# SPARC

# SH Series Simulator/Debugger

# User’s Manual

# Preface

The SPARCstation[*1] SH Series Simulator/Debugger (referred to in this manual as the simulator/debugger) is a software tool that simulates execution of programs for the SH series of single-chip 32-bit microcomputers on the SunOS[*2] to support program development and debugging.

This manual gives a general description of the functions and usage of the simulator/debugger.

Related information concerning the SH-series microcomputers and their C compiler, assembler, linkage editor, and librarian can be found in the following manuals.

- SH7032, SH7034 Hardware Manual
- SH Series C Compiler User's Manual
- SH Series Cross Assembler User's Manual
- SH Series Linkage Editor User's Manual
- SH Series Librarian User's Manual

Notes: 1. SPARCstation is a registered trademark of SPARC International Inc. It is developed by the Sun Microsystems Corp.
2. SunOS is a trademark of Sun Microsystems Corp.

# Notation

The following notational conventions are used in this manual.

1. {A|B} means that either A or B must be selected, but not both.

2. [A] means that A may be omitted.

3. Information to  be keyed in by the user is underlined.

4. <CTRL> + <\> means to press the back slash (\) key while pressing the control key.

5. <CTRL> + <C> means to press the C key while pressing the control key.

6. (RET) indicates the return key.

7. (LF) indicates the line-feed key.

8. A triangle (Δ) indicates one or more spaces or tabs.

9. Hexadecimal values are preceded by H'. (Example:  H'F81A)

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# Section 1 Overview

The SH-series simulator/debugger provides simulation and debugging functions for SH-series microcomputer CPUs and supports efficient debugging of software written in either C or assembly language.

When used in conjunction with the following software, the SH-series simulator/debugger reduces the effort required for software development.

- SH Series C compiler
- SH Series cross assembler
- H Series linkage editor
- H Series librarian
- H Series object converter
- SH Series CPU information analysis program

## 1.1 Features

- Since the simulator/debugger runs on a host computer, software debugging can start without using an actual SH-series target system, thus reducing overall system development time.
- A designated CPU information file can be used to specify an environment corresponding to any of the memory maps used with the SH-series MCUs.
- The simulator/debugger provides the following functions which enable efficient program testing and debugging.

    — The ability to handle all of the SH7000 CPUs
    — C debugging functions
    — Debugging functions for optimized C programs (which may differ from those of non-optimized C programs)
    — Test functions (stub, coverage measurement)
    — Subroutine execution functions
    — Macros (command combinations)
    — Tracing instructions or subroutines
    — Functions for stopping or continuing execution when an error occurs during object program execution
    — Standard I/O and file I/O
    — A comprehensive set of break functions
    — Saving the execution history to a file
    — Saving command lines to a file, and inputting command lines from a file

## 1.2 Debugging Object Programs

The simulator/debugger can debug object modules generated by a C compiler or cross assembler, and load modules generated by a linkage editor. These object modules and load modules are referred to as debugging object programs.

Figure 1-1 shows the software associated with creating debugging object programs.

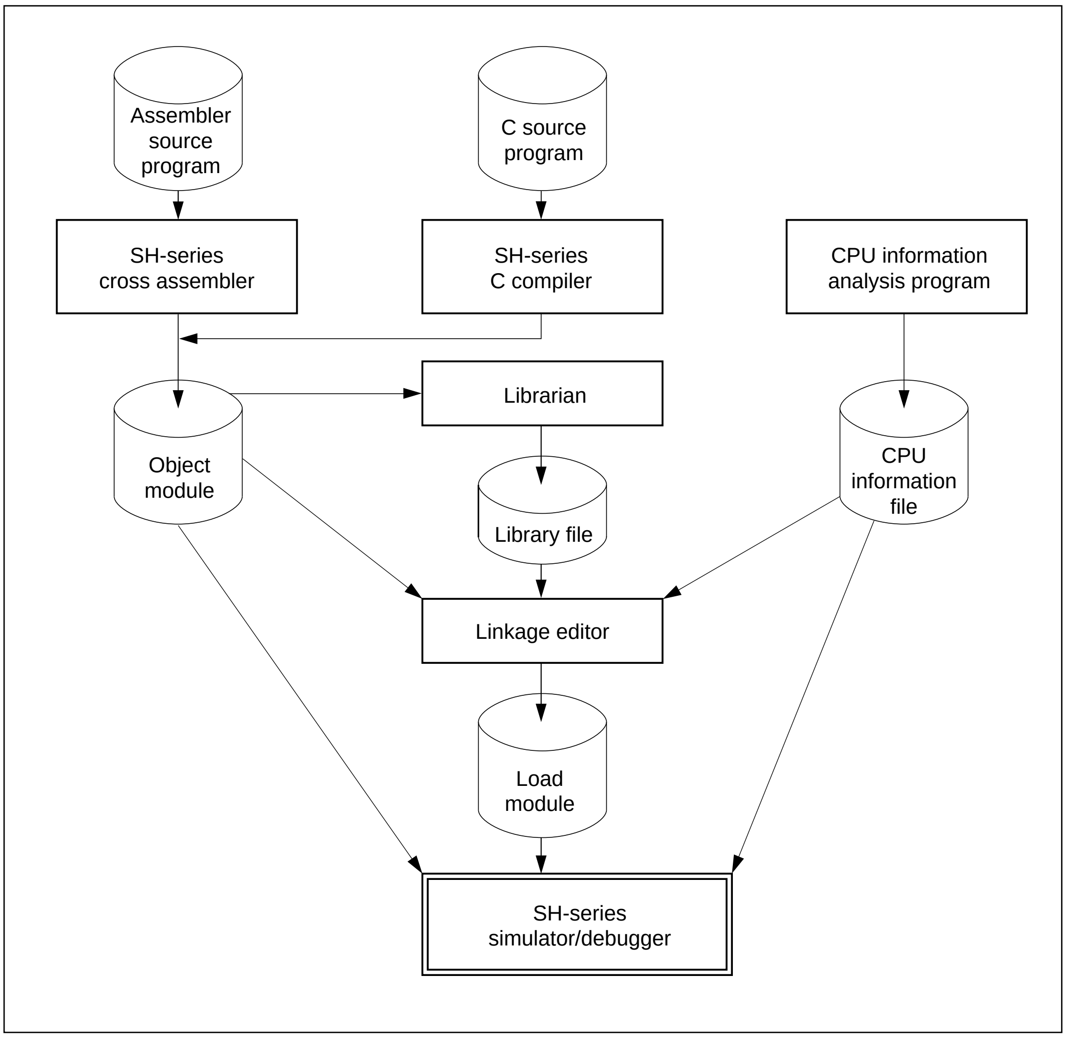


**Figure 1-1 Methods for Creating Debugging Object Programs**

## 1.3 Simulation Range

1. The simulator/debugger supports the following SH-series MCU functions.

   - All executable CPU instructions (including delayed branch instructions)
   - Exception processing
   - General registers, control registers, and system registers
   - All address areas

   Refer to the SH Series Programming Manual for details regarding the delay branch instructions.

2. The simulator/debugger does not support the following SH-series MCU functions. Programs which use these functions must be debugged using the SH-series emulator.

   - Direct memory access controller (DMAC)
   - Watchdog timer (WDT)
   - Integrated timer pulse unit (ITU)
   - Serial communications interface (SCI)
   - A/D converter
   - I/O port
   - Timing pattern controller (TPC)
   - Interrupt controller (INTC)
   - User break controller (UBC)

# Section 2   Simulator/Debugger Functions

## 2.1 Environment Specification

The simulator/debugger handles SH7000 CPUs.

When creating a CPU information file, use the CPU information analysis program (CIA) to select the CPU type. Details of the CIA program are given in part II, CPU Information Analysis Program, of this manual.

The instructions that can be used differ according to the CPU type. Refer to the SH Series Programming Manual for details of the CPU specifications.

## 2.2 Simulator/Debugger Memory Management

### (1) Memory Map Specification

The simulator/debugger supports the memory types shown in table 2-1.

**Table 2-1 Memory Types**

| Memory Type | Access Type | Debugging Object Program Execution |
|---|---|---|
| Internal ROM | Read only | Yes |
| Internal RAM | Read/write | Yes |
| External bus area | Read/write | Yes |
| Internal I/O area | Read/write | No |

The SH-series CPU memory map is a combination of the above memory types. The user must create a CPU information file which correctly specifies the memory map for the CPU used.

The CPU information analysis program is used to create a CPU information file. This file can be used to specify the CPU (its type and address bus width) and the memory (its types, the start and end addresses of the memory areas, the number of memory access states, and the memory data bus width).

When the simulator/debugger is started, a memory map corresponding to the user system is created from the specified CPU information file. (When no file is specified, external bus area is assumed.)

**(2)  Memory Allocation**

When the simulator/debugger is started or when a LOAD command is entered, the simulator/debugger allocates memory on the host computer for both the SH-series debugging object program load area and the vector area.  Areas other than these are allocated with the MAP command.

a. Vector area

   When a vector area is allocated by the debugging object program, it must be specified as an absolute address section starting at location H'0.  The simulator/debugger allocates addresses H'0 to H'3FF as the vector area when no absolute address section has been allocated in this area.

b. Stack area

   Although the stack pointer is set to the address following the end address of the internal RAM, no stack area is allocated.

   When there is no stack area allocated within the debugging object program, allocate a stack area using the simulator/debugger MAP command.

   When there is no internal RAM space, the stack pointer will be cleared to 0.

   When there is a stack area allocated within the debugging object program, set the stack pointer either by an instruction included in the program or by a .<register> command.

c. Undefined symbol area

   When the U option is specified with the LOAD command, a 4-byte area is allocated for each undefined symbol and taken as the symbol’s address.  Undefined symbol areas are allocated to an empty area in either the external bus area or the internal RAM.

**(3)  Memory Access Types**

The memory access type is determined from the memory type corresponding to the load address of the debugging object program.  The memory access type can be either read-only or read/write.  Since it is an error for the debugging object program to write to read-only memory, it is possible to detect memory access errors.  The memory access type for each memory area can be changed with the MAP command.

## 2.3 Loading Debugging Object Programs

The simulator/debugger loads debugging object programs in the order that sections appear in the source program. The loading method differs depending on whether the section is relocatable or not, as described below.

### (1) Relocatable Sections

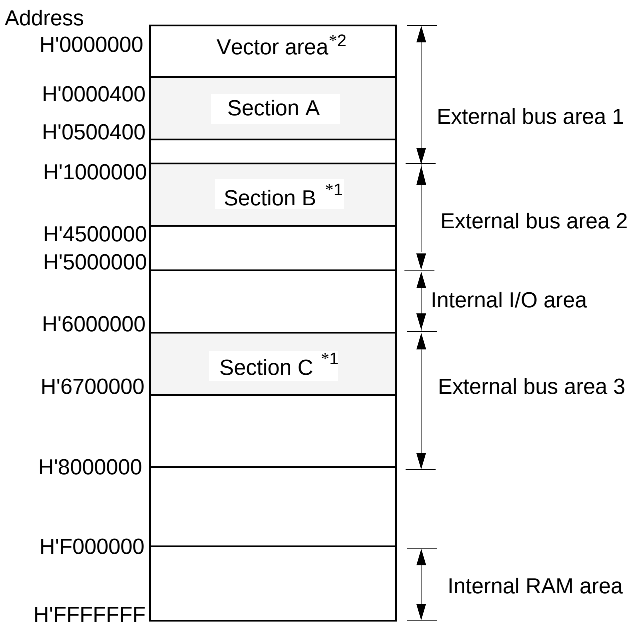
Individual sections are loaded consecutively starting at address H'400 so that they do not cross boundaries between the internal ROM space, the internal RAM, and the internal I/O area.

Example: If a program consists of three relocatable sections, use a memory map based on the SH7000 memory map (mode 0) with an external bus area set up as shown in table 2-2.

**Table 2-2 Example Memory Map**

| Memory Type | Address | Number of States | Data Bus Width |
|---|---|---|---|
| External bus area 1 | H'0000000 to H'0FFFFFF | 3 | 8 |
| External bus area 2 | H'1000000 to H'4FFFFFF | 2 | 8 |
| Internal I/O area | H'5000000 to H'5FFFFFF | 3 | 8 |
| External bus area 3 | H'6000000 to H'7FFFFFF | 3 | 8 |
| Internal RAM | H'F000000 to H'FFFFFFF | 1 | 32 |

Figure 2-1 shows the sizes and load addresses of the three relocatable sections.



| Section | Load Address | Size |
|---|---|---|
| A | H'400 | H'500000 |
| B | H'1000000[*1] | H'3500000 |
| C | H'6000000[*1] | H'700000 |

Notes: 1. Since section B would cross the boundary between external bus areas 1 and 2 if it was loaded following section A, it is loaded from the start address of external bus area 2, i.e.,address H'1000000. Similarly, section C is loaded from the start address of external bus area 3, i.e., address H'6000000 so that it does not cross the boundary between external bus areas 2 and 3. Relocatable sections cannot be loaded to the internal I/O area.

2. Regions allocated when the simulator/debugger is started up.

**Figure 2-1 Relocatable Section Load Map**

### (2) Absolute Address Sections

Absolute address sections are loaded at the specified address. A load error is generated if the absolute address section crosses any of the boundaries between the internal ROM area, the external bus area, the internal RAM area, and the internal I/O area. This makes it possible to verify that absolute address sections are correctly loaded into the appropriate memory area.

An error occurs if the load address of either a relocatable section or an absolute section exceeds the

CPU addressing range.  A load error also occurs if an attempt is made to load a program into an invalid memory area (an area which does not correspond to the actual memory) which the user specified.

Relocatable sections cannot be loaded to the internal I/O area.

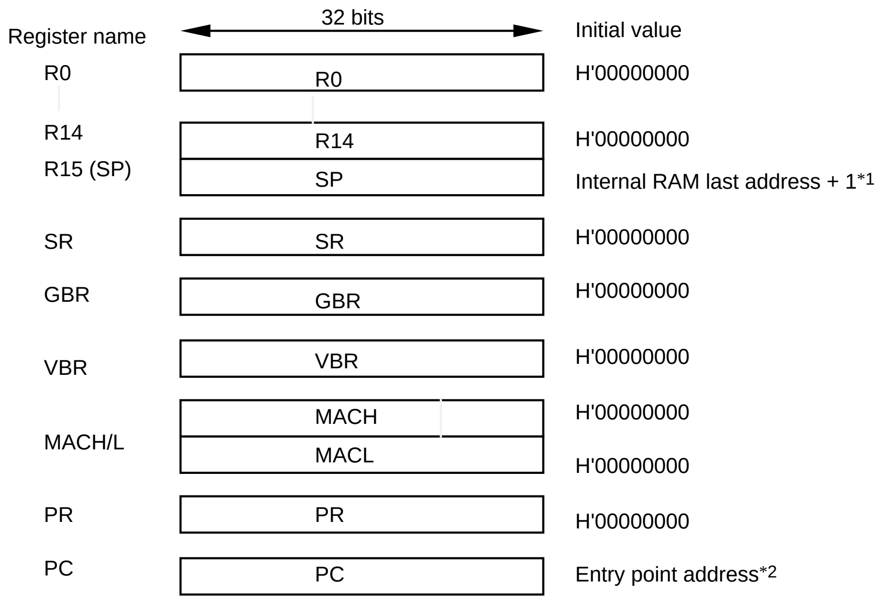
## 2.4 Setting Register Initial Values, Displaying and Changing Register Values

The simulator/debugger supports the following SH-series registers.

- General registers (R0 to R15, SP(R15))
- Control registers (SR, GBR, VBR)
- System registers (MACH, MACL, PR, PC)

### (1)  Initial Register Values

Figure 2-2 shows the initial values when the simulator/debugger is started up.



Notes:  1.  The address following the last address of internal RAM is loaded into R15.  When there is no internal RAM , R15 is set to H'00000000.

2  The entry point address is the address within the section specified either by the assembler .END directive or the ENTRY option of the linkage editor.  The start address of the first section of code is used if no entry point is specified.  If there is no code section, this resister is set to 0.

**Figure 2-2   Initial Register Values**

**(2) Displaying and Changing Register Values**

The REGISTER command is used to display and confirm the contents of the global, control, and system registers.

The .<register> command is used to change the values of these registers.

## 2.5 Displaying the Memory Map, and Allocating, Displaying, Changing, and Releasing Memory

**(1) Displaying Section Addresses and the Memory Map**

The addresses where the debugging object program is loaded can be confirmed by using the MAP command to display the section addresses.

In addition, the MAP command M option can be used to display the memory map from the CPU information file specified at simulator/debugger start-up.

**(2) Memory Area Allocation**

The MAP command is used to allocate vector areas and stack areas, and to allocate memory areas which have not yet been allocated by the debugging object program.

The following conditions must be satisfied when allocating an area, otherwise an error will occur.

- The allocated area must not overlap a previously allocated section.
- The allocated area must not cross over the boundary between two different memory types.
- The allocated area must not include any part of an invalid area.

The MAP command can allocate a maximum of 20 memory areas.

**(3) Displaying Memory Contents**

The memory contents can be displayed by using the DUMP or DISASSEMBLE command.

- DUMP: The memory contents of the specified address range are displayed as hexadecimal and ASCII data, or in floating point format.

- DISASSEMBLE: The memory contents of the specified address range are displayed as instruction mnemonics and operands.

An error is generated if an unallocated area is specified as the memory area.

**(4) Changing the Contents of Memory**

The contents of memory can be changed by using the MEMORY or ASSEMBLE command.

- MEMORY: The input values are converted to hexadecimal and stored in the specified address.

- ASSEMBLE: The instruction mnemonics and operands are converted to instruction codes and stored in the specified address.

The MEMORY and ASSEMBLE commands continue converting and storing contents to memory (updating the storage address each time) until a termination symbol is read.

**(5) Releasing a Memory Area**

Memory areas allocated with the MAP command can be released. The simulator/debugger commands operate as follows when a memory area is released.

- If a break has been set with a break-related command, it will be cancelled.

- The LOAD_STATUS command retains the released state.

- The SET_COVERAGE command treats released sections as errors at DISPLAY_COVERAGE execution.

- The TRACE command displays an error during assembly and display.

## 2.6 Execution and Trace

### (1) Execution Types

The simulator/debugger supports five ways of executing programs that are being debugged: continuous execution, single instruction execution, single line execution, single function (subroutine) execution, and execution starting from an interrupt vector address.

a. Continuous execution

   The GO command starts continuous execution of the object program. Continuous execution starts from the specified starting address or from the current value of the program counter. Execution continues until a break condition is satisfied or until execution is forcibly terminated by a (CTRL) + (C). When execution stops, the simulator/debugger displays the number of instructions executed, the contents of the registers, the last instruction executed (as a disassembled instruction), and termination information messages.

b. Single instruction execution

   When the N or I option is specified with the DEBUG_LEVEL command, the execution unit for the STEP and STEP_INTO commands becomes the single instruction. (The STEP command executes subroutines as a single step.) Each time a single instruction is executed, the mnemonic of the executed instruction is displayed. If the R option was specified, the contents of the registers after execution is also displayed.

c. Single line execution

   When the S option is specified with the DEBUG_LEVEL command, the execution unit for the STEP and STEP_INTO commands becomes the single line.

d. Single function execution

   In single function execution, the CALL command creates the C language function call stack frame, and the simulator/debugger executes the function. Execution is stopped immediately if an error occurs or if a break condition is satisfied.

e. Execution starting from an interrupt vector address

The simulator/debugger generates a vector address from the vector number specified with the VECTOR command and initiates interrupt processing. Execution continues until a break condition is satisfied or until execution is forcibly terminated by a <CTRL> + <C>. When execution stops, the simulator/debugger displays the number of instructions executed, the contents of the registers, the last instruction executed (as a disassembled instruction), and termination information messages.

**(2) Trace**

When trace is enabled during instruction execution, the results of the execution of each instruction are written into the trace buffer. The trace buffer can hold the results for up to 1023 instruction executions. (When the 1023th instruction is a delayed branch instruction, the trace buffer can store up to 1024 instruction executions.) The TRACE_CONDITION command enables tracing, and the TRACE command displays the acquired trace information.

The following information is stored in the trace buffer.

- The values of the general registers (R0 to R15, SP(R15))
- The values of the control registers (SR, GBR, VBR)
- The values of the system registers (MACH, MACL, PR, PC)
- The accessed memory data

Note that the TRACE_CONDITION command is used to specify the types of acquired instructions traced, the tracing start and end points, and the processing performed when the trace buffer becomes full.

In addition, the SHOW_CALLS command can display the functions called before arriving at the current execution address. SHOW_CALLS displays the line numbers called in reverse order. The file name, function name, line number, and arguments of the called functions are displayed.

## 2.7 Exception Processing

The simulator/debugger generates exception processing corresponding to the TRAPA instruction, general illegal instructions, slot illegal instructions, and address errors. (Other exception processing is supported as simulates exception processing by the VECTOR command.)

Exception processing simulation is performed in the following sequence.

- When the EXEC-MODE command select continuous mode:

1 The simulator/debugger detects the exception generated during instruction execution.

2 PC and SR are saved in the stack area. If an error occurs during the saving operation, the simulator/debugger stops exception processing, indicates occurrence of an exception processing error, and enters command input wait state.

3. The start address is read out of the vector address corresponding to the vector number. If an error occurs during this read operation, the simulator/debugger stops exception processing, indicates occurrence of an exception processing error, and enters command input wait state.

4. Instruction execution is simulated from the start address. If the start address was 0, the simulator/debugger stops exception processing, indicates occurrence of an exception processing error, and enters command input wait state.

- When the EXEC-MODE command selects stop mode:

The simulator/debugger executes the above steps 1 to 3, and stops.

Note: In the SH-series, the stack address which saves the PC and SR during exception processing differs depending on the access size, the type of memory, and the bus width. The addresses used by the simulator/debugger to save PC and SR are shown in table 2-3. These can be used to easily determine the values of PC and SR at the time of exception processing.

**Table 2-3 Stack Addresses Used to Save PC and SR**

| Type of Register | Stack Address |
|---|---|
| PC | The address of SP-8 when the exception processing occurs |
| SR | The address of SP-4 when the exception processing occurs |

## 2.8 Standard I/O and File I/O Processing

The simulator/debugger supports standard I/O and file I/O processing so that the object program can perform I/O from standard I/O (usually the console and keyboard) or from disk files.

The following 13 I/O processing types are supported.

- Single character input from standard input
- Single character output to standard output
- Single line input from standard input
- Single line output to standard output
- Single byte input from a file
- Single byte output to a file
- Single line input from a file
- Single line output to a file
- File open
- File close
- File pointer reference
- File pointer move
- EOF (end of file) check

The TRAP_ADDRESS command is used to implement these functions. The user writes a subroutine branch instruction (BSR or JSR) to a special location for I/O in the object program. The program is then executed by the simulator/debugger with that special location specified by the TRAP_ADDRESS command after starting the simulator/debugger. The simulator/debugger performs I/O processing with the contents of R0 and R1 as parameters when a subroutine call (BSR or JSR) to the specified location is detected during debugging object program execution.

The simulator/debugger restarts simulation at the instruction following the subroutine call instruction after completion of the I/O processing

## 2.9 Saving and Restoring the Simulation Status

### (1) Saving Simulation Status

The current simulation state can be saved using the SAVE_STATUS command. After executing this command, the LOAD_STATUS command can be used to return to the simulator/debugger status at the time the SAVE_STATUS command was executed. Command options can be used to specify the type of saved information. The following types of information can be saved.

- Option M: Saves only the current contents of memory and registers.

- Option A: Saves the complete, current status of the simulator/debugger.

### (2) Restoring Simulation Status

The LOAD_STATUS command restores the contents of memory and registers saved when the SAVE_STATUS command was executed.

Restoring the status saved when the A option was specified is not performed with the LOAD_STATUS command, but by a specification at simulator/debugger startup.

However, if the current memory map differs from the memory map in use, at the time the SAVE_STATUS command was executed, an error occurs and the state is not restored.

## 2.10 C Source Level Debugging

The simulator/debugger also provides functions for debugging programs written in C. The most important of these functions are described below.

### (1) C Source Line Display

The C source line is displayed at the time of disassembly display, trace display, coverage display, and step execution.

However, the format will differ depending on options specified by the DEBUG_LEVEL command.

### (2) Single Function and Single Source Line Stepping Function

The debugging object program can be executed in units of C source functions (subroutines) or lines.

Single function execution is performed using the CALL command, and single source line execution is performed using the DEBUG_LEVEL, STEP, or STEP-INTO command.

### (3) Symbol Reference

There are three classes of symbol scope in C: global symbols, which are valid over the entire program, static symbols, which are valid in a single file, and local symbols, which are valid within a function.

When only the name of the symbol is specified, symbols will be considered valid in the current file or function indicated by the program counter. The valid file and function names can be examined using the SCOPE command. Symbols in other files or functions can be examined by stating the name of the file and function explicitly. Symbol related information can also be examined using the SYMBOL command.

Table 2-4 shows debugging limitation, when a C program is compiled with optimization.

**Table 2-4 Limitations of C Debugging**

| Items | Limitations |
|---|---|
| 1 | Local symbols of the current function cannot be referenced. |
| 2 | Source lines deleted by optimization cannot be debugged. |
| 3 | Because lines may change places due to optimization, the program execution order or the disassembly display may differ from the order of the source listing.<br><br>Example:<br><br>Source listing<br>12 for (i = 0; i < 6; i++)<br>13 {<br>14 i_2 = i+1;<br>15 i_2++<br>16 }<br>17 i_2++<br><br>Simulator disassembly display<br>14 i_2 = i+1;<br>12 for (i = 0; i < 6; i++)<br>17 i_2++; |
| 4 | In “for” and “while” loops, disassembly display may be performed twice: once at the loop entrance and once at the loop exit. |

## 2.11 Break Conditions

The simulator/debugger provides the following conditions for breaking (interrupting) the simulation of an object program during execution started by a CALL, GO, STEP, STEP_INTO, or VECTOR command.

- Break due to satisfaction of a condition set by a break command
- Break due to detection of a run-time error in the object program
- Break due to overflow of the trace buffer
- Break due to execution of a SLEEP instruction
- Break due to input of (CTRL) + (C)

### (1) Break Due to the Satisfaction of a Condition Set by a Break Command

There are 5 break commands as follows:

| | | |
|---|---|---|
| • | BREAK: | Break based on the location of the instruction executed |
| • | BREAK_ACCESS: | Break based on access to a range of memory |
| • | BREAK_DATA: | Break based on the value of data written to memory |
| • | BREAK_REGISTER: | Break based on the value of data written to a register |
| • | BREAK_SEQUENCE: | Break based on a specified execution sequence |

When a break condition is satisfied while executing an object program, the instruction at the break point may or may not have been executed depending on the type of the break, as listed in table 2-5.

**Table 2-5 Processing When Satisfying a Break Condition**

| Command | Instruction When Satisfying a Break Condition |
|---|---|
| BREAK | Not executed |
| BREAK_ACCESS | Executed |
| BREAK_DATA | Executed |
| BREAK_REGISTER | Executed |
| BREAK_SEQUENCE | Not executed |

When a break condition is specified, the simulator/debugger program execution time increases. Table 2-6 shows which break types can increase program execution time.

**Table 2-6 Execution Time Increase Due to Break Condition Specifications**

| Command | Change in Execution Time Due to Break Condition Setting |
|---|---|
| BREAK | Not increased |
| BREAK_ACCESS | Increased |
| BREAK_DATA | Increased |
| BREAK_REGISTER | Increased |
| BREAK_SEQUENCE | Not increased |

If a break condition is specified at an address location other than the beginning of an instruction, the break condition will not be detected.

When a break condition is satisfied during object program execution, a break condition satisfaction message is displayed and execution stops.

**(2) Break Due to Detection of a Run-time Error in the Object Program**

The simulator/debugger supports a simulation error to detect program errors which cannot be detected by the CPU exception generation functions. The EXEC_MODE command specifies whether to stop or continue the simulation when such an error occurs. Table 2-7 lists the types of errors, the error causes, and the action of the simulator/debugger if execution continues.

**Table 2-7 List of Simulation Errors**

| Error Type | Error Cause | Processing in Continuation Mode |
|---|---|---|
| Memory access error | 1. Access to a memory area that has not been allocated | On memory write, nothing is written; on memory read, all bits are read as 1. |
| | 2. Write to a memory area having the write protect attribute | |
| | 3. Read from a memory area having the read disable attribute | |
| | 4. Access to a memory area where memory does not exist | |
| Invalid SP instruction | 1. Execution of an instruction that places R15 (SP) outside the four-byte boundary<br>MOV.B reg, @–R15<br>MOV.B @R15+, REG<br>MOV.W reg, @–R15<br>MOV.W @R15+, REG | The simulation continues identically to the operation of the device. |
| Illegal operation | 1. Zero division is executed by the DIV1 instruction. | The simulation continues identically to the operation of the device. |

If the simulator/debugger is in stop mode when a simulation error occurs, the simulator/debugger returns to command wait mode after stopping instruction execution and displaying the error message. Table 2-8 lists the states of the PC and SP at simulation-error stop.

**Table 2-8 Register States at Simulation Error Stop**

| Error Type | Value of the PC | Value of the SP |
|---|---|---|
| Memory access error | Error on instruction read: The address of the instruction that caused the error<br><br>Error during instruction execution: The address following the instruction that caused the error | Unchanged |
| Invalid SP instruction | The address of the instruction that caused the error | |
| Illegal operation | The address following the instruction that caused the illegal operation | |

Use the following procedure when debugging programs which include instructions that generate simulation errors.

a. First execute the program in stop mode and confirm that there are no errors except those in the intended locations.

b. After confirming the above, execute the program in continuation mode.

Note: If an error occurs in stop mode and simulation is continued after changing the simulator mode to continuation mode, the simulation may not be performed correctly. When restarting a simulation, always restore the register contents (general, control, and system registers) and memory contents to the state prior to the occurrence of the error.

The SAVE_STATUS and LOAD_STATUS commands can be used to save and restore the simulation state during debugging.

**(3) Break Due to Overflow of the Trace Buffer**

When the B option has been specified with the TRACE_CONDITION command, the simulator/ debugger stops execution when the trace buffer becomes full. The following message is displayed when execution is stopped.

```
TRACE BUFFER FULL
```

If execution is resumed with a GO, STEP, STEP_INTO, or VECTOR command the trace buffer is overwritten starting from the beginning of the buffer.

**(4) Break Due to Execution of a SLEEP Instruction**

When a SLEEP instruction is executed during simulation, the simulator/debugger stops execution. The following message is displayed when execution is stopped.

```
SLEEP
```

Execution can be resumed with a GO, STEP, STEP_INTO, or VECTOR command.

**(5) Break Due to Input of (CTRL) + (C)**

Execution can be forcibly terminated by the user during simulation using the above keys. The following message is displayed when execution is terminated.

```
MANUAL BREAK
```

Execution can be resumed with a GO, STEP, STEP_INTO, or VECTOR command.

## 2.12 Memory Manipulation

The simulator/debugger provides the COMPARE, FILL, and MOVE commands as functions to increase debugging ability.

1. The COMPARE command compares memory contents. It is used, for example, to compare the results of executions. The COMPARE command displays unmatched data.

2. The FILL command fills a memory area with initial data. It is used to initialize memory prior to program execution.

3. The MOVE command copies the contents of a specified memory area to a specified destination area.

## 2.13 Macro (Command Combination)

A macro function is a function that produces new commands by combining multiple commands. Macros can be created in the simulator/debugger by using the MACRO command.

Macros can use macro internal variables and macro internal commands. Macro internal commands are control commands which define macro internal conditions, or which can be executed.

The following macro internal commands are provided.

- WHILE
- FOR

- DO/WHILE
- IF/ELSE
- MBREAK
- CONTINUE

An executing macro command can be stopped by inputting (CTRL) + (C).

There is no limitation on the number of macro calls within a macro (the number of nesting levels).

Refer to section 5.24, MACRO (Definition, Display, Execution, and Deletion of Macro Commands), for details on the MACRO command.

## 2.14 Command Chains and Saving Execution Results to a File

**(1) Command Chains**

Commands can be input from files which are created with a text editor. Command files can be specified by the COMMAND_CHAIN command, or by a parameter when the simulator/debugger is started. It is possible to include data that makes use of standard I/O processing in command files.

**(2) Saving Execution Results to a File**

There are two methods for saving simulator/debugger execution results to a file: the PRINT command and redirection.

a. PRINT command

   The PRINT command saves to a file all command input and all execution results during the time that saving is specified. In addition, saving can be temporarily stopped and then restarted.

b. Redirection

   The results of executing a single command can be saved to a file by using redirection.

   Unlike the PRINT command, however, command input is not saved.

   There are two redirection specification formats as follows:

| | |
|---|---|
| Writing to a new file: | <command line>Δ\>Δ"<file name>" |
| Appending to an existing file: | <command line>Δ\>>Δ"<file name>" |

   Note that redirection cannot be used with the COMMAND_CHAIN command.

## 2.15 Saving Input Commands to a File

The PRINT command also provides a function for saving only command input. Test re-execution can be automated by using this function to create a command file and using that command file with the COMMAND_CHAIN command.

## 2.16 Test Functions

### 2.16.1 Stub Function

During simulation of a object program, the simulator/debugger can stop execution and execute a specified set of simulator/debugger commands each time the program passes a location specified with the STUB command. When this execution is completed, the simulator/debugger returns to simulation of the object program. This is referred to as a “stub”.

The return location following stub execution can be specified as desired. When the stub execution location is not the same as the return location, the resulting execution can be seen as stub execution replacing one part of the program simulation. This is referred to as “stub proxy execution”.

Stub proxy execution is used, for example, to jump over subroutine processing that has not yet been implemented. This allows simulation to be performed even if the program is not completed.

On the other hand, when the return location is the same as the stub location, since the simulation returns to the same location after executing the simulator commands, this function can be used to insert instructions in the debugging object program. This is referred to as an “insertion stub”. Insertion stubs can be used, for example, to insert a patch in a program.

Up to 16 stubs can be specified.

### 2.16.2 Coverage Measurement

The final stages of program development, i.e, the steps immediately prior to release as a product, include functional evaluation, performance evaluation, optimization, and quality assurance. The simulator/debugger supports the coverage method, which is a testing technique used for quality assurance.

The coverage function is a function to investigate whether program testing has covered all the program’s functions, and to determine if those tests are adequate. While there are several coverage techniques, this simulator/debugger supports C0 and C1 coverage.

C0 coverage indicates what sections of the program code have been executed as a percentage of the entire object of measurement.

C1 coverage indicates as a percentage, which branch instructions have been tested for the cases of branch taken and branch not taken, for all branch instructions within the object of measurement. Furthermore, the simulator/debugger supported coverage functions not only indicate the results as percentages, but can also indicate exactly which lines of code have been executed.

**(1) Coverage Measurement Sequence**

The coverage measurement sequence and the commands used are as follows.

| | |
|---|---|
| • Measurement range specification: | SET_COVERAGE |
| • Coverage start declaration: | COVERAGE file name |
| • Program execution: | Simulator commands |
| • Temporary stop, restart, and initialization of the coverage measurement: | COVERAGE ; option |
| • Display of measurement results: | DISPLAY_COVERAGE |
| • Coverage termination: | COVERAGE– |

a. Measurement range specification

The SET_COVERAGE command specifies the range of the measurement area.

