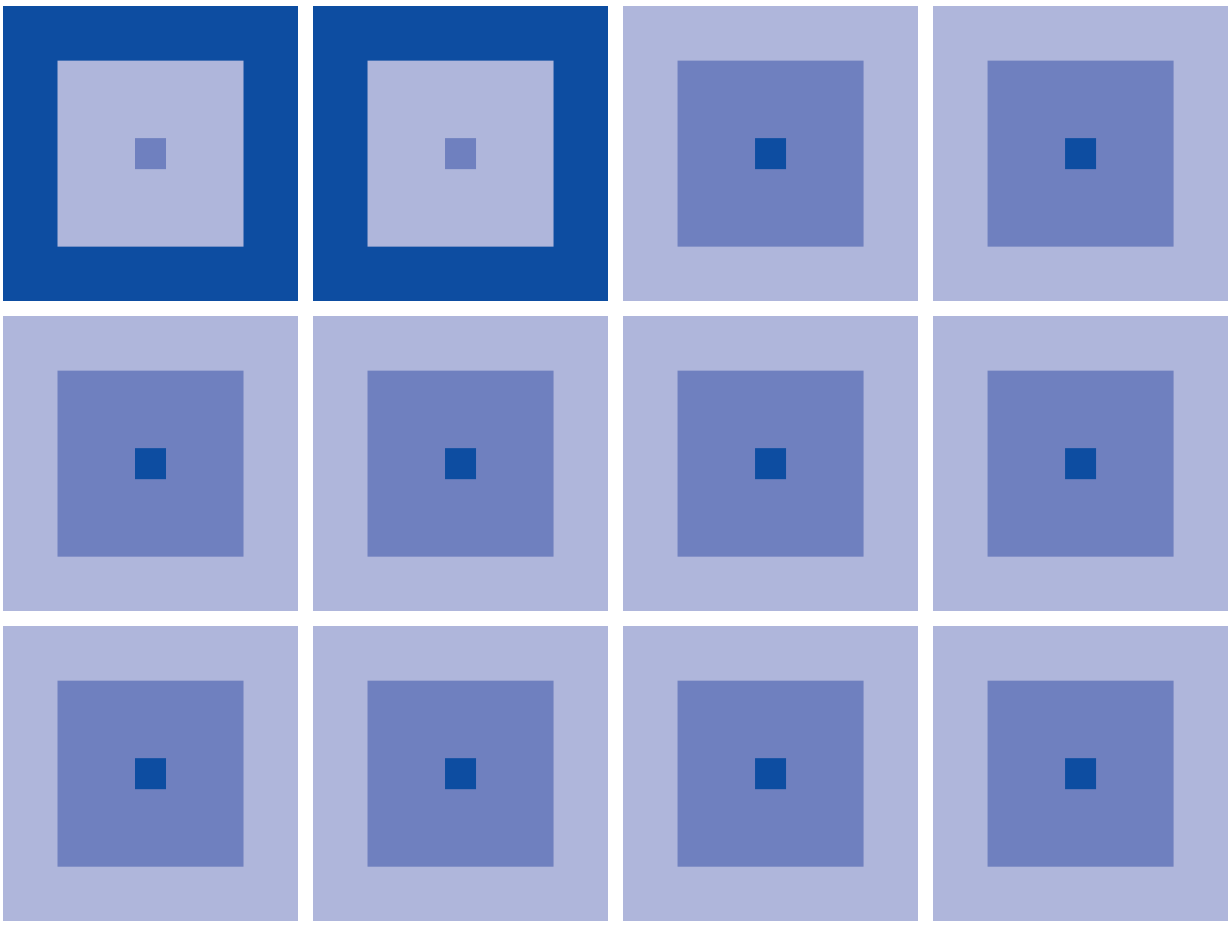
MF1121-03a

EPSON

CMOS 4-BIT SINGLE CHIP MICROCOMPUTER

S5U1C62000A Manual

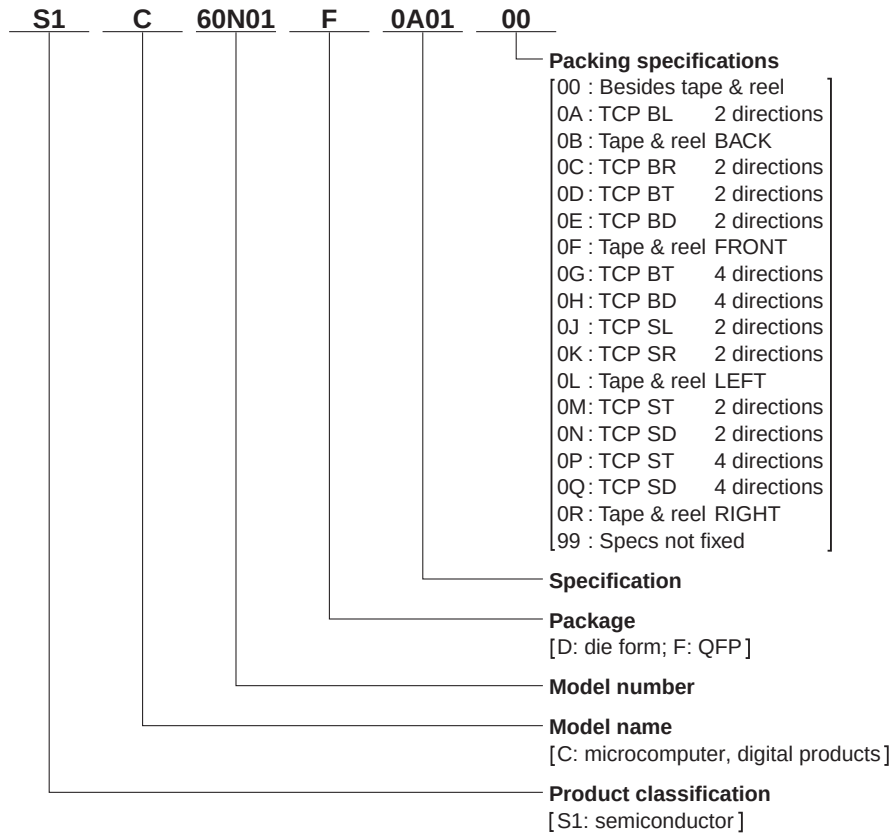
(S1C60/62 Family Assembler Package)



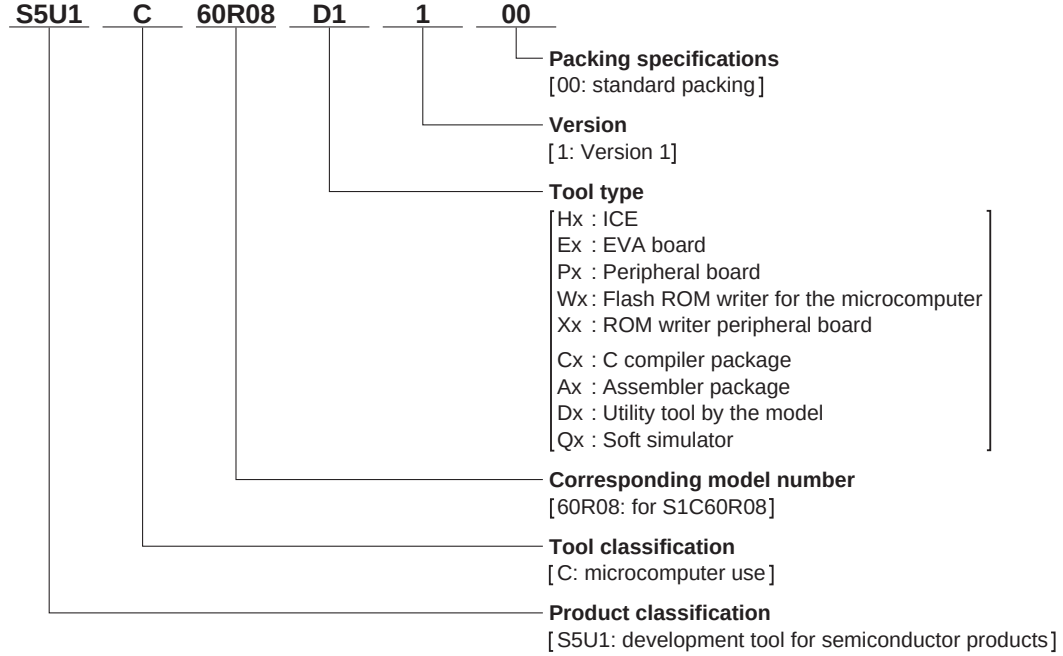
SEIKO EPSON CORPORATION

Configuration of product number

Devices



Development tools



Introduction

This document describes the development procedure from assembling source files to debugging. It also explains how to use each development tool of the S1C62 Family Assembler Package common to all the models of the S1C62 Family.

How To Read the Manual

This manual was edited particularly for those who are engaged in program development. Therefore, it assumes that the reader already possesses the following fundamental knowledge:

- Basic knowledge about assembler language
- Basic knowledge about the general concept of program development by an assembler
- Basic operating methods for Windows®95 or Windows NT®4.0

Before installation

See Chapter 1. Chapter 1 describes the composition of this package, and provides a general outline of each tool.

Installation

Install the tools following the installation procedure described in Chapter 2.

To understand the flow of program development

See the program development flow in Chapter 3.

For coding

See the necessary parts in Chapter 5. Chapter 5 describes the grammar for the assembler language as well as the assembler functions. Also refer to the following manuals when coding:

S1C62xxx Technical Manual

Covers device specifications, and the operation and control method of the peripheral circuits.

S1C6200/6200A Core CPU Manual

Has the instructions and details the functions and operation of the Core CPU.

For debugging

Chapter 9 gives detailed explanation of the debugger. Sections 9.1 to 9.8 give an overview of the functions of the debugger. See Section 9.9 for details of the debug commands. Also refer to the following manuals to understand operations of the In-Circuit Emulator ICE (S5U1C62000H) and the Evaluation Board (S5U1C62xxxE):

S5U1C62000H Manual

Explains the functions and handling methods of the In-Circuit Emulator ICE.

S5U1C62xxxE Manual

Covers the functions and handling methods of the evaluation board designed to evaluate the hardware specifications of each model.

For details of each tool

Chapters 4 to 9 explain the details of each tool. Refer to it if necessary.

Once familiar with this package

Refer to the listings of instructions and commands contained in Quick Reference.

Manual Notations

This manual was prepared by following the notation rules detailed below:

(1) Sample screens

The sample screens provided in the manual are all examples of displays under Windows®95. These displays may vary according to the system or fonts used.

(2) Names of each part

The names or designations of the windows, menus and menu commands, buttons, dialog boxes, and keys are annotated in brackets [ ]. Examples: [Command] window, [File | Exit] menu item ([Exit] command in [File] menu), [Key Break] button, [q] key, etc.

(3) Names of instructions and commands

The CPU instructions and the debugger commands that can be written in either uppercase or lowercase characters are annotated in lowercase characters in this manual, except for user-specified symbols.

(4) Notation of numeric values

Numeric values are described as follows:

Decimal numbers: Not accompanied by any prefix or suffix (e. g., 123, 1000).
Hexadecimal numbers: Accompanied by the prefix "0x" (e. g., 0x0110, 0xffff).
Binary numbers: Accompanied by the prefix "0b" (e. g., 0b0001, 0b10).

However, please note that some sample displays may indicate hexadecimal or binary numbers not accompanied by any symbol. Moreover, a hexadecimal number may be expressed as xxxxh, or a binary number as xxxxb, for reasons of convenience of explanation.

(5) Mouse operations

To click: The operation of pressing the left mouse button once, with the cursor (pointer) placed in the intended location, is expressed as "to click". The clicking operation of the right mouse button is expressed as "to right-click".

To double-click: Operations of pressing the left mouse button twice in a row, with the cursor (pointer) placed in the intended location, are all expressed as "to double-click".

To drag: The operation of clicking on a file (icon) with the left mouse button and holding it down while moving the icon to another location on the screen is expressed as "to drag".

To select: The operation of selecting a menu command by clicking is expressed as "to select".

(6) Key operations

The operation of pressing a specific key is expressed as "to enter a key" or "to press a key".
A combination of keys using "+", such as [Ctrl]+[C] keys, denotes the operation of pressing the [C] key while the [Ctrl] key is held down. Sample entries through the keyboard are not indicated in [ ].
Moreover, the operation of pressing the [Enter] key in sample entries is represented by "↵".
In this manual, all the operations that can be executed with the mouse are described only as mouse operations. For operating procedures executed through the keyboard, refer to the Windows manual or help screens.

(7) General forms of commands, startup options, and messages

Items given in [ ] are those to be selected by the user, and they will work without any key entry involved.
An annotation enclosed in < > indicates that a specific name should be placed here. For example, <file name> needs to be replaced with an actual file name.
Items enclosed in { } and separated with | indicate that you should choose an item. For example, {A | B} needs to have either A or B selected.

Contents

CHAPTER 1 GENERAL

1.1 Features

The S1C62 Family Assembler Package contains software development tools that are common to all the models of the S1C62 Family. The package comes as an efficient working environment for development tasks, ranging from source program assembly to debugging.
Its principal features are as follows:

Simple composition

A task from assembly to debugging can be made with minimal tools.

Integrated working environment

A Windows-based integrated environment allows the tool chain to be used on its Windows GUI interface.

Modular programming

The relocatable assembler lets you develop a program which is made up of multiple sources. This makes it possible to keep a common part independently and to use it as a part or a basis for the next program.

Source debugging

A debugger can display an assembler source to show its execution status and allow debugging operations on it. This makes debugging much easier to perform.

Common to all S1C62 chips

The tools (workbench, assembler, linker, hex converter, disassembler, and debugger) are common to all S1C62 Family models except for several chip dependent masking tools ("Dev" tools). The chip dependent information is read from the ICE parameter file for each chip.

Complete compatibility with old syntax sources

By supporting old syntax together with the new syntax, an existing ".dat" sources written for old 62 tools are available with these new tools.

1.2 Tool Composition

1.2.1 Composition of Package

The S1C62 Family Assembler Package contains the items listed below. When it is unpacked, make sure that all items are supplied.

1) CD-ROM ..... One
2) Warranty card ..... One each in English and Japanese

1.2.2 Outline of Software Tools

The following shows the outlines of the software tools included in the package:

Assembler (as62.exe)

Converts the mnemonic of the source files into object codes (machine language) of the S1C62. The results are output in a relocatable object file. This assembler includes preprocessing functions such as macro definition / call, conditional assembly, and file-include functions.

Linker (lk62.exe)

Links the relocatable objects created by the assembler by fixing the memory locations, and creates executable absolute object codes. The linker also provides an auto PSET insertion / correction function allowing the programmer to create sources without having to know branch destination page numbers.

Hex converter (hx62.exe)

Converts an absolute object in IEEE-695 format output from the linker into ROM-image data in Intel-HEX format or Motorola-S format. This conversion is needed when making the ROM or when creating mask data using the development tools provided with each model.

Disassembler (ds62.exe)

Disassembles an absolute object file in IEEE-695 format or a hex file in Intel-HEX format, and restores it to a source format file. The restored source file can be processed in the assembler / linker / hex converter to obtain the same object or hex file.

Debugger (db62.exe)

This software performs debugging by controlling the ICE hardware tool. Commands that are used frequently, such as break and step, are registered on the tool bar, minimizing the necessary keyboard operations. Moreover, sources, registers, and command execution results can be displayed in multiple windows, with resultant increased efficiency in the debugging tasks. The debugger has both Windows and DOS user interfaces available.

Work Bench (wb62.exe)

This software provides an integrated development environment with Windows GUI. Creating / editing source files, selecting files and major start-up options, and the start-up of each tool can be made with simple Windows operations.

CHAPTER 2 INSTALLATION

This chapter describes the required working environments for the tools supplied in the S1C62 Family Assembler Package and their installation methods.

2.1 Working Environment

To use the S1C62 Family Assembler Package, the following conditions are necessary:

Personal computer

An IBM PC / AT or a compatible machine which is equipped with a CPU equal to or better than a Pentium 75 MHz, and 32MB or more of memory is recommended.
To use the optional In-Circuit Emulator ICE, the personal computer also requires a serial port (with a D-sub 9 pin).

Display

A display unit capable of displaying 800 × 600 dots or more is necessary.

Hard disk and CD-ROM drive

Since the installation is done from a CD-ROM to a hard disk, a CD-ROM drive and a hard disk drive are required.

Mouse

A mouse is necessary to operate the tools.

System software

The S1C62 Family Assembler Package supports Microsoft® Windows®95 (English or Japanese) and Windows NT®4.0 (English or Japanese).

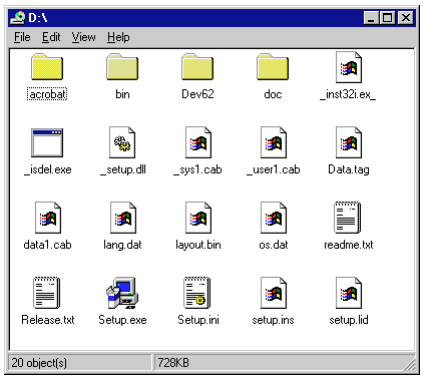
Other development tools

To debug the target program, the optional In-Circuit Emulator ICE (S5U1C62000H) and an Evaluation Board (S5U1C62xxxE) are needed as the hardware tools.
The evaluation board is prepared for each S1C62 model.

2.2 Installation Method

The supplied CD-ROM contains the installer (Setup.exe) that installs the tools.

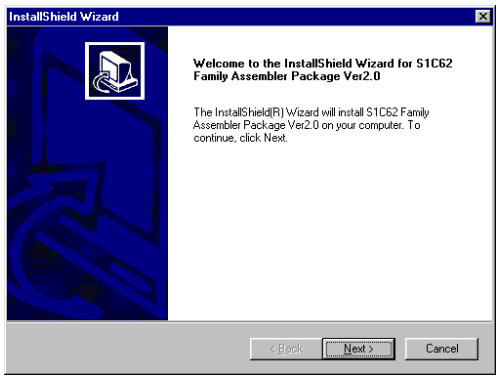
To install the tools



(1) Start up Windows®95 or Windows NT®4.0.
When Windows has already activated, terminate all the programs activated.

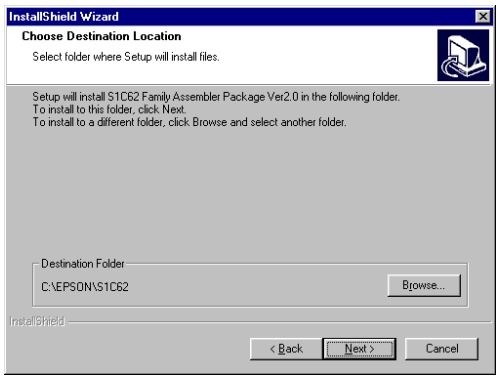
(2) Insert the CD-ROM into the CD-ROM drive, and display its contents.

(3) Start up the Setup.exe by double-clicking the icon.



Welcome

(4) Click [Next>] to continue installation.



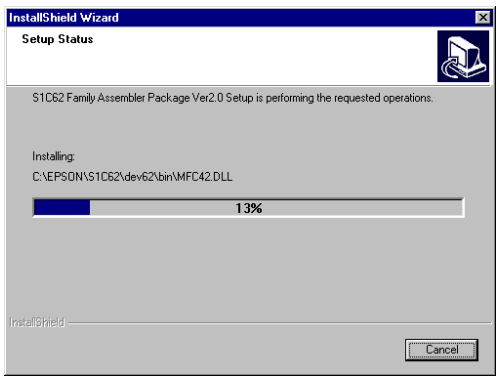
Choose Destination Location

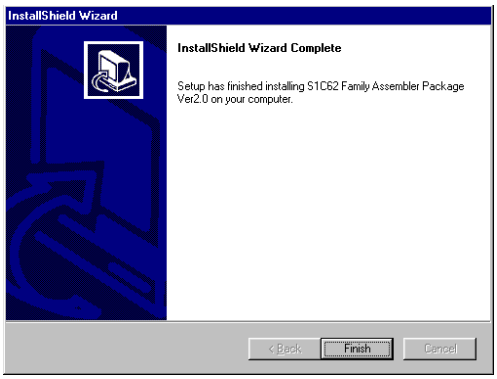
A dialog box appears for specifying the installation directory.

(5) Click [Next>] if the default directory "C:\EPSON\S1C62" is not changed to another directory.

To install the tools to another directory
Open the [Choose Folder] dialog box by clicking [Browse...] and then enter the path name or choose directory. Close the dialog box by clicking [OK] and then click [Next>].

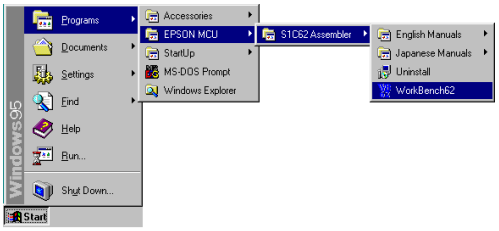
The installation starts after this selection.





InstallShield Wizard Complete

(6) Click [Finish] to terminate the installer.



Program Menu

Installer registers the WorkBench62 icon to the program menu.

To discontinue installation

The dialog boxes that appear during installation have a [Cancel] button. To discontinue installation, click [Cancel] when a dialog box appears.

To uninstall the tools

Use [Add/Remove Programs] in the control panel to uninstall the tools.

2.3 Directories and Files after Installation

The installer copies the following files in the specified directory (default is "C:\EPSON\S1C62"):

```
[Specified folder]
    README.TXT                  ... ReadMe document

    [bin]
        WB62.EXE                ... Work bench
        AS62.EXE                ... Assembler
        LK62.EXE                ... Linker
        HX62.EXE                ... Hex converter
        DS62.EXE                ... Disassembler
        DB62.EXE                ... Debugger
        IEEE695.DLL             ... Object format library for debugger
        HEXLIB.DLL              ... Hex file library for debugger
        AS62.DLL                ... Inline assembler for debugger
        CORE62.DLL              ... CPU library for debugger
        ICE62.DLL               ... ICE library for debugger
        MSVCRT.DLL              ... Run time library for work bench
        OLEPRO32.DLL            ... OLE library for work bench
        SPAWNEX.EXE             ... Child task library for work bench

    [doc]
        [English]               ... Manual folder (English)
            MANUAL_E.PDF        ... S5U1C62000A Manual
            DEV_MANUAL_E.PDF    ... S1C60/62 Family Development Tool Manual
        [Japanese]              ... Manual folder (Japanese)
            MANUAL_J.PDF        ... S5U1C62000A Manual
            DEV_MANUAL_J.PDF    ... S1C60/62 Family Development Tool Manual

    [dev62]
        [bin]
            WINFOG.EXE          ... Function option generator
            WINSOG.EXE          ... Segment option generator
            WINMDC.EXE          ... Mask data checker
            WINMLA.EXE          ... Melody assembler
        [62XXX]                 ... Model-dependent files for development tools
            :
        [dos]                   ... Model-dependent files for development tools (DOS version)
            :
```

Note: Work bench assumes the above directory structure. Do not rename these folders or file names and do not change the tree structure.

Online manual in PDF format

The online manuals are provided in PDF format, so Adobe Acrobat Reader Ver. 4.0 or later is needed to read it.

CHAPTER 3 SOFTWARE DEVELOPMENT PROCEDURE

This chapter outlines a basic development procedure.

3.1 Software Development Flow

Figure 3.1.1 represents a flow of software development work.

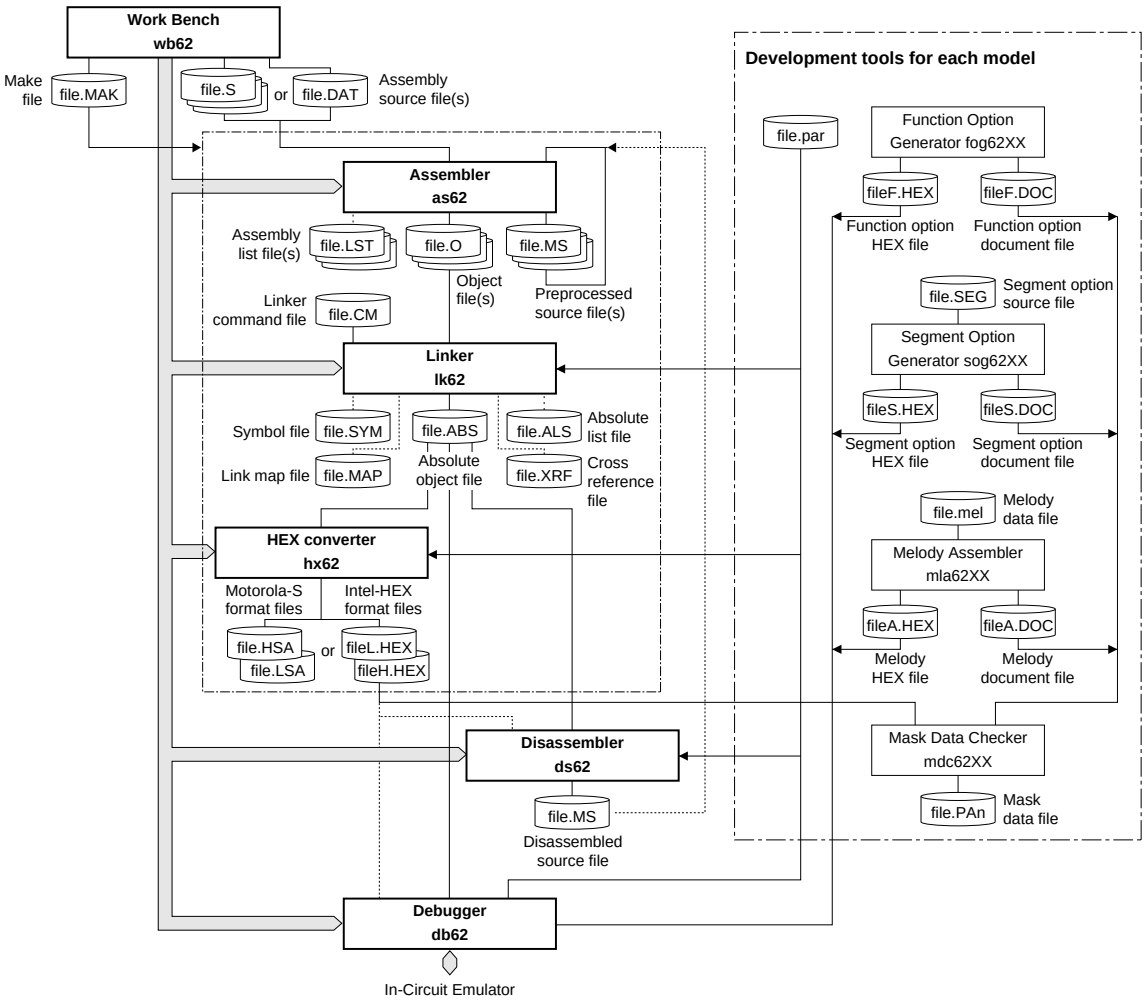


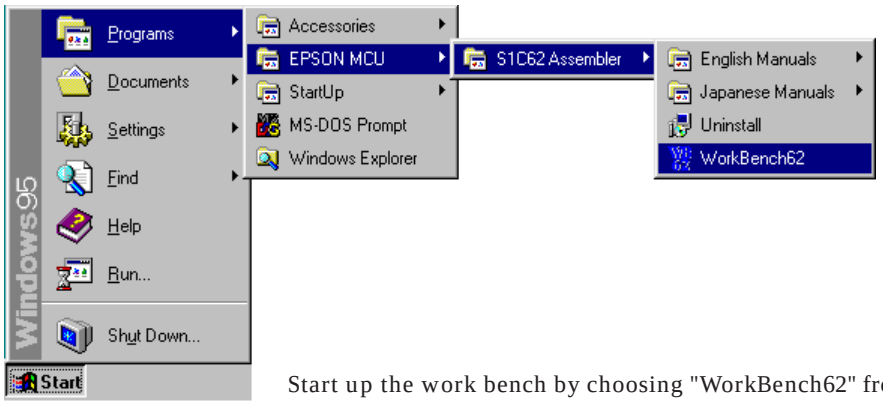
Fig. 3.1.1 Software development flow

The work bench provides an integrated development environment from source editing to debugging. Tools such as the assembler and linker can be invoked from the work bench. The tools can also be invoked individually from the DOS prompt.
Refer to the respective chapter for details of each tool.
The part indicated as "Development tools for each model" is not covered in this manual. For details, refer to the tool manual associated with each specific model.

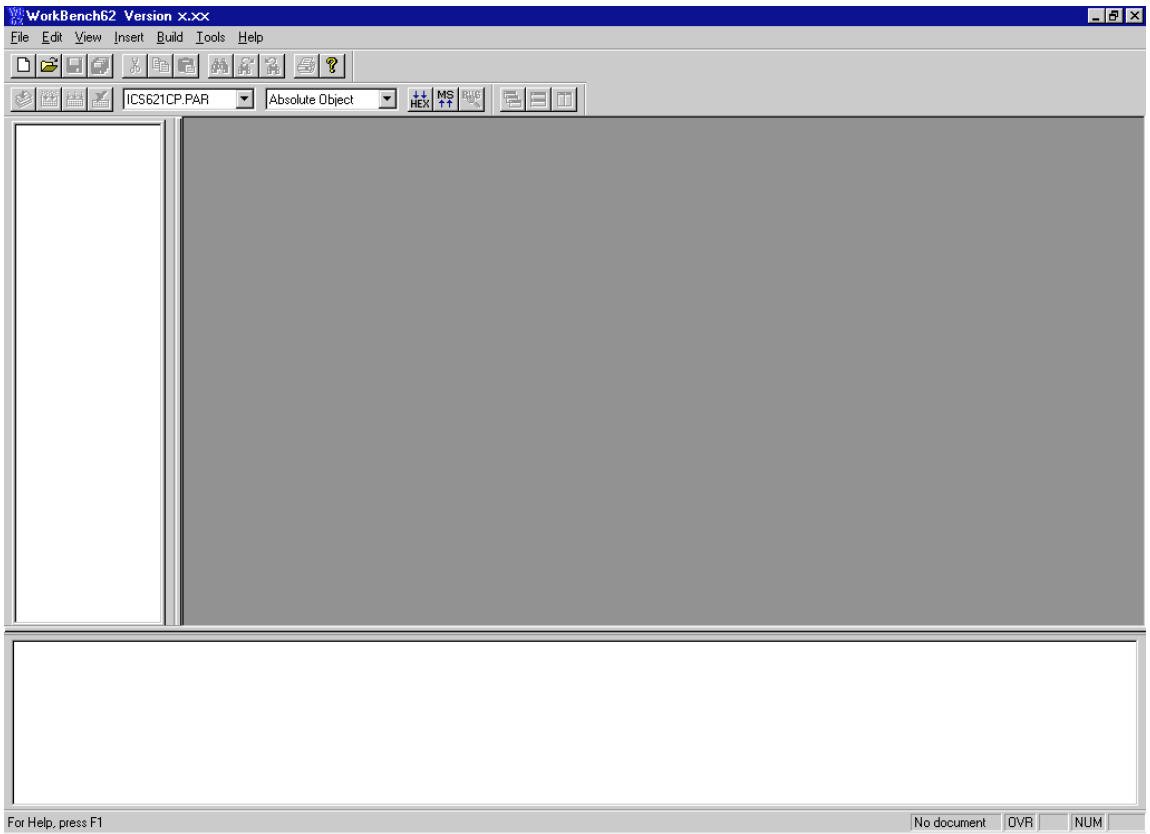
3.2 Development Using Work Bench

This section shows a basic development procedure using the work bench wb62.
Refer to Chapter 4, "Work Bench", for operation details.

3.2.1 Starting Up the Work Bench



Start up the work bench by choosing "WorkBench62" from the program menu.



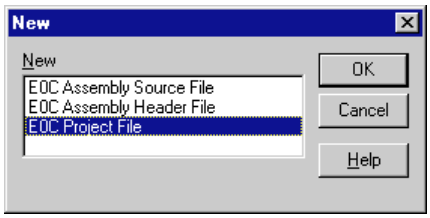
3.2.2 Creating a New Project

The work bench manages necessary file and tool setting information as a project.
First a new project file should be created.

1. Select [New] from the [File] menu (or click the [New] button).

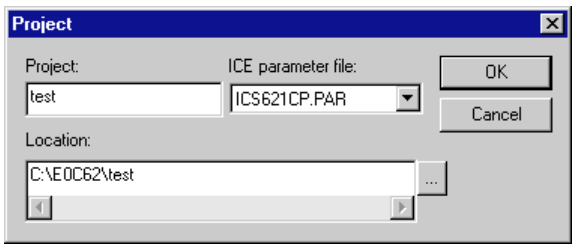
    *[New] button*

   The [New] dialog box appears.



2. Select [E0C Project File] and click [OK].

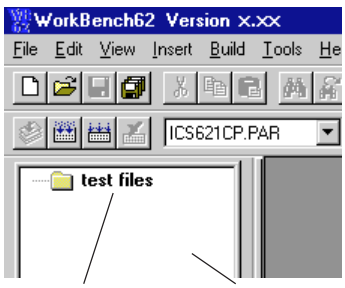
   The [Project] dialog box appears.



3. Enter a project name, select an ICE parameter file and select a directory, then click [OK].

   * The [ICE parameter file:] box lists the parameter files that exist in the "dev62" directory.

The work bench creates a folder (directory) with the specified project name as a work space, and puts the project file (.epj) into the folder.
The specified project name will also be used for the absolute object and other files.



Created project *[Project] window*

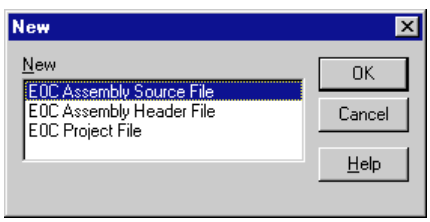
3.2.3 Editing Source Files

The work bench has an editor function. This makes it possible to edit source files without another editor.
To create a new source file:

1. Select [New] from the [File] menu (or click the [New] button).

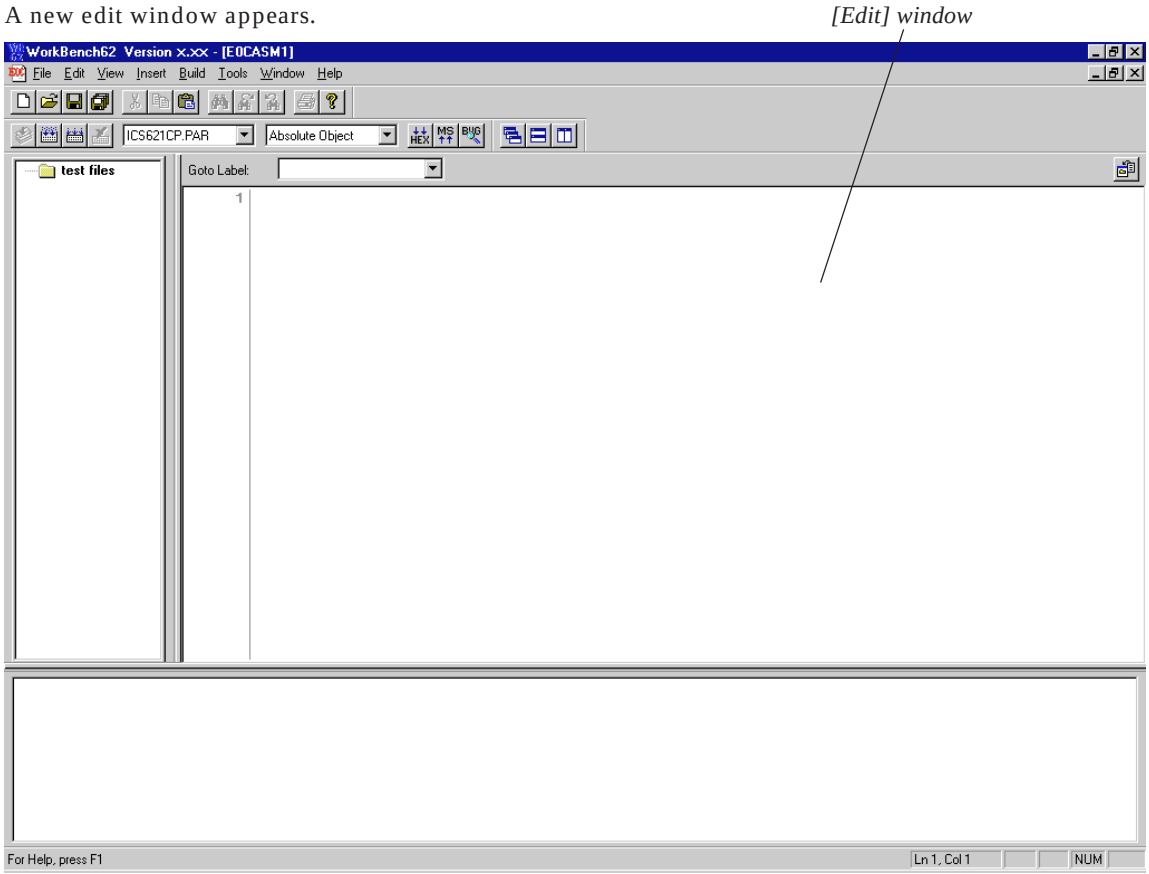
    *[New] button*

   The [New] dialog box appears.

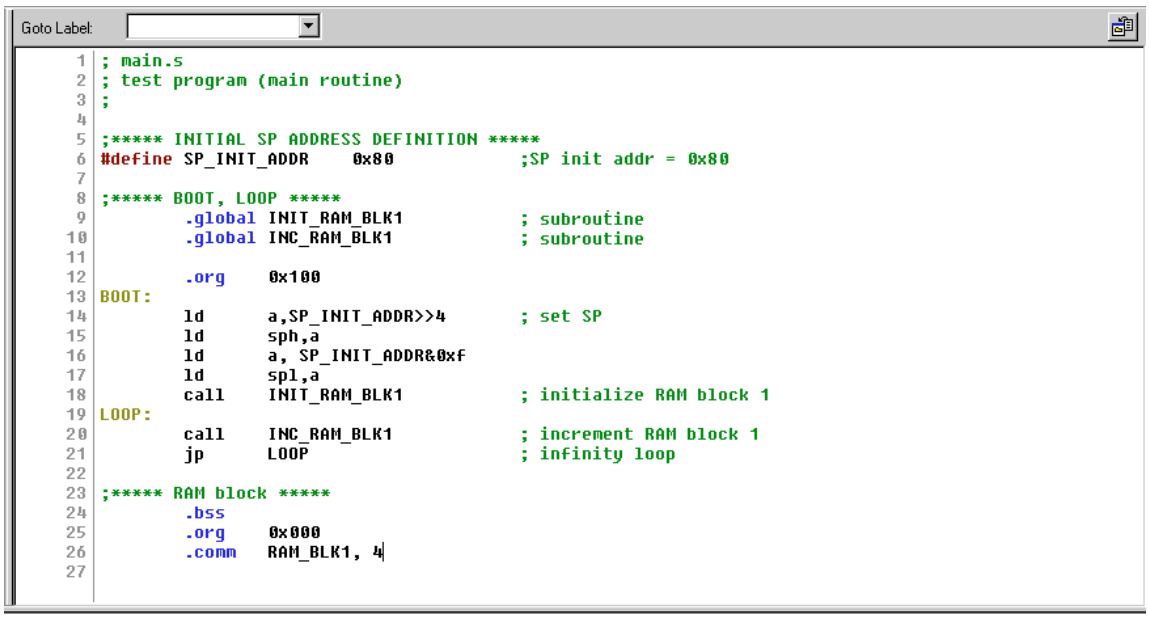


2. Select [E0C Assembly Source File] and click [OK].

A new edit window appears.



3. Enter source codes in the [Edit] window.



4. Save the source in a file by selecting [Save] from the [File] menu (or clicking the [Save] button).

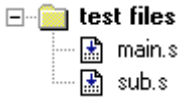
 *[Save] button*

5. Click the [Insert into project] button on the [Edit] window.


[Insert into project] button

The created source file is added in the project.

To add existing source files, use [Files into project...] in the [Insert] menu. It can also be done by dragging source files from Windows Explorer to the project window.
Create necessary source files and add them into the project.



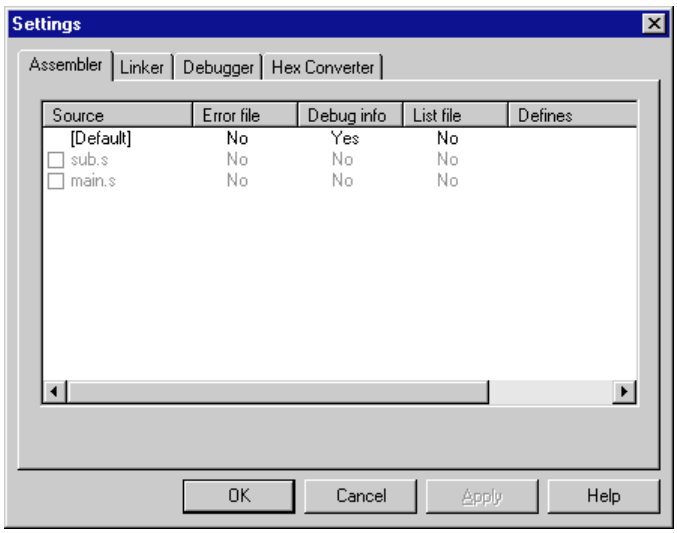
Sample list in the [Project] window

The added source files are listed in the project window. Double-clicking a listed source file name opens the edit window.

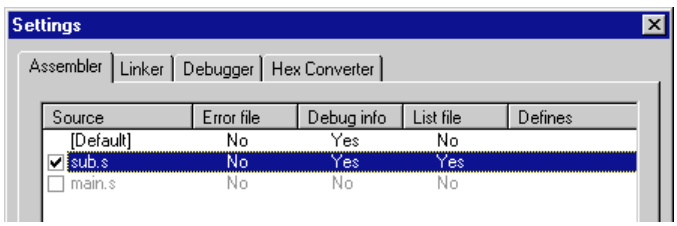
3.2.4 Configuration of Tool Options

The work bench supports all the start up options of each tool and they can be selected in a dialog box. A make process for generating an executable object will be configured based on the settings.
In addition to option selection, command files for the linker and debugger can be configured here.
To set tool options:

1. Select [Setting...] from the [Build] menu.
   A dialog box appears.



2. Configure options if necessary.
   Check box items can be selected by clicking. Items in the list can be toggled or entered by double-clicking.



Refer to Chapter 4, "Work Bench", for details of the [Settings] dialog box.

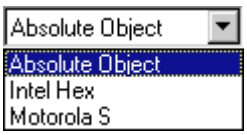
3.2.5 Building an Executable Object

To make an executable object file:

1. Select [Build] from the [Build] menu (or click the [Build] button).

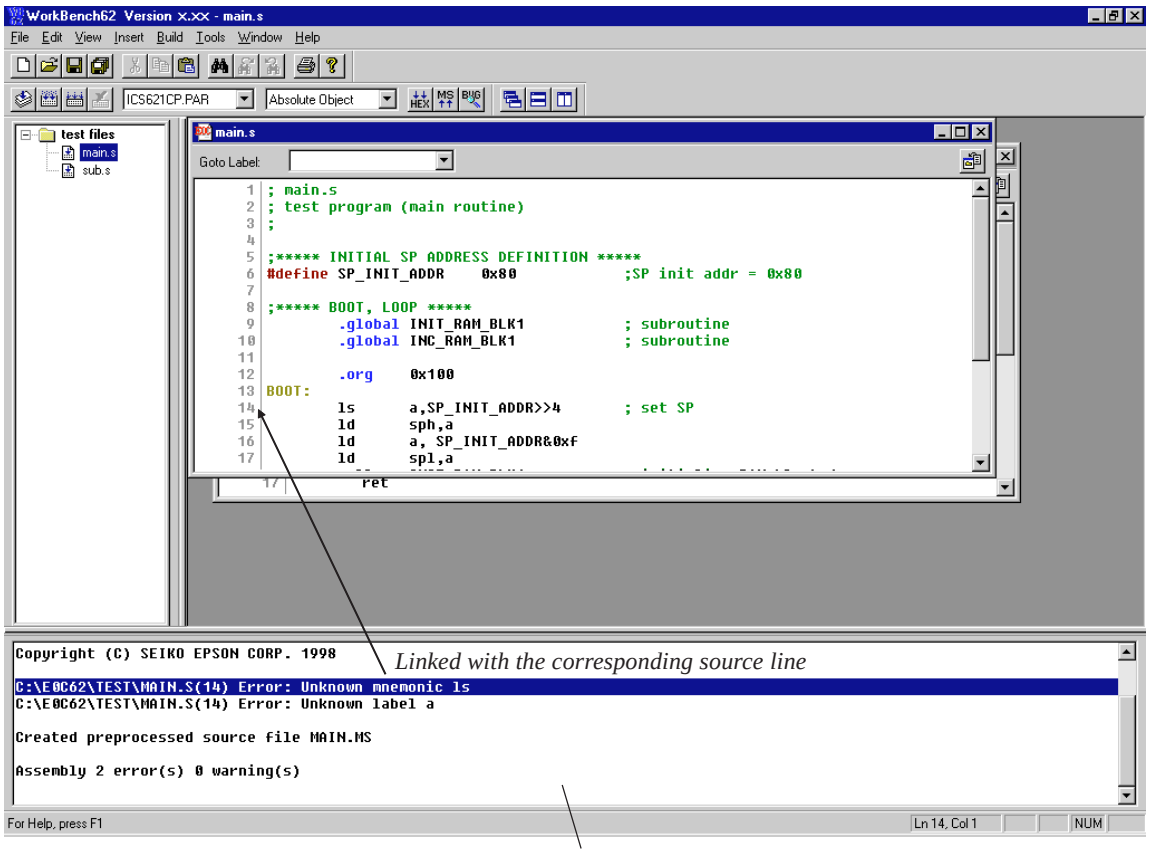

[Build] button

This will invoke the assembler and linker to create an executable object file. If a HEX file format (Intel HEX or Motorola S) is selected by the [Output format] box, the HEX converter will be invoked after linking. By default, an absolute object file in IEEE-695 format will be created.



[Output format] box

Messages delivered from each executed tool are displayed in the [Output] window. The work bench has a tag-jump function that jumps to the source line in which an error has occurred by double-clicking a source syntax error message that appears in the [Output] window. It opens the corresponding source window if it is closed.



[Output] window

In the build task, a general make process is executed to update the least necessary files. To rebuild all the files without the make function, select [Rebuild All] from the [Build] menu (or click the [Rebuild All] button).


[Rebuild All] button

To invoke the assembler only to correct syntax errors, select [Assemble] in the [Built] menu (or click the [Assemble] button).


[Assemble] button

3.2.6 Debugging

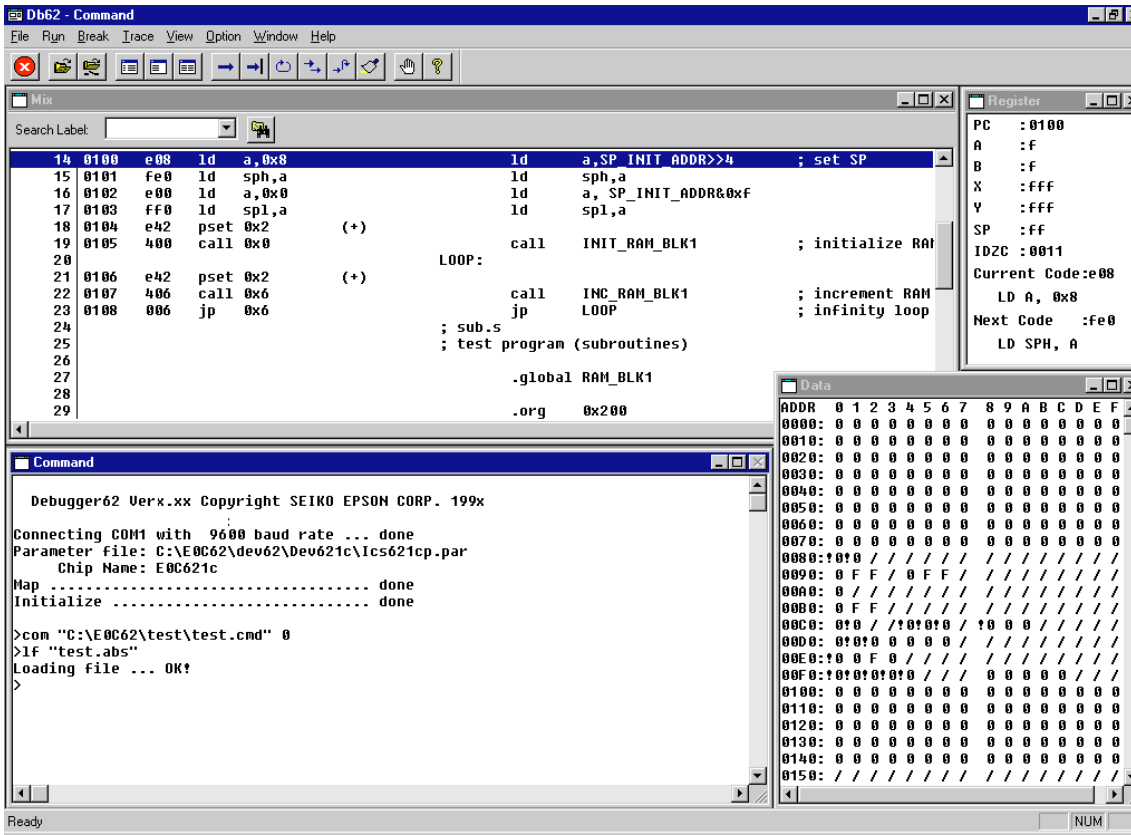
To debug the executable object:

1. Select [Debug] from the [Build] menu (or click the [Debug] button).

   
   [Debug] button

The debugger starts up with the specified ICE parameter file and then loads the executable object file.

Note: Make sure that the ICE is ready to debug before invoking the debugger. Refer to the ICE hardware manual for settings and startup method of the ICE.



For the debugging functions and operations, refer to Chapter 9, "Debugger".

CHAPTER 4 WORK BENCH

This chapter describes the functions and operating method of the Work Bench wb62.

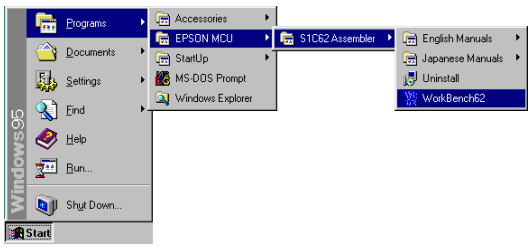
4.1 Features

The Work Bench wb62 provides an integrated operating environment ranging from editing source files to debugging. Its functions and features are summarized below:

- Source edit function that supports copy / paste, find / replace, print, label jump and tag jump from error messages.
- Allows simple management of all necessary files and information as a project.
- General make process to invoke necessary tools and to update the least necessary files.
- Supports all options of the assembler, linker, HEX converter, disassembler and debugger.
- Windows GUI interface for simple operation.

4.2 Starting Up and Terminating the Work Bench

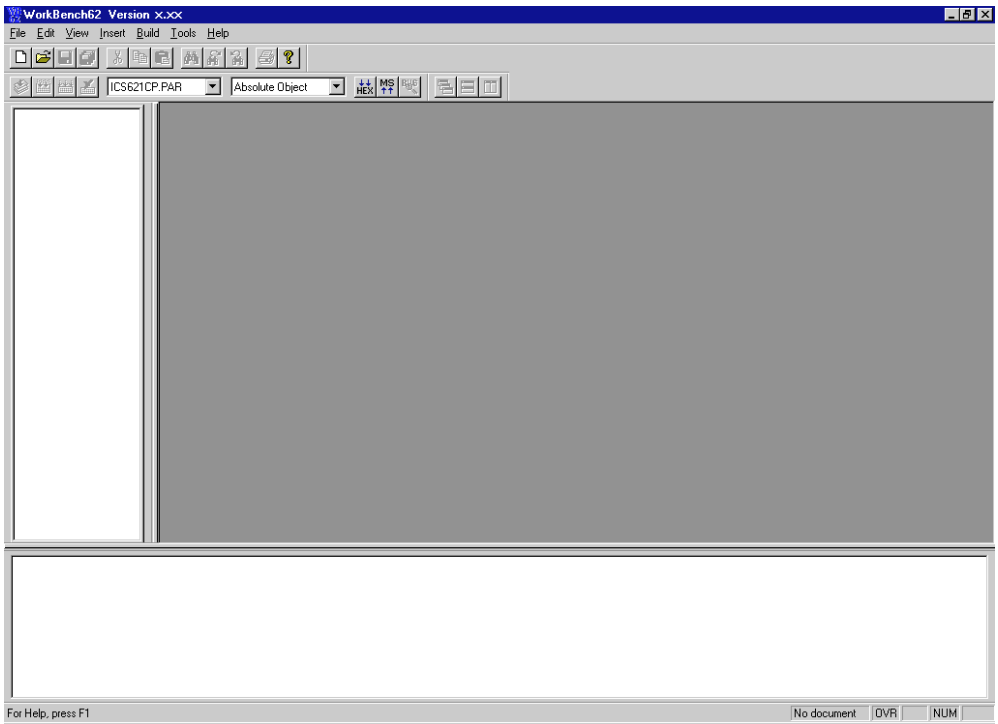
To start up the work bench



Choose "WorkBench62" from the [Program] menu to start up the work bench.

* If "WorkBench62" is not registered in the [Program] menu, it means that the installation was not successful. Therefore, reinstall the tools by referring to Chapter 2, "Installation".

When the work bench starts up, the window shown below appears.

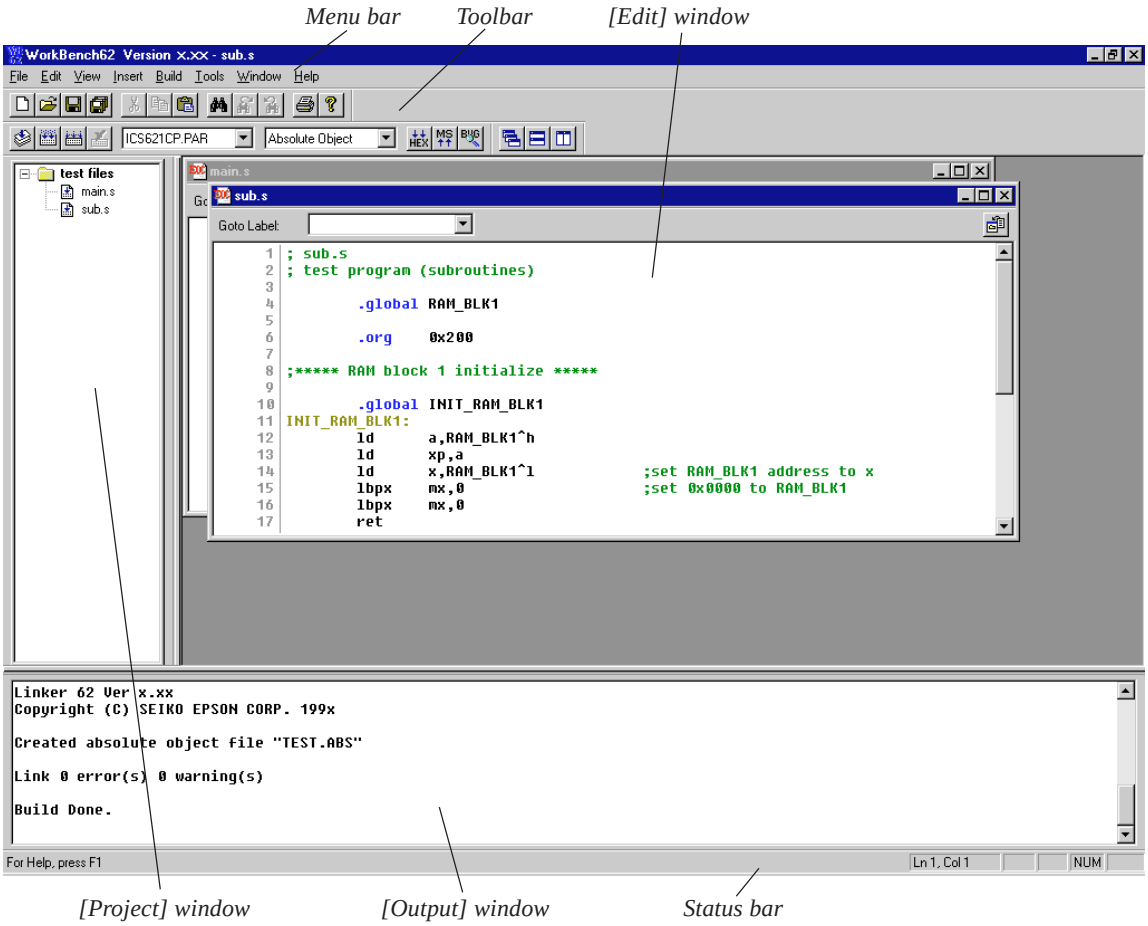


To terminate the work bench

Select [Exit] from the [File] menu.

4.3 Work Bench Windows

4.3.1 Window Configuration



The work bench has three types of windows: [Edit] window, [Project] window and [Output] window.

[Edit] window

This window is used for editing a source file. A standard text file can also be displayed in this window. Two or more windows can be opened in the edit window area.
When an E0C62 assembly source file is opened, the source is displayed with in colors according to the contents.

S1C62 instructions:	Black
Preprocess (#) pseudo-instructions:	Dark brown
Assemble (.) pseudo-instructions:	Blue
Labels:	Light brown
Comments:	Green

[Project] window

This window shows the currently opened work space folder and lists all the source files in the project, with a structure similar to Windows Explorer.
Double-clicking a source file icon opens the source file in the [Edit] window.

[Output] window

This window displays the messages delivered from the executed tools in a build or assemble process. Double-clicking a syntax error message with a source line number displayed in this window activates or opens the [Edit] window of the corresponding source so that the source line in which the error has occurred can be viewed.

Menu bar

Refer to Section 4.5.

Toolbar

Refer to Section 4.4.

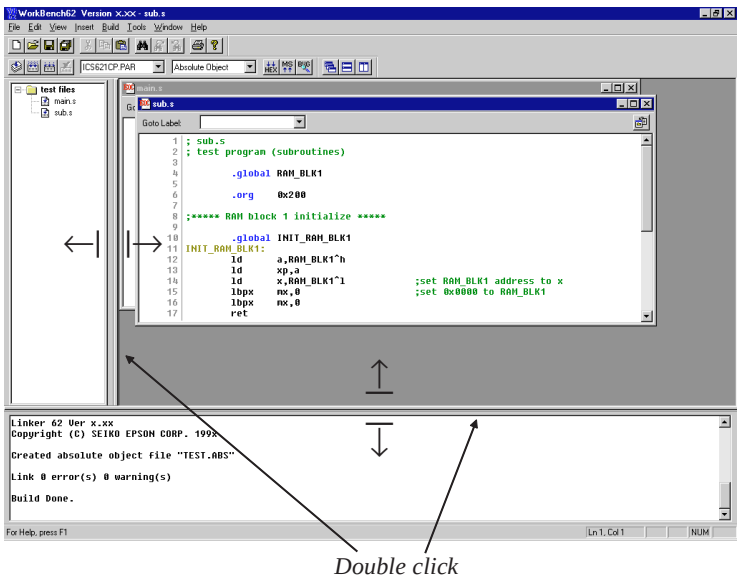
Status bar

Shows help messages when the mouse cursor is placed on a menu item or a button.
It also indicates the cursor position in the [Edit] window, Key lock status (Num lock, Caps lock, Scroll lock).

