User’s Manual

NEC

CA830, CA850

C COMPILER PACKAGES

OPERATION (Windows™ BASED)

Target Device
V800 Series™
Compatible Compilers
CA830 Ver.1.10 or later
CA850 Ver.2.00 or later

Document No. U12827EJ1V0UM00 (1st edition)
Date Published November 1997 N

[MEMO]

Trademarks

- V800 Series, V810 Family, V830 Family, V850 Family, V810, V830, V851, and V850E are trademarks of NEC Corporation.
- Windows, Windows NT, Win32s, Win32, and MS-DOS are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.
- The other company names and product names appearing in this document are the trademarks of their respective companies.

Regional Information

Some information contained in this document may vary from country to country. Before using any NEC product in your application, please contact the NEC office in your country to obtain a list of authorized representatives and distributors. They will verify:

- Device availability
- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

In addition, trademarks, registered trademarks, export restrictions, and other legal issues may also vary from country to country.

NEC Electronics Inc. (U.S.)
Santa Clara, California
Tel: 408-588-6000
800-366-9782
Fax: 408-588-6130
800-729-9288

NEC Electronics (Germany) GmbH
Duesseldorf, Germany
Tel: 0211-65 03 02
Fax: 0211-65 03 490

NEC Electronics (UK) Ltd.
Milton Keynes, UK
Tel: 01908-691-133
Fax: 01908-670-290

NEC Electronics Italiana s.r.1.
Milano, Italy
Tel: 02-66 75 41
Fax: 02-66 75 42 99

NEC Electronics (Germany) GmbH
Benelux Office
Eindhoven, The Netherlands
Tel: 040-2445845
Fax: 040-2444580

NEC Electronics (France) S.A.
Velizy-Villacoublay, France
Tel: 01-30-67 58 00
Fax: 01-30-67 58 99

NEC Electronics (France) S.A.
Spain Office
Madrid, Spain
Tel: 01-504-2787
Fax: 01-504-2860

NEC Electronics (Germany) GmbH
Scandinavia Office
Taeby, Sweden
Tel: 08-63 80 820
Fax: 08-63 80 388

NEC Electronics Hong Kong Ltd.
Hong Kong
Tel: 2886-9318
Fax: 2886-9022/9044

NEC Electronics Hong Kong Ltd.
Seoul Branch
Seoul, Korea
Tel: 02-528-0303
Fax: 02-528-4411

NEC Electronics Singapore Pte. Ltd.
United Square, Singapore 1130
Tel: 253-8311
Fax: 250-3583

NEC Electronics Taiwan Ltd.
Taipei, Taiwan
Tel: 02-719-2377
Fax: 02-719-5951

NEC do Brasil S.A.
Cumbica-Guarulhos-SP, Brasil
Tel: 011-6465-6810
Fax: 011-6465-6829

J97. 8

Revision History

Edition	Date of Issue	Description (reason)
01	November, 1997	First edition

INTRODUCTION

[Target Device]

The V800 Series^{TM} C Compiler Package creates the object codes for the NEC's V800 Series RISC microprocessors, which are compatible with each family.

The V830 Family^{TM} inherits the basic instruction set of the V810 Family^{TM}. Therefore, the software resource of the V810 Family can be used without modification.

[Target Users]

This manual is intended for users who develop application systems using the V800 Series C Compiler Package under Windows^{TM}.

[Objective]

This manual explains how to operate the commands, which are included in C compiler and assembler in each package, under Windows.

A Project Manager is included in these C compiler packages. For operation methods for integrated development, refer to the User's Manual of Project Manager.

For operation of Windows, refer to the function guide or others including in the Windows.

[Organization]

This manual consists of the following contents.

- Overview of this compiler package
- How to use this compiler package via Project Manager
- How to use this compiler package in a command line
- Command functions, options, and output messages

Commands Included in Package	
C compiler (ca)	
Assembler (as)	
Link editor (ld)	
Archiver (ar)	
Hex converter (hx)	
Dump command (dump)	
Disassembler (dis)	
ROM-storing processor (romp)	
Section file generator (sf)	* V850

[Cautions]

- This document describes two families (CA830 and CA850). The functions peculiar to a certain family are specified by title names and symbols in the text such as *V830 and *V850. Unless otherwise specified, the description in this document apply to all the families.
  A description using a command name of a specific family is also applied to all the families unless otherwise specified.
- In a description that applies to all the families, the package name and directory name are abbreviated as "ca" and "libxxx". These package names and file names should be taken as follows, depending on the device used.

Package name	CA	: CA830 or CA850
Command name	ca	: ca830 or ca850
	as	: as830 or as850
		:
Directory name	libxxx	: lib830 or lib850

- The functions peculiar to "V850E^{TM}" in the V850 Family^{TM} are specified by title name or the symbol such as "*V850E ".

[Related Documents]

- V800 Series C Compiler Package User's Manual - C Language
- CA830 C Compiler Package User's Manual - Assembly Language
- CA850 C Compiler Package User's Manual - Assembly Language
- V800 Series Microprocessor User's Manual
- Project Manager User's Manual

Published by NEC Corporation

- Attached manuals to Microsoft^{TM} Windows such as Microsoft Windows Operating System Function Guide

Published by Microsoft Corporation

- Programming Language C, 2nd edition, conforming to ANSI standard
  B.W. Kernihang, D.M. Riche, translated by Haruhisa Ishida

Published by Kyoritsu Publishing Co.

CONTENTS

LIST OF FIGURES

Figure No. Title Page

VOLUME 1 GENERAL

VOLUME 2 OPERATION METHODS

VOLUME 3 HANDLING C COMPILER

LIST OF FIGURES

VOLUME 4 HANDLING ASSEMBLER

VOLUME 5 HANDLING LINK EDITOR

LIST OF FIGURES

VOLUME 6 HANDLING ARCHIVER

VOLUME 7 HANDLING HEX CONVERTER

VOLUME 8 HANDLING DUMP COMMAND

VOLUME 9 HANDLING DISASSEMBLER

VOLUME 10 HANDLING ROM-STORING PROCESSOR

VOLUME 11 HANDLING SECTION FILE GENERATOR

LIST OF FIGURES

Figure No. Title Page

APPENDIX

LIST OF TABLES

Table No. Title Page

VOLUME 2 OPERATION METHODS

VOLUME 4 HANDLING ASSEMBLER

VOLUME 5 HANDLING LINK EDITOR

VOLUME 10 HANDLING ROM-STORING PROCESSOR

APPENDIX

VOLUME 1

GENERAL

CHAPTER 1 OVERVIEW

This chapter explains the organization of this manual and the features of the CA Windows^{TM}-based compiler packages.

1.1 Organization of This Manual

This manual consists of the following volumes and appendix.

VOLUME 1 GENERAL

Explains the organization of this manual and the operating environment of the CA830/CA850 compiler packages.

VOLUME 2 OPERATION METHOD

Explains the handling method of the CA830/CA850 compiler packages for Windows and the Make Utility (VMAKE) of the command line interface.

VOLUME 3 HANDLING C COMPILER

Explains the C compiler (ca).

VOLUME 4 HANDLING ASSEMBLER

Explains the assembler (as).

VOLUME 5 HANDLING LINK EDITOR

Explains the link editor (ld).

VOLUME 6 HANDLING ARCHIVER

Explains the archiver (ar).

VOLUME 7 HANDLING HEX CONVERTER

Explains the hex converter (hx).

VOLUME 8 HANDLING DUMP COMMAND

Explains the dump command (dump).

VOLUME 9 HANDLING DISASSEMBLER

Explains the disassembler (dis).

VOLUME 10 HANDLING ROM-STORING PROCESSOR

Explains the ROM-storing processor (romp).

VOLUME 11 HANDLING SECTION FILE GENERATOR

Explains the section file generator (sf).

APPENDIX

Explains the format of the section file and object file.