Up to 16 coverage areas can be specified. The program code sections (and no other sections) are automatically set as the coverage measurement range when the simulator/debugger is started, or when an object program (object module or load module file) is loaded with the LOAD command.

b. Coverage start

The start of the coverage function is declared with the COVERAGE command.

Prior to actually starting measurement, the file used to store the measured data is specified with the COVERAGE command. If a file which already holds measurement data is specified, the measurement range and the measurements stored in that file are read out and used, thus allowing the measurement to be continued. In this case, since the measurement range will be read from the file, there is no need to specify the range with the SET_COVERAGE command. Furthermore, the range from the file takes precedence over any SET_COVERAGE command range setting.

c. Program execution

When coverage measurement preparations are complete, use a GO, STEP, STEP_INTO, CALL, or VECTOR command to execute the object program.

d. Temporary stop, restart, and initialization of coverage measurement

Coverage data measurement is performed between the start of coverage and coverage termination. However, temporary stop of measurement, restart, and initialization of measurement data can be selected with the D (disable), E (enable), and R (reset) COVERAGE command options, respectively.

e. Display of measurement results

The DISPLAY_COVERAGE command is used to display the measurement results. Four types of display methods (selected by options) for different purposes are supported.

| | |
|---|---|
| • T option: | Displays C0 and C1 coverage |
| • G option: | Displays the coverage results in units of source line |
| • D option: | Displays the coverage results in units of machine language |
| • N0 and N1 options: | Displays the addresses of lines that were not executed |

f. Coverage termination

Coverage is terminated using the COVERAGE command termination specification: COVERAGE–.

The measured data is stored in the file specified in the coverage start declaration.

# Section 3 Using the Simulator/Debugger

This section describes the use of the simulator/debugger with a sample program. See appendix D, Sample Program, for a source listing of the sample program.

## 3.1 Sample Program Description

The sample program used in this manual dumps each record of an SH-series object file. Lines of data are read from the file and dumped one at a figure. Figure 3-1 shows an example of the input data.

```
80200080  00800080  00008080  80808080
80008080  00000000  00000000  0000005F
842B2039  31303830  36313432  35343200
01003031  30300810  10000000  00000470
726F6706  48382F33  3030D886  25400001
00000003  0470726F  6708415F  48382F33
30303931  30383036  31343235  34320000
```

**Figure 3-1 Input File Example (input.obj)**

This program consists of 5 modules.

| | | |
|---|---|---|
| • | main( ): | Handles loop control of the initialization, reading, editing, and display operations. |
| • | Print_rec( ): | Reads, edits, and displays data. |
| • | Read_rec( ): | Reads a single record. |
| • | Bin_ascii( ): | Converts binary data to ASCII. |
| • | Ph_read( ): | Inputs data by calling an assembly language routine. |

Note that when executing the sample program, an assembly language routine must be written to allow binary data to be read into a C source file.

## 3.2 Procedure for Creating the Debugging Object Program

This section describes the procedure for creating the debugging object program.

**(1) Source Program Creation**

The C source program to be debugged is created with a text editor. Here we assume that the file containing this C source program is sample.c, and that the assembler source program file is prog.src.

**(2) Object Module Creation**

The object module is created by compiling the C source program with the SH-series C compiler. Specify the DEBUG and OPTIMIZE options when compiling the sample program.

```
% shc˘sample.c˘-debug˘-optimize=0  (RET)
   1     2        3          4
```

Notes: 1 shc is the SH-series C compiler command.
2 The file name of the C source program (sample. c in this case).
3 A command line option to the C compiler. This option specifies that debugging information is output to the relocatable object program.
4 This option specifies the optimization level.

Refer to the SH-Series C Compiler User’s Manual for more information.

Create an object module by assembling the source program prog.src with the SH-series cross assembler, using the following command.

```
% asmsh˘prog.src˘-debug  (RET)
```

Refer to the SH-Series Cross Assembler User’s Manual for more information.

**(3) Creating the Debugging Object Program**

Use the linkage editor to combine the object module output by the C compiler with the object module output by the cross assembler, by entering the following command line. Be sure to include the EXCLUDE, DEBUG, and ENTRY options.

```
% lnk˘sample,prog˘-exclude˘-debug˘
   -entry =_main˘-start=P/8000400˘
   -start= D,B,dt/9000000  (RET)
```

Here, standard library (shclib.lib) and low-level library must be specified as default libraries. Refer to the H-Series Linkage Editor User’s Manual for more information.

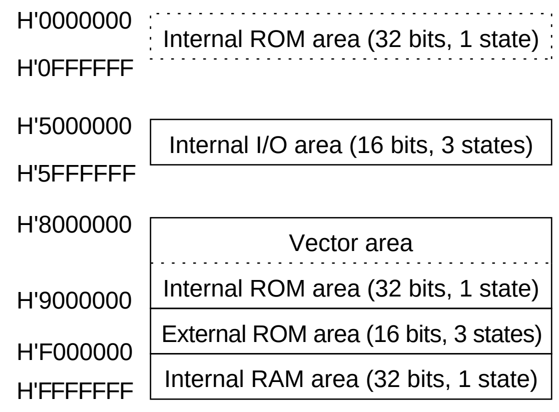
## 3.3 Simulator/Debugger Usage Example

This section describes the command inputs and simulator/debugger outputs for a sample simulator/debugger session.

### 3.3.1 Creating the CPU Information File

A CPU information file which corresponds to the SH-series device to be used must be created before using the simulator/debugger. Refer to part II, CPU Information Analysis Program, in this manual.

Our example uses the memory map for the SH7000 extended mode with ROM (mode 2). Figure 3-2 gives an overview of the SH7000 mode 2 memory map. Refer to appendix C.1, SH7000 Memory Map for more information.



H'0000000
H'0FFFFFF
Internal ROM area (32 bits, 1 state)
H'5000000
H'5FFFFFF
Internal I/O area (16 bits, 3 states)
H'8000000
Vector area
H'9000000
Internal ROM area (32 bits, 1 state)
H'F000000
External ROM area (16 bits, 3 states)
H'FFFFFFF
Internal RAM area (32 bits, 1 state)

**Figure 3-2 SH7000 Memory Map (Mode 2)**

The internal ROM areas H'0000000 to H'0FFFFFF and H'8000000 to H'8FFFFFF correspond to the same area in the SH series, but are treated separately by the simulator/debugger. To use the internal ROM area ranging from H'8000000 as the vector area, specify either of the following.

(1) Copy the data from H'8000000 to H'800000F to the memory starting from H'0.

```
: MAP    8000000  800000F  (RET)

: MOVE  8000000  800000F  0  (RET)
```

(2) Write H'8000000 to VBR.

```
 : . VBR  8000000  (RET)
```

Since VBR is not affected by reset interrupts, copy the data from H'8000000 to H'800000F to the memory starting from H'0 by entering the command line as shown in item (1).

### 3.3.2 Loading the Program

When the simulator/debugger is invoked by the following command line, the debugging object program is loaded and the simulator/debugger enters the command wait state.

```
% sdsh˘sample.abs˘-cpu=mode2  (RET)
  └────┘ └──────────┘
    1        2

SH SERIES SIMULATOR-DEBUGGER Ver. 1.1  (HS0700SDCU1SM)
Copyright (C) Hitachi, Ltd. 1992
Licensed Material of Hitachi, Ltd.
: 3
```

Notes: 1 "sdsh" is the simulator/debugger command.
2 "sample.abs" is the debugging object program file name.
3 The colon is the simulator/debugger command prompt.

### 3.3.3 Memory Map Display and Memory Allocation

The MAP command is used to verify the memory map as follows.

```
: MAP ;M  (RET)
<KIND>  <START>     <END>     <STATE>  <BUS>
NOT_A   00000000 - 04FFFFFF
I/O     05000000 - 05FFFFFF     3       16
NOT_A   06000000 - 07FFFFFF
ROM     08000000 - 08FFFFFF     1       32
EXT     09000000 - 0eFFFFFF     3       16
RAM     0F000000 - 0FFFFFFF     1       32
└─────┘ └───────────────────┘ └───────┘ └────┘
  1             2               3       4
: MAP 0F000000 0FFFFFFF  (RET)  5
:
```

Notes: The M option displays the memory map specified in the CPU information file.

1 Indicates the type of memory.

|  |  |  |  |
|---|---|---|---|
| ROM: | Internal ROM area | EXT: | External bus area |
| NOT_A: | Unused area | I/O: | Internal I/O area |
| RAM: | Internal RAM area |  |  |

2 The first and last addresses of the memory area.

3 The number of states.

4 The width of the data bus.

5 This command allocates the area from H'F000000 to H'FFFFFFF as a stack area.

### 3.3.4 Displaying Section Load Addresses and Allocating Memory Areas

The following commands are used to determine at what addresses the program sections are loaded and to change the section attributes.

```
: MAP  (RET)
<START>      <END>    <ATTR>  <SECT_NAME>
 08000400 - 08000D83    R          P          ┐
 09000000 - 09000064   RW          D          │
 09000068 - 090035AB   RW          B          │ 4
 090035AC - 09003663   RW          dt         ┘
 0F000000 - 0FFFFFFF   RW
 └──────────────────┘  └────┘    └──────┘
          1              2          3

: MAP   5000000  5FFFFFF  ;RW   (RET) 5       ┐
: MAP  (RET)                                  │
<START>      <END>    <ATTR>  <SECT_NAME>     │
05000000 - 05FFFFFF   RW                      │
08000400 - 08000D83    R          P           │ 6
09000000 - 09000064   RW          D           │
09000068 - 090035AB   RW          B           │
090035AC - 09003663   RW          dt          │
0F000000 - 0FFFFFFF   RW                      ┘
:
```

Notes: The MAP command displays the currently allocated memory areas.

1 The first and last address of each section.

2 The section attribute.

| | |
|---|---|
| R: | Read-only |
| W: | Write-only |
| RW: | Read/write |

3 The section name. Sections without a name include the vector area and those allocated by the MAP command.

4 The memory areas.
08000400 to 08000D83 is section P
09000000 to 09000064 is section D
09000068 to 090035AB is section B
090035AC to 09003663 is section dt
0F000000 to 0FFFFFFF is stack area allocated with the MAP command.

5 This command allocates memory area.

6 The MAP command verifies the allocated memory areas.

### 3.3.5 Disassembly Display

The following command disassembles 16 lines and displays the result. (When option I is specified by the DEBUG-LEVEL command.)

```
: DISASSEMBLE 8000A78  (RET)
        %prog.src!P:     1
08000A78      STS.L        PR,@-R15
08000A7A      MOV.L        R4,R0
08000A7C      MOV.L        %prog.src!PARM_1,R1
08000A7E      MOV.L        R0,@R1
08000A80      MOV.L        %prog.src!REQ_CD_1,R0
08000A82      MOV.L        %prog.src!TRP_AD_1,R3
08000A84      JSR          @R3
08000A86      NOP
08000A88      MOV.L        %prog.src!PARM_1,R3
08000A8A      MOV.L        @R3,R1
08000A8C      MOV.B        @R1,R0
08000A8E      CMP/EQ.L     #00000000,R0
08000A90      BT           %prog.src!R_EXIT
08000A92      MOV.L        #00000001,RO
08000A94      MOV.L        %prog.src!RTN_AD_1,R3
08000A96      BRA          %prog.src!R_RTN
└───────┘     └───────┘    └─────────────────────┘
   2              3                  4
:
```

Notes: 1 The line “%prog.src!P” is the symbol defined for address H'8000A78. Here, “prog.src” is the file name and “P” is the label.
Note that “%prog.src!P” can be specified instead of H'8000A78.
2 The first address of the instructions.
3 The instruction mnemonics.
4 The instruction operand.

### 3.3.6 Checking Memory Contents

```
: DUMP stop_f @6  (RET)      1
address      +0   +2   +4   +6   +8   +A   +C   +E        ASCII
09002F48     0000 0000 0000 0000 0000 0000                 .....
└───────┘    └─────────────────────────────┘               └─────┘
   2                       3                                  4
:
```

Notes: 1 This command displays six 2-byte blocks of data starting at the symbol “stop_f” in hexadecimal.
2 The first address. Displayed in 16-byte units.
3 The contents of 12 bytes of data (six 2-byte blocks).
4 The contents of 3 as ASCII characters. Periods are displayed when the values cannot be converted.

### 3.3.7 System Call Start Address

Line 24 of the sample program prog.src (see appendix D, Sample Program) inputs a single line using the instruction JSR @R3. The starting address of the system call is specified with the simulator/debugger TRAP_ADDRESS command as follows.

```
: TRAP_ADDRESS TRAP  (RET) 1
:
```

Note: 1 Specifies TRAP as the location for the start of the system call.

### 3.3.8 Setting and Checking Breakpoints

The following command sets a breakpoint so that the program will stop at location H'800040C.

```
: BREAK 800040C  (RET)  1
: BREAK  (RET)       2
<E/D>  <ADDR>  <COUNT> <COMMAND LINE>  <SYMBOL
  E   0800040C      1   -------  %sample.c/main(#   38)
└────┘ └───────┘ └──────┘ └───────┘ └─────────────────────┘
  3       4        5        6               7
```

Notes: 1 Sets a breakpoint at address H'800040C.
2 Confirms the breakpoint settings.
3 The breakpoint enable or disable condition.
4 The location where the breakpoint is set.
5 The number of times the breakpoint has been passed.
6 Command to be executed when the program execution stops at the breakpoint.
7 Indicates the symbol corresponding to the location where the breakpoint is set. When there is no corresponding symbol, nothing is displayed.
When there are multiple symbols corresponding to the same address, the displayed symbol may be different from the symbol used in setting the breakpoint.

### 3.3.9  Starting a Trace

The following command starts acquiring trace information.

```
: TRACE_CONDITION  (RET)
:
```

### 3.3.10  Program Execution

The following command executes the debugging object program starting at the current value of the program counter.

```
: GO  (RET)
Exec instructions = 18    1
PC=0800040C SR=00000000:*********************------**-- SP=0FFFFFF8
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=0800040C
R0-7   00000000 090035AC 00000000 08000CB8 09000020 00000000 00000000 00000000
R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8   2
08000ACE    LDS.L         @R15+,PR
BREAK POINT      3
:
```

Notes: 1  The number of instructions executed.
       2  The contents of the registers at the point when the program stopped.
       3  Indicates that the program has stopped at a breakpoint.

### 3.3.11  Single Step Execution

After the program has stopped at the breakpoint (H'800040C), the following command executes 3 instructions one at a time.  At each step the executed instruction is displayed. (In this example, the instruction following the delayed branch instruction is also executed because the third instruction is a delayed branch instruction.)

```
: STEP_INTO 3;R  (RET)
 PC=0800040E SR=00000000:**********************------**-- SP=0FFFFFF8
 GBR=00000000 VBR=00000000 MACH=00000000  MACL=00000000 PR=0800040C
 R0-7   00000000 090035AC 00000000 08000CB8 09003554 00000000 00000000 00000000
 R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
 %sample.c#   38   Read(f_name);
 0800040C   MOV.L         @(00000048,PC),R4
 PC=08000410 SR=00000000:**********************------**-- SP=0FFFFFF8
 GBR=00000000 VBR=000000000 MACH=00000000 MACL=00000000 PR=0800040C
 R0-7   00000000 090035AC 08000A78 08000CB8 09003554 00000000 00000000 00000000
 R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
 080040E    MOV.L         @(0000004C,PC),R2
 PC=08000A78 SR=00000000:**********************------**-- SP=0FFFFFF8
 GBR=00000000 VBR=000000000 MACH=00000000 MACL=00000000 PR=08000414
 R0-7   00000000 090035AC 08000A78 08000CB8 09003554 00000000 00000000 00000000
 R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
 08000410   JSR           @R2
 PC=08000A78 SR=00000000:**********************------**-- SP=0FFFFFF8
 GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=08000414
 R0-7   00000000 090035AC 08000A78 08000CB8 09003554 00000000 00000000 00000000
 R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
 08000412   NOP
 STEP NORMAL END
:
```

### 3.3.12 Single Subroutine Execution

The following command executes 7 instructions starting at the current program counter (H'8000406)). Each subroutine call is executed as a single step.

```
: STEP 7  (RET)
08000406       MOV.L      @(0000004C,PC,)R3
08000408       JSR        @R3
0800040A       NOP
0800040C       MOV.L      @(00000048,PC),R4
0800040E       MOV.L      @(0000004C,PC),R2
08000410       JSR        @R2                       ┐
08000412       NOP                                  │ 1
STEP NORMAL END                                     ┘
:
```

Note: 1 Indicates that a subroutine was executed within the specified range.

### 3.3.13  Trace Buffer Display

The following command displays the contents of the trace buffer.

```
: TRACE -17, @3;A  (RET)    1
08000400   MOV.L      R8,@-R15    2
PC=08000402 SR=00000000:**********************------**-- SP=0FFFFFFC
W=00000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000
0FFFFFFFC                                    3

                                                                    5
08000402   STS.L     PR,@-R15
PC=08000404 SR=00000000:**********************------**-- SP=0FFFFFF8
W=00000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
                                                                    4
08000404   MOV.L     @(00000048,PC),R4
PC=08000406 SR=00000000:**********************------**-- SP=0FFFFFF8
R=09000020
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=0800000C
R0-7   00000000 00000000 00000000 00000000 09000020 00000000 00000000 00000000
R8-15  00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF8
:
```

Notes:
1. Displays 3 instructions from the trace buffer starting 17 instructions back.  Option “;A”specifies that all of the saved trace information is to be displayed.
2. The executed instructions are disassembled and displayed.
3. The contents of the registers after instruction execution.
4. “R=09000020” indicates that data H'9000020 was read from memory by the instruction.
5. “W=00000000” indicates that data H'0 was written to memory by the instruction.

### 3.3.14 Symbol Display

The following command displays the information related to the specified symbol from the global area of the load module.

```
: SYMBOL %!stop_f  (RET)   1
stop_f......................... 09002F48 VAR S WORD 0002

   2                                 3      4  5   6     7
:
```

Notes: 1 Displays the information related to the symbol “stop_f” from the global area.
2 The symbol.
3 The symbol’s definition address.
4 The symbol type. “VAR” indicates that the symbol is variable.
5 Indicates whether the data is signed. “S” indicates that the data is signed.
6 Indicates the format of the data. “WORD” indicates that the data is a two byte integer.
7 The size of the symbol in byte units.

### 3.3.15 Automatic Command Execution during Simulation

The following command instructs the simulator/debugger to execute pre-registered simulator commands when an attempt is made to execute a specified location.

```
: STUB 800055E {  (RET)   1
STUB> DISPLAY_CHARACTERS ÒENTRY %sample.c/Print_recÓ  (RET)
STUB> REGISTER  (RET)                                           2
STUB> }  (RET)     3
: STUB  (RET)      4
<ENTRY ADDR>     <RETURN ADDR> <SYMBOL>
   0800055E        0800055E     %sample.c/Print_rec(#  85)
%sample.c/Print_rec(#  85)
     5              6                 7                          8

:
```

Notes: 1 This command instructs the simulator/debugger to start stub execution when the instruction at address H'800055E is about to be executed.

2 Specifies the stub execution commands. Here a command to display a message confirming passage through the stub point and a command to display the contents of the registers are specified. Note that “STUB>” is the prompt used by the STUB command.

3 Indicates completion of the setting.

4 Confirms the setting.

5 The stub execution start address.

6 The simulation return address.

7 The symbol corresponding to the start address and its line number.

8 The symbol corresponding to the return address and its line number.

### 3.3.16 Coverage Range Display

The following command displays the coverage range. When no coverage range has been set, the code sections of the debugging object program are used as the default value.

```
: SET_COVERAGE  (RET)
coverage area
08000400 - 08000D83
|________|   |________|
    1            2
:
```

Notes: 1 The starting address for coverage data acquisition.

2 The terminating address for coverage data acquisition.

### 3.3.17 Starting Coverage Data Acquisition

The following command starts the acquisition of coverage data. Since no coverage file is specified, the file “temp.cov” is used.

```
: COVERAGE  (RET)
coverage area
08000400 - 08000D83
:
```

### 3.3.18 Setting and Executing Sequential Breakpoints

The following command sets a breakpoint so that execution will stop when the debugging object program passes through the 3 specified locations.

```
: BREAK SEQUENCE 80004BA 80009E8 8000566  (RET)    1
: BREAK SEQUENCE  (RET)    2
1st BREAKPOINT = 080004BA  %sample.c/Print_rec (#   78)
2nd BREAKPOINT = 080009E8  %sample.c/Bin_ascii (#  217)
3rd BREAKPOINT = 08000566  %sample.c/Print_rec (#   87)
└────────────┘   └──────┘  └──────────────────────────┘
      3              4                   5
<COMMAND LINE>
└────────────┘
      6
:GO  (RET)
ENTRY %sample.c/Print_rec   7
PC=0800055E SR=00000000:**********************------**-- SP=0FFFFE40
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=0800055E
R0-7  00000000 0FFFFE44 08000030 0FFFFE45 0FFFFE45 00000000 00000000 00000000   8
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFE40
Exec instructions = 156
PC=08000566 SR=00000000:**********************------**-- SP=0FFFFE40
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=08000566
R0-7  00000000 0FFFFE44 08000030 0FFFFE44 0FFFFE44 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFE40   9
%sample.c#  225     }
BREAK SEQUENCE
:
```

Notes: 1 This command instructs the simulator/debugger to stop at location H'8000566 (the last location) when the 3 locations H'80004BA, H'80009E8, and H'8000566 are passed in sequence.
2 This command displays the sequential breakpoint settings.
3 Indicates the setting order.
4 The breakpoint address.
5 The symbol corresponding to the breakpoint address.
6 Command to be executed when the program execution stops at the breakpoint.
7 The output for confirming passage through the point set by the STUB command.
8 Register display set by the STUB command.
9 At this point the sequential break conditions are satisfied and execution stops.

### 3.3.19  Coverage Information Display

This section lists the coverage information for each of the command options.

**(1)  T Option Specification**

This option displays the C0 and C1 coverage values.

```
: DEBUG_LEVEL ;S  (RET)   1
: DISPLAY_COVERAGE /Read_rec @14 ;T  (RET)   2
C0:  44.0%     3
C1:  50.0%     4
:
```

Notes:
1. This command sets the debug level to source code line units.
2. This command sets symbol /Read_rec as the coverage start address.  Coverage is performed for 20 lines from the start address.
3. The C0 coverage value
4. The C1 coverage value

## (2) G Option Specification

The G option displays C0 coverage over a wide range.

```
: DISPLAY_COVERAGE /Read_rec @14 ;G  (RET)
%sample.c#  172 * void Read_rec()
%sample.c#  177 *   if (phg_pos == -1)
%sample.c#  179 .     Ph_read(phg_rec);         /*: First 256 bytes.
%sample.c#  180 .     Ph_read(phg_rec+256);     /*: First spare 256 bytes.
%sample.c#  181 .     phg_pos = (short)0;       /*: Index initialize.
%sample.c#  182 .     rec_num = (short)0;       /*: Physical record number
initialize
%sample.c#  185 *   phg_lng = phg_rec[phg_pos + 1];
%sample.c#  186 *   if (phg_lng < 0)
%sample.c#  188 .     phg_lng += 256;           /*: Adjust to unsigned char.
%sample.c#  191 *   wi = (short)0;
%sample.c#  192 *   while (wi <phg_lng)
%sample.c#  194 .     log_rec[wi++] = phg_rec[phg_pos++];
%sample.c#  197 *   if (phg_pos > 255)
%sample.c#  200 .     for (wi = (short)0; wi < (short)256; wi++)
%sample.c#  202 .       phg_rec[wi] = phg_rec[wi + 256];
%sample.c#  205 .     Ph_read(&phg_rec[256]);
%sample.c#  206 .     phg_pos –= 256;
%sample.c#  207 .     rec_num++;
%sample.c#  209 *   }
%sample.c#  214     void Bin_ascii(p)
      1       2                            3

:
```

Notes: 1 The file name and line number of the source code.
2 Indicates the coverage information symbolically.
- Asterisk (*): Indicates that this address was accessed and executed.
- Period (.): Indicates that this line was not executed.
- Space (Δ): Indicates that there is no machine language corresponding to this line.

3 Displays the source code in the coverage range.

# Section 4 Simulator/Debugger Invocation and Command Input

## 4.1 Invoking the Simulator/Debugger

The following command invokes the simulator/debugger.

```
%sdsh[˘{[<debugging object program file name>]
 1                      2
 [[˘]-com=<command file name>][[˘]-cpu=<CPU information file name>]}
              3                              4
 |-stat=<simulator state file name>] (RET)
                   5
```

Notes: 1 "sdsh" is the command name of the simulator/debugger installed on the host computer.

2 The file name of the debugging object program loaded when the simulator/debugger starts. When the file extension is omitted ".abs" is used as the default.

3 When the -com command line option is specified, the simulator/debugger reads a command from the file whose name is specified following the equal sign (=) and executes it.

4 When the -cpu command line option is specified, the simulator/debugger creates a memory map from the information stored in the CPU information file whose name is specified following the equal sign (=). When the file extension is omitted ".cpu" is used as the default.

5 The state at the time a SAVE_STATUS command was executed in a previous debugging session can be restored by specifying the simulator state file following an equal sign (=) with the -stat command line option. When the file extension is omitted ".sav" is used as the default.

## 4.2 Exiting the Simulator/Debugger

To exit the simulator/debugger, enter the following simulator command line.

```
: QUIT (RET)
%
```

## 4.3 Simulator/Debugger Commands

Table 4-1 lists the simulator/debugger commands.

**Table 4-1 Simulator/Debugger Commands**

| No. | Command | Abbreviation | Function |
|---|---|---|---|
| 1 | ASSEMBLE | A | Assembles line by line |
| 2 | BREAK | B | Sets, displays, and cancels breakpoints based on the instruction execution address |
| 3 | BREAK_ACCESS | BA | Sets, displays, and cancels break conditions based on memory range access |
| 4 | BREAK_DATA | BD | Sets, displays, and cancels break conditions based on memory data values |
| 5 | BREAK_REGISTER | BR | Sets, displays, and cancels break conditions based on register data values |
| 6 | BREAK_SEQUENCE | BS | Sets, displays, and cancels breakpoints based on specified execution sequences |
| 7 | CALL | CA | Calls a function |
| 8 | COMMAND_CHAIN | CC | Executes commands from a file |
| 9 | COMPARE | CMP | Compares memory contents |
| 10 | CONVERT | CV | Calculates expression |
| 11 | COVERAGE | COV | Starts and stops coverage measurement |
| 12 | DATA_SEARCH | DS | Searches for data |
| 13 | DEBUG_LEVEL | DL | Specifies debug level |
| 14 | DISASSEMBLE | DA | Disassembles and displays memory contents |
| 15 | DISPLAY_CHARACTERS | DCH | Displays character string |
| 16 | DISPLAY_COVERAGE | DCV | Displays coverage data |
| 17 | DUMP | D | Displays memory contents |
| 18 | EXEC_MODE | EM | Switches execution mode |
| 19 | FILL | F | Initializes memory area |
| 20 | GO | G | Executes instructions continuously |
| 21 | HELP | HE | Displays command name and input format |
| 22 | LOAD | L | Loads file |
| 23 | LOAD_STATUS | LS | Restores simulator/debugger memory and register state |

**Table 4-1 Simulator/Debugger Commands (cont)**

| No. | Command | Abbreviation | Function |
|---|---|---|---|
| 24 | MACRO | MA | Defines, displays, executes, and deletes simulator/debugger command macros. |
| 25 | MAP | MP | Defines, displays, modifies, and deletes memory areas. |
| 26 | MEMORY | M | Modifies memory contents |
| 27 | MOVE | MV | Copies memory block |
| 28 | PRINT | P | Executes history file |
| 29 | QUIT | Q | Exits the simulator/debugger |
| 30 | RADIX | RX | Sets the radix |
| 31 | REGISTER | R | Displays register contents |
| 32 | RESET | RS | Resets the simulator/debugger |
| 33 | SAVE | SV | Saves memory data to a file |
| 34 | SAVE_STATUS | SS | Saves the current simulator/debugger state in a file |
| 35 | SCOPE | SCP | Displays the name of function at the current execution address. |
| 36 | SET_COVERAGE | SCV | Sets coverage range |
| 37 | SHOW_CALLS | SHC | Displays function call |
| 38 | STEP | S | Performs step execution in subroutine units |
| 39 | STEP_INTO | SI | Performs step execution |
| 40 | STUB | SB | Executes command during simulation |
| 41 | SYMBOL | SY | Displays symbol information |
| 42 | TRACE | T | Displays trace buffer |
| 43 | TRACE_CONDITION | TC | Sets trace condition, and starts or stops trace |
| 44 | TRAP_ADDRESS | TA | Sets, displays, and clears the system call start address |
| 45 | TYPE | TY | Displays variable value |
| 46 | VECTOR | V | Executes from an interrupt vector address |
| 47 | .<register> | — | Modifies register contents |
| 48 | ! | — | Invokes sub-process |

## 4.4 Specifying Command Parameters

The simulator/debugger commands allow parameter specification. This section describes the aspects of parameter specification common to all commands. Refer to section 5, Simulator/Debugger Commands, for more information on the command parameters.

### 4.4.1 Expressions

Expressions (integer expressions) consist of terms, operators, and parentheses.

Operations are performed in 32-bit unsigned operations, and overflows during operation is ignored. However, divide by zero and floating-point operations generate errors.

**(1) Terms**

The following terms can be used in integer expressions.

a. Numeric constants

Numeric constants represent 32-bit integer constants. Numeric constants can be prefixed with B', Q', D', or H' to represent binary, octal, decimal, or hexadecimal constants respectively.

When the prefix is omitted, the base specified with the RADIX command is used.

| | | |
|---|---|---|
| Examples: | Binary constant: | B'1010 |
| | Octal constant: | Q'4567 |
| | Decimal constant: | D'1234 |
| | Hexadecimal constant: | H'A4FF |

Note that a leading zero must be inserted at the head of a hexadecimal constant when the first digit is A to F and the H' prefix is omitted.

Example: To write “H'A0” without the prefix, use “0A0”.

b. Register values

Register value terms represent the current value stored inside the register at the time they are evaluated. Register values are zero-extended to 32-bit integer values.

R0
 |
R15
SP
PC
SR
GBR
VBR
MACH
MACL
PR

c. Symbols

Symbols represent an address or constant value.

The syntax for symbols is shown below.

- `[!]symbol[.member name[...]]`
- `%file name`
- `/function name`

The <function name> indicates a C function. It is not used with assembler language symbols.

Although alphanumerics and the $ and _ characters can be used in symbols (as well as function and member names), symbols, function names, and member names must be 32 or fewer characters in length, and must start with either a letter, the “$” character, or the “_” character.

Upper and lower case letters are distinguished.

Member names express elements of structures or unions. Member names are not used with assembler language symbols.

There are three classes of symbol scope in C: global symbols which are valid over the whole program, static symbols that are valid in a single file, and local symbols that are valid within a function.

If a symbol is specified, the simulator debugger searches for it with local symbols in the currently valid function, static symbols in the file, and global symbols valid in the whole program, in that order. The simulator debugger allows the following specifications to refer to the same symbols of other level, or those included in other functions or files.

- `/function!symbol`
  Refers to the local symbols in the specified function
- `%file!symbol`
  Refers to the static symbols in the specified file
- `%!symbol`
  Refers to the specified global symbol

The valid file and function names can be determined with the SCOPE command. For both file names and symbol names, items specified with upper case letters and items specified with lower case letters will be treated as distinct objects.

| | | |
|---|---|---|
| Examples: | `%main.c!sym` | Indicates the symbol "sym" which appears in the file "main.c". |
| | `/func!sym` | Indicates the symbol "sym" which appears in the function "func". |
| | `!TEST` | Indicates the symbol TEST that is included in the file that the program counter is currently pointing to. |
| | `%!sym` | Indicates the global symbol "sym". |

Caution: The following points require caution when programs written in C and programs written in assembler are linked together.

When an assembler language subroutine is to be called from a C program, the subroutine name in the assembler language program must begin with an underscore (_) character.

| Example: | C source | Assembler source |
|---|---|---|
| | `Read(&b)` | `.EXPORT _Read` |
| | | `_Read:` |

To apply a breakpoint to this "Read" subroutine, either of the following commands can be used.

• From C: `BREAK _Read`
• From assembler: `BREAK _Read`

d. Indirect memory values

The contents of an address can be referenced by prefixing the address with an asterisk (`*`).

| Examples: | | |
|---|---|---|
| | `*1000:` | Indicates the contents of address H'1000. |
| | `*R1:` | Indicates the contents of the address pointed to by register R1. |

e. Line numbers

Line numbers are preceded by a number sign (#).

The value of a line number is the address of the first location in the machine language code into which that line was compiled.

Since line numbers should have consecutive values within a single file, they must generally be prefixed by a file name. If the file name is omitted, the file that includes the current value of the program counter will be used.

The syntax for line numbers is shown below.

```
[%<file name>]#<line number>
```

Line numbers are always expressed in decimal.

The RADIX command has no influence on the interpretation of line numbers.

| Examples: | | |
|---|---|---|
| | `%sub.c#100` | Indicates line 100 in the file "sub.c". |
| | `#120` | Indicates line 120 in the file which includes the current value of the program counter. |

Caution:
- Line number specification is only valid when debugging information output was specified during compilation. Also, if the specified line number is a line number for which debugging information was not output, an error occurs.

f. Special symbols that can be used as location specifiers

The following special symbols can be used for location specification.

- @RTN: Return address of a function

  Usage example: `GO ,@RTN (RET)`

  Execution will stop at the point the currently executing function returns.

- @END: The last address in a file or function.

  Usage example: `DA %file.c/func @END (RET)`

  This command disassembles and displays the function func from its first location to its last.

### (2) Operators

Table 4-2 shows the operators that can be used in expressions and their priorities.

**Table 4-2 Operators and Operator Priorities**

| Priorities | Symbol | Description | |
|---|---|---|---|
| 1 | . | Structure member operator | |
| | – > | Structure member operator | |
| 2 | + | Plus sign | (unitary operator) |
| | – | Minus sign | (unitary operator) |
| | ~ | Bit inversion | (unitary operator) |
| | * | Pointer | (unitary operator) |
| | & | Address operator | (unitary operator) |
| 3 | * | Multiplication | |
| | / | Division | |
| 4 | + | Addition | |
| | – | Subtraction | |
| 5 | < | Less than | (relational operator) |
| | < = | Less than or equal | (relational operator) |
| | > | Greater than | (relational operator) |
| | > = | Greater than or equal | (relational operator) |
| 6 | = = | Equal | (relational operator) |
| | ! = | Not equal | (relational operator) |
| 7 | & | Logical and | |
| 8 | ^ | Logical exclusive or | |
| 9 | \| | Logical or | |
| 10 | = | Assign the left hand side to the right hand side | (assignment operator) |

Relational operators are used to compare the values on the right and left sides. If the comparison is true, the value of the operation is H'FFFFFFFF, and if the comparison is false, H'00000000.
Parentheses can be used to override the operator precedence.
Assignment operator can only be used within the MACRO command.

### 4.4.2 Locations

Location expressions are expressions whose values are addresses. Instruction locations cannot contain automatic variables or pointer variables.