4.3.2 Window Manipulation

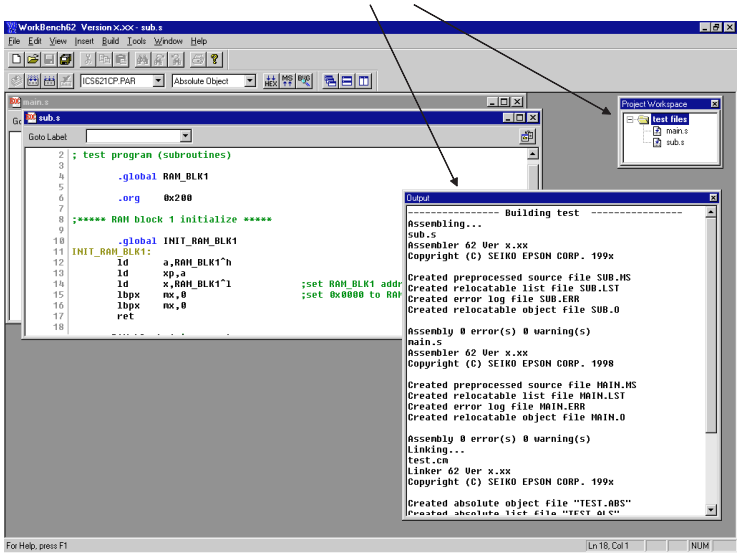
Resizing the windows

Each window area can be resized by dragging the window boundary. The size information is saved when the work bench is terminated. So the same window layout will appearat the next time the work bench starts up.



Floating and docking the [Project] and [Output] window

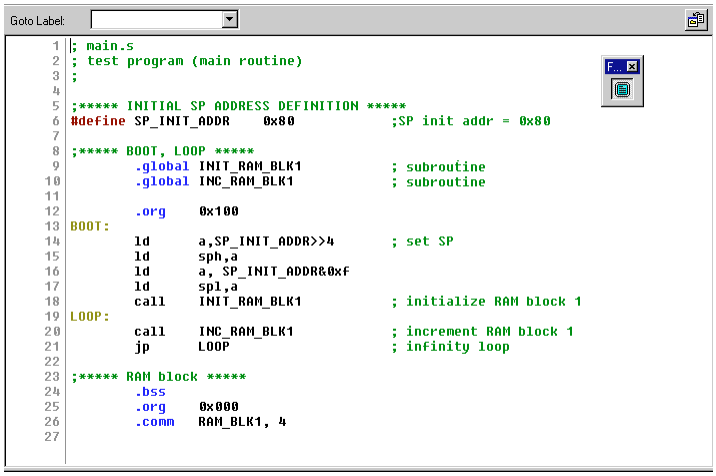
The [Project] window and the [Output] window can be made a floating window by double-clicking the window boundary and the floating window can be moved and resized in the work bench window. The floating window will be restored to a docking window by double clicking the window's title bar or dragging the title bar towards an edge of the work bench window.



Closing the [Project] and [Output] window

The [Project] window and the [Output] window can be closed by selecting [Project Window] and [Output Window] from the [View] menu, respectively. To open them, select the menu items again.

Maximizing the [Edit] window area



The [Edit] window area can be maximized to the full screen size by selecting [Full Screen] from the [View] menu. All other windows and toolbars are hidden behind the [Edit] window area.
To return it to the normal display, click the button that appears on the screen. This button can be moved anywhere in the screen by dragging its title bar. Pressing the [ESC] key also returns the window to the normal display.

Opening/Closing [Edit] windows

An [Edit] window opens when a source file (text file) is loaded using a menu, button or a file icon in the [Project] window, or when a new source is created.
[Edit] windows close by clicking the [Close] box of each window or selecting [Close] from the [File] menu.
When a project file is saved, the [Edit] window information (files opened, size and location) is also saved. So the next time the project opens, editing can begin in the saved condition.

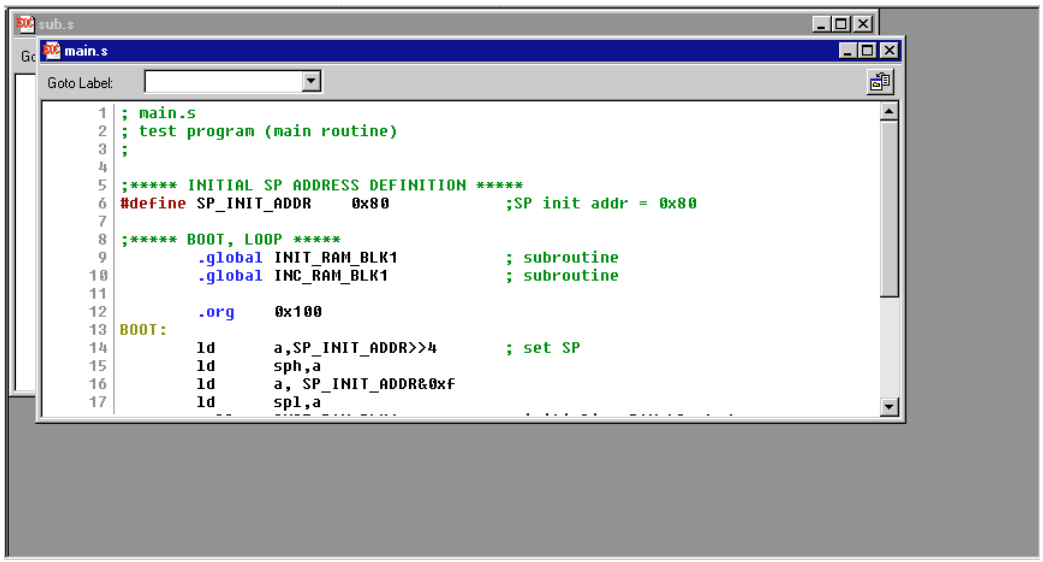
Arrangement of the [Edit] windows

The [Edit] windows being opened can be arranged similar to standard Windows applications.

1 Cascade windows

Select [Cascade] from the [Window] menu or click the [Cascade Windows] button.

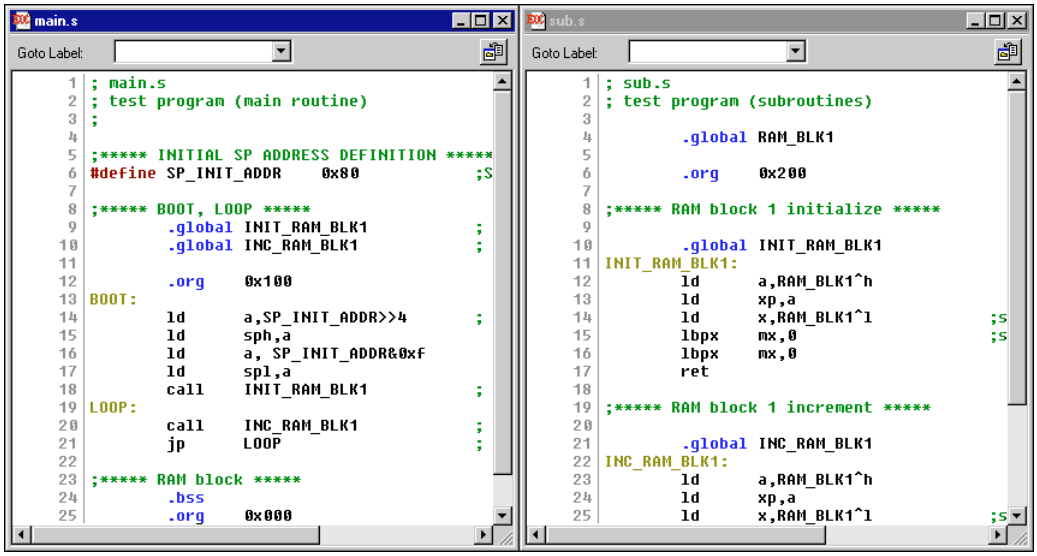
 *[Cascade Windows] button*



2 *Tile windows*

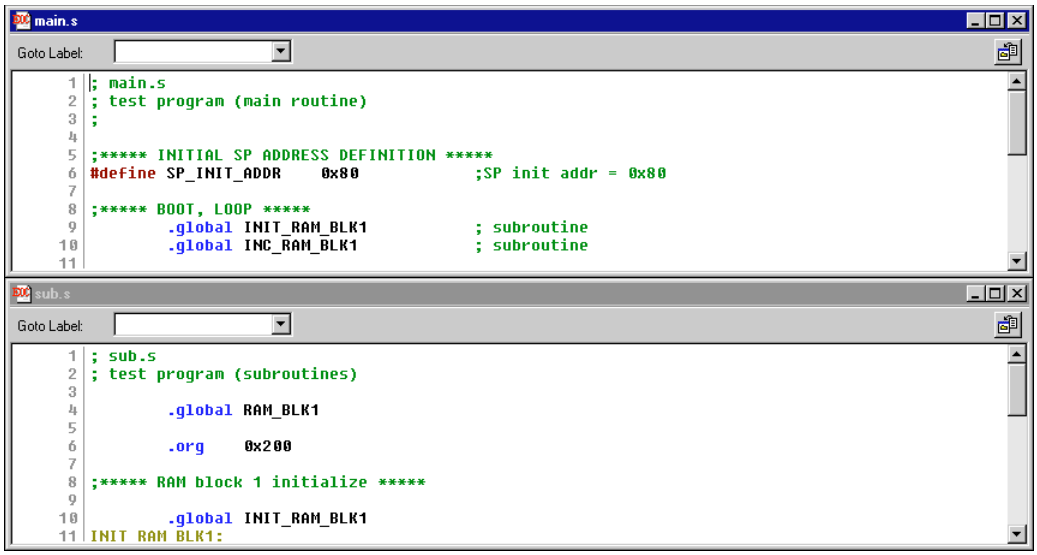
To tile windows vertically, select [Tile Vertically] from the [Window] menu or click the [Tile Vertically] button.


[Tile Vertically] button



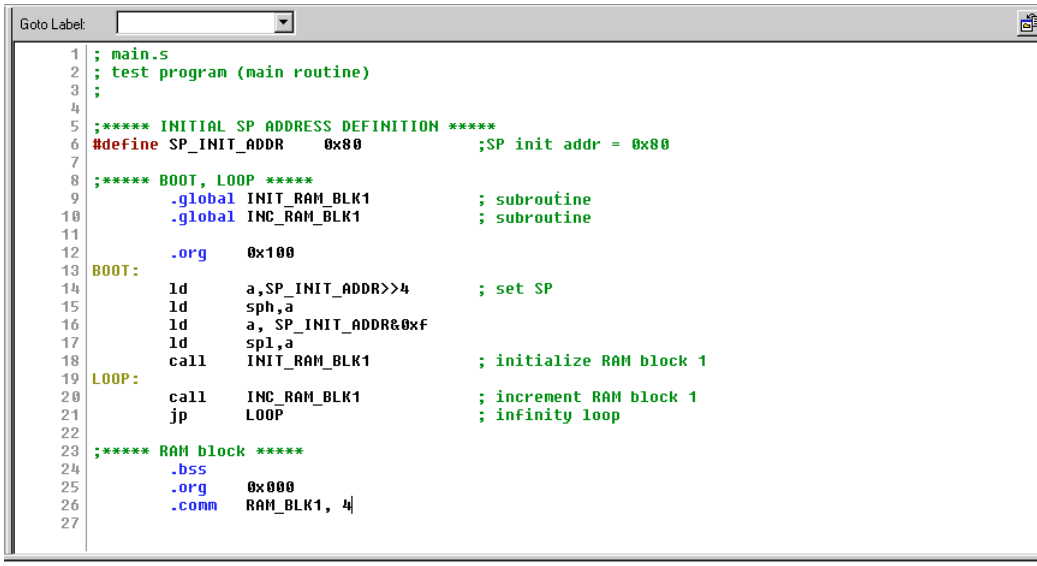
To tile windows horizontally, select [Tile Horizontally] from the [Window] menu or click the [Tile Horizontally] button.


[Tile Horizontally] button



3 Maximizing an [Edit] window

Click the [Maximize] button on the window title bar. The window will be maximized to the [Edit] window area size and other [Edit] windows will be hidden behind the active window.



4 Minimizing an [Edit] window

Click the [Minimize] button on the window title bar. The window will be minimized as a window icon. The minimized icons can be arranged at the bottom of the [Edit] window area by selecting [Arrange Icons] from the [Window] menu.

5 Moving and resizing an [Edit] window

The [Edit] window allows changing of its location and its size in the same way as the standard Windows applications if it is not maximized.

Switching active [Edit] window

Click the window to be activated if it can be viewed. Otherwise, select the window name (source file name) from the currently-opened window list in the [Window] menu.

Scrolling display contents

A standard scroll bar appears if the display contents exceed the display size of a window. Use it to scroll the display contents. The arrow keys can also be used.

Showing and hiding the status bar

The status bar can be shown or hidden by selecting [Status Bar] from the [View] menu.

4.4 Toolbar and Buttons

Tree types of toolbars have been implemented in the work bench: standard toolbar, build toolbar and window tool bar.

4.4.1 Standard Toolbar

This toolbar has the following standard buttons:

[New] button

Creates a new document. A dialog box will appear allowing selection from among three document types: E0C62 assembly source, E0C62 assembly header and project.

[Open] button

Opens a document. A dialog box will appear allowing selection of the file to be opened.

[Save] button

Saves the document in the active [Edit] window to the file. The file will be overwritten.
This button becomes inactive if no [Edit] window is opened.

[Save All] button

Saves the documents of all [Edit] windows and the project information to the respective files.

[Cut] button

Cuts the selected text in the [Edit] window to the clipboard.

[Copy] button

Copies the selected text in the [Edit] window to the clipboard.

[Paste] button

Pastes the text copied on the clipboard to the current cursor position in the [Edit] window or replaces the selected text with the copied text.

[Find] button

Finds the specified word in the active [Edit] window. A dialog box will appear allowing specification of the word to be found and a search condition.

[Find Next] button

Finds next target word towards the end of the file.

[Find Previous] button

Finds next target word towards the beginning of the file.

[Print] button

Prints the document in the active [Edit] window. A standard print dialog will appear allowing a specific print condition.

[Help] button

Displays a dialog box showing the version of the work bench.

4.4.2 Build Toolbar

This tool bar has the following buttons and list boxes used to build a project:

[Assemble] button

Assembles the assembly source in the active [Edit] window. This button becomes active only when the active [Edit] window shows an assembly source file.

[Build] button

Builds the currently opened project using a general make process.

[Rebuild All] button

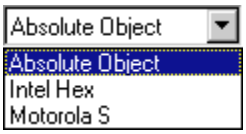
Builds the currently opened project. All the source files will be assembled regardless of whether they are updated or not.

[Stop Build] button

Stops the build process being executed. This button becomes active only while a build process is being executed.

[ICE Parameter] pull-down list box

Selects the ICE parameter file for the model being developed. In this box, all the ICE parameter files that exist in the "dev62" directory are listed.



[Output Format] pull-down list box

Selects an executable object file format. Three types of formats are available: IEEE-695 absolute object format, Intel HEX format and Motorola S format. The build process will generate an executable object in the format selected here.

[HEX Convert] button

Invokes the HEX converter to convert an absolute object into an Intel HEX object or a Motorola S object. A dialog box will appear allowing selection of an absolute object and options of the HEX converter.

[Disassemble] button

Invokes the disassembler to disassemble an absolute object. A dialog box will appear allowing selection of an absolute object and options of the disassembler.

[Debug] button

Invokes the debugger with the specified ICE parameter file.

4.4.3 Window Toolbar

This tool bar has the following buttons used in window manipulation:

[Cascade] button

Cascades the opened [Edit] windows.

[Tile Horizontally] button

Tiles the opened [Edit] window horizontally.

[Tile Vertically] button

Tiles the opened [Edit] window vertically.

4.4.4 Toolbar Manipulation

Hiding and showing toolbars

Each toolbar can be hidden if not needed. Select the toolbar name from the [View] menu. This operation toggles between hiding and showing the toolbar.

Changing the toolbar location

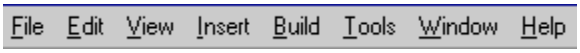
Toolbars can be moved to another location in the toolbar area by dragging them. If a toolbar is moved out of the toolbar area, it will be changed to a window.

4.4.5 [Insert into project] Button on a [Edit] Window

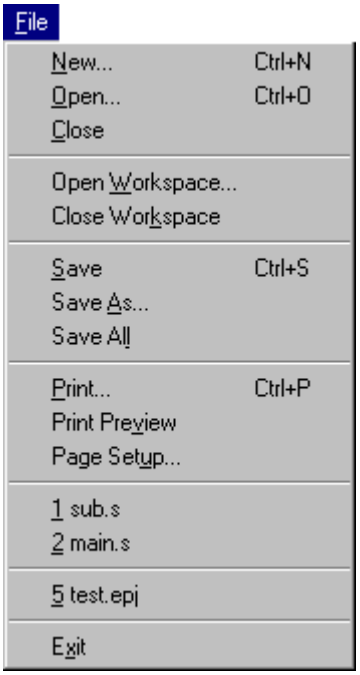

[Insert into project] button

When a source file (.s, .ms or .dat) is opened, the [Insert into project] button appears on the [Edit] window. It can be used to insert the source file into the current opened project.
For other file types, the [Edit] window opens without the [Insert into project] button.

4.5 Menus



4.5.1 [File] Menu



The file names listed in this menu are recently used source and project files. Selecting one opens the file.

[New...] ([Ctrl]+[N])

Creates a new document. A dialog box will appear allowing selection from among three document types: E0C62 assembly source, E0C62 assembly header and project.

[Open...] ([Ctrl]+[O])

Opens a document. A dialog box will appear allowing selection of the file to be opened.

[Close]

Closes the active [Edit] window. This menu item appears when an [Edit] window becomes active.

[Open Workspace...]

Opens a project. A dialog box will appear allowing selection of the project to be opened.

[Close Workspace]

Closes the currently opened project. This menu item becomes inactive if no project is opened.

[Save] ([Ctrl]+[S])

Saves the document in the active [Edit] window to the file. The file will be overwritten. This menu item appears when an [Edit] window becomes active.

[Save As...]

Saves the document in the active [Edit] window with another file name. A dialog box will appear allowing specification of a save location and a file name. This menu item appears when an [Edit] window becomes active.

[Save All]

Saves the documents of all [Edit] windows and the project information to the respective files.

[Print...] ([Ctrl]+[P])

Prints the document in the active [Edit] window. A standard [print] dialog box will appear allowing a specific print condition. This menu item appears when an [Edit] window becomes active.

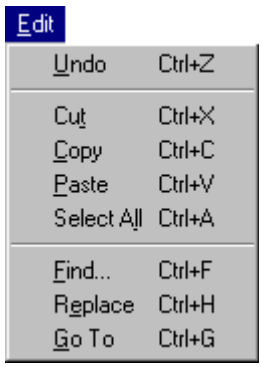
[Print Preview]

Displays a print image of the document in the active [Edit] window. This menu item appears when an [Edit] window becomes active.

[Page Setup...]

Displays a dialog box for selecting paper and printer.

4.5.2 [Edit] Menu



[Undo] ([Ctrl]+[Z])

Undoes the previous executed operation in the [Edit] window.

[Cut] ([Ctrl]+[X])

Cuts the selected text in the [Edit] window to the clipboard.

[Copy] ([Ctrl]+[C])

Copies the selected text in the [Edit] window to the clipboard.

[Paste] ([Ctrl]+[V])

Pastes the text copied on the clipboard to the current cursor position in the [Edit] window or replaces the selected text with the copied text.

[Select All] ([Ctrl]+[A])

Selects all text in the active [Edit] window.

[Find...] ([Ctrl]+[F])

Finds the specified word in the active [Edit] window. A dialog box will appear allowing specification of the word to be found and a search condition.

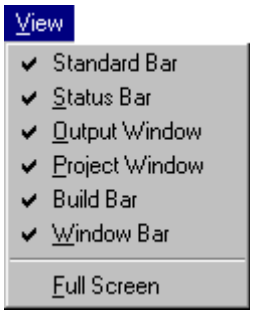
[Replace] ([Ctrl]+[H])

Replaces the specified words in the active [Edit] window with one another. A dialog box will appear allowing specification of the words.

[Go To] ([Ctrl]+[G])

Jumps to the specified line or label in the active [Edit] window. A dialog box will appear allowing specification of a line number or a label name.

4.5.3 [View] Menu



[Standard Bar]

Shows or hides the standard toolbar.

[Status Bar]

Shows or hides the status bar located at the bottom of the work bench window.

[Output Window]

Opens or closes the [Output] window.

[Project Window]

Opens or closes the [Project] window.

[Build Bar]

Shows or hides the build toolbar.

[Window Bar]

Shows or hides the window toolbar.

[Full Screen]

Maximizes the [Edit] window area to the full screen size.

4.5.4 [Insert] Menu

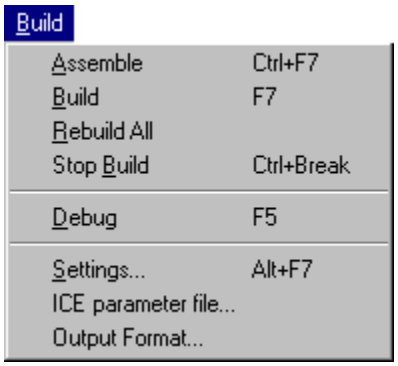
[File...]

Inserts the specified file to the current cursor position in the [Edit] window or replaces the selected text with the contents of the specified file. A dialog box will appear allowing selection of the file to be inserted.

[Files into project...]

Adds the specified source file in the currently opened project. A dialog box will appear allowing selection of the file to be added.

4.5.5 [Build] Menu



[Assemble] ([Ctrl]+[F7])

Assembles the assembly source in the active [Edit] window. This menu item becomes active only when the active [Edit] window shows an assembly source file.

[Build] ([F7])

Builds the currently opened project using a general make process.

[Rebuild All]

Builds the currently opened project. All the source files will be assembled regardless of whether they are updated or not.

[Stop Build] ([Ctrl]+[Break])

Stops the build process being executed. This button become active only while a build process is being executed.

[Debug] ([F5])

Invokes the debugger with the specified ICE parameter file.

[Settings...] ([Alt]+[F7])

Displays a dialog box for selecting tool options.

[ICE parameter file...]

Displays a dialog box for selecting an ICE parameter file.

[Output Format...]

Displays a dialog box for selecting an executable object file format. Three types of formats are available: IEEE-695 absolute object format, Intel HEX format and Motorola S format. The build process will generate an executable object in the format selected here.

4.5.6 [Tools] Menu

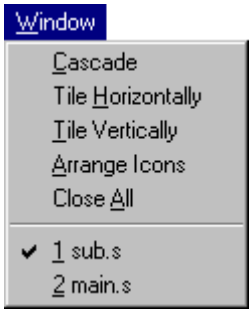
[HEX Converter...]

Invokes the HEX converter to convert an absolute object into an Intel HEX object or Motorola S object. A dialog box will appear allowing selection of an absolute object and options for the HEX converter.

[Disassembler...]

Invokes the disassembler to disassemble an absolute object. A dialog box will appear allowing selection of an absolute object and options for the disassembler.

4.5.7 [Window] Menu



The currently opened document file names are listed in this menu. Selecting one activates the [Edit] window.

This menu appears when an [Edit] window is opened.

[Cascade]

Cascades the opened [Edit] windows.

[Tile Horizontally]

Tiles the opened [Edit] window horizontally.

[Tile Vertically]

Tiles the opened [Edit] window vertically.

[Arrange Icons]

Arranges the minimized [Edit] window icons at the bottom of the [Edit] window area.

[Close All]

Closes all the [Edit] windows opened.

4.5.8 [Help] Menu

[About WB62...]

Displays a dialog box showing the version of the work bench.

4.6 Project and Work Space

The work bench manages a program development task using a work space folder and a project file that contains file and other information necessary for invoking the development tools.

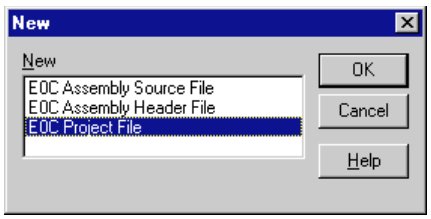
4.6.1 Creating a New Project

A new project file can be created by the following procedure:

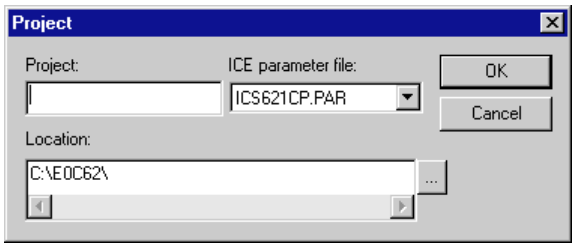
1. Select [New] from the [File] menu or click the [New] button.

   
   [New] button

   The [New] dialog box appears.



2. Select [E0C Project File] and click [OK].
   The [Project] dialog box appears.



3. Enter a project name, select an ICE parameter file and select a directory, then click [OK].

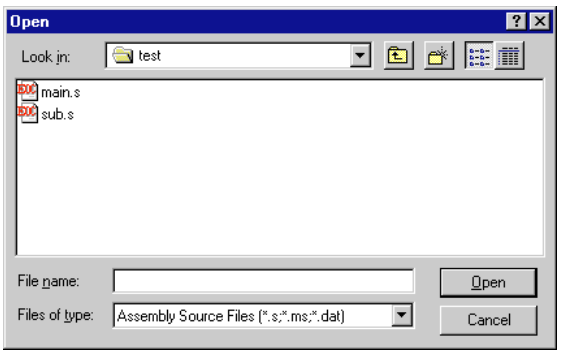
   * The [ICE parameter file:] box lists the parameter files that exist in the "dev62" directory.

The work bench creates a folder (directory) with the specified project name as a work space, and puts the project file (.epj) into the folder.
If a folder which has the same name as that of a specified one already exists in the specified location, the work bench uses the folder as the work space. Thus you can specify a folder in which sources are created. The specified project name will also be used for the absolute object and other files.

4.6.2 Inserting Sources into a Project

The sources created must be inserted into the project.
To insert a source into a project, use one of the four methods shown below:

1. [Insert | Files into project...] menu item
   A dialog box appears when this menu item is selected.

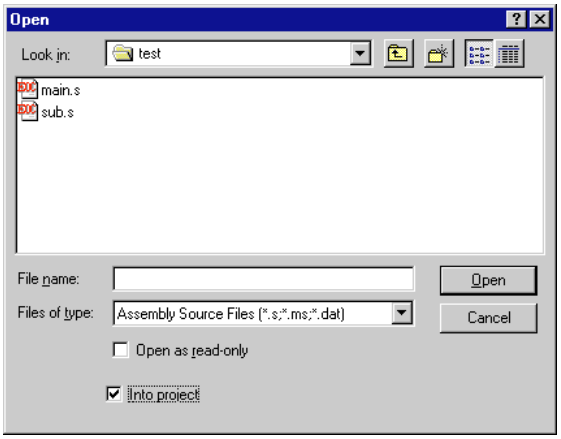


   Choose a source file from the list box and then click [Open].

2. [File | Open...] menu item or [Open] button

   [Open] button

   A dialog box appears when this menu item or button is selected.



   Choose a source file from the list box and select the [Into project] button, then click [Open].

3. [Insert into project] button on the [Edit] window

   [Insert into project] button

   When the source file has been opened, click the [Insert into project] button on the [Edit] window. Do not forget to save the source to the file before inserting into the project.

4. Dragging source files on the [Project] window
   Drag source files from Windows Explorer to the [Project] window. These files will be added to the current project.

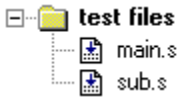
When a source file is inserted into the project, the source file name appears in the [Project] window.

Removing a source from the project

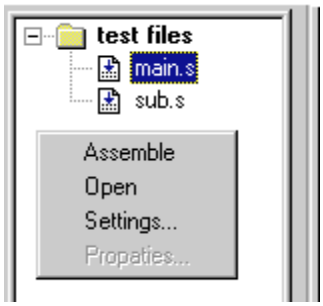
To remove a source file from the project, select the source in the [Project] window and then press the [Delete] key. This removes only the source information, and does not delete the actual source file.

4.6.3 [Project] Window

The [Project] window shows the work space folder and the source files included in the project that has been opened.



When a source file icon is double-clicked, the source file will be opened or the corresponding [Edit] window will be activated.



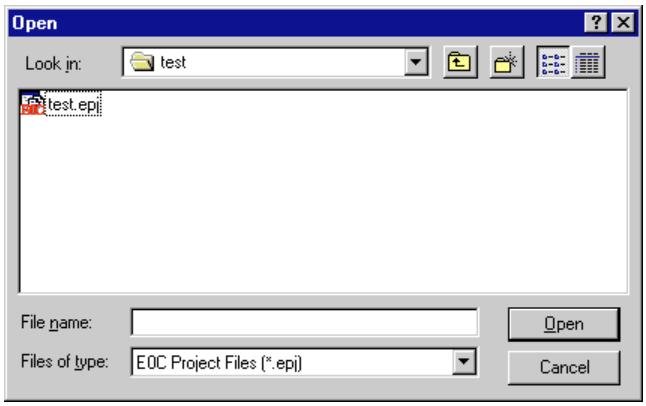
Shortcut menu in the [Project] window

When the folder icon or a source file icon is double-clicked with the right mouse button, a shortcut menu including the available build menu items appears.

Note: Note that the list in the [project] window is not the actual directory structure.
Sources of the project in other folders than the work space folder are also listed as they exist in the work space folder.

4.6.4 Opening and Closing a Project

To open a project, select [Open WorkSpace...] from the [File] menu.
A dialog box appears allowing selection of a project file.



The work bench allows only one project to be opened at a time. So if a project has been opened, it will be closed when another project is opened. At this time, a dialog box appears to select whether the current project file is to be saved or not if it has not already been saved after a modification.

The project file can also be opened by selecting [Open] from the [File] menu or clicking the [Open] button. In this case, choose the file type as S1C Project Files (*.epj) in the file open dialog box.

To close the currently opened project file, select [Close WorkSpace] from the [File] menu. At this time, a dialog box appears to select whether the current project file is to be saved or not if it has not already been saved after a modification. If [Yes] (save) is selected in this dialog box, all the modification items including sources, tool settings and window configuration will be saved.

4.6.5 Files in the Work Space Folder

The work bench generates the following files in the work space folder:

<file>.epj Project file

This file contains the project information.

<file>.cm Linker command file

This file is generated when a build task is started, and is used by the linker to generate an absolute object file.

Example:

```
; WorkBench62 Generated
; Friday, May 01, 1998

"C:\E0C62\dev62\Dev621c\Ics621cp.par"          ;ICE parameter file

-o "test.abs"        ;output file : absolute object

; linked object file(s)
"sub.o"
"main.o"
```

The contents vary according to the source files included in the project and the linker option setting.

<file>.cmd Debugger startup command file

This file is generated when a build task is started, and is used by the debugger to execute the command in this file when it is started up.

Example:

```
lf "test.abs"
```

The work bench generates this file so that the executable file according to the format selection is loaded when the debugger starts up.

<file>.mak "make" file for build task

This file is generated when a build task is started, and is used for the build process in the work bench.

Example:

```
# WorkBench62 Generated
# Friday, May 01, 1998

ASM = as62.exe
LINK = lk62.exe
HEX = hx62.exe
ASM_FLG = -g
LINK_FLG = -g
HEX_FLG = -e -b

ALL : test.abs

test.abs : test.cm sub.o main.o
     $(LINK) $(LINK_FLG) test.cm

sub.o : C:\E0C62\test\sub.s
     $(ASM) $(ASM_FLG) C:\E0C62\test\sub.s

main.o : C:\E0C62\test\main.s
     $(ASM) $(ASM_FLG) C:\E0C62\test\main.s
```

This is a generic make file that contains macro setting and dependency list.

The following files are generated by the development tools during a build process:

<file>.o	Relocatable object files (generated by the assembler)
<file>.abs	Absolute object file (generated by the linker)
<file>h.hex, <file>l.hex	Intel HEX files (generated by the Hex converter when this format is specified in the work bench)
<file>.hsa, <file>.lsa	Motorola S files (generated by the HEX converter when this format is specified in the work bench)

4.7 Source Editor

The work bench has a source editor function. Sources can be created and modified in the [Edit] window.

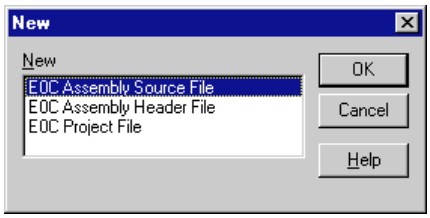
4.7.1 Creating a New Source or Header File

To create a new source file:

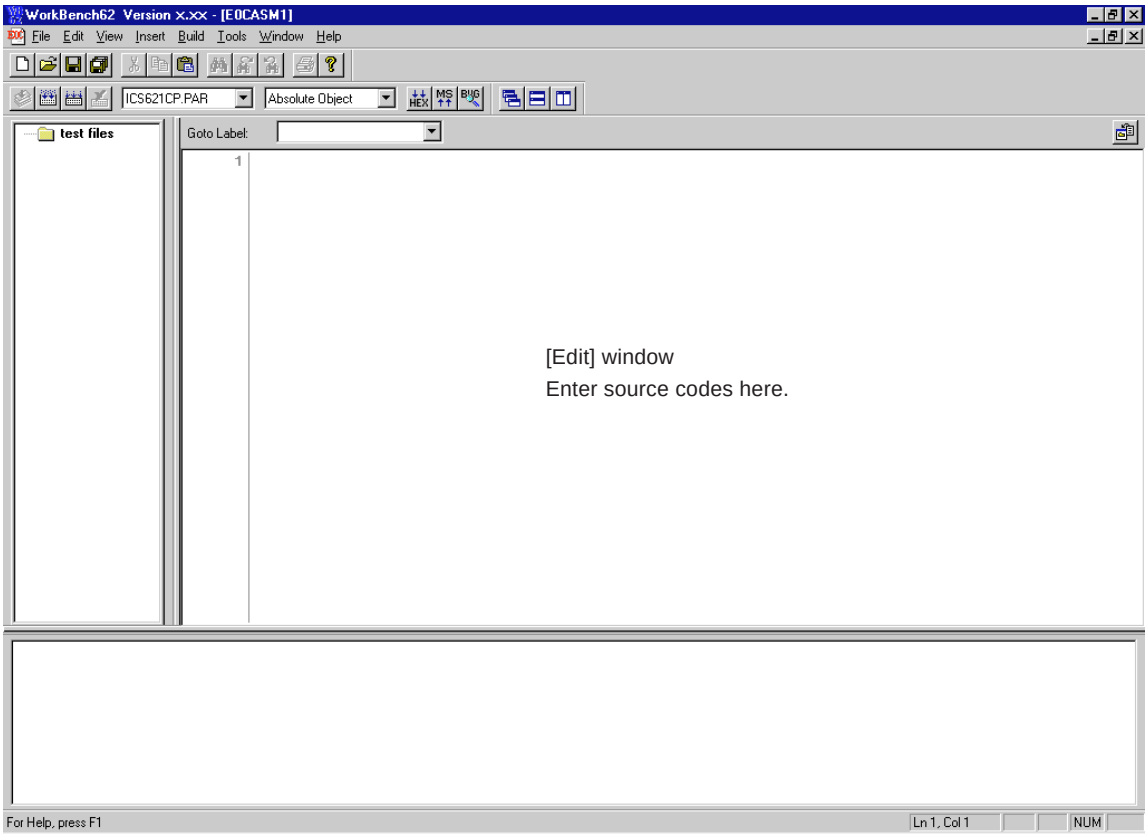
1. Select [New] from the [File] menu or click the [New] button.

    *[New] button*

   The [New] dialog box appears.



2. Select [E0C Assembly Source File] and click [OK].
   An [Edit] window appears.



Enter source codes in this window.

The [New] dialog box allows selection of the [E0C Header File]. Select it when creating a header file for constant definitions.

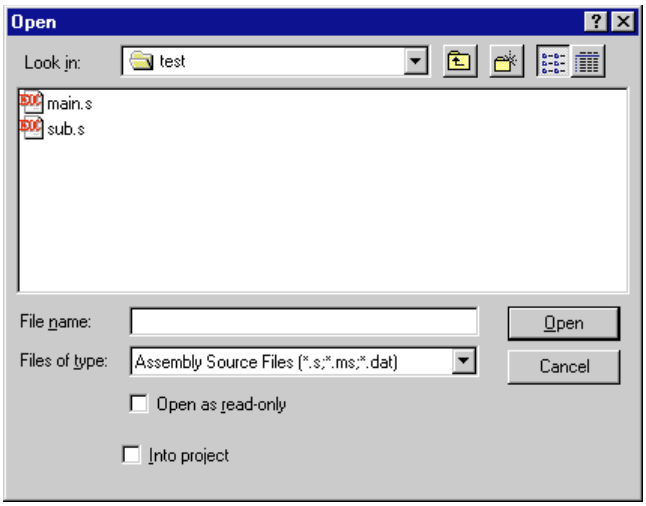
4.7.2 Loading and Saving Files

To load a source file:

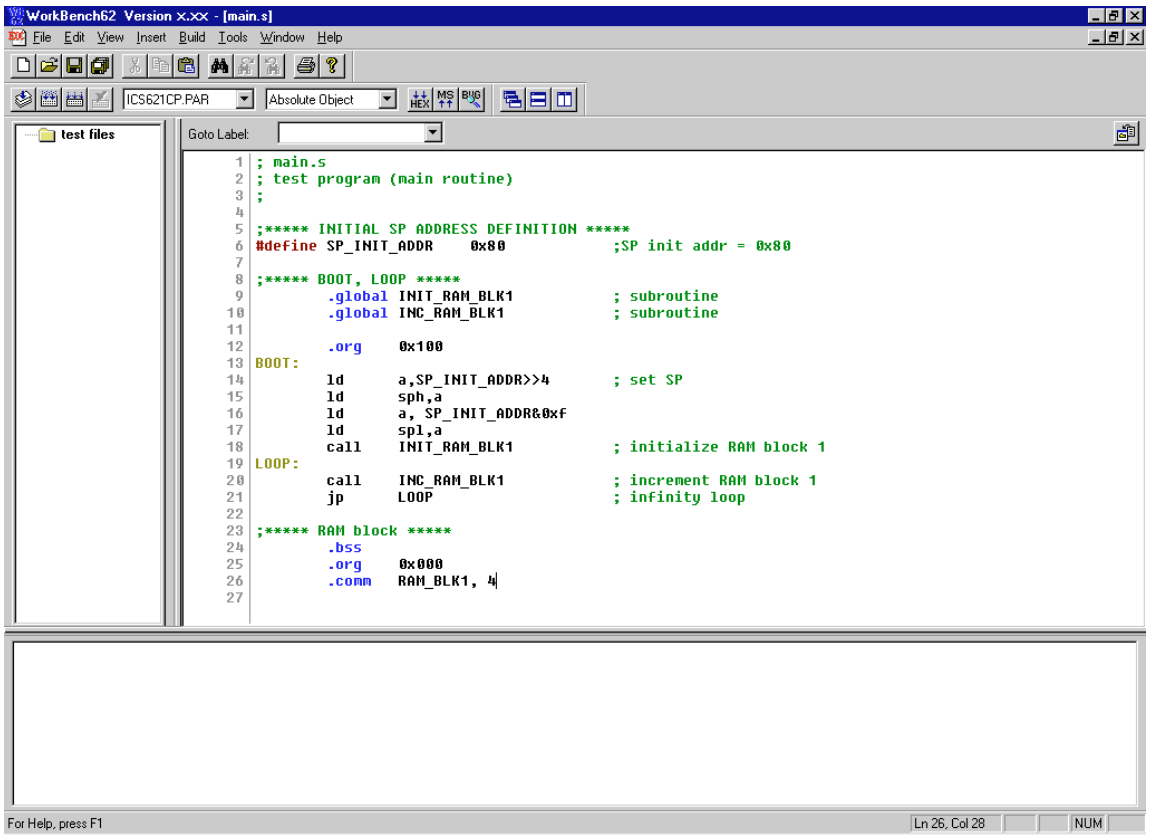
1. Select [Open...] from the [File] menu or click the [Open] button.

   
   [Open] button

   The [Open] dialog box appears.



2. Choose a source file to be opened after selecting the file type (*.s, *.ms, *.dat) and click [OK].
   An [Edit] window opens and shows the contents of the source file.



To save the source:

1. Activate the [Edit] window of the source to be saved.
2. Select [Save as...] from the [File] menu.
   The [Save As] dialog box appears.

3. Enter the file name and then click [OK].

When overwriting the source on the existing file, select [Save] from the [File] menu or click the [Save] button.

 *[Save] button*

To save all the source files opened and the project file, use the [File | Save All] menu item or the [Save All] button.

 *[Save All] button*

4.7.3 Edit Function

The source editor has general text editing functions similar to standard Windows applications.

Editing text

Basic text editing function is the same as general Windows applications.
Cut, copy and paste are supported in the [Edit] menu and with the toolbar buttons. These commands are available only in the [Edit] window.
Undo can be selected from the [Edit] menu.

The tab stops are set at every 8 characters.

Find, replace and go to

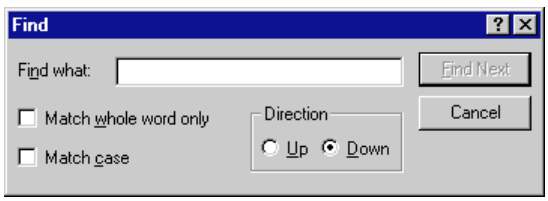
Any words can be searched in the active [Edit] window.

Find

To find a word, select [Find...] from the [Edit] menu or click the [Find] button.

 *[Find] button*

The [Find] dialog box appears.



The controls in the dialog are as follows:

[Find what:] text box
Enter the word to be found in this text box. The specified word is maintained as the finding word even if this dialog box is closed.

[Match whole word only] check box
If this option is selected, the work bench searches only the words that are completely matched with the specified word. If not, only the part of word that matches the specified word will be searched.

[Match case] check box
If this option is specified, a case-sensitive search is performed. If not, a case-insensitive search is performed.

[Direction] option
If the [Up] radio button is selected, the specified word is searched toward to the beginning of the file. If the [Down] radio button is selected, a search is performed toward to the end of the file.

[Find Next] button
Clicking this button starts searching the specified word. If the specified word is found, the [Edit] window refreshes the display and highlights the word found.

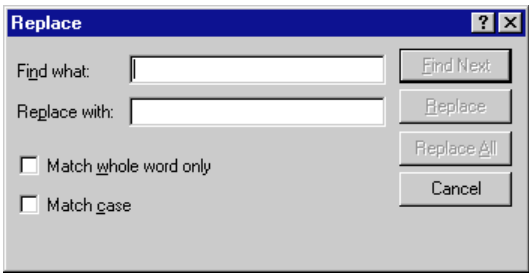
[Cancel] button
Clicking this button closes the dialog box.

Once a word to be found is specified in the [Find] dialog box, the [Find Next] and [Find Previous] buttons on the toolbar can be used for a forward or backward search.

 *[Find Next] button*  *[Find Previous] button*

Replace

To replace a word with another one, select [Replace] from the [Edit] menu.
The [Replace] dialog box appears.



The controls in the dialog are as follows:

[Find what:] text box
Enter the word to be found in this text box. If a word has been specified in the [Find] dialog box, it appears in this box.

[Replace with:] text box
Enter the substitute word in this box.

[Match whole word only] check box
If this option is selected, the work bench searches only the words that are completely matched with the specified word. If not, only the part of word that matches the specified word will be searched.

[Match case] check box
If this option is specified, a case-sensitive search is performed. If not, a case-insensitive search is performed.

[Find Next] button

Clicking this button starts searching the specified word. If the specified word is found, the [Edit] window refreshes the display and highlights the word found.

[Replace] button

By clicking this button after the specified word is found, it is replaced with the substitute word. Then the work bench searches the next.

[Replace All] button

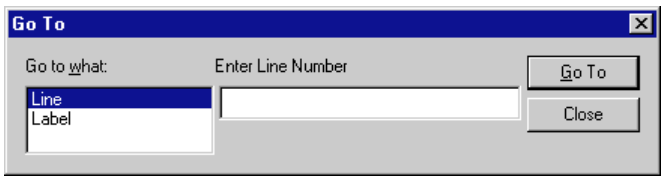
Replaces all the specified found words with the substitute word. Note that undo function cannot be performed for this operation except for the last replaced word.

[Cancel] button

Clicking this button closes the dialog box.

Go to

You can go to any source line or any label position quickly.
To do this, select [Go To] from the [Edit] menu.
The [Go To] dialog box appears.

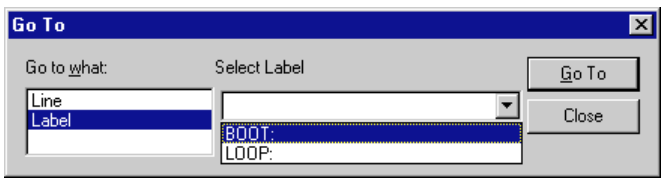


Going to a source line

1. Select "Line" in the [Go to what:] list box.
2. Type a line number in the [Enter Line Number] box and then click the [Go To] button.

Going to a label position

1. Select "Label" in the [Go to what:] list box.
   The [Enter Line Number] box changes to the [Select Label] list box.



2. Select a label from the [Select Label] box and then click the [Go To] button.

The [Select Label] list box has a pull-down menu that contains the list of labels defined in the current source file.

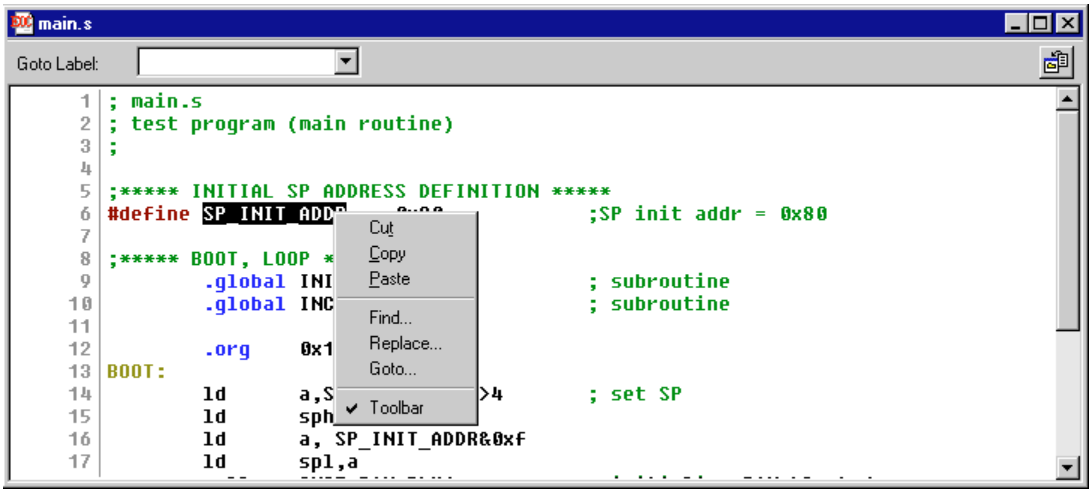
The [Edit] windows for source files (*.s, *.ms, *.dat) have the [Go To Label] list box similar to the [Select Label] list box in the [Go To] dialog box. You can also go to a label position using this box.

Inserting a file

To insert a file such as a header file and another source at the cursor position of the current source, select [File...] from the [Insert] menu.
A dialog box will appears allowing selection of the file to be inserted.

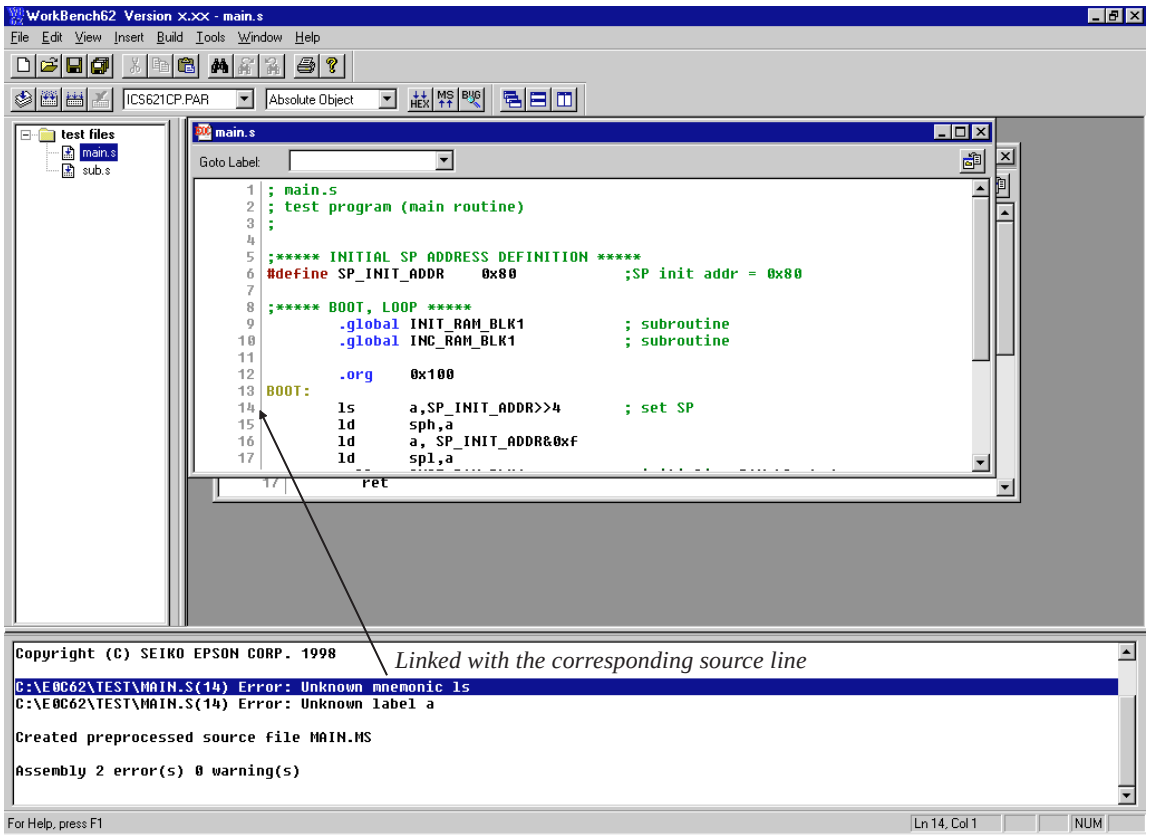
Shortcut menu

The [Edit] window supports a short cut menu that appears by clicking the right mouse button on the [Edit] window. It can also be done by pressing the [Short cut menu] key while the [Edit] window is active if the key is available on the keyboard. It contains the editing menu items descried above, so you can select an edit command using this menu.



4.7.4 Tag Jump Function

When assembler syntax errors occur during assembling, their error messages are displayed in the [Output] window. In this case, you can go to the source line in which an error has occurred by double-clicking the error message in the [Output] window.
However, this function is available only when the error message contains a source line number.



4.7.5 Printing

The document in the [Edit] window can be printed out.
The [Print...], [Print Preview] and [Page Setup...] commands are provided in the [File] menu. The [Print] button can also be used. They have the same function as those of standard Windows application.
Select one after activating the [Edit] window of the document to be printed.

4.8 Build Task

By using the [Build] menu or [Build] toolbar, the assembler, linker, debugger, HEX converter and disassembler can be executed from the work bench.
In the work bench, process to generate an executable object from the source files is called a build task.

For details of each development tool, refer to the respective chapter.

4.8.1 Preparing a Build Task

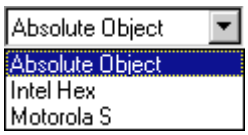
Before starting a build task, necessary source files should be prepared and tool options should be configured.

1. Create a new project. (Refer to Section 4.6.1.)
2. Select an ICE parameter file. (Refer to Section 4.6.1.)
3. Create source files and add them into the project. (Refer to Sections 4.7 and 4.6.2.)
4. Select tool options (Refer to Section 4.9.)

4.8.2 Building an Executable Object

To generate an executable object:

1. Open the project file.
2. Select an output format (absolute, Intel HEX or Motorola S) using the [Output Format] list box.



3. Select [Build] from the [Build] menu or click the [Build] button.

 *[Build] button*

The work bench generates a make file according to the source files in the project and the tool options set by the user. This file is used to control invocation of tools.
First, the make process invokes the assembler for each source file to be assembled. If the latest relocatable object file exists in the work space, the corresponding source file is not assembled to reduce process time.
Next, the linker is invoked to generate an absolute object file. The linker command file used in this phase is automatically generated.
If absolute object has been selected as the output format, the build task is completed at this phase. If Intel HEX or Motorola S has been selected, the HEX converter will be invoked to generate an object in the specified format.

To rebuild all files including the latest relocatable object files, select [Rebuild All] from the [Build] menu or click the [Rebuild All] button.

 *[Rebuild All] button*

The build task can be suspended by selecting [Stop Build] from the [Build] menu or clicking the [Stop Build] button.

 *[Stop Build] button*

To invoke only the assembler, select [Assemble] from the [Build] menu or click the [Assemble] button after activating the [Edit] window of the source to be assembled.


[Assemble] button

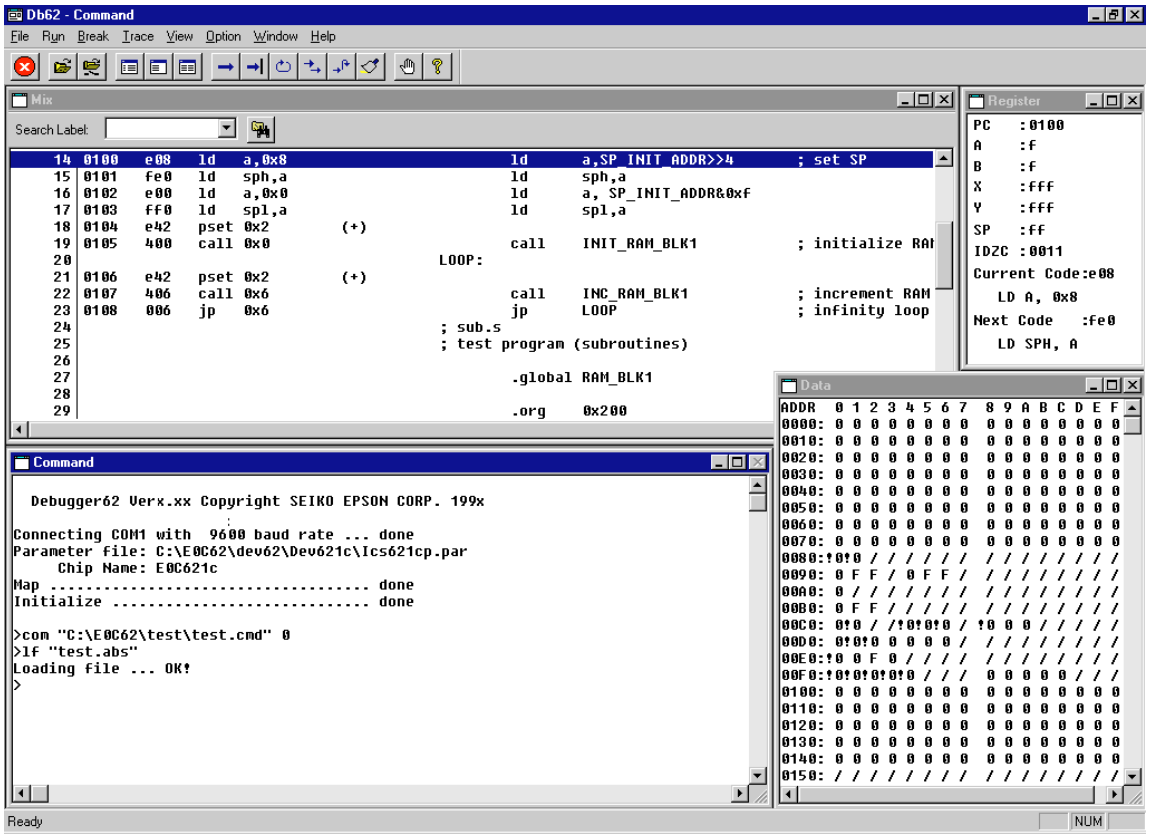
4.8.3 Debugging

To debug the generated executable file, select [Debug] from the [Build] menu or click the [Debug] button.


[Debug] button

The debugger starts up with the specified ICE parameter file and then loads the executable object by the command file generated from the work bench.
This command file contains the command to load the specified type of an executable object to the debugger. The contents of the command file can be edited in the [Settings] dialog box explained in Section 4.9.

* When the building process is performed again after invoking the debugger, the debugger will reload the object file if its window can be activated.



Refer to Chapter 9, "Debugger", for operating the debugger.

4.8.4 Executing Other Tools

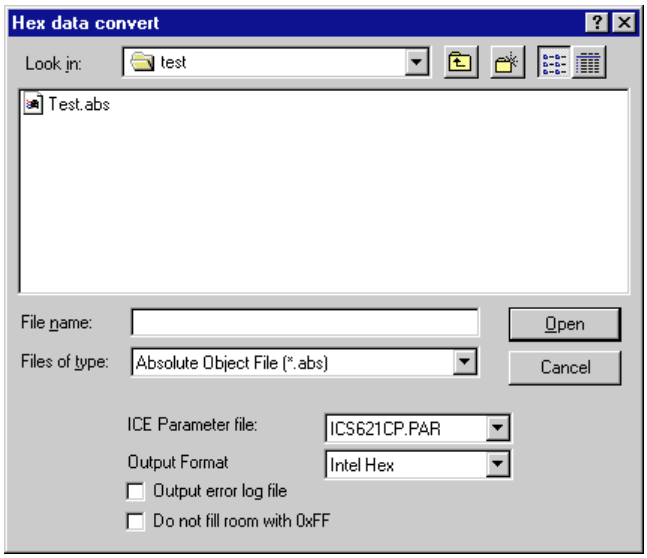
The HEX converter and disassembler can be invoked independently.

HEX converter

To invoke the HEX converter, select [HEX converter...] from the [Tools] menu or click the [HEX convert] button.

[HEX convert] button

Then select an absolute object file to be converted in the [Hex data convert] dialog box.



This dialog box allows selection of the HEX converter options.

[ICE Parameter file:] list box
Select an ICE parameter file from the pull-down list.

[Output Format:] list box
Select an output format from between Intel HEX and Motorola S.

[Output error log file] check box
Select this option to generate the error log file of the HEX converter.

[Do not fill room with 0xFF] check box
Select this option when not filling the unused program area with 0xFF.

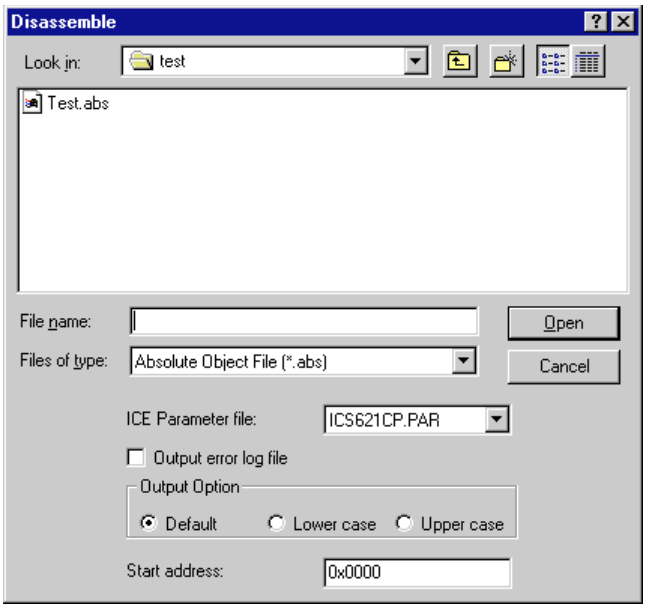
After selecting an absolute object and options, click the [Open] button. The HEX converter starts up and converts the selected object into the specified format. The messages delivered from the HEX converter are displayed in the [Output] window.