1.2 Features of CA Windows-based Compiler Package

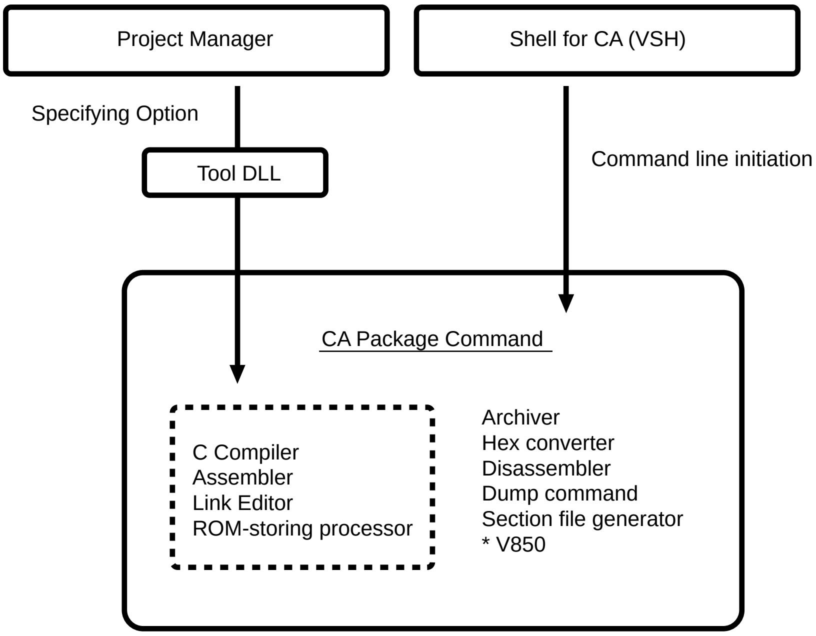
The CA830/CA850 Compiler Packages have the following features:

- Language specifications conforming to ANSI standard
  The C language specifications conform to the ANSI standard and are also compatible with the conventional C language (K&R specifications).
- High-level optimization
  The C compiler/assembler provide multi-level optimization.
- Features for embedded control
  A utility is provided to facilitate storing the application system to ROM.
- Easy description
  The expanded language specifications facilitate the description of programs in C language.

The CA830/CA850 Windows-based C compiler packages are provided with the following operating features.

- Activation from Project Manager
  CA can be activated from efficient integrated environment (Project Manager).
  The Project Manager is a control software that allows tools operating in Windows to activate efficiently and is included in this compiler package.
- Shell function added
  Because shell function (VSH) is added in CA, the activation from command interface is possible.

Figure 1-1. Package Organization Figure



The Project Manager runs on Windows and supplies graphical application development environments, so that an application load module can be created by specifying an option of the C compiler, assembler, or link editor can be specified from the Project Manager to automatically execute their commands.

The V800 Series C compiler package also supplies a shell (VSH) function as an application development environment on the command line. VSH allows utility tools such as archiver and hex converter, in addition to the C compiler, assembler, link editor, and ROM-storing processor, to run like the command line of MS-DOS^{TM} prompt.

CHAPTER 2 INSTALLATION

This chapter explains the operating environment, installation of supplied medium and points to be noted of this compiler package.

2.1 Operating Environment

This compiler package runs in the following environments:

Machine	Machine which can operate Microsoft Windows 95
Operating System	Microsoft Windows 95
Hard Disk	10 MB of empty capacity
Operating Memory	32 MB

[Cautions]

- Microsoft Windows 95 creates swap file in windows folder when various tools are operated. Always keep enough empty capacity in the drive where the windows folder is installed.
- The operation of CA is not guaranteed in Microsoft Windows for OS/2^{TM}.

For the processing of the CA command, a device file (refer to -cpu option on page 159) dependent on the target device is necessary[1].

[1] The device file is separately available.

2.2 Installation

This package consists of six FDs[2].
The read-out method of the files of the C compiler package (including Project Manager) is explained below.

(1) Insert Setup Disk 1 (1/6) of the C compiler package into the FD drive of the host machine.

(2) Execute the SETUP.EXE command, which is in the root directory of the FD, with Explorer in Windows. Install the C compiler following the instructions.

(3) Set the command search path. Set the bin directory under install directory to the environmental variable PATH in batch file autoexec.bat. In the PATH of autoexec.bat, add the bin directory under the install directory or the following description after environmental variable PATH[3]. Note that the environmental variable PATH recognizes up to 128 characters.

```
PATH△%PATH%;A\NECTOOLS\BIN
```

(4) Restart Windows.
By restarting Windows, new autoexec.bat is executed, necessary device drivers are set, and Project Manager and CA can be used.

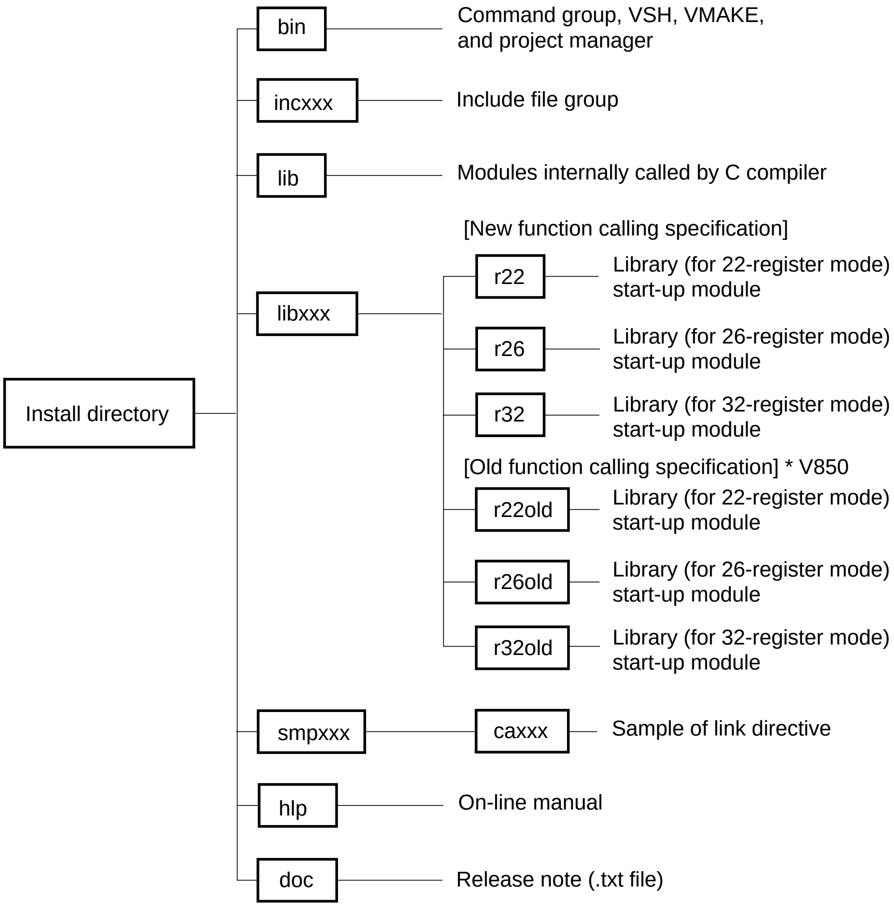
[2] 7 FDs for Japanese version.
[3] The mark "△" indicates a blank space.

2.3 Directory Configuration

The configuration of the directory of the files read from the supply media as a result of installing this compiler package is shown in Figure 2-1[4].

The default of install directory is "\NECTOOLS" in the drive where the Windows system is located.

Figure 2-1. Directory Configuration



Install directory
bin
Command group, VSH, VMAKE, and project manager
incxxx
Include file group
lib
Modules internally called by C compiler
libxxx
[New function calling specification]
r22
Library (for 22-register mode) start-up module
r26
Library (for 26-register mode) start-up module
r32
Library (for 32-register mode) start-up module
[Old function calling specification] * V850
r22old
Library (for 22-register mode) start-up module
r26old
Library (for 26-register mode) start-up module
r32old
Library (for 32-register mode) start-up module
smpxxx
caxxx
Sample of link directive
hlp
On-line manual
doc
Release note (.txt file)

Be sure to set the above bin directory to the command search path when installing the compiler package (refer to page 26).

The old function calling is not supplied in the CA830.

The library/start-up module for the old function calling specification is not included in the supply media of the CA830.

Even in the CA850, the old function calling is not supplied when the V850E^{TM} is used for the target device.