The following symbols can be used for locations:

Variable name, label, function name, file name: Symbol addresses

EQUATE name: Symbol values

Note, however, that symbols defined for registers cannot be used for locations.

| | | |
|---|---|---|
| Examples: | `1000` | Indicates location 1000. |
| | `!ABCD` | Indicates the address of the symbol ABCD in the file associated with the current value of the program counter. |
| | `#100` | Indicates the address of line 100 in the file associated with the current value of the program counter. |

### 4.4.3 Data

Data expressions consist of an expression and a size indicator.

The syntax for data expressions is shown below.

<expression>[:<size>]

| | | |
|---|---|---|
| size: | B (byte): | 8 bits |
| | W (word): | 16 bits |
| | L (long): | 32 bits |

Word is the default size when the size specification is omitted.

When the value of the expression is larger than the size, the overflow digits are ignored, i.e., only the lower order <size> digits are valid.

The following symbols can be used for data:

Variable name and label:  Symbol contents

Function name and file name:  Symbol addresses

EQUATE name:  Symbol values

Example:   The data expression H'1234:B has the same value as the expression H'34:B.

### 4.4.4  Floating Point Data

Floating point constants are either single (S) or double (D) precision and have the following syntax.

```
            n[.[m]]
F’[{–}] {          } [t[[{–}] xx]]
            .m
```

F': Prefix indicating floating-point data.  Cannot be omitted.
n: Integer part (in decimal)
m: Fraction part (in decimal)
±: Sign.   + is is the default at omission.
t: Precision specifier.  S is the default when the precision specifier is omitted.
S = Single precision
D = Double precision
xx: Exponent part (in decimal).  0 is the default when the exponent specification is omitted.

Examples:   `F’1.S`    Specifies 1.0 in single precision.

`F’.1D-2`    Specifies $0.1 \times 10^{-2}$ in double precision.

### 4.4.5  Character Strings

Character strings are handled as data sequences consisting of the ASCII code of each character in turn, and are enclosed by double quotation marks.  To include a double quotation mark in a character string, insert two double quotation marks in sequence.  To include a non-text ASCII code, surround the numeric constant representing the code in angle brackets.  Note however, that the <numeric constant> notation can only be used with the MEMORY and DATA_SEARCH commands.

Example:   `"ABCDEF"<0A>`

Note when the number of characters within the double quotation marks is four or less, the string is handled as a character constant.

### 4.4.6 File Names

File name notations must follow the restrictions on file names imposed by the operating system. File names can be optionally enclosed in double quotation marks.

### 4.4.7 Comment Lines

Lines beginning with a semicolon are treated as comment lines by the simulator/debugger. The simulator/debugger takes no action for comment lines.

### 4.4.8 Limitations on C Expressions

Table 4-3 lists the limitations on C expressions used in command parameters.

**Table 4-3 C Expression Limitations and Workarounds**

| No. | Limitation | Workaround |
|---|---|---|
| 1 | Arrays are limited to 2 dimensions | Acquire the starting address of 3-dimensional or greater arrays with the SYMBOL command and then specify the address by computing the index with an expression. |
| 2 | Parentheses are limited to 8 nesting levels | Simplify the structure of the parameter to reduce the number of parentheses. |
| 3 | Pointers and arrays are limited to 8 levels<br>Pointers: `********ptr`<br>Arrays: `a[b[c[d[e[f[g[h[0]]]]]]]]` | Simplify the data structures or specify the reference with an address. |

# Section 5 Simulator/Debugger Commands

This section provides detailed descriptions of the individual simulator/debugger commands. Figure 5-1 shows the command description format used in this section.

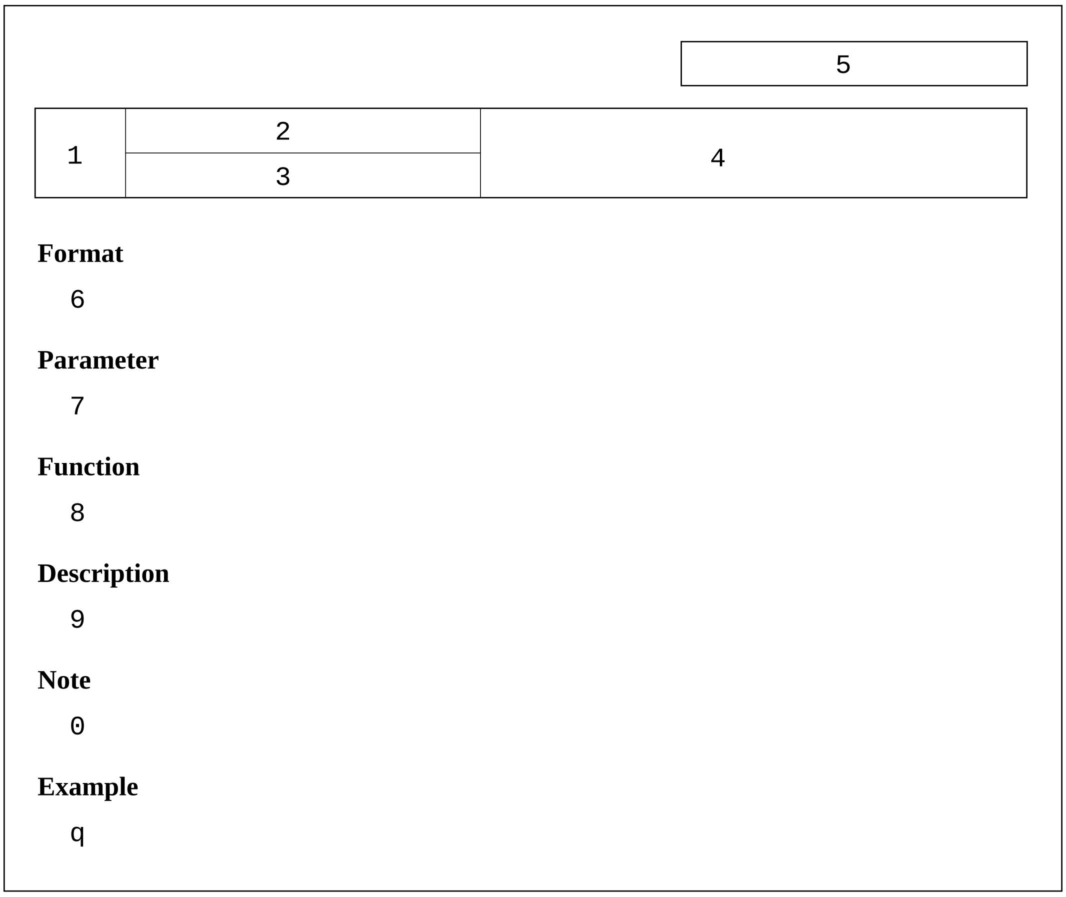


**Figure 5-1 Command Description Format**

The numbered items in the above format are described below.

| | |
|---|---|
| 1 | Section number |
| 2 | Command name |
| 3 | Command abbreviation |
| 4 | Command function |
| 5 | Command name |
| 6 | Input format for the command |

7 Description of command parameters and options.

- Options indicated as "start-up settings" are defaults at start-up only. As a result, specifying these command options creates new default values to be used if the options are omitted next time.
- Options indicated as "default" are not influenced by previous specifications if later omitted, i.e. these defaults do not change. However, in commands such as the DUMP command that continuously display memory, the value of the memory start address option is inherited from the previous command specification if omitted.

8 Command function.

9 Command description.

0 Notes on command usage.

q Usage examples.

| 5.1 | ASSEMBLE | Assembles line by line |
|---|---|---|
| | A | |

**Format**

```
ASSEMBLEΔ<start address>(RET)
```

**Parameter**

- `<start address>`
  Indicates the address to store the results of assembly.

**Function**

This command converts assembly language notations to machine language in line units and stores the results starting at the indicated start address. Long word or word integer can be defined by the .DATA directive.

**Description**

1. When this command is entered, the current contents of the specified address are displayed and the command enters interactive mode. The display and input format are as follows.

```
ASSEMBLE <start address> (RET)
<instruction mnemonic>
address xxxx ? <assembly language or .DATA notation> (RET)
address xxxx ? <assembly language or .DATA notation> (RET)
   :     :
address xxxx ? . (RET)
```

   The above terms are described below:

| | | |
|---|---|---|
| `<instruction mnemonic>` | : | The current disassembled contents of the start address. |
| `address` | : | The start address. |
| `xxxx` | : | The value of the first two bytes of the memory address indicated by "address". |
| `periods (.)` | : | Terminates the line assembly command. |

2. The following processing is performed if only (RET) is entered.

- Prior to assembly language notation input
  The address counter is advanced to value equal to the current address plus the instruction length, the instruction mnemonic is displayed, and the command waits for assembly language notation input.

- After assembly language notation input
  The address counter is advanced to the current address plus 2, and the command waits for assembly language notation input.

**Notes**

1. Refer to the SH-Series Cross Assembler User's Manual for details on assembly language syntax and the .DATA directive.

2. Refer to appendix A, Differences Between SH-Series Cross Assembler Syntax and Line Assembly Command, for differences between the notations used with this command and those of the cross assembler.

**Example**

To interactively input assembly language expressions, convert them to machine language, and store them starting at address H'400:

```
: ASSEMBLE 400 (RET)
00000400  MOV.L         #0000002E,R1
00000400  E12E ?   (RET)
00000402  MOV.L         #FFFFFFF,R2
00000402  E2FF ?   MOV.L #0FF,R3 (RET)
00000404  0009 ?   ADD R1,R2 (RET)
00000406  0009 ?   .(RET)
: DISASSEMBLE 400 @3 (RET)
00000400       MOV.L     #0000002E,R1
00000402       MOV.L     #FFFFFFFF,R3
00000404       ADD.L     R1,R2
:
```

| 5.2 | **BREAK** | **Sets, displays, and cancels breakpoints based on instruction execution address** |
|---|---|---|
| | **B** | |

**Format**

| | |
|---|---|
| Set: | `BREAKΔ<instruction address>[Δ<repeat count>]` `[;"<command line>"] (RET)` |
| Enable/disable: | `BREAKΔ<instruction address>;{E\|D} (RET)` |
| Display: | `BREAK (RET)` |
| Cancellation: | `BREAK-[Δ<instruction address>] (RET)` |

**Parameters**

- `<instruction address>`
  Specifies the address of the breakpoint.

- `<repeat count>`
  Specifies the number of times the instruction of the specific position is fetched before breaking. (A value between H'1 and H'3FFF; default is H'1.)

- Option

  — Enable/disable `{E|D}`

  | | |
  |---|---|
  | `E` (enable): | Enables previously set breakpoints. |
  | `D` (disable): | Disables previously set breakpoints. |

- `<command line>`
  Specifies a certain command line to be executed when the break occurs. To indicate a double quotation mark in a character string, insert two double quotation marks in sequence.

**Function**

Sets, displays, and cancels breakpoints based on instruction execution address.

When the instruction at the specified address has been fetched the specified number of times during execution by a CALL, GO, STEP, STEP_INTO, or VECTOR command, instruction execution is stopped.

## BREAK

### Description

| | |
|---|---|
| Set: | Sets a break address and count.<br>Program execution stops before the instruction at the break address is executed.<br>Up to 8 breakpoints can be set.<br>Note that breakpoints are automatically enabled when a breakpoint is set. |
| Enable/disable: | Allows breaking to be enabled or disabled without changing the breakpoint settings. |
| Display: | Displays the breakpoints set with the BREAK command. |
| Cancellation: | Cancels (clears) the breakpoints set with the BREAK command.<br>If no instruction addresses are specified, all breakpoints set with the BREAK command are removed. In this case a confirmation message will be displayed. Enter "Y" to remove all breakpoints or "N" to cancel the removal. |

### Notes

1. If a breakpoint is set at any address other than the first byte of an instruction, the break will not be detected.
2. The execution count is reset at the point that instruction execution stops.
3. If a breakpoint is set at an instruction following a delayed branch instruction, execution stops at the start address of the delayed branch instruction.
4. If conditions specified with the BREAK and BREAK_SEQUENCE commands are satisfied simultaneously, the command line specified with the BREAK command is executed first.

**Examples**

1. To set a breakpoint that breaks just prior to the eighth time the instruction at address H'2000 is about to be executed, and to execute the REGISTER command after stopping at the breakpoint:

```
: B 2000 8 ;"REGISTER" (RET)
:
```

2. To disable the break at address H'2000:

```
: B 2000 ;D (RET)
:
```

3. To display currently set breakpoints (note that addresses and counts are displayed in hexadecimal):

```
: B (RET)
<E/D>  <ADDR>  <COUNT>  <COMMAND LINE>  <SYMBOL>
  D   00002000      8    "REGISTER"      %file.c!symbol(#  100)
:
```

4. To clear the breakpoint at address H'2000:

```
: B- 2000 (RET)
:
```

| 5.3 | BREAK_ACCESS | Sets, displays, and cancels break conditions based on access to a range of memory |
|---|---|---|
| | BA | |

**Format**

| | |
|---|---|
| Set: | `BREAK_ACCESSΔ<start address>[Δ{<end address>\|@<byte count>}] [;[{R\|W\|RW}][,"<command line>"]] (RET)` |
| Enable/disable: | `BREAK_ACCESSΔ<start address>;{E\|D} (RET)` |
| Display: | `BREAK_ACCESS (RET)` |
| Cancellation: | `BREAK_ACCESS-[Δ<start address>] (RET)` |

**Parameters**

- `<start address>Δ{<end address>|@<byte count>}`
  Specifies the start address or the range of memory for which the simulator/debugger will stop if accessed by the object program being debugged.
  When the end address is not specified, the range consists of only the specified address.

- Options

  — Access type `{R|W|RW}`

  | | |
  |---|---|
  | `R` (read): | Break on a read from the specified memory. |
  | `W` (write): | Break on a write to the specified memory. |
  | `RW` (read/write): | Break on either a read or a write. (default) |

  — Enable/disable `{E|D}`

  | | |
  |---|---|
  | `E` (enable): | Enables previously set break conditions. |
  | `D` (disable): | Disables previously set break conditions. |

- `<command line>`
  Specifies a command line to be executed when the break occurs. To indicate a double quotation mark in a character string, insert two double quotation marks in sequence.

**Function**

This command sets, displays, and cancels breakpoints based on access to a specified memory address or range.

Instruction execution stops when the break condition (access of the specified type to the specified memory area) is satisfied during program execution due to a CALL, GO, STEP, STEP_INTO, or VECTOR command.

**Description**

| | |
|---|---|
| Set: | Sets a breakpoint so that program execution stops on an access of the specified type to the specified memory range. Up to two memory ranges can be specified. Note that breakpoints are automatically enabled when a breakpoint is set. |
| Enable/disable: | Allows breaking to be enabled or disabled without changing the breakpoint settings. |
| Display: | Displays the breakpoints set with the BREAK_ACCESS command. |
| Cancellation: | Cancels (clears) the breakpoints set with the BREAK_ACCESS command. If no addresses are specified, all breakpoints set with the BREAK_ACCESS command are removed. In this case, a confirmation message will be displayed. Enter "Y" to remove all breakpoints or "N" to cancel the removal. |

**Note**

If conditions specified with the BREAK_ACCESS, BREAK_DATA, and BREAK_REGISTER commands are satisfied simultaneously, the corresponding command lines are executed in that order.

**Examples**

1. To set a breakpoint so that execution stops when a read or a write to memory in the range from address H'1000 to H'1100 occurs, and to execute the REGISTER command after stopping at the breakpoint:

```
: BA 1000 1100 ;RW, "REGISTER" (RET)
:
```

2. To disable the breakpoint at address H'1000:

```
: BA 1000 ;D (RET)
:
```

3. To display the currently set breakpoints:

```
: BA (RET)
<E/D>   <START>   <END>   <ATTR>   <COMMAND LINE>   <SYMBOL>
  D    00001000  00001100   RW      “REGISTER”       %file.c!table_a (#  4)
:
```

4. To clear the breakpoint at address H'1000:

```
: BA- 1000 (RET)
:
```

| 5.4 | BREAK_DATA | Sets, displays, and cancels breakpoints based on the value of memory data |
|---|---|---|
| | BD | |

**Format**

| | |
|---|---|
| Set: | `BREAK_DATAΔ<break address>Δ{<data>[:<size>][Δ<mask>]\|<real number>}[;[{EQ\|NE}][,"<command line>"]] (RET)` |
| Enable/disable: | `BREAK_DATAΔ<break address>;{E\|D} (RET)` |
| Display: | `BREAK_DATA (RET)` |
| Cancellation: | `BREAK_DATA-[Δ<break address>] (RET)` |

**Parameters**

- `<break address>`
  Specifies the address whose contents are to be checked during execution.

- `<data>[:<size>]`
  Specifies the accessed data.
  Although word is the default size, when the break address corresponds to a high-level language variable, the size of that variable will be used.

- Data size `{B|W|L}`

| | |
|---|---|
| `B` (byte): | Byte data |
| `W` (word): | Word data |
| `L` (long): | Long word data |

- `<mask>`
  Only the bits for which the mask is set to 1 will be compared.
  When omitted,  all bits are compared.
  Note that a mask may not be specified when a real number is specified.

- `<real number>`
  Specifies floating point number.

**BREAK_DATA**

- Options

  — Data match/differ `{EQ|NE}`

  |  |  |
  |---|---|
  | `EQ` (equal): | Break when the data matches. (default) |
  | `NE` (not equal): | Break when the data differs. |

  — Enable/disable `{E|D}`

  |  |  |
  |---|---|
  | `E` (enable): | Enables previously set break conditions. |
  | `D` (disable): | Disables previously set break conditions. |

- `<command line>`
  Specifies a command line to be executed when the break occurs.  To indicate a double quotation mark in a character string, insert two double quotation marks in sequence.

**Function**

This command sets, displays, and cancels breakpoints based on data written to memory.

Instruction execution stops when the break condition (data written to the specified memory address matches/differs from the specified value) is satisfied during program execution due to a CALL, GO, STEP, STEP_INTO, or VECTOR command.

**Description**

|  |  |
|---|---|
| Set: | Sets up to 8 breakpoints based on the data value written to memory. Note that breakpoints are automatically enabled when a breakpoint is set. |
| Display: | Displays the breakpoints set with the BREAK_DATA command. |
| Cancellation: | Cancels (clears) the breakpoints set with the BREAK_DATA command. If no arguments are specified, all breakpoints set with the BREAK_DATA command are removed.  In this case a confirmation message will be displayed. Enter "Y" to remove all breakpoints or "N" to cancel the removal. |

**Note**

If conditions specified with the BREAK_ACCESS, BREAK_DATA, and BREAK_REGISTER commands are satisfied simultaneously, the corresponding command lines are executed in that order.

**Examples**

1. To set a breakpoint so that execution stops when word-size data with the value 10 is written to address H'2000 and execute the REGISTER command after stopping at the breakpoint:

   ```
   : BD 2000 10:W ;,"REGISTER" (RET)
   :
   ```

2. To set a breakpoint so that execution stops when byte-size data with a value other than 20 is written to address H'AF00:

   ```
   : BD 0AF00 20:B ;NE (RET)
   :
   ```

3. To set a breakpoint so that execution stops when a byte-size data whose lower 2 bits have the value 10 is written to address H'FF00:

   ```
   : BD 0FF00 2:B 3 (RET)
   :
   ```

4. To disable the breakpoint at address H'2000:

   ```
   : BD 2000 ;D (RET)
   :
   ```

5. To generate a break if 100 is written to symbol rsym:

   ```
   : BD rsym 100 (RET)
   :
   ```

6. To display the currently set breakpoints (note that addresses, data, and masks are displayed in hexadecimal):

```
: BD (RET)
<E/D>   <ADDR>      <DATA>      <EQ/NE>  <COMMAND LINE>
                    <MASK>      <SYMBOL>
  D    00002000      0010:W       EQ     "REGISTER"
                     ----        %file.c!a(#   4)
  E    0000AF00        20:B       NE     --------------
                     ----        %file.c!b(#  236)
  E    0000FF00        02:B       EQ     --------------
                       03        %file.c!c(#  246)
  E       R4     00000100:L       EQ     --------------
                 --------        rsym
:
```

If a symbol assigned to a register is specified as a break addresses, the register name is indicated at <ADDR>.

7. To clear the breakpoint at address H'FF00:

```
   : BD- 0FF00 (RET)
:
```

| 5.5 | BREAK_REGISTER | **Sets, displays, and cancels break conditions based on the value of data in a register** |
|---|---|---|
| | BR | |

**Format**

| | |
|---|---|
| Set: | `BREAK_REGISTERΔ<register>Δ[Δ<data>[:<size>][Δ<mask>]]` `[;[{EQ\|NE}][,"<command line>"]] (RET)` |
| Enable/disable: | `BREAK_REGISTERΔ<register>;{E\|D} (RET)` |
| Display: | `BREAK_REGISTER (RET)` |
| Cancellation: | `BREAK_REGISTER-[Δ<register>] (RET)` |

**Parameters**

- `<register>`
  Specifies the register for which the break is to be set. SP can be specified instead of R15.

- `<data>[:<size>]`
  Specifies the data value for the break condition.
  When the size is omitted, the register size is used as default.

- Data size `{B|W|L}`

| | |
|---|---|
| `B` (byte): | Byte data |
| `W` (word): | Word data |
| `L` (long): | Long word data |

- `<mask>`
  Only the bits for which the mask is one will be compared.
  When omitted, all bits are compared.

- Options

  — Data match/differ `{EQ|NE}`

| | |
|---|---|
| `EQ` (equal): | Break when the data matches. (default) |
| `NE` (not equal): | Break when the data differs. |

  — Enable/disable `{E|D}`

| | |
|---|---|
| `E` (enable): | Enables previously set break conditions. (default) |
| `D` (disable): | Disables previously set break conditions. |

## BREAK_REGISTER

- `<command line>`
  Specifies a command line to be executed when the break occurs. To indicate a double quotation mark in a character string, insert two double quotation marks in sequence.

### Function

This command sets, displays, and cancels breakpoints based on data written to the CPU registers.

Instruction execution stops when the break condition (data written to the specified register matches the specified value) is satisfied during program execution due to a CALL, GO, STEP, STEP_INTO, or VECTOR command.

When the data value in the BREAK_REGISTER command is omitted, the simulator/debugger stops execution on any write, regardless of the data value, to the specified register.

### Description

| | |
|---|---|
| Set: | The command sets a break condition so that execution stops when the specified register is accessed. Note that breakpoints are automatically enabled when a breakpoint is set.<br>Up to 8 breakpoints can be set. |
| Enable/disable: | Allows breaking to be enabled or disabled without changing the breakpoint settings. |
| Display: | Displays the breakpoints set with the BREAK_REGISTER command. |
| Cancellation: | Cancels (clears) the breakpoints set with the BREAK_REGISTER command.<br>All breakpoints set with the BREAK_REGISTER command are removed if the register is omitted from the break removal form of the command.<br>In this case, a confirmation message will be displayed. Enter "Y" to remove all breakpoints or "N" to cancel the removal. |

### Notes

1. If a break condition is satisfied at a delayed branch instruction, execution stops at the branch destination.

2. If conditions specified with the BREAK_ACCESS, BREAK_DATA, and BREAK_REGISTER commands are satisfied simultaneously, the corresponding command lines are executed in that order.

**Examples**

1. To set a breakpoint so that execution stops whenever R0 is written:

```
: BR R0 (RET)
:
```

2. To set a breakpoint so that execution stops if the value FF is written to register R1, and to execute the REGISTER command after the break:

```
: BR R1 0FF ;,"REGISTER" (RET)
:
```

3. To set a breakpoint so that execution stops if any value other than FF is written to register R2:

```
: BR R2 0FF ;NE (RET)
:
```

4. To set a breakpoint so that execution stops if a value whose lower two bits have the value 10 is written to register R10:

```
: BR R10 2 3 (RET)
:
```

5. To disable the breakpoint R1:

```
: BR R1 ;D (RET)
:
```

6. To display the currently set breakpoints (note that data and masks are displayed in hexadecimal):

```
: BR (RET)
<E/D>  <REGISTER>  <DATA>  <EQ/NE>     <COMMAND LINE>
                   <MASK>
  E        R0     --------   EQ
                  --------
  D        R1     000000FF   EQ          "REGISTER"
                  --------
  E        R2     000000FF   NE
                  --------
  E       R10     00000002   EQ
                  00000003
:
```

7. To clear the breakpoint R0:

```
    : BR- R0 (RET)
:
```

| 5.6 | BREAK_SEQUENCE | Sets, displays, and cancels breakpoints based on a specified execution sequence |
|---|---|---|
| | BS | |

**Format**

Set:

```
BREAK_SEQUENCEΔ<instruction address>[Δ<instruction
address>[Δ<instruction address>[...]]]
[;"<command line>"](RET)
```

Display:

```
BREAK_SEQUENCE (RET)
```

Cancellation:

```
BREAK_SEQUENCE- (RET)
```

**Parameters**

- `<instruction address>`
  Specifies the address(es) that will form the sequential breakpoint condition.
- `<command line>`
  Specifies a command line to be executed when the break occurs. To indicate a double quotation mark in a character string, insert two double quotation marks in sequence.

**Function**

This command sets, displays, and cancels a breakpoint based on a specified execution sequence.

Instruction execution stops when the break condition (sequential execution of the specified addresses) is satisfied during program execution due to a CALL, GO, STEP, STEP_INTO, or VECTOR command.

**Description**

| | |
|---|---|
| Set: | Sets a break condition so that execution stops at the last specified address when the instructions at the specified addresses have been executed in the specified order. Note that a sequence of up to 8 addresses can be specified with this command. |
| Display: | Displays the breakpoints set with the BREAK_SEQUENCE command. |
| Cancellation: | Cancels (clears) the breakpoints set with the BREAK_SEQUENCE command. |

## Notes

1. If a breakpoint is set at any address other than the first byte of an instruction, the break will not be detected.

2. The execution sequence condition is reset at the point that instruction execution is stopped.

3. If the instruction following a delayed branch instruction is specified as the last instruction address, execution stops at the start address of the delayed branch instruction.

4. If conditions specified with the BREAK and BREAK_SEQUENCE commands are satisfied simultaneously, the command line specified with the BREAK command is executed first.

## Examples

1. To set a sequential breakpoint for addresses H'2000, H'2100, and H'3000, and to execute the REGISTER command after break:

```
: BS 2000 2100 3000 ; "REGISTER" (RET)
:
```

   Execution will break when execution has passed addresses H'2000, H'2100, and H'3000. Note that “passing an address” is defined as “passing at least once”.  Thus, the breakpoint sequence is not reset when an address is executed more than once.

2. To display the currently set sequential breakpoint:

```
: BS (RET)
1ST BREAK POINT = 00002000 %file.c!entry_add(#  36)
2ND BREAK POINT = 00002100 %file.c!entry_sub(#  58)
3RD BREAK POINT = 00003000 %file.c!entry_mult(# 102)
<COMMAND LINE>
  "REGISTER"
```

3. To clear the sequential breakpoint:

```
: BS- (RET)
:
```

| 5.7 | CALL | Calls a function |
|---|---|---|
| | CA | |

### Format

```
CALLΔ<function name>([[<argument>],[<argument>]...])
[Δ<return address>] (RET)
```

### Parameters

- `<function name>`
  Specifies the name of the function to be simulated.

- `<argument>`
  These parameters specify the arguments to the function.
  The arguments are pushed onto the stack in order from right to left.
  Expressions which represent data values (including floating point values) can be used as arguments. Data items are stored on the stack in the specified size.
  Up to 63 arguments can be specified.
  When arguments are omitted, zero (0) is assumed.

- `<return address>`
  Specifies the address to store the return value.

### Function

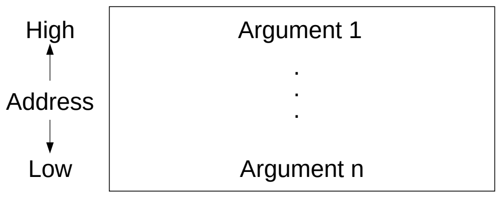
This command creates the stack frame required by C language functions, and calls the specified function. It can be used for testing individual functions. Execution stops if an error occurs or a break condition is satisfied.

### Description

Usage: The command line specifies the arguments to be passed to the function, and the address to store the return value.
This specification creates the stack frame, sets up the SP, PC and PR registers, and executes the function.
The following values are loaded into the SP, PC, and PR.
- SP: The SP is automatically decremented by an amount corresponding to the size of the area allocated.
- PC: The PC is set to the entry address of the specified function.
- PR: The PR indicates the current PC address.

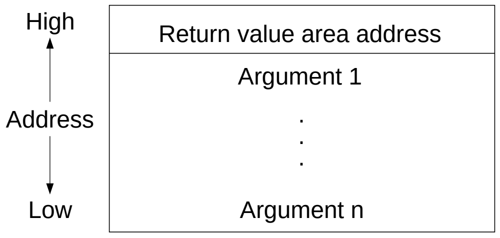
The format of the stack frame is as follows.

1. Stack frame when a register is used to pass the return value.
   This format is used when the register is equal to or larger than the size of the returned data.



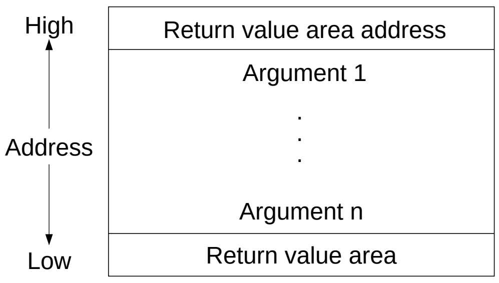
   When the function completes and returns, the return value is copied from register R0 to the specified address. However, if no return value storage address is specified, the value is not copied.

2. Stack frame when the return value is passed to the specified address.
   This format is used when the size of the return value is greater than the CPU register size, and the return value address was specified in the CALL command.



   The return area address is set to the return value address specified in the command line.

3. Stack frame when the return value is passed on the stack.
   This format is used when the size of the return value is larger than the CPU register size, and the return value address was not specified in the CALL command.



   Since the return value address was not specified, a return value area is allocated on the stack, and the return value is stored in that area.

The value of the stack pointer must be set to an appropriate value beforehand, since the current stack area, registers, and memory areas are used during function execution.

Note that the SAVE_STATUS and LOAD_STATUS commands can be used to restore the system to the simulator/debugger state prior to function execution after executing a function with the CALL command.

Refer to the SH-Series C Compiler User’s Manual for more information on the function call interface.

**Note**

If optimization is performed at compilation, arguments may be stored in the registers instead of on the stack.

## Examples

1. To call the function “func1” with the arguments 1 and 10, and to store the return value at address 5000:

```
: CA /func1(1,10) 5000 (RET)
:
```

2. To show the  setup required to test the function “func2” shown below.  The results of the arithmetic operations are stored starting at address H'1800:

```
func2(p,i,j)
int *p ;
int i,j ;
{
  *p++ = i + j ;
  *p++ = i – j ;
  *p++ = i * j ;
  *p++ = i / j ;
}
```

```
: L test2.obj (RET)               Loads the file test2.obj.
UNDEFINED SYMBOL : symbol
: MP 1000 @1000 (RET)             Allocates the stack and return areas.
: .R15 1800 (RET)                 Initializes the stack pointer.
: CA /func2(1800,50,10) (RET)     The return address will be H'100, i.e., the current value of the
                                  PC.
: D 1800 @10 (RET)                Confirms the results of the arithmetic operations.
address   +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +A +B +C +D +E +F         ASCII
00001800  00 00 00 60 00 00 00 40 00 00 05 00 00 00 00 05
...’...@........
:
```

| 5.8 | COMMAND_CHAIN | Executes commands from a file |
|---|---|---|
| | CC | |

**Format**

```
COMMAND_CHAINΔ<file name>[Δ["<actual parameter>"],["<actual
parameter>"]...] (RET)
```

**Parameters**

- `<file name>`
  Specifies the name of the command file.

- `<actual parameter>`
  Specifies a character string to replace dummy parameters.
  To omit an actual parameter, skip its position by inserting an extra comma.

**Function**

This command reads commands from a file and executes them in sequence.

Dummy arguments can be specified within a command file to be replaced with the “actual parameters” specified in the COMMAND_CHAIN command.

There are 10 dummy parameters, ¥0 to ¥9.

Use the strings ¥¥0 to ¥¥9 to represent ¥0 to ¥9 within character stings, or as character strings in option command lines of the BREAK, BREAK_ACCESS, or BREAK_DATA commands.

Dummy parameters for which no actual parameters are specified are replaced with NULL.

**Notes**

1. To include a double quotation mark in a character string, insert two double quotation marks in sequence.

2. Command chain files can be nested up to 8 levels.

3. Redirection cannot be specified.

## COMMAND_CHAIN

**Examples**

1. To execute the commands in the auto.com command file in sequence:

```
: CC auto.com (RET)
: P out.log                Execution history is stored in out.log.
: S 100                    The debugging object program is executed for H'100 steps starting
:                          at the current PC.
: ;END                     A comment line.
:
```

2. To use dummy parameters:

   a. The following command file uses dummy parameters.

```
RADIX ¥0
MEMORY ¥1 100
```

autol.sbt

The first parameter (¥0) is used as the argument to the RADIX command.
The second parameter (¥1) is used as the first argument to the MEMORY command.

   b. The following command executes the commands in the “auto1.sbt” command file.

```
: CC auto1.sbt "D", "1000" (RET)
: RX D                 The RADIX command is executed with D as the actual parameter.
: M 1000 100           The MEMORY command is executed with 1000 as the actual
:                      parameter.
```

| 5.9 | COMPARE | Compares memory contents |
|---|---|---|
| | CMP | |

**Format**

```
COMPAREΔ<start address>Δ{<end address>|@<byte count>}
Δ<comparison memory start address> (RET)
```

**Parameters**

- `<start address>Δ{<end address>|@<byte count>}`
  Specifies the range of memory (the source data) to be compared.

- `<comparison memory start address>`
  Specifies the start of the comparison data memory area.

**Function**

Compares the specified range of memory (the source data) with the comparison data in byte units.

When data that does not match is found, those data items and their addresses are displayed.

**Example**

To compare the H'500 bytes of data starting at address H'1000 with the H'500 bytes of data starting at address H'2000, and to display the addresses and values of the source data and compared data when data which does not match is found:

```
: CMP 1000 @500 2000 (RET)
source data    compared data
00001005 3F    00002005 42
             :
             :
000014FE 00    000024FE 80
:
```

| 5.10 | CONVERT | Calculates expression |
|---|---|---|
| | CV | |

**Format**

```
CONVERTΔ<expression> (RET)
```

**Parameter**

- `<expression>`
  Specifies an integer expression for conversion.

**Function**

The value of the expression is displayed in binary, octal, decimal, and hexadecimal and as ASCII characters.

**Example**

To display the result of evaluating the expression “3*5” in binary, octal, decimal, and hexadecimal and as ASCII characters:

```
: CV 3*5 (RET)
B' 00000000 00000000 00000000 00001111
Q' 00000000017
D' 15
H' 0000000F
A' ....
:
```

**Note**

If a symbol is specified in an expression, the symbol address is displayed.

| 5.11 | COVERAGE | Starts and stops coverage measurement |
|---|---|---|
| | COV | |

**Format**

| | |
|---|---|
| Start: | `COVERAGE[Δ<file name>] (RET)` |
| Restart/temporary halt/initialization: | `COVERAGE ;{E\|D\|R} (RET)` |
| Termination: | `COVERAGE-[;N] (RET)` |

**Parameters**

- `<file name>`
  Specifies the file to hold coverage data.
  The file "temp.cov" is used as default when the a file name is omitted.
  When the file extension is omitted, ".cov" is supplied as default.

