator is restricted to real-time runs.

The XMMU class registers consist of the following registers.

XMMU class registers	corresponded actual registers
xatbr0	atbr0
xatlr0	atlr0
xatbr1	atbr1
xatlr1	atlr1
xatbr2	atbr2
xatlr2	atlr2
xatbr3	atbr3
xatlr3	atlr3
mmumod	--None--

To specify a virtual address space which is used for address translations, modify the contents of the XMMU register pairs corresponded to the area table registers by using the **reg** (register) command or the **cpmmu** (copy current virtual address space to XMMU registers) command. See also the "Using the XMMU function" section of chapter 3 and the "**cpmmu**" command syntax of chapter 4.

After you have modify the contents of the XMMU register pairs, activate the XMMU function by changing the contents of XMMU mode register (mmumod) to the value 1.

```
reg mmumod=1
```

To use the caches of the area table register pairs for address translations, modify mmumod register to 0 (default).

```
reg mmumod=0
```

Besides by using the **reg** command, the **mmumod** register is reset when the emulator breaks into monitor in the following causes.

- Break by software breakpoint
- Break by single-stepping
- Break by writing to ROM
- Break by access to guarded memory

In these case, the **mmumod** register is reset to "0". As the result, the address translation of the virtual address in a command uses the actual area table register pairs.

Restrictionas and Considerations

When the microprocessor accesses data which are not aligned, the microprocessor generates more than twice memory access cycles.
If the microprocessor accepts interrupt while microprocessor reads the data which are not aligned, the microprocessor stop accessing the data and generates invalid memory write cycle.
But, memory is not changed because bus enable signals(BS0-BS3) are inactive, and stopped memory read cycles are reexecuted after interrupt routine.

If you specify that **bc -e rom** and if microproccessor generates invalid memory write cycle described above in user's program, the emulator break into the monitor.

5

In-Circuit Emulation Topics

Introduction

Many of the topics described in this chapter involve the commands which relate to using the emulator in-circuit, that is, connected to a target system.

This chapter will:

- Describe the issues concerning the installation of the emulator probe into target systems.
- Show you how to install the emulator probe.
- Describe how to set up the emulator to use a target system clock.
- Describe how to use software breakpoints with ROMed code, how to perform coverage testing on ROMed code, and how to test patches to ROMed code. These topics relate to the debugging of target system ROM.
- Describe target interrupts.
- Describe DMA operation.
- Describe how to access to target I/O resource.
- Describe FRM function.
- Describe Target Interface.

Prerequisites

Before performing the tasks described in this chapter, you should be familiar with how the emulator operates in general. Refer to the *Concepts of Emulation and Analysis* manual and the "Getting Started" chapter of this manual.

Installing the Emulator Probe into a Target System

The emulator probe has a PGA connector. The emulator probe is also provided with a conductive pin protector to protect the delicate gold-plated pins of the probe connector from damage due to impact. Since the protector is non-conductive, you may run performance verification with no adverse effects when the emulator is out-of-circuit.

Caution

Protect against static discharge. The emulation probe contains devices that are susceptible to damage by static discharge. Therefore, precautionary measures should be taken before handling the microprocessor connector attached to the end of the probe cable to avoid damaging the internal components of the probe by static electricity.

Caution

Make sure target system power is OFF. Do not install the emulator probe into the target system microprocessor socket with power applied to the target system. The emulator may be damaged if target system power is not removed before probe installation.

Caution

Make sure pin 1 of probe connector is aligned with pin 1 of the socket. When installing the emulation probe, be sure that the probe is inserted into the processor socket so that pin 1 of the connector aligns with pin 1 of the socket. Damage to the emulator probe will result if the probe is incorrectly installed.

Caution

Protect your target system CMOS components. If you target system contains any CMOS components, turn ON the target system first, then turn ON the emulator. Likewise, turn OFF your emulator first, then turn OFF the target system.

Pin Protector

The target system probe has a pin protector that prevents damage to the prove when inserting and removing the probe from the target system microprocessor socket. Do not use the probe without a pin protector installed. If the target system 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.

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 target system probe lines being shorted together.

Caution

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

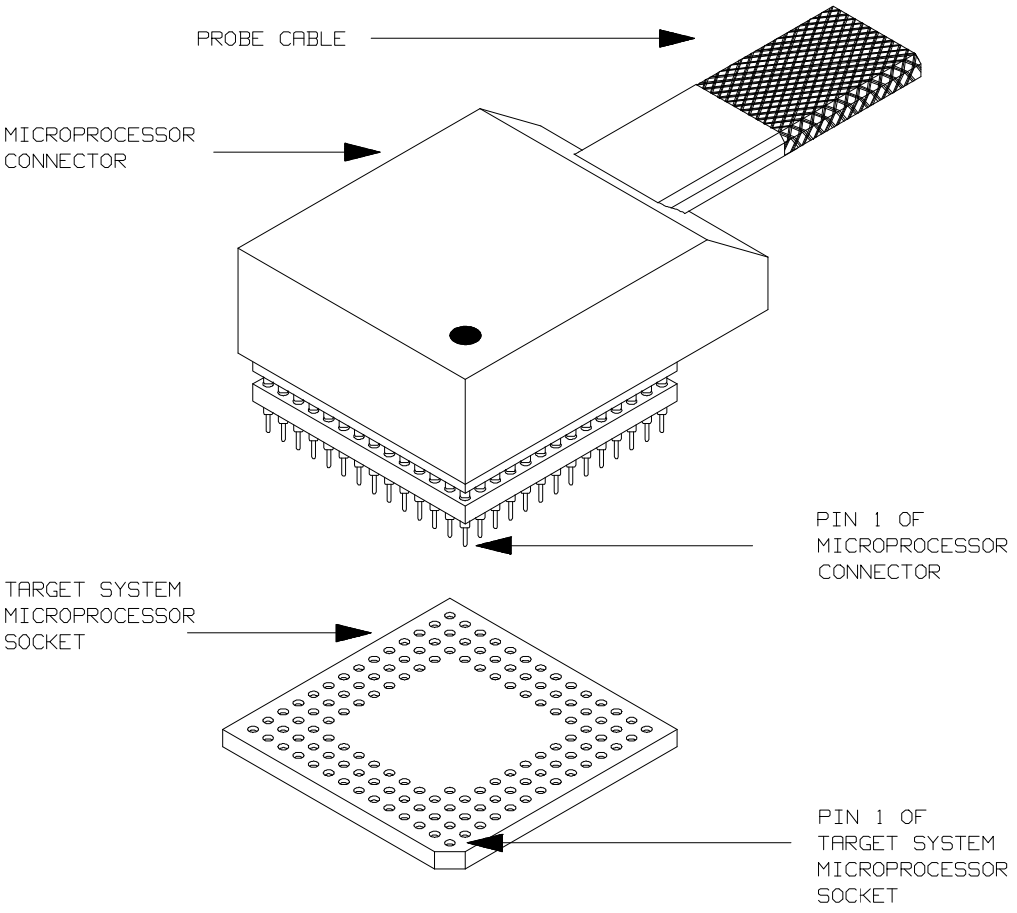


Figure 5-1. Installing Emulation Probe Into PGA Socket

Installing the Target System Probe

1. Remove the 70632 microprocessor from the target system socket. Note the location of pin 1 on the processor and on the target system socket.