[4] In this compiler package, directory libxxx and r32 under libxxx in Figure 2-1 is called the standard directory for the library, directory incxxx is called the standard directory for the include file, and the standard directory for the device file becomes the dev directory in the same level.

2.4 Library File

The header files and standard/mathematical libraries of this compiler package are “libc” in the following copyright statement transplanted by Cygnus Support for the V810 Family and then by NEC Corporation for the V830 Family and V850 Family.

Copyright © 1992, 1993, 1994, Cygnus Support

“libc” includes software developed by Berkley University in California, and others.
Copying this document and distributing the copy are permitted only if the copyright statement and this permission statement remain in all copies.
The permission to copy and distribute copies of the revised edition of this document verbatim is granted under the conditions of the GNU General Public License. This GNU General Public License includes a stipulation that all the results obtained by using “libc” are to be distributed according to the same permission statement.
The permission to translate this document into other languages and to copy and distribute the copy of the translated version is granted under the condition of the revised edition mentioned above.

“This document” in the above mentioned statement means an explanation of each function included in the standards and mathematical libraries explained in V800 Series C Compiler Package User’s Manual-C language. The ROM-storing library as well as the run-time library and emulation library added to the standard library are the original functions of NEC Corporation.

2.5 Cautions

- This compiler package creates a temporary file used internally under the following directory (The number indicates the priority).

  – To start from Project Manager

  1. Work directory set by <<Other settings>> of <<Project Manager option setting>> dialog which is displayed by Option → Project Manager Options...
  2. Directory specified by environmental variable TEMP
  3. Root directory of current drive

  – To start from the VSH command line

  1. Directory specified by -temp option of C compiler (ca)
  2. Directory specified by environmental variable TEMP
  3. Root directory of current drive

- When file name is specified by the ca or ld, both of “/” and “\” (“¥”) are regarded as delimiter of directory path. When the drive name is omitted, the files is searched in the following drives.

  – To start from Project Manager (The number indicates the priority)

  1. Drive of work directory specified by <<Other settings>> of <<Project Manager option setting>> dialog
  2. Drive of project directory specified by <<Project Setup>> dialog

  – To start from the VSH command line

  Drive of current directory

[MEMO]

VOLUME 2

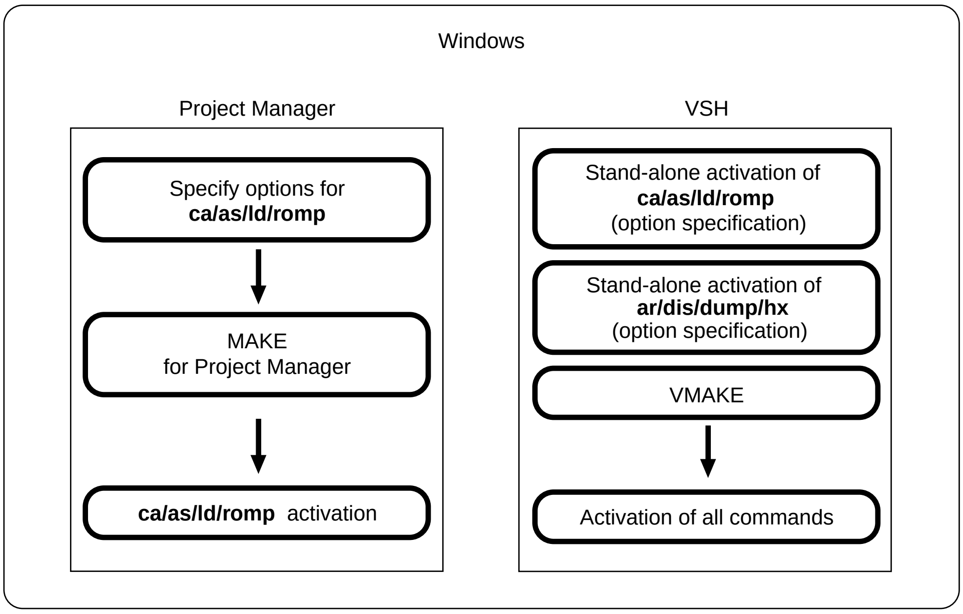
OPERATION METHODS

CHAPTER 1 OVERVIEW OF OPERATIONS

Volume 2 describes how to operate these compiler packages from the Project Manager and the VSH (shell function).

When using the CA to generate application load modules (i.e., compile/assemble source files, link object files, and create ROM-storing object file), there are two methods (shown in Figure 1-1): operating from the Project Manager as part of an integrated environment or operating from the VSH's command line interface.

Figure 1-1. Outline of CA Package Operations


Windows
Project Manager
Specify options for ca/as/ld/romp
MAKE for Project Manager
ca/as/ld/romp activation
VSH
Stand-alone activation of ca/as/ld/romp (option specification)
Stand-alone activation of ar/dis/dump/hx (option specification)
VMAKE
Activation of all commands

Chapter 2 describes how to operate the compiler package from the Project Manager.

Chapter 3 describes the functions of VSH and how to operate the compiler package from the command line interface of VSH, and Chapter 4 describes the functions and operations of the make utility VMAKE that runs on VSH.

For details of CA command functions, options, etc., see the command-specific descriptions in Volume 3 and later volumes.

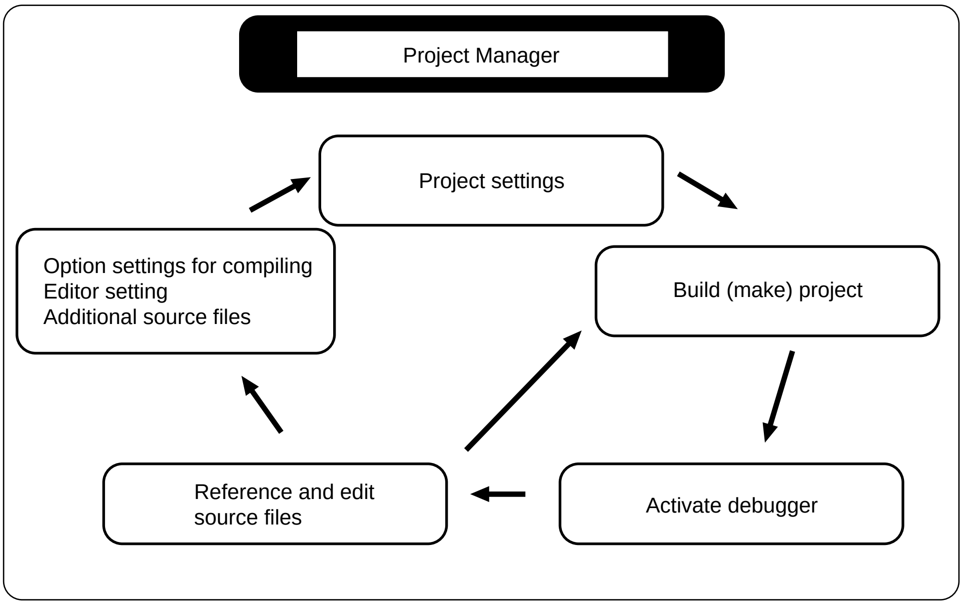
CHAPTER 2 OPERATIONS USING THE PROJECT MANAGER

This chapter describes the use of the Project Manager to specify CA command options and to generate make files.

2.1 What is the Project Manager?

The Project Manager is a control software program that helps Windows-based programs run more efficiently, and enables various operations—from editing a source program to compiling, executing, and debugging—to be performed in a series (see Figure 2-1).

Figure 2-1. Project Manager and Development Tools

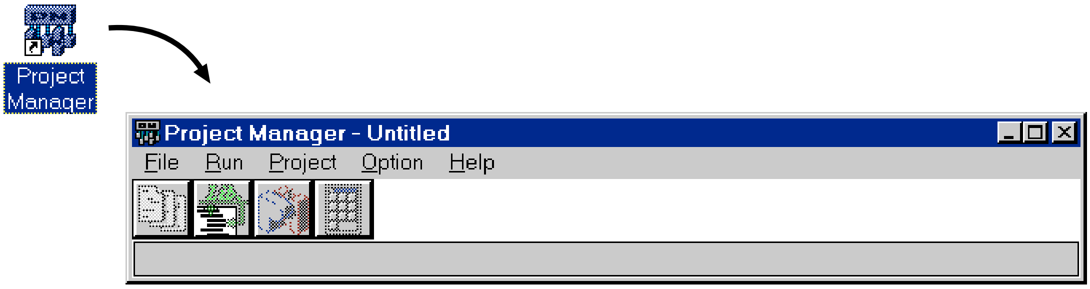


For details of the Project Manager, refer to the “Project Manager User’s Manual.”