- Options

  — Restart and temporary halt coverage measurement `{E|D}`
  `E` (enable): Restarts coverage measurement.
  `D` (disable): Temporarily halts coverage measurement.

  — Coverage data initialization specification `R`
  `R` (reset): Initializes coverage data.

  — Coverage data storage specification `N`
  `N` (not save): Coverage measurement is terminated without saving the acquired data to a file.

**Function**

Starts, temporarily stops, restarts, and terminates coverage measurement data acquisition.

**Description**

Start: Starts the acquisition of coverage data.
Previously acquired coverage data is lost.
The addresses of instructions executed by a CALL, GO, STEP, STEP_INTO, or VECTOR command following the input of this command are saved as coverage data.

| | |
|---|---|
| | If the specified file exists, the information in that file is read in, thus resetting the address range.<br>If the file name is omitted, the current coverage range setting is displayed, and acquisition of coverage data begins. |
| Restart/temporary halt/ initialization: | Data acquisition is restarted, temporarily halted, or re-initialized with no change in other settings. |
| Termination: | Acquisition of coverage data is terminated, and the acquired data is output to the file.<br>Specify the N option to terminate coverage data acquisition without saving the data to a file. |

**Notes**

1. Use the SET_COVERAGE command to confirm the setting state.

2. The coverage calculation involves disassembling the program to count instructions. As a result, correct values cannot be computed for programs which include data within their code areas.

**Examples**

1. To start the acquisition of coverage data:

```
: COV (RET)
coverage area
  00001000 - 000012FF
  00001800 - 00001FFF
:
```

2. To load a coverage file and start the acquisition of coverage data:

```
: COV test1.cov (RET)
object file name = test.abs
coverage area
  00001000 - 000012FF
  00001800 - 00001FFF
:
```

3. To initialize coverage measurement:

```
: COV ;R (RET)
:
```

4. To terminate coverage measurement:

```
: COV- (RET)
:
```

| 5.12 | DATA_SEARCH | Searches for data |
|---|---|---|
| | DS | |

**Format**

```
DATA_SEARCHΔ<start address>Δ{<end address>|@<byte count>}Δ
{<search string>|<search data>[:<size>][Δ<mask>]}[;[S=<byte
count>][Δ{EQ|NE}]] (RET)
```

**Parameters**

- `<start address>Δ{<end address>|@<byte count>}`
  Specifies the range of the addresses to be searched.

- `{<search string>|<search data>[:<size>][Δ<mask>]}`
  Specifies the string or data to be searched for.

- `<size>`

| | |
|---|---|
| `B` (byte): | Searches for byte sized data. |
| `W` (word): | Searches for word sized data (default). |
| `L` (long): | Searches for long-word sized data. |

- `<mask>`
  Only bits which correspond to 1 bits in the mask are tested.
  The size of the mask data depends on the size of the search data.

- Options

  — Search step width
  `S=<byte count>` : Specifies the search step width in byte units.
  The default search step width is the size of the data.

  — Data match/differ `{EQ|NE}`

| | |
|---|---|
| `EQ` (equal): | Searches for data that matches the search data (default). |
| `NE` (not equal): | Searches for data that differs from the search data. |

**Function**

This command searches for the specified data in the specified memory range.

When the EQ option is specified, the addresses of data which match are displayed.

When the NE option is specified, the addresses of data which differ are displayed.

When the search step width is specified with the S (step) option, the command searches for data only at addresses separated by the step width starting at the start address.

**Example**

To search for the value 005E from address H'1000 to address H'14FF:

```
: DS 1000 14FF 5E (RET)
address
00001004
00001100
000011A8
:
```

| 5.13 | DEBUG_LEVEL | Specifies debug level |
|---|---|---|
| | DL | |

### Format

Specification: `DEBUG_LEVEL [;] {S|I|N} (RET)`

Display: `DEBUG_LEVEL (RET)`

### Parameter

- Option
  - — Specification of the units for source line display and of the step count for the step execution command. `{S|I|N}`

| Option | Source Line Display | S and SI Command Step Units |
|---|---|---|
| S (Source display, source line step) | C source only | Line units |
| I (Instruction and source display, instruction step) | Both C source and machine language | Machine language instruction units |
| N (No source display, instruction step) | Machine language only | |

### Function

This command specifies whether high-level language debugging is performed or not.

There are three aspects to high-level language debugging as listed below.

1. Source line display
   The display consists of the source program corresponding to the results of command execution.
   The following commands display the source program in their execution results.

   - The disassembly command (DA)
   - The trace buffer display command (T)
   - The debugging object program execution commands (G, S, SI, V)

2. Step execution units
   This specification determines whether or not the step execution commands (S and SI) take the C source line as the step.

3. BREAK stop address
   This command also specifies whether the simulator/debugger stops on source line units or machine instruction units when a break condition specified by a BREAK_ACCESS, BREAK_DATA, or BREAK_REGISTER is detected.

**Description**

| | |
|---|---|
| Specification: | Sets the source program display and step execution unit.<br>• S option: Only C source lines are displayed, and step execution steps in source line units. (Start-up setting)<br>• I option: Both C source lines and machine language are displayed, and step execution steps in machine language units.<br>• N option: Only machine language is displayed, and step execution steps in machine language units. (Assembly source programs are displayed in the same way while the I option is specified.) |
| Display: | Displays the current setting state. |

**Note**

The S and I options cannot be specified for files without debugging information.

**DEBUG_LEVEL**

**Examples**

1. To display the setting state:

```
: DL (RET)
Source/Instruction/Not display = S
:
```

2. To set the step unit for the STEP and STEP_INTO commands to machine language instruction units:

```
: DL ;I (RET)
: S 10 (RET)
%filename.c#100    a = b + 1;
00000556     MOV.L       R1,R0
00000558     MOV.L       R3,R2
               :
               :
%filename.c#101   printf("simulator debugger¥n");
           MOV.L        R5,R3
:
```

| 5.14 | DISASSEMBLE | Disassembles and displays memory contents |
|---|---|---|
| | DA | |

**Format**

```
DISASSEMBLEΔ<start address>[Δ{@<instruction count>|<end address>}
(RET)
```

**Parameters**

- `<start address>`
  Specifies the address from which to start disassembly of memory contents.
- `<instruction count>`
  Specifies the number of instructions to disassemble.
- `<end address>`
  Specifies the address at which disassembly is terminated.

**Function**

This command disassembles and displays the contents of memory in the range specified by the start address and the end address or instruction count parameters.

**Description**

1. When the end address or instruction count parameter is omitted, 16 lines from the start address are disassembled.
2. The hexadecimal representation for the two bytes of data is displayed when an illegal instruction is encountered.
3. The first address of the instruction, the instruction mnemonic, the operands, and the symbol are displayed.

   Note that the address corresponding to a symbol displayed as a label is the address of the instruction displayed on the line following the symbol.
4. After this command is executed, pressing the RETURN key again disassembles and displays the next 16 lines until other commands are entered.

5. When the SP is specified as a register in PC-relative or register-indirect-with-displacement addressing mode, the displacement value will be converted to the corresponding automatic variable symbol and the conversion results will be displayed.

**Note**

Since the DISASSEMBLE command does not recognize delay branch instructions correctly, symbol conversion may not be performed correctly.

**Examples**

1. To disassemble and display from addresses H'400 to H'406. In the output below, "%sample.src!SECT1" is a symbol which corresponds to address H'404:

```
: DA 400 406 (RET)
00000400       MOV.W          @(12,PC),R0
00000402       MOV.W          @R1,R0
        %sample.src!SECT1:
00000404       MOV.L          #00000012,R3
00000406       ADD.L          R2,R1
:
```

2. To disassemble and display the four instructions starting at address H'400:

```
: DA 400 @4 (RET)
00000400       MOV.W          @(12,PC),R0
00000404       MOV.W          @R1,R0
        %sample.src!SECT1:
00000408       MOV.L          #00000012,R3
0000040A       ADD.L          R2,R1
:
```

| | | |
|---|---|---|
| **5.15** | **DISPLAY_CHARACTERS** | **Displays character string** |
| | **DCH** | |

**Format**

```
DISPLAY_CHARACTERS˘"<character string>" (RET)
```

**Parameter**

- `<character string>`
  Specifies an arbitrary character string.

**Function**

Displays the specified character string on the screen.

This command can be used to display messages, for example, with the STUB command.

**Examples**

1. To display "SIMULATOR" on the screen:

```
: DCH "SIMULATOR" (RET)
SIMULATOR
:
```

2. To insert the DISPLAY_CHARACTERS command in a STUB command sequence so that it displays its argument during simulation:

```
: SB 10 { (RET)
STUB > DCH "PASS 10" (RET)
STUB > } (RET)
: G 8 (RET)
PASS 10    The DCH command is executed when the instruction at address H'10 is executed.
:
```

| 5.16 | DISPLAY_COVERAGE | Displays coverage data |
|---|---|---|
| | DCV | |

**Format**

```
DISPLAY_COVERAGE [˘<first address>[˘{<end address>|@<source line
count>|@<instruction count>}]] [;{T|G|D|N0|N1}] (RET)
```

**Parameters**

- `<first address>˘{<end address>|@<source line count>|@<instruction count>}`
  Specifies the range of coverage data to be displayed.

- Options

  Display format specification `{T|G|D|N0|N1}`

| | |
|---|---|
| `T` (total): | Specifies display of both C0 and C1 coverage values. |
| `G` (general): | Specifies display of the results in source line units. (default) |
| `D` (detail): | Specifies display of the results in machine instruction units. |
| `N0, N1` (not executed): | Specifies display of addresses that were not executed. |

**Function**

Displays C0 and C1 coverage data.

- When the T option is specified
  Only coverage values are displayed.
  If only the option is specified, (i.e., if the range specification is omitted) then the whole coverage range is taken as the object of the coverage values.

- When the G option is specified
  The coverage results are displayed in source line units.
  When the range specification is omitted, display continues from the previous use of the command.
  When the end address or source line count specification is omitted, 16 lines are displayed.

- When the D option is specified
  The coverage results are displayed in machine instruction units.
  When the range specification is omitted, display continues from the previous use of the command.
  When the end address or source line count specification is omitted, 16 lines are displayed.

- When the N0 or N1 option is specified
  The addresses of unexecuted instructions are displayed.
  Line numbers will be displayed if line number information is available.
  N0 specifies the addresses not executed under C0 coverage, and N1 specifies the branches not taken under C1 coverage.

**Description**

After the DISPLAY_COVERAGE command has been executed once, pressing (RET) again will show the next 16 lines of coverage information until another command is entered.

**Examples**

1. To display the coverage data with specifying the T option:

```
: DCV 0 @30 ;T (RET)
C0 : 87.5%
C1 : 50.0%
:
```

2. To display the coverage data with specifying the G option:

```
: DCV 0 @10 ;G (RET)        (This example is a C program.)
%sample.c#    4  *   for(i=0; i<20; ++i)
%sample.c#    6  .     printf("Number is %c", number[i]);
:
```

- C0 coverage is displayed.
- The objects of display are C and assembler source programs.
- An indicator mark is inserted in column 1.
- Indicator interpretations:
  * (asterisk) — This address was accessed and executed.
  . (period) — This address was not executed.
  ˘ (space) — No machine instruction was generated for this line.

3. To display the coverage data with specifying the D option:

```
: DCV 0 ;D (RET)
*  00000000       ADD.L         #FFFFFFFC,R15
%sample.c#    4    for(i=0; i<20; ++i)
*  00000002       MOV.L         #00000000,R3
*  00000004       MOV.L         R3,@R15
*  00000006       BRA           00000010
*  00000008       NOP
*  0000000A       MOV.L         @R15,R2
*  0000000C       ADD.L         #00000001,R2
*  0000000E       MOV.L         R2,@R15
*  00000010       MOV.L         @R15,R3
*  00000012       MOV.L         #00000014,R2
*  00000014       CMP/GE.L      R2,R3
T  00000016       BF            0000040A
:
```

- The disassembled source program corresponding machine code are displayed.
- C0 and C1 are displayed.
- An indicator mark is inserted to the left of the disassembled machine code.
- Indicator interpretations:

| | | |
|---|---|---|
| * (asterisk) | — | Accessed and executed. |
| T | — | The true branch was taken. |
| F | — | The false branch was taken. |
| TF | — | Both branches have been taken. |
| . (period) | — | Not executed. |

4. To display the coverage option with specifying the N option:

```
: DCV 0 ;N1 (RET)
.F 0000002C %main#009
:
```

(This example is coverage data for a C program.)

- There are two N options, N0 and N1. N0 displays the line numbers for addresses not executed under C0, and N1 displays the line numbers for addresses not executed under C1.
- An indicator mark is inserted at column 1 for the C1 display.
- Indicator interpretations:
  `T.` — The true branch was taken.
  `.F` — The false branch was taken.
  `..` — Not executed.

| 5.17 | DUMP | Displays memory contents |
|---|---|---|
| | D | |

**Format**

```
DUMP˘<start address>[˘{<end address>|@<item count>}]
[;{B|W|L|S|D}]  (RET)
```

**Parameters**

- `<start address>[˘{<end address>|@<item count>}]`
  Specifies the range of memory to be displayed.

- Options

  — Data size `{B|W|L|S|D}`

| | |
|---|---|
| `B` (byte): | Byte data (default). |
| `W` (word): | Word data. |
| `L` (long): | Long-word data. |
| `S` (single precision): | Single-precision floating point data. |
| `D` (double precision): | Double-precision floating point data. |

**Function**

This command displays, in the specified format, the block of data from the start address to the end address, or for the specified number of data items.

If the end address is omitted, 16 lines are displayed starting at the first address.

After executing the DUMP command once, the next 16 lines of data can be displayed by just pressing (RET) before entering any other command.

**Examples**

1. To display the memory contents in byte units starting at address H'1000:

```
: D 1000 ;B (RET)
address   +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +A +B +C +D +E +F       ASCII
00001000   FF 00 FF 00 FF 00 FF 00 FF 00 FF 00 FF 00 FF 00  ................
    :                            :
    :                            :
00001070   41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50  ABCDEFGHIJKLMNOP
:
```

2. To display two items of single precision floating point data starting at address H'2000:

```
: D 2000  @2 ;S  (RET)
address    +0 +1 +2 +3
00002000   49 96 B4 38 1.234567S+6
00002004   3F 80 00 00 1.0S+0
:
```

| 5.18 | EXEC_MODE | Switches execution mode |
|---|---|---|
| | EM | |

**Format**

Set:      `EXEC_MODE ;{S|C}  (RET)`
Display:  `EXEC_MODE  (RET)`

**Parameter**

- Options

  Execution mode specifier `{S|C}`

| | |
|---|---|
| `S` (stop) | In this mode execution is stopped when the simulator/debugger detects an abnormality (simulation error) in the debugging object program. |
| `C` (continue): | In this mode simulation errors are ignored and execution continues when the simulator/debugger detects an abnormality (simulation error) in the debugging object program. |

  The simulator/debugger execution mode is set to S when first invoked.

**Function**

This command selects whether execution will continue or stop when an abnormality is detected during debugging object program execution.

When the execution mode specifier is omitted, the current setting of the execution mode is displayed.

Refer to section 2.11 (2), Break due to detection of an execution time error in the debugging object program, for more information on abnormalities occurring while executing the debugging object program.

**Description**

| | |
|---|---|
| Set: | Stop mode is recommended for the early stages of debugging, with continue mode being useful in the later stages. |
| Display: | “STOP” is displayed in stop mode, and “CONTINUE” in continue mode. |

## Examples

1. To set the execution mode to continue mode:

```
: EM ;C  (RET)
:
```

2. To display the current execution mode:

```
: EM  (RET)
EXEC_MODE = CONTINUE
:
```

| 5.19 | FILL | Initializes memory area |
|---|---|---|
| | F | |

**Format**

```
Fill˘<start address>˘{<end address>|@<data item count>}
˘<initialization data>[:<size>]  (RET)
```

**Parameters**

- `<start address>˘{<end address>|@<data item count>}`
  Specifies the range of addresses to be initialized.

- `<initialization data>`
  Specifies the data value to be stored.

- `<size> {B|W|L}`

| | |
|---|---|
| `B` (byte): | Initialization is performed in byte units. |
| `W` (word): | Initialization is performed in word units. (default) |
| `L` (long): | Initialization is performed in long word units. |

  When the size specification is omitted, word is used as the default unless the start address was specified with a high level language variable.  In that case, the size will be the size of that variable.

**Function**

The initialization data is stored in the specified memory range.

**Example**

To clear addresses H'1000 to H'1FFF to zero:

```
: F 1000 1FFF 0  (RET)
:
```

| 5.20 | GO | Executes instructions continuously |
|---|---|---|
| | G | |

**Format**

```
GO [˘[<start address>][,[<break address>]][;D]] (RET)
```

**Parameters**

- `<start address>`
  Specifies the address from which program execution starts.
  When omitted, execution starts from the address specified by the current value of the program counter.

- `<break address>`
  Specifies the address at which to stop program execution.

- Options

  — Break disable `D`

  | | |
  |---|---|
  | `D` (disable breaks): | Breakpoints specified with the break commands are temporarily disabled. |

**Function**

This command executes the debugging object program continuously starting at the specified start address.

The break address, break instruction execution cycle count, and break disable option specifications are temporary disabled during GO command execution but are enabled again when execution stops.

**Description**

1. Execution is interrupted when either a condition set by a break command is satisfied, or when an error occurs.
   However, if the D option is specified, execution is not interrupted on the satisfaction of a break condition.

2. When execution is interrupted, the instruction execution count (in decimal), the current register values, a disassembled display of the last instruction executed, and a confirmation message are displayed.

3. If the E option has been specified with the TRACE_CONDITION command, the execution history is written to the trace buffer.

**Notes**

1. If a break address is specified at a point that is not the start address of an instruction, the break will not be detected.

2. If a break address is specified at an instruction following a delayed branch instruction, execution stops at the start address of the delayed branch instruction.

**Examples**

1. To execute the debugging object program continuously while temporarily ignoring the currently specified break conditions:

```
: G ;D  (RET)
Exec Instructions = 159
PC=00000402 SR=00000000:**********************------**-- SP=05000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 05000000
00000400 SLEEP
SLEEP
:
```

2. To execute the debugging object program from address H'1000 to address H'1020:

```
: G 1000,1020  (RET)
Exec Instructions = 30
PC=00001020 SR=00000000:**********************------**-- SP=05000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 0000FFFF 00000000 00000000 01000000 00000000 00000000 00000000
R8-15 00000000 00000000 00000010 00000000 0000FFFF 00000000 00000000 05000000
0000101E   MOV.L         R0,@R4
BREAK POINT
:
```

| 5.21 | HELP | Displays command name and input format |
|---|---|---|
| | HE | |

**Format**

```
HELP [˘<command name>] (RET)
```

**Parameter**

- `<command name>`
  Specifies the name of the command for which the help message is to be displayed.

**Function**

Displays the help message for the specified command.

**Description**

- When a command name is specified, the help message for the specified command is displayed.
- When the command name is omitted, a table of commands is displayed.

## Examples

1. To display a table of commands:

```
: HE (RET)
Assemble         Break_Register Break_Access    Break_Data    Break
Break_Sequence   CAll           Command_Chain   CoMPare       ConVert
COVerage         Data_Search    Debug_Level     DisAssemble
Display_CHaracters
Display_CoVerage Dump           Exec_Mode       Fill          Go
HElp             Load           Load_Status     MAcro         MaP
Memory           MoVe           Print           Quit          RadiX
Register         ReSet          SaVe            Save_Status   SCoPe
Set-CoVerage     SHow_Calls     Step            Step_Into     StuB
SYmbol           Trace          Trace_Condition Trap_Address  TYpe
Vector           .<register>    !
:
```

2. To display the syntax of the HELP command:

```
: HE HELP (RET)
HE|HELP [command-name]
```

| 5.22 | LOAD | Loads file |
|---|---|---|
| | L | |

**Format**

```
LOAD˘<file name>[˘[<load address>][;[{OD|O|M}][,U]]] (RET)
```

**Parameters**

- `<file name>`
  Specifies the name of the file to be loaded.
  When the file format is omitted from the file name, ".abs" is supplied for debugging object programs and ".dat" is supplied for memory image files.

- `<load address>`
  Specifies the address to which the file is loaded.
  If a load position is specified for an absolute load module, the specification will be ignored. When omitted, relocatable load modules will be loaded at H'400. Absolute load modules will be loaded at their load address. Memory image files are loaded starting at address H'0.

- Options

  — File format specifier `{OD|O|M}`

| | |
|---|---|
| `OD` (object and debug information): | Both the machine language and the debugging information are loaded. (default) |
| `O` (object): | Only the machine language is loaded. |
| `M` (memory image file): | A memory image file is loaded. |

  — Undefined symbol allocation `U`

| | |
|---|---|
| `U` (undefined): | Addresses are allocated for undefined symbols. |

**Function**

This command loads debugging object programs and memory image files, including files created with the SAVE command.

When a memory image file is loaded, the load start and end addresses are displayed after loading.

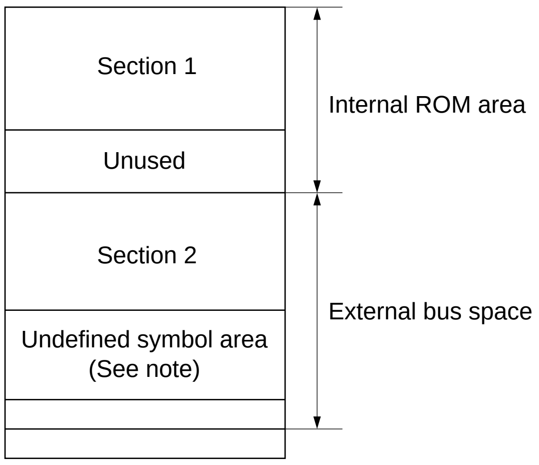
When the U option is specified, a 4-byte area is allocated for each undefined symbol, and its address is used as the value of the symbol. These areas are allocated in the external bus space or internal RAM area, and are displayed on the screen.

Although the LOAD command allocates the required memory when loading a debugging object program, memory is not allocated when loading a memory image file.

In addition, before loading a memory image file, memory must be allocated using the MAP command.

**Description**

The figure below shows the load map for a debugging object program and its undefined symbol area.



Note: The address of the area allocated will be filled with the number of undefined symbols.

The initial settings following the loading of a debugging object program are as follows:

| | |
|---|---|
| Memory areas .......... | The debugging object program areas and an undefined symbol area are allocated. |
| Coverage ................. | The coverage areas are automatically set to be the code sections. The maximum number of areas is 16. |
| PC ............................ | If an entry address was specified in the debugging object program, the PC is set to that address. Otherwise, the PC is set to the start address of the code segment that appeared first. |
| SP............................. | The SP is set to the last address of the internal RAM area + 1. |

No other registers or flags are set.

**Notes**

1. Before loading a memory image file, memory must be allocated using the MAP command.
2. The information loaded by the LOAD_STATUS command differs from that loaded by the LOAD command.

**Examples**

1. To load “test1.abs” as the debugging object program:

```
: L test1.abs (RET)
:
```

2. To load “test2.dat” as a memory image file, starting at address H'3000:

```
: L test2.dat 3000 ;M (RET)
 <START>    <END>
 00003000 - 000030FF
:
```

| 5.23 | LOAD_STATUS | Restores simulator/debugger memory and register state |
|---|---|---|
| | LS | |

**Format**

```
LOAD_STATUS [˘<file name>] (RET)
```

**Parameter**

- `<file name>`
  Specifies the name of a file that was used to save the simulator/debugger memory and register state.
  If the file name is omitted, the file "sdsh.sav" is assumed.
  If the file format is omitted, ".sav" is supplied.

**Function**

The states of memory and the registers are restored to the point when the corresponding SAVE_STATUS command was executed.

**Notes**

1. If the memory map differs from that at the point the SAVE_STATUS command was executed, the memory and register state is not restored.
2. Files saved by specifying the A option with the SAVE_STATUS command must be loaded at simulator/debugger startup time.

**Example**

To load the memory and register state saved in the file “test1.sav”:

```
: LS test1.sav (RET)
:
```

| 5.24 | MACRO | Defines, displays, executes, and deletes simulator/debugger command macros |
|---|---|---|
| | MA | |

**Format**

Definition: `MACRO˘<macro name>{ (RET)`
Display: `MACRO[˘<macro name>] (RET)`
Execution: `<macro name> [˘["<actual parameter>"],["<actual parameter>"]...] (RET)`
Deletion: `MACRO- [˘<macro name>] (RET)`

**Parameters**

- `<macro name>`
  Specifies the name of the macro.
  A macro name must be an alphanumeric string starting with an alphabetic character.
  A macro name must be 32 or fewer characters in length.
  Note that upper and lower case characters are not distinguished.
  Since the following symbols are used as macro internal functions, they may not be specified as macro names.

  — WHILE
  — FOR
  — DO
  — IF
  — ELSE
  — MBREAK
  — CONTINUE

  Also note that if a simulator/debugger command name is redefined as a macro, the macro usage will take precedence.

- `<actual parameter>`
  Specifies the parameters passed to the macro.
  To omit an actual parameter, specify both the comma delimiting the previous actual parameter and a comma to correspond to the omitted parameter.
  Omitted actual parameters are replaced by ‘NULL’ during macro expansion.

**Function**

Definition: Defines a macro command.
Up to 64 macro commands can be defined.
However, since the area used for storing the macro definitions is limited, there are cases when a full 64 macros cannot be defined.
When the command line “MACROΔ<macro name>{(RET)” is entered, the simulator/debugger displays a prompt (“0001>”) indicating macro definition in progress, and waits for input of the macro body.
The macro body can include multiple simulator/debugger commands, macro commands, and macro internal commands.
Furthermore, %0 to %9 can be used as dummy arguments inside a macro body.
The dummy arguments are replaced with the actual parameters specified when the macro is called.
Use the strings %%0 to %%9 to represent %0 to %9 in character stings, or in command line option character strings in BREAK, BREAK_ACCESS, BREAK_DATA, BREAK_REGISTER, or BREAK_SEQUENCE command lines.
Note that no command line syntax checking is performed during macro definition.
Error checking is performed during macro command execution.
Macro command definition is terminated by entering “}(RET)” at nesting depth 0.

Display: The definition state of the specified macro command is displayed.
If the macro name is omitted, all the currently defined macro names are displayed.
When a macro name is specified, the macro body (i.e., the contents of the macro definition) of the specified macro command is displayed.

Execution: The specified macro command is executed.
Processing is terminated if an error occurs in the macro command or if the user performs a manual break with (CTRL) + (C).
Although a macro command with the same name as a simulator/debugger command takes precedence over the simulator/debugger command, the simulator/debugger command can be executed by preceding the name with a caret ("^").
Macro commands are executed with the dummy arguments in the macro body replaced with the actual parameters specified in the macro call.

Deletion: A previously defined macro is deleted.
If a macro name is specified, the macro command defined with that name is deleted.
If the macro name is omitted, all defined macro commands are deleted.
In this case a confirmation message will be displayed. Respond "Y" to delete all macro commands or "N" to cancel the deletion.

**Notes**

1. Macro display, definition, and deletion, as well as execution of “!” commands, are not allowed within macro bodies.

2. Re-direct cannot be specified for macro command execution.

**Examples**

1. To define a macro command:

```
: MA ISTEP { (RET)
0001 > ·PAR = %0 (RET)
0002 > IF(*1000 == ·PAR) { (RET)        If the value of address H'1000 agrees with the
parameter,
0003 >    SI (RET)                     the STEP_INTO command will be executed.
0004 > }ELSE{ (RET)                    If they are not the same, the STEP command will be
0005 >    S (RET)                      executed.
0006 > } (RET)                         Termination of the IF internal macro command.
0007 > } (RET)                         Termination of the macro command definition.
:
```

2. To display the ISTEP macro command:

```
: MA ISTEP (RET)
ISTEP {
         ·PAR = %0
         IF(*1000 == ·PAR) {
           SI
         }ELSE{
           S
         }
        }
:
```

3. To execute the ISTEP macro command:

```
: ISTEP "10" (RET)      The value "10" is passed as the parameter.
: STEP
:
```

4. To delete the ISTEP macro command:

```
: MA- ISTEP (RET)
:
```

**Macro Internal Variables**

**Format**

```
·<variable name>
```

**Description**

1. Variables can be used within macro commands.

2. The first character must be "¥", the second character must be alphabetic, and the remaining characters must be alphanumeric.

3. The variable name, including the "¥", must be at least 2 characters and no more than 32 characters in length.

4. Variables represent 32-bit unsigned quantities.

5. Since macro variables are inherited when a macro call is nested inside a macro definition, variables of the same name within both macros are treated as the same variable, i.e., as a global variable.

6. Variables can be assigned values using the assignment operator.
   The assignment operator is an operator that can only be used inside a macro body, and has the following syntax.

   ```
   <variable>=<expression>
   ```

The names and usage of pre-defined macro internal variables are described below.
These variables are reference-only variables, and thus their values cannot be changed by the user.

·`SIMSTAT` : Indicates the simulator stop factor.
When one of the bits shown in figure 5-2 is 1, the simulator/debugger has stopped for the corresponding reason, and when a bit is 0, that factor is not the cause of the stop.

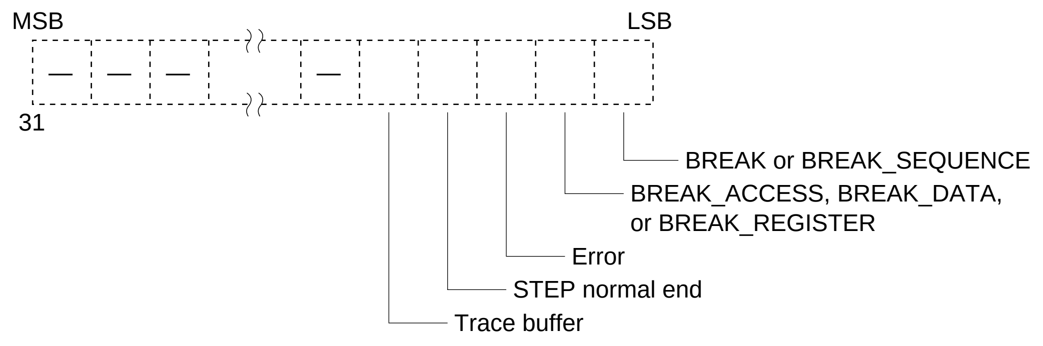


**Figure 5-2 Macro Internal Variable ¥SIMSTAT**

## Macro Internal Commands

### (1) WHILE

**Format**

```
WHILE (<expression>){
    <macro body>
}
```

**Parameters**

- `<expression>`
  The <expression> parameter expresses the condition for macro body execution or iteration.
- `<macro body>`
  The <macro body> parameter expresses the sequence of commands or macro internal commands to be executed while the condition is true.

**Function**

The <expression> is evaluated, and if its value is any value other than zero the macro body is executed.

The macro body is iterated until <expression> evaluates to zero.

If the value of <expression> is zero initially, the macro body is not executed even once.

Multiple simulator/debugger commands, macro commands, or macro internal commands can be included in the macro body.

**Example**

To display the fifth to tenth elements in array ABC:

```
·NUM = 5
WHILE(·NUM <= 10) {
  TYPE ABC[·NUM-1]
  ·NUM = ·NUM + 1
}
```

### (2) FOR

**Format**

```
FOR ([<expression 1>];[<expression 2>];[<expression 3>]) {
    <macro body>
}
```

**Parameters**

- `<expression 1>`
  The parameter <expression 1> is evaluated prior to testing the <macro body> execution condition.
- `<expression 2>`
  The parameter <expression 2> expresses the <macro body> execution or iteration condition.
- `<expression 3>`
  The parameter <expression 3> is evaluated after <macro body> execution.
- `<macro body>`
  The <macro body> parameter expresses the sequence of commands or macro internal commands to be executed when the condition is true.

**Function**

The FOR loop executes <expression 1> and then evaluates <expression 2>. If that latter value was any value other than zero, the FOR loop executes the <macro body> and then <expression 3>.

The <macro body> and <expression 3> are iterated until <expression 2> evaluates to zero.

If the value of <expression 2> is zero initially, the <macro body> is not executed even once.

Multiple simulator/debugger commands, macro commands, or macro internal commands can be included in the <macro body>.

**Examples**

1. To display the fifth to tenth elements in array ABC:

```
FOR(·NUM = 5; ·NUM <= 10; ·NUM = ·NUM+1) {
  TYPE ABC[·NUM-1]
}
```

2. To operate identically to the loop in example (1):

```
·NUM = 5
FOR(;·NUM <= 10;) {
  TYPE ABC[·NUM-1]
  ·NUM = ·NUM+1
}
```

**(3) DO/WHILE**

**Format**

```
DO {
    <macro body>
} WHILE <expression>
```

**Parameters**

- `<expression>`
  The <expression> parameter expresses the <macro body> iteration condition.

- `<macro body>`
  The <macro body> parameter expresses the sequence of commands or macro internal commands to be executed when the condition is true.

**Function**

The DO/WHILE loop first executes the macro body and then evaluates the <expression>. If that value is any value other than zero, the macro body is executed again.

The macro body is iterated until the <expression> evaluates to zero.

If the value of <expression> is zero initially, the macro body is executed exactly once.

Multiple simulator/debugger commands or macro internal commands can be included in the <macro body>.

**Examples**

To display the fifth to tenth elements in array ABC:

```
·NUM = 5
DO {
   TYPE ABC[·NUM-1]
   ·NUM = ·NUM+1
} WHILE(·NUM <= 10)
```

**(4) IF**

**Format**

```
IF (<expression>) {
   <macro body 1>
[} ELSE {
   <macro body 2>]
}
```

**Parameters**

- `<expression>`
  The <expression> parameter expresses the condition for execution of <macro body 1> selectively.

- `<macro body 1>`
  The <macro body 1> parameter expresses the sequence of commands or macro internal commands to be executed when the condition is true.

- `<macro body 2>`
  The <macro body 2> parameter expresses the sequence of commands or macro internal commands to be executed when the condition is false.

**Function**

The <expression> is evaluated, and if its value is any value other than zero, the <macro body 1> is executed.

When the value is zero, if the optional ELSE clause is present, <macro body 2> will be executed, otherwise nothing is executed.

Multiple simulator/debugger commands or macro internal commands can be included in <macro body 1> and <macro body 2>.

**Examples**

1. To display the value of address H'2000 if its value is any value other than zero:

```
IF(*2000 != 0) {
   D 2000
}
```

2. To display the value of address H'2000 if its value is any value other than zero, and if its value is zero, to display the value of address H'2100:

```
IF(*2000 != 0) {
  D 2000
}ELSE{
  D 2100
}
```

### (5) MBREAK

**Format**

```
MBREAK
```

**Function**

When an MBREAK command is executed, the enclosing WHILE, FOR, or DO/WHILE loop is interrupted, and control exits one level of iteration nesting.

**Notes**

The MBREAK command can only be used inside a WHILE, FOR, or DO/WHILE loop.