2. Store the microprocessor in a protected environment (such as antistatic foam).

3. Install the target system probe into the target system microprocessor socket. Remember to use the pin protector!

In-Circuit Configuration Options

The 70632 emulator provides configuration options for the following in-circuit emulation issues. Refer to the "CONFIG_ITEM" section in the "70632 Emulator Specific Command Syntax" appendix.

Selecting the Emulator Clock Source

The default emulator configuration selects the internal 20 MHz clock as the emulator clock source. You can configure the emulator to select an external target system clock source in the range of 8-20 MHz.

The configuration item is "**clk**".

Driving Background Cycles to the Target System

You can choose whether emulator bus cycles are driven to your target system bus when the emulator is in background cycle. If your target system requires bus cycle activities constantly, such as /BCYST, will need to drive the emulation bus cycles to your target system bus. By default, no bus cycles are driven to the target system in background operation.

The configuration item is "**dbc**".

Selecting Memory Block during Background Cycles

You can select the value of the 70632 address bus which should be driven to your target system. Pin A31 through A8 of the address bus is configurable. This configuration is meaningful when the "Driving

Background Cycles to Target System" configuration mentioned above is activated.

The configuration item is "**bbk**".

Allowing /HLDRQ Signal from Target System

You can specify whether the emulator accepts or ignores the /HLDRQ signal from your target system. By default, the emulator accepts the /HLDRQ signal from the target system.

The configuration item is "**th**".

Allowing BFREZ Signal from Target System

You can specify whether the emulator accepts or ignores the BFREZ signal from your target system. By default, the emulator accepts the BFREZ signal from the target system.

The configuration item is "**tbf**".

Allowing INT Signal from Target System

You can specify whether the emulator accepts or ignores the INT signal from your target system. By default, the emulator accepts the INT signal from the target system.

The configuration item is "**ti**".

Allowing /NMI Signal from Target System

You can specify whether the emulator accepts or ignores the /NMI signal from your target system. By default, the emulator accepts the /NMI signal from the target system.

The configuration item is "**tn**".

Allowing the Target System to Insert Wait States

High-speed emulation memory provides no-wait-state operation. However, the emulator may optionally respond to the target system /READY, /BERR, RT/EP lines while emulation memory is being accessed.

You can specify whether the emulation memory accesses are honored by these target system signals or not, in a memory mapping term. When you map emulation memory with "**map**" command, if you would like to cause the emulation memory to honor these target system signals, add "**lock**" attribute after an emulation memory type.

For example, to map the address range 00000000H through 0000ffffH as emulation rom, which accepts these signals from your target system, enter:

```
R>map 0..0ffff erom lock
```

When the ready relationship is locked to the target system by adding "**lock**" attribute in a **map** command, the emulation memory accesses honor /READY, /BERR, RT/EP signals from the target system (wait states or retry cycles are inserted if requested).

If you do not specify the "**lock**" attribute in a **map** command, the ready relationship is not locked to the target system, and the emulation memory accesses ignore these signals from the target system (no wait states are inserted).

Target ROM Debug Topics

The descriptions in this section are of emulation tasks which involve debugging target ROM. The tasks described below are made possible by the **cim** (copy target system memory image) command. The **cim** command allows you to read the contents of target memory into the corresponding emulation memory locations. Moving target ROM contents into emulation memory is the key which allows you to perform the tasks described below. For example, if target ROM exists at locations 00020000H through 0002ffffH, you can copy target ROM into emulation memory with the following commands.

```
R>map 20000..2ffff erom lock
R>cim 20000..2ffff
```

The "**lock**" attribute mentioned in the "Allowing the Target System to Insert Wait States" section above is used so that the emulation ROM accesses honor ready signals from your target system.

Using Software Breakpoints with ROMed Code

You cannot define software breakpoints in target ROM memory. However, you can copy target ROM into emulation memory which does allow you to use software breakpoints.

Once target ROM is copied into emulation memory, software breakpoints may be used normally at addresses in these emulation memory locations.

```
R>bc -e bp
R>bp 20000
```

Coverage Testing ROMed Code

Coverage testing (as described in the "Getting Started" chapter) can only be performed on emulation memory. However, if you wish to perform coverage tests on code in target system ROM, you can copy target ROM into emulation memory and perform the coverage tests on your ROMed code. Once target ROM is copied into emulation memory, coverage testing may be done normally at addresses in these emulation memory locations.

```
U>cov -a 20000..2ffff
```

Even if your application is executed in virtual address space, a "@r" suffix is not needed because the "**cov**" command accepts only real addresses. Address expressions with no suffixes are recognized as real address always.

Modifying ROMed Code

Suppose that, while debugging your target system, you begin to suspect a bug in some target ROM code. You might want to fix or "patch" this code before programming new ROMs. This can also be done by copying target system ROM into emulation memory with the **cim** (copy target memory image) command. Once the contents of target ROM are copied into emulation memory, you can modify emulation memory to "patch" your suspected code.

User Interrupts

Background Monitor

If you use the background monitor, interrupts may be suspended or ignored during background operation. /NMI and INT signal is not passed to the emulator during the background monitor, even if the configuration items "**cf tn**" and/or "**cf ti**" are enabled.

In case that /NMI is generated by target system during background operation, the /NMI is accepted if the /NMI signal status is kept asserting (low) until the transition from background monitor to user program execution.

In case that INT is generated by target system during background operation, the INT is accepted if the INT signal status is kept asserting (high) until the transition from background monitor to user program execution.

When an interrupt is generated during single-stepping, next instruction which will be stepped is the entry of the interrupt handler.

Foreground Monitor

If you use the foreground monitor, interrupts are accepted during foreground monitor cycles as same as user program execution.

However, when the emulator breaks into foreground monitor, some instructions for monitor are executed in background to transit from user program execution to foreground monitor. Interrupts status should be held for these instruction execution. The period of transition from user program to monitor is 60 uS.

When an interrupt is generated during single-stepping, the instruction will be executed after the execution of the interrupt handler.

DMA Operation

Direct memory access to 70632 emulation memory is not permitted.

The Usage of I/O Command

The emulator has "**io**" command, you can manipulate an I/O address by using the "**io**" command. You can specify an I/O address in either virtual or real address space as well as the "**m**" command.

There are two I/O spaces according to methods for accessing to I/O in the 70632 microprocessor.

The first I/O space can be accessed by using an IN/OUT instruction. In this section, this I/O space is referred as "Isolated I/O space" distinguish from Memory Mapped I/O described below.

The second I/O space can be accessed by simply reading from or writing to the memory. The I/O space can be mapped to the virtual address space and known as Memory Mapped I/O.

How to Access an Isolated I/O space

If you would like to manipulate an Isolated I/O space which is accessed by using an IN/OUT instruction of the microprocessor, designate the I/O address in real address.

How to Access a Memory Mapped I/O space

If you would like to manipulate a Memory Mapped I/O space which is accessed by reading from or writing to a memory. designate the I/O address in virtual address. The I/O mapped bit of the page table entry which includes the I/O address must be set to 1, in other word, the address is mapped as I/O.

FRM Function

When using the emulator for an FRM system, there are some restrictions.