2.2 Activation of Project Manager

To activate the Project Manager, use the <<Project Manager>> icon that was registered when this compiler package was installed.

Figure 2-2. Window for Activation of Project Manager



2.3 Project Settings

The Project Manager manages the application modules to be developed and development environments in units of “projects”.

The Project Manager also manages settings for a project by recording them into a “project file”. By “setting a project”, “a project file is generated” by Project Manager.

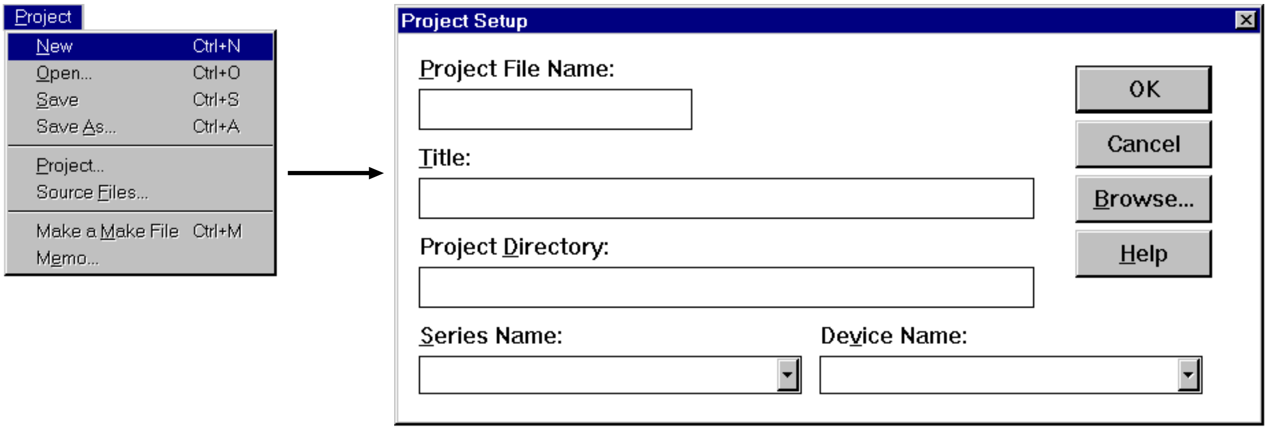
The settings listed below, which are required for creating application load modules, are automatically recorded in the Project Manager.

- Required source files
- Target device to be used
- Editor and tools to be used
- Compile option

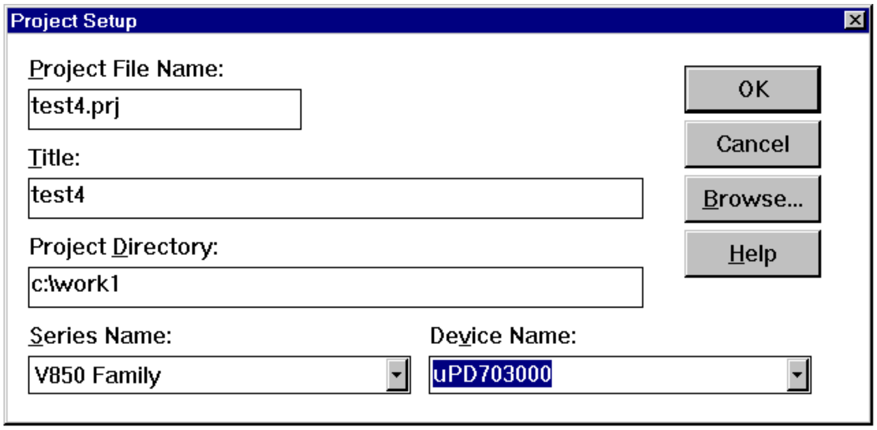
By opening the project file with the Project Manager, these settings are automatically repeated, enabling restart of development with the same settings as when Project Manager was ended previously.

The following describes a newly created sample project entitled “test4”.
For details of project-related operations, refer to “Project Manager User’s Manual”.

(1) Click New Ctrl+N in the Project menu to open the <<Project Setup>> dialog.



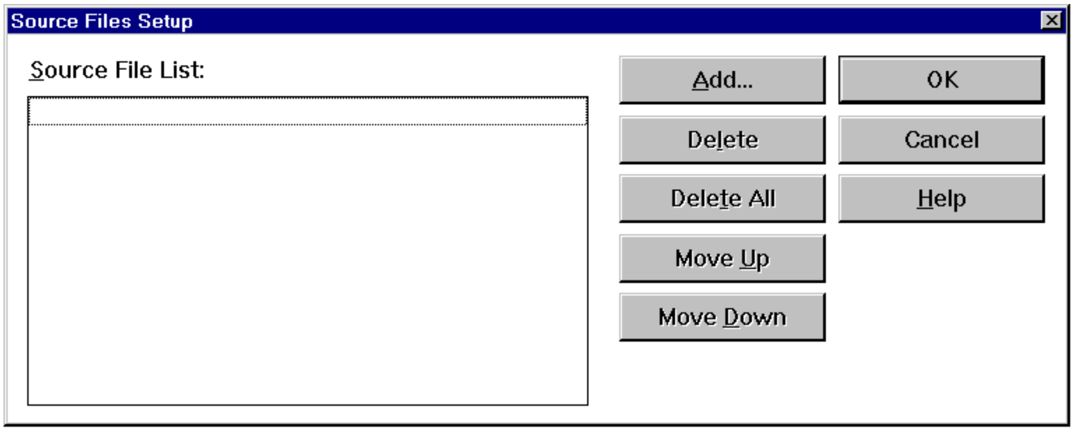
(2) Set the project file name, title, project directory, series name, and device name for the project to be created, then click the OK button.

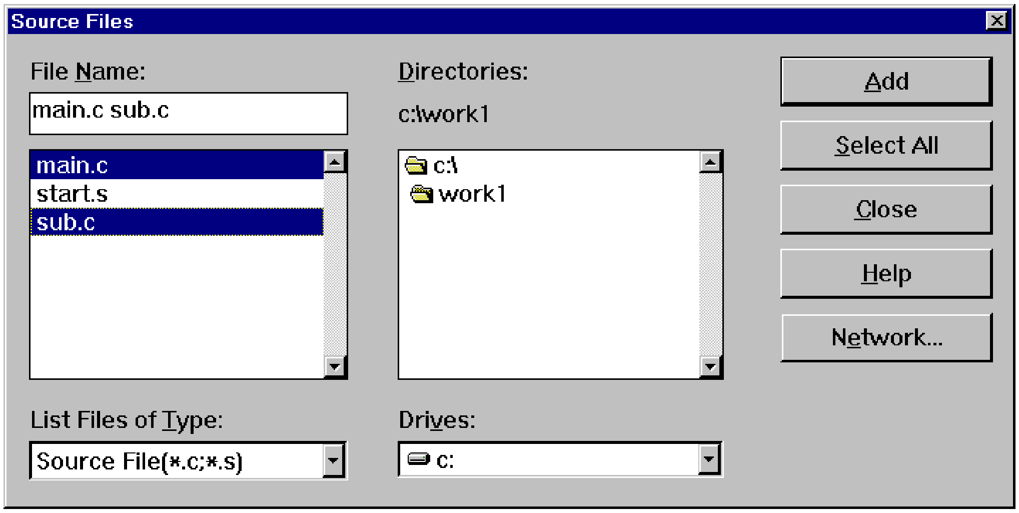


Project File Name: test4.prj
Title: test4
Project Directory: c:\work1
Series Name: V850 Family
Device Name: uPD703000

(3) Click Source Files... in the Project menu to open the <<Source Files Setup>> dialog. Since this is a new project, nothing is shown in the source file list. Click Add... to open the << Source Files>> dialog for setting the source file to be used for the project.