**Example**

To display the values of addresses H'1000 to H'2000, and to terminate the display if the value zero is encountered:

```
FOR(·ADDR = 1000; ·ADDR <= 2000; ·ADDR = ·ADDR+2) {
  D ·ADDR
  IF(*·ADDR == 0){
    MBREAK
  }
}
```

**(6) CONTINUE**

**Format**

```
CONTINUE
```

**Function**

When a CONTINUE command is executed, execution of the enclosing WHILE, FOR, or DO/WHILE loop is interrupted, and control proceeds to evaluation of the <expression> for a WHILE or DO/WHILE loop, or to the evaluation of <expression 3> for a FOR loop.

**Note**

The CONTINUE command can only be used inside a WHILE, FOR, or DO/WHILE loop.

**Example**

To display the values of addresses H'1000 to H'2000, jumping over (i.e. ignoring) addresses whose value is zero:

```
FOR(·ADDR = 1000; ·ADDR <= 2000; ·ADDR = ·ADDR+1) {
  IF(*·ADDR == 0) {
     CONTINUE
  }
  D ·ADDR
}
```

| 5.25 | MAP | Defines, displays, modifies, and deletes memory areas |
|---|---|---|
| | MP | |

**Format**

Set: `MAP˘<start address>˘{@<byte count>|<end address>} [;{R|W|RW}] (RET)`

Display: `MAP [;M] (RET)`

Modification: `MAP˘<start address> [;{R|W|RW}] (RET)`

Deletion: `MAP-[˘<start address>] (RET)`

**Parameters**

- `<start address>`
  Specifies the address of the start address in the memory area.

- `<byte count>`
  Specifies the number of bytes in the memory area.

- `<end address>`
  Specifies the address of the end address in the memory area.

- Option

  — Access type `{R|W|RW}`

  | | |
  |---|---|
  | `R` (read): | Specifies the memory area to be read-only. |
  | `W` (write): | Specifies the memory area to be write-only. |
  | `RW` (read/write): | Specifies the memory area to be read/write. |

  When omitted, the access type is set as follows.

  | | |
  |---|---|
  | Æ Internal ROM area (only when defining a memory area): | `R` |
  | Æ All other cases: | `RW` |

  — CPU information memory map display: `M`

  | | |
  |---|---|
  | `M` (map): | Specifies display of the memory map information from the CPU information file. |

**Function**

This command defines (sets) the memory area to be used by the object program, displays the state, and changes the access type for the memory areas used by the debugging object program.

**Description**

Set: This command is used to allocate memory areas other than those allocated when the debugging object program was loaded.
Up to 20 memory areas can be allocated with the MAP command.

Display: Displays the start address, end address, access type, and section names of the allocated memory areas.
When the ";M" option is specified, the CPU information file memory map is displayed.
The memory map information is displayed in the following format.

```
<KIND> <START> <END> <STATE> <BUS>
  1       2      3       4      5
```

| | | |
|---|---|---|
| 1 | Memory type: | Indicates the memory type with a keyword. |
| | | • ROM: Internal ROM area |
| | | • I/O: Internal I/O area |
| | | • NOT_A: Unused area |
| | | • EXT: External bus space |
| | | • RAM: Internal RAM area |
| 2 | Start address: | The address of the start address in the memory specified by the memory classifier. |
| 3 | Last address: | The address of the last address in the memory specified by the memory classifier. |
| 4 | State count: | The number of memory access states. |
| 5 | Bus width: | The width of the memory data bus. |

Modification: This form of the command allows the access type of an already allocated memory area to be changed by specifying its start address.

Deletion: This form of the command allows an already allocated memory area to be deleted by specifying its start address.

### Notes

1. Always confirm the address of the start address in the memory area with the MAP command before changing the access type.

2. An error occurs if an attempt is made to use the MAP command to allocate a memory area that is already allocated.

3. An error occurs if an attempt is made to use the MAP command to allocate a memory area that includes any part of the invalid area.

4. It is not possible to allocate a memory area that covers multiple memory areas, including the internal ROM area, the external bus space, the internal RAM area, and the internal I/O space.

5. Areas other than those allocated with the MAP command cannot be deleted with the MAP command.

6. Areas specified by the MAP command cannot be initialized.

### Examples

1. To allocate addresses H'3000 to H'301F as a read-only memory area:

```
: MP 3000 301F ;R (RET)
:
```

2. To allocate a 50 byte area starting at address H'4000 as a write-only memory area:

```
: MP 4000 @50 ;W (RET)
:
```

3. To change the access type for memory area allocated from address H'0 to address H'03FF to write-only:

```
: MP 0 ;W (RET)
:
```

4. To display the current memory allocation state:

```
: MP (RET)
<START>     <END>     <ATTR>     <SECT_NAME>
00000000  - 000003FF      W
00002000  - 000020EF     RW        SECT1
00003000  - 0000301F      R
00004000  - 0000404F      W
00004050  - 0000504F     RW
:
```

5. It is not possible to allocate an area that includes an already allocated memory area:

```
: MP 2000 2FFF (RET)
MEMORY AREA ALREADY EXISTS
:
```

6. The access type of a memory area that has not been allocated cannot be changed:

```
: MP 1050 ;R (RET)
INVALID ADDRESS
:
```

7. It is not possible to allocate a single memory are that covers multiple memory areas. For example, when the area from H'0 to H'3FFF is the internal ROM area and the external bus area starts at H'4000, the following command generates an error as shown:

   ```
   :MP 3F00 40FF (RET)
   ADDRESS EXCEEDS MEMORY SPACE BOUNDARY
   :
   ```

   In this case, this area must be allocated as two separate areas as shown below.

   ```
   : MP 3F00 3FFF (RET)
   : MP 4000 40FF (RET)
   :
   ```

8. To display the memory map from the CPU information file:

   ```
   : MP ;M (RET)
   <KIND>    <START>      <END>      <STATE>   <BUS>
    EXT      00000000  -  00FFFFFF      3        8
    EXT      01000000  -  04FFFFFF      2        8
    I/O      05000000  -  05FFFFFF      3        8
    EXT      06000000  -  07FFFFFF      3        8
    NOT_A    08000000  -  0EFFFFFF
    RAM      0F000000  -  0FFFFFFF      1        32
   :
   ```

| 5.26 | **MEMORY** | **Modifies memory contents** |
|---|---|---|
| | **M** | |

**Format**

Modify: `MEMORY˘<start address>˘{<data>[:size]|<real number>|<character string>} (RET)`

Interactive form: `MEMORY˘<start address>[;{B|W|L|S|D}] (RET)`

**Parameters**

- `<start address>`
  Specifies the start address to be modified.

- `<data>`
  Specifies the new value to be stored.

- `<size>`

  | | |
  |---|---|
  | `B` (byte): | Specifies that memory is to be modified in byte units. |
  | `W` (word): | Specifies that memory is to be modified in word units (default). |
  | `L` (long): | Specifies that memory is to be modified in long word units. |

  When the size specification is omitted, word units are used as the default unless the start address was specified with a high level language variable. In that case, the size will be the size of that variable.

- `<real number>`
  Specifies a floating point number.

- `<character string>`
  Specifies a character string.

- Option

  — Size specification `{B|W|L|S|D}`

  | | |
  |---|---|
  | `B` (byte): | Specifies byte units. |
  | `W` (word): | Specifies word units (default). |
  | `L` (long): | Specifies long word units. |
  | `S` (single precision): | Specifies single precision floating point units. |
  | `D` (double precision): | Specifies double precision floating point units. |

## MEMORY

### Function

Changes the contents of memory to an arbitrary value.

### Examples

1. To change the contents of one byte of memory at address H'1000 to 3E:

```
: M 1000 3E:B (RET)
:
```

2. To input in interactive form:

   a. To modify memory interactively one byte at a time starting at address H'1000:

```
: M 1000 ; B (RET)
00001000   3E  5F (RET)
00001001   FF     (RET)
00001002   55  25 (RET)
              :
              :
00001005   CC  . (RET)
:
```

The following abbreviated commands can be used here, in addition to data specification:

| | | |
|---|---|---|
| (RET) only | : | The contents of the immediately following address are displayed. |
| ^ | : | The contents of the immediately preceding address are displayed. |
| . (period) | : | Terminates the command. |

b. To interactively  modify memory a single precision floating point number at a time starting at address H'2000:

```
: M 2000 ;S (RET)
00002000  1.413991S-3 F’-3.1415922S+1 (RET)
00002004  1.234567S+5 . (RET)
:
```

| 5.27 | MOVE | Copies memory block |
|---|---|---|
| | MV | |

### Format

```
MOVE˘<start address>˘{<end address>|@<byte count>}˘<transfer
destination address> (RET)
```

### Parameters

- `<start address>˘{<end address>|@<byte count>}`
  Specifies the range of addresses to be copied.
- `<transfer destination address>`
  Specifies the address of the transfer destination.

### Function

Copies the specified range of memory data to the specified transfer destination.

### Note

The transfer destination area must have been allocated in advance with the MAP command.

### Example

To copy the H'500 bytes of data starting at address H'1000 to the area starting at address H'2000:

```
: MV 1000 @500 2000 (RET)
:
```

| 5.28 | PRINT | Creates execution history file |
|---|---|---|
| | P | |

**Format**

Start: `PRINT [˘<file name>][˘;[A][C]] (RET)`

Temporary stop/restart: `PRINT ;{E|D} (RET)`

Terminate: `PRINT- (RET)`

**Parameters**

- `<file name>`
  Specifies the file name.
  When the file name specification is omitted, the simulator/debugger creates a file in the directory from which the simulator/debugger was started with the same name as the debugging object program and the extension ".prt".
  When the file extension is omitted, the extension ".prt" is supplied.

- Options

  — Append mode specification `A`

  | | |
  |---|---|
  | `A` (append): | If a file name was specified, the execution history is appended to the specified file. When this option is omitted, the execution history is stored in the file starting at the beginning of the file. |

  — Write data selection `C`

  | | |
  |---|---|
  | `C` (commands): | When the C option is specified, only the input commands are written to the file. |

  — File output suspend/restart `{E|D}`

  | | |
  |---|---|
  | `E` (enable): | File output is restarted. |
  | `D` (disable): | File output is temporarily stopped. |

## PRINT

### Function

This command starts the output of a command execution history to a file.

When the C option is specified, only the input commands are saved to the file.

Furthermore, the file output can be temporarily halted, restarted, and terminated.

### Description

| | |
|---|---|
| Start: | Starts the output of an execution history to a file. If the specified file exists, that file is deleted and a new file is created. If the A option is specified, the execution history is appended to the end of the specified file. |
| Temporary stop/restart: | File output is suspended when the D (disable) option is specified, and restarted when the E (enable) option is specified. |
| Terminate: | Execution history output is terminated. |

### Notes

1. The C (command) option only handles typed input, and commands executed from command files are not output.
2. When an error occurs in command input or in single line I/O processing, the input/output data is not written to the output file.
3. Execution results from the “!” command (sub-process creation) are not written to the output file.

**Examples**

1. To specify output of input command and displayed data to the file “sample1.prt”, and to start output to that file:

```
: P sample1.prt (RET)
:
```

2. To specify output of only input command to the file “sample2.prt”, and to start output to that file:

```
: P sample2.prt ;C (RET)
:
```

3. To append an execution history to the file “sample1.prt”:

```
: P sample1.prt ;A (RET)
:
```

   a. To temporarily suspend execution history output:

```
: P ;D (RET)
:
```

   b. To resume execution history output:

```
: P ;E (RET)
:
```

| 5.29 | QUIT | Exits the simulator/debugger |
|---|---|---|
| | Q | |

**Format**

```
QUIT (RET)
```

**Function**

Exits the simulator/debugger and returns to the OS.

**Description**

1. If an execution history file is open, it will be closed.
2. If a command file is open, it will be closed.
3. If the COVERAGE command is being executed, the results up to the present will be written to the file and that file will be closed.

**Note**

If the coverage data could not be saved due to, e.g., insufficient disk space, when the simulator/debugger is terminated during COVERAGE command execution (i.e., coverage has not been terminated with a COVERAGE- command), the following message will be displayed.

```
Coverage data could not be saved
```

In such a case, check the program execution environment, and save the coverage data once again.

**Example**

To terminate simulator/debugger processing:

```
: Q (RET)

%
```

| 5.30 | **RADIX** | **Sets the radix** |
|---|---|---|
| | **RX** | |

### Format

Set: `RADIX˘{B|Q|D|H} (RET)`

Display: `RADIX (RET)`

### Parameter

- Options

  — Radix `{B|Q|D|H}`

  | | | |
  |---|---|---|
  | `B` | : | Sets the radix to binary. |
  | `Q` | : | Sets the radix to octal. |
  | `D` | : | Sets the radix to decimal. |
  | `H` | : | Sets the radix to hexadecimal. |

  The radix is set to hexadecimal when the simulator/debugger is first invoked.

### Function

Specifies the radix for command parameter input.

Displays the state of the radix setting.

### Examples

1. To display the current radix:

```
: RX (RET)
Hexadecimal
:
```

2. To change the radix to decimal:

```
: RX D (RET)
: RX (RET)
Decimal
:
```

| 5.31 | REGISTER | Displays register contents |
|---|---|---|
| | R | |

**Format**

```
REGISTER (RET)
```

**Function**

Displays the contents of the general registers (R0–R15), the control registers (SR, GBR, VBR) and system registers (MACH, MACL, PR, PC).

**Description**

1. The same value is displayed for the SP and R15.

2. The SR is displayed first as a value and then as the states of each bit.

   - Bits with the value 1: The mnemonic of these bits is displayed.

     | | |
     |---|---|
     | T: | Indicates true or false referred to by the MOVT, CMP, TAS, TST, BT, BF, SETT, and CLRT instruction, or indicates carry, borrow, over/underflow referred to by the ADDV/C, SUBV/C, DIVOU/S, DIV1, SHAR/L, SHLR/L,ROTR/L and ROTCR/L instructions. |
     | S: | Referred to by the MAC instruction. |
     | I: | Functions as an interrupt mask bit. |
     | Q, M: | Referred to by the DIVOU/S and DIV1 instructions. |

   - Bits with the value 0: These bits are displayed as a minus sign (-).

**Example**

To display the general and control register values:

```
: R  (RET)
PC=02000000 SR=000003F3:**********************MQIIII**ST SP=0FFFFFF4
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 0FFFFFF4
:
```

| 5.32 | **RESET** | **Resets the simulator/debugger** |
|---|---|---|
| | **RS** | |

**Format**

```
RESET (RET)
```

**Function**

This function resets the simulator/debugger.

When this command is executed, the registers, the memory, the debugging object program, and the commands are reset to the following states.

| | |
|---|---|
| Registers: | All registers are set to 0. |
| Memory: | All memory settings are cleared.<br>The simulator/debugger goes to the memory unspecified state. |
| Debugging object program: | All information concerning the debugging object program is deleted, and the simulator/debugger goes to the no program loaded state. |
| Commands: | Except for settings made with the following commands, all settings are cleared, and the simulator/debugger returns to its initial state.<br>• EXEC_MODE<br>• MACRO<br>• RADIX |

**Example**

To reset the simulator/debugger:

```
: RS (RET)
:
```

| 5.33 | SAVE | Saves memory data to a file |
|---|---|---|
| | SV | |

**Format**

```
SAVE˘<file name>˘<start address>˘{<end address>|
@<byte count>} (RET)
```

**Parameters**

- `<file name>`
  Specifies the name of the file to be saved.
  When the file extension is omitted, the extension ".dat" is supplied.

- `<start address>˘{<end address>|@<byte count>}`
  Specifies the range of addresses to be saved.

**Function**

Outputs to a file the contents of memory in the specified range as a memory image.

**Notes**

1. If the end address of the memory data exceeds the allocated memory areas, only that portion of the data within allocated memory areas is saved.

2. The data saved with this command differs from that saved with the SAVE_STATUS command.

**Examples**

1. To save the memory data from addresses H'2000 to H'3000 in the file “sample.lo”:

```
: SV sample.lo 2000 3000 (RET)
:
```

2. To save the H'100 bytes of memory starting at address H'3000 in the file “sampl2.lo”:

```
: SV sampl2.lo 3000 @100 (RET)
:
```

| 5.34 | SAVE_STATUS | Saves the current simulator/debugger status in a file |
|---|---|---|
| | SS | |

**Format**

```
SAVE_STATUS [˘<file name>][˘;{M|A}] (RET)
```

**Parameters**

- `<file name>`
  Specifies the name of the file in which to save the simulator/debugger status.
  If the file name is omitted, the file "sdsh.sav" is used.
  If the extension is omitted, the extension ".sav" is supplied.

- Options

  — Data saved `{M|A}`

| | |
|---|---|
| `M` (memory and registers): | The status of the memory and registers is saved. (default) |
| `A` (all): | The complete state of the simulator/debugger is saved. |

**Function**

Saves the current status of the simulator.

The status of the simulator/debugger immediately following the execution of this command can be restored by executing the LOAD_STATUS command.

**Description**

1. Use with the M option
   Only the status of the memory and registers is saved. This command is useful, for example, when program errors are expected during execution by the GO, STEP, or STEP_INTO command. If the status of the simulator/debugger is saved prior to execution with the GO, STEP, or STEP_INTO command, then the status can be restored after an error occurs.

2. Use with the A option
   The complete state of the simulator/debugger is saved.
   This form of the command is useful to resume program debugging from a particular point after exiting and restarting the simulator/debugger.

**SAVE_STATUS**

**Notes**

1. When the A option is specified, the resultant status file is not loaded with the LOAD_STATUS command, but rather, that file is specified at simulator/debugger startup.

2. The A option cannot be specified from within a command chain file.

**Examples**

1. To save the current status of the memory and register in the file "test1.sav":

```
: SS test1.sav ;M (RET)
:
```

2. To save the complete current status of the simulator/debugger in the file "test2.sav":

```
: SS test2.sav ;A (RET)
:
```

| 5.35 | SCOPE | Displays the function that includes the current execution address |
|---|---|---|
| | SCP | |

**Format**

```
SCOPE (RET)
```

**Function**

Displays the file and function that include the current value of the program counter.

This command allows the user to confirm the name of the currently executing function.

**Example**

To display the file and function that include the current value of the program counter:

```
: SCP (RET)
%calc.c/add32
:
```

| 5.36 | SET_COVERAGE | **Sets coverage range** |
|---|---|---|
| | SCV | |

**Format**

| | |
|---|---|
| Set: | `SET_COVERAGE˘<start address>˘{<end address>|@<byte count>} (RET)` |
| Setting state display: | `SET_COVERAGE (RET)` |
| Clear: | `SET_COVERAGE- [˘<start address>] (RET)` |

**Parameter**

- `<start address>˘{<end address>|@<byte count>}`
  Specifies the range for which coverage information is to be acquired.

**Function**

Sets, displays, and clears the range of addresses over which C0 and C1 coverage information is acquired.

Note that this command only sets the range for coverage measurement, and that the COVERAGE command is used to start the acquisition of coverage information.

**Description**

| | |
|---|---|
| Set: | Sets the area for the acquisition of C0 and C1 coverage information.<br>Up to 16 address ranges can be specified.<br>The coverage ranges may not be set during coverage execution.<br>When a debugging object program is loaded with the LOAD command, the code segment areas in that program are automatically set as the address range. |
| Setting state display: | Displays the setting state.<br>When the setting state is displayed during coverage execution, the address range(s), the file name, and the enable/disable state are displayed.<br>When coverage is not being executed, only the coverage areas are displayed. |
| Clear: | The specified coverage area is made invalid.<br>When the address specification is omitted, all areas settings are cleared. |

In this case a confirmation message will be displayed. Respond "Y" to clear all areas or "N" to cancel the clear operation.

**Examples**

1. To set the address range for coverage data acquisition to be from address H'1000 to address H'12FF:

```
: SCV 1000 12FF (RET)
:
```

2. To display coverage setting following the start of coverage measurement:

```
: SCV (RET)
file name      = test1.cov
Enable/Disable = E
coverage area
  00001000 - 000012FF
  00001800 - 00001FFF
:
```

3. To cancel the area starting at address H'1000 from the coverage address ranges:

```
: SCV- 1000 (RET)
```

| 5.37 | SHOW_CALLS | Displays function call |
|---|---|---|
| | SHC | |

**Format**

```
SHOW_CALLS [˘<display count>] (RET)
```

**Parameter**

- `<display count>`
  Specifies the number of function calls displayed.
  When omitted, all function calls are displayed.

**Function**

Displays the functions called up to arrival at the current address.

**Description**

1. Functions are displayed in the reverse order from the order called.
2. The display includes the file, function, and line number of the call and the arguments.
3. When the specified display count exceeds the actual function call depth, the number of function calls displayed is the actual function call depth.
4. The following is displayed when there is no debugging information or when the function was written in assembler.
   - The file, function, line number, and address are displayed.
   - Arguments: A “?” is displayed.

**Examples**

1. To display the last 3 function calls:

```
: SHC 3 (RET)
%file.c/func_d(#  2002)         func_e(1,3,0)
%file.c/func_c(#  1004)         func_d()
%file.c/func_b(#   777)         func_c(2)
:
```

2. To display all functions called up to the current function:

```
: SHC (RET)
%file.c/func_d(#  2002)         func_e(1,3,0)
%file.c/func_c(#  1004)         func_d()
%file.c/func_b(#   777)         func_c(2)
%file.c/func_a(#   307)         func_b(0)
%file.c/main(#    32)           func_a(10,1024)
:
```

| 5.38 | STEP | Performs step execution in subroutine units |
|---|---|---|
| | S | |

**Format**

```
STEP [˘<step count>][;R] (RET)
```

**Parameters**

- `<step count>`
  Specifies the number of instruction execution steps. (H'1 to H'7FFFFFFF)
  When omitted, 1 step is executed.

- Option

  — Register content display R
  R (register): Displays the contents of the registers after instruction execution.

**Function**

Executes instructions one at a time starting at the current program counter for the specified number of steps.

**Description**

1. Each time an instruction is executed the mnemonic of the executed instruction is displayed. If the R option was specified, the contents of the registers are displayed after instruction execution.

2. This command executes subroutines called with a BSR or JSR instruction, from the start of the subroutine through the RTN instruction, as a single step.

3. Execution is halted if a condition set by a break command is satisfied, or if a simulator/debugger error occurs. The cause of the halt is displayed when execution stops.

4. The simulator/debugger performs processing identical to that for the input of a “STEP (RET)” command line if a (RET) is input following the completion of STEP command execution.

**Note**

If a delayed branch instruction is executed during STEP command execution, execution stops at the end of the instruction following the delayed branch instruction.

**Example**

To execute five instructions, with executing the subroutine as though it were a single step:

```
: S 5 (RET)
00000000     STS.L        PR,@–R15
00000002     MOV.L        @(0000000C,PC),R3
00000004     JSR          @%file.c/func!sub1
00000006     NOP
00000008     LDS.L        @R15+,PR
STEP NORMAL END
:
```

| 5.39 | STEP_INTO | Performs step execution |
|---|---|---|
| | SI | |

**Format**

```
STEP_INTO [˘<step count>][;R] (RET)
```

**Parameters**

- `<step count>`
  Specifies the number of instruction execution steps. (H'1 to H'7FFFFFFF)
  When omitted, 1 step is executed.

- Options

  — Register content display `R`
  `R` (register): Displays the contents of the registers after instruction execution.

**Function**

Executes instructions one at a time starting at the current program counter for the specified number of steps.

**Description**

1. Each time an instruction is executed the mnemonic of the executed instruction is displayed.
   If the R option was specified, the contents of the registers are displayed after instruction execution.

2. The step unit is set to the source line unit at startup time, but can be changed to the machine language instruction level with the I or N option to the DEBUG_LEVEL command.

3. When a function is called within the program, the called function is also executed one step at a time.

4. Execution is halted if a condition set by a break command is satisfied, or if a simulator/debugger error occurs.
   The cause of the halt is displayed when execution stops.

5. The simulator/debugger performs processing identical to that for the input of a "STEP_INTO (`RET`)" command line if a (`RET`) is input following the completion of STEP_INTO command execution.

**Notes**

If a delayed branch instruction is executed during STEP_INTO command execution, execution stops at the end of the instruction following the delayed branch instruction.

**Examples**

1. To execute one instruction and then display the mnemonic of the executed instruction and the contents of the registers following the instruction execution:

```
: SI ;R  (RET)
PC=00000404 SR=00000000:**********************------**-- SP=0FE00000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 0000002E 00000000 00000000 00000000 00000000 00000000
00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0FE00000
00000402   MOV.L         #0000002E,R1
:
```

2. To execute three instructions:

```
: SI 3 (RET)
00000404      MOV.L        #0000002E,R4
00000406      MOV.L        #FFFFFFFF,R3
00000408      ADD.L        R1,R2
STEP NORMAL END
:
```

| 5.40 | STUB | Executes command during simulation |
|---|---|---|
| | SB | |

**Format**

Set: `STUB˘<stub start address>[˘<return address>] {(RET)`

Display: `STUB[˘<stub start address>] (RET)`

Delete: `STUB- [˘<stub start address>] (RET)`

**Parameters**

- `<stub start address>`
  Specifies the address in the debugging object program at which command execution is to be performed.

- `<return address>`
  Specifies the address of the address to restart the debugging object program after command execution.
  When omitted, the debugging object program is restarted at the <stub start address>.

**Function**

Specifies addresses and commands so that instruction execution is interrupted and command execution is performed at the point that the simulator/debugger is about to execute the instruction at the stub start address.

Also displays and clears the stub execution address and command settings.

**Description**

Set: Specifies the stub execution actions as simulator commands.
Up to 16 stub command executions can be specified.
However, since the command sequence storage area is limited, there are cases where a full 16 stubs cannot be specified.
When the command "STUBΔ<stub start address>`{(RET)`" is input, a prompt ("`STUB>`") indicating that STUB specification is in progress is displayed, and the simulator/debugger waits for input of the execution command sequence.
Command line syntax is not checked during command sequence input.
Error checking is performed during stub execution.

Display: When the stub start address specification is omitted, a table of the stub execution start and return positions specified with the STUB command is displayed.
When the stub start address is specified, the simulator command sequence specified for that start address is displayed.

Deletion: Deletes the stub execution for the specified address.
When a stub execution is deleted, the replacement or insertion command set is deleted, and the original execution sequence is restored.
When the stub start address is omitted, all stub execution addresses are deleted.
In this case a confirmation message will be displayed. Respond "Y" to delete all stub executions or "N" to cancel the deletion.

**Notes**

1. In the following case, the stub will be executed twice.

   • If stub execution is interrupted with a manual break, and execution resumed with a GO, STEP, or STEP_INTO command, the stub will be executed twice.

   Therefore, do not specify stubs that will generate different results when executed twice (e.g., stubs that increment memory) in situations where a manual break will be used.

2. The STUB command, “!” commands, and macro commands cannot be used within a stub.

3. If the stub start address is specified after a delayed branch instruction, stub execution starts before the delayed branch instruction.

**Examples**

1. To specify a command set starting with the MEMORY command to be executed just prior to the execution of the instruction at address H'1200:

   Simulation will be resumed at address H'1200 after execution of the stub commands.

```
: SB 1200 { (RET)                    Sets the stub execution start address to be H'1200.

STUB > M 5000 FF (RET)  ┐
STUB >         :        ├─           Specifies the stub execution commands.
               :        │
               :        ┘
STUB > } (RET)                       Terminates specification.
:
```

2. To display a table of stub execution addresses:

```
: SB (RET)
<ENTRY ADDR> <RETURN ADDR> <SYMBOL>
    00001000          00001000      %file.c!eradd(#   100) %file.c!eradd(#
100)
    00001200          00001200      %file.c!entrya(#   542) %file.c!entrya(#
542)
:
```

3. To display the simulator command set specified for the stub execution command registered at address H'1200:

```
: SB 1200 (RET)
entry address  = 00001200 %file.c!entrya(#   542)
return address = 00001200 %file.c!entrya(#   542)
command {
        M 5000 FF
            :
            :
            :
        }
:
```

4. To delete the stub execution registered at address H'1200:

```
: SB- 1200 (RET)
:
```

|  |  |  |
|---|---|---|
| **5.41** | **SYMBOL** | **Displays symbol information** |
|  | **SY** |  |

**Format**

```
SYMBOL [˘[%<file name>][/<function name>][!<symbol>[.<member
name>]]]  (RET)
```

**Parameters**

- `<file name>`
  Specifies the file in which the referenced symbol is defined.

- `<function name>`
  Specifies the function in which the referenced symbol is defined.

- `<symbol>`
  Specifies the referenced symbol.

- `<member name>`
  Specifies the member referenced.

**Function**

Displays symbol information.

**Description**

The following symbol information is displayed according to the specified parameters.

- Parameter specification and displayed information

  In items 1 to 3 in the following table, information pertaining to the member will be displayed if a structure or union member is specified along with the symbol.

## SYMBOL

| Item | Parameter Specification | Displayed Information |
|---|---|---|
| 1 | SYMBOL %<file name>/<function name>!<symbol><br><br>SYMBOL /<function name>!<symbol> | Information pertaining to the specified local symbol in the specified function is displayed. |
| 2 | SYMBOL %<file name>!<symbol> | Information pertaining to the specified local symbol in the specified file is displayed. |
| 3 | SYMBOL !<symbol> | Information pertaining to the specified global symbol is displayed. |
| 4 | SYMBOL %<file name>/<function name> | Information pertaining to the local symbols in the specified function is displayed. |
| 5 | SYMBOL %<file name> | Information pertaining to the local symbols in the specified file is displayed. |
| 6 | SYMBOL | Information pertaining to all symbols that can be referenced currently is displayed. |
| 7 | SYMBOL ! symbol  name | Local symbols in the function, static symbols in the file, and global symbols are searched for in that order, and the first symbol to be detected is displayed. |

- Symbol information display format

  Symbol information is displayed in the following format.

  | Symbol | Value | Symbol type | Sign information | Type information | Size | Bit offset |
  |---|---|---|---|---|---|---|
  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

  Undefined status
  8

  Description:

  1 Symbol

  2 Value
  - — Address .................................................. <8 digit hexadecimal number>
  - — Value ...................................................... <8 digit hexadecimal number>
  - — SP offset................................................. SP+<4 digit hexadecimal number>
  - — Structure offset....................................... +<4 digit hexadecimal number>
  - — Register name
  - — Cannot be referenced because of C compiler optimization ......................... 'REG'

3 Symbol type

| | |
|---|---|
| — Variable | 'VAR' |
| — Label | 'LAB' |
| — Function | 'FUN' |
| — Value | 'VAL' |

4 Sign information

| | |
|---|---|
| — Signed | 'S' |
| — Unsigned | 'U' |
| — Undefined | '-' |

5 Type information

| | |
|---|---|
| — Character type (1-byte integer) | 'BYTE' |
| — Integer type (2-byte) | 'WORD' |
| — Integer type (4-byte) | 'LONG' |
| — Floating point type (single precision) | 'SGL' |
| — Floating point type (double precision) | 'DBL' |
| — Bit type | 'BITF' |
| — Enumerated type | 'ENUM' |
| — Structure type | 'STRU' |
| — Union type | 'UNI' |
| — Pointer type | 'PTR' |
| — All other types | '------' |

6 Size

The number of bytes (the number of bits for integer types with a bit field type specification) is displayed as a 4-digit hexadecimal number.

7 Bit offset

A 2-digit hexadecimal value is displayed only for integer types with a bit field type specification.

8 Undefined status

| | |
|---|---|
| — Undefined symbols | 'U' |
| — Any other object | No display |

### Examples

1. To display information concerning the local symbols from the file sample:

```
: SY %sample.c (RET)
number................................. 00000038 VAR S BYTE 0015
:
```

2. To display information concerning the local symbols from the function “main” in the file sample:

```
: SY %sample.c/main (RET)
i...................................... SP+0008  VAR S LONG 0004
:
```

| 5.42 | **TRACE** | **Displays trace buffer** |
|---|---|---|
| | **T** | |

**Format**

```
TRACE [˘-<start instruction index>][˘,{@<instruction count>|-<end
instruction index>|][;{I|A}] (RET)
```

**Parameters**

- `<start instruction index>`
  Specifies the first instruction to display.
  The value indicates the point in the trace buffer at which to start display as a number of instructions back from the end instruction stored in the trace buffer.When omitted, display starts at the beginning of the trace buffer.

- `<instruction count>`
  Specifies the number of instruction to display.
  When both the instruction count and the end instruction index are omitted, the end instruction executed is displayed.

- `<end instruction index>`
  Specifies the end instruction to display.
  The value indicates the point in the trace buffer at which to end display as a number of instructions back from the end instruction stored in the trace buffer.

- Options

  — Display content `{I|A}`

| | |
|---|---|
| `I` (instruction): | Only instruction addresses and mnemonics are displayed. |
| `A` (all): | The instruction address, instruction mnemonic, register data, and memory access data are displayed. When omitted, the I option is assumed. |

**Function**

Displays the trace results stored in the trace buffer.

**Description**

1. The following information is displayed.

   - The address of the executed instruction
   - The mnemonic of the executed instruction
   - The general registers (R0 to R15), the control registers (SR, GBR, VBR), and the system registers (MACH, MACL, PR, and PC)
   - The memory access data (read  data is displayed as R=xxxxxx and write data as W=xxxxxx)

2. Display range specified by the start instruction index.

   Figure 5-3 shows the contents of the trace buffer when displaying starting at 5 instructions back from the end of the trace buffer.

   (This example assumes the command “TRACE -5”.)

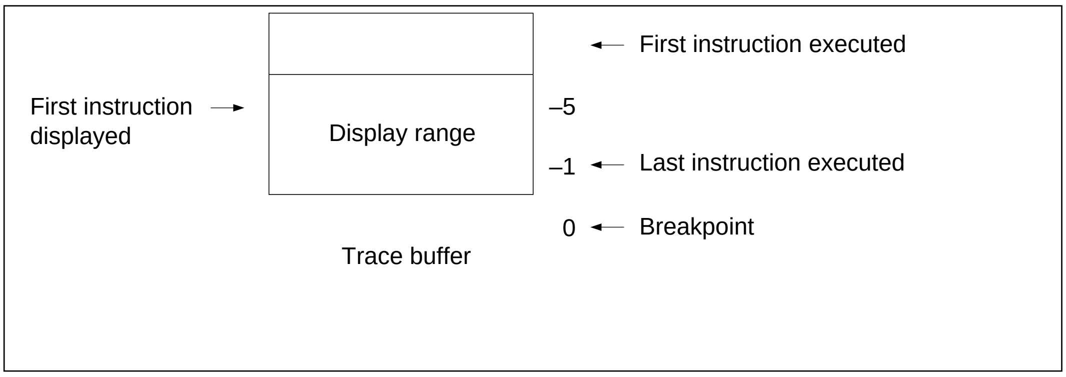

First instruction executed
First instruction displayed
Display range
–5
–1
Last instruction executed
0
Breakpoint
Trace buffer

**Figure 5-3   Display Range Specified by the Start Instruction Index**

3. Display range specified by the start instruction index and instruction count

   Figure 5-3 shows the contents of the trace buffer when displaying 3 instructions starting at 5 instruction back from the end of the trace buffer.

   (This example assumes the command “TRACE -5 @3”.)