To use the emulator in master mode, the checker CPU in your target system should be inactivated (so that the checker CPU never generates the MSMAT signals). The following are the reasons.

- Some of input signals are not connected to the emulation CPU directly. The signals are INT, /HLDRQ, /NMI and BFREZ.
- Some bus signals in the monitor operation differ from the actual CPU.

As far as your FRM system never introduces the INT, /HLDRQ, /NMI and BFREZ, you may activate the checker CPU. In this case, note the following.

- All the memory should be mapped as target ram.
- External system clock should be selected (**cf clk=ext**).
- Any operations which cause break is never allowed (**cf rrt=en**).
- All you can do is to use the analyzer.

Besides the transition from master mode to checker mode of the emulator is permitted. The 70632 emulator can accept the FMST/FCHK signal. However, the emulator does not work as checker. The emulator bus is frozen instead. So the MSMAT signal will be not generated, even if the master CPU should malfunction. The emulator can not be changed the mode to master mode by changing external FMST/FCHK signal. You can not use the any analyzer features in addition to the commands which cause break into the emulation monitor. The emulator prompt "**g>**" shows that the emulator is in checker mode.

Note

The use of the "**b**" (break) command causes the emulator to break into the emulation monitor, even though the "Restriction to real time runs" configuration is enabled (**cf rrt=en**). If you should do the "**b**" command, you would be unable to continue the execution of the program.

Pin State on Emulation Probe

The probe pins of the emulator are in the following state. While the emulator is running in background, the pin states are different according to the configuration item "**cf dbc**".

Address Bus

Foreground	Same as 70632 microprocessor
Background (cf dbc=en)	Upper 24 bits of the address bus depend on the configuration item "**cf bbk**" otherwise you direct the emulator to access target memory. When accessing target memory by background monitor, same as 70632 microprocessor.
Background (cf dbc=dis)	Always high impedance otherwise you direct the emulator to access target memory. When accessing target memory by background monitor, same as 70632 microprocessor.

Data Bus

Foreground	Same as 70632 microprocessor except for emulation memory access. When accessing emulation memory, high impedance.
Background	Always high impedance otherwise you direct the emulator to access target memory. When accessing

	target memory by background monitor, same as 70632 microprocessor.

/HLDAK

Foreground	Same as 70632 microprocessor
Background	Always high.

R/W

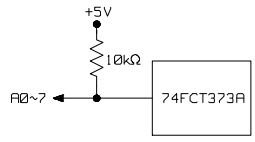
	Same as 70632 microprocessor except for emulation memory write. When accessing emulation memory, high.

Others

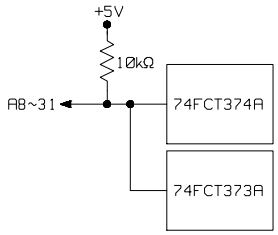
Foreground	Same as 70632 microprocessor
Background (cf dbc=en)	Same as 70632 microprocessor.
Background (cf dbc=dis)	Always high impedance otherwise you direct the emulator to access target memory. When accessing target memory by background monitor, same as 70632 microprocessor.

Target system Interface

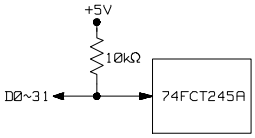
A0 thru **A7** These signals are connected to 74FCT373A and 10 Kohm pull-up resistor.



A8 thru **A31** These signals are connected to both of 74FCT373A and 74FCT374A, and 10 Kohm pull-up resistor. If you enable the emulator to drive the background cycles to target system (**cf dbc=en**), the signals are driven by 74FCT374A while background cycles except that you direct the emulator to access target memory. Otherwise, driven by 74FCT373A.

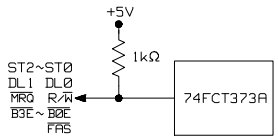


D0 thru **D31** These signals are connected to 74FCT244A and 10 Kohm pull-up resistor.



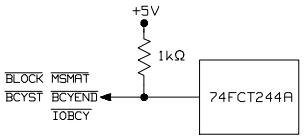
ST2 thru **ST0**
/MRQ
R/W /FAS
/B3E thru **/B0E**
DL0 DL1

These signals are connected to 74FCT373A and 1 Kohm pull-up resistor.



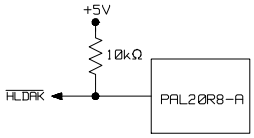
/BLOCK
/MSMAT
/BCYST/BCYEND
/IOBCY

These signals are connected to 74FCT244A and 1 Kohm pull-up resistor.



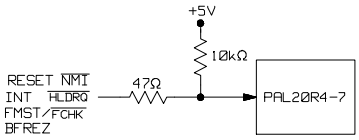
/HLDAK

This signal is connected PAL20R8-7 and 10 Kohm pull-up resistor.



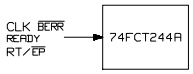
RESET /NMI
INT /HLDRQ
BFREZ
FMST/FCHK

These signals are connected to PAL20R8-7 through 47 ohm series resistor and 10 Kohm pull-up resistor.



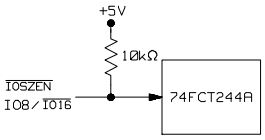
CLK /BERR
/READY RT/EP

These signals are connected to 74FCT244A mounted on probe directly.



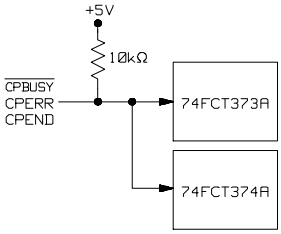
/IOSZEN
IO8/IO16

These signals are connected to 74FCT244A and 10 Kohm pull-up resistor.



/CPBUSY
CPERR
CPEND

These signals are connected to both of 74FCT373A and 74FCT374A, and 10 Kohm pull-up resistor.



A

70632 Emulator Specific Command Syntax

The following pages contain descriptions of command syntax specific to the 70632 emulator. The following syntax items are included (several items are part of other command syntax):

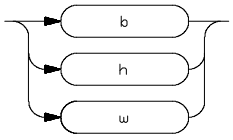
- <ACCESS_MODE>. May be specified in the **mo**(display and access mode), **m**(memory display/modify), and **io**(I/O display/modify) commands. The access mode is used when the **m** or **io** commands modify rarget memory or I/O locations.
- <ADDRESS>. May be specified in emulation commands which allow addresses to be entered.
- <CONFIG_ITEMS>. May be specified in the **cf**(emulator configuration) and **help cf** commands.
- <DISPLAY_MODE>. May be specified in the **mo**(display and access mode), **m**(memory display/modify),**io**(I/O display/modify), and **ser**(search memory for data) commands. The display mode is used when memory locations are displayed or modified.
- <REGSTER_NAME> and <REGISTER_CLASS>. May be specified in the **reg** (register display/modify) command.
- <ate>. May be specified in the **ate**(area table entry display) command.
- <pte>. May be specified in **pte**(page table entry display) command.

- <freg>. May be specified in the **freg**(floating point format register display/modify) command.
- <tcb>. May be specified in the **tcb**(TCB diaplay) command.
- <cpmmu>. May be specified in the cpmmu(XMMU copy) command.
- Error and Status Messages

ACCESS_MODE

Summary Specify cycles used by monitor when accessing target system memory or I/O.