Click the source file to be used on the list of the <<Source Files>> dialog. The source file is actually added by clicking Add . When the <<Source Files Setup>> dialog is displayed again by clicking Close , the added file will be displayed on the list.





File Name: main.c sub.c

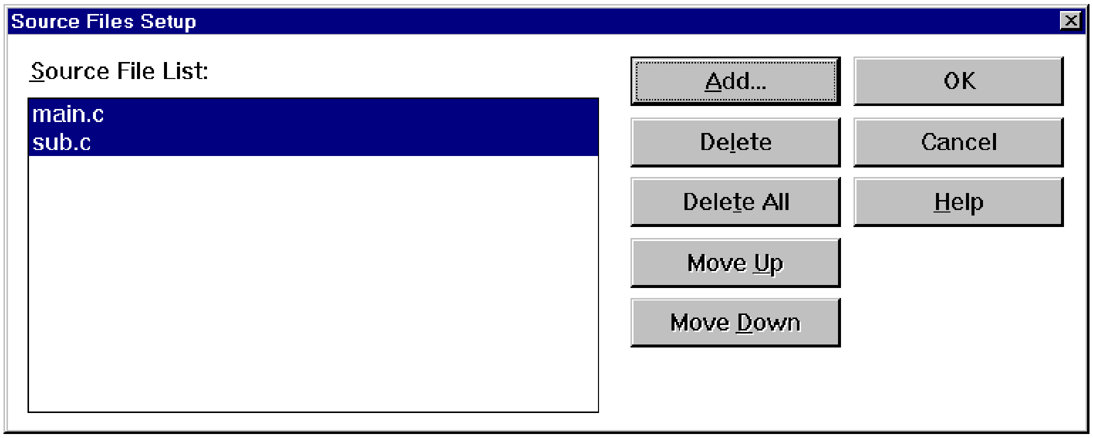
Directories: c:\work1

- main.c
- start.s
- sub.c

- c:\
- work1

List Files of Type: Source File(*.c;*.s)

Drives: c:



Source File List:

- main.c
- sub.c

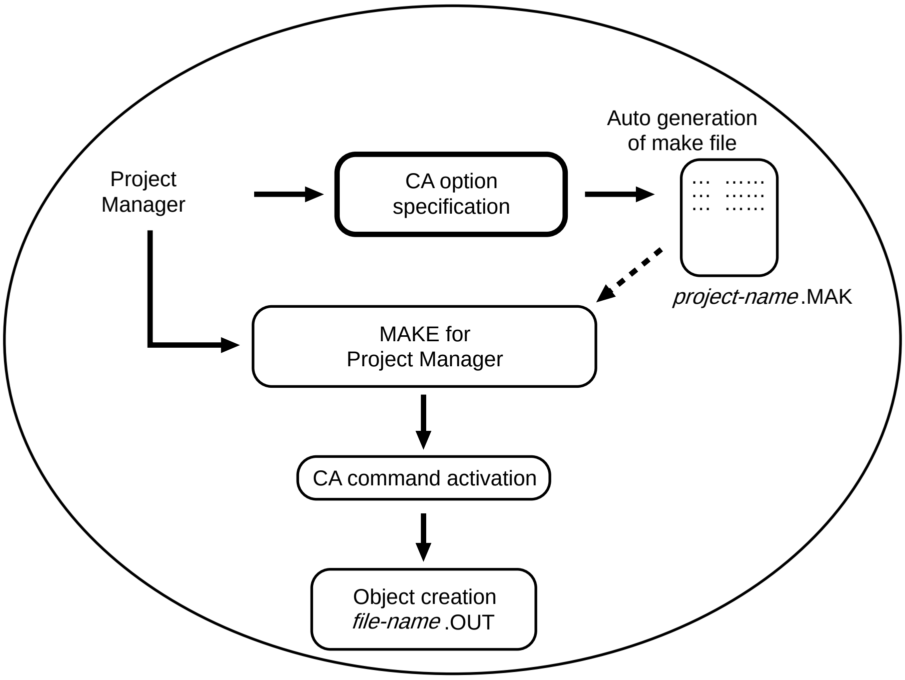
Check that all of the desired source files have been set from the source file list, then click the OK button to set project “test4” before exiting. In the title bar of the Project Manager, the project file name “test4.prj” is displayed.

2.4 Project Manager and CA

The Project Manager can specify the options of the C compiler, assembler, link editor, and ROM-storing processor for the source file to be used for the target project.

It is also possible to automatically create a make file based on the above selection.

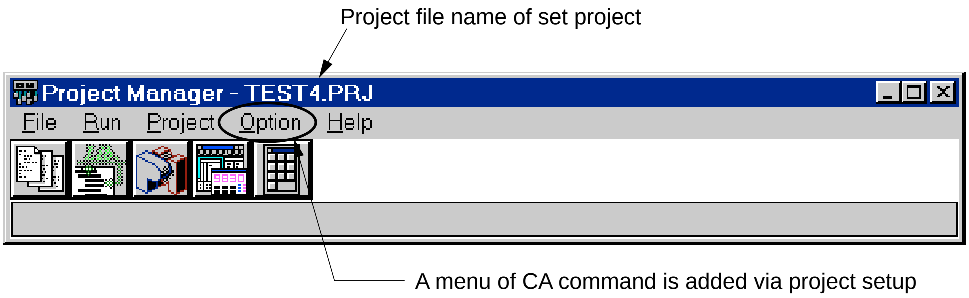
Figure 2-3. Outline of CA Option Specification from Project Manager



If you set a project file via the Project menu, the project file name will be shown in the "Titles" area as shown in Figure 2-4.

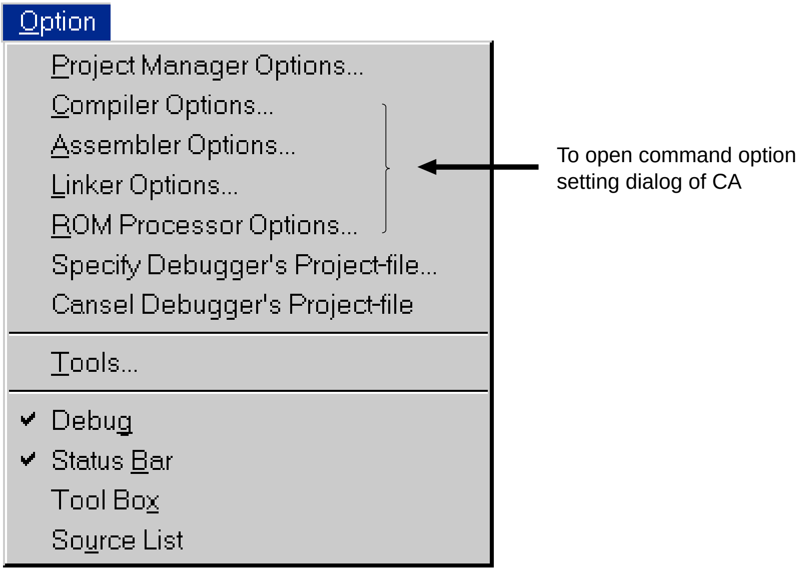
The option of the C compiler, assembler, link editor, and ROM-storing processor are set by displaying the corresponding option setting dialog box from the Option menu after the project has been set.

Figure 2-4. Window for Setting Project File


Project file name of set project
Project Manager - TEST4.PRJ
File
Run
Project
Option
Help
A menu of CA command is added via project setup

The items shown in Figure 2-5 will be displayed when you click the Project Manager's Option menu. Use this menu to open the dialogs for setting CA command options.

Figure 2-5. Project Manager's Option Menu (after setting project)


Option
Project Manager Options...
Compiler Options...
Assembler Options...
Linker Options...
ROM Processor Options...
Specify Debugger's Project-file...
Cansel Debugger's Project-file
Tools...
✓ Debug
✓ Status Bar
Tool Box
Source List
To open command option setting dialog of CA

2.5 Dialogs for Setting CA Command Options

This section explains each dialog that sets the command option of the CA for the source file of the target project.

[Cautions]

- The option names used to activate commands from the VSH command line are displayed in square brackets “[ ]”.