Disassembler

To invoke the disassembler, select [Disassembler...] from the [Tools] menu or click the [Disassemble] button.


[Disassemble] button

Then select the executable object file to be disassembled in the [Disassemble] dialog box.



This dialog box allows selection of the disassembler options.

[ICE Parameter file:] list box

Select an ICE parameter file from the pull-down list.

[Output error log file] check box

Select this option to generate the error log file of the disassembler.

[Output Option]

Select a character case option using the radio buttons.
When [Default] is selected, the disassembled source will be made with all labels in upper-case characters and instructions in lower-case characters.
When [Upper case] is selected, the source will be made with upper-case characters only.
When [Lower case] is selected, the source will be made with lower-case characters only.

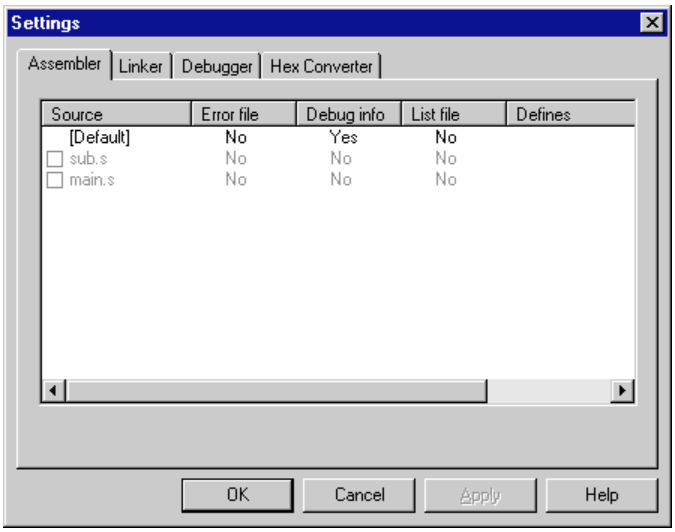
[Start address] box

Specify the address used for the first .org instruction in the disassembled source.
If this option is not specified, the disassembled source will begin with address 0.

After selecting an executable object and options, click the [Open] button. The disassembler starts up and converts the selected object into the source file. The messages delivered from the disassembler are displayed in the [Output] window.

4.9 Tool Option Settings

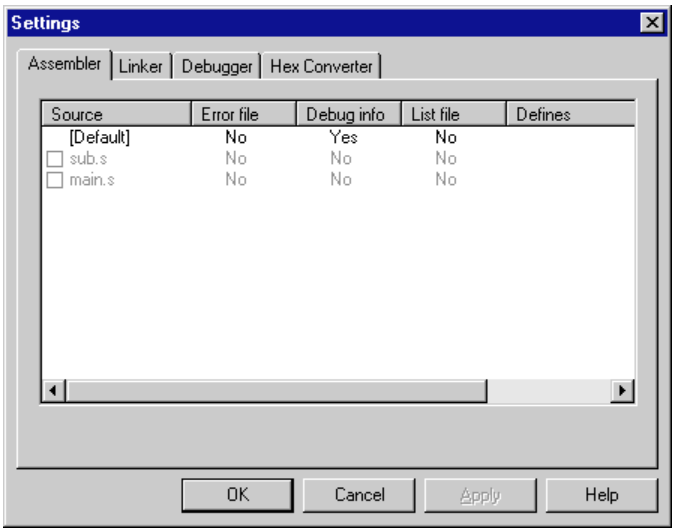
The development tools have startup options that can be specified when invoking them.
These settings can be made in the [Settings] dialog box that appears by selecting [Settings...] from the [Build] menu.



Click the tool name tab to view option settings of each tool.

Clicking the [OK] button updates option setting information in the project and then closes the dialog box. To continue to select other tool options, click the [Apply] button. This does not close the dialog box. Clicking the [Cancel] button closes the dialog box.

4.9.1 Assembler Options



In this dialog, the following four assembler options can be selected.

[Error file] Output of an error file (No: Not output, Yes: Output)
[Debug info] Addition of debugging information to the relocatable object (No: Not added, Yes: Added)
[List file] Output of the relocatable list file (No: Not output, Yes: Output)
[Defines] Name definition for conditional assembly (Enter a define name.)

The edit box shows the default setting ([Default]) and the list of source files in the project.
The default setting applies to all the sources excluding ones that are specified independently.
To select options of a specific source, select the check box at the front of the source file name.

Check here → ☐ sub.s No No No

Each of the [Error file], [Debug info] and [List file] options is set to either "No" or "Yes" and it toggles by double-clicking. For example, to change the default [List file] option from "No" to "Yes", double click "No" in the [Default] line. It changes to "Yes".

Source	Error file	Debug info	List file	Defines
[Default]	No	Yes	No	← *Double-click here. It will be changed to Yes.*

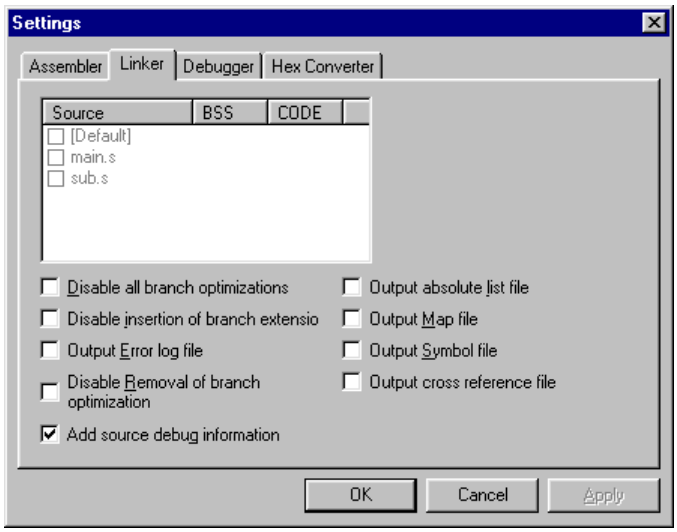
To define a name for conditional assembly, double-clicking the [Defines] part.

Source	Error file	Debug info	List file	Defines
[Default]	No	Yes	No	← *Double-click here, then type a define name.*

An text box appears. Type a name in the box. If two or more names are to be entered, separate each name with a comma (,).

Refer to Chapter 5, "Assembler", for details of the assembler options.

4.9.2 Linker Options



In this dialog, section allocation, symbol definition and other linker options can be specified.
The work bench generates a linker command file including these specifications, and specifies it when invoking the linker.

Specifying section allocation

This option is set by default as all the sections will be allocated from the memory start address. To specify a section start address, double click the cell and then enter the address.

Source	BSS	CODE	
☐ [Default]			← *Double-click here to change default CODE section start address, then type an address.*

Source	BSS	CODE
☐ [Default]		0x100

The edit box shows the default setting ([Default]) and the list of source files in the project.
The default setting applies to all the sections excluding those of the source specified.
To set a specific source independently, select the check box at the front of the source file name.

Check here → ☐ sub.s 0x200

Other option selections

[Disable all branch optimizations] check box
Select this option if PSET insertions, deletions and corrections are not necessary.

[Disable insertion of branch extension] check box
Select this option if PSET insertions are not necessary.

[Output Error log file] check box
Select this option to generate the error log file of the linker.

[Disable Removal of branch optimization] check box
Select this option if PSET deletions are not necessary.

[Add source debug information] check box
Select this option to add the debugging information. If this option is not specified, the sources cannot be displayed in debugging.

[Output absolute list file] check box
Select this option to generate the absolute list file.

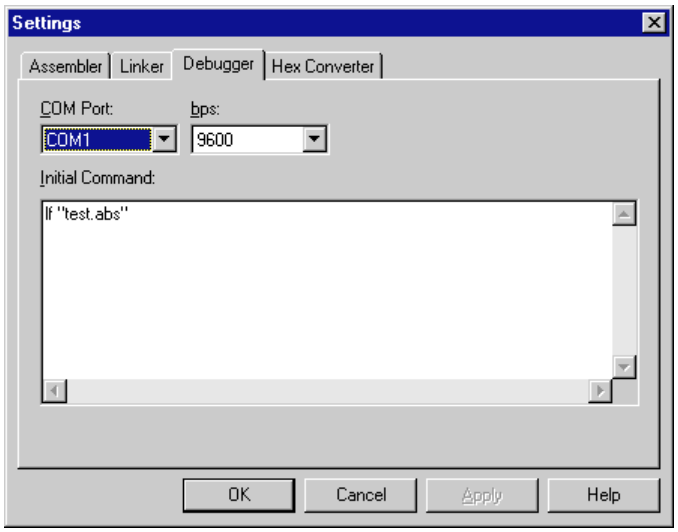
[Output Map file] check box
Select this option to generate the link map file.

[Output Symbol file] check box
Select this option to generate the symbol file.

[Output cross reference file] check box
Select this option to generate the cross reference file.

Refer to Chapter 6, "Linker", for details of the linker options.

4.9.3 Debugger Options



[COM Port:] list box

Select a COM port of the personal computer used to communicate with the ICE. COM1 is set by default.

[bps:] list box

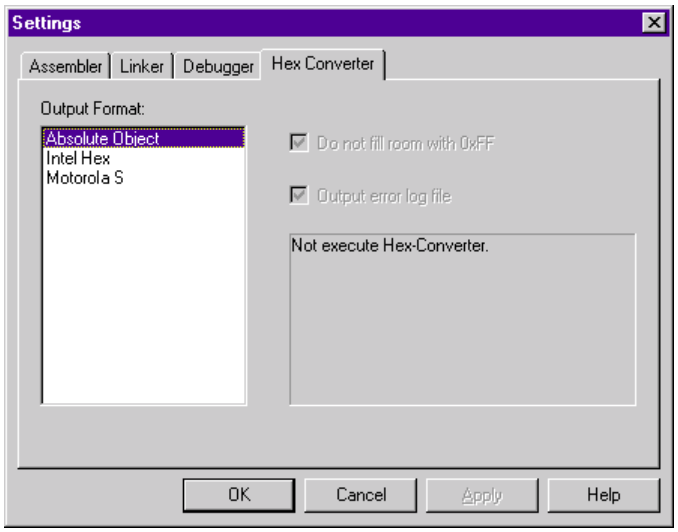
Select a baud rate to communicate with the ICE. 9600 bps is set by default.

[Initial Command:] edit box

This box is used to edit the debugger commands to be executed when the debugger starts up. The work bench generates a command file with the commands entered in this box and specifies it when invoking the debugger. A load command is initially set so that the debugger can load the object at start up.

Refer to Chapter 9, "Debugger", for details of the debugger options.

4.9.4 HEX Converter Options



[Output Format:] list box

An output format of the executable object to be generated by the build task can be selected.
When "Absolute Object" is selected, the build task will be terminated after linking has completed. The HEX converter will not be invoked.
When "Intel Hex" or "Motorola S" is selected, the HEX converter will be invoked after linking has completed. Other HEX converter options become selectable when one of them is selected.

[Do not fill room with 0xFF] check box

Select this option when not filling the unused program area with 0xFF.

[Output error log file] check box

Select this option to generate the error log file of the HEX converter.

Refer to Chapter 7, "HEX Converter", for details of the HEX converter options.

4.10 Short-Cut Key List

Key operation	Function
Ctrl + N	Creates a new document
Ctrl + O	Opens an existing document
Ctrl + F12	Opens an existing document
Ctrl + S	Saves the document
Ctrl + P	Print the active document
Ctrl + Shift + F12	Print the active document
Ctrl + Z	Undoes the last action
Alt + BackSpace	Undoes the last action
Ctrl + X	Cuts the selection and puts it on the clipboard
Shift + Delete	Cuts the selection and puts it on the clipboard
Ctrl + C	Copies the selection to the clipboard
Ctrl + Insert	Copies the selection to the clipboard
Ctrl + V	Inserts the clipboard contents at the insertion point
Shift + Insert	Inserts the clipboard contents at the insertion point
Ctrl + A	Selects the entire document
Ctrl + F	Finds the specified text
F3	Finds next
Shift + F3	Finds previous
Ctrl + H	Replaces the specified text with different text
Ctrl + G	Moves to the specified location
Ctrl + F7	Assembles the file
F7	Builds the project
Ctrl + Break	Stops the build
F5	Debugs the project
Alt + F7	Edits the project build and debug settings
Ctrl + Tab	Next MDI Window
Short-cut-key	Opens the popup menu
Shift + F10	Opens the popup menu

4.11 Error Messages

The work bench error messages are given below.

Error message	Description
<filename> is changed by another editor. Reopen this file ?	The currently opened file is modified by another editor.
Cannot create file : <filename>	The file (linker command file, debugger command file, etc.) cannot be created.
<filename> was not found	The source file cannot be found.
Cannot find ICE parameter file	The ICE parameter file cannot be found.
Cannot open file : <filename>	The source file cannot be opened.
You cannot close workspace while a build is in progress. Select the Stop Build command before closing.	The project close command or work bench terminate command is specified while the build task is being processed.
Would you like to build it ?	The debugger invoke command is specified when the build task has not already been completed.

4.12 Precautions

(1) The source file that can be displayed and edited in the work bench is limited to 16M byte size.

(2) The label search and coloring function of the work bench does not support labels that have not ended with a colon.

(3) The work bench can create a make, linker command and debugger command files, note, however, that these files or settings created with another editor cannot be input into the work bench.

CHAPTER 5 ASSEMBLER

This chapter will describe the functions of the Assembler as62 and grammar involved with the creation of assembly source files.

5.1 Functions

The Assembler as62 is a tool that constitutes the core of this software package. It assembles (translates) assembly source files and creates object files in the machine language.
The functions and features of the assembler are summarized below:

- Allows absolute and relocatable sections mixed in one source.
- Allows to develop programs in multiple sources by creating relocatable object files that can be combined by the linker.
- Can add source debugging information for source debugging on the debugger.

The assembler provides the following additional functions as well as the basic assembly functions:

- Macro definition and macro invocation
- Definition of Define name
- Operators
- Insertion of other file
- Conditional assembly
- Conversion of old-format source files created for the asm62XX into the current format.

The assembler processes source files in two stages: preprocessing stage and assembling stage. The preprocessing stage expands the additional function part described in the source file to mnemonics that can be assembled, and delivers them to a temporary file (preprocessed file). The assembling stage assemble the preprocessed file to convert the source codes into the machine codes.

5.2 Input/Output Files

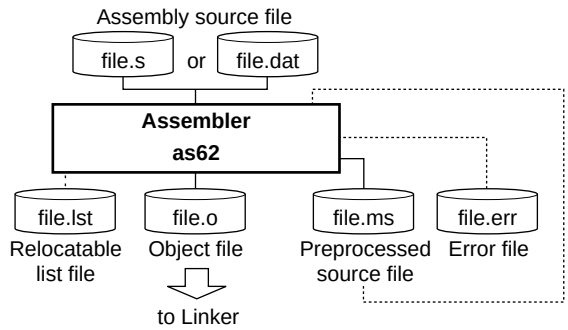


Fig. 5.2.1 Flow chart

5.2.1 Input File

Assembly source file

File format: Text file
File name: <File name>.s, <File name>.dat
<File name>.ms (A preprocessed source file created by the assembler or disassembler.)
Description: File in which a source program is described. If the file extension is omitted, the assembler finds a source file that has the specified file name and an extension ".s".
Note: The extension ".dat" is allowed for assembling source files created for an old assembler asm62XX. Extension ".s" is recommended for creating new sources. Actually a ".s" source file and a ".dat" source file can have the same contents with the new and old syntax mixed. However, if the first section does not have an absolute address specification, the section is regarded as a relocatable section in a ".s" source, while in a ".dat" source it is regarded as an absolute section and ".org 0" is placed at the beginning of the source by preprocessing.

5.2.2 Output Files

Object file

File format: Binary file in relocatable IEEE-695 format
File name: <file name>.o (The <file name> is the same as that of the input file, unless otherwise specified with -o option.)
Output destination: Current directory
Description: File in which machine language codes are stored in a relocatable form available for the linker to link with other modules and to generate an executable absolute object.

Relocatable list file

File format: Text file
File name: <file name>.lst (The <file name> is the same as that of the input file, unless otherwise specified with -o option.)
Output destination: Current directory
Description: File in which offset locations, machine language codes and source codes are stored in plain text.

Preprocessed file

File format: Text file
File name: <file name>.ms (The <file name> is the same as that of the input file, unless otherwise specified with -o option.)
Output destination: Current directory
Description: File in which instructions for preprocessing (e.g. conditional assembly and macro instructions) are expanded into an assembling format. Also the source codes described in the old syntax are converted into the new syntax.
When developing a program using old-style sources, this temporary file can be used as a base file to start creating sources in the new syntax.

Error file

File format: Text file
File name: <file name>.err (The <file name> is the same as that of the input file, unless otherwise specified with -o option.)
Output destination: Current directory
Description: File delivered when the start-up option (-e) is specified. It records error messages and other information which the assembler delivers via the Standard Output (stdout).

5.3 Starting Method

General form of command line

as62 ∧ [options] ∧ [<source file name>]

∧ denotes a space.
[ ] indicates the possibility to omit.

Source file name

In the command line, only one assembly source file can be specified at a time. Therefore, you will have to process multiple files by executing the assembler the number of times equal to the number of files to be processed.
A long file name supported in Windows and a path name can be specified. When including spaces in the file name, enclose the file name with double quotation marks (").

Options

The assembler comes provided with five types of start-up options:

-d <define name>

Function: Definition of Define name
Explanation:
- Works in the same manner as you describe "#define <define name>" at top of the source. It is an option to control the conditional assembly at the start-up.
- One or more spaces are necessary between -d and the <define name>.
- To define two or more Define names, repeat the specification of "-d <define name>".

-g

Function: Addition of debugging information
Explanation:
- Creates an output file containing symbolic/source debugging information.
- Always specify this function when you perform symbolic/source debugging.

Default: If this option is not specified, no debugging information will be added to the relocatable object file.

-o <file name>

Function: Specification of output path/file name
Explanation:
- Specifies an output path/file name without extension or with an extension ".o". If no extension is specified, ".o" will be supplemented at the end of the specified output path/file name.

Default: The input file name is used for the output files.

-l

Function: Output of relocatable list file
Explanation:
- Outputs a relocatable list file.

Default: If this option is not specified, no relocatable list file will be output.

-e

Function: Output of error file
Explanation:
- Also delivers in a file (<File name>.err) the contents that are output by the assembler via the Standard Output (stdout), such as error messages.

Default: If this option is not specified, no error file will be output.

When entering an option in the command line, you need to place one or more spaces before and after the option. The options can be specified in any order. It is also possible to enter options after the source file name.

Example: `c:\e0c62\bin\as62 -g -e -l -d TEST1 -d TEST2 test.s`

5.4 Messages

The assembler delivers all its messages through the Standard Output (stdout).

Start-up message

The assembler outputs only the following message when it starts up.

```
Assembler 62 Ver x.xx
Copyright (C) SEIKO EPSON CORP. 199x
```

End message

The assembler outputs the following messages to indicate which files have been created when it ends normally.

```
Created preprocessed source file <FILENAME.MS>
Created relocatable object file <FILENAME.O>
Created relocatable list file <FILENAME.LST>
Created error log file <FILENAME.ERR>

Assembly 0 error(s) 0 warning(s)
```

Usage output

If no file name was specified or the option was not specified correctly, the assembler ends after delivering the following message concerning the usage:

```
Usage: as62 [options] <file name>
Options: -d <symbol>    Add preprocess definition
         -e             Output error log file (.ERR)
         -g             Add source debug information in object
         -l             Output relocatable list file (.LST)
         -o <file name> Specify output file name (.O or no extension)
File name: Source file name (.DAT, .S, or .MS)
```

When error/warning occurs

If an error is produced, an error message will appear before the end message shows up.
Example:

```
TEST.S(5) Error: Illegal syntax
Assembly 1 erros(s) 0 warning(s)
```

In the case of an error, the assembler ends without creating an output file. If an error occurs at the preprocessing stage in the assembler, the assembler stops processing and outputs preprocess-level errors only.

If a warning is issued, a warning message will appear before the end message shows up.
Example:

```
TEST.S(6) Warning: Expression out of range
Assembly 0 error(s) 1 warning(s)
```

In the case of a warning, the assembler ends after creating an output file.

The source file name that was specified in the command line will appear at the beginning of the error and warning messages.
For details on errors and warnings, refer to Section 5.11, "Error / Warning Messages".

5.5 Grammar of Assembly Source

Assembly source files should be created on a general-purpose editor or the source editor of the work bench. Save sources as standard text files. For the file name, a long file name supported in Windows can be specified. Define the extension as ".s" when creating sources in the new syntax (for as62). When using source files described in the old syntax (for asm62XX), the default extension ".dat" should be used. Actually a ".s" source file and a ".dat" source file can have the same contents with the new and old syntax mixed. However, if the first section does not have an absolute address specification, the section is regarded as a relocatable section in a ".s" source, while in a ".dat" source it is regarded as an absolute section and ".org 0" is placed at the beginning of the source by preprocessing.

This section explains the rules and grammar involved with the creation of assembly source files.

5.5.1 Statements

Each individual instruction or definition of an assembly source is called a statement. The basic composition of a statement is as follows:

Syntax pattern

(1) Mnemonic	Operand	(;comment)
(2) Assembler pseudo-instruction	Parameter	(;comment)
(3) Label:		(;comment)
(4) ;comment		

Example:

```
<Statement>                                  <Syntax Pattern>
#include  "define.h"                              (2)
          .set  IO1, 0x200                        (2)

; TEXT SECTION (ROM, 12bit width)                 (4)

          .org  0x100                             (2)
START:                                            (3)
          jp    INIT    ; execute initial routine (1)
          reti                                    (1)
 :        :     :

          .org  0x110                             (2)
INIT:                                             (3)
          ld    a,0                               (1)
          ld    b,0                               (1)
 :        :     :
```

The example given above is an ordinary source description method. For increased visibility, the elements composing each statement are aligned with tabs and spaces.

Restrictions

- Only one statement can be described in one line. A description containing more than two instructions in one line will result in an error. However, a comment or a label may be described in the same line with an instruction.
  Example:
```
;OK
BOOT:     ld   a,0x4

;Error
BOOT:     ld   a,0x4     ld   b,0x0
```
- One statement cannot be described in more than one line. A statement that cannot complete in one line will result in an error.
  Example:
```
.codeword  0x0,0x1,0x2,0x3 ... OK
.codeword  0xa,0xb,0xc,0xd ... OK

.codeword  0x0,0x1,0x2,0x3
           0xa,0xb,0xc,0xd ... Error
```
- The maximum describable number of characters in one line is 259 (ASCII characters). If this number is exceeded, an error will result.
- The usable characters are limited to ASCII characters (alphanumeric symbols), except for use in comments. Also, the usable symbols have certain limitations (details below).
- The reserved words such as mnemonics and pseudo-instructions are all not case sensitive, while items definable by the user such as labels and symbols are all case sensitive. Therefore, mnemonics and pseudo-instructions can be written in uppercase (A–Z) characters, lowercase (a–z) characters, or both. For example, "ld", "LD", and "Ld" are all accepted as "ld" instructions. For purposes of discrimination from symbols, this manual uses lowercase characters for the reserved words.

5.5.2 Instructions (Mnemonics and Pseudo-instructions)

The assembler supports all the mnemonics of the S1C6200 instruction set and the assembler pseudo-instructions. The following shows how to describe the instructions.

Mnemonics

An instruction is generally composed of [mnemonic] + [operand]. Some instructions do not contain an operand.

General notation forms of instructions

General forms: **<Mnemonic>**
<Mnemonic> tab or space **<Operand>**
<Mnemonic> tab or space **<Operand1>, <Operand2>**

Examples:
```
nop5
jp   SUB1
ld   a,0x4
```

There is no restriction as to where the description of a mnemonic should begin in a line. A tab or space preceding a mnemonic is ignored.

An instruction containing an operand needs to be separated into the mnemonic and the operand with one or more tabs or spaces. If an instruction requires multiple operands, the operands must be separated from each other with one comma (,). Space between operands is ignored.

The elements of operands will be described further below.

Types of mnemonics

The following 46 types of mnemonics can be used in the S1C62 Family:

```
acpx acpy adc add and call calz cp dec di ei fan halt inc jpba jp lbpx ld
ldpx ldpy nop5 nop7 not or pop pset push rcf rdf ret retd rets rlc rrc rst
rzf sbc scf scpx scpy sdf set slp sub szf xor
```

For details on instructions, refer to the "S1C6200/6200A Core CPU Manual".

Note

The assembler is commonly used for all the S1C62 Family models, so all the instructions can be accepted. Be aware that no error will occur in the assembler even if instructions or operands unavailable for the model are described. They will be checked in the linker.

Assembler pseudo-instructions

The assembler pseudo-instructions are not converted to execution codes, but they are designed to control the assembler or to set data.
For discrimination from other instructions, all the assembler pseudo-instructions begin with a sharp (#) or a period (.).

General notation forms of pseudo-instructions

General forms: **<Pseudo-instruction>**
<Pseudo-instruction> tab or space **<Parameter>**
<Pseudo-instruction> tab or space **<Parameter1>** tab, space or comma **<Parameter2>** ...

Examples:
```
#define    SW1  1
.org       0x100
.comm      BUF  4
```

There is no restriction as to where the description of an instruction may begin in a line.

An instruction containing a parameter needs to be separated into the instruction and the parameter with one or more tabs or spaces. If an instruction requires multiple parameters, they are separated from each other with an appropriate delimiter.

Types of pseudo-instructions

The following 23 types of pseudo-instructions are available:

```
#include #define #macro #endm #ifdef #ifndef #else #endif
.align .org .page .bank .code .bss .codeword .comm .lcomm
.global .set .list .nolist .stabs .stabn
```

The assembler supports the old-format pseudo-instructions for asm62XX as well as the above instructions.
For details of each pseudo-instruction and its functionality, refer to Section 5.7, "Assembler Pseudo-Instructions".

Restriction

The mnemonics and pseudo-instructions are all not case sensitive. Therefore, they can be written in uppercase (A–Z) characters, lowercase (a–z) characters, or both. For example, "ld", "LD", and "Ld" are all accepted as "ld" instructions. However, the user defined symbols used in the operands or parameters are case sensitive. They must be the same with the defined characters.

5.5.3 Labels

A label is an identifier designed to refer to an arbitrary address in the program. It is possible to refer to a branch destination of a program or a data memory address using a symbol defined as a label.

Definition of a label

Usable labels are defined as 13-bit values by any of the following methods:

1. <Symbol>:
   Example: `LABEL1:`
   ... LABEL1 is a label that indicates the address of a described location.

   Preceding spaces and tabs are ignored. It is a general practice to describe from the top of a line.

2. Definition using the ***.comm*** or ***.lcomm*** pseudo-instruction
   Example: `.comm  BUF1  4`
   ... BUF1 is a label that represents a RAM address.

   The ***.comm*** and ***.lcomm*** pseudo instructions can define labels only in bss sections (data memory such as RAM). Program memory addresses cannot be defined.

Reference with labels

A defined symbol denotes the address of a described location.
An actual address value should be determined in the linking process, except in the case of absolute sections.
Examples:

```
LABEL1:
        :
        jp      LABEL1              ... Jumps to the LABEL1 location.

        .comm   BUF   0x04
        .code

        ld      a,BUF&0b11110000
        ld      xh,a
        ld      b,BUF&0b00001111
        ld      xl,b                ... The address defined in BUF is loaded to X register.
```

Scope

The scope is a reference range of a label. It is called local if the label is to be referenced within the same file, and it is called global if the label is to be referenced from other files.
Any defined label's scope is local in default. To make a label's scope global, use the ***.global*** pseudo-instruction both in the file in which the label is defined and in the file that references the label.
A double definition of local labels will be an error at the assembly stage, while a double definition of global labels will be an error at the link stage.
Example:

File in which global label is defined (file1)

```
        .global    SYMBOL      ... Global declaration of a label which is to be defined in this file.
SYMBOL:
           :
LABEL:                         ... Local label
           :                           (Can be referenced to only in this file)
```

File in which a global label is referenced to (file2)

```
        .global    SYMBOL      ... Global declaration of a label defined in other source file.
        call       SYMBOL      ... Label externally referenced to.
           :
LABEL:                         ... Local label
           :                           (Treated as a different label from LABEL of file1)
```

The assembler regards those labels as those of undefined addresses in the assembling, and includes that information in the object file it delivers. Those addresses are finally determined by the processing of the linker.

* When a label is defined by the ***.comm*** pseudo-instruction, that label will be a global label. Therefore, in a defined file, no global declaration needs to be made using the ***.global*** pseudo-instruction. On the contrary, in a file to be referenced, the global declaration is necessary prior to the reference.

Restrictions

- The maximum number of characters of a label is limited to 259 the same as that of one line.
- Only the following characters can be used:
  A–Z a–z _ 0–9 ?
- A label cannot begin with a numeral.
  Examples:

```
;OK                  ;Error
FOO;                 1lable:
_Abcd:               0_ABC:
L1:                  L 1:
.comm  BUF  4        .lcomm  1st_BUF  2
```

- Since labels are case sensitive, uppercase and lowercase are discriminated. When referencing a defined label, use the symbol exactly the same as the defined label.
  Examples:

```
_Abcd:
           :
        jp    _ABCD        ... Does not jump to _Abcd
```

5.5.4 Comments

Comments are used to describe a series of routines, or the meaning of each statement. Comments cannot comprise part of coding.

Definition of comment

A character string beginning with a semicolon (;) and ending with a line feed code (LF) is interpreted as a comment. Not only ASCII characters, but also other non-ASCII characters can be used to describe a comment.

Examples:
```
;This line is a comment line.
LABEL:       ;This is the comment for LABEL.
     ld  a,b ;This is the comment for the instruction on the left.
```

Restrictions

- A comment is allowed up to 259 characters, including a semicolon (;), spaces before, after and inside the comment, and a return / line feed code.
- When a comment extends to several lines, each line must begin with a semicolon.

  Examples:
```
;These are
  comment lines.     ... The second line will not be regarded as a comment. An error will result.
;These are
; comment lines.     ... Both lines will be regarded as comments.
```

5.5.5 Blank Lines

This assembler also allows a blank line containing only a return / line feed code. It need not be made into a comment line using a semicolon.

5.5.6 Register Names

The CPU register names may be written in either uppercase or lowercase letters.

Table 5.5.6.1 Notations of register names

Register/memory location/flag		Notation
A	A register	a or A
B	B register	b or B
XP	Four high-order bits of IX register	xp or XP
YP	Four high-order bits of IY register	yp or YP
X	Eight low-order bits of IX register	x or X
Y	Eight low-order bits of IY register	y or Y
XH	Four high-order bits of XHL register	xh or XH
XL	Four low-order bits of XHL register	xl or XL
YH	Four high-order bits of YHL register	yh or YH
YL	Four low-order bits of YHL register	yl or YL
SP	Stack pointer SP	sp or SP
SPH	Four high-order bits of stack pointer SP	sph or SPH
SPL	Four low-order bits of stack pointer SP	spl or SPL
MX	Data memory location whose address is specified by IX	mx or MX
MY	Data memory location whose address is specified by IY	my or MY
M0–MF	Data memory location in the register area (0x000–0x00f)	m0–mf or M0–MF
F	Flag register (IDZC)	f or F
C	Carry	c or C
NC	No carry	nc or NC
Z	Zero	z or Z
NZ	Not zero	nz or NZ

Note: These symbols are reserved words, therefore they cannot be used as user-defined symbol names.

5.5.7 Numerical Notations

This Assembler supports three kinds of numerical notations: decimal, hexadecimal, and binary.

Decimal notations of values

Notations represented with 0–9 only will be regarded as decimal numbers. To specify a negative value, put a minus sign (-) before the value.
Examples: `1  255  -3`

Characters other than 0–9 and the sign (-) cannot be used.

Hexadecimal notations of values

To specify a hexadecimal number, place "0x" before the value.
Examples: `0x1a  0xff00`

"0x" cannot be followed by characters other than 0–9, a–f, and A–F.

Binary notations of values

To specify a binary number, place "0b" before the value.
Examples: `0b1001  0b1001100`

"0b" cannot be followed by characters other than 0 or 1.

Specified ranges of values

The size (specified range) of immediate data varies with each instruction.
The specifiable ranges of different immediate data are given below.

Table 5.5.7.1 Types of immediate data and their specifiable ranges

Symbol *	Type	Decimal	Hexadecimal	Binary
p	5-bit immediate data/label	0–31	0x0–0x1f	0b0–0b11111
s	8-bit immediate data/label	0–255	0x0–0xff	0b0–0b11111111
l	8-bit immediate data	0–255	0x0–0xff	0b0–0b11111111
i	4-bit immediate data	0–15	0x0–0xf	0b0–0b1111

* These symbols are used in the instruction list of the "S1C6200/6200A Core CPU Manual" or Quick Reference.

Compatibility with the older tools

The assembler allows the notation in the old syntax for the asm62XX.
Thus the following numerical notations can be used:
nnnnB: Binary numbers
nnnnO: Octal numbers
nnnnQ: Octal numbers
nnnnH: Hexadecimal numbers

"nnnnB" (binary numbers) and "nnnnH" (hexadecimal numbers) are converted into the new format ("0bnnnn" and "0xnnnn") in the preprocessing stage.
"nnnnO" and "nnnnQ" (octal numbers) are converted into hexadecimal numbers ("0xnnnn") in the preprocessing stage.

5.5.8 Symbols

The .set and #define pseudo-instructions allow definition of values as symbols.

```
Examples:   .set      ADDR1  0x0f0      ... ADDR1 is a symbol that represents absolute address 0x0f0.
            #define   CONST  0xf        ... CONST is a symbol that represents data 0x0f.
                  :
            ld        a,CONST           ... Will be expanded into "ld  a, 0xf".
```

The defined symbols can be used for specifying the immediate data of instructions. They are expanded into the defined value in the preprocess stage and the symbol information does not output to the object file. Therefore, these symbols cannot be allowed as labels used for symbolic debugging.

Restrictions

- The maximum number of characters of a symbol is limited to 259 the same as that of one line.
- The characters that can be used are limited to the following:
  A–Z a–z _ 0–9 ?
  Note that a symbol cannot begin with a numeral. Uppercase and lowercase characters are discriminated.

5.5.9 Operators

An expression that consists of operators, numbers and / or defined symbols (including labels) can be used for specifying a number or defining a Define name (only for number definition).
The preprocess in the assembler handles expressions in signed 16-bit data and expands them as hexadecimal numbers.

Types of operators

Arithmetic operators		Examples	Old operators (for asm62XX)
+	Addition, Plus sign	+0xff, 1+2	+
-	Subtraction, Minus sign	-1+2, 0xff-0b111	-
*	Multiplication	0xf*5	*
/	Division	0x123/0x56	/
%	Residue	0x123%0x56	MOD
>>	Shifting to right	1>>2	SHR
<<	Shifting to left	0x113<<3	SHL
^H	Acquires upper 8 bits	0x1234^H	HIGH
^L	Acquires lower 8 bits	0x1234^L	LOW
()	Parenthesis	1+(1+2*5)	not available

The arithmetic operator returns the result of arithmetic operation on the specified terms.

Logical operators		Examples	Old operators
&	Bit AND	0b1101&0b111	AND
|	Bit OR	0b123|0xff	OR
^	Bit XOR	12^35	XOR
~	Bit inversion	~0x1234	NOT

The logical operator returns the result of logic operation on the specified terms.

Relational operators		Examples	Old operators
==	Equal	SW==0	EQ
!=	Not equal	SW!=0	NE
<	Less than	ABC<5	LT
<=	Less than or equal	ABC<=5	LE
>	Greater than	ABC>5	GT
>=	Greater than or equal	ABC>=5	GE
&&	AND	ABC&&0xf	not available
||	OR	ABC||0b1010	not available

The relational operator returns 1 if the expression is true, otherwise it returns 0.

Priority

The operators have the priority shown below. If there are two or more operators with the same priority in an expression, the assembler calculates the expression from the left.

1. + (plus sign), - (minus sign) — High priority
2. ^h, ^l, ~ — ↑
3. (
4. *, /, %, <<, >>
5. + (addition), - (subtraction)
6. ==, !=, <, <=, >, >=
7. &
8. |, ^
9. &&
10. || — ↓
11.) — Low priority

Examples

```
#define BLK_START  0x0
#define BLK_SIZE   16
#define BLK_END    BLK_START+BLK_SIZE-1
#define INIT_DATA  0xaa
        :
LOOP:

        ld    a,BLK_START^h>>4&0xf
        ld    xh,a
        ld    b,BLK_START^l&0xf
        ld    xl,b
        ldpx  mx,(((INIT_DATA&0x80)!=0)*2+INIT_DATA)>>4&0xf
        ldpx  mx,(((INIT_DATA&0x80)!=0)*2+INIT_DATA)&0xf
        cp    a,BLK_END>>4&0xf
        JP    NZ,LOOP
        cp    b,BLK_END&0xf
        JP    NZ,LOOP
```

Compatibility with the older tools

The assembler supports the old-type operators for the asm62XX shown in "Types of operators". They have the same priority as the corresponding new-type operators. Consequently, it is possible to use sources created for the older tools.
The old-type operators are converted into the new format in the preprocessing stage.

Precautions

- Minus numbers -1 to -32768 are handled as 0xffff to 0x8000.
- The assembler handles expressions as 16-bit data. Pay attention to the data size when using it as 4-bit immediate data, especially when it has a minus value.
  Example:
  ```
  ld  a,-2+1          ... NG. It will be expanded as "ld  a,0xffff".
  ld  a,(-2+1)&0xf    ... OK. It will be expanded as "ld  a,0xf".
  ```
- Expressions are calculated with a sign (like a signed short in C language).
  Pay attention to the calculation results of the >>, / and % operators using hexadecimal numbers.
  Example:
  ```
  #define NUM1 0xfffe/2      ... -2/2 = -1 (0xffff)
  ```
  The / and % operators can only be used within the range of +32767 to -32768.
  ```
  #define NUM2 0xfffe>>1     ... -2>>1 = -1 (0xffff)
  ```
  Mask as (0xfffe>>1)&0x7fff.
- Do not insert a space or a tab between an operator and a term.

5.5.10 Location Counter Symbol "$"

The address of each instruction code is set in the 13-bit location counter when a statement is assembled. It can be referred using a symbol "$" as well as labels. "$" indicates the current location, thus it can be used for relative branch operation. The operators can be used with this symbol similar to labels.

```
Example: jp  $                  ... Jumps to this address (means endless loop).
         jp  $+2                ... Jumps to two words after this address.
         jp  $-10               ... Jumps to 10 words before this address.
         jp  $+16+(16*(BLK>16)) ... Operators and defined symbols can be used.
```

Precaution

When the address referred to relatively with "$" is in another section, it should be noted if the intended section resides at the addressed place, because if the section is relocatable, the absolute address is not fixed until the linking is completed.

5.6 Section Management

5.6.1 Definition of Sections

The memory configuration of the S1C62 Family is divided into a ROM that contains programs written, and data memories such as data RAM and I/O memory.
A section refers to an area where codes are written (or to be mapped), and there are two types of sections in correspondence with the memories:

1. CODE section Area located within program ROM.
2. BSS section Area for dynamic data storage (built-in RAM, display memory and I/O memory).

To allow to specify these sections in a source file, the assembler comes provided with pseudo-instructions.

CODE section

The ***.code*** pseudo-instruction defines a CODE section. Statements from this instruction to another section defining instruction will be regarded as program codes, and will be so processed as to be mapped in the program ROM. The source file will be regarded as a CODE section by default. Therefore, the part that goes from top of the file, to another section will be processed as CODE section. Because this section is of 12 bits/word, 4-bit data cannot be defined.

BSS section

The ***.bss*** pseudo-instruction defines a BSS section. Statements from this instruction to another section defining instruction will be regarded as 4-bit data, and will be so processed as to be mapped in the data memory (RAM). Therefore, nothing else can be described in this area other than the symbols for referring to the address of the data memory, the area securing pseudo-instructions (***.comm*** and ***.lcomm***).
The ***.comm*** pseudo-instruction and the ***.lcomm*** pseudo-instruction are designed to define the symbol and size of a data area. Although the BSS section basically consists in a RAM area, it can as well be used as a data memory area, such as display memory and I/O memory. Since code definition in this area is meaningless in embedded type microcomputers, such as those of the S1C62 Family, nothing else can be described other than the two instructions and comments.

5.6.2 Absolute and Relocatable Sections

The assembler is a relocatable assembler that always generates an relocatable object and needs the linker to make it into an executable absolute object. However, each section in one source can be absolute or relocatable depending on how they are described. The section whose absolute address is specified with either ***.org***, ***.page*** or ***.bank*** pseudo-instruction in the source is an absolute section, while the section whose absolute address is not specified is an relocatable section. Absolute addresses of relocatable sections will be fixed by the linker. Both types of sections can be included in one source.

5.6.3 Sample Definition of Sections

```
        :
      CODE1 (Relocatable program)
        :
.bss
        :
      BSS1 (Relocatable RAM area definition)
        :
.code
        :
      CODE2 (Relocatable program)
        :
.bss
.org  0x100       ... If this specification is omitted, a BSS section begins from the address following BSS1.
        :
      BSS2 (Absolute RAM area definition)
        :
.code
        :
      CODE3 (Relocatable program)
        :
.code
.org  0x0
        :
      CODE4 (Absolute program)
        :
```

In the section definition shown above, absolute sections and relocatable sections are mixed in one source. Absolute sections are sections whose absolute addresses are specified with the ***.org*** pseudo-instructions. BSS2 and CODE4 are absolute sections. Absolute sections will be located at the place specified.

Other sections are relocatable in the sense that the absolute location addresses are not fixed at the assembly stage and will be fixed later at the linking stage.

Precautions

- When there appears in a section a statement which is designed for other section, a warning will be issued and a new section will be started according to the statement.

  Examples:
  ```
  .code
  .comm BUF 16   ... Warning; A new bss section begins
  .bss
  ld    a,b      ... Warning; A new code section begins
  ```

- One section cannot cross over a bank or page boundary.

5.7 Assembler Pseudo-Instructions

The assembler pseudo-instructions are not converted to execution codes, but they are designed to control the assembler or to set data.
For discrimination from other instructions, all the assembler pseudo-instructions begin with a character "#" or ".". The instructions that begin with "#" are preprocessed pseudo-instructions and they are expanded into forms that can be assembled. The expanded results are delivered in the preprocessed file (.ms). The original statements of the pseudo-instructions (#) are changed as comments by attaching a ";" before delivering to the file. The instruction that begins with "." are used for section and data definitions. They are not converted at the preprocessing stage.
All the pseudo-instruction characters are not case sensitive.
The following pseudo-instructions are available in the assembler:

Pseudo-instruction	Function	Old instruction
#include	Includes another source.	–
#define	Defines a constant string.	EQU
#macro–#endm	Defines a macro.	MACRO–ENDM
#ifdef–#else–#endif	Defines an assemble condition.	–
#ifndef–#else–#endif	Defines an assemble condition.	–
.align	Sets alignment of a section.	–
.org	Sets an absolute address.	ORG
.page	Sets a page number.	PAGE
.bank	Sets a bank number.	BANK
.code	Declares a CODE section (mapping to the built-in ROM).	SECTION
.bss	Declares a BSS section (mapping to the built-in RAM).	–
.codeword	Defines data in the CODE section.	DW
.comm	Secures a global area in the BSS section.	–
.lcomm	Secures a local area in the BSS section.	–
.global	Defines an external reference symbol.	–
.set	Defines an absolute address symbol.	SET
.list	Controls assembly list output.	–
.nolist	Controls assembly list output.	–
.stabs	Debugging information (source name).	–
.stabn	Debugging information (line number).	–

The assembler supports the old-type pseudo-instructions shown above.
They are converted into the new format in the preprocessing stage. The LOCAL pseudo-instruction is removed in the preprocessing stage. The END pseudo-instruction functions the same as the older tool.

5.7.1 Include Instruction (#include)

The include instruction inserts the contents of a file in any location of a source file. It is useful when the same source is shared in common among several source files.

Instruction format

#include "<File name>"

- A drive name or path name can as well be specified as the file name.
- One or more spaces are necessary between the instruction and the "<File name>".
- Character case is ignored for both ***#include*** itself and "<File name>".

Sample descriptions:

```
#include     "sample.def"
#include     "c:\E0C62\header\common.h"
```

Expansion rule

The specified file is inserted in the location where ***#include*** was described.

Precautions

- Only files created in text file format can be inserted.
- The ***#include*** instruction can be used in the including files. However, nesting is limited up to 10 levels. If this limit is surpassed, an error will result.

5.7.2 Define Instruction (#define)

Any substitute character string can be left defined as a Define name by the define instruction (***#define***), and the details of that definition can be referred to from various parts of the program using the Define name.

Instruction format

#define <Define name> [<Substitute character string>]

<Define name>:

- The first character is limited to a–z, A–Z, ? and _.
- The second and the subsequent characters can use a–z, A–Z, 0–9, ? and _.
- Uppercase and lowercase characters are discriminated. (***#define*** itself is not case sensitive.)
- One or more spaces or tabs are necessary between the instruction and the Define name.

<Substitute character string>:

- The usable characters are limited to a–z, A–Z, 0–9, ?, and _. They must not contain any space or comma (,).
  Values, mnemonics, labels, register names, and expressions using operators can also be specified.
- Uppercase and lowercase characters are discriminated.
- One or more spaces or tabs are necessary between the Define name and the substitute character string.
- The substitute character string can be omitted. In that case, NULL is defined in lieu of the substitute character string. It can be used for the conditional assembly instruction.

Sample definitions:

```
#define   TYPE1
#define   L1      LABEL_01
#define   Xreg    x

#define   CONST   (DATA1+DATA2)*2
#define   BtoA    a,b             ... Error   Comma (,) cannot be used.
```

Expansion rule

If a Define name defined appears in the source, the assembler substitutes a defined character string for that Define name.

Sample expansion:

```
#define INT_F1     0xf
#define INT_F1_RST INT_F1^0xf
#define MEMORY_X   mx
          :
        ldpx  MEMORY_X,INT_F1_RST   ... Expanded to "ldpx  mx, 0".
          :
```

Precautions

- The assembler only permits backward reference of a Define name. Therefore the name definition must precede the use of it.
- Once a Define name is defined, it cannot be canceled. However, redefinition can be made using another Define name.
  Example:

```
#define    MemX1 mx
#define    MemX2 MemX1
           ldpx  MemX2,my        ... Expanded to "ldpx  mx, my".
```

- When the same Define name is defined duplicatedly, an error will result.
- No other characters than delimiters (space, tab, line feed, and comma) can be added before and after a Define name in the source. However, an operator can be added to a Define name string without delimiters.
  Examples:

```
#define    L      LABEL
           ld     a,(L^h>>4)&0b00001111    ... Replaced with "ld  a, LABEL[7:4]".
           ld     b,(L^l)&0b00001111       ... Replaced with "ld  b, LABEL[3:0]".
```

- The internal preprocess part of the assembler does not check the validity of a statement as the result of the replacement of the character string.

5.7.3 Macro Instructions (#macro ... #endm)

Any statement string can be left defined as a macro using the macro instruction (***#macro***), and the content of that definition can be invoked from different parts of the program with the macro name. Unlike a subroutine, the part that is invoking a macro is replaced with the content of the definition.

Instruction format

#macro <Macro name> [<Dummy parameter>] [,<Dummy parameter>] ...
<Statement string>
#endm

<Macro name>:
- The first character is limited to a–z, A–Z, ? and _.
- The second and the subsequent characters can use a–z, A–Z, 0–9, ? and _.
- Uppercase and lowercase characters are discriminated. (***#macro*** itself is not case sensitive.)
- One or more spaces or tabs are necessary between the instruction and the macro name.

<Dummy parameter>:
- Dummy parameter symbols for macro definition. They are described when a macro to be defined needs parameters.
- One or more spaces or tabs are necessary between the macro name and the first parameter symbol. When describing multiple parameters, a comma (,) is necessary between one parameter and another.
- The same symbols as for a macro name are available.
- The number of parameters are limited according to the free memory space.

<Statement string>:
- The following statements can be described:
  - Basic instruction (mnemonic and operand)
  - Conditional assembly instruction
  - Internal branch label*
  - Comments
- The following statements cannot be described:
  - Assembler pseudo-instructions (excluding conditional assembly instruction)
  - Other labels than internal branch labels
  - Macro invocation

* ***Internal branch label***

A macro is spread over to several locations in the source. Therefore, if you describe a label in a macro, a double definition will result, with an error issued. So, use internal branch labels which are only valid within a macro.
- The number of internal-branch labels are limited according to the free memory space.
- The same symbols as for a macro name are available.

Sample definition:

```
#define  C_RESET   0b1101
#macro   WAIT      COUNT
         ld        a,COUNT
         rst       f,C_RESET
LOOP:
         nop5
         jp        LOOP
#endm
```

Expansion rules

When a defined macro name appears in the source, the assembler inserts a statement string defined in that location.
If there are actual parameters described in that process, the dummy parameters will be replaced with the actual parameters in the same order as the latter are arranged.
The internal branch labels are replaced, respectively, with __L0001 ... from top of the source in the same order as they appear.

Sample expansion:
When the macro WAIT shown above is defined:
Macro invocation

```
          :
        WAIT 15
          :
```

After expansion

```
          :
        ld   a,15       ;WAIT    15
        rst  f,0b1101
__L0001:
        nop5
        jp   __L0001
```

("__L0001" denotes the case where an internal branch label is expanded for the first time in the source.)

Precautions

- The assembler only permits backward reference of a macro invocation. Therefore the macro definition must precede the use of it.
- Once a defined macro name is defined, it cannot be canceled. If the same macro name is defined duplicatedly, a warning message will appear. Until it is redefined, it is expanded with the original content, and once it is redefined, it is expanded with the new content. Definition should be done with distinct names, although the program operation will not be affected.
- No other characters than delimiters (space, tab, line feed, and commas) can be added before and after a dummy parameter in a statement.
- The same character string as that of the define instruction cannot be used as a macro name.
- When the number of dummy parameters differs from that of actual parameters, an error will result.
- The maximum number of parameters and internal branch labels are limited according to the free memory space.
- "__Lnnnn" used for the internal branch labels should not be employed as other label or symbol.

5.7.4 Conditional Assembly Instructions (#ifdef ... #else ... #endif, #ifndef... #else ... #endif)

A conditional assembly instruction determines whether assembling should be performed within the specified range, dependent on whether the specified name (Define name) is defined or not.

Instruction formats

Format 1)
```
#ifdef      <Name>
            <Statement string 1>
[#else
            <Statement string 2> ]
#endif
```

If the name is defined, <Statement string 1> will be subjected to the assembling.
If the name is not defined, and #else ... <Statement string 2> is described, then <Statement string 2> will be subjected to the assembling. #else ... <Statement string 2> can be omitted.

Format 2)
```
#ifndef     <Name>
            <Statement string 1>
[#else
            <Statement string 2> ]
#endif
```

If the name is not defined, <Statement string 1> will be subjected to the assembling.
If the name is defined, and #else ... <Statement string 2> is described, <Statement string 2> will be subjected to the assembling. #else ... <Statement string 2> can be omitted.

<Name>:

Conforms to the restrictions on Define name. (See ***#define***.)

<Statement string>:

All statements, excluding conditional assembly instructions, can be described.

Sample description:

```
#ifdef   TYPE1
         ld     x,0x12
#else
         ld     x,0x13
#endif

#ifndef  SMALL
#define  SP1    0x31
#endif
```

Name definition

Name definition needs to have been completed by either of the following methods, prior to the execution of a conditional assembly instruction:

(1) Definition using the start-up option (-d) of the assembler.
Example: `as62 -d TYPE1 sample.s`

(2) Definition in the source file using the ***#define*** instruction.
Example: `#define TYPE1`

The ***#define*** statement is valid even in a file to be included, provided that it goes before the conditional assembly instruction that uses its Define name. A name defined after a conditional assembly instruction will be regarded as undefined.

When a name is going to be used only in conditional assembly, no substitute character string needs to be specified.

Expansion rule

A statement string subjected to the assembling is expanded according to the expansion rule of the other preprocessing pseudo-instructions. (If no preprocessing pseudo-instruction is contained, the statement will be output in a file as is.)

Precaution

A name specified in the condition is evaluated with discrimination between uppercase and lowercase. The condition is deemed to be satisfied only when there is the same Define name defined.

5.7.5 Section Defining Pseudo-Instructions (.code, .bss)

The section defining pseudo-instructions define one related group of codes or data and make it possible to reallocate by the groups at the later linking stage. Even if these section defining pseudo-instructions are not used, the section kind will be automatically judged by its contents and causes no error. If the new codes or data without section definition are different from the previous code or data kind, they will be taken as another new section.

.code pseudo-instruction

Instruction format

.code

Function

Declares the start of a CODE section. Statements following this instruction are assembled as those to be mapped in the program ROM, until another section is declared.
The CODE section is set by default in the assembler. Therefore, the ***.code*** pseudo-instruction can be omitted at top of a source file. Always describe it when you change a section to a CODE section.

Precautions

- A CODE section can be divided among multiple locations of a source file for purpose of definition (describing the ***.code*** pseudo-instruction in the respective start positions).
- Sections are relocatable by default unless those locations are specified with the ***.org***, ***.page*** or ***.bank*** pseudo-instructions, or more loosely with the ***.align*** pseudo-instruction.

.bss pseudo-instruction

Instruction format

.bss

Function

Declares the start of a BSS section. Statements following this instruction are assembled as those to be mapped in the RAM, until another section is declared.

Precautions

- In a BSS section, nothing else other than the ***.comm***, ***.lcomm***, and ***.org*** pseudo-instructions, symbols, and comments can be described.
- A BSS section can be divided among multiple locations of a source file for purpose of definition (describing the ***.bss*** pseudo-instruction in the respective start positions).
- A BSS section is relocatable by default unless its address is specified with the ***.org*** pseudo-instruction. It is possible to specify absolute locations for CODE sections by page number with the ***.page*** pseudo-instruction or by bank number with the ***.bank*** pseudo-instruction, or by 2^n words alignment with the ***.align*** pseudo-instruction, but only the ***.org*** and ***.align*** pseudo-instructions are applicable to BSS sections to define completely absolute location.

5.7.6 Location Defining Pseudo-Instructions (.org, .bank, .page, .align)

The absolute addressing pseudo-instructions (***.bank***, ***.page***, ***.align*** and ***.org***) work to specify absolute location of a section in different precision such as bank number level, page number level, 2^n words alignment level and complete absolute address level.

The ***.bank*** and ***.page*** pseudo-instructions are applicable to CODE section only, others are applicable to any kinds of sections (CODE and BSS sections).

.org pseudo-instruction

Instruction format

.org <Address>

<Address>:

Absolute address specification

- Only decimal, binary and hexadecimal numbers can be described.
- The addresses that can be specified are from 0 to 8,192 (0x1fff).
- One or more spaces or tabs are necessary between the instruction and the address.

Sample description:

```
.code
.org    0x0100
```

Function

Specifies an absolute address location of a CODE or BSS section in an assembly source file. The section with the ***.org*** pseudo-instruction is taken as an absolute section.

Precautions

- If an overlap occurs as the result of specifying absolute locations with the ***.org*** pseudo-instruction, an error will result.

  Examples:

```
.bss
.org  0x00
.comm RAM0  4    ... RAM secured area (0x00–0x03)
.org  0x01
.comm RAM1  4    ... Error (because the area of 0x01–0x03 is overlapped)
```

- When the ***.org*** pseudo-instruction appears in a section, a new absolute section starts at that point. The section type does not change. The ***.org*** pseudo-instruction keeps its effect only in that section until the next section definer (***.code*** or ***.bss***) or the next location definer (***.org***, ***.align***, ***.page***, or ***.bank)*** appears.

  Example:

```
      :
.code             ... The latest relocatable section definition.
      :
.org 0x100        ... Starts new absolute CODE section from address 0x100.
      :
.bss              ... This section is relocatable not affected by the ".org" pseudo-instruction.
      :
.code             ... This section is also relocatable not affected by the ".org" pseudo-instruction.
      :
```

- If the ***.org*** pseudo-instruction is defined immediately after a section definer (***.code*** or ***.bss***), the section definer does not start a new section. But ***.org*** starts a new section with the attribute of the section definer.
  Example:

```
.code           ... This does not start a new CODE section.
.org 0x100      ... This starts an absolute CODE section.
     :
```

- If the ***.org*** pseudo-instruction is defined immediately before a section definer (***.code*** or ***.bss***), it does not start a new section and makes no effect to the following sections.
  Example:

```
.code           ... The latest relocatable section definition.
     :
.org 0x100      ... This does not start a new absolute section and makes no effect.
.bss            ... The another kind (BSS) of section which is not affected by the
     :              previous ".org" pseudo-instruction in the CODE section.
.code           ... This will be an relocatable CODE section not affected by the
     :              previous ".org" pseudo-instruction.
```

.page pseudo-instruction

Instruction format

.page <Page number>

<Page number>:

Absolute page number specification

- Only decimal, binary and hexadecimal numbers can be described.
- The page numbers that can be specified are from 0 to 15 (0xf).
- One or more spaces or tabs are necessary between the instruction and the page number.

Sample description:

```
.code
.page   0x1
```

Function

Specifies an absolute page address of a CODE section in an assembly source file. The section with the ***.page*** pseudo-instruction will be located at the top of the specified page.

Precautions

- When the ***.page*** pseudo-instruction appears in a section, a new absolute section starts at that point. The section type does not change. The ***.page*** pseudo-instruction keeps its effect only in that section until the next section definer (***.code*** or ***.bss***) or the next location definer (***.org***, ***.align***, ***.page***, or ***.bank)*** appears.

  Example:

```
        :
    .code           ... The latest relocatable section definition.
        :
    .page 5         ... Starts new absolute CODE section from page 5.
        :
    .bss            ... This section is relocatable not affected by the ".page" pseudo-instruction.
        :
    .code           ... This section is also relocatable not affected by the ".page" pseudo-instruction.
        :
```

- If the ***.page*** pseudo-instruction is defined immediately after a section definer (***.code*** or ***.bss***), the section definer does not start a new section. But ***.page*** starts a new section with the attribute of the section definer.

  Example:

```
    .code           ... This does not start a new CODE section.
    .page 5         ... This starts an absolute CODE section.
        :
```

- If the ***.page*** pseudo-instruction is defined immediately before a section definer (***.code*** or ***.bss***), it does not start a new section and makes no effect to the following sections.

  Example:

```
    .code           ... The latest relocatable section definition.
        :
    .page 5         ... This does not start a new absolute section and makes no effect.
    .bss            ... The another kind (BSS) of section which is not affected by the
        :               previous ".page" pseudo-instruction in the CODE section.
    .code           ... This will be an relocatable CODE section not affected by the
        :               previous ".page" pseudo-instruction.
```

.bank pseudo-instruction

Instruction format

.bank <Bank number>

<Bank number>:

Absolute bank number specification

- Only decimal, binary and hexadecimal numbers can be described.
- The bank number that can be specified is 0 or 1.
- One or more spaces or tabs are necessary between the instruction and the bank number.

Sample description:

```
.code
.bank   1
```

Function

Specifies an absolute bank address of a CODE section in an assembly source file. The section with the ***.bank*** pseudo-instruction will be located at the top of the specified bank.

Precautions

- ***.bank*** is applicable to a CODE section only.
- When the ***.bank*** pseudo-instruction appears in a section, a new absolute section starts at that point. The section type is fixed at CODE section. The ***.bank*** pseudo-instruction keeps its effect only in that section until the next section definer (***.code*** or ***.bss***) or the next location definer (***.org***, ***.align***, ***.page***, or ***.bank)*** appears.