Syntax



Function The **<ACCESS_MODE>** specifies the type of microprocessor cycles that are used by the monitor program to access target memory. When a command requests the monitor to read or write target system memory or I/O, the monitor program will look at the access mode setting to determine whether byte, halfword, or word instructions should be used.

Parameters

b	**Byte.** Selecting the byte access mode specifies that the emulator will access target memory using byte cycles (one byte at a time).
h	**Halfword.** Selecting the word access mode specifies that the emulator will access target memory using halfword cycles (one word at a time).
w	**Word.** Selecting the word access mode specifies that the emulator will access target memory using word cycles (one word at a time).

Example:

```
mo -ab
mo -aw
```

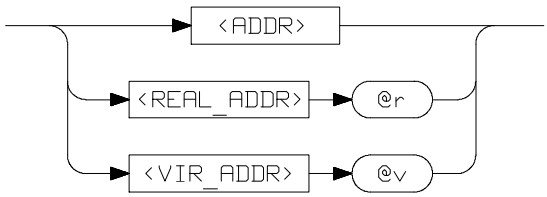
Defaults The **<ACCESS_MODE>** is **b** at power up initialization. Access mode specifications are saved; that is, when a command changes the access mode, the new access mode becomes the current default.

Related Commands **mo** (specify display and access modes) **m** (memory) **io** (I/O)

ADDRESS

Summary Address specifications used in emulation commands.

Syntax



Function The **<ADDRESS>** parameter used in emulation commands may be specified as a virtual address or as a real address. You can specify the address as real or virtual by adding a suffix "**@r**" or "**@v**". If neither suffix is specified, the address is interpreted in the manner described in "" below.

<REAL_ADDR> This expression with "**@r**" suffix is a real (actual) address in the 70632 address range 0 through 0ffffffffH.

The following emulation commands never accept real addresses completely.

```
ate, pte
```

The following emulation commands never accept real addresses when the emulator is in virtual mode.

```
r ,rx ,s
```

<VIR_ADDR> This expression with "**@v**" suffix is a virtual address in the 70632 address range 0 through 0ffffffffH. When you specify the address in virtual address, the emulator refers to corresponded address translation tables in order to translate virtual address to real (actual) address. In multiple virtual space, may be there are plural real addresses equivalent to specified virtual address. The emulator uses one of the virtual space to determine a real address which corresponds to the specified virtual address. By default, the emulator uses the current address space, which is specified by the contents of the area table register pairs of the 70632

microprocessor, to translate virtual address to real address. The details of the address translation are shown in chapter 4.

The following emulation commands never accept virtual addresses completely.

`cim, cov, map`

The following emulation commands never accept virtual addresses when the emulator is in real mode.

`r, rx, s`

<ADDR> This expression with no suffix is interpreted as either real or virtual by the emulator. The address mode, which is required to interpret the address expression with no suffix, is determined as follows with a few exceptions.

1. When the processor is reset, the expression is evaluated as the real address.

2. When the processor never runs in virtual mode after reset, the expression is evaluated as the real address.

3. Once the processor has run in virtual mode after reset, the expression is evaluated as the virtual address.

Note

Although the processor is running in real mode, the address expression which has no suffix is recognized as the virtual address, if the processor has ever run in virtual mode since the processor was reset.

For each address mode, see the description of **<REAL_ADDR>** or **<VIR_ADDR>** mentioned above.

There are exceptions to this rule, when the address expression with no suffix is specified in the following commands.

`ate, pte`

When addresses are specified with no suffix in the above command, the addresses are interpreted as virtual, whether or not the current address mode is virtual or real.

`cim, cov, map`

When addresses are specified with no suffix in the above command, the addresses are interpreted as real, whether or not the current address mode is virtual or real.

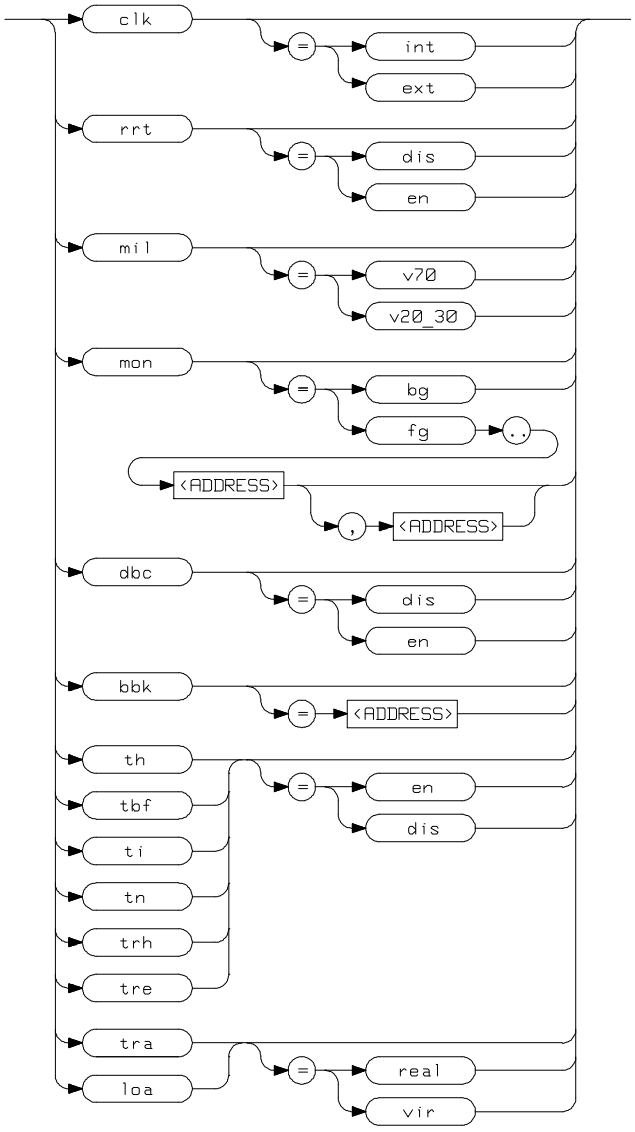
`r, rx, s`

When addresses are specified with no suffix in the above command, the addresses are interpreted with the current address mode.

CONFIG_ITEMS

Summary 70632 emulator configuration items.

Syntax



Function

The **<CONFIG_ITEMS>** are the 70632 specific configuration items which can be displayed/modified using the **cf** (emulator configuration) command. If the "=" portion of the syntax is not used, the current value of the configuration item is displayed.

Parameters

clk — **Clock Source**. This configuration item allows you to specify whether the emulator clock source is to be internal (**int**, provided by the emulator) or external (**ext**, provided by the target system). The internal clock speed is 20 MHz (system clock). The emulator will operate at external clock speed from 8-20 MHz (entered clock or crystal frequency connected).

rrt — **Restrict to Real-Time Runs.** This configuration item allows you to specify whether program execution should take place in real-time or whether commands should be allowed to cause breaks to the monitor during program execution. If **en** is selected, the emulator is restricted execution to real-time. If **dis** is selected, the emulator is allowed breaks to the monitor during program execution. When runs are restricted to real-time, commands which access target system resources are not allowed.