- For details of the various command functions, see the command-specific descriptions in Volume 3 and later volumes.

- Volume 3 and later volumes contain lists of options for the various commands, including some options that are not shown in the dialogs. These include options that do not have to be activated from the Project Manager and options that cannot be specified from the Project Manager because they are fixed (refer to page 29 for work directory description).
  For example, the device specification “*-cpu*” that is in the option list for the ca and as commands is not included since the device specification is already made when setting a project via the Project Manager.

- Debugger options (such as -g of ca and as) are not included in the option dialog described in the next section. With the Option menu, the debug mode can be switched. Checking the Debug on the menu sets the debug mode and not checking sets the non-debug mode. The default setting is debug mode.

2.5.1 Setting compiler options

The C compiler option setting dialog box for the C source file can be displayed by performing either of the following operations after a project has been set with the Project Manager.

- Click the Option menu
  → Click Compiler Options...

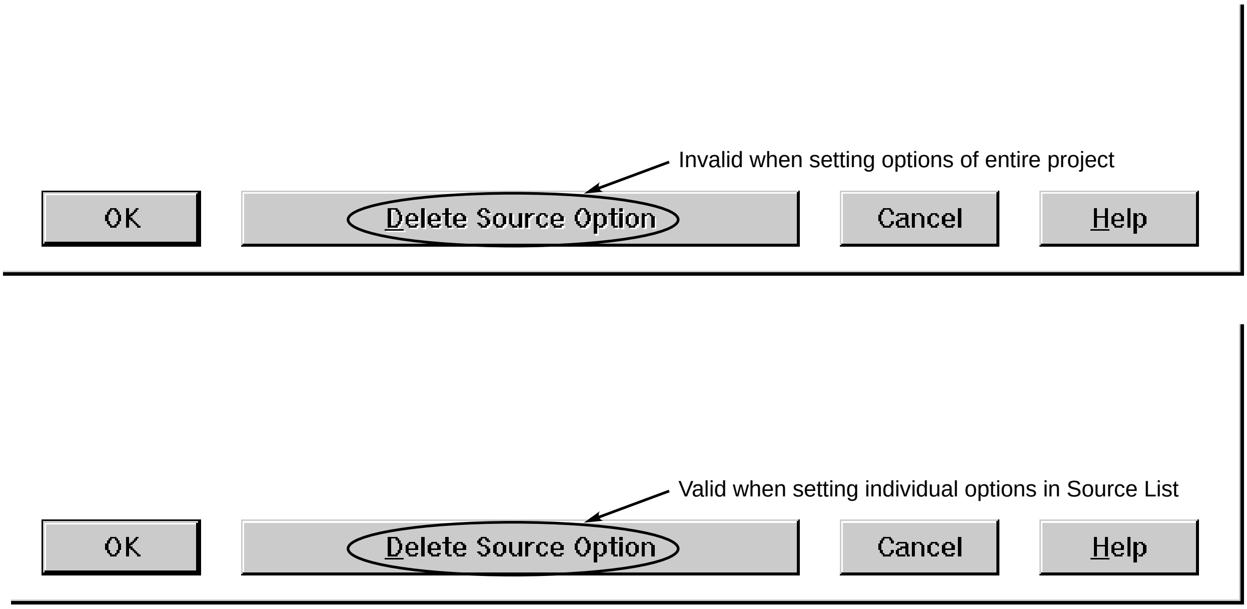
- Click the Option menu
  → Click Source List
  → Click the source file for which options are to be set
  → Click the Options... button

The former is the setting for the C source file for the all target projects and the latter is the individual setting for that C source file[1]. When source file-specific settings are made, overall option settings become invalid for the particular source file.

If the Delete Source Option button is clicked on the setting dialog of each source, the option set for each source file is deleted, and the option for the all projects set by the former method becomes valid.

[1] “*” mark is appended to the file that is set to the individual option setting in <<Source List>>.

Figure 2-6. Delete Source Option Button



Invalid when setting options of entire project

Valid when setting individual options in Source List

Eight option buttons are displayed at the upper part of the C compiler option setting dialog. By selecting an option button, the display of the dialog is changed.

(1) Option buttons for displaying option setting dialogs

1 Input

Opens the dialog box that is used to set the options related to input to the C compiler (refer to page 42).

2 Preprocessor

Opens the dialog box that is used to set preprocessor-related options (refer to page 44).

3 Language

Opens the dialog box that is used to switch language specifications (refer to page 46).

4 Optimization

Opens the dialog box that is used to set the optimization level and type (refer to page 48).

5 Output 1

Opens the dialog box that is used to make output object-related settings such as data allocation to .sdata/.sbss sections and kanji code specifications of the target (refer to page 50).

6 Output 2

Opens the dialog box that is used to make output object-related settings such as register mode and ROM-storing object creation specification (refer to page 53).

7 Message

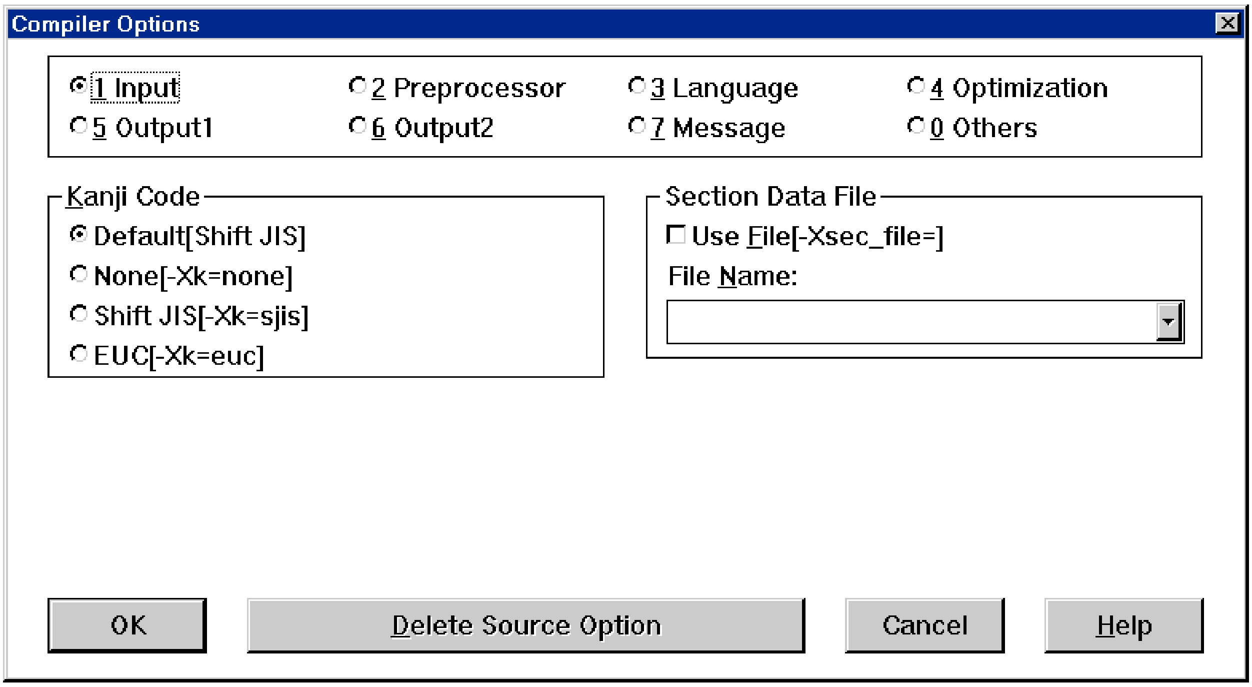
Opens the dialog box that is used to set the level and item of warning message to be output (refer to page 56).

0 Others

Opens the dialog box that is used to set the other parameters (refer to page 58).