  Example:

```
        :
.code           ... The latest relocatable section definition.
        :
.bank 1         ... Starts new absolute CODE section from bank 1.
        :
.bss            ... This section is relocatable not affected by the ".bank" pseudo-instruction.
        :
.code           ... This section is also relocatable not affected by the ".bank" pseudo-instruction.
        :
```

- If the ***.bank*** pseudo-instruction is defined immediately after a section definer (***.code*** or ***.bss***), the section definer does not start a new section. The ***.bank*** pseudo-instruction starts a new CODE section.

  Example:

```
.code           ... This does not start a new CODE section.
.bank 1         ... This starts an absolute CODE section.
        :
```

- If the ***.bank*** pseudo-instruction is defined immediately before a section definer (***.code*** or ***.bss***), it does not start a new section and makes no effect to the following sections.

  Example:

```
.code           ... The latest relocatable section definition.
        :
.bank 1         ... This does not start a new absolute section and makes no effect.
.bss            ... The another kind (BSS) of section which is not affected by the
        :           previous ".bank" pseudo-instruction in the CODE section.
.code           ... This will be an relocatable CODE section not affected by the
        :           previous ".bank" pseudo-instruction.
```

.align pseudo-instruction

Instruction format

.align <Alignment number>

<Alignment number>:

Word alignment in 2^n value

- Only decimal, binary and hexadecimal numbers can be described.
- The alignment that can be specified is a 2^n value.
- One or more spaces or tabs are necessary between the instruction and the alignment number.

Sample description:

```
.code
.align  32      ... Sets the location to the next 32-word boundary address.
```

Function

Specifies location alignment in words of a CODE or BSS section in an assembly source file. The section with the ***.align*** pseudo-instruction can be taken as a loosely absolute section in the sense that its location is partially defined. This declaration does not allocate any memory space.

Precautions

- ***.align*** is applicable to any kinds of sections such CODE and BSS.
- When the ***.align*** pseudo-instruction appears in a section, a new absolute section starts at that point. The section type does not change. The ***.align*** pseudo-instruction keeps its effect only in that section until the next section definer (***.code*** or ***.bss***) or the next location definer (***.org***, ***.align***, ***.page***, or ***.bank)*** appears.

  Example:

```
        :
.code       ... The latest relocatable section definition.
        :
.align 32   ... Starts new loosely absolute CODE section from the next 32-word boundary address.
        :
.bss        ... This section is relocatable not affected by the ".align" pseudo-instruction.
        :
.code       ... This section is also relocatable not affected by the ".align" pseudo-instruction.
        :
```

- If the ***.align*** pseudo-instruction is defined immediately after a section definer (***.code*** or ***.bss***), the section definer does not start a new section. But ***.align*** starts a new section with the attribute of the section definer.

  Example:

```
.code       ... This does not start a new CODE section.
.align 32   ... This starts a loosely absolute CODE section.
        :
```

- If the ***.align*** pseudo-instruction is defined immediately before a section definer (***.code*** or ***.bss***), it does not start a new section and makes no effect to the following sections.

  Example:

```
.code       ... The latest relocatable section definition.
        :
.align 32   ... This does not start a new absolute section and makes no effect.
.bss        ... The another kind (BSS) of section which is not affected by the
        :       previous ".align" pseudo-instruction in the CODE section.
.code       ... This will be an relocatable CODE section not affected by the
        :       previous ".align" pseudo-instruction.
```

5.7.7 Symbol Defining Pseudo-Instruction (.set)

Instruction format

.set <Symbol>[,] <Value>

<Symbol>:

Symbols for value reference

- The 1st character is limited to a–z, A–Z, ? and _.
- The 2nd and the subsequent character can use a–z, A–Z, 0–9, ? and _.
- Uppercase and lowercase are discriminated.
- One or more spaces, or tabs are necessary between the instruction and the symbol.

<Value>:

Value specification

- Only decimal, binary, and hexadecimal numbers can be described.
- The values that can grammatically be specified are from 0 to 65,535 (0xffff).
- One or more spaces, tabs, or a comma (,) are necessary between the instruction and the value.

Sample description:

```
.set    DATA1 0x20
.set    DATA2 0xf2
```

Function

Defines a symbol for a constant value.

Precaution

When the defined symbol is used as an operand, the defined value is referred as is. Therefore, if the value exceeds the valid range of the operand, an error will result.

Example:

```
.set DATA1 0xf0
ld   x,DATA1          ... OK
ld   y,DATA1          ... OK
ld   a,DATA1          ... Error
```

5.7.8 Data Defining Pseudo-Instruction (.codeword)

.codeword pseudo-instruction

Instruction format

.codeword <Data>[,<Data> ...,<Data>]

<Data>:

12-bit data

- Only decimal, binary and hexadecimal numbers can be described.
- The data that can be specified are from 0 to 4096 (0xfff).
- One or more spaces or tabs are necessary between the instruction and the first data.
- A comma (,) is necessary between one data and another.

Sample description:

```
.code
.codeword    0xa,0xa40,0xff3
```

Function

Defines the 12-bit data to be written to the program ROM.

Precaution

The ***.codeword*** pseudo-instruction can be used only in a CODE section.

5.7.9 Area Securing Pseudo-Instructions (.comm, .lcomm)

Instruction format

.comm <Symbol>[,] <Size>
.lcomm <Symbol>[,] <Size>

<Symbol>:

Symbols for data memory access (address reference)

- The 1st character is limited to a–z, A–Z, ? and _.
- The 2nd and the subsequent character can use a–z, A–Z, 0–9, ? and _.
- Uppercase and lowercase are discriminated.
- One or more spaces or tabs are necessary between instruction and symbol.

<Size>:

Number of words of the area to be secured (4 bits / word)

- Only decimal, binary and hexadecimal numbers can be described.
- The size that can grammatically be specified is from 0 to 8,192.
- One or more spaces, tabs or a comma (,) are necessary between symbol and size.

Sample description:

```
.comm   RAM0 4
.lcomm  BUF,1
```

Function

Sets an area of the specified size in the BSS section (RAM and other data memory), and creates a symbol indicating its top address with the specified name. By using this symbol, you can describe an instruction to access the RAM.

Difference between .comm and .lcomm

The ***.comm*** pseudo-instruction and the ***.lcomm*** pseudo-instruction are exactly the same in function, but they do differ from each other in the scope of the symbols they create. The symbols created by the ***.comm*** pseudo-instruction become global symbols, which can be referred to externally from other modules (however, the file to be referred to needs to be specified by the ***.global*** pseudo-instruction). The symbols created by the ***.lcomm*** pseudo-instruction are local symbols, which cannot be referred to from other modules.

Precaution

The ***.comm*** and ***.lcomm*** pseudo-instructions can only be described in BSS sections.

5.7.10 Global Declaration Pseudo-Instruction (.global)

Instruction format

.global <Symbol>

<Symbol>:

Symbol to be defined in the current file, or symbol already defined in other module

- One or more spaces or tabs are necessary between the instruction and the symbol.

Sample description:

```
.global   GENERAL_SUB1
```

Function

Makes global declaration of a symbol. The declaration made in a file with a symbol defined converts that symbol to a global symbol which can be referred to from other modules. Prior to making reference, declaration has to be made by this instruction on the side of the file that is going to make the reference.

5.7.11 List Control Pseudo-Instructions (.list, .nolist)

Instruction format

.list
.nolist

Function

Controls output to the relocatable list file.
The ***.nolist*** pseudo-instruction stops output to the relocatable list file after it is issued.
The ***.list*** pseudo-instruction resumes from there the output which was stopped by the ***.nolist*** pseudo-instruction.

Precaution

The assembler delivers relocatable list files only when it is started up with the -l option specified. Therefore, these instructions are invalid, if the -l option was not specified.

5.7.12 Source Debugging Information Pseudo-Instructions (.stabs, .stabn)

Instruction formats

(1) .stabs "<File name>", FileName
(2) .stabn 0, FileEnd
(3) .stabn <Line number>, LineInfo

Function

The assembler outputs object files in IEEE-695 format, including source debugging information conforming to these instructions. This debugging information is necessary to perform debugging by Debugger db62, with the assembly source displayed.

Format (1) delivers information on the start position of a file.
Format (2) delivers information on the end position of a file.
Format (3) delivers information on the line No. of an instruction in a source file.

Insertion of debugging information

When the -g option is specified as a start option, the preprocess stage of the assembler will insert debugging pseudo-instructions in the preprocessed file. Therefore, you do not have to describe these pseudo-instructions in creating source files.

5.7.13 Comment Adding Function

The preprocessing pseudo-instructions that begin with "#" are all expanded to codes that can be assembled, and delivered in the preprocessed file. Even after that, those instructions are rewritten with comments beginning with a semicolon (;), so that the original instructions can be identified. However, note that the replacements of Define names will not subsist as comments.

The comment is added to the first line following the expansion. In case the original statement is accompanied by a comment, that comment is also added.
A macro definition should have a semicolon (;) placed at top of the line.

Example:

- Before expansion

```
#macro  LDM     REG,ADDR
        LD      X,ADDR
        LD      REG,MX
#endm

        LDM     A,1     ;load memory to A reg.
```

- After expansion (no debugging information)

```
;#macro  LDM     REG,ADDR
;         LD     X,ADDR
;         LD     REG,MX
;#endm

        LD      X,1     ;        LDM     A,1     ;load memory to A reg.
        LD      A,MX
```

5.7.14 Priority of Pseudo-Instructions

Some remarks concerning the priority among the preprocessing pseudo-instructions will be given below:

1. The conditional assembly instructions (***#ifdef***, ***#ifndef***) have the first priority. Nesting cannot be made of those instructions.
2. Define instruction (***#define***), include instruction (***#include***), or macro instruction (***#macro***) can be described within a conditional assembly instruction.
3. Define instruction (***#define***), include instruction (***#include***), and macro instruction (***#macro***) cannot be described within a macro definition.
4. Define name definitions are expanded with priority over macro definitions.

5.8 Summary of Compatibility with the Older Tool

The assembler provides the new features added to the old assembler asm62XX. However the compatibility with the old syntax is preserved by supporting old syntax as the synonym of the new syntax. As the result, as62 can process the old syntax sources without any modification. To realize it, the assembler accepts old syntax elements and interprets them to their equivalent counterparts in new syntax elements. The converted results are delivers to the preprocessed file (.ms).
The priority of the operators follows the old tool's priory.

The old syntax elements are handled as follows:

Numeric notation

Old	Meaning		New
####B	Binary number	→	0b####
####O	Octal number	→	0x#### (the base is converted)
####Q	Octal number	→	0x#### (the base is converted)
####H	Hexadecimal number	→	0x####

Arithmetic operators

Old	Meaning		New
+	Addition, positive	→	+
-	Subtraction, negative	→	-
*	Multiplication	→	*
/	Division	→	/
MOD	Residue	→	%
SHL	Shift left	→	<<
SHR	Shift right	→	>>
HIGH	High-order 8 bits	→	^h
LOW	Low-order 8 bits	→	^l

Logical operators

Old	Meaning		New
AND	Logical and	→	&
OR	Logical or	→	|
XOR	Logical exclusive or	→	^
NOT	Logical negation	→	~

Relation operators

Old	Meaning		New
EQ	Equal to	→	==
NE	Not equal to	→	!=
LT	Less than	→	<
LE	Less than or equal to	→	<=
GT	Greater than	→	>
GE	Greater than or equal	→	>=

Pseudo-instructions

Old	Meaning		New
CALLM	Optimized call	→	call (instruction)
JPM	Optimized jump	→	jp (instruction)
EQU	Fixed constant symbol	→	#define
SET	Redefinable constant symbol	→	.set
DW	Data definition	→	.codeword
ORG	Address location definition	→	.org
BANK	Bank location definition	→	.bank
PAGE	Page location definition	→	.page
SECTION	Section alignment	→	.align 16
END	End definition	→	(Ignore everything below END)
MACRO–ENDM	Macro definition	→	#macro–#endm
LOCAL	Local symbol declaration	→	none (will be removed)
$	Location counter	→	$

5.9 Relocatable List File

The relocatable list file is an assembly source file that carries assembled results (offset addresses and object codes) added to the first half of each line. It is delivered only when the start-up option (-l) is specified.
Its file format is a text file, and the file name, <File name>.lst. (The <File name> is the same as that of the input source file.)
The format of each line of the assembly list file is as follows:

Line No.: Address Code Source statement

Example

```
Assembler 62 ver x.xx Relocatable List File MAIN.LST Wed Apr 22 15:31:00 1998

        1:               ; main.s
        2:               ; test program (main routine)
        3:               ;
        4:
        5:               ;***** INITIAL SP ADDRESS DEFINITION *****
        6:               #define      SP_INIT_ADDR 0x80         ;SP init addr = 0x80
        7:
        8:               ;***** BOOT, LOOP *****
        9:                     .global      INIT_RAM_BLK1       ; subroutine
       10:                     .global      INC_RAM_BLK1        ; subroutine
       11:
       12:                     .org   0x100
       13:               BOOT:
       14:   0100   e08        ld     a,SP_INIT_ADDR>>4         ; set SP
       15:   0101   fe0        ld     sph,a
       16:   0102   e00        ld     a, SP_INIT_ADDR&0xf
       17:   0103   ff0        ld     spl,a
       18:   0104   400        call   INIT_RAM_BLK1             ; initialize RAM block 1
       19:               LOOP:
       20:   0105   400        call   INC_RAM_BLK1              ; increment RAM block 1
       21:   0106   000        jp     LOOP                      ; infinity loop
       22:
       23:               ;***** RAM block *****
       24:                     .bss
       25:                     .org   0x000
       26:   0000   00         .comm  RAM_BLK1,4
```

Content of line No.

The source line number from top of the file will be delivered.

Content of address

In the case of an absolute section, an absolute address will be delivered in hexadecimal number.
In the case of a relocatable section, a relative address will be delivered in hexadecimal number from top of the file.

Content of code

CODE section: The instruction (machine language) codes are delivered in hexadecimal numbers. One address corresponds with one instruction. The assembler sets the operand (immediate data) of the code that refers to unresolved address to 0. The immediate data will be decided by the linker.

BSS section: Irrespective of the size of the secured area, 00 is always delivered here.
Only the address defined for a symbol (top address of the secured area) is delivered as the address of the BSS section.

5.10 Sample Executions

Command line

```
C:\E0C62\bin\as62 -g -e -l main.s
```

Assembly source file

```
; main.s
; test program (main routine)
;

;***** INITIAL SP ADDRESS DEFINITION *****
#define      SP_INIT_ADDR 0x80         ;SP init addr = 0x80

;***** BOOT, LOOP *****
       .global      INIT_RAM_BLK1       ; subroutine
       .global      INC_RAM_BLK1        ; subroutine

       .org   0x100
BOOT:
       ld     a,SP_INIT_ADDR>>4         ; set SP
       ld     sph,a
       ld     a, SP_INIT_ADDR&0xf
       ld     spl,a
       call   INIT_RAM_BLK1             ; initialize RAM block 1
LOOP:
       call   INC_RAM_BLK1              ; increment RAM block 1
       jp     LOOP                      ; infinity loop

;***** RAM block *****
       .bss
       .org   0x000
       .comm  RAM_BLK1, 4
```

Preprocessed file

```
.stabs "C:\E0C62\test\main.s", FileName
; main.s
; test program (main routine)
;

;***** INITIAL SP ADDRESS DEFINITION *****
;#define     SP_INIT_ADDR 0x80         ;SP init addr = 0x80

;***** BOOT, LOOP *****
       .global      INIT_RAM_BLK1       ; subroutine
       .global      INC_RAM_BLK1        ; subroutine

       .org   0x100
.stabn 13, LineInfo
BOOT:
.stabn 14, LineInfo
       ld     a,0x80>>4                 ; set SP
.stabn 15, LineInfo
       ld     sph,a
.stabn 16, LineInfo
       ld     a, 0x80&0xf
.stabn 17, LineInfo
       ld     spl,a
.stabn 18, LineInfo
       call   INIT_RAM_BLK1             ; initialize RAM block 1
.stabn 19, LineInfo
LOOP:
.stabn 20, LineInfo
       call   INC_RAM_BLK1              ; increment RAM block 1
.stabn 21, LineInfo
       jp     LOOP                      ; infinity loop

;***** RAM block *****
       .bss
       .org   0x000
       .comm  RAM_BLK1, 4
.stabn 0, FileEnd
```

Assembly list file

```
Assembler 62 ver x.xx Relocatable List File MAIN.LST Wed Apr 22 15:31:00 1998

         1:                ; main.s
         2:                ; test program (main routine)
         3:                ;
         4:
         5:                ;***** INITIAL SP ADDRESS DEFINITION *****
         6:                #define      SP_INIT_ADDR 0x80   ;SP init addr = 0x80
         7:
         8:                ;***** BOOT, LOOP *****
         9:                .global      INIT_RAM_BLK1       ; subroutine
        10:                .global      INC_RAM_BLK1        ; subroutine
        11:
        12:                      .org   0x100
        13:                BOOT:
        14:   0100   e08         ld     a,SP_INIT_ADDR>>4   ; set SP
        15:   0101   fe0         ld     sph,a
        16:   0102   e00         ld     a, SP_INIT_ADDR&0xf
        17:   0103   ff0         ld     spl,a
        18:   0104   400         call   INIT_RAM_BLK1       ; initialize RAM block 1
        19:                LOOP:
        20:   0105   400         call   INC_RAM_BLK1        ; increment RAM block 1
        21:   0106   000         jp     LOOP                ; infinity loop
        22:
        23:                ;***** RAM block *****
        24:                      .bss
        25:                      .org   0x000
        26:   0000   00          .comm  RAM_BLK1,4
```

Error file

```
Assembler 62 Ver x.xx Error log file MAIN.ERR Sun May 03 11:33:39 1998

Assembler 62 Ver x.xx
Copyright (C) SEIKO EPSON CORP. 1998

Created preprocessed source file MAIN.MS
Created relocatable list file MAIN.LST
Created error log file MAIN.ERR
Created relocatable object file MAIN.O

Assembly 0 error(s) 0 warning(s)
```

5.11 Error/Warning Messages

5.11.1 Errors

When an error occurs, no object file will be generated.
The assembler error messages are delivered / displayed in the following format:

<Source file name> (<Line number>) Error : <Error message>

Example: `TEST.S(431) Error: Illegal syntax`

∗ Some error messages are displayed without a line number.

The assembler error messages are given below:

Error message	Description
Cannot open <file kind> file <FILE NAME>	The specified file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The specified file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Division by zero	The divisor in the expression is 0.
Illegal syntax	The statement has a syntax error.
Macro parameter range <macro parameter range> exceeded	The number of macro parameters has exceeded the limit.
CODE section <address> overlaps with CODE section <address>	The address is duplicated.
Multiple statements on the same line	Two or more statements were described in one line.
Nesting level limit <nesting level limit> exceeded	Nesting of #include has exceeded the limit.
Number of macro labels limit <number of macro label limit> exceeded	The number of internal branch labels has exceeded the limit.
Second definition of label <label>	The label is multiply defined.
Second definition of symbol <symbol>	The symbol is multiply defined.
Unknown label <label>	Reference was made to an undefined label.
Unknown mnemonic <name>	A non-existing instruction was described.
Unknown symbol mask <name>	The symbol mask has a description error.
Unsupported directive <directive>	A non-existing pseudo-instruction was described.

5.11.2 Warning

When a warning occurs, the assembler will keep on processing, and terminates the processing after displaying a warning message, unless any other error is produced.
The warning message is delivered / displayed in the following formats:

<Source file name> (<Line number>) Warning : <Warning message>

Example: `TEST.S(41) : Warning : Expression out of range`

The warning messages are given below:

Warning message	Description
Second definition of define symbol <symbol>	The symbol is multiply defined by #define.
Section activation expected, use <.code/.bss>	There is no section definition.
Expression out of range	The result of the expression is out of the effective range.

5.12 Precautions

(1) Nesting of the ***#include*** pseudo instruction is limited to a maximum 10 levels. If this limit is surpassed, an error will result.

(2) A maximum of 64 internal branch labels can be specified per macro and maximum 9999 internal branch labels can be expanded within one source file. If these limits are exceeded, an error will result.

(3) Other limitations such as the number of sections depend on the free memory space.

CHAPTER 6 LINKER

This chapter will describe the functions of the Linker lk62.

6.1 Functions

The Linker lk62 is a software that generates executable object files. It provides the following functions:

- Puts together multiple object modules to create one executable object file.
- Resolves external reference from one module to another.
- Relocates relative addresses to absolute addresses.
- Delivers debugging information, such as line numbers and symbol information, in the object file created after linking.
- Capable of outputting a link map file, symbol file, absolute list file and a cross reference file.
- Automatic page correction function (insertion / removal / correction of the pset instruction) for branch instructions.

6.2 Input/Output Files

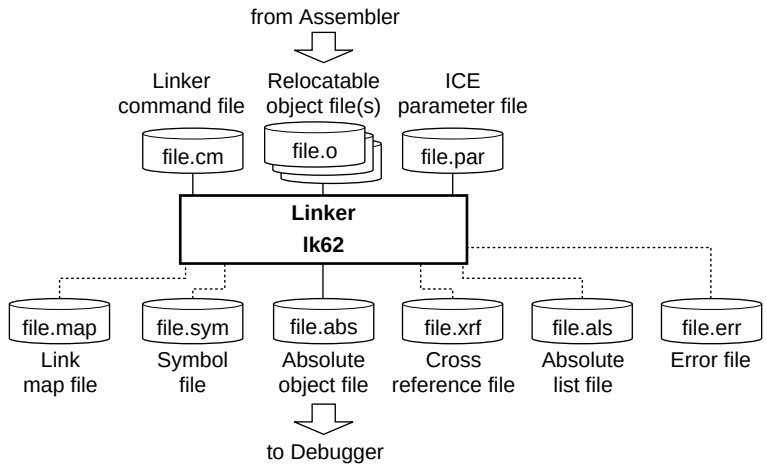


Fig. 6.2.1 Flow chart

6.2.1 Input Files

Relocatable object file

File format: Binary file in IEEE-695 format
File name: <File name>.o (A path can also be specified.)
Description: Object file of individual modules created by the assembler.

Linker command file

File format: Text file
File name: <File name>.cm (A path can also be specified.)
Description: File to specify the linker options. This makes it possible to reduce typing in a command line. This file is dispensable if all start-up options can be input in a command line.

ICE parameter file ∗ This file must always be specified.

File format: Text file
File name: <File name>.par (A path can also be specified.)
Description: File to specify the memory mapping and unsupported instruction information of each S1C62 Family model. This file is supplied in the development tools for each model and commonly used with the debugger, HEX converter and disassembler.

6.2.2 Output Files

An output file name can be specified in the command line or command file using the -o option. If no output file name is specified, the same name as that of the relocatable object file to be linked first is used.

Absolute object file

File format: Binary file in IEEE-695 format
File name: <File name>.abs
Output destination: Current directory
Description: Object file in executable format that can be input to the debugger. All the modules comprising one program are linked together in the file, and the absolute addresses that all the codes will map are determined. It also contains the necessary debugging information in IEEE-695 format.

Link map file

File format: Text file
File name: <File name>.map
Output destination: Current directory
Description: Mapping information file showing from which address of a section each input file was mapped. This file is output when the -m start-up option is specified.

Symbol file

File format: Text file
File name: <File name>.sym
Output destination: Current directory
Description: Symbols defined in all the modules and their address information are delivered to this file. This file is delivered when the -s start-up option is specified.

Cross reference file

File format: Text file
File name: <File name>.xrf
Output destination: Current directory
Description: Labels defined in all the modules and their defined and referred addresses are delivered in this file. This file is delivered when the -x start-up option is specified.

Absolute list file

File format: Text file
File name: <File name>.als
Output destination: Current directory
Description: File delivered when the start-up option (-l) is specified. The file contents are similar to the relocatable list file output by the assembler except that the location addresses are absolute and takes the form of an integrated single file.

Error file

File format: Text file
File name: <File name>.err
Output destination: Current directory
Description: File delivered when the start-up option (-e) is specified. It records the information which the linker outputs to the Standard Output (stdout), such as error messages.

6.3 Starting Method

General form of command line

lk62 ∧ [Options] ∧ [<Relocatable object files>] ∧ [<Linker command file>] ∧ <ICE parameter file>

∧ denotes a space.
[ ] indicates the possibility to omit.
The order of options and file names can be arbitrary.

File names

Files are identified with their extensions. Therefore, an appropriate extension should be included in each file name. However, the extension ".o" of the relocatable object file can be omitted.
Relocatable object files: <File name.o>
Linker command file: <File name.cm>
ICE parameter file: <File name.par>

When using a linker command file, options, relocatable object file names, an ICE parameter file name and an output file name can be described in the linker command file. If all the items to be specified are entered in a command line, the linker command file is not necessary.

When linking multiple relocatable object files from a command line, one or more spaces should be placed between the file names.

For the output file name, specify an absolute object file name (.abs). The file name will be used for other output files. If no absolute object file name is specified, the same name as that of the relocatable object file to be linked first is used as the output file name.

The ICE parameter file cannot be omitted.

A long file name supported in Windows and a path name can be specified. When including spaces in the file name, enclose the file name with double quotation marks (").

Options

The linker comes provided with the following options:

-d

Function: Disable full PSET optimization
Explanation: Disables automatic insertion / deletion / correction of the pset instructions for branch instructions (jumps and calls).
Default: If this option is not specified, the automatic page correction function will be enabled.

-dr

Function: Disable PSET deletion function
Explanation: Disables PSET deletion only among full PSET optimization (insertion / deletion / correction). This will be needed when at least the existing PSET should not be removed as in the case of a source contained jump table made up with page set and jump instructions.
Default: If this option is not specified, unnecessary pset instructions will be removed when the automatic page correction function is specified.
Note: Be sure to specify this option, if the objects need to keep compatibility with the older tool (asm62XX) that does not remove the PSET instructions.

-di

Function: Disable PSET insertion function
Explanation: Disables PSET insertion only among full PSET optimization (insertion / deletion / correction).
Default: If this option is not specified, the automatic insertion will be enabled when the automatic page correction function is specified.

-e

Function: Output of error file
Explanation: Also delivers in a file (.err) the contents to be output by the linker through the Standard Output (stdout), such as error messages.
Default: If this option is not specified, no error file will be output.

-g

Function: Addition of debugging information
Explanation:
- Creates an absolute object file containing debugging information.
- Always specify this function when you perform source display or use the symbolic debugging facility of the debugger.

Default: If this option is not specified, no debugging information will be added to the absolute object file.

-l

Function: Output of absolute list file
Explanation: Outputs an absolute list file.
Default: If this option is not specified, no absolute list file will be output.

-o <file name>

Function: Specification of output path / file name
Explanation: Specifies an output path / file name without extension or with an extension ".abs". If no extension is specified, ".abs" will be supplemented at the end of the specified output path / file name.
Default: The 1st input file name is used for the output files.

-m

Function: Output of link map file
Explanation: Outputs a link map file.
Default: If this option is not specified, no link map file will be output.

-s

Function: Output of symbol file
Explanation: Outputs a symbol file.
Default: If this option is not specified, no symbol file will be output.

-x

Function: Output of cross reference file
Explanation: Outputs a cross reference file.
Default: If this option is not specified, no cross reference file will be output.

-code <address>

Function: Set up of a relocatable CODE section start address
Explanation:
- Sets the absolute start address of a relocatable CODE section. Absolute sections remain unaffected.
- CODE sections are mapped from this address, unless otherwise specified.
- One or more spaces or tabs are necessary between -code and <address>.
- The address should be described in hexadecimal format (0x####).

Default: If this option is not specified, the CODE section will begin from the program ROM physical start address specified with the ICE parameter file.
Sample description: `-code 0x100`

-bss <address>

Function: Set up of a relocatable BSS section start address

Explanation:
- Sets the absolute start address of a relocatable BSS section. Absolute sections remain unaffected.
- BSS sections are mapped from this address, unless otherwise specified.
- One or more spaces or tabs are necessary between -bss and <address>.
- The address should be described in hexadecimal format (0x####).

Default: If this option is not specified, the BSS section will begin from the RAM physical start address specified with the ICE parameter file.

Sample description: `-bss 0x000`

-rcode <file name>=<address>

Function: Set up of the file-specific CODE section start address

Explanation:
- Sets the absolute address to map the CODE section of the specified module. This command serves to specify a module having a code to be fixed at a specific address, such as the interrupt vector. Absolute sections in the specified file remain unaffected.
- One or more spaces or tabs are necessary between -rcode and <file name>.
- The address should be described in hexadecimal format (0x####).

Default: If this option is not specified, the CODE section of each module is mapped continuously from the address that was set by the -code option.

Sample description: `-rcode test1.o = 0x0110`

-rbss <file name>=<address>

Function: Set up of the file-specific BSS section start address

Explanation:
- Sets the absolute address to map the BSS section of the specified module. This command serves to specify a module having a symbol to be fixed at a specific address of the RAM. Absolute sections in the specified file remain unaffected.
- One or more spaces or tabs are necessary between -rbss and <file name>.
- The address should be described in hexadecimal format (0x####).

Default: If this option is not specified, the BSS section of each module is mapped continuously from the address that was set by the -bss command.

Sample description: `-rbss test1.o = 0x100`

When inputting an option in the command line, one or more spaces are necessary before and after the option.

Example: `c:\e0c62\lk62 -g -e -s -m test1.o test2.o -o test.abs ics62xxp.par`

6.4 Messages

The linker delivers all its messages to the Standard Output (stdout).

Start-up message

The linker outputs only the following message when it starts up.

```
Linker 62 Ver x.xx
Copyright (C) SEIKO EPSON CORP. 199x
```

End message

The linker outputs the following messages to indicate which files has been created when it ends normally.

```
Created absolute object file <FILENAME.ABS>
Created absolute list file <FILENAME.ALS>
Created map file <FILENAME.MAP>
Created symbol file <FILENAME.SYM>
Created cross reference file <FILENAME.XRF>
Created error log file <FILENAME.ERR>

Link 0 error(s) 0 warning(s)
```

Usage output

If no file name was specified or an option was not specified correctly, the linker ends after delivering the following message concerning the usage:

```
Usage: lk62 [options] <object files.O> <ICE param file.PAR> <command file.CM>
Options: -d                          Disable all branch optimizations
         -di                         Disable insertion of branch extension
         -dr                         Disable removal of branch extension
         -e                          Output error log file (.ERR)
         -g                          Add source debug information
         -l                          Output absolute list file (.ALS)
         -m                          Output map file (.MAP)
         -o <file name>              Specify output file name
         -s                          Output symbol file (.SYM)
         -x                          Output cross reference file (.XRF)
         -code <address>             Specify CODE start address
         -bss <address>              Specify BSS start address
         -rcode <file name>=<address> Specify CODE start address of the file
         -rbss <file name>=<address>  Specify BSS  start address of the file
```

When error/warning occurs

If an error takes place, an error message will appear before the end message shows up.

Example:

```
Error: Cannot open file TEST.CM
Link 1 error(s) 0 warning(s)
```

In the case of an error, the linker ends without creating an output file.

If a warning is issued, a warning message will appear before the end message shows up.

Example:

```
Warning: No symbols found
Link 0 error(s) 1 warning(s)
```

In the case of a warning, the linker ends after creating an output file, but the result cannot be guaranteed.

For details on errors and warnings, refer to Section 6.12, "Error / Warning Messages".

6.5 Linker Command File

To simplify the keystroke in the command line at the time of start up, execute the link processing through the linker by inputting a linker command file (.cm) that holds the necessary specifications (options and file names) described.

Sample linker command file

```
-e                      ; Generate error file
-g                      ; Add debug information
-code 0x0100            ; Fix CODE section start address
-rcode test2.o = 0x0110 ; Fix CODE section start position of test2.o
-bss 0x00e0             ; Fix BSS section start address

-o test.abs             ; Specify output file name
test1.o                 ; Specify input file 1
test2.o                 ; Specify input file 2
```

Create the linker command file with the following rules:

File format

The linker command file is a general text format as shown above.
".cm" should be used for the file name extension.

Option description

All options should begin with a hyphen (-). Each individual option needs to be delineated with more than one space, tab, or line feed. For better visibility, it is recommended to describe each option in a separate line.

Notes:
- *A numeric value to specify an address should be described in the hexadecimal format (0x####). Decimal and binary notations will not be accepted.*
- *When an option that is only permitted in single setting is specified in a duplicated manner, the last entered option will be effective.*

  Example:
  ```
  -code 0x0000
  -code 0x0100
  ```
  ... -code 0x0100 is effective.

Input file specification

Describe the relocatable object file names at the end of the link command file. The mapping by linking takes place in described order, unless otherwise specified.
The extension (.o) of the relocatable object files can be omitted.

Comment

A comment can be described in the linker command file.
As in the source file, the character string from a semicolon (;) to the end of the line is regarded as a comment.

Blank line

A blank line carrying only blank characters and a line feed will be ignored. It need not be converted to a comment using a semicolon.

6.6 Link Map File

The link map file serves to refer to the mapping information for the modules of each section. It is output if the -m option is specified.
The file format is a text file, and its file name is "<File name>.map". (<File name> is the same as that of the output object file.)

Sample link map file

```
Linker 62 ver x.xx Link map file "TEST.MAP" Sun May 03 14:16:16 1998

CODE section map of "TEST.ABS"
Index  Page  Start   End     Size   Pset  Type File         SecNbr
    1: 0x00  0x0000  0x00ff  0x0100  ---   ---  ------------ ---
    2: 0x01  0x0100  0x0108  0x0009   +2  Abs  MAIN.S       1
    3: 0x01  0x0109  0x01ff  0x00f7  ---   ---  ------------ ---
    4: 0x02  0x0200  0x020f  0x0010   +0  Rel  SUB.S        2
    5: 0x02  0x0210  0x02ff  0x00f0  ---   ---  ------------ ---
    6: 0x03  0x0300  0x03ff  0x0100  ---   ---  ------------ ---
    7: 0x04  0x0400  0x04ff  0x0100  ---   ---  ------------ ---
    8: 0x05  0x0500  0x05ff  0x0100  ---   ---  ------------ ---
    9: 0x06  0x0600  0x06ff  0x0100  ---   ---  ------------ ---
   10: 0x07  0x0700  0x07ff  0x0100  ---   ---  ------------ ---
   11: 0x08  0x0800  0x08ff  0x0100  ---   ---  ------------ ---
   12: 0x09  0x0900  0x09ff  0x0100  ---   ---  ------------ ---
   13: 0x0a  0x0a00  0x0aff  0x0100  ---   ---  ------------ ---
   14: 0x0b  0x0b00  0x0bff  0x0100  ---   ---  ------------ ---
   15: 0x0c  0x0c00  0x0cff  0x0100  ---   ---  ------------ ---
   16: 0x0d  0x0d00  0x0dff  0x0100  ---   ---  ------------ ---
   17: 0x0e  0x0e00  0x0eff  0x0100  ---   ---  ------------ ---
   18: 0x0f  0x0f00  0x0fff  0x0100  ---   ---  ------------ ---

     Total: 0x19 occupied, 0xfe7 blank

BSS section map of "TEST.ABS"
Index  Start  End    Size  Type  File         SecNbr
    1: 0x000  0x003  0x004  Abs  MAIN.S       3
    2: 0x004  0xfff  -----  ---  ------------ ---

     Total: 0x4 occupied, 0xffc blank
```

Contents of link map file

Index	Indicates the index number of the section.
Page	Indicates the page number in which the section is allocated.
Start	Indicates the start address of the section.
End	Indicates the end address of the section.
Size	Indicates the size of the section.
Pset	Indicates the number of pset instructions that are inserted or removed.
Type	Indicates the section type: Rel = relocatable section and Abs = absolute section.
File	Indicates the file names of the linked module.
SecNbr	Indicates the section number.
Total	Indicates the total map size and the unused area size.

"---" in the Size, Pset, Type, File and SecNbr columns indicate that no section is allocated.

6.7 Symbol File

The symbol file serves to refer to the labels defined in all the modules and their address information. It is delivered if the -s start-up option is specified.
The file format is a text file, and its file name is "<File name>.sym". (<File name> is the same as that of the output object file.)

Sample symbol file

```
Linker 62 ver x.xx Symbol file "TEST.SYM" Sun May 03 14:16:16 1998

CODE section labels of "TEST.ABS"
Address Type   File          Symbol
0x0100  Local  "MAIN.O" .... BOOT
0x0206  Global "SUB.O" ..... INC_RAM_BLK1
0x0200  Global "SUB.O" ..... INIT_RAM_BLK1
0x0106  Local  "MAIN.O" .... LOOP

BSS section labels of "TEST.ABS"
Address Type   File          Symbol
0x000   Global "MAIN.O" .... RAM_BLK1
```

Contents of symbol file

Symbol Indicates all the defined labels in in alphabetical order.

Address Indicates the absolute address defined for the label.

Type Indicates the scope of the label: Global or Local.

File Indicates the object file in which the labal has been defined.

6.8 Absolute List File

The absolute list file is an assembly source file that carries the absolute addresses and object codes added to the first half of each line. It is delivered only when the -l option is specified. Its file format is a text file, and the file name is <file name>.als. (The <file name> is the same as that of the output object file.) While a relocatable list file can be made for each assembly source file, the absolute list file is made as a single file integrating all the linked objects and their according sources.

Sample absolute list file

```
Linker 62 ver x.xx Absolute list file "TEST.ALS" Sat May 30 07:53:14 1998

         1:                     ; main.s
         2:                     ; test program (main routine)
         3:                     ;
         4:
         5:                     ;***** INITIAL SP ADDRESS DEFINITION *****
         6:                     #define      SP_INIT_ADDR 0x80         ;SP init addr = 0x80
         7:
         8:                     ;***** MACRO DEFINITION
         9:                     #macro CL_AB
        10:                            ld     a,0
        11:                            ld     b,0
        12:                     #endm
        13:
        14:                     ;***** BOOT, LOOP *****
        15:                            .global      INIT_RAM_BLK1       ; subroutine
        16:                            .global      INC_RAM_BLK1        ; subroutine
        17:
        18:                            .org   0x100
        19:                     BOOT:
        20:   0100   e08               ld     a,SP_INIT_ADDR>>4         ; set SP
        21:   0101   fe0               ld     sph,a
        22:   0102   e00               ld     a, SP_INIT_ADDR&0xf
        23:   0103   ff0               ld     spl,a
        24:   0104   e42 (+)           pset 0x2
        25:   0105   400               call   INIT_RAM_BLK1             ; initialize RAM block 1
        26:                            CL_AB
        27:   0106   e00          +    ld     a,0                       ;      CL_AB
        28:   0107   e10          +    ld     b,0
        29:                     LOOP:
        30:   0108   e42 (+)           pset 0x2
        31:   0109   406               call   INC_RAM_BLK1              ; increment RAM block 1
        32:   010a   008               jp     LOOP                      ; infinity loop
         :      :     :                        :
```

Contents of absolute list file

The format of each line of the absolute list file is as follows:

Line No. Absolute address Code Source statement

Line No. Indicates the line number from the top of the file.
Address Indicates the absolute address after the instruction is allocated.
Code Indicates the object code.
Source The contents of the assembly source file are delivered.

Results of automatic pset insertion/deletion/correction

As the result of automatic pset insertion / deletion / correction, the pset instruction may be coded without accordance to the source part. To show the result of such code optimizations clearly, the following description will be made on an absolute list file.

When "pset" is inserted:

"(+)" is placed to the right of the code part. There is no original source for the code but the disassembled "pset <bank / page number>" is delivered at the source part.

When "pset" is deleted:

"(-)" is placed to the left of the original source part. The original statement appears at the source part in the list file but no code is delivered.

When the operand of "pset" is corrected:

"(*)" is placed to the left of the source statement.

Instructions preprocessed in the assembler

The instructions expanded in the assembler (macros, include sources, JPM instruction and CALLM instruction) are listed with a "+".

6.9 Cross Reference File

The cross reference file enumerates all the address labels with their absolute addresses and all the addresses where the address labels are referred to. It is delivered only when the -x option is specified. Its file format is a text file, and the file name is <file name>.xrf. (The <file name> is the same as that of the output object file.)

Sample cross reference file

```
Linker 62 ver x.xx Cross reference file "TEST.XRF" Sun May 03 14:16:16 1998

Label "RAM_BLK1" at 0x000  "MAIN.O"  BSS, Global
   0x0200  "SUB.O"  CODE
   0x0202  "SUB.O"  CODE
   0x0206  "SUB.O"  CODE
   0x0208  "SUB.O"  CODE

Label "BOOT" at 0x0100  "MAIN.O"  CODE, Local

Label "LOOP" at 0x0106  "MAIN.O"  CODE, Local
   0x0108  "MAIN.O"  CODE

Label "INIT_RAM_BLK1" at 0x0200  "SUB.O"  CODE, Global
   0x0105  "MAIN.O"  CODE

Label "INC_RAM_BLK1" at 0x0206  "SUB.O"  CODE, Global
   0x0107  "MAIN.O"  CODE
```

Contents of cross reference file

The format of each label information is as follows:

Label information
    Address File name Type
      :   :

Label information
: Indicates the following information:
- Label name
- Defined address
- Object file in which the label is defined.
- Section type
- Scope

Address : Indicates the address where the label is referred.

File : Indicates the object file in which the label is referred.

Type : Indicates the type of section that contains the address where the label is referred.

6.10 Linking

Linking rules

The linking process takes place in conformity with the following rules:

- Absolute sections are mapped ahead of relocatable sections, according to the absolute addresses which were defined at the time of assembling. If an absolute section exceeds the available memory area, an error will occur.
- The relocatable sections in the file of which the section start address was specified with an option (-rcode, -rbss) are mapped from the specified address. Other relocatable sections are mapped from top of the relocatable CODE/BSS section.
- Basically, the relocatable sections except those that are specified with the -rcode or -rbss option are arranged successively in the order of processing. However, if a relocatable section cannot be mapped subsequent to the previous mapped section, for instance, there is unused area indicated by the ICE parameter file, an already mapped absolute section or if there is a page boundary, the linker searches another area to map the section. If there is no available area, an error will occur. A section is not divided into two or more blocks when it is mapped.
  After that, another section may be mapped in the vacant area if it is possible to map there.
  If the -or option is specified, the linker tries to arrange as much as possible, a relocatable section in the same page as the section that has many branching relationships in order to decrease unnecessary pset instructions.

Restrictions on linking

Note that all sections may not be mapped depending on each section size or address specifications even if the relocatable object size is within the available memory size.

Example of linking

A sample case where two relocatable object files, "test1.o" and "test2.o", are linked together under the following condition is described further below.

Memory configuration of the model

ROM: 8K words (0x0000 to 0x1fff; 16 pages × 2 banks)
RAM: 3,585 words (0x000 to 0xdff; 14 pages)
I/O memory: 512 words (0xe00 to 0xfff; 2 pages)

Relocatable object files

test1.o

CODE1	(relocatable)	
BSS1	(relocatable)	
CODE2	(absolute 0x000–)	(.org is used.)
BSS2	(absolute 0xe00–)	(.org is used.)

test2.o

CODE3	(relocatable)	
BSS3	(absolute 0xf00–)	(.org is used.)
CODE4	(relocatable)	
BSS4	(relocatable)	

Fig. 6.10.1 Structure of sample relocatable files

Sample linker command file

```
-code 0x0100           ; Relocatable CODE section start address
-rcode test2.o = 0x0110; CODE section start address of test2.o
-bss 0x0500            ; Relocatable BSS section start address
-rbss test2.o = 0x600  ; BSS section start address of test2.o
-o test.abs            ; Output file name
test1.o                ; Input file 1
test2.o                ; Input file 2
```

When linking is executed with the commands defined above, the linker maps the sections of each module in the manner graphically presented in Figure 6.10.2.

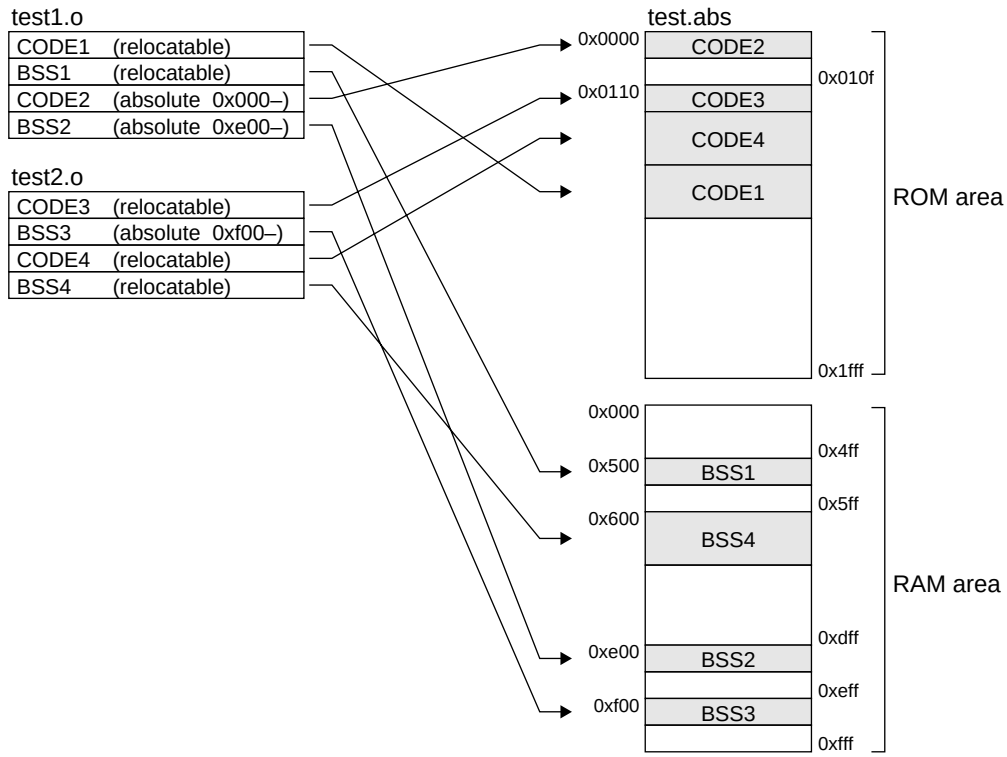


Fig. 6.10.2 Example of linking

The absolute sections CODE2, BSS2 and BSS3 are mapped to the location specified in the source files. The start addresses of the relocatable sections in "test2.o" is specified by the -rcode and -rbss options, so CODE3 is mapped from address 0x110 and CODE 4 follows CODE3. BSS4 is mapped from address 0x600.

Since the start addresses of the relocatable CODE and BSS sections in "test1.o" have not been specified, they are mapped from the relocatable section start addresses specified by the -code and -bss options. First the linker will try to map CODE1 from address 0x0100 to address 0x010f. If CODE2 is smaller than 0x100 words and CODE 1 is smaller than 0x10 words, CODE1 can be mapped from address 0x0100. In this example, CODE1 is mapped behind CODE4 because CODE1 is larger than 0x10 words. When the -or option is specified, the linker will try to map CODE1 in the same page as one of the already mapped sections that has many branching relationships.

BSS1 is mapped from address 0x500, however it may be mapped behind BSS4 if BSS1 is larger than 0x100 words.

A section cannot be overlapped to other sections, therefore an error will occur if there is no free area larger than the section size. For example, an error will occur if CODE2 is larger than 0x110 words.

6.11 Automatic Insertion/Removal/Correction of "pset" Instruction

To branch the program sequence to another page, the pset instruction is required immediately before a branch instruction (jp or call) is executed. Since the location of relocatable sections is not decided until the linking process is completed, the linker has a function that automatically inserts, removes or corrects the pset codes. This makes it possible to omit the pset instruction in the source. However, this function is valid only for the branch instructions that use a label to specify the destination address.
This function can be disabled by specifying the -d option. The -dr option can also be specified to disable only the pset deletion function (in the case of the -d option is not specified). To keep compatibility with the older assembler asm62XX (when the sources for the asm62XX are used), the -dr option must be specified.

For jp instruction

First the linker checks if the destination label and the jp instruction are within the same page.
If the label exists in the same page, the linker does not insert the pset code, or remove the existing one for the jp instruction.
When the label exists in another bank / page, the linker inserts the adequate pset instruction code in front of the jp instruction, or corrects the bank / page number in the pset code if the pset code has a wrong operand.
Examples:

Original (source)		After corrected (disassembled code)	
`ld`	`a,b`	`ld`	`a,b`
`jp`	`OTHER_PAGE`	`pset`	`XX` ... Necessary "pset XX" instruction is inserted.
		`jp`	`OTHER_PAGE`
`pset`	`YY`	`jp`	`SAME_PAGE`
`jp`	`SAME_PAGE`		... "pset YY" is removed if unnecessary. Even when "pset YY" is necessary, YY is checked and corrected if wrong.

For call instruction

Subroutine calls between banks are not allowed because the return instructions cannot handle bank numbers. Therefore if a wrong call is made between banks, an error will result. This occurs only when the section that calls the subroutine and the section in which the subroutine exists are absolute sections and are in different banks. Relocatable sections are located so that a cross bank call does not occur. If the subroutine call is made within the same bank, the optimization process is the same as that for the jp instruction.
Examples:

Original (source)		After corrected (disassembled code)	
`ld`	`a,b`	`ld`	`a,b`
`call`	`SUBROUTINE`	`pset`	`XX`
		`call`	`SUBROUTINE`
			... Necessary "pset XX" instruction is inserted. If both the subroutine and current section are absolute and are in different banks, an error will result.
`pset`	`YY`	`call`	`SUBROUTINE`
`call`	`SUBROUTINE`		... "pset YY" is removed if unnecessary. Even when "pset YY" is necessary, YY is checked and corrected if wrong. If both the subroutine and current section are absolute and are in different banks, an error will result.

∗ If the -dr option is specified, existing pset instructions will not be removed.

6.12 Error/Warning Messages

6.12.1 Errors

When an error occurs, the linker will immediately terminate the processing after displaying an error message. No object file will be output. Other files will be delivered only in the part which was processed prior to the occurrence of the error.
The error messages are given below.

Error message	Description
CALL for different bank at <address>	The call instruction calls a subroutine in another bank.
CALZ for non zero page at <address>	The calz instruction calls a subroutine in another bank or another page other than page 0.
Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Illegal file name <FILE NAME>	The file name is incorrect.
Illegal file name <FILE NAME> specified with option <option>	The file name specified with the option is incorrect.
Illegal object format <FILE NAME>	The input file is not an object file in IEEE-695 format.
Illegal option <option>	An illegal option is specified.
CODE section <address> - <address> overlaps with <section type> section <address> - <address>	The address range of the section is duplicated.
No address specified with option <option>	Address is not specified with the option.
No code to locate	There is no valid code for mapping.
No ICE parameter file specified	ICE parameter file is not specified.
No name and address specified with option <option>	Name and address are not specified with the option.
No object file specified	Object files to be linked are not specified.
CODE section <address> - <address> crossed page boundary	The CODE section is across the page boundary.
<section type> section <address> - <address> overlaps with the unavailable memory	The section exceeds the valid memory range.
Unusable instruction code <operation code> at <address> <object file name>	An undefined code is used.
Unresolved external <label> in <FILE NAME>	Reference was made to an undefined symbol.
Branch destination too far from <address>	A destination address in another page is specified.

6.12.2 Warning

Even when a warning appears, the linker continues with the processing. It completes the processing after displaying a warning message, unless, in addition, an error takes place. The output files will all be delivered, but the operation of the program cannot be guaranteed.
The warning messages and their contents are given below.

Warning message	Description
Cannot create <file kind> file <FILE NAME>	Symbols cannot be found.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Second definition of label <label> in <FILE NAME>	The label has already been defined.

6.13 Precautions

(1) Upper limits, such as a maximum section count and the number of objects to be linked, depend on the free memory space.

(2) The -dr option (disabling pset deletion) is provided to keep compatibility with the older assembler asm62XX. It must be specified to create the same object as one that is created with the asm62XX.

(3) To load the absolute object file created by the linker to the debugger, the same ICE parameter file must be specified when the debugger is invoked.

CHAPTER 7 HEX CONVERTER

This chapter will describe the functions of Hex Converter hx62.

7.1 Functions

Hex Converter hx62 converts an absolute object file in IEEE-695 format output from the linker into a hex file in Intel-HEX format or Motorola-S format. This conversion is needed when debugging the program with the ROM or when creating mask data using the mask data checker provided for each model.
When creating the ROM-image hex data, the hex converter fills the unused area of each model with 0xff.

7.2 Input/Output Files

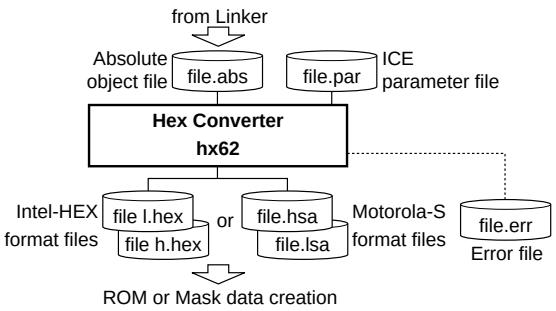


Fig. 7.2.1 Flow chart

7.2.1 Input Files

Absolute object file

File format: Binary file in IEEE-695 format
File name: <File name>.abs (A path can also be specified.)
Description: Absolute object file created by the linker.

ICE parameter file * This file must always be specified.

File format: Text file
File name: <File name>.par (A path can also be specified.)
Description: File to specify the memory mapping information of each S1C62 Family model. This file is supplied in the development tools for each model and is commonly used with the linker, debugger and disassembler.

7.2.2 Output Files

Hex file

File format: Text file in Intel-HEX or Motorola-S format
File name: Intel-HEX format <File name>h.hex and <File name>l.hex
Motorola-S format <File name>.hsa and <File name>.lsa
Output destination: Current directory
Description: Two hex files are generated: one ("h.hex" or ".hsa") contains the four high-order bits of the object codes with 0b0000 extended and the other ("l.hex" or ".lsa") contains the eight low-order bits. Intel-HEX format files are delivered by default. Motorola-S format files can be specified using the -m option.

Error file

File format: Text file
File name: <File name>.err
Output destination: Current directory
Description: File that is delivered when the start-up option (-e) is specified. It records information that the hex converter outputs to the Standard Output (stdout), such as error messages.

7.3 Starting Method

General form of command line

hx62 ∧ [Options] ∧ <Absolute object file name> ∧ <ICE parameter file name>

∧ denotes a space.
[ ] indicates the possibility to omit.
The order of options and file names can be arbitrary.

File names

Absolute object file: <File name>.abs
ICE parameter file: <File name>.par

The extension of an absolute object file can be omitted. The ICE parameter file must be specified with its extension.

A long file name supported in Windows and a path name can be specified. When including spaces in the file name, enclose the file name with double quotation marks (").

Options

The hex converter comes provided with the following four types of start-up options:

-b

Function: Conversion of existing codes only
Explanation: Converts and delivers only the object codes that exist in the specified absolute object file. Data for unused addresses is not delivered.
Default: If this option is not specified, the hex data for the entire available memory range of the model is delivered to the output file. Unused addresses are filled with 0xff.

-e

Function: Output of error files
Explanation: Also delivers in a file the contents to be output by the hex converter through the Standard Output (stdout), such as error messages.
Default: If this option is not specified, no error file will be output.

-m

Function: Conversion into Motorola-S format
Explanation: Generates the hex files (".hsa" and ".lsa") in Motorola-S format.
Default: If this option is not specified, Intel-HEX format files ("h.hex" and "l.hex") are generated.

-o <file name>

Function: Specification of output path / file name
Explanation: Specifies an output path / file name without extension or with an extension "l.hex", "h.hex", ".lsa" or ".hsa". By specifying only one file name, two HEX files will be generated.
If no extension is specified, an appropriate extension will be supplemented at the end of the specified output path / file name. In this case, "l.hex" or "h.hex" is added to the output file name. It may change a DOS file name (8 character max.) to a long file name for Windows.
Default: The input file name is used for the output files.

When entering an option in the command line, one or more spaces are necessary before and after the option.
Example: `c:\e0c62\bin\hx62 -e test.abs ics62xxp.par`

7.4 Messages

The hex converter delivers all its messages via the Standard Output (stdout).

Start-up message

The hex converter outputs only the following message when it starts up.

```
Hex converter 62 Ver x.xx
Copyright (C) SEIKO EPSON CORP. 199x
```

End message

The hex converter outputs the following messages to indicate which files have been created when it ends normally.

```
Created hex file <FILE NAME>H.HEX
Created hex file <FILE NAME>L.HEX
Created error log file HX62.ERR

Hex conversion 0 error(s) 0 warning(s)
```

Usage output

If no file name was specified or an option was not specified correctly, the hex converter ends after delivering the following message concerning the usage:

```
Usage: hx62 [options] <file names>
Options: -b             Do not fill room with 0xff
         -e             Output error log file (HX62.ERR)
         -m             Use Motorola-S format
         -O <file name> Output file name (L/H.HEX, .L/HSA or no extension)
File name: Absolute object file (.ABS)
           ICE parameter file (.PAR)
```

When error/warning occurs

If an error occurs, an error message will appear before the end message shows up.

Example:

```
Error : No ICE parameter file specified
Hex conversion 1 error(s) 0 warning(s)
```

In the case of an error, the hex converter ends without creating an output file.

If a warning is issued, a warning message will appear before the end message shows up.

Example:

```
Warning : Output file name conflict
Hex conversion 0 error(s) 1 warning(s)
```

In the case of a warning, the hex converter ends after creating the output files, but the result cannot be guaranteed.

For details on errors and warnings, refer to Section 7.6 "Error / Warning Messages".

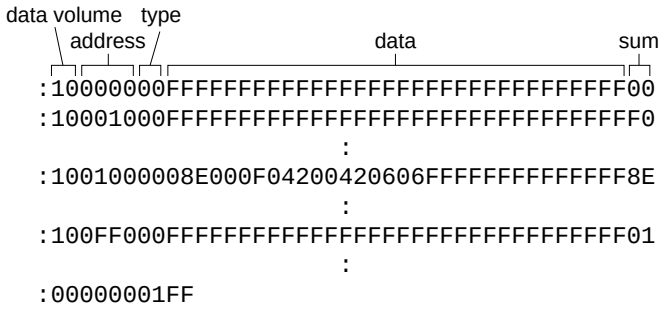
7.5 Output Hex Files

7.5.1 Hex File Configuration

Since each S1C6200 instruction has a 12-bit code, the hex converter always generates two hex files for the high-order data and the low-order data.
The low-order data hex file ("l.hex" or ".lsa") contains the low-order bytes (bits 7 to 0) of the object codes.
The high-order data hex file ("h.hex" or ".hsa") contains the high-order bytes (bits 11 to 8 suffixed by high-order bits 0b0000).
When creating the ROMs to be installed to the ICE or the Evaluation Board, write these files using a ROM writer.
By specifying the -m option, the hex converter can convert the absolute object file into Motorola-S format files as well as Intel-HEX format. However, use Intel-HEX format when loading the hex files to the debugger or creating the mask data by the mask data checker because the debugger and mask data checker do not support Motorola-S format files.

7.5.2 Intel-HEX Format

The hex converter converts an absolute object file in the IEEE-695 format into the Intel-HEX format files by default.
The high-order data file is generated with a name "<file name>h.hex", and the low-order data file is generated with a name "<file name>l.hex".
The following shows a sample data in Intel-HEX format:

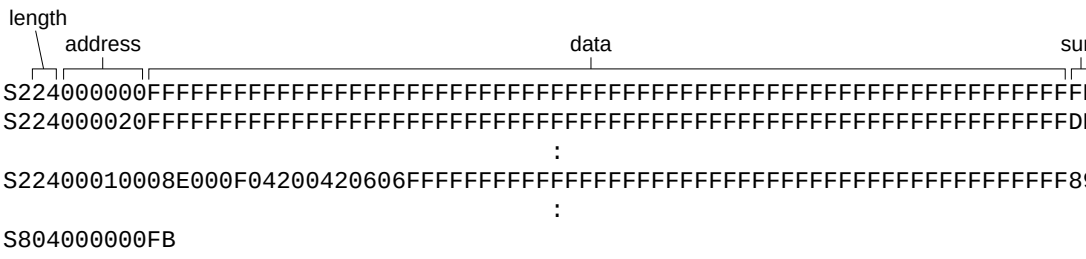


data volume (1 byte): Indicates the data length of each record. The maximum length of a data record is 0x10, while the end record is fixed at 0x00.
address (2 bytes): Indicates the address where the head data in a record is placed.
type (1 byte): Indicates the type of hexadecimal format, currently only "00".
data (16 bytes max.): The object codes are placed here. This is not included in the end record.
sum (1 byte): This is a checksum (2's complement) from "Data volume" to the last data.