For the commands which is refused when runs are restricted to real-time, refer to the "Target Memory Access" section of chapter 4.

mil — **Select Memory Inverse Assembler.** This configuration item allows you to specify inverse assembler for either 70108/70116 or 70632 microprocessor. The 70632 microprocessor has the 70108/70116 emulation mode. In this mode, the 70632 executes the instruction as 70108/70116 microprocessor's one.

The emulator provides both inverse assemblers for 70108/70116 and 70632. If **v70** is selected, the 70632 inverse assembler is used when you display memory in mnemonic format. If **v20_30** is selected, the 70108/70116 inverse assembler is used when you display memory in mnemonic format.

mon

Monitor Options. This configuration item is used to select the type of monitor to be used by the emulator. If **bg** (background monitor) is selected, all monitor functions are performed in background.

If **fg** (foreground monitor) is selected, all monitor functions are performed in foreground. (Breaks to the monitor still put the emulator into the background mode, but the monitor program returns to foreground before performing any functions.) Specify the real memory location of foreground monitor at the first **<ADDRESS>** term (which follows two periods; "**..**"). When the foreground monitor is executed in virtual mode, specify the virtual location at the second **<ADDRESS>** term. The first **<ADDRESS>** term and the second **<ADDRESS>** term must be separated by comma (**,**). Refer to the "Using the foreground monitor" appendix.

dbc

Bus Drives During Background Operation. You can choose whether emulator bus cycles are driven to your target system bus when the emulator is in background cycle. If your target system requires bus cycle activities constantly, you will need to drive the emulation bus cycles to your target system bus. If **en** is selected, the emulator drives its bus cycles to target system bus whether or not the emulator executed in the background cycles. If **dis** is selected, the emulator does not drive any bus cycles to target system bus in background operation.

By default, no bus cycles are driven to the target system in background operation. If your target system have some circuitry which monitors bus activities, you may need to enable this configuration. related configuration .

bbk **Memory Location In Background Operation.** This configuration item allows you to specify the location of the background monitor program. The monitor may be located on any 4K byte boundary. If the **<ADDRESS>** specified is not on a 4K boundary, the 4K boundary below the address is used. The location of background monitors may be important because background cycles of the 70632 emulator are always visible to the target system. In default, the monitor is located on 00000H through 00FFFH (physical address). The **<ADDRESS>** should be specified with no suffix. This configuration does not make sense when the "Bus Drives During Background Operation" configuration is disabled (**cf dbc=dis**).

Note 

If your target system have some circuitry which monitors bus activities to detect illegal access to resources, You may need to relocate monitor address.

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th **Allow Target Hold Request Signal.** This configuration item allows you to specify whether /HLDRQ signal from target system is accepted or ignored by the emulator. If **en** is selected, the emulator accepts Hold Request from target system. If **dis** is selected, the emulator ignores Hold Request. When th is set to **dis**, the emulator ignores /HLDRQ signal input from target system.

tbf — **Allow Target Bus Freeze Signal.** This configuration item allows you to specify whether BFREZ from target system is accepted or ignored by the emulator. If **en** is selected, the emulator accepts BFREZ signal from target system. If **dis** is selected, the emulator ignores BFREZ signal. When **tbf** is set to **dis**, the emulator ignores BFREZ signal input from target system.

ti — **Enable/disable user INT.** This configuration item allows you to specify whether user INT is accepted or ignored by the emulator. If **en** is selected, the emulator accepts user INT. If **dis** is selected, the emulator ignores user INT. When **ti** is set to **dis**, the emulator ignores user INT input.

tn — **Enable/disable user NMI.** This configuration item allows you to specify whether user NMI is accepted or ignored by the emulator. If **en** is selected, the emulator accepts user NMI. if **dis** is selected, ignores user NMI. When **ti** is set to **dis**, the emulator ignores user NMI input.

trh — **Allow analyzer to trace bus hold sequence.** This configuration item allows you to specify whether analyzer traces microprocessor generated bus hold sequence. If you configure to trace bus hold cycles, the analyzer capture , a "hold" status state when bus hold request (/HLDRQ) is acknowledged by the CPU.

If **en** is selected, the analyzer traces bus hold cycles. If **dis** is selected, the analyzer traces no bus hold cycles. If you wish to exclude bus hold cycles from trace listings, you can set **trh** to **dis** and execute the **t** command.

tre — **Executed Instruction Address Trace Selection**

Bus states show actual processor bus activity.

Exe states indicate the address of the first byte of an executed opcode. Only the address and processor status channels are valid during these states.

If **en** is selected, both exe states and bus states are captured by the emulation analyzer. You will see the disassembles of executed instructions in trace listing. Lines with disassembles indicate exe states of the instructions.

If **dis** is selected, only bus states are captured by the emulation analyzer. When you display trace listing, the emulator disassembles with "fetch" states, and their disassembled processor mnemonics is displayed at the "fetch" states which are the first byte of the instructions. In this mode, the analyzer can trace with time tagging or # of states counter.

Refer to the "Using the Emulator" chapter for more details of the analyzer features.

tra **Selection of Virtual or Real Address Trace.** This configuration item allows you to specify whether analyzer should trace virtual address or real address. If **real** is selected, the analyzer captures real address bus which is the same that the actual microprocessor outputs to. If **vir** is selected, the analyzer captures virtual address.

loa **Selection of Virtual or Real Address for Loading Absolute File.** This configuration item allows you to specify whether the emulator should load absolute files into virtual address or real address when you use the **load** command. In other words, you can specify that in which address space the address location information are recorded in the absolute files. If **real** is selected, the emulator interprets the location address information in the absolute files as real address.

If **vir** is selected, the emulator interprets the location address information in the absolute files as virtual address. The default virtual address are used to translate the location address to actual memory address.

Defaults The default values of the configuration items are listed below.

```
cf clk=int
cf rrt=dis
cf mil=v70
cf mon=bg
cf dbc=dis
cf bbk=0
cf th=en
cf tbf=en
cf ti=en
cf tn=en
cf trh=en
cf tre=en
cf tra=real
cf loa=real
```

Related Commands **help**

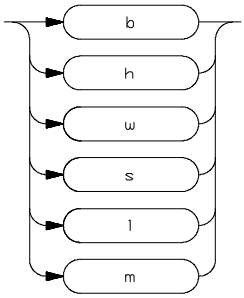
You can get an on line help information for particular configuration items by typing:

```
R>help cf <CONFIG_ITEM>
```

DISPLAY_MODE

Summary Specify the memory display format or the size of memory locations to be modified.

Syntax



Function The **<DISPLAY_MODE>**n specifies the format of the memory display or the size of the memory which gets changed when memory is modified.

Parameters

b	**Byte.** Memory is displayed in a byte format, and when memory locations are modified, bytes are changed.
h	**Halfword.** Memory is displayed in a halfword format, and when memory locations are modified, halfwords are changed.
w	**Word.** Memory is displayed in a word format, and when memory locations are modified, words are changed.
s	**Short-Float**. Memory is displayed in a short-float format, and when memory locations are modified, short-floats are changed. When this display mode used, the current default display mode is not changed.

l	**Long-Float.** Memory is displayed in a long-float format, and when memory locations are modified, long-floats are changed. When this display mode used, the current default display mode is not changed.
m	**Mnemonic.** Memory is displayed in mnemonic format; that is, the contents of memory locations are inverse-assembled into mnemonics and operands. When memory locations are modified, the last non-mnemonic display mode specification except for **s** and **l** is used. You cannot specify this display mode in the **ser** (search memory for data) command.