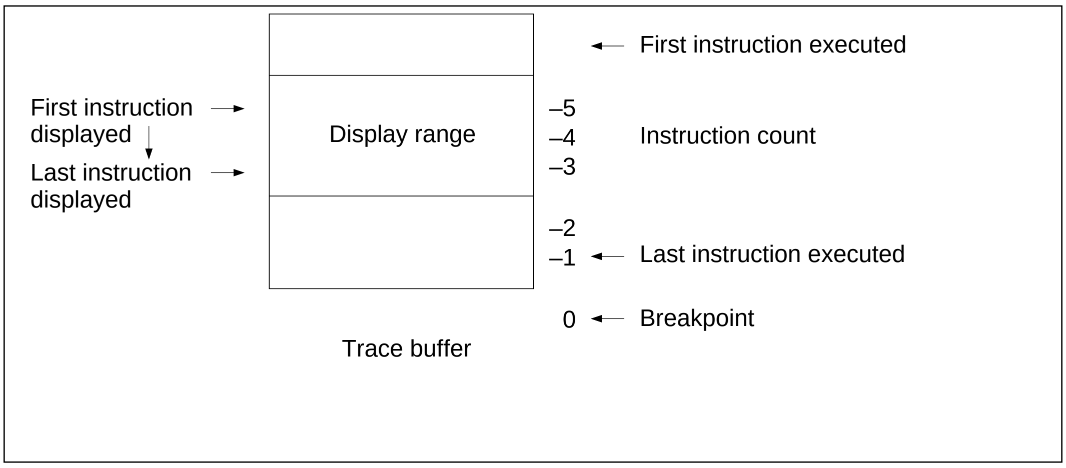

First instruction executed
First instruction displayed
Last instruction displayed
Display range
–5
–4
–3
Instruction count
–2
–1
Last instruction executed
0
Breakpoint
Trace buffer

**Figure 5-4 Display Range Specified by the Start Instruction Index and the Instruction Count**

**Notes**

1. The addresses of the executed instructions are stored in the trace buffer during trace data acquisition.
   When displaying the contents of the trace buffer, the contents of the stored address is disassembled and displayed as a mnemonic instruction.
   As a result, if memory contents are overwritten between trace data acquisition and trace buffer display, the displayed mnemonic can differ from the actually executed instruction.

2. The trace buffer can hold 1023 instruction execution cycles of data. If the 1023th instruction is a delayed branch instruction, the trace buffer can hold 1024 instructions.

**TRACE**

**Examples**

1. To display the instruction addresses and mnemonics for the last five instructions stored in the trace buffer:

```
: T -5 (RET)
00000100       STS.L       PR,@—R15
00000102       MOV.L       #00000000,R4
0000010E       ADD.L       #00000001,R4
00000110       MOV>L       #0000000A,R3
00000114       CMP/GE.L    R3,R4
:
```

2. To display the instruction address, instruction mnemonic, register data, and memory access data for the H'3 instructions starting five instructions back from the end of the trace buffer:

```
: T -5 @3 ;A (RET)
00000400   STS.L        PR,@—R15
PC=00000402 SR=00000000:**********************------**-- SP=FFFFFF8
W=00000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 0000002E 00000000 0000000A 00000001 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 FFFFFFF8
00000402   MOV.L         #00000000,R4
PC=00000404 SR=00000000:**********************------**-- SP=FFFFFF8
W=00000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 0000002E 00000000 0000000A 00000001 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 FFFFFFF8
00000404   ADD.L         #00000001,R4
PC=00000406 SR=00000000:**********************------**-- SP=FFFFFF8
W=00000000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 0000002E 00000000 0000000A 00000001 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000 FFFFFFF8
:
```

| | | |
|---|---|---|
| **5.43** | **TRACE_CONDITION** | **Sets trace condition,  and starts or stops trace** |
| | **TC** | |

## TRACE_CONDITION

**Format**

Start: `TRACE_CONDITION [;[{I|S}][˘E][˘{C|B}]] (RET)`

Stop: `TRACE_CONDITION ;D (RET)`

**Parameter**

- Options

  — Instruction type `{I|S}`

  | | |
  |---|---|
  | `I` (instruction): | All instructions are recorded in the trace buffer. (default) |
  | `S` (subroutine): | Only subroutine calling instructions (BSR and JSR) are recorded in the trace buffer. |

  The I setting is assumed when this option is omitted.

  — Trace start/stop `{E|D}`

  | | |
  |---|---|
  | `E` (enable): | Starts recording to the trace buffer. (default) |
  | `D` (disable): | Turns off recording to the trace buffer. |

  The E setting is assumed when this option is omitted.

  — Trace buffer full handling `{C|B}`

  | | |
  |---|---|
  | `C` (continue): | Overwrites the previous contents of the trace buffer after the trace buffer overflows. |
  | `B` (break): | Interrupts program execution when the trace buffer overflows. |

  The C setting is assumed when this option is omitted.

**Function**

Specifies the conditions for storing the results of instruction execution in the trace buffer during debugging object program execution due to a CALL, GO, STEP, STEP_INTO, or VECTOR command.

**Description**

1. The following items are stored in the trace buffer.

   - The general registers (R0 to R15), the control registers (SR, GBR, VBR), and the system registers (MACH, MACL, PR, and PC)
   - The memory access data

2. The trace buffer is initialized at trace start.

3. The trace buffer is organized as a ring buffer with storage for 1023 instructions.

   When the B option is specified, and when 1023 instructions for trace information have been stored, instruction execution is halted, and the simulator/debugger returns to the command wait state.  However, note that if the 1023th instruction is a delayed branch instruction, the simulator/debugger enters command wait state when the 1024 instructions of trace information has been acquired.

   When the C option is specified, if 1024 or more instructions have been executed, the buffer is overwritten starting at the beginning.

   Figure 5-5 shows the contents of the trace buffer.

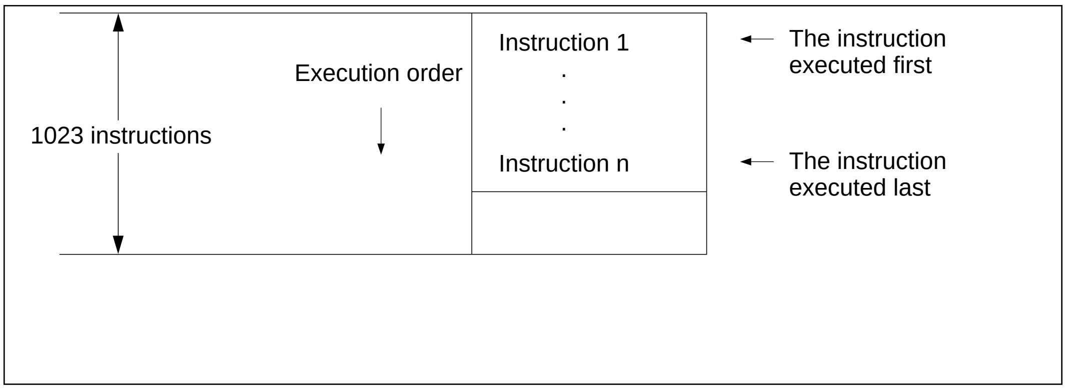


**Figure 5-5   Trace Buffer Contents**

| | | |
|---|---|---|
| **5.44** | **TRAP_ADDRESS** | **Sets, displays, and clears the system call start address** |
| | **TA** | |

**Examples**

1. To record all instructions in the trace buffer following the execution of the following command:

```
: TC ;I (RET)
:
```

2. To record only subroutine calls in the trace buffer:

```
: TC ;S E (RET)
:
```

3. To terminate recording in the trace buffer:

```
: TC ;D (RET)
:
```

4. To store the results of program execution in the trace buffer when instructions are executed by a CALL, GO, STEP, STEP_INTO, or VECTOR command:

```
: TC ;I (RET)
: B 348 (RET)
: G (RET)
Exec Instructions = 97 Cycle=387
PC=00000348 SR=00000000:***********************------**-- SP=0FF00000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0FF00000
00000346   MOV.L         R6,R5
: T –5 (RET)
00000340   MOV.L         #00000000,R4
00000342   ADD.L         #00000001,R4
00000344   MOV.L         #0000000A,R3
00000346   MOV.L         R6,R5
```

```
00000348   MOV.L         R6,R5
:
```

**Format**

Set: `TRAP_ADDRESS˘<instruction address> (RET)`

Display: `TRAP_ADDRESS (RET)`

Clear: `TRAP_ADDRESS- (RET)`

**Parameter**

- `<instruction address>`
  Specifies the system call start address.

**Function**

Sets, displays, and clears the system call start address used when the debugging object program uses standard I/O or file I/O.

Only one address can be specified.

**Description**

Set: If the branch address of an executed JSR or BSR instruction is the same as the address specified with this command, normal simulation is not performed, but rather the system call indicated by the function code is executed.
A parameter block and an I/O buffer must be allocated within the debugging object program.
The debugging object program must set up R0 and R1, the parameter block, and the I/O buffer before executing the JSR or BSR instruction.
Simulation is restarted from the instruction following the JSR or BSR when the system call processing finishes.
The contents of R0 and R1 and the other registers are shown below.
Since the contents stored in the parameter bock differ for each system call function, the parameter block contents are described under each function.

**TRAP_ADDRESS**

| MSB | 1 byte | 1 byte |  | LSB |
|---|---|---|---|---|
| Register R0 | H'01 | Function code | — | — |
| Register R1 | Parameter block address |  |  |  |

Display: Displays the state of the system call start address setting.

Clear: Clears the system call start address.

**Notes**

1. If a JSR or BSR instruction is executed following a delayed branch instruction, an INVALID SLOT INSTRUCTION error occurs during simulation.

2. If a JSR or BSR instruction executed as a system call, the following instruction is executed as a normal instruction, and not as a slot instruction. Accordingly, JSR and BSR instructions must not be followed by an instruction whose execution results differ between the cases when it is executed as a slot instruction and when it is executed as a normal instruction.

**<System Call Functions>**

The simulator/debugger provides functions to simulate system calls to the host system by the debugging object program.
The table below lists the host system calls that can be used by a debugging object program.

**Table 5-1 System Call Functions**

| Item | Function code | Function | Description |
|---|---|---|---|
| 1-1 | H'21 | GETC | Inputs one character from standard input. |
| 1-2 | H'22 | PUTC | Outputs one character to standard output. |
| 1-3 | H'23 | GETS | Inputs a line of characters from standard input. |
| 1-4 | H'24 | PUTS | Outputs a line of characters to standard output. |
| 2-1 | H'25 | FOPEN | Opens a file. |
| 2-2 | H'26 | FCLOSE | Closes a file. |
| 2-3 | H'27 | FGETC | Inputs one byte from a file. |
| 2-4 | H'28 | FPUTC | Outputs one byte to a file. |
| 2-5 | H'29 | FGETS | Inputs a line from a file. |
| 2-6 | H'2A | FPUTS | Outputs a line to a file. |
| 2-7 | H0B | FEOF | Checks for end of file. |
| 2-8 | H'0C | FSEEK | Moves the file pointer. |
| 2-9 | H'0D | FTELL | Returns the current position of the file pointer. |

**TRAP_ADDRESS**

1. Standard I/O

These functions perform I/O from standard I/O.

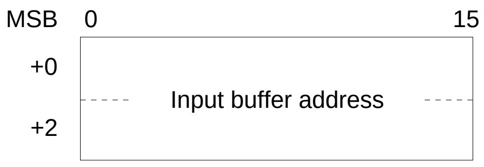
Character input from standard I/O during COMMAND_CHAIN execution is taken from the command file.

1-1 GETC

<Function>
Inputs one character from standard input.

<Function code>
H'21

<Parameter block>



<Example>
To input one character from standard input (usually the keyboard):

```
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         ALIGN 4
CALL_ADR DATA.L SYS_CALL
REQ_COD .DATA.L H’01210000
PAR_ADR .DATA.L PARM
PARM    .DATA.L INBUF
```

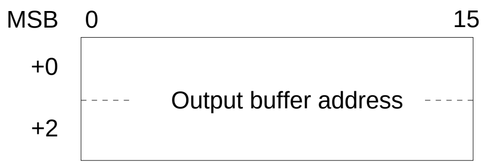
```
INBUF    .RES.B 2
         .END
```

1-2 PUTC

<Function>
Outputs one character to standard output.

<Function code>
H'22

<Parameter block>



<Example>
To output the character 'A' to standard output (usually the console):

```
          MOV.L  PAR_ADR,R1
          MOV.L  REQ_COD,R0
          MOV.L  CALL_ADR,R3
          JSR    @R3
          NOP
STOP      NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR.DATA.L SYS_CALL
REQ_COD .DATA.L H’01220000
PAR_ADR .DATA.L PARM
PARM    .DATA.L OUTDATA
OUTDATA .DATA.B "A"
        .END
```

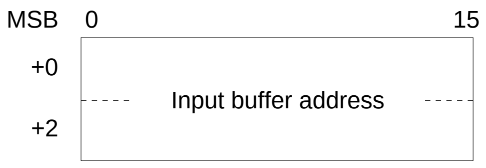
**TRAP_ADDRESS**

## 1-3 GETS

<Function>
Inputs a line of characters from standard input.
A line feed character (LF) terminates the input line.
Up to 79 characters can be input in a line.
If more than 79 characters are input, the eightieth character will be converted to a line feed (LF).

<Function code>
H'23

<Parameter block>



<Example>
To input one line from standard input (usually the keyboard):

```
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
        .ALIGN 4
CALL_ADR.DATA.L SYS_CALL
REQ_COD .DATA.L H’01230000
PAR_ADR .DATA.L PARM
PARM    .DATA.L INBUF
INBUF   .RES.B  80
        .END
```

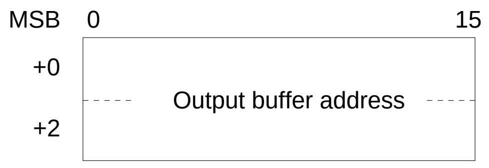
**TRAP_ADDRESS**

## 1-4 PUTS

<Function>
Outputs a line of characters to standard output.
A line feed character (LF) terminates the output line.
Up to 131 characters can be output on a line.
If more than 131 characters are output, the 132nd character will be converted to a line feed (LF).

<Function code>
H'24

<Parameter block>



<Example>
To output the string "Hello world" to standard output (usually the console):

```
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR .DATA.L SYS_CALL
REQ_COD  .DATA.L H'01240000
PAR_ADR  .DATA.L PARM
PARM     .DATA.L OUTDATA
OUTDATA  .SDATA "Hello world"
         .DATA.B H'0A
```

```
                .END
```

2. File I/O
   A file number is returned when a file is opened with FOPEN.
   All following operations on that file, including I/O and closing, are performed using that file number.
   Up to 16 files can be opened at the same time.

## 2-1 FOPEN

<Function>
Opens a file

<Function code>
H'25

<Parameter block>

| MSB | 0 | 8 15 |
|---|---|---|
| +0 | Return value | File number |
| +2 | Open mode | Unused |
| +4 | Start address of file name | |
| +6 | | |

- Return value (output)
  0: Normal termination
  –1: Error

- File number (output)
  The value to be used in all processing following the open.

**TRAP_ADDRESS**

- Open mode (Input)

  ```
  00 : "r"
  01 : "w"
  02 : "a"
  03 : "r+"
  04 : "w+"
  05 : "a+"
  10 : "rb"
  11 : "wb"
  12 : "ab"
  13 : "rb+"
  14 : "wb+"
  15 : "ab+"
  ```

  These modes are interpreted as follows.

  | | | |
  |---|---|---|
  | `"r"` | : | Open for reading. |
  | `"w"` | : | Open for writing. |
  | `"a"` | : | Open for appending (write starting at the end of the file). |
  | `"r+"` | : | Open for reading and writing. |
  | `"w+"` | : | Open an empty file for reading and writing. |
  | `"a+"` | : | Open for reading and appending. |
  | `"b"` | : | Open in binary mode. |

- Start address of file name
  The first address in the area that holds the file name.

<Example>
To open the file "sample.src":

```
         .EXPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
        .ALIGN 4
CALL_ADR.DATA.L SYS_CALL
REQ_COD .DATA.L H'01250000
PAR_ADR .DATA.L PARM
PARM:
FOPEN_BUF.RES.B  1
FNUM    .RES.B  1
        .DATA.B.0
        .RES.B. 1
        .DATA.L FNAME
FNAME   .SDATA "sample.src"
        .DATA.B 0
        .END
```

2-2 FCLOSE

<Function>
Closes a file.

<Function code>
H'06

<Parameter block>

**TRAP_ADDRESS**

| MSB | 0 | 8 15 |
|---|---|---|
| +0 | Return value | File number |

- Return value (output)
  0: Normal termination
  –1: Error
- File number (input)
  The number returned when the file was opened.

<Example>
To close the file with the file number 2:

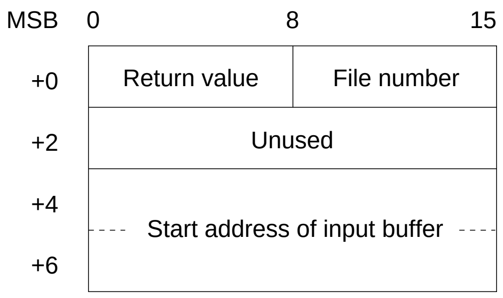
```
         MOV.L  FNUM_ADR,R0
         MOV.L  #H'00000002, R1
         MOV.B  R1,@R0
         MOV.L  REQ_COD,R0
         MOV.L  PAR_ADR,R1
         MOV.L  CALL_ADR,R3
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
          .ALIGN 4
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H'01060000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM:
FCLSE_BUF .RES.B  1
FNUM      .RES.B  1
          .END
```

2-3 FGETC

<Function>
Inputs one byte from a file.

<Function code>
H'27

<Parameter block>



- Return value (output)
   0: Normal termination
  –1: EOF detected

- File number (input)
  The number returned when the file was opened.

- Input buffer start address
  The start address of the buffer for writing input data.

<Example>
To read one byte of data from the file "sample.src":

```
         .IMPORT FNUM
         MOV.L   PAR_ADR,R1
         MOV.L   REQ_COD,R0
         MOV.L   CALL_ADR,R3
         MOV.L   FNUM_ADR,R2
         MOV.B   @R2,R4
         MOV.L   PAR_ADR,R2
         ADD.L   #01,R2
         MOV.B   R4,@R2
         JSR     @R3
         NOP
STOP     NOP
SYS_CALL NOP
          .ALIGN 4
```

**TRAP_ADDRESS**

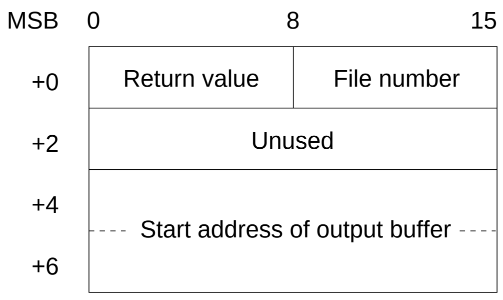
```
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H’01270000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM:
FGETC_BUF .RES.B  2
          .RES.W  1
          .DATA.L INBUF
INBUF     .RES.B
         .END
```

2-4 FPUTC

<Function>
Outputs one byte to a file.

<Function code>
H'28

<Parameter block>



- Return value (output)
  0: Normal termination
  –1: Error

- File number (input)
  The number returned when the file was opened.

- Output buffer start address
  The start address of the buffer used to hold the output data.

<Example>
To output one byte of data (the character 'A') to the file "sample.src":

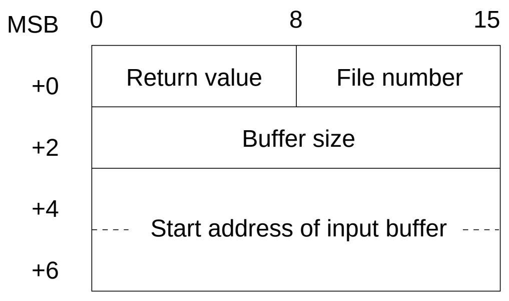
```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
        .ALIGN 4
CALL_ADR.DATA.L SYS_CALL
REQ_COD .DATA.L H’01280000
PAR_ADR .DATA.L PARM
FNUM_ADR.DATA.L FNUM
PARM:
FPUTC_BUF.RES.B  2
         .RES.W  1
         .DATA.L OUTDATA
OUTDATA  .DATA.B "A"
         .END
```

## 2-5 FGETS

<Function>
Reads in character string data from a file. Data is read in until either a newline code or a NULL code is read, or until the buffer is full.
A NULL code is appended to the end of the character string read from the file.

<Function code>
H'29

<Parameter block>



- Return value (output)
  0: Normal termination
  –1: EOF detected

- File number (input)
  The number returned when the file was opened.

- Buffer size (input)
  The size of the area for storing data. A maximum of 256 bytes can be stored.

- Input buffer start address (input)
  The start address of the buffer for storing input data.

<Example>
To read character string data from the file "sample.src":

```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H'01290000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM      .RES.B  2
          .DATA.W  256
          .DATA.L INBUF
OUTDATA  .RES.B  256
         .END
```

## 2-6 FPUTS

<Function>
Writes character string data to a file.
The NULL character terminating the character string is not written to the file.

<Function code>
H'2A

<Parameter block>

| MSB | 0 | 8 15 |
|---|---|---|
| +0 | Return value | File number |
| +2 | Unused | |
| +4 | Start address of output buffer | |
| +6 | | |

- Return value (output)
  0: Normal termination
  –1: Error

- File number (input)
  The number returned when the file was opened.

- Output buffer start address (input)
  The start address of the buffer used to hold the output data.

**TRAP_ADDRESS**

<Example>
To write the character string "Hello world" the file "sample.src":

```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H’012A0000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM:
FPUTS_BUF .RES.B 2
          .RES.W 1
          .DATA.L OUTDATA
OUTDATA   .SDATA "Hollow world"
          .DATA.B 0
          .END
```

## 2-7 FEOF

<Function>
Checks for end of file.

<Function code>
H'0B

<Parameter block>

| MSB | 0 | 8 | 15 |
|---|---|---|---|
| +0 | Return value | File number | |

- Return value (output)
  0: File pointer is not at EOF.
  –1: EOF detected.

- File number (input)
  The number returned when the file was opened.

<Example>
To test the file "sample.src" for EOF:

```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR .DATA.L SYS_CALL
REQ_COD  .DATA.L H’010B0000
```

```
PAR_ADR  .DATA.L PARM
FNUM_ADR .DATA.L FNUM
PARM:
FEOF_BUF .RES.B 2
         .END
```

## 2-8 FSEEK

<Function>
Moves the file pointer to the specified position.

<Function code>
H'0C

<Parameter block>

| MSB | 0 | 8 | 15 |
|---|---|---|---|
| +0 | Return value | File number | |
| +2 | Direction | Unused | |
| +4 | Offset (upper word) | | |
| +6 | Offset (lower word) | | |

- Return value (output)
  0: Normal termination
  –1: Error

- File number (input)
  The number returned when the file was opened.

- Direction (input)
  0: The offset specifies the position as a byte count from the start of the file.
  1: The offset specifies the position as an offset from the current file pointer.
  2: The offset specifies the position as a byte count from the end of the file.

- Offset (input)

| | | |
|---|---|---|
| **5.45** | **TYPE** | **Displays variable value** |
| | **TY** | |

The byte count to be interpreted as specified by the direction parameter.

<Example>
To move the file pointer in "sample.src" to the H'100th byte from the start of the file:

```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H'010C0000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM:
FSEEK_BUF .RES.B  2
          .DATA.B 0
          .RES.B  1
          .DATA.W 0
          .DATA.W H'100
          .END
```

| | | |
|---|---|---|
| **5.46** | **VECTOR** | **Executes from an interrupt vector address** |
| | **V** | |

2-9 FTELL

<Function>
Returns the current position of the file pointer.

<Function code>
H'0D

<Parameter block>

| MSB | 0 | 8 15 |
|---|---|---|
| +0 | Return value | File number |
| +2 | Unused | |
| +4 | Offset (upper word) | |
| +6 | Offset (lower word) | |

- Return value (output)
  0: Normal termination
  –1: Error

- File number (input)
  The value returned when the file was opened.

- Offset (output)
  The current position of the file pointer, as a byte count from the start of the file.

<Example>
To determine the current position of the file pointer in the file "sample.src":

```
         .IMPORT FNUM
         MOV.L  PAR_ADR,R1
         MOV.L  REQ_COD,R0
         MOV.L  CALL_ADR,R3
         MOV.L  FNUM_ADR,R2
         MOV.B  @R2,R4
         MOV.L  PAR_ADR,R2
         ADD.L  #01,R2
         MOV.B  R4,@R2
         JSR    @R3
         NOP
STOP     NOP
SYS_CALL NOP
         .ALIGN 4
CALL_ADR  .DATA.L SYS_CALL
REQ_COD   .DATA.L H’010D0000
PAR_ADR   .DATA.L PARM
FNUM_ADR  .DATA.L FNUM
PARM:
FTELL_BUF .RES.B  2
          .RES.W  1
          .RES.W  2
          .END
```

| 5.47 | .<register> | Modifies register content |
|---|---|---|
| | | |

**Format**

```
TYPE˘<variable>[;{B|Q|D|H|A}] (RET)
```

**Parameters**

- <variable>
  Specifies the variable whose value is to be displayed.

- Options

  — Display format specifier `{B|Q|D|H|A}`

  | | | |
  |---|---|---|
  | `B` | : | Display in binary. |
  | `Q` | : | Display in octal. |
  | `D` | : | Display in decimal. |
  | `H` | : | Display in hexadecimal. |
  | `A` | : | Display as an ASCII character. |

**Function**

Displays the value of the specified variable in the specified format.

When the display format specification is omitted, pointer variables are displayed in hexadecimal, character variables are displayed in ASCII, and other variables are displayed in decimal. However, a period is displayed for character variables with values that cannot be displayed.

**.<register>**

**Examples**

1. To display the value of the variable "abc" in hexadecimal:

```
: TY abc ;H (RET)
abc  100F
:
```

2. To display the value of the variable "xyz".  Since the display format specifier is omitted, the value is displayed in decimal:

```
: TY xyz (RET)
xyz  14770
:
```

3. To display the value of the static variable "efg":

```
: TY %file.c!efg (RET)
%file.c!efg    32768
:
```

| 5.48 | ! | Invokes sub-process |
|---|---|---|
| | | |

**Format**

```
VECTOR˘<vector number> (RET)
```

**Parameters**

- `<vector number>`
  Specifies the interrupt vector number.

**Function**

Generates the vector address from the vector number and starts exception processing from the contents of the vector address.

(1) The current PC and SR are saved on the stack.
(2) The vector address is generated from the vector number and exception processing is initiated from the contents of the vector address.

**Description**

1. This command is used to test the operation of exception handlers when exceptions occur.

2. The terminating conditions are the same as those for the GO, STEP, and STEP_INTO, CALL commands.

3. H'0 to H'FF can be specified as the vector number.

**Notes**

1. When the content of the vector area memory address is H'0, execution halts after steps (1) and (2).

2. There are cases where the range of vector numbers that can be specified in the simulator/debugger differs from the range that can be specified with the actual CPU.

| ! |
|---|

**Example**

To start execution at the address specified in vector number 1:

```
: VECTOR 1 (RET)
Exec Instructions = 159
PC=0000014A SR=00000000:**********************------**-- SP=0FF00000
GBR=00000000 VBR=00000000 MACH=00000000 MACL=00000000 PR=00000000
R0-7  00000000 00000000 00000000 0000000A 00000000 00000000 00000000 00000000
R8-15 00000000 00000000 00000000 00000000 00000000 00000000 0FF00000 0FF00000
00000148   MOV.L         R7,R6
BREAK POINT
:
```

# Part II   CPU Information Analysis Program

# Section 1   Creating the CPU Information

The simulator/debugger uses a CPU information file to load segments according to the memory map for the corresponding SH series CPU and to assure that segments are not loaded crossing memory type boundaries. The CPU information file is created using the CIA (CPU information analysis) program. Note that the H-series linkage editor can also use the CPU information file to check segment allocation. Refer to the H-Series Linkage Editor User’s Manual for details.

## 1.1 CIA Functions

The CIA program provides the following three functions.

1. CPU information file creation
   Produces the CPU memory map information file for the SH-series CPU used.

2. CPU information file display
   Allows the contents of the generated CPU information file to be checked.

3. CPU information file editing (deletion/addition)
   Allows the contents of the generated CPU information file to be modified by deletion or addition.

## 1.2 Invoking the CIA Program

The format of the command line used to invoke the CIA program is shown below.

```
% cia˘<CPU information file name> (RET)
  1             2

SH SERIES CIA Ver. 1.1 (HS0700CICU1SM)
Copyright (C) Hitachi, Ltd. 1992

Licensed Material of Hitachi, Ltd.
```

1 The CIA invocation command.

2 Either an existent or a new CPU information file can be specified. When an existent CPU information file is specified, the program requests the input of a name for the output CPU information file. If the extension is omitted, the extension ".cpu" is supplied.

## 1.3 CIA Usage Procedures and Selection Menus

Figure 1-1 shows the procedure used with the CIA program.

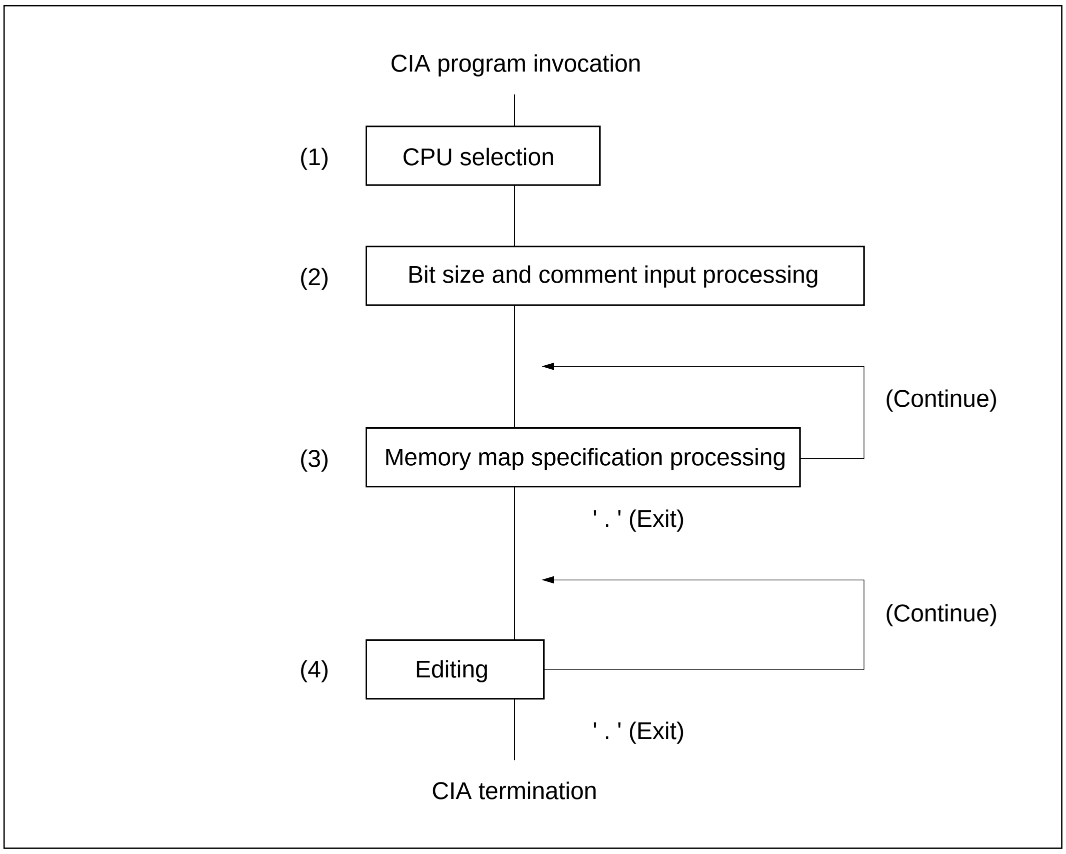


**Figure 1-1 CIA Usage Procedure**

1. The following is presented as a CPU information menu.

   1: SH 7000

   - When '1' (SH 7000) is selected, the SH 7000 is specified.

2. Bit size and comment input

   The bit size specifies the number of bits in addresses in the memory map, and thus defines the settable range. For example, if a bit size of 28 is specified, locations from H'0 to H'FFFFFFF can be used, and if a bit size of 32 is specified, locations from H'0 to H'FFFFFFFF can be used.

   A comment can be specified to identify the CPU information. A comment of up to 127 characters can be specified.

   The bit size and comment are only input when creating a new CPU information file. The CIA procedure starts with step (4), Editing, when an existent CPU information file is specified.

3. Memory map specification

   The following options are presented as a CPU information input menu. Memory map specification is iterated until a period (the exit command) is specified.

   0: ROM     1: EXTERNAL     2: RAM     3: I/O     .: END

   - Options 0 to 3 specify a memory type, and each time one of these options is selected, the system prompts for the start address, the end address, the number of states, and the data bus width.

   - When a period ('.') is entered, the memory map setup menu processing terminates.

4. Editing

   The following options are presented as a CPU information editing menu.

   1: ADD     2: DELETE     3: COMMENT     4: CIA ABORT     .: CIA END

   - When '1' (ADD) is selected, the memory map specification of step (3) is performed.

   - When '2' (DELETE) is selected, the system prompts (by index number) for input of an address range to be deleted.

   - When '3' (COMMENT) is selected, the system inputs a new comment line.

   - When '4' (CIA ABORT) is selected, CIA processing is terminated without saving the CPU information file.

   - When '.' (CIA END) is selected, the system writes out the memory map information to the CPU information file and completes CIA processing normally.

## 1.4 CIA Sample Sessions

This section presents two sample CIA sessions. The underlined sections are user inputs.