The end records are always "00000001FF".

7.5.3 Motorola-S Format

The hex converter converts an absolute object file in the IEEE-695 format into the Motorola-S2 format files when the -m option is specified.
The high-order data file is generated with an extension ".hsa", and the low-order data file is generated with an extension ".lsa".
The following shows a sample data in Motorola-S2 format:



S2 (2 bytes):	Indicates that the line is a data record.
S8 (2 bytes):	Indicates that the line is an end record (end of data).
length (1 byte):	Indicates the record length of "address + data + sum". The maximum length of a data record is 0x24, while the end record is fixed at 0x04.
address (3 bytes):	Indicates the address where the head data in a record is placed.
data (36 bytes max.):	The object codes are placed here. This is not included in the end record.
sum (1 byte):	This is a checksum (1's complement) from "length" to the last data.

The end records are always "S804000000FB".

Note: When using hex files for creating the mask data, do not specify Motorola-S format because the the mask data checker does not support this format.

7.5.4 Conversion Range

By default, the hex converter generates the hex files that include all the codes of the ROM area available for each model. Data for unused addresses are delivered as 0xff. For example, if the model has a built-in 2KB ROM and the program uses the area from address 0x0 to address 0x6ff, the hex converter fills the area from address 0x700 to address 0x7ff with 0xff. If there are unused addresses in the range from 0x0 to 0x6ff, those data are also delivered as 0xff.
When creating the mask data by the mask data checker provided for each model, the hex files must be generated in this format.

When the -b option is specified, the hex converter does not deliver data in unused addresses of the absolute object file. This allows minimization of the output hex files. Note, however that the hex files generated in this format cannot be used for creating the mask data.

7.6 Error/Warning Messages

7.6.1 Errors

When an error occurs, the hex converter immediately terminates the processing after displaying an error message. It will not output hex files.
The hex converter error messages are given below.

Error message	Description
Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Different processor types	The ICE parameter file contains an illegal parameter setting.
Illegal file name <FILE NAME>	The specified input file name is incorrect.
Illegal option <option>	An illegal option is specified.
Illegal absolute object format	The input file is not an object file in IEEE-695 format.
Out of memory	Cannot secure memory space.

7.6.2 Warning

Even if a warning is issued, the hex converter keeps on processing, and completes the processing after displaying a warning message, unless, in addition, any error occurs.

Warning message	Description
Input file name extension .XXX conflict	Two or more file names with the same extension have been specified. The last one is used.

7.7 Precautions

(1) When creating the hex files for making the mask data file in the mask data checker, specify Intel-HEX format and convert for the entire available memory range of the model (do not specify the -b and -m options). Otherwise, an error will occur in the mask data checker. Refer to the development Tool manual of each model for details of the mask data checker.

(2) The ICE and Evaluation Board support 4 types of ROMs: 2764, 27128, 27256 and 27512.
When making the program ROMs from the hex files generated by the hex data converter, write data with an offset address as shown below.

Table 7.7.1 ROM offset address

ROM type	Offset value	
	For ICE	For Evaluation Board
2764	0	0
27128	0	0
27256	0	0x4000
27512	0x8000	0xC000

(3) If an 8-character output file name (DOS file name) without extension is specified for the Intel HEX files, it will be changed to a long file name because "l.hex" or "h.hex" is added to the file name.

CHAPTER 8 DISASSEMBLER

This chapter will describe the functions of the Disassembler ds62.

8.1 Functions

The Disassembler ds62 inputs an object file in IEEE-695 or Intel-HEX format, and disassembles the codes to mnemonics. The results are output as a source file. The restored source file can be processed in the assembler / linker / hex converter to obtain the same object or hex file.

8.2 Input/Output Files

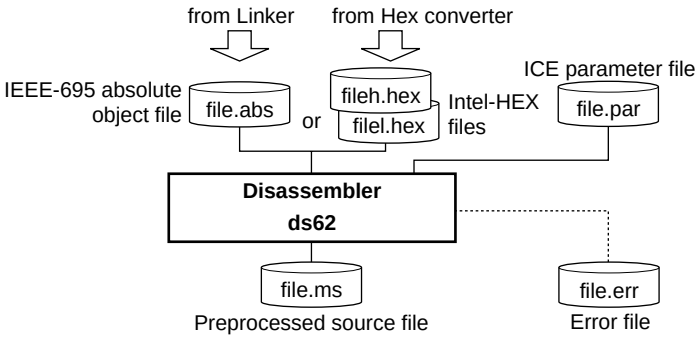


Fig. 8.2.1 Flow chart

8.2.1 Input Files

Absolute object file

File format: Binary file in IEEE-695 format
File name: <File name>.abs (A path can also be specified.)
Description: Absolute object file created by the linker.

Hex file

File format: Text file in Intel-HEX format
File name: <File name>h.hex and <File name>l.hex
Description: HEX file created by the HEX converter. Two hex files are needed: one ("h.hex") contains the four high-order bits of the object codes with 0b0000 extended and the other ("l.hex") contains the eight low-order bits.

ICE parameter file * This file must always be specified.

File format: Text file
File name: <File name>.par (A path can also be specified.)
Description: File to specify the memory mapping information of each S1C62 Family model. This file is supplied in the development tools for each model and is commonly used with the linker, debugger and HEX converter.

8.2.2 Output Files

Source file

File format: Text file
File name: <File name>.ms
Output destination: Current directory
Description: Disassembled contents of the input file are delivered.

Error file

File format: Text file
File name: <File name>.err
Output destination: Current directory
Description: File that is delivered when the start-up option (-e) is specified. It records the information that the disassembler outputs to the Standard Output (stdout), such as error messages.

8.3 Starting Method

General form of command line

ds62 ∧ [Options] ∧ <Absolute object or hex file name> ∧ <ICE parameter file name>

∧ denotes a space.
[ ] indicates the possibility to omit.

File names

Absolute object file: <File name>.abs
Intel-HEX files: <File name>h.hex, <File name>l.hex
ICE parameter file: <File name>.par

The input files must be specified with their extension.
The Intel-HEX files can be specified with either "h.hex" or "l.hex" as the extension. The other one unless specified will be automatically loaded.

A long file name supported in Windows and a path name can be specified. When including spaces in the file name, enclose the file name with double quotation marks (").

Options

The disassembler comes provided with the following five types of start-up options:

-cl

Function: Use of lower-case characters
Explanation: Creates all instructions and labels using lower-case characters.
Default: If neither this option nor the -cu option is specified, the source will be made with all labels in upper-case characters and instructions in lower-case characters.

-cu

Function: Use of upper-case characters
Explanation: Creates all instructions and labels using lower-case characters.
Default: If neither this option nor the -cl option is specified, the source will be made with all labels in upper-case characters and instructions in lower-case characters.

-e

Function: Output of error files
Explanation: Also delivers in a file the contents to be output by the disassembler through the Standard Output (stdout), such as error messages.
Default: If this option is not specified, no error file will be output.

-o <file name>

Function: Specification of output path / file name
Explanation: Specifies an output path / file name without extension or with an extension ".ms". If no extension is specified, ".ms" will be supplemented at the end of the specified output path / file name.
Default: The input file name is used for the output file.

-s <address>

Function: Specification of start address
Explanation: Specifies the start address of the object. This address is used to decide the address parameter of the first ".org" instruction.
Default: If this option is not specified, the disassembled source will begin with address 0.

When entering an option in the command line, one or more spaces are necessary before and after the option.
Example: `c:\e0c62\ds62 -e -cl test.abs ics62xxp.par`

8.4 Messages

The disassembler delivers all its messages via the Standard Output (stdout).

Start-up message

The hex converter outputs only the following message when it starts up.

```
Disassembler 62 Ver x.xx
Copyright (C) SEIKO EPSON CORP. 199x
```

End message

The hex converter outputs the following messages to indicate which files have been created when it ends normally.

```
Created preprocessed source file <FILE NAME>.MS
Created error log file DS62.ERR

Disassembly 0 error(s) 0 warning(s)
```

Usage output

If no file name was specified or an option was not specified correctly, the hex converter ends after delivering the following message concerning the usage:

```
Usage: ds62 [options] <file names>
Options: -cl            Use lower case characters
         -cu            Use upper case characters
         -e             Output error log file (DS62.ERR)
         -o <file name> Output file name (.MS or no extension)
         -s <address>   Offset address (default 0x0)
File names: Absolute object file (.ABS or L/H.HEX)
            ICE parameter file (.PAR)
```

When error/warning occurs

If an error occurs, an error message will appear before the end message shows up.

Example:

```
Error: Cannot open file TEST.ABS
Disassembly 1 error(s) 0 warning(s)
```

In the case of an error, the disassembler ends without creating an output file.

If a warning is issued, a warning message will appear before the end message shows up.

Example:

```
Warning: Output file name conflict
Disassembly 0 error(s) 1 warning(s)
```

In the case of a warning, the disassembler ends after creating an output file.

For details on errors and warnings, refer to Section 8.6 "Error / Warning Messages".

8.5 Disassembling Output

The data / code mnemonics are restored from the target code. As for the branch instructions, a label will be automatically generated like "LXXXX:" where XXXX denotes a hexadecimal number string. ".org" pseudo-instruction is used to specify the starting location of each code block.
The following shows examples of disassembled sources:

Sample outputs

Absolute list file "test.abs"

```
Linker 62 ver x.xx Absolute list file "TEST.ALS" Sun May 03 14:16:16 1998

 1:                  ; main.s
 2:                  ; test program (main routine)
 3:                  ;
 4:
 5:                  ;***** INITIAL SP ADDRESS DEFINITION *****
 6:                  #define      SP_INIT_ADDR 0x80         ;SP init addr = 0x80
 7:
 8:                  ;***** BOOT, LOOP *****
 9:                        .global      INIT_RAM_BLK1       ; subroutine
10:                        .global      INC_RAM_BLK1        ; subroutine
11:
12:                        .org   0x100
13:                 BOOT:
14:   0100   e08            ld     a,SP_INIT_ADDR>>4         ; set SP
15:   0101   fe0            ld     sph,a
16:   0102   e00            ld     a, SP_INIT_ADDR&0xf
17:   0103   ff0            ld     spl,a
18:   0104   e42 (+)        pset 0x2
19:   0105   400            call   INIT_RAM_BLK1             ; initialize RAM block 1
20:      LOOP:
21:   0106   e42 (+)        pset 0x2
22:   0107   406            call   INC_RAM_BLK1              ; increment RAM block 1
23:   0108   006            jp     LOOP                      ; infinity loop
24:                 ; sub.s
25:                 ; test program (subroutines)
26:
27:                       .global RAM_BLK1
28:
29:                       .org   0x200
30:
31:                 ;***** RAM block 1 initialize *****
32:
33:                       .global INIT_RAM_BLK1
34:                 INIT_RAM_BLK1:
35:   0200   e00            ld     a,RAM_BLK1^h
36:   0201   e80            ld     xp,a
37:   0202   b00            ld     x,RAM_BLK1^l              ;set RAM_BLK1 address to x
38:   0203   900            lbpx   mx,0                      ;set 0x0000 to RAM_BLK1
39:   0204   900            lbpx   mx,0
40:   0205   fdf            ret
41:
42:                 ;***** RAM block 1 increment *****
43:
44:                       .global INC_RAM_BLK1
45:                 INC_RAM_BLK1:
46:   0206   e00            ld     a,RAM_BLK1^h
47:   0207   e80            ld     xp,a
48:   0208   b00            ld     x,RAM_BLK1^l              ;set RAM_BLK1 address to x
49:   0209   e00            ld     a,0
50:   020a   f41            scf
51:   020b   f28            acpx   mx,a                      ; increment 16bit value
52:   020c   f28            acpx   mx,a
53:   020d   f28            acpx   mx,a
54:   020e   a98            adc    mx,a
55:   020f   fdf            ret
```

Output source file "test.ms" (default)

```
;Disassembler 62 Ver x.xx Assembly source file TEST.MS Mon May 04 11:49:34 1998

       .org   0x100
       ld     a,0x8
       ld     sph,a
       ld     a,0x0
       ld     spl,a
       pset   0x2
       call   LABEL1
LABEL3:
       pset   0x2
       call   LABEL2
       jp     LABEL3
       .org   0x200
LABEL1:
       ld     a,0x0
       ld     xp,a
       ld     x,0x0
       lbpx   mx,0x0
       lbpx   mx,0x0
       ret
LABEL2:
       ld     a,0x0
       ld     xp,a
       ld     x,0x0
       ld     a,0x0
       scf
       acpx   mx,a
       acpx   mx,a
       acpx   mx,a
       adc    mx,a
       ret
```

Output source file "test.ms" (when -cl is specified)

```
;Disassembler 62 Ver x.xx Assembly source file TEST.MS Mon May 04 11:50:20 1998

       .org   0x100
       ld     a,0x8
       ld     sph,a
       ld     a,0x0
       ld     spl,a
       pset   0x2
       call   label1
label3:
       pset   0x2
       call   label2
       jp     label3
       .org   0x200
label1:
       ld     a,0x0
       ld     xp,a
       ld     x,0x0
       lbpx   mx,0x0
       lbpx   mx,0x0
       ret
label2:
       ld     a,0x0
       ld     xp,a
       ld     x,0x0
       ld     a,0x0
       scf
       acpx   mx,a
       acpx   mx,a
       acpx   mx,a
       adc    mx,a
       ret
```

Output source file "test.ms" (when -cu is specified)

```
;Disassembler 62 Ver x.xx Assembly source file TEST.MS Mon May 04 11:51:08 1998

       .ORG   0X100
       LD     A,0X8
       LD     SPH,A
       LD     A,0X0
       LD     SPL,A
       PSET   0X2
       CALL   LABEL1
LABEL3:
       PSET   0X2
       CALL   LABEL2
       JP     LABEL3
       .ORG   0X200
LABEL1:
       LD     A,0X0
       LD     XP,A
       LD     X,0X0
       LBPX   MX,0X0
       LBPX   MX,0X0
       RET
LABEL2:
       LD     A,0X0
       LD     XP,A
       LD     X,0X0
       LD     A,0X0
       SCF
       ACPX   MX,A
       ACPX   MX,A
       ACPX   MX,A
       ADC    MX,A
       RET
```

8.6 Error/Warning Messages

8.6.1 Errors

When an error occurs, the disassembler immediately terminates the processing after displaying an error message. It will not output a source file.
The disassembler error messages are given below.

Error message	Description
Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Illegal file name <FILE NAME>	The specified input file name is incorrect.
Illegal HEX data format	The input file is not an Intel-HEX format file.
Illegal offset address <offset address>	The specified address is invalid.
Illegal option <option>	An illegal option is specified.
No ICE parameter file specified	ICE parameter file is not specified.
Out of memory	Cannot secure memory space.

8.6.2 Warning

Even if a warning is issued, the disassembler keeps on processing, and completes the processing after displaying a warning message, unless, in addition, any error is produced.

Warning message	Description
Input file name extension .XXX conflict	Two or more file names with the same extension have been specified. The last one is used.

CHAPTER 9 DEBUGGER

This chapter describes how to use the Debugger db62.

9.1 Features

The Debugger db62 is used to debug a program after reading an object file in the IEEE-695 format that is generated by the linker.
It has the following features and functions:

- Various data can be referenced at the same time using multiple windows.
- Frequently used commands can be executed from tool bars and menus using a mouse.
- Also available are source display and symbolic debug functions which correspond to assembly source codes.
- Consecutive program execution and two types of single-stepping are possible.
- Four break functions are supported.
- A real-time display function shows register and memory contents on-the-fly.
- A time display function showing execution time by both duration and steps.
- An advanced trace function.
- An automatic command execution function using a command file.

9.2 Input/Output Files

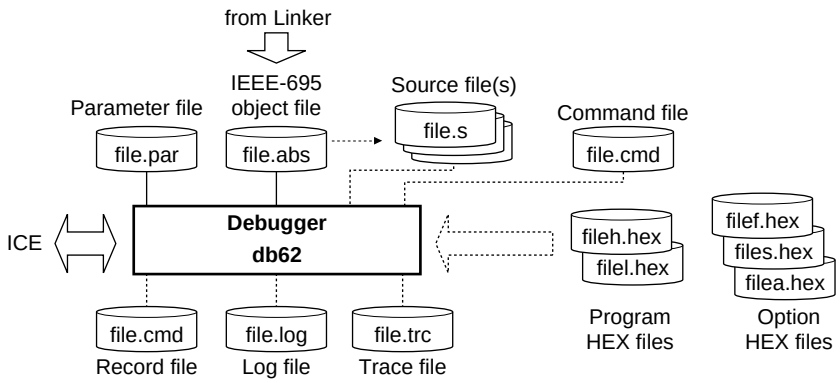


Fig. 9.2.1 Flow chart

9.2.1 Input Files

Parameter file

File format: Text file
File name: <file name>.par
Description: This file contains memory information on each microcomputer model and is indispensable for starting the debugger. This file is included with the development tool package for each microcomputer model.

The following files are read by the debugger according to command specification.

Object file

File format: Binary file in the IEEE-695 format
File name: <file name>.abs (An extension other than ".abs" can also be used.)
Description: This is an object file generated by the linker. This file is read into the debugger by the ***lf*** command. By reading a file in the IEEE-695 format that contains debug information, source display and symbolic debugging can be performed.

Source file

File format: Text file
File name: <file name>.s
Description: This is the source file of the above object file. It is read when the debugger performs source display.

Program file

File format: HEX file in Intel-HEX format
File name: <file name>h.hex, <file name>l.hex
Description: This is a load image file of the program ROM, and is read into the debugger by the ***lo*** command. The file "h.hex" corresponds to the 4 high-order bits of the program code and the file "l.hex" corresponds to the 8 low-order bits of the program code. These files are generated for the purpose of creating mask data from an object file in the IEEE-695 format by a HEX conversion utility. Unlike files in the IEEE-695 format, these files cannot be used for source display or symbolic debugging, but can be used to check the operation of final program data.

Option data file

File format: HEX file in Intel-HEX format
File name: <file name>f.hex, <file name>s.hex, <file name>a.hex (Varies with the type of microcomputer)
Description: These data files are used to set up hardware options for each microcomputer model and is read by the ***lo*** command. These files are generated by a development tool available for each microcomputer model.

Command file

File format: Text file
File name: <file name>.cmd (An extension other than ".cmd" can also be used.)
Description: This file contains a description of debug commands to be executed successively. By writing a series of frequently used commands in this file, the time and labor required for entering commands from the keyboard can be saved. The command described in the file are read and executed using the ***com*** command.

9.2.2 Output Files

Log file

File format: Text file
File name: <file name>.log (An extension other than ".log" can also be used.)
Description: This file contains the information of executed commands and execution results that are output to a file. Output of this file can be controlled by the ***log*** command.

Record file

File format: Text file
File name: <file name>.rec (An extension other than ".rec" can also be used.)
Description: This file contains the information of executed commands that are output to a file. Output of this file can be controlled by the ***rec*** command.

Trace file

File format: Text file
File name: <file name>.trc (An extension other than ".trc" can also be used.)
Description: This file contains the specified range of trace information. Output of this file can be controlled by the ***tf*** command.

9.3 Starting Method

9.3.1 Start-up Format

General form of command line

db62 ∧ <parameter file name> ∧ [start-up option]

∧ denotes a space.
[ ] indicates the possibility to omit.

Note: The parameter file will be recognized by its extension ".par", so ".par" must be included in the parameter file name to be specified.

9.3.2 Start-up Options

The debugger has three start up options available.

<command file name>

Function: Specifies a command file.
Explanation: For a series of commands to be executed immediately after the debugger starts up, specify a command file that describes those commands.

-comX

Function: Specifies a communication port.
Explanation: This option specifies the communication port through which a personal computer is communicated with by the ICE. Specify a port number in the X part of this option. The port that can be used for this purpose varies among different personal computers.
Unless this option is specified, the com1 port is used to communicate with the ICE.

-b <baud rate>

Function: Specifies a communication transmission rate.
Explanation: This option specifies the baud rate on the personal computer. For <baud rate>, select one from 1200, 4800, 9600, or 19200.
Unless specified otherwise, the baud rate is set to 19200 bps. This value is the same as the initial setting of the ICE.
The baud rate on the ICE is set using the DIP switch mounted on the ICE.

When entering an option in a command line, make sure that there is at least one space before and after the option.
Example: `c:\e0c62\bin\db62 ics62xxp.par startup.cmd -com2 -b 19200`

The default start-up options are set as: -com1 & -b 19200
If no parameter file name was specified or the option was not specified correctly, the debugger ends after delivering the following message concerning the usage:

```
-Usage-
   db62^<parameter file name>^[startup option]
Options:
   command file:  ... specifies a command file
   -comX(X:1-4)   ... com port, default com1
   -b             ... baud rate, 1200, 4800, 9600, 19200(default)
```

9.3.3 Start-up Messages

When Debugger db62 starts up, it outputs the following message in the [Command] window. (Refer to the next section for details about windows.)

```
Debugger for E0C62 Ver x.x Copyright (C) SEIKO EPSON CORP. 199x

Connecting COMx with xxxxx baud rate...done
Parameter file: XXXXX.par
     Chip name: E0C62XX
Map.................................done
Initialize..........................done

>
```

9.3.4 Hardware Check at Start-up

If the debugger is invoked, it first performs the tests and initializing operations as follows:

(1) The debugger first checks to see that the ICE is connected to the system and that communication is possible without any problems. The following message is displayed in the [Command] window.

During test

```
Connecting COMx with xxxxx baud rate...
```

When terminated normally

```
Connecting COMx with xxxxx baud rate...done
```

When an error is encountered

```
Connecting COMx with xxxxx baud rate...Error
```

The Error indicates that communication between the personal computer and ICE is not functioning properly. In this case, verify the following:

- A standard RS-232C cable is used
- The COM port is correct
- The baud rates on both sides are matched
- The ICE's power is turned on
- The ICE remains reset

(2) When the connection test terminates normally, the debugger checks the contents of the parameter file and initializes the ICE.

When terminated normally

```
Parameter file: XXXXX.par
     Chip name: E0C62XX
Map.................................done
Initialize..........................done

>
```

When an error is encountered

```
Parameter file: XXXXX.par
     Chip name: E0C62XX
Map.................................Error
Initialize..........................Error

>
```

If an error occurs in the above initialization process, temporarily quit the debugger. Check the cause of the error and repair it before restarting the debugger.

After initialization, the state of the screen including the position and size of the windows will return the same as the last time the debugger was terminated. The contents displayed in each window if it is opened are as follows:

Window	Display contents
[Command] window	Initialization information (and waits for command input)
[Data] window	Data memory contents starting from data memory address 0
[Register] window	Current register values
[Source] window	Unassemble display starting from program memory address 0x0100
[Trace] window	Blank

9.3.5 Method of Termination

To terminate the debugger, select [Exit] from the [File] menu.

You can also input the ***q*** command in the [Command] window to terminate the debugger.

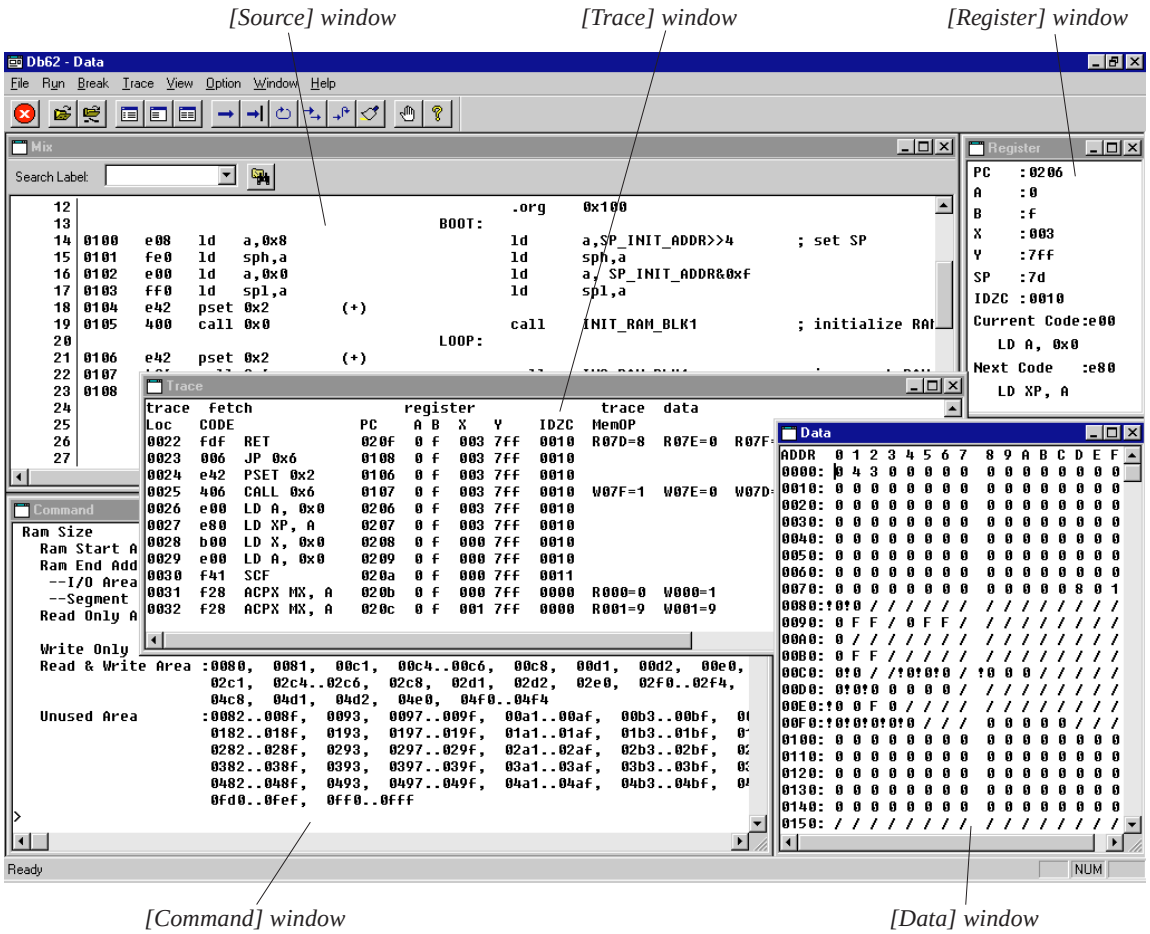
```
>q
```

9.4 Windows

This section describes the types of windows used by the debugger.

9.4.1 Basic Structure of Window

The diagram below shows the window structure of the debugger.



Depending on the computer used, the windows may differ from the above display depending on the screen resolution, the number of dots in system font, etc. Adjust the size of each window to suit needs.

Features common to all windows

(1) Open/close and activating a window

All windows except [Command] can be closed or opened.
To open a window, select the window name from the [View] menu. When a command is executed, the corresponding window opens if the command uses the window for displaying the executed results.
To close a window, click the [Close] box on the window. After initialization, the state of the screen including the position and size of the windows will return to the same as the last time the debugger was terminated.
The opened windows are listed in the [Window] menu. Selecting one from the list activates the selected window. It can also be done by simply clicking on an inactive window. Furthermore, pressing [Ctrl]+[Tab] switches the active window to the next open window.

(2) Resizing and moving a window

Each window can be resized as needed by dragging the boundary of the window with the mouse. The [Minimize] and [Maximize] buttons work in the same way as in general Windows applications. Each window can be moved to the desired display position by dragging the window's title bar with the mouse. However, windows can only be resized and moved within the range of the application window.

(3) Scrolling a window

All windows can be scrolled. (The [Register] window can be scrolled only when its size is reduced.)
Use one of the following three methods to scroll a window:

1. Click on an arrow button or enter an arrow key (cursor movement) to scroll a window one line at a time.
2. Click on the scroll bar of a window to scroll it one page (current window size) at a time.
3. Drag the scroll bar handle of a window to move it to the desired area.

(4) Other

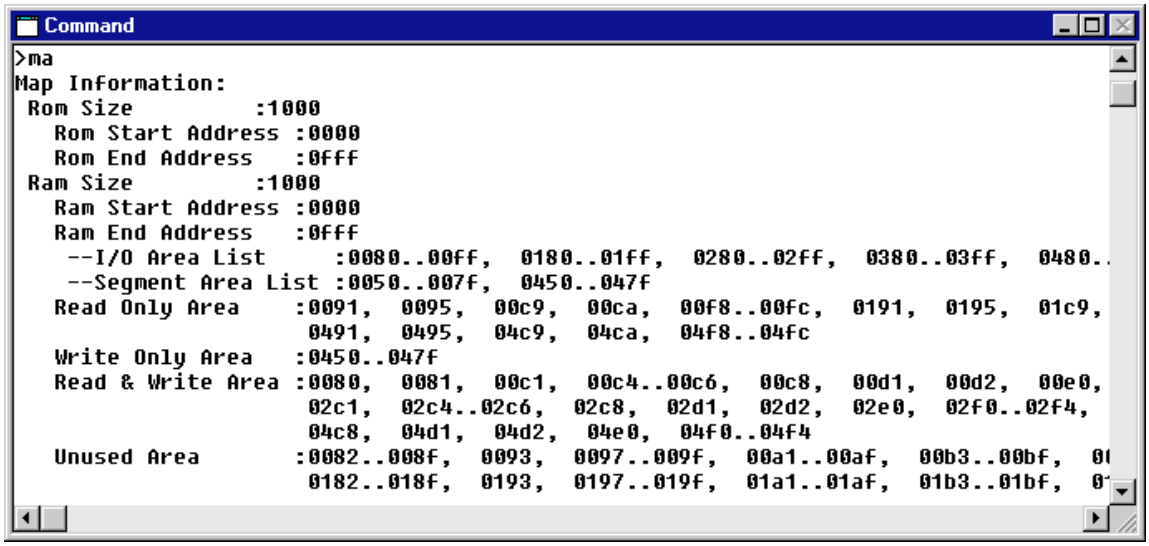
The opened windows can be cascaded or tiled using the [Window] menu.

Note for display

The windows may display incorrect contents caused by incompatibility between the OS and the video card or driver. If there is any problem try the following methods to fix it.

- Update the driver to the latest version if an older version has been installed.
  Please inquire about the version to the distributor.
- If the driver allows selection of extended function such as acceleration, turn the functions off.
- If the problem is not fixed using the above, try the standard driver supplied with Windows95 (NT).

9.4.2 [Command] Window



The [Command] window is used to do the following:

(1) Entering debug commands

When the prompt ">" appears in the [Command] window, the system will accept a command entered from the keyboard.

If some other window is selected, click on the [Command] window. A cursor will blink at the prompt, indicating that readiness to input a command. (Refer to Section 9.7.1, "Entering Commands from Keyboard".)

(2) Displaying debug commands selected from menus or tool bar

When a command is executed by selecting the menu item or tool bar button, the executed command line is displayed in the [Command] window.

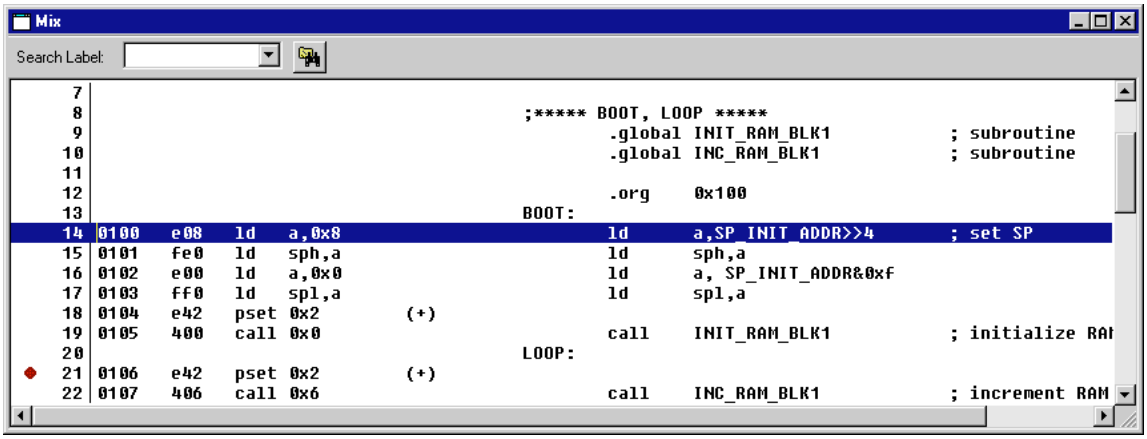
(3) Displaying command execution results

The [Command] window displays command execution results. However, some command execution results are displayed in the [Source], [Data], [Register], or [Trace] windows. The contents of these execution results are displayed when their corresponding windows are open. If the corresponding window is closed, the execution result is displayed in the [Command] window.

When writing to a log file, the content of the write data is displayed in the window. (Refer to the description for ***log*** command.)

Note: The [Command] window cannot be closed.

9.4.3 [Source] Window



The [Source] window displays the contents of (1) to (3) listed below. This window also allows breakpoints to be set and words or labels to be found.

(1) Unassembled codes and source codes

You can choose one of the following three display modes:


[Mix] button

1. Mix mode

(selected by the [Mix] button or entering the ***m*** command)
In this mode, the window displays the addresses, codes, unassembled contents, and corresponding source line numbers and source statements. (See the diagram above.)


[Source] button

2. Source mode

(selected by the [Source] button or entering the ***sc*** command)
In this mode, the window displays the source line numbers and source statements.


[Unassemble] button

3. Unassemble mode

(selected by the [Unassemble] button or entering the ***u*** command)
In this mode, the window displays the addresses, codes, and unassembled contents. This format is selected when the debugger starts up.

All program code in the 8K address space can be referenced by scrolling the window. When a break occurs, the display content is updated so that the address line to be executed next is displayed, with the entire line highlighted for identification.
Use the scroll bar or arrow keys to scroll the window. Or enter a command to display the program code beginning with a specified position.

* ***Display of source line numbers and source statements***

The source line numbers and source statements can only be displayed when the IEEE-695 absolute object file including debugging information for the source display is loaded. Furthermore, the source statements that are actually displayed from this file are those which have had the -g option specified by the assembler.

* ***Updating of display***

When a program is loaded and executed (***g***, ***gr***, ***s***, ***n***, or ***rst*** command), or the memory contents are changed (***as***, ***pe***, ***pf***, or ***pm*** command), the display contents are updated. In this case the [Source] window updates its display contents so that the current PC address can always be displayed. The display contents are also updated when the display mode is changed.

(2) Current PC

The address line indicated by the current PC (program counter) is highlighted. (Address 0x0100 in the diagram)

(3) PC breakpoint

The address line where a breakpoint is set is indicated by a red ◆ mark at the beginning of the line. (Address 0x0106 in the diagram)

(4) Break setting at the cursor position

Place the cursor at an address line where a breakpoint is to be set (not available for a source-only line).

[Break] button

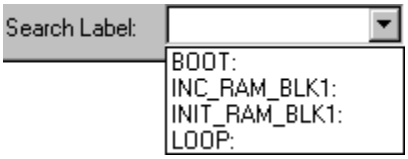
Then click on the [Break] button. A PC breakpoint will be set at that address. If the same is done at the address line where a PC breakpoint has been set, the breakpoint will be cleared.

[Go to Cursor] button

If the [Go to Cursor] button is clicked, the program will execute beginning with the current PC position, and program execution breaks at the line where the cursor is located.

(5) Finding labels and words

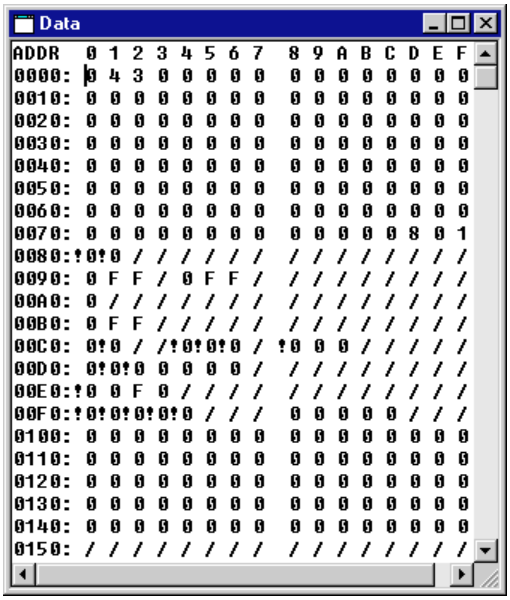
Any labels and words can be found using the [Search Label] pull-down list box or the [Find] button on the [Source] window.



[Search Label] pull-down list box

[Find] button

9.4.4 [Data] Window



(1) Displaying data memory contents

The [Data] window displays the memory dump results in hexadecimal numbers.
The symbols that appear in the [Data] window indicate the following status:

/: Unused address
-: Write-only I/O address
!: An address that contains a write-only bit or a read-only bit

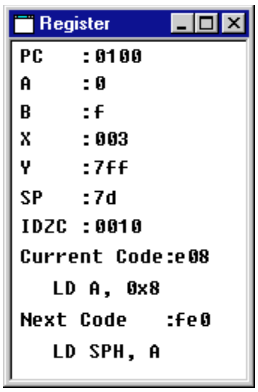
* *Updating of display*

The display contents of the [Data] window are updated automatically when memory contents are modified with a command (***de***, ***df***, or ***dm*** command), or by direct modification. After executing the program (***g***, ***gr***, ***s***, ***n***, or ***rst*** command), the display contents are also updated. To refresh the [Data] window manually, execute the ***dd*** command or click the vertical scroll bar.

(2) Direct modification of data memory contents

The [Data] window allows direct modification of data memory contents. To modify data on the [Data] window, place the cursor at the front of the data to be modified or double click the data, and then type a hexadecimal character (0–9, a–f). Data in the address will be modified with the entered number and the cursor will move to the next address. This allows successive modification of a series of addresses.

9.4.5 [Register] Window



(1) Displaying register contents and fetched code

The [Register] window displays the contents of the program counter (PC), A register, B register, X register, Y register, stack pointer (SP) and flags (I, D, Z, and C). The currently fetched instruction (at the PC address) and the next one are also displayed.

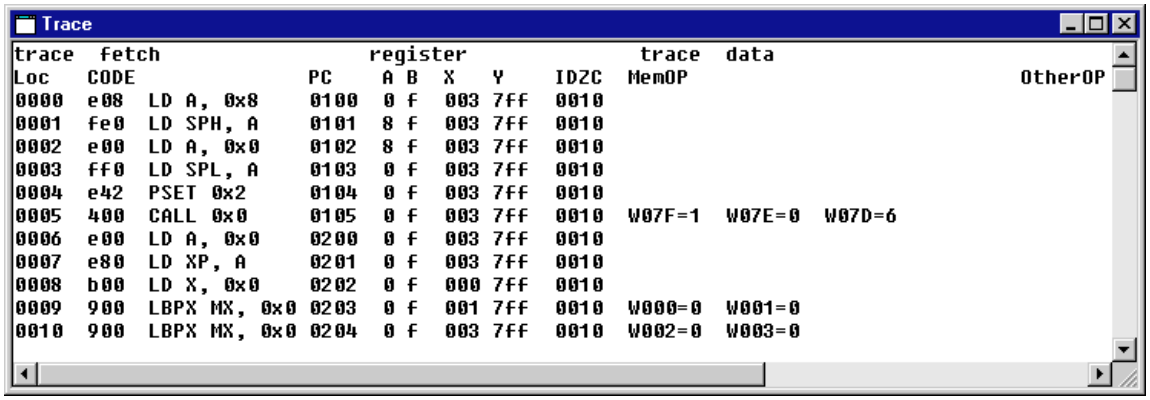
* *Updating the display*

The display is updated when registers are dumped (***rd*** command), when register data is modified (***rs*** command), when the CPU is reset (***rst*** command), or after program execution (***g***, ***gr***, ***s***, or ***n*** command) is completed. When the on-the-fly function is enabled, the PC address is updated in real time at 0.5 second intervals while the program is being executed. Other contents are left unchanged until the program is stopped by a break.

(2) Direct modification of register contents

The [Register] window allows direct modification of register contents. To modify data on the [Register] window, select (highlight) the data to be modified and type a hexadecimal number (0–9, a–f), then press [Enter]. The register data will be modified with the entered number.

9.4.6 [Trace] Window



The [Trace] window displays the trace result up to 8,192 cycles by reading it from the ICE's trace memory. The following lists the trace contents:

- Traced cycle number
- Fetched code and disassembled contents
- Register contents (PC, A, B, X, Y, and flags)
- Memory access status (R/W, address, data)

This window also displays the trace data search results by the ***ts*** command.

∗ ***Updating of display:***

The contents of the [Trace] window are cleared when the target program is executed. During this period, the [Trace] window does not accept scrolling and resizing operations.
To display the latest contents of this window, execute the ***td*** command or temporarily close the [Trace] window and then reopen it.

9.5 Tool Bar

This section outlines the tool bar available with the debugger.

9.5.1 Tool Bar Structure

The tool bar has 14 buttons, each one assigned to a frequently used command.

The specified function is executed when you click on the corresponding button.

9.5.2 [Key Break] Button

This button forcibly breaks execution of the target program. This function can be used to cause the program to break when the program has fallen into an endless loop.

9.5.3 [Load File] and [Load Option] Buttons

[Load File] button
This button reads an object file in the IEEE-695 format into the debugger. It performs the same function when the ***lf*** command is executed.

[Load Option] button
This button reads a program or optional HEX file in Intel-HEX format into the debugger. It performs the same function when the ***lo*** command is executed.

9.5.4 [Source], [Mix], and [Unassemble] Buttons

These buttons open the [Source] window or switch over the display modes.

[Source] button
This button switches the display of the [Source] window to the source mode. The [Source] window opens if it is closed. This button performs the same function when the ***sc*** command is executed.

[Unassemble] button
This button switches the display of the [Source] window to the unassemble mode. The [Source] window opens if it is closed. This button performs the same function when the ***u*** command is executed.

[Mix] button
This button switches the display of the [Source] window to the mix mode (unassemble & source). The [Source] window opens if it is closed. This button performs the same function when the ***m*** command is executed.

9.5.5 [Go], [Go to Cursor], [Go from Reset], [Step], [Next], and [Reset] Buttons

[Go] button
This button executes the target program from the address indicated by the current PC. It performs the same function when the ***g*** command is executed.

[Go to Cursor] button
This button executes the target program from the address indicated by the current PC to the cursor position in the [Source] window (the address of that line). It performs the same function when the ***g <address>*** command is executed.
Before this button can be selected, the [Source] window must be open and the address line where the program is to break must be clicked. Selecting a break address by clicking on the address line is valid for only the lines that have actual code, and is invalid for the source-only lines.

[Go from Reset] button
This button resets the CPU and then executes the target program from the program start address (0x100). It performs the same function when the ***gr*** command is executed.

[Step] button
This button executes one instruction step at the address indicated by the current PC. It performs the same function when the ***s*** command is executed.

[Next] button
This button executes one instruction step at the address indicated by the current PC. If the instruction to be executed is call or calz, it is assumed that a program section until control returns to the next address constitutes one step and all steps of their subroutines are executed. This button performs the same function when the ***n*** command is executed.

[Reset] button
This button resets the CPU. It performs the same function when the ***rst*** command is executed.

9.5.6 [Break] Button

Use this button to set and clear a breakpoint at the address where the cursor is located in the [Source] window. This function is valid only when the [Source] window is open. Note that selecting a break address by clicking on the address line is valid for only the lines that have actual code and is invalid for the source-only lines.

9.5.7 [Help] Button

This button displays an About dialog box for the debugger.

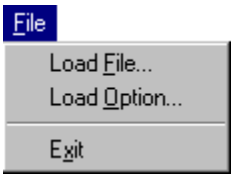
9.6 Menu

This section outlines the menu bar available with the debugger.

9.6.1 Menu Structure

The menu bar has eight menus, each including frequently-used commands.

9.6.2 [File] Menu

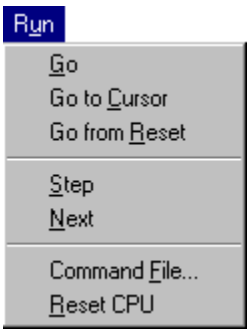


[Load File...]
This menu item reads an object file in the IEEE-695 format into the debugger. It performs the same function when the ***lf*** command is executed.

[Load Option...]
This menu item reads a program or optional HEX file in Intel-HEX format into the debugger. It performs the same function when the ***lo*** command is executed.

[Exit]
This menu item quits the debugger. It performs the same function when the ***q*** command is executed.

9.6.3 [Run] Menu



[Go]
This menu item executes the target program from the address indicated by the current PC. It performs the same function when the ***g*** command is executed.

[Go to Cursor]
This menu item executes the target program from the address indicated by the current PC to the cursor position in the [Source] window (the address of that line). It performs the same function when the ***g*** **<*address*>** command is executed. Before this menu item can be selected, the [Source] window must be open and the address line where the program is to break must be clicked. Selecting a break address by clicking on the address line is valid for only the lines that have actual code, and is invalid for the source-only lines.

[Go from Reset]
This menu item resets the CPU and then executes the target program from the program start address (0x100). It performs the same function when the ***gr*** command is executed.

[Step]
This menu item executes one instruction step at the address indicated by the current PC. It performs the same function when the ***s*** command is executed.

[Next]
This menu item executes one instruction step at the address indicated by the current PC. If the instruction to be executed is call or calz, it is assumed that a program section until control returns to the next address constitutes one step and all steps of their subroutines are executed. This menu item performs the same function when the ***n*** command is executed.

[Command File...]
This menu item reads a command file and executes the debug commands written in that file. It performs the same function when the ***com*** command is executed.

[Reset CPU]
This menu item resets the CPU. It performs the same function when the ***rst*** command is executed.

9.6.4 [Break] Menu

[Breakpoint Set...]
This menu item displays, sets or clears PC breakpoints using a dialog box. It performs the same function as executing the ***bp*** command.

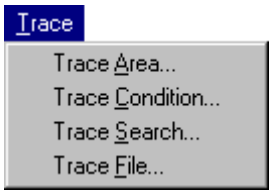
[Data Break...]
This menu item displays, sets or clears data break conditions using a dialog box. It performs the same function as executing the ***bd*** command.

[Register Break...]
This menu item displays, sets or clears register break conditions using a dialog box. It performs the same function as executing the ***br*** command.

[Multiple Break...]
This menu item displays, sets or clears multiple break conditions using a dialog box. It performs the same function as executing the ***bm*** command.

[Break All Clear]
This menu item clears all break conditions. It performs the same function as executing the ***bac*** command.

9.6.5 [Trace] Menu



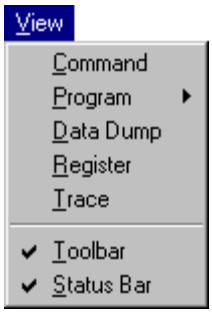
[Trace Area...]
This menu item sets or clears program address ranges for tracing executed cycles using a dialog box. It performs the same function as executing the ***ta*** or ***tac*** command.

[Trace Condition...]
This menu item sets a trace condition (Start, Middle, End) using a dialog box. It performs the same function as executing the ***tc*** command.

[Trace Search...]
This menu item searches trace information from the trace memory under the condition specified using a dialog box. It performs the same function as executing the ***ts*** command.

[Trace File...]
This menu item saves the specified range of the trace information displayed in the [Trace] window to a file. It performs the same function as executing the ***tf*** command.

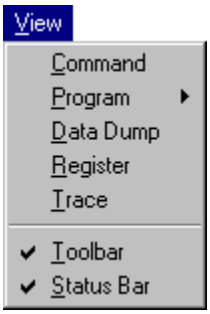
9.6.6 [View] Menu



[Command]
This menu item activates the [Command] window.

[Program]
This menu item opens or activates the [Source] window and displays the program from the current PC address in the display mode selected from the sub menu items. These sub menu items perform the same functions as executing the ***u***, ***sc***, and ***m*** command, respectively.

[Data Dump]
This menu item opens or activates the [Data] window and displays the data memory contents from the memory start address.



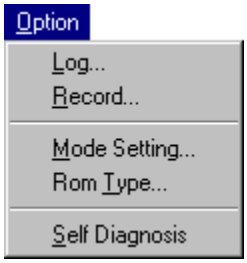
[Register]
This menu item opens or activates the [Register] window and displays the current values of the registers.

[Trace]
This menu item opens or activates the [Trace] window and displays the trace data sampled in the ICE trace memory.

[Toolbar]
This menu item shows or hides the toolbar.

[Status Bar]
This menu item shows or hides the status bar.

9.6.7 [Option] Menu



[Log...]
This menu item starts or stops logging using a dialog box. It performs the same function as executing the ***log*** command.

[Record...]
This menu item starts or stops recording of a command execution using a dialog box. It performs the same function as executing the ***rec*** command.

[Mode Setting...]
This menu item sets the on-the-fly display, break and execution counter modes using a dialog box. It performs the same functions as executing the ***otf***, ***be/bsyn***, and ***tim*** command.

[Rom Type...]
This menu item specifies the program ROM type which is installed in the ICE ROM socket. It performs the same function as executing the ***rom*** command.

[Self Diagnosis]
This menu item displays the results of the diagnostic test in the ICE. It performs the same function as executing the ***chk*** command.

9.6.8 [Windows] Menu

[Cascade]
This menu item cascades the opened windows.

[Tile]
This menu item tiles the opened windows.

This menu shows the currently opened window names. Selecting one activates the window.

9.6.9 [Help] Menu

[Contents...]
This menu item displays the contents of help topics.

[About Db62...]
This menu item displays an About dialog box for the debugger.

9.7 Method for Executing Commands

All debug functions can be performed by executing debug commands. This section describes how to execute these commands. Refer to the description of each command for command parameters and other details.

To execute a debug command, activate the [Command] window and input the command from the keyboard. The menu and tool bar can be used to execute frequently-used commands.

9.7.1 Entering Commands from Keyboard

Select the [Command] window (by clicking somewhere on the [Command] window). When the prompt ">" appears on the last line in this window and a cursor is blinking behind it, the system is ready to accept a command from the keyboard.
Input a debug command at the prompt position. The commands are not case-sensitive; they can be input in either uppercase or lowercase.

General command input format

>command [parameter [parameter ... parameter]] ↵

- A space is required between a command and parameter.
- Space is required between parameters.

Use the arrow keys, [Back Space] key, or [Delete] key to correct erroneous input.
When you press the [Enter] key after entering a command, the system executes that command. (If the command entered is accompanied by guidance, the command is executed when the necessary data is input according to the displayed guidance.)

Input example:

```
>g↵                    (Only a command is input.)
>com test.cmd↵         (A command and parameter are input.)
```

Command input accompanied by guidance

For commands that cannot be executed unless a parameter or the commands that modify the existing data are specified, a guidance mode is entered when only a command is input. In this mode, the system brings up a guidance field, so input a parameter there.

Input example:

```
>lf↵
File name    ? :test.abs↵   ... Input data according to the guidance (underlined part).
>
```

- **Commands requiring parameter input as a precondition**
  The ***lf*** command shown in the above example reads an absolute object file into the debugger. Commands like this that require an entered parameter as a precondition are not executed until the parameter is input and the [Enter] key pressed. If a command has multiple parameters to be input, the system brings up the next guidance, so be sure to input all necessary parameters sequentially. If the [Enter] key is pressed without entering a parameter in some guidance session of a command, the system assumes the command is canceled and does not execute it.

- **Commands that replace existing data after confirmation**

  The commands that rewrite memory or register contents one by one provide the option of skipping guidance (do not modify the contents), returning to the immediately preceding guidance, or terminating during the input session.

  [Enter] key ..... Skips input.
  [^] key ..... Returns to the immediately preceding guidance.
  [q] key ..... Terminates the input session.

  Input example:

```
>de↵                              ... Command to modify data memory.
Data enter address ? :0↵          ... Inputs the start address.
0000 A:1↵                         ... Modifies address 0x0000 to 1.
0001 A:^↵                         ... Returns to the immediately preceding address.
0000 1:0↵                         ... Inputs address 0x0000 back again.
0001 A:↵
0002 A:↵
0001 A:q↵                         ... Terminates the input session.
>
```

Numeric data format of parameter

For numeric values to be accepted as a parameter, they must be input in hexadecimal numbers for almost all commands. However, some parameters accept decimal or binary numbers.

The following characters are valid for specifying numeric data:

Hexadecimal: 0–9, a–f, A–F, *
Decimal: 0–9
Binary: 0, 1, *
("*" is used to mask bits when specifying a data pattern.)

Specification with a symbol

For address specifications, symbols defined in the source can also be used. However, it is necessary to load an absolute object file that contains debug information.
Symbols should be used as follows:

Global symbol	@<symbol name>	e.g. @RAM_BLK1
Local symbol	@<symbol name>@<source file name>	e.g. @LOOP@main.s

Refer to the description of each command for parameter input examples.

Step execution using the [Enter] key

When the [Enter] key is pressed without entering any command, the debugger single steps the instruction at the current PC address if a program has been loaded.

9.7.2 Executing from Menu or Tool Bar

The menu and tool bar are assigned frequently-used commands as described in Sections 9.5 and 9.6. A command can be executed simply by selecting desired menu command or clicking on the tool bar button. Table 9.7.2.1 lists the commands assigned to the menu and tool bar.

Table 9.7.2.1 Commands that can be specified from menu or tool bar

Command	Function	Menu	Button
lf	Load IEEE-695 absolute object file	[File | Load File...]	
lo	Load Intel-HEX file	[File | Load Option...]	
g	Execute program successively	[Run | Go]	
g <address>	Execute program to <address> successively	[Run | Go to Cursor]	
gr	Reset CPU and execute program successively	[Run | Go from Reset]	
s	Step into	[Run | Step]	
n	Step over	[Run | Next]	
com	Load and execute command file	[Run | Command File...]	–
rst	Reset CPU	[Run | Reset CPU]	
bp, bpc	Set/clear PC breakpoint	[Break | Breakpoint Set...]	
bd, bdc	Set/clear data break	[Break | Data Break...]	–
br, brc	Set/clear register break	[Break | Register Break...]	–
bm, bmc	Set/clear multiple break	[Break | Multiple Break...]	–
bac	Clear all break conditions	[Break | Break All Clear]	–
ta, tac	Set/clear trace area	[Trace | Trace Area...]	–
tc	Set trace condition	[Trace | Trace Condition...]	–
ts	Search trace information	[Trace | Trace Search...]	–
tf	Save trace information to a file	[Trace | Trace File...]	–
u	Unassemble display	[View | Program | Unassemble]	
sc	Source display	[View | Program | Source Display]	
m	Mix display	[View | Program | Mix Mode]	
dd	Dump data memory	[View | Data Dump]	–
rd	Display register values	[View | Register]	–
td	Display trace information	[View | Trace]	–
log	Turn log output on or off	[Option | Log...]	–
rec	Record commands to a command file	[Option | Record...]	–
otf, be/bsyn, tim	Set modes	[Option | Mode Setting...]	–
rom	Set ROM type	[Option | Rom Type...]	–

9.7.3 Executing from a Command File

Another method for executing commands is to use a command file that contains descriptions of a series of debug commands. By reading a command file into the debugger the commands written in it can be executed.

Creating a command file

Create a command file as a text file using an editor.
Although there are no specific restrictions on the extension of a file name, Seiko Epson recommends using ".cmd".

Command files can also be created using the ***rec*** command. The ***rec*** command creates a command file and saves the executed commands to the file.

Example of a command file

The example below shows a command group necessary to read an object file and an option file.

Example: File name = startup.cmd

```
lf test.abs
lo testf.hex
lo tests.hex
```

A command file to write the commands that come with a guidance mode can be executed. In this case, be sure to break the line for each guidance input item as a command is written.

Reading in and executing a command file

There are two methods to read a command file into the debugger and to execute it, as described below.

(1) Execution by the start-up option

By specifying a command file in the debugger start-up command, one command file can be executed when the debugger starts up.
If the above example of a command file is specified, for example, the necessary files are read into the debugger immediately after the debugger starts up, so everything is ready to debug the program.

Example: Startup command of the debugger

```
db62 startup.cmd ics62xxp.par
```

(2) Execution by a command

The debugger has the ***com*** commands available that can be used to execute a command file.
The ***com*** command reads in a specified file and executes the commands in that file sequentially in the order they are written. An execution interval between the commands can be specified up to 30 seconds.

Example: `com startup.cmd`

The commands written in the command file are displayed in the [Command] window.

Restrictions

Another command file can be read from within a command file. However, nesting of these command files is limited to a maximum of five levels. An error is assumed and the subsequent execution is halted when the ***com*** command at the sixth level is encountered.

9.7.4 Log File

The executed commands and the execution results can be saved to a file in text format that is called a "log file". This file allows verification of the debug procedures and contents.
The contents displayed in the [Command] window are saved to this file.

Command example

```
>log tst.log
```

After the debugger is set to the log mode by the ***log*** command (after it starts outputting to a log file), the ***log*** command toggles (output turned on in log mode ↔ output turned off in normal mode). Therefore, you can output only the portions needed can be output to the log file.

Display of [Command] window in log mode

The contents displayed in the [Command] window during log mode differ from those appearing in normal mode.

(1) When executing a command when each window is open

(When the window that displays the command execution result is opened)

Normal mode: The contents of the relevant display window are updated. The execution results are not displayed in the [Command] window.

Log mode: The same contents as those displayed in the relevant window are also displayed in the [Command] window. However, changes made to the relevant window by scrolling or opening it are not reflected in the [Command] window.

(2) When executing a command while each window is closed

When the relevant display window is closed, the execution results are always displayed in the [Command] window except for the program display commands (***u***, ***sc***, ***m***), regardless of whether operation is in log mode or normal mode.

For the display format in the [Command] window, refer to each command description.

9.8 Debug Functions

This section outlines the debug features of the debugger, classified by function.
Refer to Section 9.9, "Command Reference" for details about each debug command.

9.8.1 Loading Program and Option Data

Loading files

The debugger can read a file in IEEE-695 format or Intel-HEX format in the debugging process.
Table 9.8.1.1 lists the files that can be read by the debugger and the load commands.

Table 9.8.1.1 Files and load commands

File type	Data type	Ext.	Generation tool	Com.	Menu	Button
IEEE-695	Program/data	.abs	Linker	**lf**	[File | Load File...]	
Intel-HEX	Program (4 high-order bits)	h.hex	HEX convertor	**lo**	[File | Load Option...]	
	Program (8 low-order bits)	l.hex	HEX convertor			
	Function option	f.hex	Function option generator			
	Segment option	s.hex	Segment option generator			
	Melody data	a.hex	Melody assembler			

(Ext. = Extension, Com. = Command)

Loading ROM data

The debugger can load a program from the program ROMs installed in the ICE.
The following three commands are provided for handling ROM data.

Table 9.8.1.2 ROM access commands

Function	Command	Menu
Load program from ROM	**rp**	–
Verify ROM data with emulation memory	**vp**	–
Set ROM type	**rom**	[Option | Rom Type...]

The ROM type of the ICE must be specified using the rom command before loading or verifying ROM data.

Debugging a program with source display

To debug a program using the source display and symbols, the object file must be in IEEE-695 format read into the debugger. If any other program file is read, only the unassemble display is produced.