Defaults

The <**DISPLAY_MODE**> is **b** at power up initialization. Display mode specifications are saved; that is, when a command changes the display mode, the new display mode becomes the current default.

Related Commands

mo (specify access and display modes) **m** (memory display/modify) **io** (I/O display/modify) **ser** (search memory for data)

REGISTER CLASS and NAME

Summary 70632 register designators. All available register class names and register names are listed below.

<REG_CLASS>

<REG_NAME> Description

*** (All basic registers)**

pc psw sycw	All basic registers.
r0 r1 r2 r3 r4	The **ap** and **r29**, **fp** and **r30**, **sp** and **r31** have same
r5 r6 r7 r8 r9	values because of only difference of their register
r10 r11 r12 r13	mnemonics.
r14 r15 r16 r17	
r18 r19 r20 r21	
r22 r23 r24 r25	
r26 r27 r28 r29	
r30 r31 ap fp sp	

priv (Privilege registers)

isp l0sp l1sp l2sp
l3sp sbr tr sycw
tkcw pir psw2

mmu (MMU registers)

atbr0 atlr0 atbr1	Area Table Register Pairs
atlr1 atbr2 atlr2	
atbr3 atlr3	

debg (Debug registers)

trmod adtr0 adtr1
adtmr0 adtmr1

all (All of the 70632 registers)

all of the 70632
registers

xmmu (XMMU function registers)

mmumod	XMMU function registers. These registers are **not actual 70632 registers**. Refer to the XMMU function section of the "Using the Emulator" chapter for the detail.
xatbr0 xatlr0	
xatbr1 xatlr1	
xatbr2 xatlr2	
xatbr3 xatlr3	

Function

The **<REG_CLASS>** names may be used in the **reg** (register) command to display a class of 70632 registers. The **<REG_NAME>** names may be used with the **reg** command to either display or modify the contents of an 70632 register. Refer to your 70632 user's manual for complete details on the use of the 70632 registers.

Related Commands

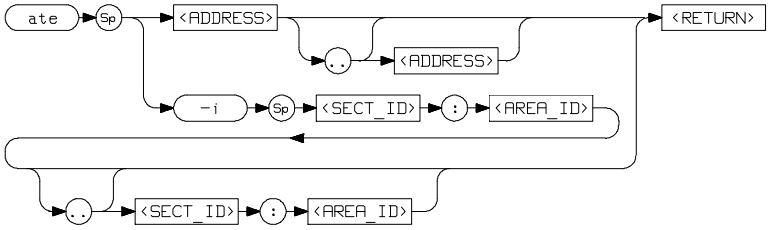
reg (register display/modify)

ate

Summary

Display processor's area table entry for specified address in default virtual address space.

Syntax



Function

The **ate** command allows you to display a 70632 area table entry for the address which you specify. The virtual address space which is used for displaying area table entry depend on the contents of register mmumod and whether the emulator is restricted real-time runs.

When the values which are equivalent to the area table register pairs are invalid, or the corresponded area table entry is invalid or out-of-bounds, error messages will be displayed. The values mentioned above are defined by the contents of either caches or XMMU class registers. Refer to the "Virtual Address Translation" section of chapter 4.

Parameters

-i The **-i** option allows you to specify the area table entry by using section ID and area ID

<ADDRESS> Specifies the virtual address which belongs to the area based on the area table entry. You cannot specify the address with real address by adding suffix "@r". If you specify the address with no suffix, the address is interpreted as virtual. The only bits 20 to 31 of the **<ADDRESS>** are effective.

Refer to the **<ADDRESS>** syntax pages in this chapter.

<SECT_ID> Specifies the ID number of the section which includes the area pointed by the area table entry. **<SECT_ID>** is a hexadecimal value from 0 to 3.

<AREA_ID> Specifies the ID number of the area pointed by the area table entry. **<AREA_ID>** is a hexadecimal value from 0 to 3ff.

Note 

As noted in the syntax, an address/IDs followed by two periods (..) and another address/IDs specifies a range of addresses/IDs to display. If you specify only the first address/IDs of a range followed by two periods and omit the second address/IDs of the range, four are table entries of the range starting at the first address/IDs specified are selected for display.

Defaults One address or one pair of IDs must be specified.

Examples

```
ate 12345678
ate -i 2:2de
```

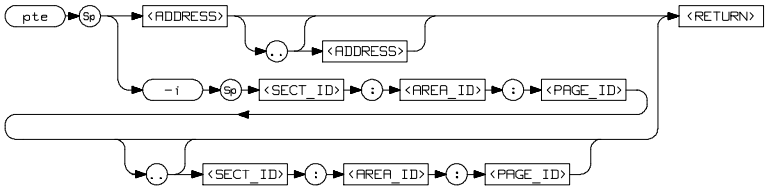
Related Commands **pte**

pte

Summary

Display processor's page table entry for specified address in default virtual address space.

Syntax



Function

The **pte** command allows you to display a 70632 page table entry for the address which you specify. The virtual address space which is used for displaying page table entry depend on the contents of register mmumod and whether the emulator is restricted real-time runs.

When the values which are equivalent to the area table register pairs are invalid, or the corresponded area table entry or the corresponded page table entry is invalid or out-of-bounds, error messages will be displayed. The values mentioned above are defined by the contents of either caches or XMMU class registers. Refer to the "Virtual Address Translation" section of chapter 4.

Parameters

-i The **-i** option allows you to specify the page table entry by using section ID, area ID and page ID.

<ADDRESS> Specifies the virtual address which belongs to the page based on the page table entry. You cannot specify the address with real address by adding suffix "@r". If you specify the address with no suffix, the address is interpreted as virtual. The only bits 20 to 31 of the **<ADDRESS>** are effective.

Refer to the **<ADDRESS>** syntax pages in this chapter.

<SECT_ID> Specifies the ID number of the section which includes the page pointed by the page table entry. **<SECT_ID>** is a hexadecimal value from 0 to 3.

<AREA_ID> Specifies the ID number of the area which includes the page pointed by the page table entry. **<AREA_ID>** is a hexadecimal value from 0 to 3ff.

<PAGE_ID> Specifies the ID number of the page pointed by the page table entry. **<PAGE_ID>** is a hexadecimal value from 0 to 0ff.

Note 

As noted in the syntax, an address/IDs followed by two periods (..) and another address/IDs specifies a range of addresses/IDs to display. If you specify only the first address/IDs of a range followed by two periods and omit the second address/IDs of the range, four are table entries of the range starting at the first address/IDs specified are selected for display.

Defaults One address or one pair of IDs must be specified.

Examples

```
pte 12345678
pte -i 2:2de
```

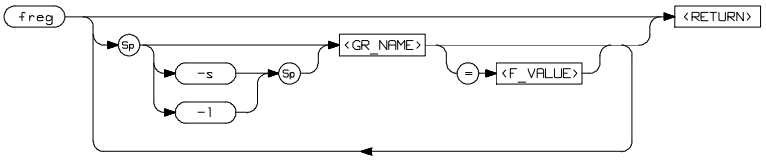
Related Commands **ate**

freg

Summary

Display and modify the 70632 general purpose registers using floating point format.