1. Creating a new CPU information file for the SH 7000 (mode 0).

```
% cia shmode0.cpu (RET) ←———————————————————————————————————————————— 1

SH SERIES CIA Ver. 1.1 (HS0700CICU1SM)
Copyright (C) Hitachi, Ltd. 1992
Licensed Material of Hitachi, Ltd.

*** NEW FILE ***
    *** CPU MENU ***
    1:SH 7000
    ?  1 (RET)          ←———————————————————————————————————————————— 2
BIT SIZE 32 ? :32 (RET) ←———————————————————————————————————————————— 3
COMMENT?      :'93.01.25 SH SAMPLE (RET) ←——————————————————————————— 4
             *** MAP MENU ***
             0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
             ?  1  (RET)←———————————————————————————————————————————— 5
                   *  EXTERNAL START ADDRESS?  00000000  (RET)
←———————————                                                      6
                               END   ADDRESS?  00FFFFFF  (RET)
←———————————                                                      7
                      STATE COUNT            ?  3  (RET)←——————————————
8
                      DATA BUS SIZE          ?  8  (RET)←——————————————
9
                   *  EXTERNAL START ADDRESS?  01000000  (RET)
                               END   ADDRESS?  04FFFFFF  (RET)
                      STATE COUNT            ?  2  (RET)
                      DATA BUS SIZE          ?  8  (RET)
                   *  EXTERNAL START ADDRESS?  .  (RET)←——————————————
0
*** MAP MENU ***
             0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
             ?  3  (RET)
                   *  I/O AREA START ADDRESS?  05000000  (RET)
                               END   ADDRESS?  05FFFFFF  (RET)
                      STATE COUNT            ?  3 (RET)
                      DATA BUS SIZE          ?  8 (RET)
```

```
*  I/O AREA START ADDRESS?  . (RET)
```

```
            *** MAP MENU ***
            0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
            ?  1  (RET)
                  *  EXTERNAL START ADDRESS?  06000000  (RET)
                              END   ADDRESS?  07FFFFFF  (RET)
                     STATE COUNT           ?  3  (RET)
                     DATA BUS SIZE         ?  8  (RET)
                  *  EXTERNAL START ADDRESS?  .  (RET)
            *** MAP MENU ***
            0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
            ?  2  (RET)
                  *  RAM AREA START ADDRESS?  0F000000  (RET)
                              END   ADDRESS?  0FFFFFFF  (RET)
                     STATE COUNT           ?  1  (RET)
                     DATA BUS SIZE         ?  32 (RET)
                  *  RAM AREA START ADDRESS?  .  (RET)
            *** MAP MENU ***
            0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
            ?  .  (RET) ←―――――――――――――――――――――――――――――――――――――――――――― q
                    ***** CPU INFORMATION *****
                    CPU : SH 7000←――――――――――――――――――――――――――――――――――――― (a)
                    '93.01.25 SH SAMPLE←―――――――――――――――――――――――――――――――― (b)
                    BIT SIZE : 32←――――――――――――――――――――――――――――――――――――― (c)
                       No   Device     Start      End     State   Bus
                        1 : EXTERNAL : 00000000 - 00FFFFFF  3      8
                        2 : EXTERNAL : 01000000 - 04FFFFFF  2      8
                        3 : I/O AREA : 05000000 - 05FFFFFF  3      8
                        4 : EXTERNAL : 06000000 - 07FFFFFF  3      8
                        5 : RAM AREA : 0F000000 - 0FFFFFFF  1      32
                      (d)     (e)        (f)         (g)   (h)     (i)
        ** EDIT MENU **
        1:ADD    2:DELETE   3:COMMENT  4:CIA ABORT   .:CIA END
        ? .  (RET) ←――――――――――――――――――――――――――――――――――――――――――――――――――― w
*** CIA COMPLETED ***
%
```

**Description:**

1 The name of a new CPU information file is specified when the CIA program is invoked.

2 This item specifies the CPU type.

3 The bit size is specified in decimal. The displayed default is taken if the specification is omitted.

4 This line is a comment. The comment field is left blank if this line is omitted. If more than 127 characters are entered, a warning message is displayed and the characters following the first 127 are ignored.

5 The memory type is entered as a number corresponding to the input menu.

6 The start address of the corresponding memory area is entered in hexadecimal.

7 The end address of the corresponding memory area is entered in hexadecimal.

8 The number of states for the corresponding memory area is entered in decimal.

9 The data bus width for the corresponding memory area is entered in decimal.

0 Data entry for the corresponding memory area is terminated with a period ('.').

q The edit menu is automatically displayed when the input menu is terminated.

(a) The CPU type specified in item 2
(b) The comment entered in item 4
(c) The bit size specified in item 3
(d) The map number
(e) The memory type specified in item 5
(f) The start address specified in item 6
(g) The end address specified in item 7
(h) The number of states specified in item 8
(i) The data bus width specified in item 9

w This input terminates CIA processing normally. The memory map data is written to the file specified when the CIA program was invoked.

2. A sample session in which an SH 7000 CPU information file is edited
   Mode 0 is changed to mode 2 in this session.

```
%  cia shmode0.cpu (RET)←——————————————————————————————————————————— 1

SH SERIES CIA Ver. 1.1 (HS0700CICU1SM)
Copyright (C) Hitachi, Ltd. 1992
Licensed Material of Hitachi, Ltd.

*** OLD FILE ***
  NEW CPU FILE NAME? shmode2  (RET) ←——————————————————————————————— 2

                       ***** CPU INFORMATION *****
                       CPU : SH 7000
                       '93.01.25 SH SAMPLE
                       BIT SIZE : 32
                          No   Device      Start      End      State  Bus
                           1 : EXTERNAL  : 00000000 - 00FFFFFF   3     8
                           2 : EXTERNAL  : 01000000 - 04FFFFFF   2     8
                           3 : I/O AREA  : 05000000 - 05FFFFFF   3     8
                           4 : EXTERNAL  : 06000000 - 07FFFFFF   3     8
                           5 : RAM AREA  : 0F000000 - 0FFFFFFF   1     32

       ** EDIT MENU **
         1:ADD     2:DELETE   3:COMMENT   4:CIA ABORT   .:CIA END
       ? 2  (RET)  ←————————————————————————————————————————————————— 3
       DELETE MAP NUMBER? 1  (RET)←————————————————————————————————— 4

                       ***** CPU INFORMATION *****
                       CPU : SH  7000
                       '93.01.25  SH SAMPLE
                       BIT SIZE : 32
                          No   Device     Start      End      State  Bus
                           1 : EXTERNAL : 01000000 - 04FFFFFF   2     8
                           2 : I/O AREA : 05000000 - 05FFFFFF   3     8
                           3 : EXTERNAL : 06000000 - 07FFFFFF   3     8
                           4 : RAM AREA : 0F000000 - 0FFFFFFF   1     32
```

```
        ** EDIT MENU **
        1:ADD    2:DELETE    3:COMMENT   4:CIA ABORT   .:CIA END
        ? 1  (RET) ←────────────────────────────────────────────────── 5

               *** MAP MENU ***
               0:ROM    1:EXTERNAL   2:RAM    3:I/O    .:END
               ?  0  (RET)←─────────────────────────────────────────── 6
                  *  ROM AREA START ADDRESS?  00000000  (RET)
                              END   ADDRESS?  00FFFFFF  (RET)
                     STATE COUNT           ?  1  (RET)
                     DATA BUS SIZE         ?  32 (RET)
                  *  ROM AREA START ADDRESS?  .  (RET)

              *** MAP MENU ***
              0:ROM    1:EXTERNAL    2:RAM     3:I/O    .:END
              ?  .  (RET)

                      ***** CPU INFORMATION *****
                      CPU : SH  7000
                      '93.01.25 SH SAMPLE
                      BIT SIZE : 32
                         No   Device     Start      End      State   Bus
                          1 : ROM AREA : 00000000 - 00FFFFFF   1      32
                          2 : EXTERNAL : 01000000 - 04FFFFFF   2      8
                          3 : I/O AREA : 05000000 - 05FFFFFF   3      8
                          4 : EXTERNAL : 06000000 - 07FFFFFF   3      8
                          5 : RAM AREA : 0F000000 - 0FFFFFFF   1      32

        ** EDIT MENU **
        1:ADD    2:DELETE    3:COMMENT   4:CIA ABORT   .:CIA END
        ? .  (RET)
*** CIA COMPLETED ***
%
```

**Description:**

1 The name of the file to be edited is specified when the CIA program is invoked. ".cpu" is supplied if the extension is omitted.

2 This item specifies a new file to be created when editing is done. If only (RET) is entered, the data will be output to the file specified in item 1 . If only the extension is omitted, ".cpu" will be supplied. The map data is automatically displayed.

3 "DELETE" is specified to delete information to be changed in the edit menu.

4 The information to be deleted is specified as a map number. The state of the map information after the deletion is displayed.
5 “ADD” is specified to input the changed information.
6 The input menu is displayed, and the memory type is entered in the same manner as that used when creating a new CPU information file. The state of the map information after the addition is displayed.

## 1.5 CIA Limitations

Table 1-1 lists the limitations on data specified using the CIA program. The CIA program cannot handle values which exceed these limitations.

**Table 1-1 CIA Limitations**

| Item | Limitation Value | Notes |
|---|---|---|
| Input file format | • CPU information files output by the SH CIA | |
| Bit size | • Only values specified in decimal<br>• The specifiable range is from 24 to 32 | |
| Address specifications | • Only values specified in hexadecimal<br>• The specifiable range depends on the bit size | The range is from H'0 to H'FFFFFF when the bit size is 24. |
| Number of states | • Only values specified in decimal<br>• The specifiable range is from 1 to 65535 | Specify the number of states including the wait states when wait states are inserted. |
| Data bus width | • Only values specified in decimal<br>• The specifiable values are multiples of 8 between 8 and 65528 | |
| Comment length | • Up to 127 characters | |
| Number of map information items | • Up to 65535 items | Note that there may be limitations imposed by the memory capacity of the system on which the CIA program is running. Invalid regions are also included in the number of items. |

# Appendix A Differences between Line Assemble Command and SH-Series Cross Assembler Syntax

Table A-1 lists the differences between the syntax of the SH-series cross assembler and the syntax of the simulator/debugger line assembly function.

**Table A-1 Differences between Line Assemble Command and SH-Series Cross Assembler Syntax**

| Item | Line Assemble Command | SH-Series Cross Assembler |
|---|---|---|
| Location counter reference | Not allowed | Allowed<br>Example:<br>MOV.L @(H'100-$,R0),R1 |
| Use of the '-' character to represent unitary negation | Not allowed<br>Example:<br>Use 0-10 to specify -10,<br>e.g. MOV.L #0-10,R0 | Allowed<br>Example:<br>The notation -10 can be used,<br>e.g. MOV.L #-H'10,R0 |
| Use of control directives | Allowed in .DATA only | Allowed |
| Label definition | Not allowed | Allowed |
| Data value default radix | Hexadecimal | Decimal |
| Handling of instructions that generate warnings with the SH assembler. | These instructions are errors, and no code is generated. | Code is generated. |
| An instruction following a delay branch instruction is branch instruction. (Invalid slot Instruction) | Code is generated. During simulation, exception processing starts. | An error occurs and no code is generated. |

# Appendix B SH-Series Assembler Mnemonics

Table B-1 lists the mnemonics that can be used with the simulator/debugger's line assemble commands.

**Table B-1 Assembler Mnemonics Recognized by the Line Assemble Command**

| Type | Instruction | Number of Instructions |
|---|---|---|
| Data transfer | MOV, MOVA, MOVT, SWAP, XTRCT | 5 |
| Arithmetic operation | ADD, ADDC, ADDV, CPM/cond, DIV1, DIV0S, DIV0U, EXTS, EXTU, MAC, MULS, MULU, NEG, NEGC, SUB, SUBC, SUBV | 17 |
| Logic operation | AND, NOT, OR, TAS, TAT, XOR | 6 |
| Shift and rotate | ROTL, ROTR, ROTCL, ROTCR, SHAL, SHAR, SHLL, SHLR, SHLLn, SHLRn | 10 |
| Branch, jump, and return | BF, BT, BRA, BSR, JMP, JSR, RTS | 7 |
| Privileged and control register manipulations | CLRT, CLRMAC, LDC, LDS, NOP, RTE, SETT, SLEEP, STC, STS, TRAPA | 11 |

# Appendix C   SH-Series Memory Maps

Table C-1 shows the SH7000 memory maps.

**Table C-1   SH7000 Memory Map**

| Address | Mode 0 (Extended mode without ROM) | Mode 1 (Extended mode without ROM) | Mode 2 (Extended mode with ROM) | Mode 7 (PROM mode) |
|---|---|---|---|---|
| H'0x00000–H'0x003FF | Vector area | Vector area | Vector area | Vector area |
| | External bus area/cs0 (Bus width: 8 bits) | External bus area/cs0 (Bus width: 16 bits) | External bus area/cs0 (Bus width: 32 bits) | Internal ROM area (Bus width: 32 bits) |
| H'1x00000 | External bus area/ cs1–cs4 (Bus width: 8 bits) | External bus area/ cs1–cs4 (Bus width: 8 bits) | External bus area/ cs1–cs4 (Bus width: 8 bits) | |
| H'5x00000 | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) |
| H'6x00000 | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | |
| H'8x00000 | External bus area/cs0 (Bus width: 8/16 bits) | External bus area/cs0 (Bus width: 16 bits) | Internal bus area (Bus width: 32 bits) | Internal ROM area (Bus width: 32 bits) |
| H'9x00000 | External bus area/ cs1–cs6 (Bus width: 16 bits) | External bus area/ cs1–cs6 (Bus width: 16 bits) | External bus area/ cs1–cs6 (Bus width: 16 bits) | |
| H'Fx00000–H'FxFFFFF | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) |

Notes: 1. The example in section 1.4.1, CPU Information File Creation Program, uses mode 0 (extended mode without ROM).
2. The example in section 1.4.2, CPU Information File Creation Program, uses mode 2 (extended mode with ROM).
3. In the SH-series, external bus spaces do not coexist with the same/csn (chip select pins).
4. Two internal ROM areas exist in modes 2 and 7 are actually the same area in the SH-series.

**Table C-1 SH7000 Memory Map**

| Address | Mode 0 (Extended mode without ROM) | Mode 1 (Extended mode without ROM) | Mode 2 (Extended mode with ROM) | Mode 7 (PROM mode) |
|---|---|---|---|---|
| H'0x00000–H'0x003FF | Vector area | Vector area | Vector area | Vector area |
| | External bus area/cs0 (Bus width: 8 bits) | External bus area/cs0 (Bus width: 16 bits) | External bus area/cs0 (Bus width: 32 bits) | Internal ROM area (Bus width: 32 bits) |
| H'1x00000 | External bus area/ cs1–cs4 (Bus width: 8 bits) | External bus area/ cs1–cs4 (Bus width: 8 bits) | External bus area/ cs1–cs4 (Bus width: 8 bits) | |
| H'5x00000 | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) | Internal I/O area (Bus width: 8/16 bits) |
| H'6x00000 | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | External bus area/ cs6 and cs7 (Bus width: 8/16 bits) | |
| H'8x00000 | External bus area/cs0 (Bus width: 8/16 bits) | External bus area/cs0 (Bus width: 16 bits) | Internal bus area (Bus width: 32 bits) | Internal ROM area (Bus width: 32 bits) |
| H'9x00000 | External bus area/ cs1–cs6 (Bus width: 16 bits) | External bus area/ cs1–cs6 (Bus width: 16 bits) | External bus area/ cs1–cs6 (Bus width: 16 bits) | |
| H'Fx00000–H'FxFFFFF | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) | Internal RAM area (Bus witdth: 32 bits) |

Notes: 1. The example in section 1.4.1, CPU Information File Creation Program, uses mode 0 (extended mode without ROM).
2. The example in section 1.4.2, CPU Information File Creation Program, uses mode 2 (extended mode with ROM).
3. In the SH-series, external bus spaces do not coexist with the same/csn (chip select pins).
4. Two internal ROM areas exist in modes 2 and 7 are actually the same area in the SH-series.

# Appendix D   Sample Programs

```
/***************************************/
/**       FILE NAME IS sample.c       **/
/***************************************/
#include "stdio.h"
struct rec_ctl {
       short   rec_it;
       short   rec_ln;
       short   rec_no;
       struct rec_ctl *rec_nx;
       };

short  Print_rec(void);
void   Read_rec(void);
void   Bin_ascii(char *p);
void   Ph_read(char *bp);
/*-------------------------------------------------------------------*/
/* ASSEMBLER I/O SIMULATION SUBROUTINES.                             */
/*-------------------------------------------------------------------*/
extern short F_open(char *name, char *mode, short f_id);
extern short F_close(short f_id);
extern short Read(char *p);
extern void  Write(char *p);
extern short F_read(short f_id char *p);

struct rec_ctl rec_v0[1000];
short  stop_f, phg_pos, phg_lng, rec_num, nxt_f, l_rec_no;
char   log_rec[512], phg_rec[1024];
char   l_buf[30] = "--------------------¥n";
char   f_name[80];
short  f_id;
short  f_no;

void main()
{

/*: Make the file name prompt. ----------------------------------------*/
  Write("File Name please.");
  Read(f_name);
/*: Try to open INPUT file._------------------------------------------*/
/*: “F_open” will return 0   n : successful. The number is file ID. ----*/
/*:                      -1    : open failed. -------------------------*/
  f_no =  (short)0;
  f_id == F_open(f_name, “rt”, f_no);

/*: Initialization. ---------------------------------------------------*/
  stop_f   = (shortt)0;       /*: Loop control.                        */
  phg_pos  = (shortt)-1;      /*: Record extract index. (-1 = No data)  */
  nxt_f    = (shortt)0;       /*: EOF marker.                          */
  l_rec_no = (shortt)0;       /*: Record counter.                      */
/*:-------------------------------------------------------------------*/
/*: Loop of record read/print process.                               */
/*: “Print_rec” will return 1 when ending data had been processed.     */
```

```
/*:----------------------------------------------------------------------*/
  while (stop_f == 0)
    {
    stop_f = Print_rec();
    }
/*: Completed. Close and exit. ------------------------------------------*/
/*: “F_close” will return 0 : successful. -----------------------------*/
/*:                        1 : unsuccessful. ---------------------------*/
  F_close(f_no);
  }

/*:----------------------------------------------------------------------*/
/*: Name : Printf_rec; Read and print records.                           */
/*: Func : Read and printf 1 logical record.                             */
/*:----------------------------------------------------------------------*/
short Print_rec()
{
  short wi, put_pos, rec_pos, rec_lng, rtncd;
  char  hex_buf[100], asc_buf[100],
        l_char, r_char, il_char, ir_char, *hx_p;

/*: Read 1 record. “Read_rec” sets the data to "log_rec" array. --------*/
  Read-rec();
/*: Save Record IT (ID), Length, and record number. --------------------*/
  rec_v0[1_rec_no].rec_it = (char)(0x7f & log_rec[0]);
  rec_v0[1_rec_no].rec_ln = (unsigned char)log_rec[l];
  rec_v0[1_rec_no].rec_no = rec_num;
/*: Make IT characters. -------------------------------------------------*/
  il_char = (char)(rec_v0[l_rec_no].rec_it >> 4);
  ir_char = (char)(rec_v0[1_rec_no].rec_it & 0x0f);
  Bin_ascii(&il_char);
  Bin_ascii(&ir_char);
/*: Make record length characters. -------------------------------------*/
  l_buf[15] = il_char;
  l_buf[16] = ir_char;
/*: Print header. IT and length. ---------------------------------------*/
  Write(l_buf);

/*: Ending record check. Ending record IT is 0x7F. ---------------------*/
  if (rec_v0[1_rec_no}.rec_it == (char)0x7f)
    {
    rtncd = (short)l;
    return (rtncd);
    }

/*: Not a endinf record. Edit and print each 16 bytes. -----------------*/
  rec_lng = (short)(
          rec_v0[l_rec_no].rec_ln - (short)2 ); /*: length adjust.      */
  rec_pos = (short)2;                           /*: data position.      */
  for (wi = (short)0; wi < (short)36;
          hex_buf[wi++] = (char)0x20);   /*: buffer initial             */
  for (wi = (short)0; wi < (short)16;
asc_buf[wi++] = (char)0x20);                    /*:              clear. */
  hx_p = &hex_buf[0];                           /*:                     */
  put_pos = (short)0;                           /*: 1 line position.    */
```

```
/*:-----------------------------------------------------------------*/
/*: Edit and print loop.                                           */
/*:-----------------------------------------------------------------*/
  while (rec_lng > 0)
    {
    if (put_pos == 16)
      {
/*: buffer full with 16 bytes. print them via asm- I/O simulation.      */
      hex_buf[36] = (char)0x00;         /*: Terminal NULL.              */
      asc_buf[16] = (char)0x0a;         /*: Terminal LF and             */
      asc_buf[17] = (char)0x00;         /*:                 NULL        */
      Write(hex_buf);
      Write("     ");
      Write(asc_buf);
/*: Re-initialization. ----------------------------------------------*/
      for (wi = (short)0; wi < (short)36; hex_buf[wi++] = (char)0x20);
      for (wi = (short)0; wi < (short)16; asc_buf[wi++] = (char)0x20);
      hx_p = &hex_buf[0];
      put_pos = (short)0;
      }
/*: Set 1 byte data. Hex-dump and ASCII image. -------------------------*/
    1_char = (char)(log_rec[rec_pos] >> 4);
    r_char = (char)(log_rec[rec_pos] & (char)0x0f);
/*: HEX-dump. -------------------------------------------------------*/
    Bin_ascii(&1_char);
    Bin_ascii(&r_char);
    *hx_p++ = 1_char;
    *hx_p++ = r_char;
    if ( (put_pos % 4) == 3)            /*: space gap for 4-bytes       */
      {
      *hx_p++ = ' ';
      }
/*: ASCII image.----------------------------------------------------*/
    if (log_rec[rec_pos] >= 0x7f || log_rec[rec_pos] <= 0xlf)
      {
      asc_buf[put_pos] = (chart) '.';
      }
    else
      {
      asc_buf[put_pos] = log_rec[rec_pos];
      }
/*: pointer increment and counter decrement. --------------------------*/
    put_pos++;
    rec_pos++;
    rec_lng–;
    }
/*: Final printf. ---------------------------------------------------*/
  hex_buf[36] = (chart)0x00;
  asc_buf[16] = (chart)0x0a;
  asc_buf[17] = (chart)0x00;
  Write(hex_buf);
  Write("     ");
  Write(asc_buf);
/*: Increment the record number for next read. -------------------------*/
  1_rec_no++;
  rtncd = (short)0;
  return (rtncd);
  }

/*:-------------------------------------------------------------------*/
/*: Name : Read_rec; Read 1 logical record.                           */
/*: Func : Read 1 logical from physical record buffer.                */
/*:-------------------------------------------------------------------*/
void Read_rec()
{
  short wi;

/*: Initial record reading check. -------------------------------------*/
  if (phg_pos == -1)
    {
    Ph_read(phg_rec);         /*: First 256 bytes.                    */
    Ph_read(phg_rec+256);     /*: first spare 256 bytes.              */
    phg_pos = (short)0;       /*: Index initialize.                   */
    rec_num = (short)0;       /*: physical record number initialize.  */
    }
/*: Top of data. It is the record length. -----------------------------*/
  phg_lng = phg_rec[phg_pos + 1];
  if (phg_lng < 0)
    {
    phg_lng += 256;           /*: Adjust to unsigned char.            */
    }
/*: Record extracting loop. -------------------------------------------*/
  wi = (short)0;
  while (wi <phg_lng)
    {
    log_rec[wi++] = phg_rec[phg_pos++];
    }
/*: physical record buffer arranging. ---------------------------------*/
  if (phg_pos > 255)
    {
/*: Set spare 256 bytes to normal extracting area. --------------------*/
    for (wi = 0; wi < (short)256; wi++)
      {
      phg_rec[wi] = phg_rec[wi + 256];
      }
/*: Read next spare 256 bytes. ----------------------------------------*/
    Ph_read(&phg_rec[256]);
    phg_pos -= 256;
    rec_num++;
    }
  }

/*:-------------------------------------------------------------------*/
/*: Name : Bin_ascii; Binary —> ASCII conver.                         */
/*: Func : Convert 4 bit binary data to 1 ASCII character.            */
/*:-------------------------------------------------------------------*/
void Bin_ascii(p)
char *p;
{

  if (*p >= (char)0x0a)
    {
```

```
    *p += (char)((char)0x41 - (char)0x0a);        /*: 'A' - 'F'         */
    }
  else
    {
    *p += (char)0x30;                             /*: '0' - '9'         */
    }
  }

/*:-----------------------------------------------------------------------*/
/*: Name : Ph_read; physical 256 bytes read.                             */
/*: Func : Read 256 bytes via ASM I/O simulation subroutine.             */
/*:-----------------------------------------------------------------------*/
void Ph_read(bp)
char *bp;
{

  char pb[256], *pp;
  short pi, pj, pcl, pcr, f_no ;

/*: Read loop. "F_read" reads 16 bytes data as 1 line INPUT. -----------*/
  f_no = (short)0;
  if (F_read(0, bp) != 0)
    {
/*: Data less than 256 byte block. -------------------------------------*/
    if (F_close(0) != 0)
      {
      Write("ALSO, CLOSE failed.¥n");
      }
    nxt_f = (short)1;
    }
  }
```

```
;*************************************************************
;* SAMPLE OF SD38 I/O SIMULATION.   FILE NAME IS PROG.SRC   *
;* THIS PROGRAM IS DESIGNATED FOR SH........................*
;*************************************************************
          .EXPORT   TRAP
          .EXPORT   _Read,_Write
          .EXPORT   _F_open,_F_close,_F_read
;-------------------------------------------------------------
;  1 LINE READ FROM CONSOLE ................................-
;-------------------------------------------------------------
_Read:
;-------------------------------------------------------------
; REGISTER SAVING.
          STS.L     PR,@_R15; SAVE PR
;-------------------------------------------------------------
; PARAMETER BLOCK SETTING.
          MOV.L     R4,R0                  ; INPUT AREA ADDRESS (ARGUMENT_1 =
R4)
          MOV.L     PARM_1,R1              ; PARAMETER ARER ADRESS
          MOV.LP0,  @R1     ; SET
;-------------------------------------------------------------
; GO TRAP.
          MOV.L     REQ_CD_1,R0            ; REQUEST CODE
          MOV.L     TRP_AD_1,R3            ; TRAP ADDRESS SET
          JSR       @R3                    ; GO TRAP! (DELAY_BRANCH)
          NOP
;----------------------------------------------------------------
; RETURN CODE CHECK. IF TOP OF DATA IS 0,  NO DATA HAD BEEN READ.
          MOV.L     PARM_1,R3              ; BUFFER ADDRESS,ADRRESS
          MOV.L     @R3,R1                 ; BUFFER ADDRESS
          MOV.B     @R1,R0                 ; READ CHECK
          CMP/EQ    #0,R0                  ; IF 0X00, NOTHING HAD BEEN READ
          BT        R_EXIT          ; NORMAL

;-------------------------------------------------------------
; RETURN CODE SET. I/O ERROR OR EOF = 1
          MOV.L     #1,R0
          MOV.L     RTN_AD_1,R3
          BRA       R_RTN   ; DELAY BRANCH
          MOV.L     R0,@R3  ; SET 1

;-------------------------------------------------------------
; RETURN CODE SET. NORMAL END = 0.
R_EXIT:
          SUB.L    R0,R0
          MOV.L    RTN_AD_1,R4
          MOV.L    R0,@R4
;-------------------------------------------------------------
; RETURNNING SEQUENCE
R_RTN
          MOV.L    RTN_AD_1,R2             ; RETURN POINTER SET
          MONV.L   @R2,R0                  ; SET RETUTRN CODE
          RTS                              ; DELAY RETURN
          LDS.L    @R15+,PR                ; LOAD PR
;-------------------------------------------------------------
; POINTER AREA
```

```
;-------------------------------------------------------------
       .align 4
PARM-_1       .DATA.L PARM
REQ_CD_1      .DATA.L H'01230000
TRP_AD_1      .DATA.L TRAP
RTN_AD_1      .DATA.L RTN_CD
;-------------------------------------------------------------
;  1 LINE WRITE TO CONSOLE ................................-
;-------------------------------------------------------------
_Write:
;-------------------------------------------------------------
; REGISTER SAVING.
          STS.L    PR,@-R15        ; SAVE PR
;-------------------------------------------------------------
; PARAMETER BLOCK SETTING.
          MOV.L    R4,R0           ; INPUT AREA ADDRESS (ARGUMENT_1 = R4)
          MOV.L    PARM_2,R1
          MOV.L    R0,@R1
;-------------------------------------------------------------
; GO TRAP.
          MOV.L    REQ_CD_2,R0
          MOV.L    PARN_2,R1
          MOV.L    TRP_AD_2,R3
          JSR      @R3
          NOP
;-------------------------------------------------------------
; RETURNNING SEQUENCE
;-------------------------------------------------------------
W_RTN
          SUB.L    R0,R0           ; SET RETURN CODE
          RTS                      ; DELAY RETURN
          LDS.L     @R15+,PR       ; LOAD PR
;-------------------------------------------------------------
; POINTER AREA
;-------------------------------------------------------------
          .align 4
PARM_2           .DATA.L PARNM
REQ_CD_2         .DATA.L H'01240000
TRP_AD_2         .DATA.L TRAP
;-------------------------------------------------------------
;  FILE OPEN
;-------------------------------------------------------------
_F_open:
;-------------------------------------------------------------
; REGISTER SAVING.
          STS.L     PR,@-R15       ; SAVE PR
;-------------------------------------------------------------
; PARAMETER BLOCK SETTING.
          MOV.L     R5,R0                 ; OPEN MODE (ARGUNMENT_2 = R5)
          BSR       CNV_MODE              ; CHAR –> MODE-ID
          NOP                      ; (DELAY BRANCH)
          MOV.L     FP_ FUNUM_3,R3 ;          SET
          MOV.B     R0,@R3
          CMP/PZ    R0
          BF        FR_ERROR       ; -1,MODE-CONVERSION ERROR
          MOV.L     R6,R0          ; FILR NUMBER (ARGUMENT_3 = R6)
          MOV.L     FP_FNUM_3,R3
          MOV.B     R0,@R3            ;              SET
          MOV.L     R4,R0             ; FILE NAME ADDRESS (ARGUMENT_1 = R4)
          MOV.L     FP_FNMA_3,R3      ;              SET
          MOV.L     R0,@R3
          SUB.L     R0,R0
          MOV.L     FP_RCOD_3,R3
          MOV.B     R0,@R3            ; CLEAR RETURN CODE AREA
;-----------------------------------------------------------
; GO TRAP.
          MOV.L     REQ_CD_3,R0       ; REQUEST CODE
          MOV.L     PARM_FP_3,R1      ; PARAM AREA ADDRESS
          MOV.L     TRP_AD_3,R3
          JSR       @R3               ; GO TRAP !
          NOP
;-----------------------------------------------------------
; RETURN CODE SAVING.
          SUB.L     R0,R0             ; WORK
          MOV.L     FP_RCOD_3,R3      ; LOAD RETURN CODE
          MOV.B     @R3,R0
          EXTU.B    R0,R0
          MOV.L     RTN_AD_3,R3
          BRA       F0_RTN            ; GOTO RETURN SEQUENCE
          MOV.L     R0,@R3            ; SAVE RETURN CODE (DELAY BRANCH)
;-----------------------------------------------------------
; MODE CONVERSION ERROR. RETURN -2.
FR_ERROR:
          MOV.L     #H'FE,R0
          MOV.L     RTN_AD_3,R3
          MOV.L     R0,@R3
;-----------------------------------------------------------
; RETURNNING SEQUENCE
F0_RTN:
          MOV.L     RTN_AD_3,R8
          MOV.L     @r8,R0            ; SET RETURN CODE
          RTS                         ; DELAY RETURN
          LDS.L     @R15+,PR          ; LOAD PR
;-----------------------------------------------------------
; POINTER AREA
;-----------------------------------------------------------
        .align 4
FP_FUNM_3          .DATA.L FP_FUNM
FP_MODE_3          .DATA.L FP_MODE
FP_FNMA_3          .DATA.L FP_FNMA
FP_RCOD_3          .DATA.L FP_RCOD
REQ_CD_3           .DATA.L H'01250000
PARNM_FP_3         .DATA.L PARM_FP
TRP_AD_3           .DATA.L TRAP
RTN_AD_3           .DATA.L RTN_CD
;-----------------------------------------------------------
;  FILE CLOSE ............................................-
;-----------------------------------------------------------
_F_close:
;-----------------------------------------------------------
; REGISTER SAVING.
        STS.L  PR,@-R15               ; SAVE PR
```

```
;-----------------------------------------------------------
; PARAMETER BLOCK SETTING.
          MOV.L    R4,R0               ; FILE NUMBER (ARGUNMENT_1 = R4)
          MOV.L    FP_FNUM_4,R3        ;          SET
          MOV.B    R0,@R3              ;
          SUB.L    R0,R0               ;
          MOV.L    FP_RCOD_4,R3        ;
          MOV.L    R0,@R3              ; CLEAR RETURN CODE AREA

;----------------------------------------------------------
; GO TRAP.
          MOV.L    REQ_CD_4,R0         ; REQUEST CODE
          MOV.L    PARM_FR4,R1         ; PARAM AREA ADDRESS
          MOV.L    TRP_AD_4,R3         ; GO TRAP !
          JSR      @R3
;----------------------------------------------------------
; RETURN CODE SAVING.
          SUB.L    0,R0                ; WORK
          MOV.L    FP_RCOD_4,R3        ;
          MOV.B    @R3,R0              ; LOAD RETURN CODE
          EXTU.B   R0,R0               ;
          MOV.L    RTN_AD_4,R3         ; SAVE RETURN CODE
          MOV.L    R0,#r3              ;
;----------------------------------------------------------
; RETURNNING SEQUENCE
C_RTN:
          MOV.L    RTN_AD_4,R2
          MOV.L    @R2,R0              ; SET RETURN CODE
          RTS                          ; DELAY BRANCH
          LDS.L    @R15+,PR            ; LOAD PR
;----------------------------------------------------------
; POINTER AREA
;----------------------------------------------------------
                                       .align 4
FP_FNUM_4         .DATA.L FP_FNUM
FP_RCOD_4         .DATA.L FP_RCOD
REQ_CD_4          .DATA.L H'01060000
PARM_FP_4         .DATA.L PARM_FP
TRP_AD_4          .DATA.L TRAP
RTN_AD_4          .DATA.L RTN_CD
;----------------------------------------------------------
;  1 LINE READ FROM FILE ................................-
;----------------------------------------------------------
_F_read;
;----------------------------------------------------------
; REGISTER SAVING.
          STS.L     PR,@-R15; SAVE PR
;----------------------------------------------------------
; PARAMETER BLOCK SETTING.
          MOV.L     R4,R0              ; FILE NUMBER (ARGUNMENT_1 = R4)
          MOV.L     FR_FNUM_5,R3       ;          SET
          MOV.L     R0,@R3             ;
          MOV.L     R14,R8             ;
          ADD       #H'10,R8           ; INPUT AREA ADDRESS
          MOV.L     @R8,R0             ;          SET
          MOV.L     FR_BUFP_5,R3       ;
          MOV.L      R0,@R3              ;
         SUB.L      R0,R0               ;
         MOV.L      FR_RCOD_5,R3        ;
         MOV.B      R0,@R3              ; CLEAR RETURN CODE AREA

;-------------------------------------------------------------
; GO TRAP.
         MOV.L      REQ_CD_5,R0         ; REQUEST CODE
         MOV.L      PARM_FR_5,R1        ; PARAM AREA ADDRESS
         MOV.L      TRP_AD_5,R4                ; GO TRAP!
         JSR        @R4                 ; DELAY BRANCH
         NOP
;-------------------------------------------------------------
; RETURN CODE SAVING.
         SUB.L      R0,R0               ; WORK
         MOV.L        FR_RCOD5,R4              ;
         MOV.B      @R4,R0              ; LOAD RETURN CODE
         EXTU.B     R0R0                ;
         CMP/EQ     #0,R0               ;
         BT         FR_SET              ; NORMAL
         MOV       #H'FF,R0             ; EOF
FR_SET:
         MOV.L      RTN_AD_5,R3         ; SAVE RETURN COD
         MOV.L     R0,@R3               ;
;-------------------------------------------------------------
; RETURNNING SEQUENCE
FR_RTN:
         MOV.L      RTN_AD_5,R8
         MOV.L      @R8,R0              ; SET RETURN CODE
         RTS                            ; DELAY RETURN
         LDS.L      @R15+,PR            ; LOAD PR
;-------------------------------------------------------------
; POINTER AREA
;-------------------------------------------------------------
       .align 4
FR_FNUM_5           .DATA.L FR_FNUM
FR_BUFP_5           .DATA.L FR_BUFP
FR_RCOD_5           .DATA.L FR_RCOD
REQ_CD_5            .DATA.L H'01290000
PARM_FR5            .DATA.L PARM_FR
TRP_AD_5            .DATA.L TRAP
RTN_AD_5            .DATA.L RTN_CD
;-------------------------------------------------------------
; CONVERT MODE STRING TO BE MODE ID NUMBER.                  -
;-------------------------------------------------------------
CNV_MODE:
         STS.L      PR,@-R15            ; PR SAVE
         MOV.L      R8,@-R15            ; R8 SAVE
         MOV.L      SV_R1P,R8
         MOV.L      R1,@R8              ; R1 SAVE
         MOV.L     SV_R2P,R8
         MOV.L     R2,@R8               ; R2 SAVE
         MOV.L     SV_R3P,R8
         MOV.L     3,@R8                ; R3 SAVE
         MOV.L     SV_R4P,R8
         MOV.L     R4,@R8               ; R4 SAVE
         MOV.L    SV_R5P,R8
         MOV.L     R5,@R8           ; R5 SAVE
         MOV.L     SV_R6P,R8
         MOV.L     R6,@R8           ; R6 SAVE
         MOV.L     SV_R7P,R8
         MOV.L     R7,@R8           ; R7 SAVE
;-------------------------------------------------------------
; LOAD USER SPECIFICATION AND CONVER TO BE lower CASE STRING.
          MOV.L     CNV_STR6,R2
CNV000:
         MOV.B     @R0,R1           ;---------------+
         EXTU.B    R1,R1            ; TERMINATOR    +
         SUB.L     R4,R4            ;               +
         CMP/EQ    R1,R4            ;               +
         BT        CNV100           ;               +
         MOV       #H'61,R4         ;               +
         CMP/GT    R1,R4            ;               + -- lower CHANGE LOOP
         BF        CNV0101          ;               +
         ADD       #H'20,R1         ;               +
         EXTU.B    R1R              ; TO BE lower   +
CNV010:                                    ;              +
         MOV.B     R1,@R2           ; LOCAL SAVE    +
         ADD.L     #1,R0            ;               +
         BRA       CNV000                  ; DELAY BRANCH  +
         ADD.L     #1,R2            ;---------------+
;-------------------------------------------------------------
; COMPARE WITH MODE-STRING.
CNV100:
         MOV.L     CNV_TBL6,ER1     ; TOP OF COMPARE STRING ADDRESS ARRAY
         SUB.L     R2,R2            ; LOCAL INDEX
CNV110:
         MOV.L     @R1,R3           ; DATA ADDRESS
         SUB.L     R6,R6                   ; WORK 0 CLEAR
         CMP/EQ    R6,R3
         BT        CNV400                  ; NULL, NO DATA MORE. IT IS AN
ERROR
         MOV.L     CNV_STR6,R4             ; TOP OF USER STRING
CNV120:
         MOV.B     @R4,R5           ; LOAD 1 CHAR
         MOV.L     #0,R7                   ;
         CMP/EQ    R5,R7                   ;
         BT        CNV300                  ; NULL-CHAR, NOW COMPLETED
         MOV.B     @R3,R6                  ; SET TO UPPER
         CMP/EQ    R5,R6            ; SAME?
         BF        CNV190           ; NO, TRY NEXT
         ADD       #1,R3
         BRA       CNV120
         ADD       #1,R4
;-------------------------------------------------------------
; TRY NEXT STRING.
CNV190:
         ADD       #4,R1                   ; NEXT STRING TABLE ENTRY
         ADD       #1,R2            ; INCREMENT THE INDEX
         BRA       CNV110           ; TRY NEXT
         EXTU.B    R2,R2            ;
;-------------------------------------------------------------
```

```
; COMPARE SUCCESSFUL. ER2 HAS THE MODE-ID INDEX.
CNV300:
         SUB.L      R0,R0            ;
         MOV.L      CNV_RC6,R4       ; RESET THE RC.
         MOV.L      R0,@R4           ;
         MOV.L     MODE_TBL6,R3      ; MODE-ID NUMBER TABLE
         SHLL      R2                ; INDEX * 2
         EXTU.B     R2,R2            ;
         ADD.L      R2,R3            ; TABLE ENTRY
         MOV.W      @R3,R0           ; R0 NOW THE MODE-ID
         ADD.L      #2,R4            ; SAVE TEMPORARY
         BRA        CNV500           ; GO TO RETURN SEQUENCE
         MOV.W      R0,@R4
;-------------------------------------------------------------
; ERROR RETURN. COMPARE FAILED.
CNV400:
         MOV.L      #H'FF,R0
         MOV.L      CNV_RC6,R4
         MOV.L      R0,@R4
;-------------------------------------------------------------
; RETURNNING RESEQUENCE
CNV500:
         MOV.L      SV_R1P,R8        ; RELOAD REGISTER
         MOV.L      @R8,R1           ;
         MOV.L      SV_R2P,R8        ;
         MOV.L      @R8,R2           ;
         MOV.L      SV_R3P,R8        ;
         MOV.L      @R8,R3           ;
         MOV.L      SV_R4P,R8        ;
         MOV.L      @R8,R4           ;
         MOV.L      SV_R5P,R8        ;
         MOV.L      @R8,R5                  ;
         MOV.L      SV_R6P,R8               ;
         MOV.L      @R8,R6                  ;
         MOV.L      SV_R7P,R8        ;
         MOV.L      @R8,R7           ;
         MOV.L      CNV_RC6,R8              ; LOAD RETURN CODE
         MOV.L      @R8,R0           ;
         MOV.L      @R15+,R8         ; LOAD R8 REGISTER
         RTS                         ; DELAY BRANCH
         LDS.L     @R15+,PR          ; PR LOAD
;-------------------------------------------------------------
; POITER AREA
;-------------------------------------------------------------
       .align 4
SV_R1P            .DATA.L SV_R1
SV_R2P            .DATA.L SV_R2
SV_R3P            .DATA.L SV_R3
SV_R4P            .DATA.L SV_R4
SV_R5P            .DATA.L SV_R5
SV_R6P            .DATA.L SV_R6
SV_R7P            .DATA.L SV_R7
CNV_STR6          .DATA.L CNV_STR
CNV_TBL6          .DATA.L CNV_TBL
CNV_RC6           .DATA.L CNV_RC
MODE_TBL6         .DATA.L MODE_TBL
```

```
;-------------------------------------------------------------
; TRAP ADDRESS. SAY "TRAP_ADDR %PROG!TRAP"
;-------------------------------------------------------------
TRAP      NOP
;-------------------------------------------------------------
; DATA AREA. PARAMETER BLOCK AND I/O BUFFER.                 -
;-------------------------------------------------------------
          .section    dt,data
;-------------------------------------------------------------
; CONSOLE I/O SIMULATION PARAMETER BLOCK.                    -
;-------------------------------------------------------------
PARM      .RES.L    1         ; I/O BUFFER ADDRESS
;-------------------------------------------------------------
; FILE I/O SIMULATION PARAMETER BLOCK.                       -
;-------------------------------------------------------------
PARM_FP:
FP_RCOD   .RES.B    1       ; RETURN CODE AREA
FP_FNUM   .RES.B    1              ; FILE ID NUMBER
FP_MODE   .RES.B    1       ; OPEN MODE
FP_RESV   .RES.B    1       ; RESERVED
FP_FNMA   .RES.L    1       ; FILE NAME AREA ADDRESS
;-------------------------------------------------------------
; FILE I/O SIMULATION /FILE-READ PARAMETER BLOCK.            -
;-------------------------------------------------------------
PARM_FR:
FR_RCOD   .RES.B    1       ; RETURN CODE AREA
FR_FNUM   .RES.B    1       ; FILE ID NUMBER
          .align   4
FR_BUFP   .RES.L    1       ; FILE NAME AREA ADDRESS
FR_SIZE   .DATA.W   H'100   ; RESERVED
          .align   4
;-------------------------------------------------------------
RTN_CD    .RES.L    1              ; RETURN CODE SAVE AREA
;-------------------------------------------------------------
; OPEN MODE CONVERSION TABLE.                                -
;-------------------------------------------------------------
CNV_TBL:
          .DATA.L   STR_0
          .DATA.L   STR_1
          .DATA.L   STR_2
          .DATA.L   STR_3
          .DATA.L   STR_4
          .DATA.L   STR_5
          .DATA.L   STR_10
          .DATA.L   STR_11
          .DATA.L   STR_12
          .DATA.L   STR_13
          .DATA.L   STR_14
          .DATA.L   STR_15
STR_0     .SDATAZ   "r"
STR_1     .SDATAZ   "w"
STR_2     .SDATAZ   "a"
STR_3     .SDATAZ   "r+"
STR_4     .SDATAZ   "w+"
STR_5     .SDATAZ   "a+"
STR_10    .SDATAZ   "rb"
```

```
STR_11    .SDATAZ   "wb"
STR_12    .SDATAZ   "ab"
STR_13    .SDATAZ   "r+b"
STR_14    .SDATAZ   "w+b"
STR_15    .SDATAZ   "a+b"
MODE_TBL:
          .DATA.W    H'0000
          .DATA.W    H'0001
          .DATA.W    H'0002
          .DATA.W    H'0003
          .DATA.W    H'0004
          .DATA.W    H'0005
          .DATA.W    H'0010
          .DATA.W    H'0011
          .DATA.W    H'0012
          .DATA.W    H'0013
          .DATA.W    H'0014
          .DATA.W    H'0015
;-------------------------------------------------------------
; MODE CONVERTER REGISTER SAVE AREA                          -
;-------------------------------------------------------------
SV_R1     .RES.L    1
SV_R2     .RES.L    1
SV_R3     .RES.L    1
SV_R4     .RES.L    1
SV_R5     .RES.L    1
SV_R6     .RES.L    1
SV_R7     .RES.L    1
CNV_STR   .SRES     16
CNV_RC    .RES.L    1
;-------------------------------------------------------------
          .END
```