9.8.2 Source Display and Symbolic Debugging Function

The debugger allows program debugging while displaying the assembly source statements. Address specification using a symbol name is also possible.

Displaying program code

The [Source] window displays the program in the specified display mode. The display mode can be selected from among the three modes: Unassemble mode, Source mode, Mix mode.

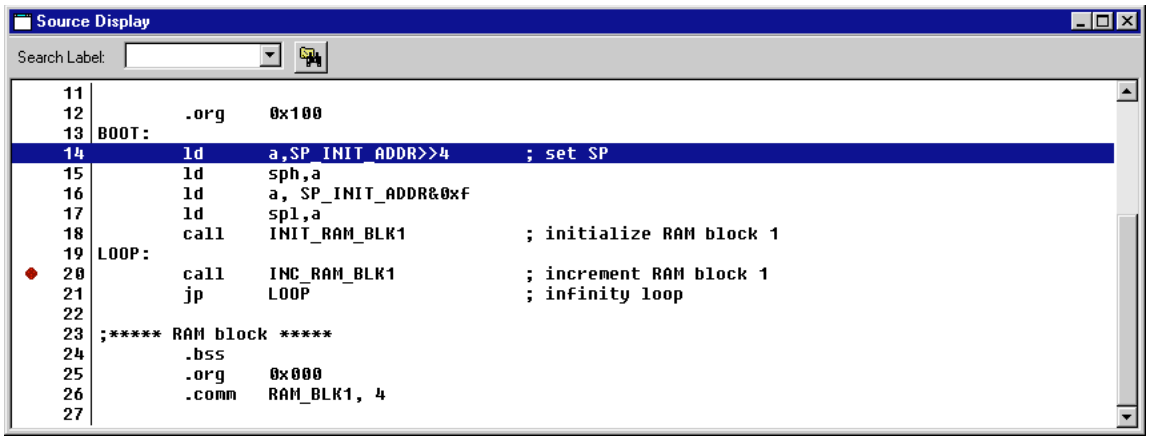
Table 9.8.2.1 Commands/tool bar buttons to switch display mode

Display mode	Command	Menu	Button
Unassemble	**u**	[View | Program | Unassemble]	
Source	**sc**	[View | Program | Source Display]	
Mix	**m**	[View | Program | Mix Mode]	

(1) Unassemble mode

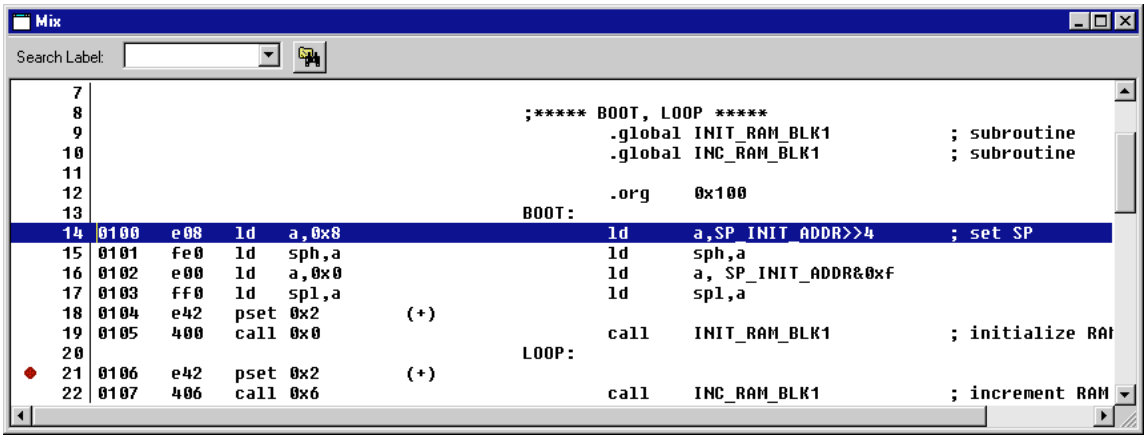
In this mode, the debugger displays the program codes after unassembling into mnemonics.

(2) Source mode



In this mode, the source that contains the code at the current PC address is displayed like an editor screen. This mode is available only when an absolute object file that contains source debugging information has been loaded.

(3) Mix mode



In this mode, both unassembled codes and sources are displayed like an absolute list. This mode is available only when an absolute object file that contains source debugging information has been loaded.

Refer to Section 9.4.3, "[Source] Window" for details about the display contents.

Symbol reference

When debugging a program after reading an object file in IEEE-695 format, the symbols defined in the source file can be used to specify an address. This feature can be used when entering a command having <address> in its parameter from the [Command] window or a dialog box.

(1) Referencing global symbols

Follow the method below to specify a symbol that is declared to be a global symbol/label by the .global or .comm pseudo-instruction.

@<symbol>

Example of specification:

```
>m @BOOT
>de @RAM_BLK1
```

(2) Referencing local symbols

Follow the method below to specify a local symbol/label that is used in only the defined source file.

@<symbol>@<file name>

The file name here is the source file name (.s) in which the symbol is defined.

Example of specification:

```
>bp @SUB1@test.s
```

(3) Displaying symbol list

All symbols used in the program and the defined addresses can be displayed in the [Command] window.

Table 9.8.2.2 Command to display symbol list

Function	Command
Displaying symbol list	**sy**

9.8.3 Displaying and Modifying Program, Data, and Register

The debugger has functions to operate on the program memory, data memory, and registers. Each memory area is set to the debugger according to the map information that is given in a parameter file.

Operating on program memory area

The following operations can be performed on the program memory area:

Table 9.8.3.1 Commands to operate on program memory

Function	Command
Entering/modifying program code	**pe**
In-line assemble	**as**
Rewriting specified area	**pf**
Copying specified area	**pm**

(1) Entering/modifying program code

The program code at a specified address is modified by entering hexadecimal data.

(2) In-line assemble

The program code at a specified address is modified by entering a mnemonic code.

(3) Rewriting specified area

An entire specified area is rewritten with specified code.

(4) Copying specified area

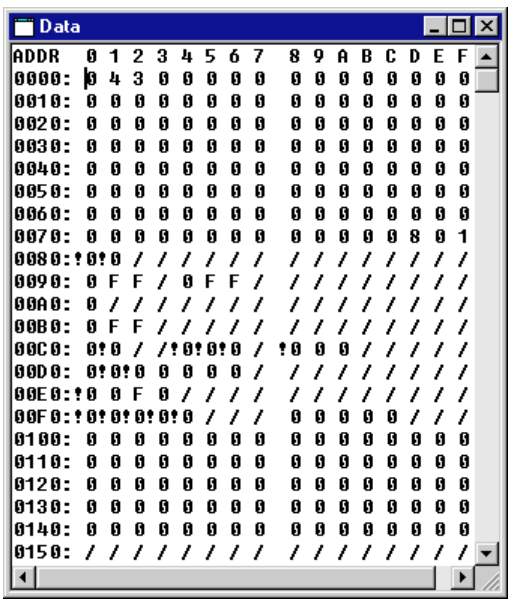
The content of a specified area is copied to another area.

Operating on data memory area

The following operations can be performed on the data memory areas (RAM, display memory, I/O memory):

Table 9.8.3.2 Commands/menu item to operate on data memory

Function	Command	Menu
Dumping data memory	**dd**	[View | Data Dump]
Entering/modifying data	**de**	–
Rewriting specified area	**df**	–
Copying specified area	**dm**	–



(1) Dumping data memory

The contents of the data memory are displayed in hexadecimal dump format. If the [Data] window is opened, the contents of the [Data] window are updated; if not, the contents of the data memory are displayed in the [Command] window.

(2) Entering/modifying data

Data at a specified address is rewritten by entering hexadecimal data. Data can be directly modified on the [Data] window.

(3) Rewriting specified area

An entire specified area is rewritten with specified data.

(4) Copying specified area

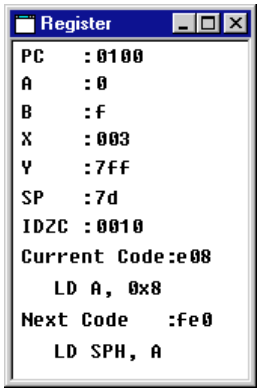
The content of a specified area is copied to another area.

Operating registers

The following operations can be performed on registers:

Table 9.8.3.3 Commands/menu items to operate registers

Function	Command	Menu
Displaying registers	**rd**	[View | Register]
Modifying register values	**rs**	–



(1) Displaying registers

Register contents can be displayed in the [Register] or [Command] window.

Registers: PC, A, B, X, Y, SP and IDZC flags

While the program is being executed, the PC address is updated in real time every 0.5 seconds by the on-the-fly function.

(2) Modifying register values

The contents of the above registers can be set to any desired value.

The register values can be directly modified on the [Register] window.

9.8.4 Executing Program

The debugger can execute the target program successively or execute instructions one step at a time (single-stepping).

Successive execution

(1) Types of successive execution

There are two types of successive execution available:

- Successive execution from the current PC
- Successive execution from the program start address (0x0100) after resetting the CPU

Table 9.8.4.1 Commands/menu items/tool bar buttons for successive execution

Function	Command	Menu	Button
Successive execution from current PC	**g**	[Run | Go]	
		[Run | Go to Cursor]	
Successive execution after resetting CPU	**gr**	[Run | Go from Reset]	

(2) Stopping successive execution

Using the successive execution command (***g <address>***), can specify a temporary break address that is only effective during program execution.
The temporary break address can also be specified from the [Source] window.
If the cursor is placed on an address line in the [Source] window and the [Go to Cursor] button clicked, the program starts executing from the current PC address and breaks after executing the instruction at the address the cursor is placed.

Except being stopped by this temporary break, the program continues execution until it is stopped by one of the following causes:

- Break conditions set by a break set up command are met.
- The [Key Break] button is clicked or the [Esc] key is pressed.
- The [Break] or [Reset] switch on the ICE is pushed.

 *[Key Break] button* ∗ When the program does not stop, use this button to forcibly stop it.

(3) On-the-fly function

The ICE and debugger provide the on-the-fly function to display the PC address every 0.5 seconds during successive execution. The PC address is displayed in the relevant positions of the [Register] window. If the [Register] window is closed, it is displayed in the [Command] window. The on-the-fly function can be disabled and re-enabled using the ***otf*** command.

(4) Measuring execution time/steps

The ICE contains a 16-bit execution counter allowing measurement of the program execution time or the number of steps executed. When the program starts executing successively, the execution counter starts counting after resetting the counter. When the program execution is suspended, the counter stops counting and the counted value is displayed in the [Command] window.
The count mode can be selected using the ***tim*** command. In the initial debugger settings, the execution time count mode is selected.
The following lists the maximum values that can be measured by the execution counter and measurement error:

Execution time count mode: 6.5 × 65535 µsec = 425.9775 msec, error = ±6.5 µsec
Step count mode: 65535 steps, error = ±1 step

If the counter overflows during program execution, "Run time = Time over" will be displayed as the results.

Single-stepping

(1) Types of single-stepping

There are two types of single-stepping available:

- Stepping through all instructions (STEP)
  All instructions are executed one step at a time according to the PC, regardless of the type of instruction.
- Stepping through instructions except subroutines (NEXT)
  The call and calz instructions are executed under the assumption that one step constitutes the range of statements until control is returned to the next step by a return instruction. Other instructions are executed in the same way as in ordinary single-stepping.

In either case, the program starts executing from the current PC.

Table 9.8.4.2 Commands/menu items/tool bar buttons for single-stepping

Function	Command	Menu	Button
Stepping through all instructions	**s**	[Run | Step]	
Stepping through all instructions except subroutines	**n**	[Run | Next]	

When executing single-stepping by command input, the number of steps to be executed can be specified, up to 65,535 steps. When using menu commands or tool bar buttons, the program is executed one step at a time. One step execution can also be performed by pressing the [Enter] key only.
In the following cases, single-stepping is terminated before a specified number of steps is executed:
- The [Key Break] button is clicked or the [Esc] key is pressed.
- The [Break] or [Reset] switch on the ICE is pushed.

Single-stepping is not suspended by breaks set by the user such as a PC break or data break.

 *[Key Break] button* ∗ When the program does not stop, use this button to forcibly stop it.

(2) Display during single-stepping

In the initial debugger settings, the display is updated every step as follows:
When the [Source] window is open, the highlighted line designating the next address to be executed moves every step as the program is stepped through. The display contents of the [Register] window are also updated every step. If the [Register] window is closed, its contents are displayed in the [Command] window. The display of the [Data] window is updated after the specified number of step executions are completed.

Resetting the CPU

The CPU is reset when the ***gr*** command is executed, or by executing the ***rst*** command.
When the CPU is reset, the internal circuits are initialized as follows:

(1) Internal registers of the CPU
  PC = 0x0100
  Other registers = not initialized

(2) The [Source] and [Register] windows are redisplayed.
  Because the PC is set to 0x0100, the [Source] window is redisplayed beginning with that address.
  The PC value in the [Register] window is redisplayed.

The data memory contents are not modified.

9.8.5 Break Functions

The target program is made to stop executing by one of the following causes:
- Break command conditions are satisfied.
- The [Key Break] button is clicked or the [Esc] key is pressed.
- The [Break] or [Reset] switch on the ICE is pushed.

Break by command

The debugger has four types of break functions that allow the break conditions to be set by a command. When the set conditions in one of these break functions are met, the program under execution is made to break.

(1) Break by PC

This function causes the program to break when the PC matches the set address. The program is made to break after executing the instruction at that address. When the pset instruction is entered at the set address, the pset and subsequent instructions are executed before a break occurs. The PC breakpoints can be set for multiple addresses.

Table 9.8.5.1 Commands/menu items/tool bar button to set breakpoints

Function	Command	Menu	Button
Set breakpoints	**bp**	[Break | Breakpoint Set...]	
Clear breakpoints	**bpc**	[Break | Breakpoint Set...]	

The addresses that are set as PC breakpoints are marked with a ◆ as they are displayed in the [Source] window.
Using the [Break] button easily allows the setting and canceling of breakpoints.
Click on the address line in the [Source] window at where the program break is desired (after moving the cursor to that position) and then click on the [Break] button. A ◆ mark will be placed at the beginning of the line indicating that a breakpoint has been set there, and the address is registered in the breakpoint list. Clicking on the line that begins with a ◆ and then the [Break] button cancels the breakpoint you have set, in which case the address is deleted from the breakpoint list.

∗ The temporary break addresses that can be specified by the successive execution commands (***g***) do not affect the set addresses in the breakpoint list.

(2) Data break

This break function allows a break to be executed when a location in the specified data memory area is accessed. In addition to specifying a memory area in which to watch accesses, specification as to whether the break is to be caused by a read or write, as well as specification of the content of the data read or written. The read / write condition can be masked, so that a break will be generated for whichever operation, read or write, is attempted. Similarly, the data condition can also be masked in bit units. A break occurs after completing the cycle in which an operation to satisfy the above specified condition is performed.

Table 9.8.5.2 Commands/menu item to set data break

Function	Command	Menu
Set data break condition	**bd**	[Break | Data Break...]
Clear data break condition	**bdc**	[Break | Data Break...]

For example, if the program is executed after setting the data break condition as Address = 0x10, Data pattern = ∗ (mask) and R / W = W, the program breaks after writing any data to the data memory address 0x10.

(3) Register break

This break function causes a break when the A, B, X, Y, and flag (IDZC) registers reach a specified value. Each register can be masked (so they are not included in break conditions). The flag register can be masked in bit units. A break occurs when the above registers are modified to satisfy all set conditions.

Table 9.8.5.3 Commands/menu item to set register break

Function	Command	Menu
Set register break conditions	**br**	[Break | Register Break...]
Clear register break conditions	**brc**	[Break | Register Break...]

For example, if the program is executed after setting 0 for the data of register A and 1 for the data of flag C and masking all others, the program breaks when the A register is cleared to 0 and the C flag is set to 1.

(4) Multiple break

The debugger supports a multiple break function that consists of a PC breakpoint, a data break condition and a register break condition. Each break condition is the same as that of the independent break function. A break occurs when all the set conditions are satisfied. The program will not break at the position set by multiple break when executing the command ***g <address>*** or ***n***.

Table 9.8.5.4 Commands/menu item to set multiple break

Function	Command	Menu
Set multiple break conditions	**bm**	[Break | Multiple Break...]
Clear multiple break conditions	**bmc**	[Break | Multiple Break...]

Forced break by the [Key Break] button or the [Esc] key

The [Key Break] button or the [Esc] key can be used to forcibly terminate the program under execution when the program has fallen into an endless loop or cannot exit a standby (HALT or SLEEP) state.

 *[Key Break] button*

Forced break by the [Break] or [Reset] switch on the ICE

The [Break] or [Reset] switch can also be used to forcibly terminate the program being executed.

Break enable/disable mode in the ICE

The ICE has two break modes: break enable mode and break disable mode.

Break enable mode (default)

In this mode, any break factor can suspend the target program being executed.

Break disable mode

In this mode, only the forced break function ([Key Break] button, [Esc] key, [Break] switch and [Reset] switch) can suspend the target program being executed. When a break condition that is set by a break command is met during program execution, the ICE outputs a SYNC pulse from the SYNC pin but does not suspend the program being executed. This function can be used as an oscilloscope synchronous signal to measure the target circuit timing using the pulse as a reference.

Table 9.8.5.5 Commands to set ICE break mode

Function	Command
Set break enable mode	**be**
Set break disable mode	**bsyn**

Note

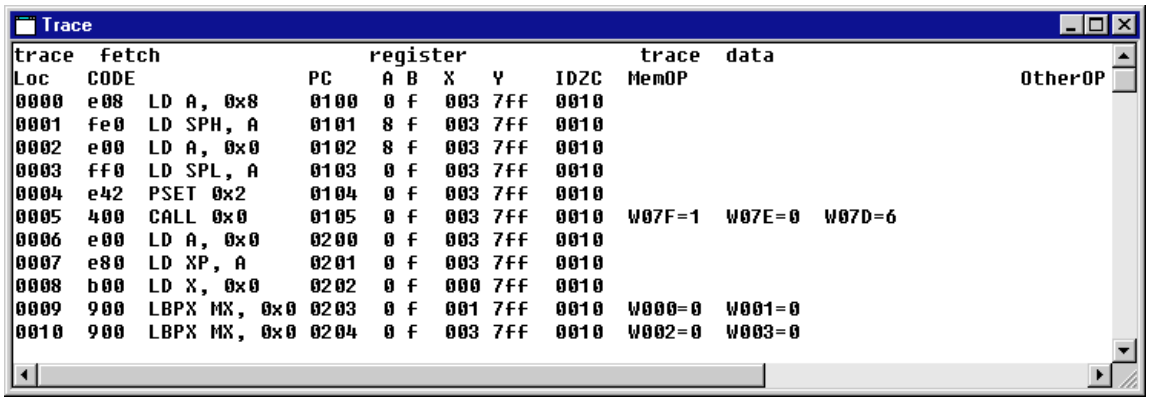
The command breaks control of the trace operation according to the set trace condition. If "Start" or "Middle" is selected as the trace condition, the target program temporarily breaks when the set break condition is met but restarts for sampling trace information. The program execution is terminated after the trace information is completely sampled.

9.8.6 Trace Functions

The debugger has a function to trace program execution.

Trace memory and trace information

The ICE contains a trace memory. When the program executes instructions in the trace range set by a command, the trace information on each cycle is taken into this memory. The trace memory has the capacity to store information for 8,192 cycles, making it possible to trace up to 2,730 instructions (for five-clock instructions only). When the trace information exceeds this capacity, the data is overwritten, the oldest data first. Consequently, the trace information stored in the trace memory is always within 8,192 cycles. The trace memory is cleared when a program is executed, starting to trace the new execution data.



The following lists the trace information that is taken into the trace memory in every cycle. This list is corresponded to display in the [Trace] window.

Loc: Trace cycle number (decimal)
The last information taken into the trace memory becomes 0000.
CODE: Fetched code (hexadecimal) and unassembled content (mnemonic)
PC: PC address (hexadecimal)
A, B, X, Y: Values of A, B, X, Y registers (hexadecimal)
IDZC: Values of I, D, Z and C flags (binary) after cycle execution
MemOP: Read / write operation (denoted by R or W at the beginning of data), accessed data memory address (hexadecimal), and data (hexadecimal)
OtherOP: Interrupt process: INT1 (stack), INT2 (vector fetch)

Trace areas and conditions

Trace areas (address ranges) and a trace condition can be selected using the following commands.

Table 9.8.6.1 Trace area/condition set-up command

Function	Command	Menu
Set trace area	**ta**	[Trace | Trace Area...]
Set trace condition	**tc**	[Trace | Trace Condition...]

(1) Trace area

Multiple program address ranges can be specified as the trace areas. The debugger samples trace information from the set areas only.

(2) Trace condition

The trace starts when the target program starts executing and ends relative to an instruction that generates a break set by a break command (***bp***, ***bd***, ***br*** or ***bm***). The trace range is decided according to the trace condition that can be selected from the three positions shown below:

- Start

  The trace is halted after sampling trace information for 8,192 cycles beginning from the first-hit break point. In this case, the trace information at the break point is the oldest information stored in the trace memory.

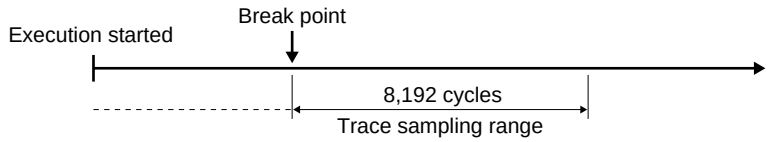


Fig. 9.8.6.1 Trace range when "start" is selected

- Middle

  The trace is halted after sampling trace information for 4,096 cycles beginning from the first-hit break point. In this case, the trace information of 4,096 cycles before and after the break point are sampled into the trace memory.

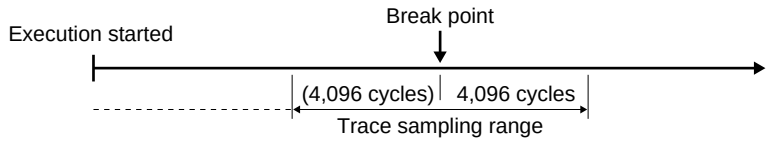


Fig. 9.8.6.2 Trace range when "middle" is selected

- End (default)

  The trace is halted after sampling trace information at the first-hit break point. In this case, the trace information at the break point is the latest information stored in the trace memory.

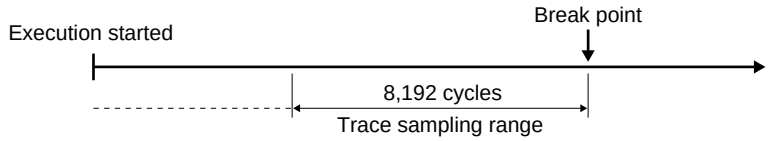


Fig. 9.8.6.3 Trace range when "end" is selected

Displaying and searching trace information

The sampled trace information can be displayed in the [Trace] window by a command. If the [Trace] window is closed, the information is displayed in the [Command] window. In the [Trace] window, the entire trace memory data can be seen by scrolling the window. The trace information can be displayed beginning from a specified cycle.
The display contents are as described above.

Table 9.8.6.2 Command/menu item to display trace information

Function	Command	Menu
Display trace information	**td**	[View | Trace]

It is possible to specify a search condition and display the trace information that matches a specified condition.
The search condition can be selected from the following three:
1. Program's execution address
2. Address from which data is read
3. Address to which data is written

When the above condition and one address are specified, the system starts searching. When the trace information that matches the specified condition is found, the system displays the found data in the [Trace] window (or in the [Command] window if the [Trace] window is closed).

Table 9.8.6.3 Command/menu item to search trace information

Function	Command	Menu
Search trace information	**ts**	[Trace | Trace Search...]

Saving trace information

After the trace information is displayed in the [Trace] window using the ***td*** or ***ts*** commands, the trace information within the specified range can be saved to a file.

Table 9.8.6.4 Command/menu item to save trace information

Function	Command	Menu
Save trace information	**tf**	[Trace | Trace File...]

9.8.7 Coverage

The ICE retains coverage information (i.e., information on addresses at which a program is executed) and it can be displayed in the [Command] window.
Because the executed address range is displayed as shown below, it is possible to know which areas have not been executed.

```
Coverage Information:
    0: 0100..0108
    1: 0200..020f
```

Table 9.8.7.1 Coverage commands

Function	Command
Display coverage information	**cv**
Clear coverage information	**cvc**

9.9 Command Reference

9.9.1 Command List

Table 9.9.1.1 lists the debug commands available with the debugger.

Table 9.9.1.1 Command list

Classification	Command		Function	Page
Program memory operation	as	(assemble)	Assemble mnemonic	156
	pe	(program memory enter)	Input program code	158
	pf	(program memory fill)	Fill program area	159
	pm	(program memory move)	Copy program memory	160
Data memory operation	dd	(data memory dump)	Dump data memory	161
	de	(data memory enter)	Input data	163
	df	(data memory fill)	Fill data area	165
	dm	(data memory move)	Copy data area	166
Register operation	rd	(register display)	Display register values	167
	rs	(register set)	Modify register values	168
Program execution	g	(go)	Execute successively	169
	gr	(go after reset CPU)	Reset CPU and execute successively	171
	s	(step)	Step into	172
	n	(next)	Step over	173
CPU reset	rst	(reset CPU)	Reset CPU	174
Break	bp	(breakpoint set)	Set breakpoint	175
	bpc	(breakpoint clear)	Clear breakpoint	177
	bd	(data break)	Set data break	178
	bdc	(data break clear)	Clear data break	180
	br	(register break)	Set register break	181
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9.9.2 Reference for Each Command

The following sections explain all the commands by functions.

The explanations contain the following items.

Function

Indicates the functions of the command.

Format

Indicates the keyboard input format and parameters required for execution.

Example

Indicates a sample execution of the command.

Note

Shows notes on using.

GUI utility

Indicates a menu item or tool bar button if they are available for the command.

Notes:
- *In the command format description, the parameters enclosed by < > indicate they are necessary parameters that must be input by the user; while the ones enclosed by [ ] indicate they are optional parameters.*
- *The input commands are case-insensitive, you can use either upper case or lower case letters or even mixed.*
- *An error results if the number of parameters is not correct when you input a command using direct input mode.*

```
Error : number of parameter.
```

9.9.3 Program Memory Operation

as (assemble mnemonic)

Function

This command assembles the input mnemonic and rewrites the corresponding code to the program memory at the specified address.

Format

>as↵ **(guidance mode)**
Start address ? : <address>↵
Address Original code Original mnemonic **: <mnemonic>↵**
.....
>

<address>: Start address from which to write code; hexadecimal or symbol (IEEE-695 format only)
<mnemonic>: Input mnemonic; valid mnemonic of S1C62 (expression and symbols are supported)
Condition: 0 ≤ address ≤ last program memory address

Example

```
>as↵
Start address ? 100↵                    ... Address is input.
0100  e0f  LD A, 0xf  : LD A,0xF↵       ... Mnemonic is input.
Source file name (enter to ignore) : ↵ ... Ignored *
0101  fe0  LD SPH, A  : LD B,0xA↵
Source file name (enter to ignore) : ↵
0102  e00  LD A, 0x0  : q↵               ... Command is terminated.
>
```

* Source file name should be entered when a symbol/label is used as the operand. Specify the source file name in which the symbol was defined.

```
0100  e0f  LD A, 0xf  : JP LOOP↵                  ... Symbol is used.
Source file name (enter to ignore) : main.s↵      ... Source file name is input.
```

Notes

- The start address you specified must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or not a valid symbol.
  `Error : invalid value.`
  An error results if the limit is exceeded.
  `Error : Program address out of range.`
- An error results if the input mnemonic is invalid for S1C62.
  `Error : illegal mnemonic.`
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  If the maximum address of program memory is reached and gets a valid input other than "^↵", the command is terminated.

- When the contents of the program memory are modified using the ***as*** command in direct mode, the unassemble contents of the [Source] window are updated immediately. When it is done in guidance mode, the unassemble contents of the [Source] window are updated immediately in unassemble display mode, but will be updated when the "q↵" is input to terminate the command in mix display mode.
- Although the contents of the unassemble display are modified by rewriting code, those of source display remain unchanged.

GUI utility

None

pe (program memory enter)

Function

This command rewrites the contents of the specified address in the program memory with the input hexadecimal code.

Format

>pe↵ **(guidance mode)**
Program enter address ? <address>↵
Address Original code **: <code>**↵
.....
>

<address>: Start address from which to write code; hexadecimal or symbol (IEEE-695 format only)
<code(1–8)>: Write code; hexadecimal (valid operation code of S1C62)
Condition: 0 ≤ address ≤ last program memory address, 0 ≤ input code ≤ 0xfff

Example

```
>pe↵
Program enter address ? 100↵        ... Address is input.
0100 fff   : 1a0↵                   ... Code is input.
0101 fff   : ↵                      ... Address 0x101 is skipped.
0102 fff   : q↵                     ... Command is terminated.
>
```

Notes

- The start address you specified must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not hexadecimal number or not a valid symbol.
  `Error : invalid value.`
  An error results if the limit is exceeded.
  `Error : Program address out of range.`
- Code must be input using a hexadecimal number in the range of 12bits (0 to 0xfff).
  An error results if the input one is not a hexadecimal number.
  `Error : invalid value.`
  An error results if the input code exceeds the limit or it is invalidated by the "DEL" command in the .PAR file.
  `Error : illegal code.`
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  If the maximum address of program memory is reached and gets a valid input other than "^↵", the command is terminated.
- When the contents of the program memory are modified using the ***pe*** command in direct mode, the unassemble contents of the [Source] window are updated immediately. When it is done in guidance mode, the unassemble contents of the [Source] window are updated immediately in unassemble display mode, but will be updated when the "q↵" is input to terminate the command in mix display mode.
- Although the contents of the unassemble display are modified by rewriting code, those of source display remain unchanged.

GUI utility

None

pf (program memory fill)

Function

This command rewrites the contents of the specified program memory area with the specified code.

Format

(1) >pf <address1> <address2> <code>↵ (direct input mode)
(2) >pf↵ (guidance mode)
Start address ? <address1>↵
End address ? <address2>↵
Fill code ? <code>↵
>

<address1>: Start address of specified range; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address of specified range; hexadecimal or symbol (IEEE-695 format only)
<code>: Write code; hexadecimal (valid operation code of S1C62)
Condition: 0 ≤ address1 ≤ address2 ≤ last program memory address, 0 ≤ code ≤ 0xfff

Examples

Format (1)

```
>pf 200 2FF FFB↵          ... Fills the area from address 0x200 to address 0x2ff with 0xffb.
```

Format (2)

```
>pf↵
Start address ? 200↵          ... Start address is input.
End address ? 2ff↵            ... End address is input.
Fill code ? fff↵              ... Code is input.
>
```

∗ Command execution can be canceled by entering only the [Enter] key and nothing else.

Notes

- The addresses specified here must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or not a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Program address out of range.
  ```
- An error results if the start address is larger than the end address.
  ```
  Error : end address < start address.
  ```
- When the contents of the program memory is modified using the ***pf*** command , the contents of the [Source] window are updated automatically.
- Although the contents of the unassemble display are modified by rewriting code, those of source display remain unchanged.

GUI utility

None

pm (program memory move)

Function

This command copies the content of a specified program memory area to another area.

Format

(1) >pm <address1> <address2> <address3>↵ (direct input mode)

(2) >pm↵ (guidance mode)

Start address ? <address1>↵
End address ? <address2>↵
Destination address ? <address3>↵
>

<address1>: Start address of source area to be copied from; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address of source area to be copied from; hexadecimal or symbol (IEEE-695 format only)
<address3>: Address of destination area to be copied to; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address1 ≤ address2 ≤ last program memory address
0 ≤ address3 ≤ last program memory address

Examples

Format (1)

```
>pm 200 2FF 280↵
```
... Copies the codes within the range from address 0x200 to address 0x2ff to the area from address 0x280.

Format (2)

```
>pm↵
Start address ? 200↵
End address ? 2ff↵
Destination address ? 280↵
>
```
... Source area start address is input.
... Source area end address is input.
... Destination area start address is input.

∗ Command execution can be canceled by entering only the [Enter] key and nothing else.

Notes

- The addresses you specified must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or not a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Program address out of range.
  ```
  If any portion of the destination area to be copied to is outside the program memory, no code is copied to that area and results in an error, and no copy operation is done.
  ```
  Error : no mapping area.
  ```
- An error results if the start address is larger than the end address.
  ```
  Error : end address < start address.
  ```
- When the contents of the program memory is modified using the ***pm*** command, the contents of the [Source] window are updated automatically.
- Although the contents of the unassemble display are modified by rewriting code, those of source display remain unchanged.

GUI utility

None

9.9.4 Data Memory Operation

dd (data memory dump)

Function

This command displays the content of the data memory in a 16 words/line hexadecimal dump format.

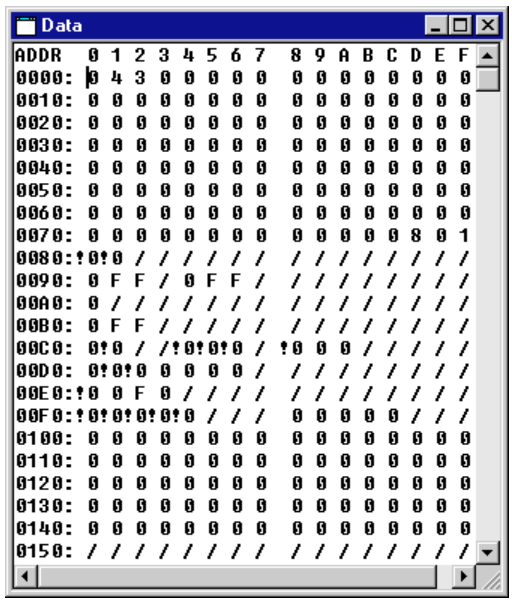
Format

>dd [<address1> [<address2>]]↵ (direct input mode)

<address1>: Start address to display; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address to display; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address1 ≤ address2 ≤ last data memory address

Display

(1) When [Data] window is opened



If both <address1> and <address2> are not defined, the [Data] window is redisplayed beginning with address 0x000.
If <address1> is defined , or even <address2> is defined, the [Data] window is redisplayed in such a way that <address1> is displayed at the uppermost line.
Even when <address1> specifies somewhere in 16 addresses/line, data is displayed beginning with the top of that line. For example, even though you may have specified address 0x118 for <address1>, data is displayed beginning with address 0x110.
However, if an address near the uppermost part of data memory (e.g. maximum address is 0xfff), such as 0xff5, is specified as <address1>, the last line displayed in the window in this case is 0xff0, the specified address is not at the top of the window.
Since the [Data] window can be scrolled to show the entire data memory, defining <address2> does not have any specific effect. Only defining <address1> and both defining <address1> and <address2> has same display result.

(2) When [Data] window is closed

If both <address1> and <address2> are not defined, the debugger displays data for 256 words from address 0x000 in the [Command] window.

```
>dd↵
      0 1 2 3 4 5 6 7  8 9 A B C D E F
0000: 0 c 1 0 0 0 0 0  0 0 0 0 0 0 0 0
0010: 0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0
0020: 0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0
  :           :              :
00e0:!0 0 f 0 / / / /  / / / / / / / /
00f0:!0!0!0!0!0 / / /  0 0 0 0 0 / / /
>
```

"/" indicates an unused address. "!" indicates that the address contains write-only bits or read-only bits.

If only <address1> is defined, the debugger displays data for 256 words from <address1>.

```
>dd 008↵
      0 1 2 3 4 5 6 7  8 9 A B C D E F
0000:                  0 0 0 0 0 0 0 0
0010: 0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0
0020: 0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0
 :          :                  :
00e0:!0 0 f 0 / / / /  / / / / / / / /
00f0:!0!0!0!0!0 / / /  0 0 0 0 0 / / /
0100: 0 0 0 0 0 0 0 0
>
```

If both <address1> and <address2> are defined, the debugger displays data from <address1> to <address2>.

```
>dd 008 017↵
      0 1 2 3 4 5 6 7  8 9 A B C D E F
0000:                  0 0 0 0 0 0 0 0
0010: 0 0 0 0 0 0 0 0
>
```

(3) During log output

If a command execution is being output to a log file by the ***log*** command when you dump the data memory, 256 words of data are displayed in the [Command] window even if the [Data] window is opened and are also output to the log file.

Notes

- Both the start and end addresses specified here must be within the range of the data memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or not a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Data address out of range.
  ```
- An error results if the start address is larger than the end address.
  ```
  Error : end address < start address.
  ```
- The contents of the write-only I/O area cannot be read, but will be marked as hyphens (-).
  For the contents of address of mixed read-only and write-only bits in I/O area, an exclamation mark (!) will be marked in front of the data.
  The contents of the unused area will be marked as slashes (/).

GUI utility

[View | Data Dump] menu item

When this menu item is selected, the [Data] window opens or becomes active and displays the current data memory contents.

de (data memory enter)

Function

This command rewrites the contents of the data memory with the input hexadecimal data. Data can be written to continuous memory locations beginning with a specified address.

Format

(1) >de <address> <data1> [<data2> [...<data16>]]↵ **(direct input mode)**

(2) >de↵ **(guidance mode)**

Data enter address ? <address>↵

Address Original data **: <data>↵**

.....

>

<address>: Start address from which to write data; hexadecimal or symbol (IEEE-695 format only)
<data(1–16)>: Write data; hexadecimal
Condition: 0 ≤ address ≤ last data memory address, 0 ≤ data ≤ 0xf

Examples

Format (1)

```
>de 100 A↵          ... Rewrites data at address 0x100 with 0xa.
```

Format (2)

```
>de↵
Data enter address ? 100↵     ... Address is input.
100   0 : a↵                  ... Data is input.
101   0 : ↵                   ... Skipped.
102   0 : q↵                  ... Command is terminated.
>
```

Notes

- The start address specified here must be within the range of the data memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Data address out of range.
  ```
- The contents of the read only area cannot be rewritten. A warning message will be displayed if you specify such an address.
  ```
  Warning : read only address, can't write.
  ```
- In guidance mode, the contents of the write-only I/O area will be marked as hyphens (-).
  For the contents of address of mixed read-only and write-only bits in I/O area, an exclamation mark (!) will be marked in front of the data.
  The contents of the unused area will be marked as slashes (/). If you encounter any address marked by "/", press [Enter] key to skip that address or terminate the command.
- Data must be input using a hexadecimal number in the range of 4 bits (0 to 0xf). An error results if the limit is exceeded.
  ```
  Error : Data out of range, use 0-0xf.
  ```
- When the contents of the data memory is modified using the ***de*** command, the displayed contents of the [Data] window are updated automatically.

- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  If the maximum address of data memory is reached and gets a valid input other than "^↵", the command is terminated.

GUI utility

[Data] window

The [Data] window allows direct modification of data. Click the [Data] window and select the displayed data to be modified then enter a hexadecimal number.

df (data memory fill)

Function

This command rewrites the contents of the specified data memory area with the specified data.

Format

(1) >df <address1> <address2> <data>↵ (direct input mode)

(2) >df.↵ (guidance mode)

Start address ? <address1>↵
End address ? <address2>↵
Fill data ? <data>↵
>

<address1>: Start address of specified range; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address of specified range; hexadecimal or symbol (IEEE-695 format only)
<data>: Write data; hexadecimal
Condition: 0 ≤ address1 ≤ address2 ≤ last data memory address, 0 ≤ data ≤ 0xf

Examples

Format (1)

```
>df 200 2FF 0↵
```
... Fills the data memory area from address 0x200 to address 0x2ff with 0x0.

Format (2)

```
>df↵
Start address ? 200↵
End address ? 2ff↵
Fill data ? 0↵
>
```
... Start address is input.
... End address is input.
... Data is input.

∗ Command execution can be canceled by entering only the [Enter] key and nothing else.

Notes

- Both the start and end addresses specified here must be within the range of the data memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Data address out of range.
  ```
- An error results if the start address is larger than the end address.
  ```
  Error : end address < start address.
  ```
- Data must be input using a hexadecimal number in the range of 4 bits (0 to 0xf). An error results if the limit is exceeded.
  ```
  Error : Data out of range, use 0-0xf.
  ```
- Write operation is not performed to the read only address of the I/O area.
- When there is an unused area in the specified address range, no error occurs. The area other than the unused area will be filled with the specified data.
- When the contents of the data memory is modified using the ***df*** command, the displayed contents of the [Data] window are updated automatically.

GUI utility

None

dm (data memory move)

Function

This command copies the contents of the specified data memory area to another area.

Format

(1) >dm <address1> <address2> <address3>↵ (direct input mode)

(2) >dm↵ (guidance mode)

Start address ? <address1>↵
End address ? <address2>↵
Destination address ? <address3>↵
>

<address1>: Start address of source area to be copied from; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address of source area to be copied from; hexadecimal or symbol (IEEE-695 format only)
<address3>: Address of destination area to be copied to; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address1 ≤ address2 ≤ last data memory address, 0 ≤ address3 ≤ last data memory address

Examples

Format (1)

```
>dm 200 2FF 280↵
```
... Copies data within the range from address 0x200 to address 0x2ff to the area from address 0x280.

Format (2)

```
>dm↵
Start address ? 200↵
End address ? 2ff↵
Destination address 280↵
>
```
... Source area start address is input.
... Source area end address is input.
... Destination area start address is input.

∗ Command execution can be canceled by entering only the [Enter] key and nothing else.

Notes

- All the addresses specified here must be within the range of the data memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Data address out of range.
  ```
- Write operation is not performed to the read-only address of the I/O area.
- Data in the write-only area cannot be read. If the source area contains write-only address, 0 is written to the corresponding destination. If the destination area contains read-only address, the data of that address can not be rewritten. If the source and destination areas contain I/O address of mixed read-only bits and write-only bits, either read or write operation can be executed for the corresponding bits.
- An error results if there is an unused area in the specified source or destination area, and no copy operation will be done.
  ```
  Error : no mapping area.
  ```
- When the contents of the data memory is modified using the ***dm*** command, the displayed contents of the [Data] window are updated automatically.

GUI utility

None

9.9.5 Register Operation

rd (register display)

Function

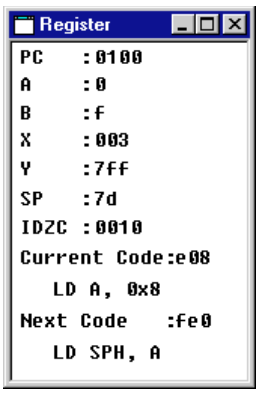
This command displays the contents of the registers, current and next operation code and corresponding mnemonic.

Format

>rd↵ **(direct input mode)**

Display

(1) Contents of display



The following lists the contents displayed by this command.

PC:	Program counter
A:	A register
B:	B register
X:	X register
Y:	Y register
SP:	Stack pointer
IDZC:	Flags
Current Code:	Currently fetched program code at address indicated by PC and corresponding mnemonic
Next Code:	Next code and corresponding mnemonic

(2) When [Register] window is opened

When the [Register] window is opened, all the above contents are displayed in the [Register] window according to the program execution. When you use the ***rd*** command, the displayed contents of the [Register] window is updated.

(3) When [Register] window is closed

Data is displayed in the [Command] window in the following manner:

```
>rd↵
PC:0206   A:0   B:f   SP:7d    X:003   Y:0ff   IDZC:0010
Current Code:e00  LD A, 0x0    Next Code:e80  LD XP, A
>
```

(4) During log output

If a command execution result is being output to a log file by the ***log*** command, the register values are displayed in the [Command] window even if the [Register] window is opened and are also output to the log file.

GUI utility

[View | Register] menu item

When this menu item is selected, the [Register] window opens or becomes active and displays the current register contents.

rs (register set)

Function

This command modifies the register values.

Format

(1) >rs <register> <value> [<register> <value> [...<register> <value>]]↵ (direct input mode)

(2) >rs↵ (guidance mode)

PC = *Old value* **: <value>↵**
A = *Old value* **: <value>↵**
B = *Old value* **: <value>↵**
X = *Old value* **: <value>↵**
Y = *Old value* **: <value>↵**
FI = *Old value* **: <value>↵**
FD = *Old value* **: <value>↵**
FZ = *Old value* **: <value>↵**
FC = *Old value* **: <value>↵**
SP = *Old value* **: <value>↵**
>

<register>: Register name (A, B, X, Y, SP, PC, F)
<value>: Value to be set to the register; binary for F, hexadecimal for others

Examples

Format (1)

```
>rs PC 0110 F 0000↵
```

... Sets PC to 0x0110 and resets all the flags.

Format (2)

```
>rs↵
PC =  206   : 100↵
 A =    0   : 0↵
 B =    f   : 0↵
 X =    3   : 000↵
 Y =   ff   : 100↵
FI =    0   : ↵
FD =    0   : 1↵
FZ =    1   : 0↵
FC =    0   : ↵
SP =   7d   : 7f↵
>
```

After you execute the command, the [Register] window is updated to show the contents you have input. If you input "q↵" to stop entering in the middle, the contents input up to that time are updated.

Notes

- An error results if you input a value exceeding the register's bit width.
  `Error : invalid value.`
- An error results if you input a register name other than PC, A, B, X, Y, F or SP in direct input mode.
  `Error : register name (PC/A/B/X/Y/F/SP).`
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous register.
  "↵" … Input is skipped. (keep current value)

GUI utility

[Register] window

The [Register] window allows direct modification of data. Click the [Register] window, select the displayed data to be modified and enter a value then press [Enter].

9.9.6 Program Execution

g (go)

Function

This command executes the target program from the current PC position.

Format

>g [<address>]↵ (direct input mode)

<address>: Temporary break addresses; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address ≤ last program memory address

Operation

The target program is executed from the address indicated by the PC. Program execution is continued until it is made to break for one of the following causes:

- The set break condition is met
- The [Key Break] button is clicked or the [Esc] key is pressed
- The break or reset switch on the ICE is pushed

If <address> is specified, the program execution will be suspended after executing the instruction at the specified address.

```
>g 1a0↵
```
... Executes the program from the current PC address to address 0x1a0.

Display

In the initial debugger settings, the on-the-fly function is turned on.
During program execution, the PC content in the [Register] window is updated in real time every 0.5 seconds by the on-the-fly function. If the [Register] window is closed, the PC content is displayed in the [Command] window. The on-the-fly function can be turned off by the ***otf*** command. In this case, the [Register] window is updated after a break.

The execution time or execution steps (set by the ***tim*** command) are displayed in the [Command] window after a break.

The [Source] window is updated after a break in such a way that the break address is displayed within the window.

If the [Trace] window is opened, the display contents are cleared as the program is executed. It is updated with the new trace information after a break.

If the [Data] window is opened, the display contents are updated after a break.

Notes

- If a break condition is met, program execution is suspended and the PC will be set to the program address next to the breakpoint.
- When a temporary break is specified (***g <address>***), the multi break function is invalidated due to the hardware specification while the program is running. It takes effect again after the program is suspended at the temporary break address.
- The address you specified must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Program address out of range.
  ```

GUI utility

[Run | Go] menu item, [Go] button

When this menu item or button is selected, the ***g*** command without temporary break is executed.

 *[Go] button*

[Run | Go to Cursor] menu item, [Go to Cursor] button

When this menu item or button is selected after placing the cursor to the temporary break address line in the [Source] window, the ***g*** command with a temporary break is executed. The program execution will be suspended after executing the address at the cursor position.

 *[Go to Cursor] button*

gr (go after reset CPU)

Function

This command executes the target program from the boot address after resetting the CPU.

Format

>gr↵ (direct input mode)

Operation

This command resets the CPU before executing the program. This causes the PC to be set at address 0x100, from which the command starts executing the program.
Once the program starts executing, the command operates in the same way as the ***g*** command.

GUI utility

[Run | Go from Reset] menu item, [Go from Reset] button

When this menu item or button is selected, the ***gr*** command is executed.

 *[Go from Reset] button*

S (step)

Function

This command single-steps the target program from the current PC position by executing one instruction at a time.

Format

>s [<step>]↵ (direct input mode)

<step>: Number of steps to be executed; decimal (default is 1)
Condition: 0 ≤ step ≤ 65,535

Operation

If the <step> is omitted, only the program step at the address indicated by the PC is executed, otherwise the specified number of program steps is executed from the address indicated by the PC.

```
>s↵          ... Executes one step at the current PC address.
>s 20↵       ... Executes 20 steps from the current PC address.
```

The program execution is suspended by the following cause even before the specified number of steps is completed.

- The [Key Break] button is clicked or the [Esc] key is pressed
- The break or reset switch on the ICE is pushed

After each step is completed, the register contents in the [Register] window are updated. If the [Register] window is closed, the register contents are displayed in the [Command] window same as executing the ***rd*** command.

Notes

- The step count must be specified within the range of 0 to 65,535. An error results if the limit is exceeded.

```
Error : Number of steps out of range, use 0-65535.
```

- If the [Data] window is opened, its display contents are updated after the execution.
- During a single-step operation, the program will not break even if the break condition set by a command is met.
- Unlike in successive executions (***g*** or ***gr*** command), the [Register] window is updated every time a step is executed.
- The ***s*** command (one step) is also executed by pressing [Enter] at the command prompt ">".

GUI utility

[Run | Step] menu item, [Step] button

When this menu item or button is selected, the ***s*** command without step count is executed.

 *[Step] button*

n (next)

Function

This command single-steps the target program from the current PC position by executing one instruction at a time.

Format

>n [<step>].↵ (direct input mode)

<step>: Number of steps to be executed; decimal (default is 1)
Condition: 0 ≤ step ≤ 65,535

Operation

This command basically operates in the same way as the ***s*** command.
However, the call and calz instructions, including all subroutines until control returns to the next address, are executed as one step. After executing such step, the PC will be set to the second instruction address after the call or calz instruction. If the next instruction is also call or calz, the PC will be set to the first instruction address in the subroutine called by the second call or calz instruction.

Example when 1 call instruction is executed by the n command without step count

```
                        ......
PC when "n" is executed →       call  _test1
                                ld    a,0
PC after "n" is completed →     ld    b,0
                                ......
```

Example when 2 call instructions are executed by the n command without step count

```
                        ......
PC when "n" is executed →       call  _test1
                                call  _test2
                                ld    a,0
                                ld    b,0
                                ......
PC after "n" is completed →  _test2: ld    a,1
                                ......
```

Notes

- The step count must be specified within the range of 0 to 65,535. An error results if the limit is exceeded.

```
Error : Number of steps out of range, use 0-65535.
```

- If the [Data] window is opened, its display contents are updated after the execution.
- When the n command is executed, the multi break function is invalidated due to the hardware specification while the program is running. It takes effect again after the next execution is completed.
- During a single-step operation, the program will not break even if the break condition set by a command is met.
- Unlike in successive executions (***g*** or ***gr*** command), the [Register] window is updated every time a step is executed.

GUI utility

[Run | Next] menu item, [Next] button

When this menu item or button is selected, the ***n*** command without step count is executed.

 *[Next] button*

9.9.7 CPU Reset

rst (reset CPU)

Function

This command resets the CPU.

Format

>rst↵ (direct input mode)

Notes

- The registers and flags are set as follows:

PC	0x0100
A	Undefined
B	Undefined
X	Undefined
Y	Undefined
I	0
D	Undefined (S1C6200) or 0 (S1C6200A)
Z	Undefined
C	Undefined
SP	Undefined

- If the [Source] window is opened, the window is redisplayed beginning with address 0x0100. If the [Register] window is opened, the window is redisplayed with the above contents.
- The debug status, such as memory contents and break conditions, is not reset.

GUI utility

[Run | Reset CPU] menu item, [Reset] button

When this menu item or button is selected, the ***rst*** command is executed.

 *[Reset] button*

9.9.8 Break

bp (break point set)

Function

This command sets or clears breakpoints using a program's execution address or address ranges.

Format

(1) >bp <break1> [<break2> [<break3> [<break4>]]]↵ (direct input mode)

(2) >bp↵ (guidance mode)

PC break set status
1. set 2. clear 3. clear all ... ? <1 | 2 | 3>↵
..... (guidance depends on the above selection, see examples)
>

<break1–4>: Break address or address area; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address ≤ last program memory address

Examples

Format (1)

```
>bp 100 200..300↵          ... Sets PC break points at address 0x100 and the area from 0x200 to 0x300.
                               * The direct input mode cannot clear the set break points.
```

Format (2)

```
>bp↵     (Set)
PC break: None.
1. set   2. clear   3. clear all ... ? 1↵    ... "1. set" is selected.
Set new PC break   ? : 100↵                   ... Address 0x100 is set as a breakpoint.
Set new PC break   ? : 200..300↵              ... Area 0x200–0x300 is set as a break area.
Set new PC break   ? : ↵                      ... Terminated by [Enter] key.
>bp↵     (Clear)
    0: 0100
    1: 0200..0300
1. set   2. clear   3. clear all ... ? 2↵    ... "2. clear" is selected.
Clear PC break : 150..250↵                    ... Break area 0x150(0x200)–0x250 is cleared.
Clear PC break : ↵                            ... Terminated by [Enter] key.
>bp↵     (Clear all)
    0 : 0100
    1 : 0251..0300
1. set   2. clear   3. clear all ... ? 3↵    ... "3. clear all" is selected.
>bp↵
PC break: None.
1. set   2. clear   3. clear all ... ? ↵     ... Terminated by [Enter] key.
>
```

Notes

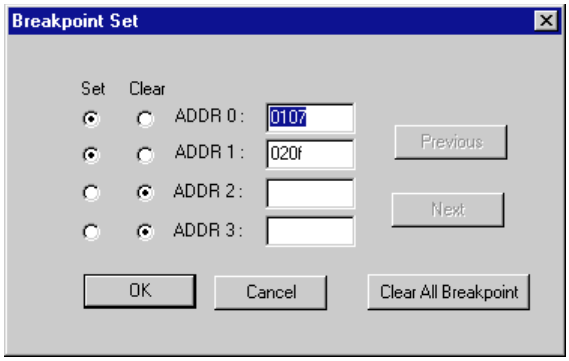
- All PC breaks are cleared by executing the ***bm*** command.
- The addresses must be specified within the range of the program memory area available for each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  `Error : invalid value.`
  An error results if the limit is exceeded.
  `Error : Program address out of range.`
- The consecutive address area is set by entering as "<start address>..<end address>". An error results if the start address is larger than the end address.
  `Error : end address < start address.`
- When clearing PC break points, the specified addresses or areas that have not been set as PC breakpoints are ignored. The break points within the specified area are cleared.

- For direct input mode, an error results if you attempt to set breakpoints at more than 4 locations at a time. But for guidance mode, there is no such limitation, so you can specify more than 4 PC breaks before terminating the command by the [Enter] key.
- You can use this command for multiple times to set new breakpoints.
- Do not set a breakpoint to the address in which the EI instruction is located, as it will interfere with interrupt operations.

GUI utility

[Break | Breakpoint Set...] menu item

When this menu item is selected, a dialog box appears for setting PC breakpoints.



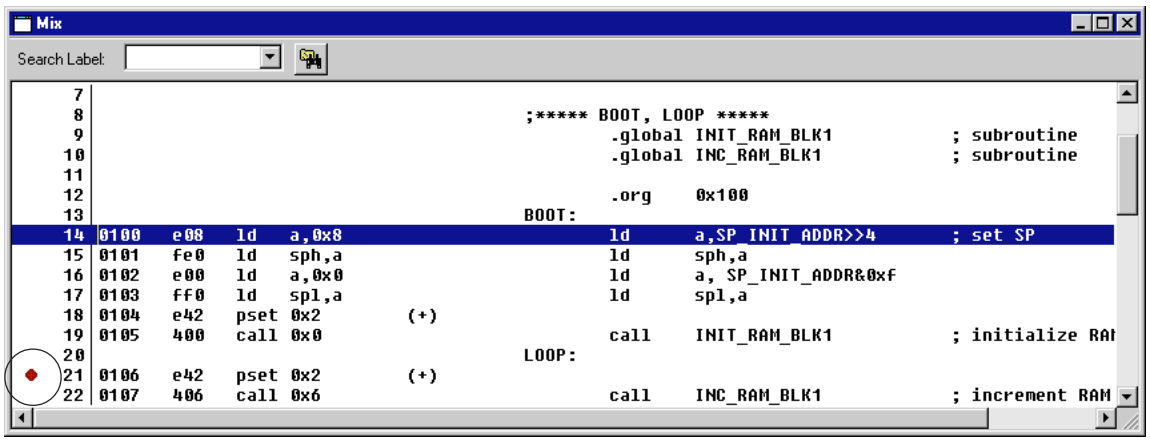
To set a breakpoint, select a [Set] button and enter an address in the text box corresponding to the selected button.
When setting more than four breakpoints, click the [Next] button to continue settings.
The [Previous] and [Next] buttons are used to view previous and subsequent four breakpoints.
To clear a breakpoint, select the [Clear] button of the address to be cleared.
The [Clear All Breakpoint] button clears all the set breakpoints

[Break] button

When this button is clicked after placing the cursor to a line in the [Source] window, the address at the cursor position is set as a PC breakpoint. If the address has been set as a PC breakpoint, this button clears the PC breakpoint.

 *[Break] button*

The set breakpoints are marked with a ◆ at the beginning of the address lines in the [Source] window.



bpc (break point clear)

Function

This command clears the specified breakpoints that have been set.

Format

>bpc <break1> [<break2> [<break3> [<break4>]]]↵ (direct input mode)

<break1–4>: Break address or address area; hexadecimal or symbol (IEEE-695 format only)

Example

```
>bp↵
    0: 0100                                    ... Break points that have been set
    1: 0200..0300
1. set   2. clear   3. clear all ... ? ↵
>bpc 100 150..250↵      ... Clears PC break points at address 0x100 and the area from 0x150 (0x200)
>bp↵                        to 0x250.
   0 : 0251..0300
1. set   2. clear   3. clear all ... ? ↵
>
```

Notes

- The format of parameters is same as the ***bp*** command. You can also use the guidance input mode of ***bp*** command to do the same operation.
- You can use this command for multiple times to clear breakpoints.
- If the specified addresses or areas have not been set as PC breakpoints, no clear operation is done.

GUI utility

[Break | Breakpoint Set ...] menu item

When this menu item is selected, a dialog box appears for clearing PC breakpoints. (See the ***bp*** command.)

[Break] button

When this button is clicked after placing the cursor to a PC break address line in the [Source] window, the breakpoint is cleared. If the address has not been set as a PC breakpoint, this button sets a new PC breakpoint at the address.

 *[Break] button*

bd (data break)

Function

This command sets or clears data break. This command allows you to specify the following break conditions:

1. Memory address to be read or written (one location)
2. Data pattern to be read or written (bit mask possible)
3. Memory read / write (three conditions: read, write, or read or write)

The program breaks after completing a memory access that satisfies the above conditions.

Format

(1) >bd <address> <data> <option>↵ **(direct input mode)**

(2) >bd↵ **(guidance mode)**

Data break set status

1. set 2. clear ...? <1 | 2>↵ (Command is completed when "2" is selected.)
ADDR *Old address* **: <address>↵**
DATA *Old data* **: <data>↵**
R/W *Old option* **: <option>↵**
>

<address>: The specified address; hexadecimal or symbol (IEEE-695 format only)
<data>: Data pattern; hexadecimal or binary with 'B' suffix (* can be input for the bits to be masked)
<option>: Memory read/write option; r, w, or *
Condition: 0 ≤ address ≤ last data memory address, 0 ≤ data ≤ 0xf

Examples

Format (1)

```
>bd 0020 5 W↵          ... Sets a data break condition so that the program breaks when "5" is written
                           to address 0x20.
                       * The direct input mode cannot clear the set condition.
```

Format (2)

```
>bd↵
ADDR : 020   DATA: 5   R/W: W      ... Currently set condition.
1. set   2. clear      ...? 1↵     ... "1. set" is selected.
ADDR     020 : 100↵                ... Break address is set to 0x100.
DATA       5 : 1*1*B↵              ... Data pattern is set to 0b1*1*.
R/W        W : *↵                  ... R/W condition is set for read and write access.
>bd↵
ADDR : 100   DATA: 1*1*B   R/W: *
1. set   2. clear      ...? 2↵     ... "2. clear" is selected.
>bd↵
Data break: None
1. set   2. clear      ...? ↵      ... Terminated by [Enter] key.
```

"*" in the binary data pattern specifies that the bit will not be compared with the actual read / write data.

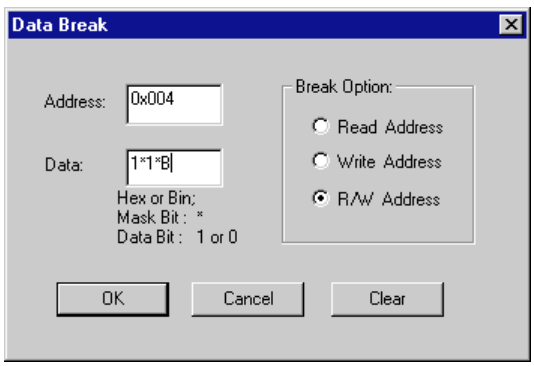
Notes

- For the first time this command is executed, no item can be skipped because no default value is set.
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  When the command is terminated in the middle of guidance by "q↵", the contents that have been input up to that time will be modified. However, these contents will not be modified if some cleared settings are left intact.
- A data break condition can be cleared by executing the ***bm*** command.
- The addresses must be specified within the range of the data memory area available for each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Data address out of range.
  ```
- The data value can be input as a binary number with or without mask bits or a hexadecimal number in the range of 4 bits (0 to 0xf). An error results if the limit is exceeded.
  ```
  Error : invalid data pattern.
  ```
  To input a binary value, a suffix 'B' must be used. When specifying a binary number without mask bits, all four bits should be input, otherwise, the value is treated as a hexadecimal number. For example, to specify 0b10, "0010B" should be input. If only "10B" is input, it will be treated as 0x10b. However, when specifying mask bits, only the required lower bits can be input. In this case the higher bits will be treated as 0 by default. For example, "1*B" will be treated as "001*B".
- An error results if you input the R/W option other than "r", "w" or "*".
  ```
  Error : r/w option (r, w or *).
  ```

GUI utility

[Break | Data Break ...] menu item

When this menu item is selected, a dialog box appears for setting a data break condition.