Syntax



Function

The **freg** command allows you to display and modify the 70632 general purpose register contents. The general purpose registers (R0 through R31) may be displayed or modified in short or long format; combinations of display and modify or short and long formats are permitted on the same command line.

Parameters

<GR_NAME> The **<GR_NAME>** parameter allows you to specify a specific register to display or modify. The valid register names are the following registers.

r0 r1 r2 r3 r4 r5 r6 r7 r8 r9 r10 r11 r12 r13 r14 r15 r16 r17 r18 r19 r20 r21 r22 r23 r24 r25 r26 r27 r28 r29 r30 r31

<F_VALUE> To modify a register's contents, supply the new contents in the **<F_VALUE>** variable. This is a floating-point value.

-s Specifies the display or modification format as short floating-point format.

-l Specifies the display or modification format as short floating-point format. If **-l** option is specified, you can not specify register **r31** in the <**GR_NAME**>.

Defaults

If no <**GR_NAME**> is specified, all of the general purpose registers are displayed in short float format. The **-s** option is in effect, if no option is specified. If one of the options is specified, you cannot omit the <**GR_NAME**>.

Examples

```
freg
freg -s r0 r1 r2
freg -l r30
freg -s r0=123.456
freg -s r0=1.23456e+10
freg -l r0=5678.123 -s r3=987.543
```

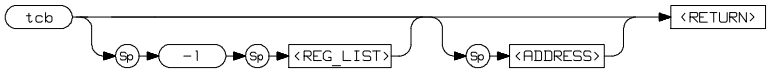
Related Commands

reg

tcb

Summary Display processor's TCB of specified address in default virtual address space.

Syntax



Function The **tcb** command allows you to display the task control block.

Parameters

-l	The **-l** option allows you to specify the register list to display the complete TCB contents.
<REG_LIST>	Specifies the register list to display the complete TCB contents with **-l** option. The register list specifies registers to be stored to or loaded from TCB when the task is switched. The format of the register list is same as the 70632 processor's LDTASK or STTASK instruction operand. **<REG_LIST>** is a value from 0 to 07ffffff (hex).
<ADDRESS>	Specifies the address which is the base address of the TCB to be displayed. Refer to the **<ADDRESS>** syntax pages in this chapter.

Defaults If no option is specified, only the contents of register SYCW and stack pointers for each level in the current TCB are displayed. If **<ADDRESS>** is not specified, the TCB contents of the current task which is specified by register TR contents are displayed.

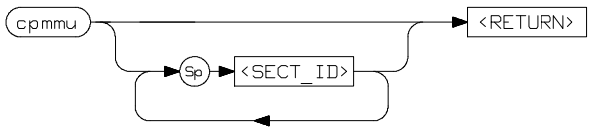
Examples

```
tcb
tcb -l 07fff0000
tcb 12345678
tcb -l 07fffffff 12345678
```

cpmmu

Summary Copy the contents of the current area table register pairs to XMMU class registers.

Syntax



Function The **cpmmu** command allows you to copy the contents of the current area table register pairs to XMMU function registers. You can specify the IDs of the sections which correspond to the area table register pairs. After you set up the XMMU function registers, activate the XMMU function by modifying the mmumod register to the value 1. The XMMU function allows you to specify a virtual address space where the virtual address which you specify in a certain command is interpreted by the emulator. The virtual address is defined by the contents of XMMU function registers, if activated. Refer to the "Using the XMMU Function" section of chapter 4.

Parameters

<SECT_ID> Specifies the ID number of the section which correspond to the area table register pair to be copied to XMMU function registers. **<SECT_ID>** is a value from 0 to 3.

Defaults If no **<SECT_ID>** is specified, all of the area table register pairs are copied to the XMMU function registers.

Examples

```
cpmmu
cpmmu 0
cpmmu 0 1
```

Error and Status Message

The following are error and status messages which are unique to the 70632 emulator.

The following are ERROR messages which are of the form

!ERROR XXX! error message where XXX is the error number

140 "Cannot access target memory; Not in-circuit"

146 "Unable to load user supplied foreground monitor"

147 "Area table register pair not valid (atbr%d)"

148 "Area out of bounds: (sect%x area=%03x..%03x)"

149 "Area table entry not valid (ate%x:%x=%08x,%08x)"

150 "Page table not exist (ate%x:%x)"

151 "Page out of bounds: (ate%x:%x page=%02x..%02x)"

152 "Page table entry not valid (pte%x:%x:%x=%08x)"

153 "Page not exist: %s"

154 "Address translation failed"

155 "Page mapped as I/O port: %s"

156 "Page not mapped as I/O port: %s"

157 "Page locked: %s"

The following are STATUS messages which are of the form

!STATUS XXX! status message where XXX is the status number

152 "Target system has been switched off"

153 "Target system has been switched on"

Notes

B

Using the Foreground Monitor

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. 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.

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.

Foreground Monitor Selection

The HP 64758 emulator provides two kinds of foreground monitor. One is included in the emulator, the other is provided with assembler source file.

The foreground monitor included in the emulator allows you to use the foreground monitor quickly. When you use this built-in foreground monitor, you do not have to assemble, link and load the monitor program.

The foreground monitor provided with assembler source file allows you to customize the foreground monitor as you desire. When you use this custom foreground monitor, you need to assemble, link and load the monitor program.

Using Built-in Foreground monitor

The 70632 emulator includes foreground monitor. The built-in foreground monitor saves your tasks for assembling, linking and loading the monitor. To use the built-in foreground monitor, all you have to do is to specify the location of the monitor. The location is

specified by the configuration item "**cf mon=fg**". Specify the monitor location (real address) as follows.

```
R>cf mon=fg..<real_address>
```

When your application is executed in virtual mode, you should also specify the virtual memory location for the monitor. The address translation tables for the monitor must be set up.

```
R>cf
mon=fg..<real_address>,<virtual_addres
s>
```

After you issued the configuration command, the built-in foreground monitor is set up automatically.

Interrupt/Exception Handler

The foreground monitor supports interrupt/exception handler. The interrupt/exception handler allows you to break the emulator into monitor when a certain interrupt or exception is generated.

When you issue the "**cf mon=fg**" command, six equation label pairs are defined. These equation label pairs contain the entry addresses of the handlers, which are included in the foreground monitor. One of each equation label pair contains real address of the entry, the other (which has "V" prefix) contains virtual address of the entry. The description of these equation label pairs are as follows.

```
real address entry,  virtual address entry,   description

NMI_ENTRY            VNMI_ENTRY               NMI handler entry
INT_ENTRY            VINT_ENTRY               INT handler entry
EXC1_ENTRY           VEXC1_ENTRY              3 words stacking Exception handler entry
EXC2_ENTRY           VEXC2_ENTRY              4 words stacking Exception handler entry
STEP_ENTRY           VSTEP_ENTRY              Single-Step Trap handler entry
BRK_ENTRY            VBRK_ENTRY               Breakpoint Instruction Trap handler entry
```

Either of each equation label pair can be used so that vectors in system base table point to the corresponded handlers, if desired. The system base table must be defined in your program. For using single-step and software breakpoint features the single-step trap and breakpoint instruction trap handler entries must be set up.