# Appendix E   Limitations on Debugging Object Programs

The following type of programs cannot be loaded as debugging object programs.  An error message will be displayed on attempts to load such programs.

**Condition**

1. Section areas overlap

   Coding example 1:

   ```
   .SECTION SC1,CODE,LOCATE=0
   .RES.W 1000

   .SECTION SC2,CODE
   .DATA    100
   ```

   Since SC2 is a relocatable section, it will be loaded starting at address H'400.  However, this overlaps SC1, causing an error.

   Coding example 2:

   ```
   .SECTION SC3,CODE
   .ORG H'1000
    MOV.L R0,R1
   .ORG H'2000
    MOV.L R0,R2
   .SECTION SC4,CODE,LOCATE=H'1500
   .DATA    100
   .END
   ```

   The section SC3 extends from address H'400 to address H'2401 due to the use of the .ORG control statement.  As a result, section SC4 overlaps that section and generates an error.

   Note that is possible to avoid this overlap by specifying an appropriate start address for the relocatable section to the H-series linkage editor.

2. A section with the same name but with a differing attribute (CODE, DATA, STACK, or COMMON) exists in another unit.

   Coding example:

   ```
   ;UNIT1                       ;UNIT2
    .SECTION SC,CODE             .SECTION SC,DATA
    NOP                          .DATA.W 100
    .END                         .END
   ```

Since the attributes of SC in unit 1 and SC in unit 2 differ, an error occurs.

3. An object module or load module has a section size of 0.

   Coding example:
   ```
   .SECTION SC,CODE
   .END
   ```

   Since SC has a section size of 0, an error occurs.

4. A section is allocated across the boundary between memory areas with differing attributes, or an absolute address section is allocated to an invalid area.

   Coding example:  Assuming an SH 7000 CPU information file.
   ```
   .SECTION SC,CODE,LOCATE=H'EF00000.

   SDATAB H'20000,"0123456789ABCDEF"
   .END
   ```

   Although SC is allocated from addresses H'EF00000 to H'F0FFFFF, an error occurs since the memory type changes at address H'F000000.The following measures can be used to avoid the above errors.

**Process**

1. Review the starting addresses of absolute sections and the section sizes, and modify the program so that overlaps do not occur.

2. Code programs so that sections with the same name have the same attribute.

3. Specify modules that have actual contents.

4. Modify the start addresses of absolute section so that section allocation across memory boundaries does not occur.  Alternatively, modify the memory map specified in the CPU information file so that sections to not cross memory area boundaries.

# Appendix F Messages

The simulator/debugger outputs the following two types of message.

1. Information messages
   These messages inform the user of the simulator/debugger execution process.

2. Error messages
   These messages inform the user that an error has occurred.

## F.1 Information Messages

### F.1.1 Information Messages at Instruction Execution Interruption

Table F-1 lists the messages that are displayed when execution is interrupted during instruction execution initiated by a GO, STEP, STEP_INTO, VECTOR, or CALL command.

**Table F-1 Information Messages at Instruction Execution Interruption**

| Error No. | Message | Description |
|---|---|---|
| 1001 | BREAK ACCESS (<first location> - <last location>) | Execution was interrupted due to the occurrence of a break access condition. |
| 1002 | BREAK DATA (<break location>ΔΔ<data>) | Execution was interrupted due to the occurrence of a break data condition. |
| 1003 | BREAK POINT | Execution was interrupted due to the occurrence of a breakpoint condition. |
| 1004 | BREAK REGISTER (<register>Δ<data>) | Execution was interrupted due to the occurrence of a break register condition. |
| 1005 | BREAK SEQUENCE | Execution was interrupted due to the occurrence of a break sequence condition. |
| 1006 | MANUAL BREAK | Execution was interrupted due to <CTRL> + <C>. |
| 1007 | SLEEP | Execution was interrupted due to the execution of a SLEEP instruction. |
| 1008 | STEP NORMAL END | Execution due to a STEP or STEP_INTO command completed normally. |
| 1009 | TRACE BUFFER FULL | Execution was interrupted at the point the trace buffer became full, since the B option was specified to the TRACE_CONDITION command. |

### F.1.2 Information Messages during Command Analysis

Table F-2 lists the messages displayed by the simulator/debugger during command analysis.

**Table F-2 Information Messages during Command Analysis**

| Error No. | Message | Description |
|---|---|---|
| 2001 | FIXED UNRESOLVED EXTERNAL REFERENCE SYMBOL | An address was allocated for an unresolved external reference symbol. |
| 2002 | NO BREAK ACCESS | There is no break access condition set. |
| 2003 | NO BREAK DATA | There is no break data condition set. |
| 2004 | NO BREAK POINT | There is no breakpoint condition set. |
| 2005 | NO BREAK REGISTER | There is no break register condition set. |
| 2006 | NO BREAK SEQUENCE | There is no break sequence condition set. |
| 2007 | NO FUNCTION CALL | No function was called. |
| 2008 | NO MACRO DEFINITION | No macro was defined. |
| 2009 | NO STUB POINT | No stub point was set. |
| 2010 | NO TRAP ADDRESS | The system call start location trap address was not set. |

## F.2 Error Messages

### F.2.1 Error Messages during Startup or Load Command Execution

Table F-3 lists the error messages displayed by the simulator/debugger during startup and during execution of the LOAD command.

**Table F-3 Error Messages during Startup or Load Command Execution**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 3001 | ADDRESS SPACE DUPLICATED : sect | The section indicated by “sect” overlaps with another section. Correct the program so that sections do not overlap. |
| 3002 | CAN NOT GET MEMORY SPACE | Memory space required by the simulator/ debugger could not be allocated. Increase memory or modify the debugging object program. |
| 3003 | CAN NOT GET TABLE AREA | The table memory area required by the simulator/debugger could not be allocated. Increase the user memory area on the host computer. |
| 3004 | CAN NOT GET TRACE BUFFER | The required trace buffer memory area could not be allocated.<br>Increase the user memory area on the host computer.<br>However, commands other than the trace system commands will operate normally. |
| 3005 | CAN NOT OPEN | A file could not be opened.<br>Specify the correct file name. |
| 3006 | CAN NOT OPEN CPU INFORMATION FILE | The CPU information file could not be opened.<br>Specify the correct directory and file name. |
| 3007 | CAN NOT OPEN OBJECT FILE | The debugging object program file could not be opened.<br>Specify the correct file name. |
| 3008 | CAN NOT READ | A file could not be read.<br>Check the contents of the file. |
| 3009 | COMMAND LINE SYNTAX ERROR | There was an error in the command line. |

**Table F-3 Error Messages during Startup or Load Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 3010 | DEVICE TYPE IS NOT CONSISTENT | The debugging object program file identifying information (the ID that indicates whether the program is for the SH series) does not agree with the file identifying information from the CPU information file (set by the CIA program). Check that the object program is actually an SH-series program. |
| 3011 | ILLEGAL BLOCK TYPE | The debugging object program contains one or more errors. Correct any errors that occurred in creating the debugging object program. |
| 3012 | INTERNAL ERROR (nnn) | An internal error occurred. Contact your Hitachi, Ltd. sales representative. |
| 3013 | INVALID CPU INFORMATION | There was an error in the CPU information file. Check and correct the CPU information file. |
| 3014 | INVALID OBJECT FORMAT | The input file exceeds the range of debugging object programs. Specify the correct file name. |
| 3015 | INVALID RELOCATION EXPRESSION | An invalid relocation expression occurred in the debugging object program. Correct any errors that occurred in creating the debugging object program. |
| 3016 | LOADING FAILED : sect | The section specified by “sect” could not be loaded. Either modify the CPU information file or modify the start address of the section. |
| 3017 | RELOCATION SIZE OVERFLOW : sect | The result of relocating the section indicated by “sect” exceeded the relocation size. Review both the displacement size of the section of the corresponding name in the source program as well as the valid object size. |
| 3018 | SECTION NUMBER = 0 | There were no executable sections in the debugging object program. Add code and data sections to the debugging object program. |
| 3019 | UNDEFINED SYMBOL : symbol | The symbol indicated by “symbol” was not defined in the debugging object program. Correct the program to define the corresponding symbol. |

### F.2.2 Error Messages during Command Execution

Table F-4 lists the error messages displayed during simulator/debugger command execution.

**Table F-4 Error Messages during Command Execution**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4001 | ADDRESS EXCEEDS MEMORY SPACE BOUNDARY | It is not possible to allocate areas that exceed the boundaries of the internal ROM area, the external bus area, the internal RAM area, and internal I/O area.<br>Divide the area into multiple sections and allocate each section within the boundaries of a region. |
| 4002 | BREAK ACCESS ADDRESS CONFLICTS | There is already a condition set for the location specified with the BREAK_ACCESS command.<br>Check the current settings and specify the address correctly. |
| 4003 | BREAK DATA ADDRESS CONFLICTS | There is already a condition set for the location specified with the BREAK_DATA command.<br>Check the current settings and specify the address correctly. |
| 4004 | BREAK POINT CONFLICTS | There is already a condition set for the location specified with the BREAK command.<br>Check the current settings and specify the address correctly. |
| 4005 | BREAK REGISTER CONFLICTS | There is already a condition set for the register specified with the BREAK_REGISTER command.<br>Check the current settings and specify the register correctly. |
| 4006 | BREAK SEQUENCE CONFLICTS | There is already a condition set for the sequence specified with the BREAK_SEQUENCE command.<br>Check the current settings and specify the address correctly. |
| 4007 | CAN NOT ACCESS EXTERNAL MEMORY | An address not allocated for the memory map was specified.<br>Specify a correct address. |
| 4008 | CAN NOT CLOSE | The specified file cannot be closed.<br>If there is inadequate user disk space, increase the available disk space. |
| 4009 | CAN NOT OPEN | The specified file could not be opened.<br>Specify the correct file name. |

**Table F-4 Error Messages during Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4010 | CAN NOT READ | The specified file cannot be read.<br>Specify the correct file name. |
| 4011 | CAN NOT WRITE | The specified file cannot be written.<br>The disk may be full, or there may be a disk hardware error.<br>Re-execute the write after checking the disk status. |
| 4012 | COMMAND NOT FOUND | A non-existent command name was specified.<br>Specify the command correctly. |
| 4013 | COVERAGE ALREADY STARTED | An attempt was made to start coverage measurement when coverage measurement had already been started.<br>Or, an attempt was made to change the coverage area setting.<br>To measure a differing range of locations, terminate the current measurement, reset the range, and restart the measurement. |
| 4014 | COVERAGE NOT STARTED | Coverage has not been started.<br>Check the state of the coverage settings. |
| 4015 | COVERAGE RANGES EXCEED 16 | Up to 16 coverage areas can be specified.<br>To add another area, first remove any unnecessary coverage areas. |
| 4016 | COVERAGE RANGE NOT DEFINED | An attempt was made to start coverage measurement with no coverage areas defined.<br>Specify the coverage areas before starting coverage measurement. |
| 4017 | DIVIDE BY ZERO | A divisor of 0 appeared in an integer expression.<br>Modify the divisor to be a value other than 0. |
| 4018 | DUPLICATE ADDRESS | The specified address was already specified.<br>Check the value of the address used. |
| 4019 | EXPRESSION TOO COMPLEX | An expression was overly complex.<br>Expressions are overly complex when there are 8 or more parentheses. |
| 4020 | FLOATING POINT DATA OVERFLOW | A floating point overflow occurred in the specified precision.<br>Review the precision or the data values. |
| 4021 | FLOATING POINT DATA UNDERFLOW | A floating point underflow occurred in the specified precision.<br>Review the precision or the data values. |

**Table F-4 Error Messages during Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4022 | FUNCTION NOT FOUND | The function specified in a CALL command does not exist. Check the name of the function. |
| 4023 | ILLEGAL EXPRESSION | There was an error in an integer expression. Re-input the command with a correct expression. |
| 4024 | ILLEGAL FLOATING POINT DATA | There was an error in the format of a floating point data item. Review the format of the floating point data item. |
| 4025 | ILLEGAL MACRO NAME | A name which cannot be specified as a macro name was specified. Check the macro name. |
| 4026 | ILLEGAL SYMBOL FORMAT | There was a syntax error in a symbol. Re-input the command with the correct syntax. |
| 4027 | INVALID ADDRESS | The value used was invalid as an address value. Specify a valid value. |
| 4028 | INVALID DATA | The value used was invalid as an address value. Specify a valid value. |
| 4029 | INVALID MNEMONIC | An instruction mnemonic specified to the ASSEMBLE command was incorrect. Input a correct mnemonic. |
| 4030 | INVALID OPERAND | The specified instruction operand was incorrect. Input a correct operand. |
| 4031 | LINE NUMBER NOT FOUND | The specified line number could not be found. Check the line numbers in the source program. |
| 4032 | MACRO BUFFER OVERFLOW | The macro registration buffer overflowed. Delete any unnecessary macros. |
| 4033 | MACRO VARIABLE NOT FOUND | An attempt was made to reference a macro internal variable whose value had not been set. Modify the macro to reference the macro internal variable only after its value has been set. |
| 4034 | MEMORY AREA ALREADY EXISTS | The specified memory area was already allocated. (It is also possible that the address specification was incorrect.) Check the memory area allocations with the MAP command and then specify a correct value. |

**Table F-4 Error Messages during Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4035 | MEMORY AREA NOT EXIST | The specified memory area has not been allocated.<br>Allocate memory areas with the MAP command as necessary, and then specify memory areas that have already been allocated. |
| 4036 | NESTING OF COMMAND_CHAIN EXCEEDS 8 | The command chain nesting exceeded 8 levels.<br>Revise usage of the COMMAND_CHAIN command so that the nesting level does not exceed 8 levels. |
| 4037 | NOT A COVERAGE FILE | The specified file was not a coverage file.<br>Check the file. |
| 4038 | NO SCOPE SET | A function name could not be found due to an unusual value in the PC.<br>After checking the value of the PC, modify the program to operate normally. |
| 4039 | NOT A SAVE_STATUS FILE | The specified file was not a SAVE_STATUS file.<br>Alternatively, insufficient information.<br>Check the file. |
| 4040 | SAVE_STATUS OPTION CONFLICT | The file cannot be loaded since the options used when saving the file were different.<br>Check the file. |
| 4041 | STUB BUFFER OVERFLOW | The STUB command registration buffer overflowed.<br>Delete any unnecessary stubs. |
| 4042 | STUB POINTS EXCEED 16 | Up to 16 stub points can be specified.<br>Delete any unnecessary stubs and retry the command. |
| 4043 | SYMBOL NOT FOUND | The specified symbol was not registered.<br>Specify the correct symbol name. |
| 4044 | SYNTAX ERROR | The command parameters were incorrect.<br>Specify the parameters correctly. |
| 4045 | SYSTEM ERROR (<error number>) | An OS error occurred during execution of a “!” command. The specified OS command was not executed. Review the system environment. |
| 4046 | TOO MANY ARGUMENTS | Too many arguments were specified in a function call.<br>Check the function’s specifications. |

**Table F-4 Error Messages during Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4047 | TOO MANY BREAK ACCESS | The number of break access conditions exceeded the number supported. Up to 2 break access conditions can be set. |
| 4048 | TOO MANY BREAK DATA | The number of break data conditions exceeded the number supported. Up to 8 break data conditions can be set. |
| 4049 | TOO MANY BREAK POINTS | The number of breakpoints exceeded the number supported. Up to 8 breakpoints can be set. |
| 4050 | TOO MANY BREAK REGISTERS | The number of break register conditions exceeded the number supported. Up to 8 break register conditions can be set. |
| 4051 | TOO MANY MACRO DEFINITION | The number of macro definitions exceeded the number supported. Up to 64 macros can be defined. Delete any unnecessary macros and re-input the macro definition that generated the error. |
| 4052 | TOO MANY MACRO VARIABLE | The number of macro variables exceeded the number supported. Up to 255 macros variables can be used. |
| 4053 | TOO MANY SECTIONS | The number of memory areas allocated with the MAP command exceeded the number supported. Up to 10 areas can be allocated. |
| 4054 | TOO MANY UNDEFINED SYMBOL | There are too many undefined symbols. Addresses can not be allocated for any other undefined symbols. |
| 4055 | TRACE COMMAND NOT AVAILABLE | The trace command cannot be used since a trace buffer was not allocated. Expand the user environment so that a trace buffer can be allocated. |
| 4056 | TRAP ADDRESS CONFLICTS | Only 1 system call start address can be specified. Check the specified address by using the TRAP_ADDRESS command. |

**Table F-4 Error Messages during Command Execution (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 4057 | MEMORY SPACE INSUFFICIENCY | The size of the memory area is too small to display all the functions called. Check the size of memory available for the simulator/debugger size. |
| 4058 | CAN NOT REFER TO THE SYMBOL | The specified symbols could not be referred due to C compiler optimization. Specify the address or data for the symbols. |
| 4059 | ILLEGAL ADDRESS RANGE SPECIFIED | The specified memory area size is too large. Divide the memory areas and specify each. |

### F.2.3 Error Messages during Simulation

Table F-5 lists the error messages displayed during simulator/debugger simulation of a debugging object program.

**Table F-5 Error Messages during Simulation**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 5001 | GENERAL INVALID INSTRUCTION | One of the following conditions caused a general invalid instruction error.<br>1. The program attempted to execute a code that is not an instruction.<br>2. An error occurred during exception processing of general invalid instructions.<br>Correct the debugging object program so that the error does not occur. |
| 5002 | INVALID SLOT INSTRUCTION | One of the following conditions caused an invalid slot instruction error.<br>1. The branch instruction to change PC immediately after the branch instruction was executed.<br>2. An error occurred during exception processing of the invalid slot instruction.<br>Correct the debugging object program so that the error does not occur. |
| 5003 | ADDRESS ERROR | One of the following conditions caused an address error.<br>1. The value of the PC became an odd number.<br>2. The program attempted to read an instruction from internal I/O space.<br>3. An attempt was made to access a long word data at an address other than 4n.<br>4. An attempt was made to access a word data at an address other than 2n.<br>5. VBR and SP are not in multiples of four. An error occurred during exception processing of the address error.<br>6. Correct the debugging object program so that the error does not occur. |

**Table F-5 Error Messages during Simulation (cont)**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 5004 | EXCEPTION ERROR | An error occurred during exception processing.<br>Correct the debugging object program so that the error does not occur. |
| 5005 | ILLEGAL OPERATION | Division by zero was caused by a DIV1 instruction.<br>Correct the debugging object program so that the error does not occur. |
| 5006 | MEMORY ACCESS ERROR | One of the following conditions caused a memory access error.<br>1. The program attempted to access a memory area that was not allocated.<br>2. The program attempted to write to a memory area that has the write-protect attribute.<br>3. The program attempted to read from a memory area that has the read-protect attribute.<br>4. An attempt was made to access an area with no memory.<br>Either modify the memory allocation and attributes, or correct the debugging object program so that the corresponding memory access error does not occur. |
| 5007 | INVALID SP INSTRUCTION | The program executed the instruction to make R15 (SP) to point to an address other than 4-byte boundary.<br>Correct the debugging object program so that the error does not occur |
| 5008 | SYSTEM CALL ERROR | A system call error occurred.<br>Correct the error(s) in the contents of the parameter block and/or registers R0 and R1. |

## F.3 CIA Error Messages

### F.3.1 I/O Related Error Messages

Table F-6 shows the CIA error messages related to I/O.

**Table F-6 I/O Related Error Messages**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 6001 | CAN NOT GET MEMORY SPACE | The memory for CIA use could not be allocated. Check the OS environment and assure that there is adequate memory allocated for CIA use. |
| 6002 | CAN NOT OPEN INPUT CPU INFORMATION FILE | The specified existent CPU information file could not be opened. (See note.) |
| 6003 | CAN NOT OPEN OUTPUT CPU INFORMATION FILE | The specified output CPU information file could not be opened. (See note.) |
| 6004 | CAN NOT READ | A file could not be read. (See note.) |
| 6005 | CAN NOT WRITE | Write to a file failed. (See note.) |
| 6006 | CAN NOT CLOSE | The output CPU information file could not be closed. (See note.) |
| 6007 | INVALID CPU INFORMATION | Errors were encountered in the CPU information file.<br>Check the contents of the file and correct the errors. |
| 6008 | SYNTAX ERROR | There was an error in the file specification syntax.<br>Enter the file name correctly. |

Note: In these cases, if the file name was correct, the disk may be full, or there may be a disk hardware error. After checking the disk status, re-execute the CIA program.

### F.3.2 Keyboard Input Related Error Messages

Table F-7 lists the error messages related to keyboard input.

**Table F-7 Keyboard Input Related Error Messages**

| Error No. | Message | Error Description and Recovery Procedure |
|---|---|---|
| 7001 | COMMENT LINE TOO LONG | The specified comment line exceeded 127 characters.<br>The comment line must be 127 chracters or less. |
| 7002 | ADDRESS RE-USE | Address ranges overlap.<br>Check the addresses and re-enter correctly. |
| 7003 | ADDRESS SIZE OVERFLOW | An address value exceeding the bit size was specified.<br>Enter a correct address value. |
| 7004 | INVALID VALUE | A numeric value outside the allowed range was specified.<br>Correct the input to specify a value within the allowed range. |
| 7005 | INVALID CHARACTER | A character that cannot be used was input.<br>Input a character that corresponds to one of the selection choices. |
| 7006 | INVALID END ADDRESS | An end address smaller than the start address was specified.<br>Re-enter the end address with the correct value. |

# Appendix G   ASCII Code Table

**Table G-1   ASCII Code Table**

| | **Upper 4 Bits** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Lower 4 Bits** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 0 | NUL | DLE | SP | 0 | @ | P | ` | p |
| 1 | SOH | DC1 | ! | 1 | A | Q | a | q |
| 2 | STX | DC2 | “ | 2 | B | R | b | r |
| 3 | ETX | DC3 | # | 3 | C | S | c | s |
| 4 | EOT | DC4 | $ | 4 | D | T | d | t |
| 5 | ENQ | NAK | % | 5 | E | U | e | u |
| 6 | ACK | SYN | & | 6 | F | V | f | v |
| 7 | BEL | ETB | ' | 7 | G | W | g | w |
| 8 | BS | CAN | ( | 8 | H | X | h | x |
| 9 | HT | EM | ) | 9 | I | Y | i | y |
| A | LF | SUB | * | : | J | Z | j | z |
| B | VT | ESC | + | ; | K | [ | k | { |
| C | FF | FS | , | < | L | \ | l | \| |
| D | CR | GS | – | = | M | ] | m | } |
| E | SO | RS | . | > | N | ^ | n | ~ |
| F | SI | US | / | ? | O | _ | o | DEL |

# Appendix H Installation

The following instructions describe how to install the SH-series simulator/debugger in the host system.

## H.1 Contents of the Cartridge Tape

The simulator/debugger is provided with a cartridge tape, which contains the following files.

- file type: archive file
- file name
  - — Simulator/debugger: sdsh
  - — CPU information analysis program: cia

## H.2 How to Install the Simulator/Debbuger in the Host System

To install the simulator/debugger in the host system, follow the instructions below. Underlined sections should be input by the user.

- Making a directory

  To make a directory for storing simulator/debugger files, enter the command below. The path name is /usr/tool in this example.

  ```
  % mkdirΔ/usr/tool (RET)        (RET): Press the return key
                                 Δ: Press the space bar or tab key
  ```

- Changing the directory

  To change the current directory to the directory /usr/tool made above, enter the command below.

  ```
  % cdΔ/usr/tool (RET)
  ```

- Copying files

  To copy the simulator/debugger files from the cartridge tape to the directory made in the above step, enter the command below. In this example, /dev/rst0 is the name of the cartridge tape drive.

  ```
  % tarΔ-xvfΔ/dev/rst0ΔsdshΔcia (RET)
  ```

- Setting the start-up environment

  To set the start-up environment for the simulator/debugger, follow the instructions below.

  — Add the following  command to the file ".login" in the home directory.

  ```
  % setΔpath=(/usr/tool)  (RET)
  ```

  If  a path has already been specified, add the path name "/usr/tool" separated by a space to the path list in parentheses.

  — When the Born-shell or Corn-shell is used:

  Add the following command to the file ".profile" in the home directory.

  ```
  % PATH =/usr/tool (RET)
   % exportΔPATH   (RET)
  ```

  If a path has already been  specified, add a colon ( : ) and the path name "/usr/tool" after the path list.

## H.3 Equipment

The following equipment is required when using the simulator/debugger.

- Host computer: SPARC Station
- OS: SunOS (release 4.0.3 or later version)
- User memory space: 4 Mbytes or over
- Hard disk drive
- Cartridge tape drive

## H.4 Special Keys

Two special keys are used by the simulator/debugger: (CTRL) + (C) and (CTRL) + (\).  (CTRL) + (C) or (CTRL) + (\) indicates pressing C or \ while the control key is being pressed.  To use the simulator/debugger, first make the following settings with the SunOS stty command.

```
stty    intr    (CTRL) + (C)
stty    quit    (CTRL) + (\)
```

- (CTRL) + (C)

  When the special key (CTRL) + (C) is entered, command execution stops immediately and the simulator/debugger returns to the command wait state.

(Ex. 1) During execution of the user program by a CALL, STEP, STEP_INTO, or VECTOR command, (CTRL) + (C) stops the program execution are returns the simulator/debugger to the command wait state.

(Ex. 2) While the contents of memory or the trace buffer are being displayed by a DUMP or TRACE command, (CTRL) + (C) stops the command execution and returns the simulator/debugger to the command wait state.

(Ex. 3) During execution of a command file by a COMMAND_CHAIN command, (CTRL) + (C) stops the command execution and returns the simulator/debugger to the command wait state.

Note: During interactive command input, (CTRL) + (C) does not return the simulator/debugger to the command wait state. To exit the interactive command input state, enter ".".

- (CTRL) + (\)

The special key (CTRL) + (\) terminates the simulator/debugger and returns it to the SunOS command wait state.

Note: When (CTRL) + (\) is entered, SunOS creates the core file "core" on the current directory.