◊ **Setting input options** ◊

Figure 2-7. Input Option Settings Dialog



Compiler Options

● 1 Input ○ 2 Preprocessor ○ 3 Language ○ 4 Optimization
○ 5 Output1 ○ 6 Output2 ○ 7 Message ○ 0 Others

Kanji Code

● Default[Shift JIS]
○ None[-Xk=none]
○ Shift JIS[-Xk=sjis]
○ EUC[-Xk=euc]

Section Data File

□ Use File[-Xsec_file=]

File Name:

(1) Options

Kanji Code

Specifies the character code to be used for Japanese comments and character strings[2] in the input file. Error message is output if the codes other than the specified code exists in the input file. If <<None>> is specified, the code cannot be guaranteed. The <<Default>> setting is Shift JIS.

Section Data File

Specifies a section file name to allocate data to a section by using an option, instead of #pragma (refer to page 397). By checking <<Use File >>, a file name can be set in the text box. Be sure to specify a file name when <<Use File>> is checked. Since a section file is divided into several files, delimit each file names with “;” from others when specifying two or more file names.

This option cannot be set independently for each source file, and is always used for all files.

This area is in the form of a drop-down list, and a file once specified is registered to the list (up to 10 files). This option can be selected by clicking or arrow key.

[2] Refer to the section of the **V800 Series C Compiler Package User's Manual - C Language** that describes character strings and comments in the language specifications.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.

When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

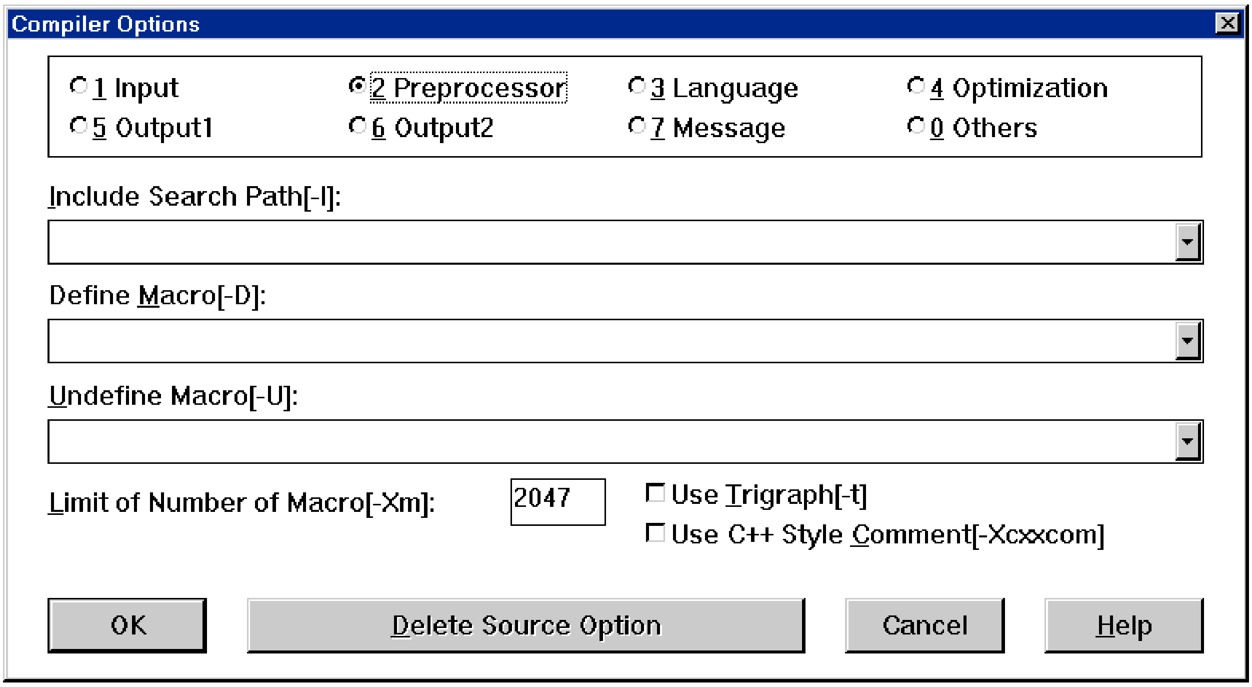
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

◊ **Setting pre-processor options** ◊

Figure 2-8. Pre-processor Option Settings Dialog



Compiler Options

○ 1 Input ● 2 Preprocessor ○ 3 Language ○ 4 Optimization
○ 5 Output1 ○ 6 Output2 ○ 7 Message ○ 0 Others

Include Search Path[-I]:

Define Macro[-D]:

Undefine Macro[-U]:

Limit of Number of Macro[-Xm]: 2047

□ Use Trigraph[-t]
□ Use C++ Style Comment[-Xcxxcom]

(1) Options

Include Search Path [-I]

This specifies one or more directories to be searched before the standard directory when searching for header files. When specifying several paths, use a semicolon ";" to separate the path specifications. This area uses the "drop-down list" type of display to list all directories that have been specified at least once (up to 10 paths). To select a directory, either click on the desired directory or use the arrow keys to select it.

When this option is omitted, only the standard directory[3] will be searched[4].

Define Macro [-D]

Uses the "macro_name *name* = definition_value *def*" format to define macro names. If the "= *def*" specification is omitted, a value of 1 is assumed as "*def*".

(Example) test = 2

It is assumed that "#define *name def*" is entered before a C-language program.

When specifying several macros, separate them with a semicolon ";".

[3] The standard directory is the installation directory (\incxxx).

[4] In the format that encloses a file name with "", the directory where the source file exists is searched first. For the details of file search of header file loading, refer to **V800 Series C Compiler Package User's Manual - C Language**.

This area uses the “drop-down list” type of display to list all macros that have been specified at least once (up to 10 macros). To select a macro, either click the desired macro or use the arrow keys to select it.

Undefine Macro [-U]

Use this to specify the macro name *name* to be rendered invalid. It is assumed that “#undef *name*” is entered before a C-language source program. When specifying several macros to be rendered invalid, separate them with a semicolon “;”.
This area uses the “drop-down list” type of display to list all macros that have been rendered invalid (up to 10 macros). To select a macro, either click the desired macro or use the arrow keys to select it.

Limit of Number of Macro [-Xm]

Specifies the upper limit of the number of macro identifiers with a decimal number of up to 32767. The default value is 2047.

Use Trigraph [-t]

Replaces the trigraph series.

Use C^{++} Style Comment [-Xcxxcom]

In addition to ordinary comments, this allows any text from “//” to the end of the line to be handled as comments (C^{++} comment style).

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager’s <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

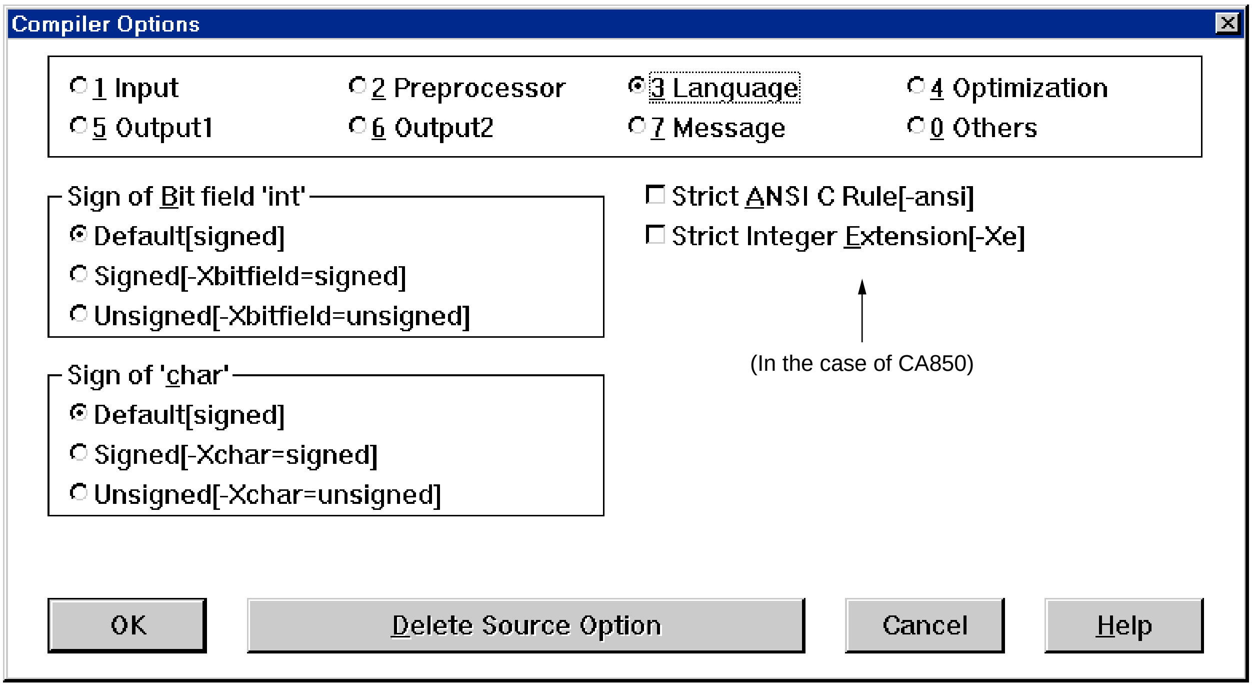
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