For example, if you wish to use the emulator's single-step feature, you must define the single-step trap handler entry in the corresponded vector table.

```
M>m -dd 30=STEP_ENTRY
```

If you use the single-step feature in virtual mode, you should have entered the following command instead.

```
M>m -dd 30=VSTEP_ENTRY
```

According to the system base table location, you may have to change the address (in this case, 30H) to be modified.

Using Custom Foreground monitor

The custom foreground monitor allows you to customize the monitor for your target system. To use the monitor, you need to assemble, link and load the monitor program into emulator.

The monitor program is provided with HP 64758 emulator. You should modify the following statement of the monitor program to specify the monitor location.

```
.text   "FG_MON" > 0x000000000
```

The default monitor location is defined at address 000000000 (hex).

To tell the monitor location to the emulator, you should specify the monitor location (real address) as follows.

```
cf mon=fg..<real_address>
```

When your application is executed in virtual mode, you should also specify the virtual memory location for the monitor. The address translation tables for the monitor must be set up.

```
cf
mon=fg..<real_address>,<virtual_addres
s>
```

After you issued the configuration command, you must load the monitor program into the emulator. The memory for the foreground monitor is already mapped when configuring the monitor location.

Interrupt/Exception Handler

The foreground monitor supports interrupt/exception handler. The interrupt/exception handler allows you to break the emulator into monitor when a certain interrupt or exception is generated.

In the foreground monitor program, some entry labels of the handlers are defined. See the monitor program for these entry labels. Write these labels in your program's system base table description. When you link the foreground monitor with your program, these labels will be referred

by your program. The system base table must be defined in your program.

To use the single-stepping and/or software breakpoints feature(s), you must define the single step trap vector and/or the breakpoint instruction trap vector into the system base table. When you use these features in virtual mode, you must set up these vectors to point to their handler's entry in the foreground monitor in virtual address.

Even if you link the monitor with your program, you should also prepare the absolute file separated from user program to load the monitor program.

Loading Foreground Monitor

To load the monitor program, enter the following command; whether or not the monitor program is linked with your program.

```
R>load -fios "cat
<foreground_monitor>"
```

The "**-f**" option was used to load the foreground monitor program. According to file format and terminal configuration, the rest options (ios) may be different. You should specify the file name of the foreground monitor absolute separated from your program. After loading the monitor, map the memory for your program and load your program into the emulator.

Loading User Program

To load your program into target memory and emulation memory, do the following.

Loading into Target Memory

To load the program into target memory, enter the following commands.

```
R>b
M>load -uios "cat <user_program>"
```

The first command (**b**) cause the emulator to break into the monitor. For loading into target memory, the emulator must be running in monitor.

The "**-u**" option specify to load only target memory portion of the program.

Loading into Emulation Memory

To load the program into emulation memory, enter the following commands.

```
M>rst
R>load -eios "cat <user_program>"
```

The first command (**rst**) causes the emulator to reset. For loading into emulation memory (which includes monitor program portion), the emulator must be reset.

The "**-e**" option specifies to load only emulation memory portion of the program.

Restrictions and Considerations

When using the foreground monitor, there are some restrictions and considerations.

Cannot Single-step the Instruction RETIS and RETIU

The foreground monitor cannot step the RETIS and RETIU instruction. If you step either the RETIS or RETIU instruction, the emulator cannot break into monitor. As a result, the emulator runs your program without stepping.

Two Pages for the Monitor Program Must be Set Up

When you use the foreground monitor in virtual mode, the address translation tables for the foreground monitor must be set up. The monitor occupies one page (4 Kbytes memory), and further, one more page is required for accessing to target memory. In virtual mode, when accessing to target memory, the monitor modifies the page table to point to the target memory to be accessed to. The page must follows the foreground monitor page. For this reason, you must set up the address translation tables of two pages for the foreground monitor.

Monitor Must be Located at the Same Virtual Address Always.

The foreground monitor must be located at the same virtual address whenever virtual space is changed. This allows the emulator to break into monitor in any virtual space.

An Example Configuration of the Foreground Monitor

In the following example, we will illustrate how to set up the emulator to use the custom foreground monitor in virtual mode.

For this example, we will locate the monitor at 400000000h (virtual) and 1000h (real).

Modify Monitor Source Program

To use the monitor, you must modify the following statement near the top of the monitor program. In this example, the monitor will be located at 40000000h in virtual.

```
.text   "FG_MON" > 0x40000000
```

Defining System Base Table in Your Program

To use the single-step and software breakpoint feature of the emulator, you must define the single-step trap and breakpoint instruction trap vector into the system base table. Assuming that the system table description in **your program** as follows.

```
.data "sys_base"
.word  .....       -- + 00
.word  .....       -- + 04
.word  NMI_ENTRY   -- + 08
.word  .....       -- + 0C
         :
         :
.word  STEP_ENTRY  -- + 30
.word  BRK_ENTRY   -- + 34
         :
         :
```

The NMI_ENTRY label is also defined to break the emulator into monitor when NMI signal is generated.

Defining Address Translation Tables for Monitor Program

The following statements define two page tables for monitor program. The real address location of label PTE_FGMON must be pointed by the Area Table Entry of Section 1, Area 0 because the monitor location is 40000000h (virtual).

```
PTE_FGMON:    .word   0x00001e05  -- for foreground monitor location
              .word   0x00001e05  -- for accessing to target memory by monitor
```

The PTE in the second line must be defined to access to target memory

by monitor program. The monitor modifies the PTE to point to target memory location to be accessed. Initially, the PTE had better point to the foreground monitor location.

Note that the foreground monitor must be reside in the fixed virtual address, even if virtual space is changed. This allows the emulator to break into monitor in any virtual space.

Assembling and Linking the Foreground Monitor

To refer to these labels (in this example, NMI_ENTRY, STEP_ENTRY and BRK_ENTRY), the foreground monitor program and your program should be linked together. Suppose that the generated absolute file name is "usr_prog.x".

You must prepare another absolute file which contains only foreground monitor program. The absolute file will be used to load the monitor program into the emulator. Suppose that the generated absolute file name is "monitor.x".

Setting Up the Monitor Configuration Item

The following command should be issued to tell the use of foreground monitor and the location of the monitor to the emulator.

```
R>cf mon=fg..1000,40000000
```

Mapping Memory for Your Program

Map memory for your program by using **map** command. The monitor location is already mapped as emulation RAM (eram).

Loading Foreground Monitor

Load the foreground monitor program.

```
R>load -fios "cat monitor.x"
```

The linked monitor program (monitor.x) is separated from user program. In this example, the Intel hexadecimal format and transparent configuration are assumed.

Loading User Program

Load the target memory portion of your program. To load the program into target memory, the emulator must be running in monitor.

```
R>b
M>load -uios "cat usr_prog.x"
```

Next, load the emulation portion of your program. Since the portion includes the foreground monitor program, which is linked to refer to the symbols (in this example, STEP_ENTRY, BRK_ENTRY and NMI_ENTRY), the monitor program should not be running. Therefore, reset the emulator.

```
M>rst
R>load -eios "cat usr_prog.x"
```

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Notes