To set a data break condition, enter an address and a data pattern in the text box, and select R/W condition from the radio buttons. Then click [OK].
To clear the set data break condition, click [Clear].

bdc (data break clear)

Function

This command clears the data break condition that has been set.

Format

>bdc↵ **(direct input mode)**

GUI utility

[Break | Data Break ...] menu item

When this menu item is selected, a dialog box appears for clearing the set data break condition. (See the ***bd*** command.)

br (register break)

Function

This command sets or clears register break. This command allows you to specify data or a mask that constitutes a break condition for each register (A, B, F, X, and Y). The program will break when all setting conditions are met.

Format

(1) >br <register> <value> [<register> <value> [...<register> <value>]]↵ (direct input mode)

(2) >br↵ (guidance mode)

Register break set status
1. set 2. clear …? <1 | 2>↵ (Command is completed when "2" is selected.)
A *Old value* **: <value>↵**
B *Old value* **: <value>↵**
FI *Old value* **: <value>↵**
FD *Old value* **: <value>↵**
FZ *Old value* **: <value>↵**
FC *Old value* **: <value>↵**
X *Old value* **: <value>↵**
Y *Old value* **: <value>↵**
>

<register>: Register name; A, B, F, X or Y
<value>: Data pattern for the register; hexadecimal or binary with 'B' suffix (* can be used for the bits to be masked)

Examples

Format (1)

```
>br F ***1B↵          ... Sets a register break condition so that the program breaks when the C flag is set.
```

Format (2)

```
>br↵
Register break: None
1. set   2. clear      ...? 1↵          ... "1. set" is selected.
A          - : a↵                       ... Data 0xa is set for A register condition.
B          - : *↵                       ... "*" masks the register condition.
FI         - : 1↵
FD         - : *↵
FZ         - : 0↵
FC         - : *↵
X          - : 20↵
Y          - : ^↵                       ... "^↵" returns guidance to previous setting.
X        020 : 60↵
Y          - : *↵
>br↵
  A:A  B:*  X:060  Y:*  IDZC:1*0*B
1. set   2. clear      ...? 2↵          ... "2. clear" is selected.
>br↵
Register break: None
1. set   2. clear      ...? ↵           ... Terminated by [Enter] key.
```

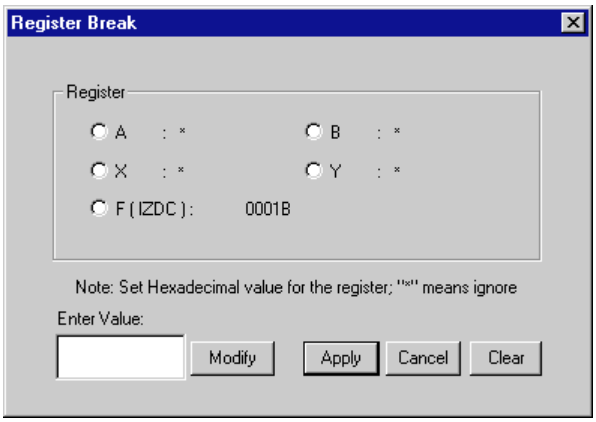
Notes

- For the first time this command is executed, no item can be skipped because no default value is set.
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  When the command is terminated in the middle of guidance by "q↵", the contents that have been input up to that time will be modified. However, these contents will not be modified if some cleared settings are left intact.
- A register break condition can be cleared by executing the ***bm*** command.
- An error results if you input the register name other than A, B, X, Y or F when using the direct input mode.
  ```
  Error : Incorrect register name, use (PC/A/B/X/Y/F).
  ```
- You can use the direct input mode to set register break condition at a time, or change one or several items for register break setting.
- The register value can be input as a binary number with or without mask bits or a hexadecimal number in the range of the bit width of each register (refer to the notes for ***bd*** command). An error results if the limit is exceeded.
  ```
  Error : invalid data pattern.
  ```

GUI utility

[Break | Register Break ...] menu item

When this menu item is selected, a dialog box appears for setting register break conditions.



To set a register condition, select the radio button for the register and enter a value in the [Enter Value:] box, then click [Modify]. All the register condition must be set. Enter an "*" to exclude the register from the break condition.
When the [Apply] button is clicked, the dialog box closes and the register break is set with the specified conditions. However, if there is a register of which the condition has not been set (indicated with "---"), no register break condition is set.
To clear the register break conditions, click [Clear].

brc (register break clear)

Function

This command clears the register break conditions that have been set.

Format

>brc↵ **(direct input mode)**

GUI utility

[Break | Register Break ...] menu item

When this menu item is selected, a dialog box appears for clearing the register break conditions. (See the ***br*** command.)

bm (multiple break)

Function

This command sets or clears multiple break conditions combined with a PC, data RAM access and register breaks.

Format

(1) >bm <item> <value> [<item> <value> [... <item> <value>]]↵ (direct input mode)

(2) >bm↵ (guidance mode)

Multiple break set status

1. set 2. clear ...? <1 | 2>↵ (Command is completed when "2" is selected.)

PC *Old value* **: <value>↵**
ADDR *Old value* **: <value>↵**
DATA *Old value* **: <value>↵**
R/W *Old value* **: <value>↵**
A *Old value* **: <value>↵**
B *Old value* **: <value>↵**
FI *Old value* **: <value>↵**
FD *Old value* **: <value>↵**
FZ *Old value* **: <value>↵**
FC *Old value* **: <value>↵**
X *Old value* **: <value>↵**
Y *Old value* **: <value>↵**
>

<item>: PC/ADDR/DATA/OPT/A/B/F/X/Y
(ADDR, DATA and OPT are for data RAM access, please refer to ***bd*** command)

<value>: Value set for each item; hexadecimal or binary with 'B' suffix (* can be used for the bits to be masked)

Examples

Format (1)

```
>bm PC 150 ADDR 20 DATA 0 OPT W↵
```

... Sets a PC and a data memory conditions. In this case, a break will occur when the program writes 0 to data memory address 0x20 and the program counter is set to 0x150.

Format (2)

```
>bm↵
Combined break: None
1. set   2. clear      ...? 1↵                  ... "1. set" is selected.
PC      ---- : 100↵                             ... PC condition is input.
ADDR     --- : 80↵                              ... Data memory address is input.
DATA       - : A↵                               ... Data pattern is input.
R/W        - : *↵                               ... "*" masks the condition.
A          - : *↵
B          - : 6↵                               ... Register condition is input.
FI         - : *↵
FD         - : *↵
FZ         - : 1↵
FC         - : *↵
X        --- : *↵
Y        --- : 120↵
>bm↵
 PC:0100  ADDR:080  DATA:A  R/W:*
  A:*  B:6  X:*  Y:120  IDZC:**1*B
1. set   2. clear      ... ? 2↵                 ... "2. clear" is selected.
>
```

Notes

- For the first time this command is executed, no item can be skipped because no default value is set.
- A multiple break will occur when all the conditions for the PC, data RAM access, and register values coincide.
- The previously set PC break, data break and register break conditions are cleared by the ***bm*** command. Also, the multiple break setting is cleared when the ***bp***, ***bd*** and / or ***br*** conditions are set after the ***bm*** condition is set.
- An error results if you input the item name other than one listed below, when using the direct input mode.

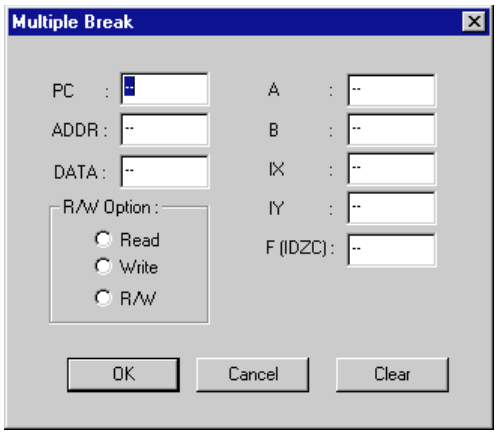
```
Error : Incorrect identifier, use PC/ADDR/DATA/OPT/A/B/X/Y/F.
```

- You can use the direct input mode to set multiple break condition at a time, or change one or several items for multiple break setting.
- In guidance mode, the following keyboard inputs have special meaning:
  "q↵" … Command is terminated. (finish inputting and start execution)
  "^↵" … Return to previous address.
  "↵" … Input is skipped. (keep current value)
  When the command is terminated in the middle of guidance by "q↵", the contents that have been input up to that time will be modified. However, these contents will not be modified if some cleared settings are left intact.

GUI utility

[Break | Multiple Break ...] menu item

When this menu item is selected, a dialog box appears for setting multi break conditions.



To set a multiple break, enter each condition in the box and select a R / W condition from the radio buttons, then click [OK]. All the conditions must be set. Enter an "*" to exclude the condition. If there is a condition that has not been set (indicated with "---"), no multiple break condition is set.
To clear the multiple break condition, click [Clear].

bmc (multiple break clear)

Function

This command clears the multiple break condition that has been set.

Format

>bmc↵ **(direct input mode)**

GUI utility

[Break | Multi Break ...] menu item

When this menu item is selected, a dialog box appears for clearing multi break conditions. (See the ***bm*** command.)

bl (break point list)

Function

This command lists the current setting of all break conditions.

Format

>bl↵ **(direct input mode)**

Example

```
>bl↵
Data Break Condition:
ADDR : 100   DATA: 1*1*B   R/W: *
Register Break Condition:
  A:A  B:*  X:060  Y:*  IDZC:1*0*B
PC Break List:
    0: 0100
    1: 0200..0300
>
```

GUI utility

None

bac (break all clear)

Function

This command clears all break conditions set by the ***bp***, ***bd***, ***br*** and / or ***bm*** commands.

Format

>bac↵ **(direct input mode)**

GUI utility

[Break | Break All Clear] menu item

When this menu item is selected, the ***bac*** command is executed.

be (break enable)

Function

This command sets the break enable mode. A break is generated when the PC break, data break, register break or multi break condition is met with the Evaluation Board CPU state.

Format

>be↵ **(direct input mode)**

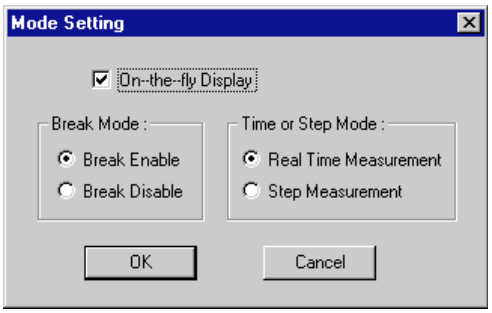
Example

```
>be↵
Set to break enable mode.
```

GUI utility

[Option | Mode Setting ...] menu item

When this menu item is selected, a dialog box appears for setting break enable mode.



Select the [Break Enable] button.

bsyn (break disable)

Function

This command sets the break disable (synchronous) mode. When the PC break, data break, register break or multi break condition is met with the Evaluation Board CPU state, a pulse is output to the ICE SYNC pin. However, a break is not generated.

Format

>bsyn↵ (direct input mode)

Example

```
>bsyn↵
Set to break disable (synchronous) mode.
```

GUI utility

[Option | Mode Setting …] menu item

When this menu item is selected, a dialog box appears for setting break disable mode. Select the [Break Disable] button in the dialog box. (See the ***be*** command.)

9.9.9 Program Display

u (unassemble)

Function

This command displays a program in the [Source] window after unassembling it. The display contents are as follows:

- Program memory address
- Object code
- Unassembled contents of the program

Format

>u [<address>]↵ (direct input mode)

<address>: Start address for display; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address ≤ last program memory address

Display

When the [Source] window is opened, the display is refreshed. When the [Source] window is closed, the window automatically opens in the unassemble mode.
If <address> is not specified, the program is displayed from the current PC address by default; if <address> is specified, it is displayed from the specified address.

GUI utility

[View | Program | Unassemble] menu item, [Unassemble] button

When this menu item or button is selected, the [Source] window opens or activates and displays the program from the current PC address.

 *[Unassemble] button*

SC (source code)

Function

This command displays the contents of the program source file in the [Source] window. The display contents are as follows:

- Line number in the source file
- Source code

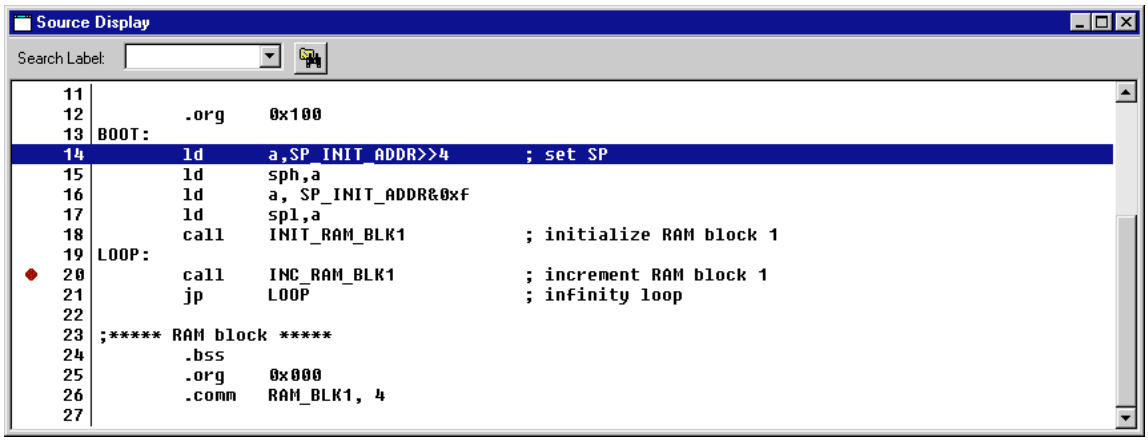
Format

>sc [<address>]↵ (direct input mode)

<address>: Start address for display; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address ≤ last program memory address

Display

When the [Source] window is opened, the display is refreshed. When the [Source] window is closed, the window automatically opens in the source mode.
If <address> is not specified, the program is displayed from the current PC address by default; if <address> is specified, it is displayed from the specified address.



Note

Source codes can be displayed only when an absolute object file that contains source debug information has been loaded.

GUI utility

[View | Program | Source Display] menu item, [Source] button

When this menu item or button is selected, the [Source] window opens or activates and displays the program from the current PC address.

 *[Source] button*

m (mix)

Function

This command displays the unassembled result of the program and the contents of the program source file in the [Source] window. The display contents are as follows:

- Line number
- Program memory address
- Object code
- Unassembled contents of the program
- Source code

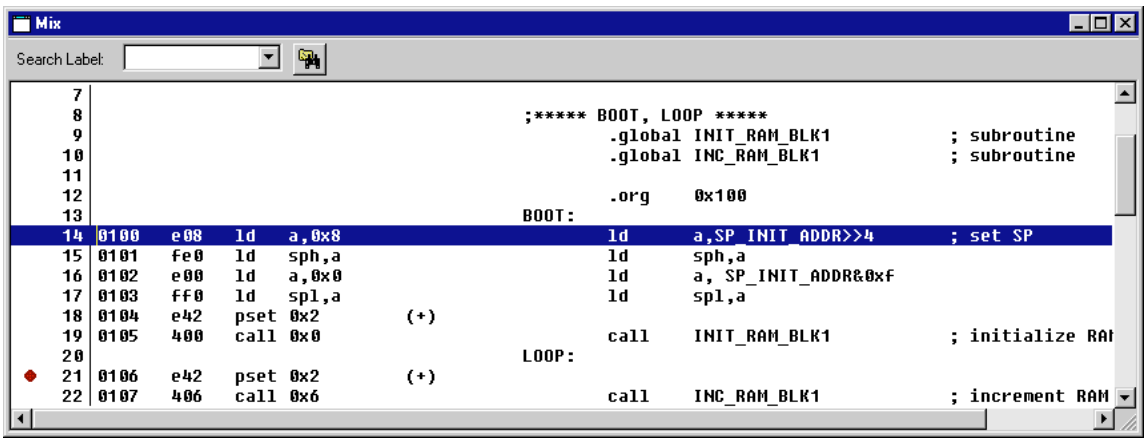
Format

>m [<address>]↵ (direct input mode)

<address>: Start address for display; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address ≤ last program memory address

Display

When the [Source] window is opened, the display is refreshed. When the [Source] window is closed, the window automatically opens in the mix mode.
If <address> is not specified, the program is displayed from the current PC address by default; if <address> is specified, it is displayed from the specified address.



Note

Source codes can be displayed only when an absolute object file that contains source debug information has been loaded.

GUI utility

[View | Program | Mix Mode] menu item, [Mix] button

When this menu item or button is selected, the [Source] window opens or activates and displays the program from the current PC address.

 *[Mix] button*

9.9.10 Symbol Information

sy (symbol list)

Function

This command displays a list of symbols in the [Command] window.

Format

(1) >sy [/a]↵ (direct input mode)
(2) >sy $<keyword> [/a]↵ (direct input mode)
(3) >sy #<keyword> [/a]↵ (direct input mode)

<keyword>: Search character string; ASCII character
Condition: 0 ≤ length of keyword ≤ 32

Examples

Format (1)

```
>sy↵
INC_RAM_BLK1                          206
INIT_RAM_BLK1                         200
RAM_BLK1                                0
BOOT@C:\E0C62\TEST\MAIN.S             100
LOOP@C:\E0C62\TEST\MAIN.S             106
>
```

In format (1), all the defined symbols are displayed in alphabetical order. Global symbols are displayed first, then local symbols. Shown to right to each symbol is the address that is defined in it.

Format (2)

```
>sy $R↵
INC_RAM_BLK1                          206
INIT_RAM_BLK1                         200
RAM_BLK1                                0
>
```

In format (2), the debugger displays global symbols that contain the character string specified by <keyword>.

Format (3)

```
>sy #B↵
BOOT@C:\E0C62\TEST\MAIN.S             100
>
```

In format (3), the debugger displays local symbols that contain the character string specified by <keyword>.

When local symbols are displayed, @ and the source file name in which the symbol is defined are added.

Notes

- The symbol list will be sorted by letter order if no option is added. If the option is added, the symbol list will be sorted by address.
- The symbol list can only be displayed when the object file in IEEE-695 format has been read.
- The specification of keyword conforms to which defined for assembler tools.

GUI utility

None

9.9.11 Load File

lf (load file)

Function

This command loads an object file in IEEE-695 format into the debugger.

Format

(1) >lf <file name>↵ **(direct input mode)**

(2) >lf↵ **(guidance mode)**

File Name ? <file name>↵

>

<file name>: File name to be loaded (path can also be specified)

Examples

Format (1)

```
>lf test.abs↵
Loading file ... OK!
>
```

Format (2)

```
>lf↵
File name   ? test.abs
Loading file ... OK!
>
```

Notes

- An error results if the loaded file is linked with a different ICE parameter file than the one the debugger is using.

  ```
  Error : different chip type, can't load this file.
  ```

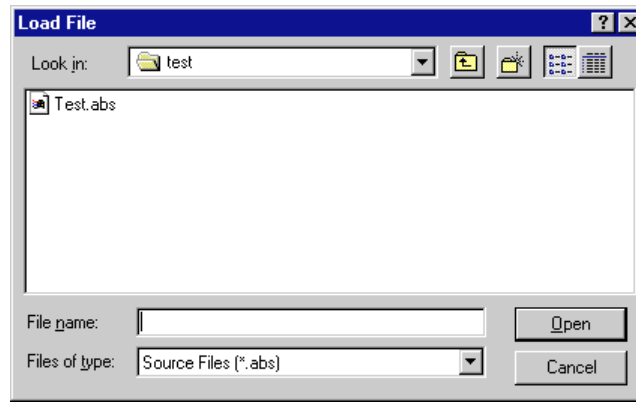
- Only an IEEE-695 format object file (generated by the linker) can be loaded by the ***lf*** command.
- If you want to use source display and symbols when debugging a program, the object file must be in IEEE-695 format that contains debug information loaded into the computer.
- If the [Source] window is opened when loading a file, its contents are updated. The program contents are displayed from the current PC address.
- If an error occurs when loading a file, portions of the file that have already been read will remain in the emulation memory.

GUI utility

[File | Load File ...] menu item, [Load File] button

When this menu item or button is selected, a dialog box appears allowing selection of an object file to be loaded.

[Load File ...] button



lo (load option)

Function

This command loads an Intel HEX format program or option file listed below into the debugger.

File	Name specification
Program file	~h.hex (4 high-order bits), ~l.hex (8 low-order bits)
Function option data file	~f.hex
Segment option data file	~s.hex
Melody data file*	~a.hex

* Not used in some microcomputer models

Format

(1) >lo <file name>↵ **(direct input mode)**

(2) >lo↵ **(guidance mode)**

File Name ...? <file name>↵

>

<file name>: File name to be loaded (path can also be specified)

Examples

Format (1)

```
>lo testl.hex↵                    ... Loads the program files testl.hex and testh.hex.
Loading file ... OK!
>
```

Format (2)

```
>lo↵
File name   ? tests.hex↵          ... Loads a segment option file.
Loading file ... OK!
>
```

Notes

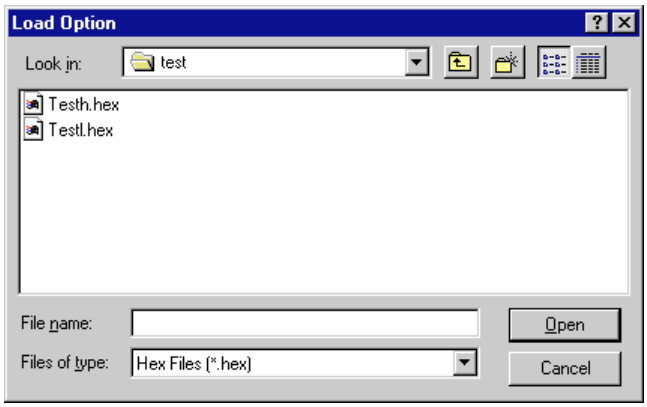
- The debugger determines the file type based on the specified file name. Therefore, the debugger cannot load a file not following to the name specification listed above, and an error will result.
  ```
  Error : File name error.
  ```
- If an error occurs when loading a file, portions of the file that have already been read are left as they were loaded.

GUI utility

[File | Load Option ...] menu item, [Load Option] button

When this menu item or button is selected, a dialog box appears allowing selection of a hex file to be loaded.


[Load Option] button



9.9.12 ROM Access

rp (ROM program load)

Function

This command loads program to ICE's emulation memory from the ROM at the ICE ROM socket.

Format

>rp↵ (direct input mode)

Notes

- An error results if high and / or low ROM chips are not installed, and so the program is not loaded to the emulation memory.

```
Error : no low ROM.
Error : no high ROM.
Error : no high and low ROM.
```

- An error results when an undefined code is detected, and the execution is terminated.

```
Error : undefined code detected.
```

GUI utility

None

vp (ROM program verify)

Function

This command verifies the contents of the ICE emulation memory and the ROM at the ICE ROM socket.

Format

>vp↵ (direct input mode)

Notes

- An error results if high and / or low ROM chips are not installed.

```
Error : no low ROM.
Error : no high ROM.
Error : no high and low ROM.
```

- If there is any non-agreeing data, it (ROM address, ROM contents, emulation memory contents) is displayed in the [Command] window.

```
>vp↵
Rom verifying ... NG!
Rom verify Errors:
FFF  FFC, 0300  0FF  0FC, ...
>
```

This command just verifies the contents of the ICE emulation memory and the ROM, so no error results if an undefined code exists either in the emulation memory or the ROM. It is checked when loading program from ROM by ***rp*** command.

- If many non-agreeing data are detected, the display can be interrupted by pressing the [Esc] key.

GUI utility

None

rom (ROM type)

Function

This command specifies the type of the ROM chip which is installed to the ICE ROM socket.

Format

(1) >rom <type>↵ **(direct input mode)**

(2) >rom↵ **(guidance mode)**

rom *Current type setting* **: <type>↵**

>

<type>: Value indicating the ROM type; 64/128/256/512

Examples

Format (1)

```
>rom 64↵                    ... 2764 type ROM is specified.
>
```

Format (2)

```
>rom↵
ROM   64 : 256↵             ... 27256 type ROM is specified.
>
```

Notes

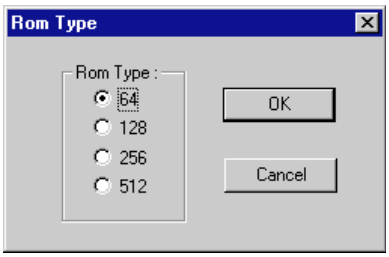
- The initial value is set as 64.
- An error results if you input a value other than the valid ones listed above.

```
Error : Incorrect ROM type (64/128/256/512).
```

GUI utility

[Option | ROM Type ...] menu item

When this menu item is selected, a dialog box appears allowing selection of a ROM type.



Select a ROM type from the radio buttons.

9.9.13 Trace

tc (trace condition)

Function

This command sets up the trace condition by means of the break point.
One of the following three trace conditions can be specified with respect to the break point:
Start: Extract the trace information from the break point.
Middle: Extract the trace information before and after the break point.
End: Extract the trace information up to the break point.

Format

(1) >tc <condition>↵ **(direct input mode)**

(2) >tc↵ **(guidance mode)**

Current type setting
Set condition 1. start 2. middle 3. end .....? <1 | 2 | 3>↵
>

<condition>: Position for trace extraction with respect to the break point; s/m/e

Examples

Format (1)
```
>tc s↵                          ... "Start" is specified.
>
```

Format (2)
```
>tc↵
Trace condition:
End
1. start   2. middle    3. end  ...? 2↵
>
```

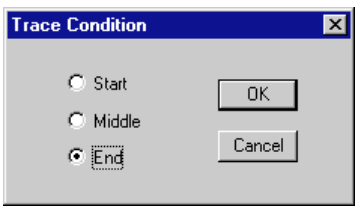
Note

An error results if you input the condition other than listed above.
```
Error : Invalid value.
```

GUI utility

[Trace | Trace Condition ...] menu item

When this menu item is selected, a dialog box appears allowing selection of a trace condition.



Select a condition using the radio button.

ta (trace area)

Function

This command sets or clears the trace area by the specified program address range.

Format

(1) >ta [<staddr1> <endaddr1> [..... <staddr4> <endaddr4>]]↵ **(direct input mode)**

(2) >ta all↵ **(direct input mode)**

(3) >ta↵ **(guidance mode)**

Current trace area
1. set 2. clear 3. clear all ...? <1 | 2 | 3>↵
Start address ? <staddr>↵
End address ? <endaddr>↵
.....
>

<staddr1–4>: Start address of each specified address range; hexadecimal or symbol (IEEE-695 format only)
<endaddr1–4>: End address of each specified address range; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ staddr(1–4) ≤ endaddr(1–4) ≤ last program memory address

Examples

Format (1)

```
>ta 400 600↵                          ... Sets a trace area from address 0x400 to 0x600.
>
```

Format (2)

```
>ta all↵                              ... Sets as entire program memory to be traced.
>
```

Format (3)

```
>ta↵
Trace area:
0000..0fff
1. set   2. clear   3. clear all   ...? 3↵   ... Clears all areas.
>ta
No trace extract address is defined
1. set   2. clear   3. clear all   ...? 1↵
Start address ? 100↵                    ... Sets a trace area from address 0x100 to 0x17f.
End address ? 17f↵
Start address ? 200↵                    ... Sets a trace area from address 0x200 to 0x2ff.
End address ? 2ff↵
Start address ? ↵                       ... Terminated by [Enter] key.
>ta↵
Trace area:
0100..017f
0200..02ff
1. set   2. clear   3. clear all   ...? 2↵
Start address ? 150↵                    ... Clears a trace area from address 0x150 to 0x24f.
End address ? 24f↵
Start address ? ↵
>ta↵
Trace area:
0100..014f
0250..02ff
1. set   2. clear   3. clear all   ...? ↵
>
```

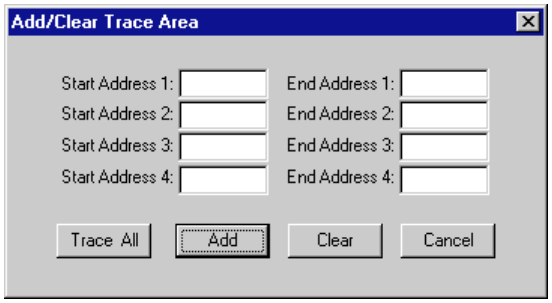
Notes

- The addresses must be specified within the range of the program memory area available for each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  ```
  Error : invalid value.
  ```
  An error results if the limit is exceeded.
  ```
  Error : Program address out of range.
  ```
- An error results if the start address is larger than the end address.
  ```
  Error : end address < start address.
  ```
- You can set all program area as trace area using format (2).
- If the end address of the last location is not specified, it is treated as the maximum program address.
- For direct input mode in format (1), an error results if you attempt to specify more than 4 address ranges at a time. But for guidance mode, there is no such limitation, so you can specify more than 4 address ranges before terminating the command by the [Enter] key.
- If you set an address range to trace area, this address range will be added to current trace area. So if you want to set trace area from nothing, you should at first clear current trace area.
- You can use this command for multiple times to set new address ranges to trace area, or clear address ranges from trace area.

GUI utility

[Trace | Trace Area ...] menu item

When this menu item is selected, a dialog box appears for setting trace areas.



Enter the start and end addresses and then click [Add].
Up to four areas can be set at a time. To set more than four areas, select this menu item every four areas.
When the [Clear] button is clicked, the entered address ranges are cleared.
The [Trace All] button set the entire program memory to be traced.

tac (trace area clear)

Function

This command clears program address ranges from the trace area.

Format

>tac [<staddr1> <endaddr1> [... <staddr4> <endaddr4>]]↵ (direct input mode)

<staddr1–4>: Start address of each specified address range; hexadecimal or symbol (IEEE-695 format only)
<endaddr1–4>: End address of each specified address range; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ staddr(1–4) ≤ endaddr(1–4) ≤ last program memory address

Example

```
>ta↵
Trace area:
0000..0fff                                        ... Current trace area
1. set   2. clear   3. clear all   ...? ↵
>tac 400 600↵                                     ... Clears a trace area from 0x400 to 0x600.
>ta↵
Trace area:
0000..03ff
0601..0fff
1. set   2. clear   3. clear all   ...? ↵
>
```

Notes

- The addresses must be specified within the range of the program memory area available for each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  `Error : invalid value.`
  An error results if the limit is exceeded.
  `Error : Program address out of range.`
- An error results if the start address is larger than the end address.
  `Error : end address < start address.`
- If you input the ***tac*** command without any parameter, the entire trace area is clear by default.
- You can use this command for multiple times to clear address ranges from trace area.

GUI utility

[Trace | Trace area ...] menu item

When this menu item is selected, a dialog box appears for clearing trace areas. (See the ***ta*** command.)

tp (trace pointer)

Function

This command displays the current location of the trace pointer. The pointer points to the location in the trace memory into which the last trace information has been stored.

Format

>tp↵ **(direct input mode)**

Example

```
>tp↵
LOC=2058              ... Current trace pointer value
>
```

GUI utility

None

td (trace data display)

Function

This command displays the trace information that has been sampled into the ICE's trace memory.

Format

(1) >td [<num>]↵ **(direct input mode)**

(2) >td↵ **(guidance mode)**

Start point ?: (ENTER from the latest) <num>↵

(Trace data is displayed)

>

<num>: Start pointer of trace data; decimal (from 0 to 2,730)

Display

The following lists the contents of trace information:

Loc: Trace cycle number (decimal)
The last information taken into the trace memory becomes 0000.

CODE: Fetched code (hexadecimal) and unassembled content (mnemonic)

PC: PC address (hexadecimal)

A, B, X, Y: Values of A, B, X, Y registers (hexadecimal)

IDZC: Values of I, D, Z and C flags (binary) after cycle execution

MemOP: Read / write operation (denoted by R or W at the beginning of data), accessed data memory address (hexadecimal), and data (hexadecimal)

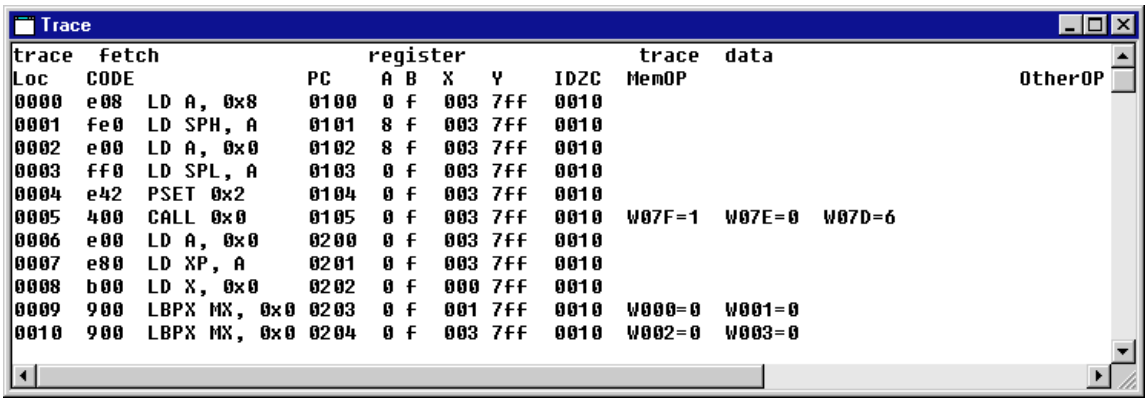
OtherOP: Interrupt process: INT1 (stack), INT2 (vector fetch)

(1) When [Trace] window is opened:

When the ***td*** command is input without <num>, the [Trace] window redisplays the latest data; when the ***td*** command is input with <num>, the trace data starting from <num> is displayed in the [Trace] window.

The display contents of the [Trace] window is updated after an execution of the target program.

All trace data can be displayed by scrolling the window.



(2) When [Trace] window is closed:

When the ***td*** command is input without <num>, the debugger displays 11 lines of the latest trace data in the [Command] window. When the ***td*** command is input with <num>, the debugger displays 11 lines of the trace data from <num> in the [Command] window.

```
>td↵
Start point ?:(ENTER from the latest)↵
trace  fetch                register              trace  data
Loc   CODE              PC    A B  X   Y    IDZC  MemOP                      OtherOP
0000  e08 LD A, 0x8     0100  0 0  001 100  0100
0001  fe0 LD SPH, A     0101  8 0  001 100  0100
0002  e00 LD A, 0x0     0102  8 0  001 100  0100
0003  ff0 LD SPL, A     0103  0 0  001 100  0100
0004  e42 PSET 0x2      0104  0 0  001 100  0100
0005  400 CALL 0x0      0105  0 0  001 100  0100  W07F=1  W07E=0  W07D=6
0006  e00 LD A, 0x0     0200  0 0  001 100  0100
0007  e80 LD XP, A      0201  0 0  001 100  0100
0008  b00 LD X, 0x0     0202  0 0  000 100  0100
0009  900 LBPX MX, 0x0  0203  0 0  001 100  0100  W000=0  W001=0
0010  900 LBPX MX, 0x0  0204  0 0  003 100  0100  W002=0  W003=0
>td 10↵
trace  fetch                register              trace  data
Loc   CODE              PC    A B  X   Y    IDZC  MemOP                      OtherOP
0010  900 LBPX MX, 0x0  0204  0 0  003 100  0100  W002=0  W003=0
0011  fdf RET           0205  0 0  004 100  0100  R07D=6  R07E=0  R07F=1
0012  e42 PSET 0x2      0106  0 0  004 100  0100
0013  406 CALL 0x6      0107  0 0  004 100  0100  W07F=1  W07E=0  W07D=8
0014  e00 LD A, 0x0     0206  0 0  004 100  0100
0015  e80 LD XP, A      0207  0 0  004 100  0100
0016  b00 LD X, 0x0     0208  0 0  000 100  0100
0017  e00 LD A, 0x0     0209  0 0  000 100  0100
0018  f41 SCF           020a  0 0  000 100  0101
0019  f28 ACPX MX, A    020b  0 0  000 100  0100  R000=0  W000=1
0020  f28 ACPX MX, A    020c  0 0  001 100  0110  R001=0  W001=0
>
```

Notes

- Trace memory has a capacity of 8,192 cycles. On the other hand, the S1C6200 has 5, 7 and 12 clock instructions. The 5 clock instructions require 3 bus cycles, 7 clock instructions require 4 bus cycles, and 12 clock instructions require 6 bus cycles. Thus, the final value of the trace pointer is changed according to the executed instruction. The maximum final value when only 5 clock instructions are executed is about 2,730, while the execution for only 12 clock instructions is about 1,300. So the maximum possible value of trace pointer is 2,730.
  An error results if the <num> you specified exceeds the maximum possible value (2,730).
- The trace memory receives new data until a break occurs. When the trace memory is filled, old data is overwritten by new data.
- If there is no trace information can be read out, the warning message will be displayed.
  ```
  No trace data.
  ```
- An error results if the <num> value you input is bigger than the last location in the trace memory.
  ```
  Error : Data address out of range.
  ```

GUI utility

[View | Trace] menu item

When this menu item is selected, the [Trace] window opens and displays the latest trace data.

ts (trace search)

Function

This command searches trace information from the trace memory under a specified condition. The search condition can be selected from three available conditions:

1. Search by executed address
   In this mode, you can specify a program memory address. The debugger searches the cycle in which the specified address is executed.
2. Search for a specified memory read cycle
   In this mode, you can specify a data memory address. The debugger searches the cycle in which data is read from the specified address.
3. Search for a specified memory write cycle
   In this mode, you can specify a data memory address. The debugger searches the cycle in which data is written to the specified address.

Format

(1) >ts <option> <address>↵ (direct input mode)

(2) >ts↵ (guidance mode)

1. Pc address 2. Data read address 3. Data write address ...? <1 | 2 | 3>↵
Search address ?: <address>↵
(Search result is displayed)
>

<option>: Condition type (program address, data read address or data write address); pc/dr/dw
<address>: Search address; hexadecimal or symbol (IEEE-695 format only)

Display

The search results are displayed in the [Trace] window if it is open; otherwise, the results are displayed in the [Command] window.

Format (1)

```
>ts pc 200↵
Trace searching ... Done!
0006  e00 LD A, 0x0     0200  0 0  001 100  0100
>
```

Format (2)

```
>ts↵
1.Pc address   2.Data read address   3.Data write address ...? 1↵
Search address ?:200↵
Trace searching ... Done!
0006  e00 LD A, 0x0     0200  0 0  001 100  0100
>
```

```
Loc      CODE            PC   A B   X   Y   IDZC  MemOP          OtherOP
0006  e00 LD A, 0x0     0200  0 0  001 100  0100
```

When command execution results are being output to a log file by the ***log*** command, the search results are displayed in the [Command] window as well as output to the log file even when the [Trace] window is opened.

Note

The address specified for search must be within the range of the program / data memory area available for each microcomputer model.

An error results if the input one is not a hexadecimal number or not a valid symbol.

```
Error : invalid value.
```

An error results if the limit is exceeded for program memory address.

```
Error : Program address out of range.
```

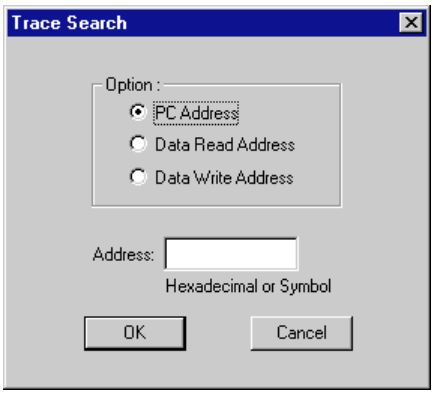
An error results if the limit is exceeded for data memory address.

```
Error : Data address out of range.
```

GUI utility

[Trace | Trace Search ...] menu item

When this menu item is selected, a dialog appears for setting a search condition.



Select a option using the radio button and enter an address in the text box, then click [OK].

tf (trace file)

Function

This command saves the specified range of the trace information displayed in the [Trace] window by the ***td*** command to a file.

Format

(1) >tf [<num1> <num2>] <file name>↵ (direct input mode)

(2) >tf↵ (guidance mode)

Start pointer ? <num1>↵
End pointer ? <num2>↵
File Name ? <file name>↵
>

<num1>: Start pointer; decimal (min 0)
<num2>: End pointer; decimal (max 2,730)
<file name>: Output file name (path can also be specified)

Examples

Format (1)

```
>tf trace.trc↵          ... Saves all trace information extracted by the td command.
Tracing into file ... OK!
>
```

Format (2)

```
>tf↵
Start point ? 0↵
End point ? ↵           ... The oldest data is specified by the [Enter] key.
File name   ? test.trc↵
Tracing into file ... OK!
>
```

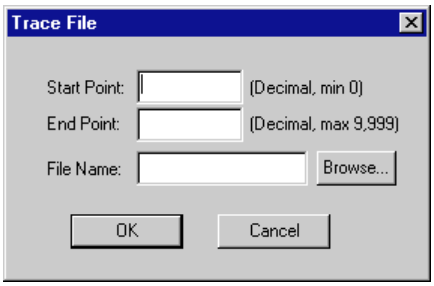
Notes

- If an existing file is specified, the file is overwritten with the new data.
- The default value of <num1> is "0", the default value of <num2> is the last location.

GUI utility

[Trace | Trace File ...] menu item

When this menu item is selected, a dialog box appears allowing specification of the parameters.



Enter a start pointer, end pointer and a file name, then click [OK].
To save all the trace information, enter 0 to the [Start Point] box and leave the [End Point] box blank.
The file name can be selected using a standard file selection dialog box that appears by clicking [Browse...].

9.9.14 Coverage

CV (coverage)

Function

This command displays coverage information (addresses where the program is executed).
The coverage information is displayed in the [Command] window.

Format

>cv [<address1> [<address2>]]↵ (direct input mode)

<address1>: Start address; hexadecimal or symbol (IEEE-695 format only)
<address2>: End address; hexadecimal or symbol (IEEE-695 format only)
Condition: 0 ≤ address1 ≤ address2 ≤ last program memory address

Example

```
>cv 100 1ff↵      ... Displays the executed addresses within the range from 0x100 to 0x1ff.
Coverage Information:
    0: 0100..0108
>
```

Notes

- The addresses specified here must be within the range of the program memory area available with each microcomputer model.
  An error results if the input one is not a hexadecimal number or a valid symbol.
  `Error : invalid value.`
  An error results if the limit is exceeded.
  `Error : Program address out of range.`
- If the ***cv*** command is input without <address1> and <address2>, coverage information in all address is displayed; if both <address1> and <address2> are specified, coverage information within the specified address range is displayed; if just <address1> is specified, the end address is treated as the maximum program address and coverage information within that range is displayed.

GUI utility

None

CVC (coverage clear)

Function

This command clears the coverage information.

Format

>cvc↵ **(direct input mode)**

GUI utility

None

9.9.15 Command File

com (execute command file)

Function

This command reads a command file and executes the debug commands written in that file. You can execute the commands successively, or set an interval between each command execution.

Format

(1) >com <file name> [<interval>]↵ (direct input mode)

(2) >com↵ (guidance mode)

File name ? <file name>↵
Execute commands 1. successively 2. With wait ...? <1 | 2>↵
Interval (0 - 30 seconds) : <interval>↵ (appears only when "2. With wait" is selected)
>*(Display execution progress)*

<file name>: Command file name (path can also be specified)
<interval>: Interval (wait seconds) between each command; decimal (0–30)

Examples

Format (1)
```
>com batch1.cmd↵
>.....
```
... Commands in "batch1.com" are executed successively.

Format (2)
```
>com↵
File name   ? test.cmd↵
Execute commands   1. successively   2. with wait   ...? 2↵
Wait time (0 - 30 seconds) : 2↵
>.....
```
... 2 sec. of interval is inserted after each command execution.

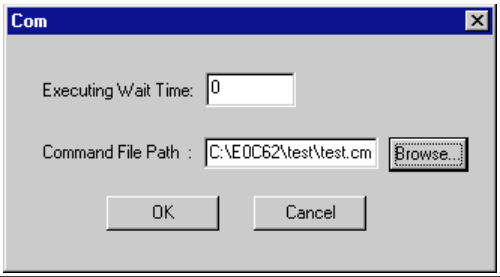
Notes

- Any contents other than commands cannot be written in the command file.
- An error results if the file you specified does not exist.
  ```
  Error : can't open file.
  ```
- Another command file can be read from a command file. However, the nesting of command files is limited to a maximum of 5 levels. An error results if a ***com*** command at the sixth level is encountered, the commands in the file specified by that ***com*** command will not be executed, but the subsequent execution of the commands in upper level files will be executed continuously.
  ```
  Error : over max nesting level (5), can't open file.
  ```
- If you specify an interval more than 30 seconds, it is set to 30 by default.
- Use the hot key ([CTRL]+[ESC]) to stop executing a command file.

GUI utility

[Run | Command File ...] menu item

When this menu item is selected, a dialog box appears allowing selection of a command file.



Enter an interval and a file name, then click [OK]. The file name can be selected using a standard file selection dialog box that appears by clicking [Browse...].

rec (record commands to a file)

Function

This command records all debug commands following this command to a specified command file.

Format

(1) >rec <file name>↵ (direct input mode)

(2) >rec↵ (guidance mode) ... See Examples for guidance.

<file name>: Command file name (path can also be specified)

Examples

(1) First rec execution after debugger starts up

```
>rec↵
File name   ? sample.cmd↵
1. append   2. clear and open   ...? 2↵      ... Displayed if the file is already exists.
>
```

(2) "rec" command input in the second and following sessions

```
>rec↵
Set to record off mode.      ... Record function toggles when rec is input.
.....
>rec↵
Set to record on mode.
```

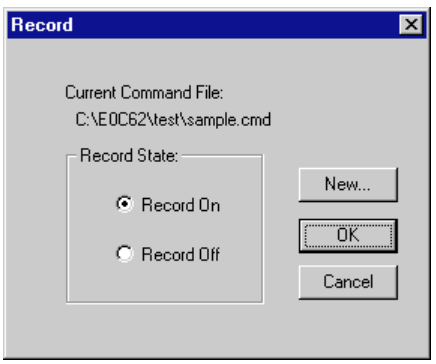
Notes

- In record on mode, besides the commands directly input in the [Command] window, the commands executed by selecting from a menu or with a tool bar button (except the [Help] menu commands) are also displayed in the [Command] window, and output to the specified file.
  If you modify the register value or data memory contents by direct editing in the [Register] or [Data] window, or set breakpoints in the [Source] window by double-clicking the mouse, the corresponding commands are also displayed in the [Command] window, and output to the specified file.
- At the first time, you should specify the file name to which all debug commands following the ***rec*** command will be output.
- Once an output command file is open, the recording is suspended and resumed (toggled) every time you input the ***rec*** command. This toggle operation remains effective until you terminate the debugger. If you want to record following commands to another file, you can use format (1) to specify the file name, then current output file is closed and all following commands will be recorded in the newly specified file.
- If you want to execute some commands frequently, you can record them to a file at the first execution, and then use the ***com*** command to execute that command file you made.

GUI utility

[Option | Record ...] menu item

When this menu item is selected, a standard file selection dialog box appears for specifying a command recording file. If the recording function has been activated, a dialog box appears allowing selection of either record-off mode or record-on mode. A new recording file can also be specified using the [New...] button.



9.9.16 log

log (log)

Function

This command saves the input commands and the execution results to a file.

Format

(1) >log <file name>↵ (direct input mode)

(2) >log↵ (guidance mode) ... See Examples for guidance.

<file name>: Log file name (path can also be specified)

Examples

(1) First log execution after debugger starts up

```
>log↵
File name   ? debug1.log↵
1. append   2. clear and open   ...? 2↵      ... Displayed if the file is already exists.
>
```

(2) "log" command input in the second and following sessions

```
>log↵
Set to log off mode.          ... Logging function toggles when log is input.
.....
>log↵
Set to log on mode.
```

Notes

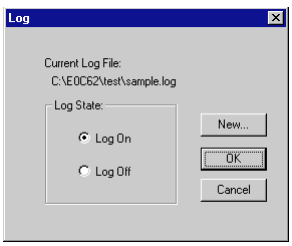
- In log on mode, the contents displayed in the [Command] window are written as displayed directly to the log file.
  The commands executed by selecting from a menu or with a tool bar button are displayed in the [Command] window. However, the [Help] menu and button commands are not displayed. If you modify the register value or data memory contents by direct editing in the [Register] or [Data] window, or set breakpoints in the [Source] window by double-clicking the mouse, the corresponding commands and the execution results are also displayed in the [Command] window, and output to the specified file.

  The displayed contents of the [Data], [Trace] or [Register] window produced by command execution are displayed in the [Command] window as well. The on-the-fly information is also displayed. However, the updated contents of each window after some execution, as well as the contents of each window scrolled by scroll bar or arrow keys, are not displayed.
- At the first time, you should specify the file name to which all following debug commands and execution results will be output.
- Once a log file is open, log output is suspended and resumed (toggled) every time you input the ***log*** command. This toggle operation remains effective until you terminate the debugger. If you want to specify a new log file, you can use format (1) to specify the file name, then current log file is closed and following commands and results will be output to the newly specified file.

GUI utility

[Option | Log ...] menu item

When this menu item is selected, a standard file selection dialog box appears for specifying a log file.
If the logging function has been activated, a dialog box appears allowing selection of either log-off mode or log-on mode. A new log file can also be specified using the [New...] button.



9.9.17 Map Information

ma (map information)

Function

This command displays the map information that is set by a parameter file.

Format

>ma↵ **(direct input mode)**

Example

```
>ma↵
Map Information:
 Rom Size         :1000
   Rom Start Address :0000
   Rom End Address   :0fff
 Ram Size         :1000
   Ram Start Address :0000
   Ram End Address   :0fff
    --I/O Area List     :0080..00ff,  0180..01ff,  0280..02ff,        ....
    --Segment Area List :0050..007f,  0450..047f
   Read Only Area    :0091,  0095,  00c9,  00ca,  00f8..00fc,  0191,  ....
   Write Only Area   :0450..047f
   Read & Write Area :0080,  0081,  00c1,  00c4..00c6,  00c8,  00d1,  ....
   Unused Area       :0082..008f,  0093,  0097..009f,  00a1..00af,    ....
>
```

GUI utility

None

9.9.18 Mode Setting

otf (on-the-fly display)

Function

This command selects whether or not to run the on-the-fly display during target program execution by the ***g*** (go) or ***gr*** (go after reset) command.

Format

>otf↵ (direct input mode)

Example

```
>otf↵
Set on-the-fly display off.  ... This command toggles the on-the-fly display function.
>otf↵
Set on-the-fly display on.
```

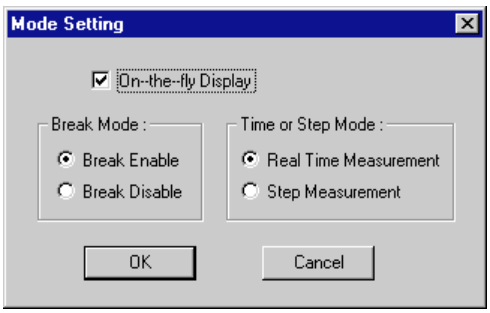
Note

The on-the-fly display is turned on at power on by default.

GUI utility

[Option | Mode Setting…] menu item

When this menu item is selected, a dialog box appears allowing selection of the on-the-fly display option.



Use the [On-the-fly Display] check box for this selection.

tim (time or step mode)

Function

This command selects a measurement mode of the execution counter during target program execution by the ***g*** (go) or ***gr*** (go after reset) command. Either execution time count mode or step count mode can be selected.

Format

>tim↵ **(direct input mode)**

Example

```
>tim↵
Set step count mode.          ... This command toggles the measurement mode.
>tim↵
Set real time count mode.
>
```

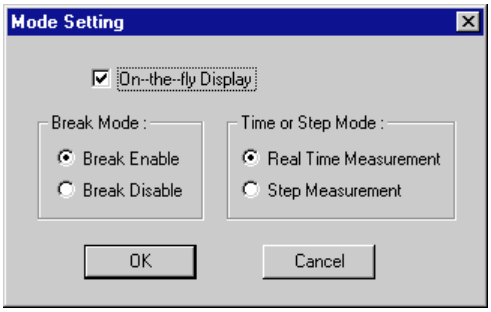
Note

The execution time count mode is set at power on by default.

GUI utility

[Option | Mode Setting…] menu item

When this menu item is selected, a dialog box appears allowing selection of a measurement mode.



Use the radio buttons for this selection.

9.9.19 Self Diagnosis

chk (self diagnostic test)

Function

This command displays the results of the ICE initial test. The test consists of the following items:
(1) Sum check test of ICE firmware
(2) ICE RAM read / write test

Format

>chk↵ **(direct input mode)**

Display

- If a ROM check error is detected, the normal value and the error value will be displayed.

```
>chk↵
ROM check error: 5F => FF.          ... normal value: 5F; error value: FF
>
```

- If a RAM check error is detected, the memory address, the normal value and the error value will be displayed.

```
>chk↵
RAM check error: 110  5 => F.       ... address: 110; normal value: 5; error value: F
>
```

GUI utility

[Option | Self Diagnosis] menu item
When this menu item is selected, the ***chk*** command is executed.

9.9.20 Quit

q (quit)

Function

This command quits the debugger.

Format

>q↵ (direct input mode)

GUI utility

[File | Exit] menu item

Selecting this menu item terminates the debugger.

9.10 Error/Warning Messages

1. ICE errors

Error message	Content of message
Error : communication error	There is a probrem in communication between Host and ICE.
Error : ID not match	ICE protocol ID error
Error : ROM sum check error	ICE62 firmware ROM sum error found during self diagnostic test.
Error : RAM check error	ICE62 firmware RAM errorfound during self diagnostic test.
Error : undefined code detected	Some undefined code is detected when loading file.

2. ICE status

Status message	Content of message
Status : break hit	A breakpoint is met when executing a program.
Status : break switch pushed	Break switch is pressed.
Status : halt	The status of ICE is halt.
Status : key break	Key break is pressed.
Status : reset switch target	Reset switch is pressed.
Status : reset switch idle	Reset switch is idle.
Status : target down	There is a problem in communication between the ICE and Evaluation Board.
Status : time out	The time waiting for a message from ICE is too long.

3. Command errors/warning

Error message	Content of message (Commands involved)
No coverage address	There is no coverage information. (cv)
No trace data	There is no trace data in trace memory. (td, ts)
Error : Program address out of range	The specified program memory address is out of range. (pe, pf, pm, sc, m, u, g, bp, cv, ts)
Error : Data address out of range	The specified data memory address is out of range. (de, df, dm, dd, ts)
Error : can't open file	The file cannot be opened. (lf, lo)
Error : Data out of range, use 0-0xf	The specified number is out of the data range. (de, df)
Error : different chip type, can't load this file	A different ICE parameter is used in the file. (lf)
Error : end address < start address	The start address is larger than the end address. (pf, pm, df, dm, bp, cv)
Error : error file type (extension should be CMD)	The extension of the command file should be CMD. (com)
Error : Incorrect identifier, use PC/ADDR/DATA/OPT/A/B/X/Y/F	An illegal parameter has been specified for an item of the bm command. (bm)
Error : illegal code	The input code is not available. (pe, pf)
Error : illegal mnemonic	The input mnemonic is invalid for S1C62. (as)
Error : invalid command	This is an invalid command. (All commands)
Error : invalid data pattern	The input data pattern is invalid. (bd)
Error : invalid value	The input data, address or symbol is invalid. (All commands)
Error : no high and low ROM	No ROM is installed in ICE. (rp)
Error : no high ROM	No high-order ROM is installed in ICE. (rp)
Error : no low ROM	No low-order ROM is installed in ICE. (rp)
Error : no mapping area	A no-map area is specified. (pm, dm)
Error : no such symbol	There is no such symbol. (All symbol support commands)
Error : Incorrect number of parameter	The parameter number is incorrect. (All commands)
Error : over max nesting level (5), can't open file	Nestling of the com command exceeds the limit. (com)
Error : r/w option (r, w or *)	An illegal R/W option is specified. (bd, bm)
Error : ROM program verify error	ROM program checks out different codes. (vp)
Error : Incorrect ROM type (64/128/256/512)	An illegal value is specified for the ROM type parameter of the rom command. (rom)
Error : Number of steps out of range, use 0-65535	The specified step count is out of range. (s, n)
Error : symbol type error	The symbol type (CODE / BSS) is error. (All symbol support commands)
Error : this chip not support this function	The chip with the used parameter file cannot support this option function. (lo)
Error : undefined code detected	Undefined code is detected when loading file. (rp)
Error : Incorrect register name, use (PC/A/B/X/Y/F)	An invalid register name is specified. (br)
Warning : read only address, can't write	This data address is read only, cannot be written to. (de)

S1C62 Family Assembler Package

Quick Reference

EPSON

CMOS 4-bit Single Chip Microcomputer

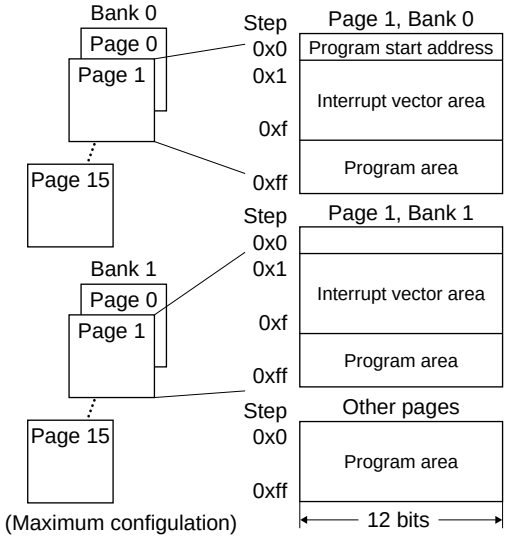
S1C62 Family Assembler Package

Quick Reference for Development

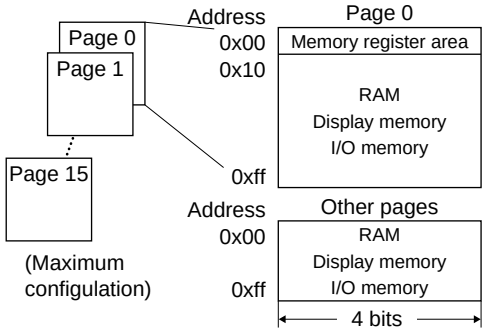
Memory Map

S1C6200 Core CPU

Program Memory Map



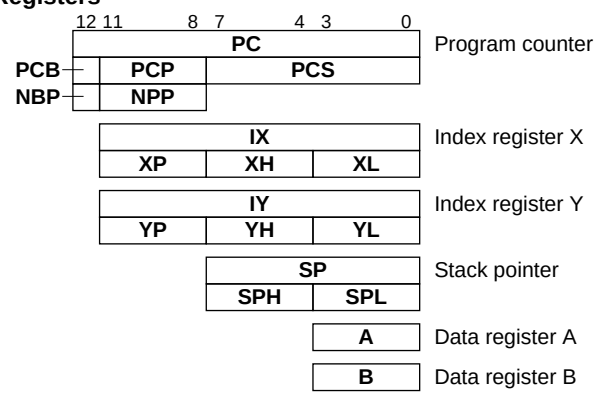
Data Memory Map



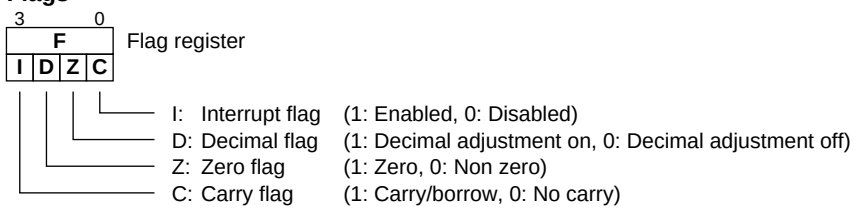
Registers

S1C6200 Core CPU

Registers



Flags



Symbols in the Instruction List

Registers/Register Data

A: Data register A or its contents (4 bits)
B: Data register B or its contents (4 bits)
X: Register XHL or its contents (8 low-order bits of the IX register)
XP: Register XP or its contents (4 high-order bits of the IX register)
XH: Register XH or its contents (4 high-order bits of the XHL register)
XL: Register XL or its contents (4 low-order bits of the XHL register)
Y: Register YHL or its contents (8 low-order bits of the IY register)
YP: Register YP or its contents (4 high-order bits of the IY register)
YH: Register YH or its contents (4 high-order bits of the YHL register)
YL: Register YL or its contents (4 low-order bits of the YHL register)
F: Flag register F or its contents (4 bits)
SP: Stack pointer SP or its contents (8 bits)
SPH: Stack pointer SPH or its contents (4 high-order bits of the stack pointer)
SPL: Stack pointer SPL or its contents (4 low-order bits of the stack pointer)
NBP: New bank pointer NBP or its contents (1 bit)
NPP: New page pointer NPP or its contents (4 bits)
PCB: Program counter bank PCB or its contents (1 bit)
PCP: Program counter page PCP or its contents (4 bits)
PCS: Program counter step PCS or its contents (8 bits)
PCSH: 4 high-order bits of PCS (4 bits)
PCSL: 4 low-order bits of PCS (4 bits)

Memory/Addresses/Memory Data

MX, M(X): Data memory addressed by IX or the contents of the specified memory
MY, M(Y): Data memory addressed by IY or the contents of the specified memory
Mn, M(n): Data memory addressed by n (n = 0 to 0xf) or the contents of the specified memory
M(SP): Stack addressed by SP or the contents of the stack address

Immediate Data

p: 5-bit immediate data or a label (0x0–0x1f)
s: 8-bit immediate data or a label (0x0–0xff)
l, x, y: 8-bit immediate data (0x0–0xff)
i: 4-bit immediate data (0x0–0xf)
n: 4-bit address for specifying Mn (0x0–0xf)
r, q: 2-bit immediate data for specifying a register or a data memory

r		q		Register/memory
r1	r0	q1	q0	specified
0	0	0	0	A
0	1	0	1	B
1	0	1	0	MX
1	1	1	1	MY

Functions

←: Indicates that the right item is loaded or set to the left item.
+: Addition
-: Subtraction
&: AND
|: OR
^: XOR
!: NOT

Flags

Z: Zero flag
C: Carry flag
I: Interrupt flag
D: Decimal flag
–: Not changed
↔: Set (1), reset (0) or not changed
1: Set (1)
0: Reset (0)
★: Indicates that the instruction performs a decimal operation if the D flag is set.

Clk

Indicates the number of execution cycles.

Clasiffication	Mnemonic		Code														Flags				Clk	Function
	Opcode	Operand	MSB													LSB	I	D	Z	C		
Branch instructions	PSET	p	1	1	1	0	0	1	0				p				–	–	–	–	5	NPB←p[4], NPP←p[3:0]
	JP	s	0	0	0	0							s				–	–	–	–	5	PCB←NBP, PCP←NPP, PCS←s
		C, s	0	0	1	0							s				–	–	–	–	5	PCB←NBP, PCP←NPP, PCS←s, if C=1
		NC, s	0	0	1	1							s				–	–	–	–	5	PCB←NBP, PCP←NPP, PCS←s, if C=0
		Z, s	0	1	1	0							s				–	–	–	–	5	PCB←NBP, PCP←NPP, PCS←s, if Z=1
		NZ, s	0	1	1	1							s				–	–	–	–	5	PCB←NBP, PCP←NPP, PCS←s, if Z=0
	JPBA		1	1	1	1	1	1	1	0	1	0	0	0			–	–	–	–	5	PCB←NBP, PCP←NPP, PCSH←B, PCSL←A
	CALL	s	0	1	0	0							s				–	–	–	–	7	M(SP-1)←PCP, M(SP-2)←PCSH, M(SP-3)←PCSL+1, SP←SP-3, PCP←NPP, PCS←s
	CALZ	s	0	1	0	1							s				–	–	–	–	7	M(SP-1)←PCP, M(SP-2)←PCSH, M(SP-3)←PCSL+1, SP←SP-3, PCP←0, PCS←s
	RET		1	1	1	1	1	1	0	1	1	1	1	1			–	–	–	–	7	PCSL←M(SP), PCSH←M(SP+1), PCP←M(SP+2), SP←SP+3
	RETS		1	1	1	1	1	1	0	1	1	1	1	0			–	–	–	–	12	PCSL←M(SP), PCSH←M(SP+1), PCP←M(SP+2), SP←SP+3, PC←PC+1
	RETD	l	0	0	0	1							l				–	–	–	–	12	PCSL←M(SP), PCSH←M(SP+1), PCP←M(SP+2), SP←SP+3, M(X)←l[3:0], M(X+1)←l[7:4], X←X+2
System control instructions	NOP5		1	1	1	1	1	1	1	1	1	0	1	1			–	–	–	–	5	No operation (5 clock cycles)
	NOP7		1	1	1	1	1	1	1	1	1	1	1	1			–	–	–	–	7	No operation (7 clock cycles)
	HALT		1	1	1	1	1	1	1	1	1	0	0	0			–	–	–	–	5	Halt (stop CPU)
	SLP		1	1	1	1	1	1	1	1	1	0	0	1			–	–	–	–	5	Sleep (stop CPU and oscillation)
Index operation instructions	INC	X	1	1	1	0	1	1	1	0	0	0	0	0			–	–	–	–	5	X←X+1
		Y	1	1	1	0	1	1	1	1	0	0	0	0			–	–	–	–	5	Y←Y+1
	LD	X, x	1	0	1	1							x				–	–	–	–	5	XH←x[7:4], XL←x[3:0]
		Y, y	1	0	0	0							y				–	–	–	–	5	YH←y[7:4], YL←y[3:0]
		XP, r	1	1	1	0	1	0	0	0	0	0		r			–	–	–	–	5	XP←r
		XH, r	1	1	1	0	1	0	0	0	0	1		r			–	–	–	–	5	XH←r
		XL, r	1	1	1	0	1	0	0	0	1	0		r			–	–	–	–	5	XL←r
		YP, r	1	1	1	0	1	0	0	1	0	0		r			–	–	–	–	5	YP←r
		YH, r	1	1	1	0	1	0	0	1	0	1		r			–	–	–	–	5	YH←r
		YL, r	1	1	1	0	1	0	0	1	1	0		r			–	–	–	–	5	YL←r
		r, XP	1	1	1	0	1	0	1	0	0	0		r			–	–	–	–	5	r←XP
		r, XH	1	1	1	0	1	0	1	0	0	1		r			–	–	–	–	5	r←XH
		r, XL	1	1	1	0	1	0	1	0	1	0		r			–	–	–	–	5	r←XL
		r, YP	1	1	1	0	1	0	1	1	0	0		r			–	–	–	–	5	r←YP
		r, YH	1	1	1	0	1	0	1	1	0	1		r			–	–	–	–	5	r←YH
		r, YL	1	1	1	0	1	0	1	1	1	0		r			–	–	–	–	5	r←YL
	ADC	XH, i	1	0	1	0	0	0	0	0			i				–	–	↔	↔	7	XH←XH+i+C
		XL, i	1	0	1	0	0	0	0	1			i				–	–	↔	↔	7	XL←XL+i+C
		YH, i	1	0	1	0	0	0	1	0			i				–	–	↔	↔	7	YH←YH+i+C
		YL, i	1	0	1	0	0	0	1	1			i				–	–	↔	↔	7	YL←YL+i+C

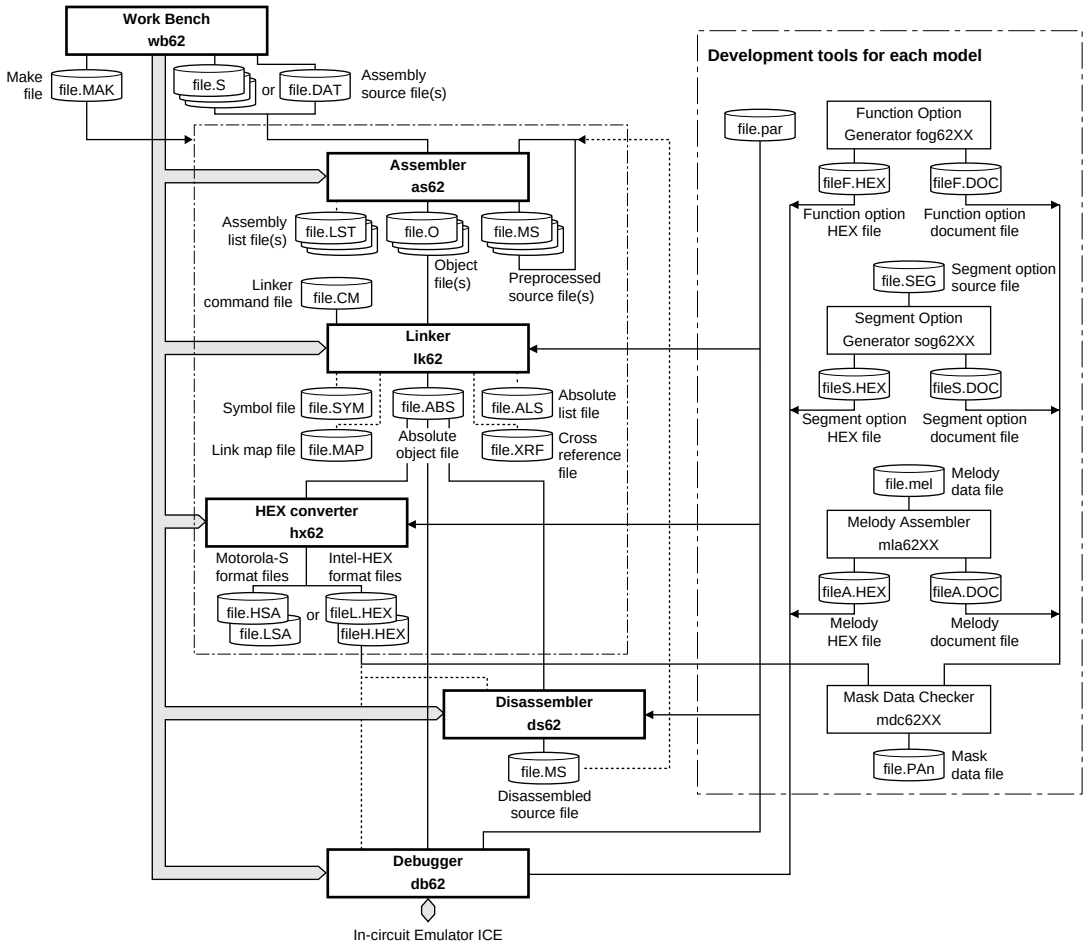
Remarks

Clasiffication	Mnemonic		Code														Flags				Clk	Function
	Opcode	Operand	MSB													LSB	I	D	Z	C		
Index operation instructions	CP	XH, i	1	0	1	0	0	1	0	0	i						–	–	↔	↔	7	XH-i
		XL, i	1	0	1	0	0	1	0	1	i						–	–	↔	↔	7	XL-i
		YH, i	1	0	1	0	0	1	1	0	i						–	–	↔	↔	7	YH-i
		YL, i	1	0	1	0	0	1	1	1	i						–	–	↔	↔	7	YL-i
Data transfer instructions	LD	r, i	1	1	1	0	0	0	r		i						–	–	–	–	5	r←i
		r, q	1	1	1	0	1	1	0	0	r		q				–	–	–	–	5	r←q
		A, Mn	1	1	1	1	1	0	1	0	n						–	–	–	–	5	A←M(n)
		B, Mn	1	1	1	1	1	0	1	1	n						–	–	–	–	5	B←M(n)
		Mn, A	1	1	1	1	1	0	0	0	n						–	–	–	–	5	M(n)←A
		Mn, B	1	1	1	1	1	0	0	1	n						–	–	–	–	5	M(n)←B
	LDPX	MX, i	1	1	1	0	0	1	1	0	i						–	–	–	–	5	M(X)←i, X←X+1
		r, q	1	1	1	0	1	1	1	0	r		q				–	–	–	–	5	r←q, X←X+1
	LDPY	MY, i	1	1	1	0	0	1	1	1	i						–	–	–	–	5	M(Y)←i, Y←Y+1
		r, q	1	1	1	0	1	1	1	1	r		q				–	–	–	–	5	r←q, Y←Y+1
	LBPX	MX, I	1	0	0	1					I						–	–	–	–	5	M(X)←I[3:0], M(X+1)←I[7:4], X←X+2
Flag operation instructions	SET	F, i	1	1	1	1	0	1	0	0	i						1	1	1	1	7	F←F | i
	RST	F, i	1	1	1	1	0	1	0	1	i						0	0	0	0	7	F←F & i
	SCF		1	1	1	1	0	1	0	0	0	0	0	1			–	–	–	1	7	C←1
	RCF		1	1	1	1	0	1	0	1	1	1	1	0			–	–	–	0	7	C←0
	SZF		1	1	1	1	0	1	0	0	0	0	1	0			–	–	1	–	7	Z←1
	RZF		1	1	1	1	0	1	0	1	1	1	0	1			–	–	0	–	7	Z←0
	SDF		1	1	1	1	0	1	0	0	0	1	0	0			–	1	–	–	7	D←1 (Decimal adjustment ON)
	RDF		1	1	1	1	0	1	0	1	1	0	1	1			–	0	–	–	7	D←0 (Decimal adjustment OFF)
	EI		1	1	1	1	0	1	0	0	1	0	0	0			1	–	–	–	7	I←1 (Enable interrupt)
	DI		1	1	1	1	0	1	0	1	0	1	1	1			0	–	–	–	7	I←0 (Disable interrupt)
Stack operation instructions	INC	SP	1	1	1	1	1	1	0	1	1	0	1	1			–	–	–	–	5	SP←SP+1
	DEC	SP	1	1	1	1	1	1	0	0	1	0	1	1			–	–	–	–	5	SP←SP-1
	PUSH	r	1	1	1	1	1	1	0	0	0	0	r				–	–	–	–	5	SP←SP-1, M(SP)←r
		XP	1	1	1	1	1	1	0	0	0	1	0	0			–	–	–	–	5	SP←SP-1, M(SP)←XP
		XH	1	1	1	1	1	1	0	0	0	1	0	1			–	–	–	–	5	SP←SP-1, M(SP)←XH
		XL	1	1	1	1	1	1	0	0	0	1	1	0			–	–	–	–	5	SP←SP-1, M(SP)←XL
		YP	1	1	1	1	1	1	0	0	0	1	1	1			–	–	–	–	5	SP←SP-1, M(SP)←YP
		YH	1	1	1	1	1	1	0	0	1	0	0	0			–	–	–	–	5	SP←SP-1, M(SP)←YH
		YL	1	1	1	1	1	1	0	0	1	0	0	1			–	–	–	–	5	SP←SP-1, M(SP)←YL
		F	1	1	1	1	1	1	0	0	1	0	1	0			–	–	–	–	5	SP←SP-1, M(SP)←F
	POP	r	1	1	1	1	1	1	0	1	0	0	r				–	–	–	–	5	r←M(SP), SP←SP+1

Remarks

Clasiffication	Mnemonic		Code												Flags				Clk	Function
	Opcode	Operand	MSB											LSB	I	D	Z	C		
Stack operation instructions	POP	XP	1	1	1	1	1	1	0	1	0	1	0	0	–	–	–	–	5	XP←M(SP), SP←SP+1
		XH	1	1	1	1	1	1	0	1	0	1	0	1	–	–	–	–	5	XH←M(SP), SP←SP+1
		XL	1	1	1	1	1	1	0	1	0	1	1	0	–	–	–	–	5	XL←M(SP), SP←SP+1
		YP	1	1	1	1	1	1	0	1	0	1	1	1	–	–	–	–	5	YP←M(SP), SP←SP+1
		YH	1	1	1	1	1	1	0	1	1	0	0	0	–	–	–	–	5	YH←M(SP), SP←SP+1
		YL	1	1	1	1	1	1	0	1	1	0	0	1	–	–	–	–	5	YL←M(SP), SP←SP+1
		F	1	1	1	1	1	1	0	1	1	0	1	0	↔	↔	↔	↔	5	F←M(SP), SP←SP+1
	LD	SPH, r	1	1	1	1	1	1	1	0	0	0	r		–	–	–	–	5	SPH←r
		SPL, r	1	1	1	1	1	1	1	1	0	0	r		–	–	–	–	5	SPL←r
		r, SPH	1	1	1	1	1	1	1	0	0	1	r		–	–	–	–	5	r←SPH
		r, SPL	1	1	1	1	1	1	1	1	0	1	r		–	–	–	–	5	r←SPL
Arithmetic operation instructions	ADD	r, i	1	1	0	0	0	0	r				i		–	★	↔	↔	7	r←r+i
		r, q	1	0	1	0	1	0	0	0	r		q		–	★	↔	↔	7	r←r+q
	ADC	r, i	1	1	0	0	0	1	r				i		–	★	↔	↔	7	r←r+i+C
		r, q	1	0	1	0	1	0	0	1	r		q		–	★	↔	↔	7	r←r+q+C
	SUB	r, q	1	0	1	0	1	0	1	0	r		q		–	★	↔	↔	7	r←r-q
	SBC	r, i	1	1	0	1	0	1	r				i		–	★	↔	↔	7	r←r-i-C
		r, q	1	0	1	0	1	0	1	1	r		q		–	★	↔	↔	7	r←r-q-C
	AND	r, i	1	1	0	0	1	0	r				i		–	–	↔	–	7	r←r & i
		r, q	1	0	1	0	1	1	0	0	r		q		–	–	↔	–	7	r←r & q
	OR	r, i	1	1	0	0	1	1	r				i		–	–	↔	–	7	r←r | i
		r, q	1	0	1	0	1	1	0	1	r		q		–	–	↔	–	7	r←r | q
	XOR	r, i	1	1	0	1	0	0	r				i		–	–	↔	–	7	r←r ^ i
		r, q	1	0	1	0	1	1	1	0	r		q		–	–	↔	–	7	r←r ^ q
	CP	r, i	1	1	0	1	1	1	r				i		–	–	↔	↔	7	r-i
		r, q	1	1	1	1	0	0	0	0	r		q		–	–	↔	↔	7	r-q
	FAN	r, i	1	1	0	1	1	0	r				i		–	–	↔	–	7	r & i
		r, q	1	1	1	1	0	0	0	1	r		q		–	–	↔	–	7	r & q
	RLC	r	1	0	1	0	1	1	1	1	r		r		–	–	↔	↔	7	d3←d2, d2←d1, d1←d0, d0←C, C←d3
	RRC	r	1	1	1	0	1	0	0	0	1	1	r		–	–	↔	↔	5	d3←C, d2←d3, d1←d2, d0←d1, C←d0
	INC	Mn	1	1	1	1	0	1	1	0	n				–	–	↔	↔	7	M(n)←M(n)+1
	DEC	Mn	1	1	1	1	0	1	1	1	n				–	–	↔	↔	7	M(n)←M(n)-1
	ACPX	MX, r	1	1	1	1	0	0	1	0	1	0	r		–	★	↔	↔	7	M(X)←M(X)+r+C, X←X+1
	ACPY	MY, r	1	1	1	1	0	0	1	0	1	1	r		–	★	↔	↔	7	M(Y)←M(Y)+r+C, Y←Y+1
	SCPX	MX, r	1	1	1	1	0	0	1	1	1	0	r		–	★	↔	↔	7	M(X)←M(X)-r-C, X←X-1
	SCPY	MY, r	1	1	1	1	0	0	1	1	1	1	r		–	★	↔	↔	7	M(Y)←M(Y)-r-C, Y←Y-1
	NOT	r	1	1	0	1	0	0	r		1	1	1	1	–	–	↔	–	7	r←!r

Remarks



Note:
The part indicated as "Development tools for each model" and "*" (Steps 3 and 5) are not covered in the S1C62 Family Assembler Package, and the tools used for development depend on the model. For details, refer to the tool manual associated with each specific model.

1. Programming
Create assembly source files using the work bench or an editor.

2. Assembly and Linking
2-1) Start up the work bench.
2-2) Create a project file, then insert source files into the project.
2-3) Execute the build process.
The work bench executes the assembler and linker sequentially to generate an executable object file.

3. Option Data Creation *
Create the option HEX/document files (function option, segment option, melody data) using the tools provided for each model.

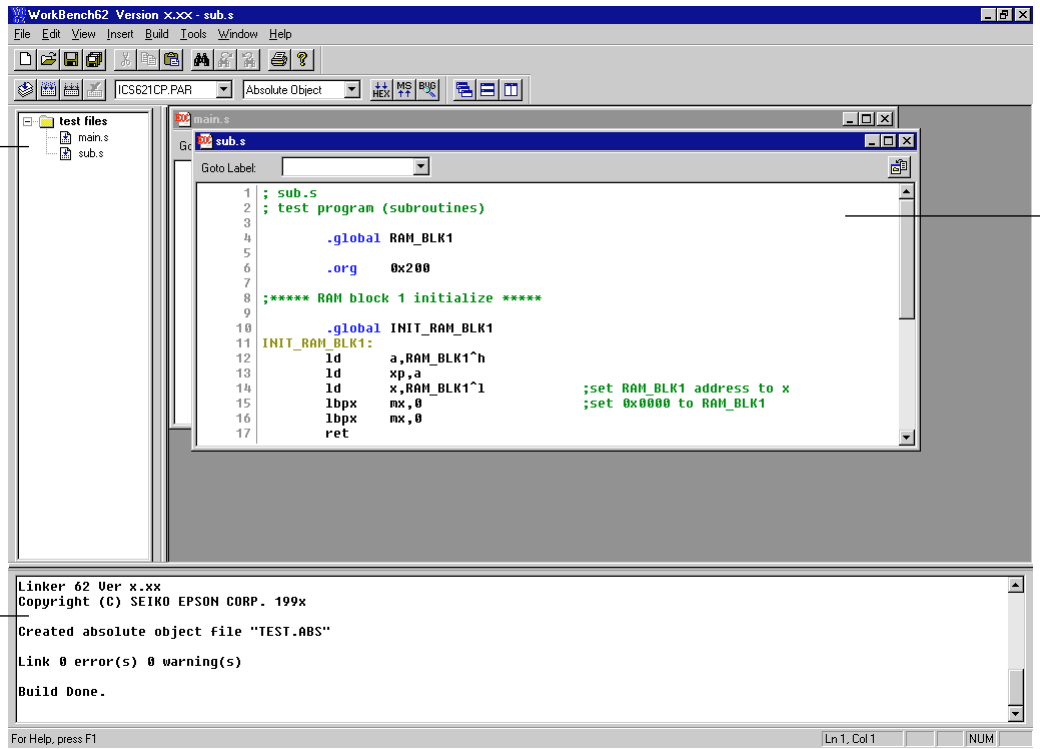
4. Debugging
4-1) Start up the debugger from the work bench.
4-2) Load the executable object file and option HEX files, then debug the program using the debug commands.

5. Mask Data Creation *
When the program development has been completed, create a mask data file.
5-1) Create the program HEX files using the HEX converter.
5-2) Convert the program and option document files into a mask data file using the mask data checker.
5-3) Submit the mask data file to Seiko Epson.

Outline

The work bench provides an integrated development environment with Windows GUI. Creating/editing source files, selecting files and major startup options, and the startup of each tool can be made with simple Windows operations.

Window



[Project] window

This window shows the currently opened work space folder and lists all the source files in the project, with a structure similar to Windows Explorer. Double-clicking a source file icon opens the source file in the [Edit] window.

[Edit] window

This window is used for editing a source file. A standard text file can also be displayed in this window. Two or more windows can be opened in the edit window area.

[Output] window

This window displays the messages delivered from the executed tools in a build or assemble process. Double-clicking a syntax error message with a source line number displayed in this window activates or opens the [Edit] window of the corresponding source so that the source line in which the error has occurred can be viewed.

Tool bars

[Standard] tool bar

[New] button
Creates a new document (source, header or project).

[Open] button
Opens a document (source, header or project).

[Save] button
Saves the document in the active [Edit] window to the file. The file will be overwritten.

[Save All] button
Saves the documents of all [Edit] windows and the project information to the respective files.

[Cut] button
Cuts the selected text in the [Edit] window to the clipboard.

[Copy] button
Copies the selected text in the [Edit] window to the clipboard.

[Paste] button
Pastes the text copied on the clipboard to the current cursor position in the [Edit] window.

[Find] button
Finds the specified word in the active [Edit] window.

[Find Next] button
Finds next target word towards the end of the file.

[Find Previous] button
Finds next target word towards the beginning of the file.

[Print] button
Prints the document in the active [Edit] window.

[Help] button
Displays a dialog box showing the version of the work bench.

[Build] tool bar

[Assemble] button
Assembles the assembly source in the active [Edit] window.

[Build] button
Builds the currently opened project using a general make process.

[Rebuild All] button
Rebuilds the currently opened project.

[Stop Build] button
Stops the build process being executed.

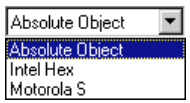
[Build] tool bar

[HEX Convert] button
Invokes the HEX converter.

[Disassemble] button
Invokes the disassembler.

[Debug] button
Invokes the debugger with the specified ICE parameter file.

[ICE Parameter] pull-down list box
Selects the ICE parameter file for the model being developed. In this box, all the ICE parameter files that exist in the "Dev62" directory are listed.



[Output Format] pull-down list box
Selects an executable object file format.
The build process will generate an executable object in the format selected here.

[Window] tool bar

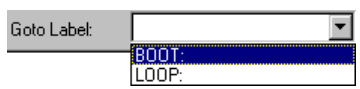
[Cascade] button
Cascades the opened [Edit] windows.

[Tile Horizontally] button
Tiles the opened [Edit] window horizontally.

[Tile Vertically] button
Tiles the opened [Edit] window vertically.

Controls on [Edit] window

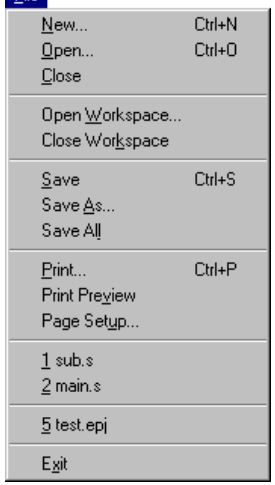
[Insert Into project] button
Inserts the source file being edited into the current opened project.



[Goto Label] pull-down list box
Goes to the selected label position.

Menus

[File] menu



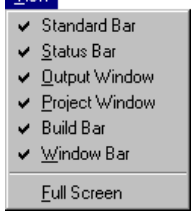
The file names listed in this menu are recently used source and project files.
Selecting one opens the file.

New... ([Ctrl]+[N])
Creates a new document (source, header or project).
Open... ([Ctrl]+[O])
Opens a document (source, header or project).
Close
Closes the active [Edit] window.
Open Workspace...
Opens a project.
Close Workspace
Closes the currently opened project.
Save ([Ctrl]+[S])
Saves the document in the active [Edit] window to the file.
Save As...
Saves the document in the active [Edit] window with another file name.
Save All
Saves the documents of all [Edit] windows and the project information to the respective files.
Print... ([Ctrl]+[P])
Prints the document in the active [Edit] window.
Print Preview
Displays a print image of the document in the active [Edit] window.
Page Setup...
Displays a dialog box for selecting paper and printer.
Exit
Terminates the work bench.

[Edit] menu

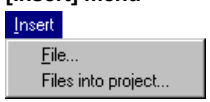
Undo ([Ctrl]+[Z])
Undoes the previous executed operation in the [Edit] window.
Cut ([Ctrl]+[X])
Cuts the selected text in the [Edit] window to the clipboard.
Copy ([Ctrl]+[C])
Copies the selected text in the [Edit] window to the clipboard.
Paste ([Ctrl]+[V])
Pastes the text copied to the the [Edit] window.
Select All ([Ctrl]+[A])
Selects all text in the active [Edit] window.
Find... ([Ctrl]+[F])
Finds the specified word in the active [Edit] window.
Replace ([Ctrl]+[H])
Replaces the specified words in the active [Edit] window.
Go To ([Ctrl]+[G])
Jumps to the specified line or label in the active [Edit] window.

[View] menu



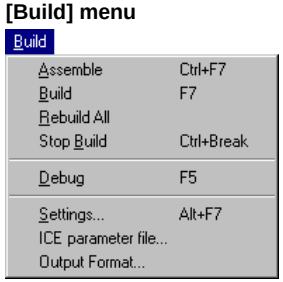
Standard Bar
Shows or hides the standard toolbar.
Status Bar
Shows or hides the status bar.
Output Window
Opens or closes the [Output] window.
Project Window
Opens or closes the [Project] window.
Build Bar
Shows or hides the build toolbar.
Window Bar
Shows or hides the window toolbar.
Full Screen
Maximizes the [Edit] window area to the full screen size.

[Insert] menu



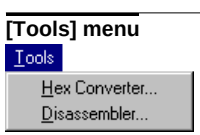
File...
Inserts the specified file to the text in the [Edit] window.
Files into project...
Adds the specified source file in the currently opened project.

[Build] menu



Assemble ([Ctrl]+[F7])
Assembles the assembly source in the active [Edit] window.
Build ([F7])
Builds the currently opened project using a general make process.
Rebuild All
Rebuilds the currently opened project.
Stop Build ([Ctrl]+[Break])
Stops the build process being executed.
Debug ([F5])
Invokes the debugger with the specified ICE parameter file.
Settings... ([Alt]+[F7])
Displays a dialog box for selecting tool options.
ICE parameter file...
Displays a dialog box for selecting an ICE parameter file.
Output Format...
Displays a dialog box for selecting an executable object file format.

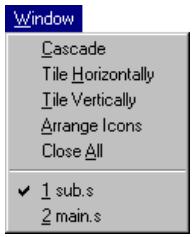
[Tools] menu



HEX Converter...
Invokes the HEX converter.
Disassembler...
Invokes the disassembler.

Menus

[Window] menu



This menu appears when an [Edit] window is opened.

Cascade
Cascades the opened [Edit] windows.

Tile Horizontally
Tiles the opened [Edit] window horizontally.

Tile Vertically
Tiles the opened [Edit] window vertically.

Arrange Icons
Arranges the minimized [Edit] window icons.

Close All
Closes all the [Edit] windows opened.

[Help] menu

About WB62...
Displays a dialog box showing the version of the work bench.

Error Messages

<filename> is changed by another editor. Reopen this file ?	The currently opened file is modified by another editor.
Cannot create file : <filename>	The file (linker command file, debugger command file, etc.) cannot be created.
<filename> was not found	The source file cannot be found.
Cannot find ICE parameter file	The ICE parameter file cannot be found.
Cannot open file : <filename>	The source file cannot be opened.
You cannot close workspace while a build is in progress. Select the Stop Build command before closing.	The project close command or work bench terminate command is specified while the build task is being processed.
Would you like to build it ?	The debugger invoke command is specified when the build task has not already been completed.

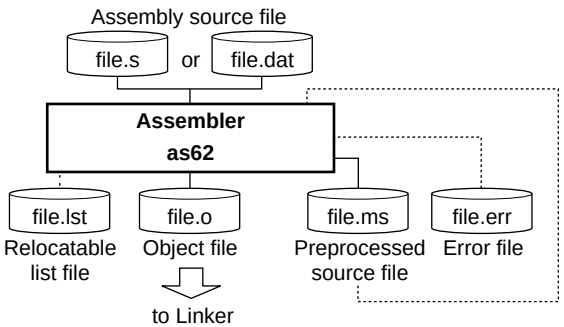
Short-Cut Key List

Ctrl + N	Creates a new document
Ctrl + O	Opens an existing document
Ctrl + F12	Opens an existing document
Ctrl + S	Saves the document
Ctrl + P	Print the active document
Ctrl + Shift + F12	Print the active document
Ctrl + Z	Undoes the last action
Alt + BackSpace	Undoes the last action
Ctrl + X	Cuts the selection and puts it on the clipboard
Shift + Delete	Cuts the selection and puts it on the clipboard
Ctrl + C	Copies the selection to the clipboard
Ctrl + Insert	Copies the selection to the clipboard
Ctrl + V	Inserts the clipboard contents at the insertion point
Shift + Insert	Inserts the clipboard contents at the insertion point
Ctrl + A	Selects the entire document
Ctrl + F	Finds the specified text
F3	Finds next
Shift + F3	Finds previous
Ctrl + H	Replaces the specified text with different text
Ctrl + G	Moves to the specified location
Ctrl + F7	Assembles the file
F7	Builds the project
Ctrl + Break	Stops the build
F5	Debugs the project
Alt + F7	Edits the project build and debug settings
Ctrl + Tab	Next MDI Window
Short-cut-key	Opens the popup menu
Shift + F10	Opens the popup menu

Outline

Converts the mnemonic of the source files into object codes (machine language) of the S1C62. The results are output in a relocatable object file. This assembler includes preprocessing functions such as macro definition/call, conditional assembly, and file-include functions.

Flowchart



Start-up Command Usage

```
Usage: as62 [options] <file name>
Options: -d <symbol>    Add preprocess definition
         -e             Output error log file (.ERR)
         -g             Add source debug information in object
         -l             Output relocatable list file (.LST)
         -o <file name> Specify output file name (.O or no extension)
File name: Source file name (.DAT, .S, or .MS)
```

Pseudo-instructions

#include	<file name>	Inserts other file in the source file.
#define	<define name> [<string>]	Defines a character string with a define name.
#macro	<macro name> [par] [,par] ...	Defines a statement string with a macro name.
	<statements>	Branch labels in a macro are specified with $$1 to $$n.
#endm		(par: Dummy parameters)
#ifdef	<name>	Conditional assembling
	<statements 1>	<name> defined: <statements 1> is assembled.
[#else		<name> undefined: <statements 2> is assembled.
	<statements 2>]	
#endif		
#ifndef	<name>	Conditional assembling
	<statements 1>	<name> undefined: <statements 1> is assembled.
[#else		<name> defined: <statements 2> is assembled.
	<statements 2>]	
#endif		
.code		Declares the start of a code section.
.bss		Declares the start of a bss section.
.org	<address>	Specifies an absolute address.
.page	<page number>	Specifies a page number.
.bank	<bank number>	Specifies a bank number.
.align	<alignment number>	Specifies alignment of a section.
.comm	<global symbol> <size>	Defines a global symbol and secures memory area in a bss section.
.lcomm	<local symbol> <size>	Defines a local symbol and secures memory area in a bss section.
.set	<symbol> <address>	Defines an absolute address for a symbol.
.global	<symbol>	Declares the symbol as global.
.codeword	<data>[<data> ... <data>]	Defines codes in the CODE section.
.list		Turns output ON(.list)/OFF(.nolist) in the assembly list
.nolist		file. (Effective only when the -l option is specified)
.stabs	"<file name>", FileName	Outputs source information for debugging.
.stabn	0, FileEnd	(Effective only when the -g option is specified)
.stabn	<line number>, LineInfo	

Operators

		Priority
+	Plus sign	1
-	Minus sign	1
^H	Acquires 8 high-order bits	2
^L	Acquires 8 low-order bits	2
~	Negation	2
( )	Parenthesis	(=3,)=11
*	Multiplication	4
/	Division	4
%	Residue	4
<<	Shifting to left	4
>>	Shifting to right	4
+	Addition	5
-	Subtraction	5
==	Equal (relational operator)	6
!=	Not equal (relational operator)	6
<	Less than (relational operator)	6
<=	Less than or equal (relational operator)	6
>	Greater than (relational operator)	6
>=	Greater than or equal (relational operator)	6
&	Bit AND	7
|	Bit OR	8
^	Bit XOR	8
&&	AND (relational operator)	9
||	OR (relational operator)	10

Numbers and symbols can be used as terms in expressions.
The expression is calculated as a signed 16-bit data.
Do not put any space or TAB between operator and number.

Error Messages

Cannot open <file kind> file <FILE NAME>	The specified file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The specified file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Division by zero	The divisor in the expression is 0.
Illegal syntax	The statement has a syntax error.
Macro parameter range <macro parameter range> exceeded	The number of macro parameters has exceeded the limit.
CODE section <address> overlaps with CODE section <address>	The address is duplicated.
Multiple statements on the same line	Two or more statements were described in one line.
Nesting level limit <nesting level limit> exceeded	Nesting of #include has exceeded the limit.
Number of macro labels limit <number of macro label limit> exceeded	The number of internal branch labels has exceeded the limit.
Second definition of label <label>	The label is multiply defined.
Second definition of symbol <symbol>	The symbol is multiply defined.
Unknown label <label>	Reference was made to an undefined label.
Unknown mnemonic <name>	A non-existing instruction was described.
Unknown symbol mask <name>	The symbol mask has a description error.
Unsupported directive <directive>	A non-existing pseudo-instruction was described.

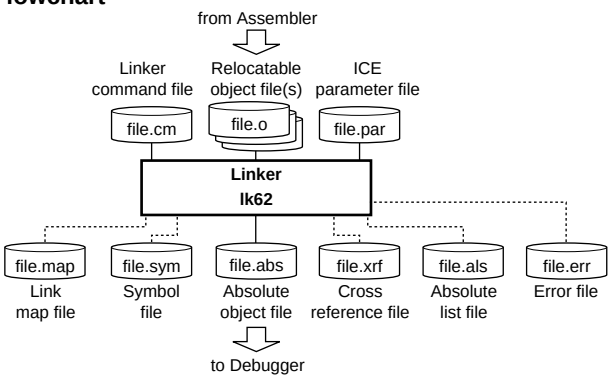
Warning Message

Second definition of define symbol <symbol>	The symbol is multiply defined by #define.
Section activation expected, use <.code/.bss>	There is no section definition.
Expression out of range	The result of the expression is out of the effective range.

Outline

Links the relocatable objects created by the assembler by fixing the memory locations, and creates executable absolute object codes. The linker also provides an auto PSET insertion/correction function allowing the programmer to create sources without having to know branch destination page numbers.

Flowchart



Start-up Command Usage

```
Usage: lk62 [options] <object files.O> <ICE param file.PAR> <command file.CM>
Options: -d                          Disable all branch optimizations
         -di                         Disable insertion of branch extension
         -dr                         Disable removal of branch extension
         -e                          Output error log file (.ERR)
         -g                          Add source debug information
         -l                          Output absolute list file (.ALS)
         -m                          Output map file (.MAP)
         -o <file name>              Specify output file name
         -s                          Output symbol file (.SYM)
         -x                          Output cross reference file (.XRF)
         -code <address>             Specify CODE start address
         -bss <address>              Specify BSS start address
         -rcode <file name>=<address> Specify CODE start address of the file
         -rbss <file name>=<address>  Specify BSS  start address of the file
```

Error Messages

CALL for different bank at <address>	The call instruction calls a subroutine in another bank.
CALZ for non zero page at <address>	The calz instruction calls a subroutine in another bank or another page other than page 0.
Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Illegal file name <FILE NAME>	The file name is incorrect.
Illegal file name <FILE NAME> specified with option <option>	The file name specified with the option is incorrect.
Illegal object format <FILE NAME>	The input file is not an object file in IEEE-695 format.
Illegal option <option>	An illegal option is specified.
CODE section <address> - <address> overlaps with <section type> section <address> - <address>	The address range of the section is duplicated.
No address specified with option <option>	Address is not specified with the option.
No code to locate	There is no valid code for mapping.
No ICE parameter file specified	ICE parameter file is not specified.
No name and address specified with option <option>	Name and address are not specified with the option.
No object file specified	Object files to be linked are not specified.
CODE section <address> - <address> crossed page boundary	The CODE section is across the page boundary.
<section type> section <address> - <address> overlaps with the unavailable memory	The section exceeds the valid memory range.
Unusable instruction code <operation code> at <address> <object file name>	An undefined code is used.
Unresolved external <label> in <FILE NAME>	Reference was made to an undefined symbol.
Branch destination too far from <address>	A destination address in another page is specified.

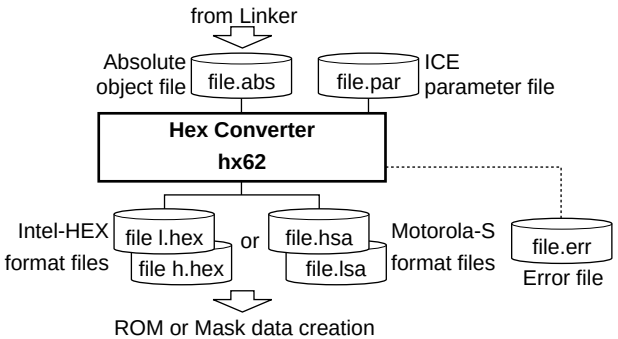
Warning Messages

Cannot create <file kind> file <FILE NAME>	Symbols cannot be found.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Second definition of label <label> in <FILE NAME>	The label has already been defined.

Outline

Converts an absolute object in IEEE-695 format output from the linker into ROM-image data in Intel-HEX format or Motorola-S format. This conversion is needed when making the ROM or when creating mask data using the development tools provided with each model.

Flowchart



Start-up Command Usage

```
Usage: hx62 [options] <file names>
Options: -b             Do not fill room with 0xff
         -e             Output error log file (HX62.ERR)
         -m             Use Motorola-S format
         -O <file name> Output file name (L/H.HEX, .L/HSA or no extension)
File name: Absolute object file (.ABS)
           ICE parameter file (.PAR)
```

Error Messages

Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Different processor types	The ICE parameter file contains an illegal parameter setting.
Illegal file name <FILE NAME>	The specified input file name is incorrect.
Illegal option <option>	An illegal option is specified.
Illegal absolute object format	The input file is not an object file in IEEE-695 format.
Out of memory	Cannot secure memory space.

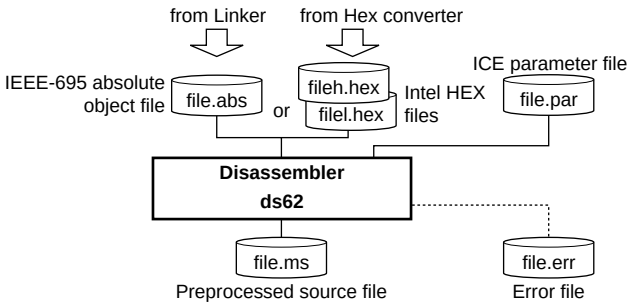
Warning Message

Input file name extension .XXX conflict	Two or more file names with the same extension have been specified. The last one is used.

Outline

Disassembles an absolute object file in IEEE-695 format or a hex file in Intel-HEX format, and restores it to a source format file. The restored source file can be processed in the assembler/linker/hex converter to obtain the same object or hex file.

Flowchart



Start-up Command Usage

```
Usage: ds62 [options] <file names>
Options: -cl            Use lower case characters
         -cu            Use upper case characters
         -e             Output error log file (DS62.ERR)
         -o <file name> Output file name (.MS or no extension)
         -s <address>   Offset address (Default 0x0)
File names: Absolute object file (.ABS or L/H.HEX)
            ICE parameter file (.PAR)
```

Error Messages

Cannot create <file kind> file <FILE NAME>	The file cannot be created.
Cannot open <file kind> file <FILE NAME>	The file cannot be opened.
Cannot read <file kind> file <FILE NAME>	The file cannot be read.
Cannot write <file kind> file <FILE NAME>	Data cannot be written to the file.
Illegal file name <FILE NAME>	The specified input file name is incorrect.
Illegal HEX data format	The input file is not an Intel-HEX format file.
Illegal offset address <offset address>	The specified address is invalid.
Illegal option <option>	An illegal option is specified.
No ICE parameter file specified	ICE parameter file is not specified.
Out of memory	Cannot secure memory space.

Warning Message

Input file name extension .XXX conflict	Two or more file names with the same extension have been specified. The last one is used.

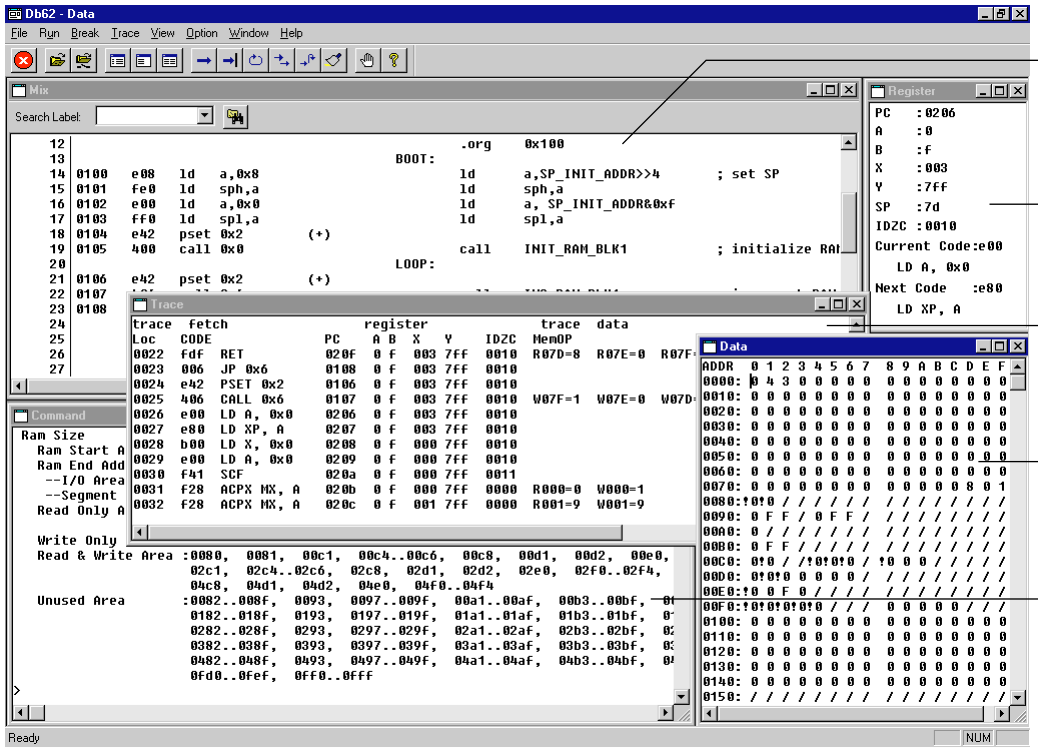
Outline

This software performs debugging by controlling the ICE hardware tool. Commands that are used frequently, such as break and step, are registered on the tool bar, minimizing the necessary keyboard operations. Moreover, sources, registers, and command execution results can be displayed in multiple windows, with resultant increased efficiency in the debugging tasks.

Start-up Command Usage

```
-Usage-
   db62^<parameter file name>^[startup option]
Options:
   command file:  ... specifies a command file
   -comX(X:1-4)   ... com port, default com1
   -b             ... baud rate, 1200, 4800, 9600, 19200(default)
```

Window



[Source] window
Displays programs with unassemble codes, source codes or disassemble and source codes.

[Register] window
Displays register values and fetched codes.

[Trace] window
Displays traced data.

[Data] window
Displays the contents of the data memory.

[Command] window
Used to enter debug commands and display the execution results.

Buttons

Tool bar

[Key Break] button
Forcibly breaks execution of the target program.

[Load File] button
Reads an object file in the IEEE-695 format into the debugger.

[Load Option] button
Reads a program or optional HEX file in Intel-HEX format into the debugger.

[Source] button
Switches the display of the [Source] window to the source mode.

[Unassemble] button
Switches the display of the [Source] window to the unassemble mode.

[Mix] button
Switches the display of the [Source] window to the mix mode.

[Go] button
Executes the target program from the address indicated by the current PC.

[Go to Cursor] button
Executes the target program from the address indicated by the current PC to the cursor position in the [Source] window (the address of that line).

[Go from Reset] button
Resets the CPU and then executes the target program from the program start address (0x100).

[Step] button
Executes one instruction step at the address indicated by the current PC.

[Next] button
Executes one instruction step at the address indicated by the current PC.
The call and calz instructions and their subroutines are executed as one step.

[Reset] button
Resets the CPU.

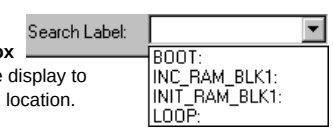
[Break] Button
Sets or clears a breakpoint at the address where the cursor is located in the [Source] window.

[Help] Button
This button displays an About dialog box for the debugger.

Controls on [Source] window

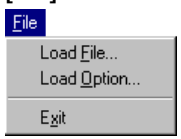
[Find] button
Searches the specified word and moves the source display to the found word location.

[Search Label] pull-down list box
Moves the source display to the selected label location.



Menus

[File] menu

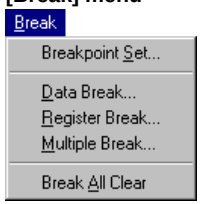


Load File...
Reads an object file in the IEEE-695 format into the debugger.
Load Option...
Reads a program or optional HEX file in Intel-HEX format into the debugger.
Exit
Terminates the debugger.

[Run] menu

Go
Executes the target program from the address indicated by the current PC.
Go to Cursor
Executes the target program from the address indicated by the current PC to the cursor position in the [Source] window.
Go from Reset
This menu item resets the CPU and then executes the target program from the program start address (0x100).
Step
Executes one instruction step at the address indicated by the current PC.
Next
Executes one instruction step at the address indicated by the current PC.
The call and calz instructions and their subroutines are executed as one step.
Command File...
Reads a command file and executes the debug commands written in that file.
Reset CPU
Resets the CPU.

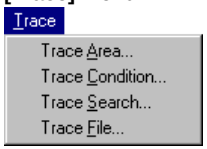
[Break] menu



Breakpoint Set...
Displays, sets or clears PC breakpoints.
Data Break...
Displays, sets or clears data break conditions.
Register Break...
Displays, sets or clears register break conditions.
Multiple Break...
Displays, sets or clears multiple break conditions.
Break All Clear
Clears all break conditions.

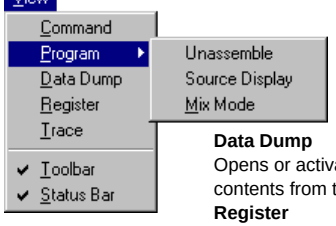
Menus

[Trace] menu



Trace Area...
Sets or clears program address ranges for tracing.
Trace Condition...
Sets a trace condition (Start, Middle, End).
Trace Search...
Searches trace information from the trace memory.
Trace File...
Saves the specified range of the trace information displayed in the [Trace] window to a file.

[View] menu



Command
Activates the [Command] window.

Program (Unassemble, Source Display, Mix Mode)
Opens or activates the [Source] window and displays the program from the current PC address in the display mode selected from the sub menu items.

Data Dump
Opens or activates the [Data] window and displays the data memory contents from the memory start address.
Register
Opens or activates the [Register] window and displays the current values of the registers.
Trace
Opens or activates the [Trace] window and displays the trace data sampled in the ICE trace memory.
Toolbar
Shows or hides the toolbar.
Status Bar
Shows or hides the status bar.

[Option] menu

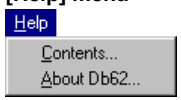
Log...
Starts or stops logging.
Record...
Starts or stops recording of commands executed.
Mode Setting...
Sets the on-the-fly display, break and execution counter modes.
Rom Type...
Specifies the program ROM type which is installed in the ICE ROM socket.
Self Diagnosis
Displays the results of the diagnostic test in the ICE.

[Window] menu

Cascade
Cascades the opened windows.
Tile
Tiles the opened windows.

This menu shows the currently opened window names.
Selecting one activates the window.

[Help] menu



Contents...
Displays the contents of help topics.
About Db62...
Displays an About dialog box for the debugger.

Debug Commands

Program memory operation

as	Assemble mnemonic
pe	Input program code
pf [<addr1> <addr2> <code>]	Fill program area
pm [<addr1> <addr2> <addr3>]	Copy program memory

Data memory operation

dd [<addr1> [<addr2>]]	Dump data memory
de [<addr> <data1> [<data2> [..<data16>]]]	Input data
df [<addr1> <addr2> <data>]	Fill data area
dm [<addr1> <addr2> <addr3>]	Copy data area

Register operation

rd	Display register values
rs [<reg> <value> [<reg> <value>..]]	Modify register values

Program execution

g [<addr>]	Execute successively
gr	Reset CPU and execute successively
s [<step(D)>]	Step into
n [<step(D)>]	Step over

CPU reset

rst	Reset CPU

Break

bp [<addr1> [<addr2> [..<addr4>]]]	Set PC breakpoint
bpc [<addr1> [<addr2> [..<addr4>]]]	Clear PC breakpoint
bd [<addr> <data> {r|w|*}]	Set data break
bdc	Clear data break
br [<reg> <value> [<reg> <value>..]]	Set register break
brc	Clear register break
bm [{pc|addr|data|opt|a|b|f|x|y|} <value>..]	Set multiple break
bmc	Clear multiple break
bl	Display all break conditions
bac	Clear all break conditions
be	Set break enable mode
bsyn	Set break disable (synchronous) mode

Program display

u [<addr>]	Unassemble display
sc [<addr>]	Source display
m [<addr>]	Mix display

Symbol information

sy [{$<keyword>|#<keyword>}] [/a]	List symbols

Load file

lf [<file name>]	Load IEEE-695 format absolute object file
lo [<file name>]	Load Intel-HEX format file

ROM access

rp	Load program from ROM
vp	Verify the contents of ROM with program memory
rom [{64|128|256|512}]	Set ROM type

Trace

tc [{s|m|e}]	Set trace condition
ta [{all | <start1> <end1> [..<start4> <end4>]}]	Set trace area
tac [<start1> <end1> [..<start4> <end4>]]	Clear trace area
tp	Display current trace pointer
td [<num(D)>]	Display trace information
ts [{pc|dr|dw} <addr>]	Search trace information
tf [[<num1(D)> <num2(D)>] <file name>]	Save trace information into file

Others

cv [<addr1> [<addr2>]]	Display coverage information
cvc	Clear coverage information
com [<file name> [<interval(D)>]]	Load & execute command file
rec [<file name>]	Record commands to a command file
log [<file name>]	Turn log output on or off
ma	Display map information
otf	Turn on-the-fly display on or off
tim	Set time or step measurement mode
chk	Report results of ICE self diagnostic test
q	Quit debugger

The parameters with (D) should be specified with a decimal number. For other parameters, hexadecimal numbers can only be used.
A symbol can be used to specify an address as follows:
@<global symbol> or @<local symbol>@<source file name>

Debugger Messages

ICE errors

Error : communication error	There is a probrem in communication between Host and ICE.
Error : ID not match	ICE protocol ID error
Error : ROM sum check error	ICE62 firmware ROM sum erro found during self diagnostic test.
Error : RAM check error	ICE62 firmware RAM error found during self diagnostic test.
Error : undefined code detected	Some undefined code is detected when loading file.

ICE status

Status : break hit	A breakpoint is met when executing a program.
Status : break switch pushed	Break switch is pressed.
Status : halt	The status of ICE is halt.
Status : key break	Key break is pressed.
Status : reset switch target	Reset switch is pressed.
Status : reset switch idle	Reset switch is idle.
Status : target down	There is a problem in communication between the ICE and Evaluation Board.
Status : time out	The time waiting for a message from ICE is too long.

Command errors

No coverage address	There is no coverage information. (cv)
No trace data	There is no trace data in trace memory. (td, ts)
Error : Program address out of range	The specified program memory address is out of range. (pe, pf, pm, sc, m, u, g, bp, cv, ts)
Error : Data address out of range	The specified data memory address is out of range. (de, df, dm, dd, ts)
Error : can't open file	The file cannot be opened. (lf, lo)
Error : Data out of range, use 0-0xf	The specified number is out of the data range. (de, df)
Error : different chip type, can't load this file	A different ICE parameter is used in the file. (lf)
Error : end address < start address	The start address is larger than the end address. (pf, pm, df, dm, bp, cv)
Error : error file type (extension should be CMD)	The extension of the command file should be CMD. (com)
Error : Incorrect identifier, use PC/ADDR/DATA/OPT/A/B/X/Y/F	An illegal parameter has been specified for an item of the bm command. (bm)
Error : illegal code	The input code is not available. (pe, pf)
Error : illegal mnemonic	The input mnemonic is invalid for S1C62. (as)
Error : invalid command	This is an invalid command. (All commands)
Error : invalid data pattern	The input data pattern is invalid. (bd)
Error : invalid value	The input data, address or symbol is invalid. (All commands)

Command errors

Error : no high and low ROM	No ROM is installed in ICE. (rp)
Error : no high ROM	No high-order ROM is installed in ICE. (rp)
Error : no low ROM	No low-order ROM is installed in ICE. (rp)
Error : no mapping area	A no-map area is specified. (pm, dm)
Error : no such symbol	There is no such symbol. (All symbol support commands)
Error : Incorrect number of parameter	The parameter number is incorrect. (All commands)
Error : over max nesting level (5), can't open file	Nestling of the com command exceeds the limit. (com)
Error : r/w option (r, w or *)	An illegal R/W option is specified. (bd, bm)
Error : ROM program verify error	ROM program checks out different codes. (vp)
Error : Incorrect ROM type (64/128/256/512)	An illegal value is specified for the ROM type parameter of the rom command. (rom)
Error : Number of steps out of range, use 0-65535	The specified step count is out of range. (s, n)
Error : symbol type error	The symbol type (CODE / BSS) is error. (All symbol support commands)
Error : this chip not support this function	The chip with the used parameter file cannot support this option function. (lo)
Error : undefined code detected	Undefined code is detected when loading file. (rp)
Error : Incorrect register name, use (PC/A/B/X/Y/F)	An invalid register name is specified. (br)

Command warning

Warning : read only address, can't write	This data address is read only, cannot be written to. (de)

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