◊ **Setting language options** ◊

Figure 2-9. Language Option Settings Dialog



Compiler Options

○ 1 Input ○ 2 Preprocessor ● 3 Language ○ 4 Optimization

○ 5 Output1 ○ 6 Output2 ○ 7 Message ○ 0 Others

Sign of Bit field 'int'

● Default[signed]

○ Signed[-Xbitfield=signed]

○ Unsigned[-Xbitfield=unsigned]

Sign of 'char'

● Default[signed]

○ Signed[-Xchar=signed]

○ Unsigned[-Xchar=unsigned]

□ Strict ANSI C Rule[-ansi]

□ Strict Integer Extension[-Xe]

(In the case of CA850)

(1) Options

Sign of Bit field 'int' [-Xbitfield]

This area is used to specify the signed or unsigned status of an integer type bit field for which the signed/ unsigned status has not been specified. The default setting is "signed".

Sign of 'char' [-Xchar]

This area is used to specify the signed or unsigned status of simple char type for which the signed/ unsigned status has not been specified. The default setting is "signed".

Strict ANSI C Rule [-ansi]

Check this box to compile strictly according to the language specification in the ANSI standards (refer to page 155).

Strict Integer Extension [-Xe]

When this box is checked, ___mul/___mulu and ___div/___divu from the runtime library[5] are used instead of mulh and divh instructions for integers having data lengths of 16 bits or less.
Multiplication and division are performed strictly according to the ANSI standards, although this slows down the processing speed.
If this check box is not selected, the mulh and divh instructions are used.
* V850

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

Ignores the specified items and closes the dialog.

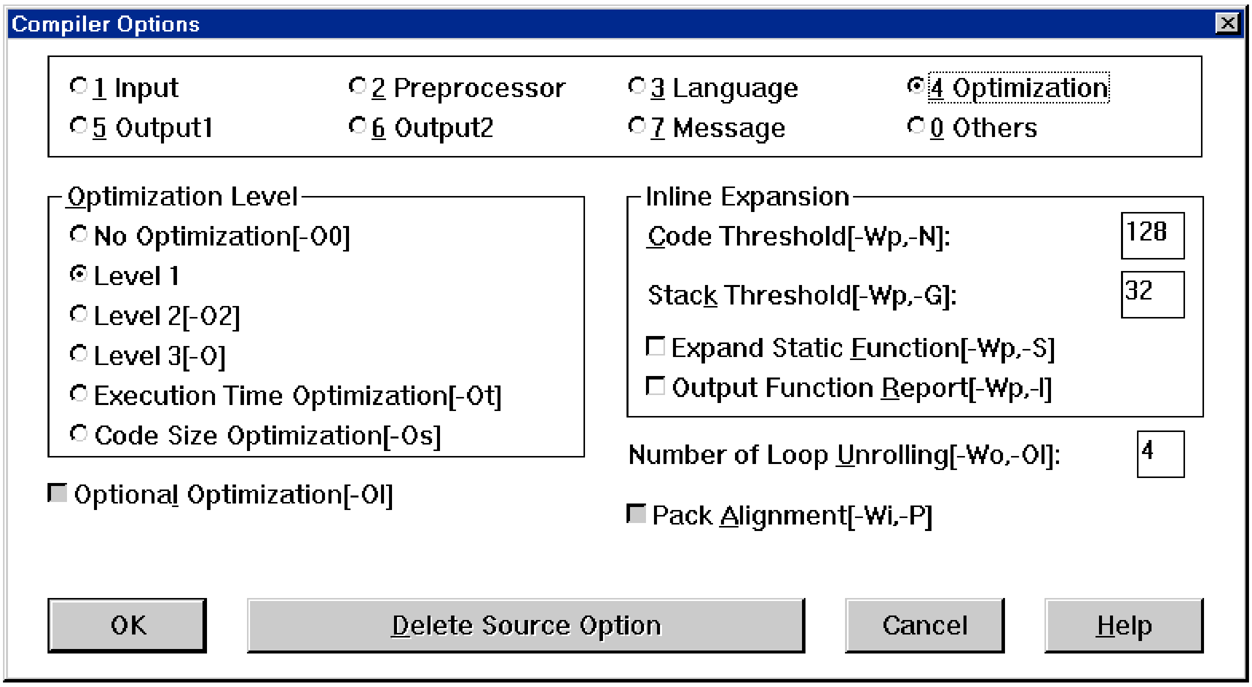
Help

Opens the Help window.

[5] The runtime library in the CA850 is provided as this compiler's standard library in order to fulfill the ANSI standards with regard to instructions that are not included in the V850 Family architecture.
For details of the runtime library, refer to **V800 Series C Compiler Package User's Manual - C Language**.

◊ **Setting optimization options** ◊

Figure 2-10. Optimization Option Settings Dialog



Compiler Options

○ 1 Input ○ 2 Preprocessor ○ 3 Language ● 4 Optimization
○ 5 Output1 ○ 6 Output2 ○ 7 Message ○ 0 Others

Optimization Level
- ○ No Optimization[-O0]
- ● Level 1
- ○ Level 2[-O2]
- ○ Level 3[-O]
- ○ Execution Time Optimization[-Ot]
- ○ Code Size Optimization[-Os]

□ Optional Optimization[-Ol]

Inline Expansion
- Code Threshold[-Wp,-N]: 128
- Stack Threshold[-Wp,-G]: 32
- □ Expand Static Function[-Wp,-S]
- □ Output Function Report[-Wp,-I]

Number of Loop Unrolling[-Wo,-Ol]: 4

□ Pack Alignment[-Wi,-P]

(1) Options

Optimization Level [-O]	Use this area to specify the optimization level and related items (refer to page 156). The default setting is level 1.
Optional Optimization [-Ol]	Check this box to perform optional optimization. This emphasizes optimization measures such as code scheduling and redundant instruction elimination. However, the compiling speed is reduced. This box can be selected where optimization level 2 or above, or execution time-priority or size-priority optimization is selected.
Code Threshold [-Wp, -N]	Limits the intermediate language size of a function subject to inline expansion to the specified number of bytes and does not execute inline expansion a function exceeding this number of bytes. For the guideline of the length, refer to “Output Function Report”. The default size is 128. This option can be specified only when execution time-priority optimization is specified.

Stack Threshold [-Wp, -G]

Limits the stack length in the intermediate language of a function subject to inline expansion to the specified number of bytes and does not execute inline expansion a function exceeding this number of bytes. For the guideline of the length, refer to <<Output Function Report>>. The default size is 32. This option can be specified only when execution time-priority optimization is executed.

Expand Static Function [-Wp, -S]

Performs inline expansion of static functions that are referenced only once.

Output Function Report [-Wp, -I]

Displays information on functions. The displayed information serves as a guideline for specifying the upper limits of <<Code Threshold>> and <<Stack Threshold>>.

(Output example)

```
function name     code   stack
-------------      15      4
```

Number of Loop Unrolling [-Wo, -Ol]

Specifies the number of loop unrolling (refer to page 173). This option can be selected only when execution time-priority optimization is specified.

Pack Alignment [-Wi, -P]

Suppresses optimization that aligns labels. As a result, this enables a smaller code length.
This option can be specified where optimization level is 2 or above, and when execution time-priority optimization is selected. When size-priority optimization is selected, however, this option appears dimmed because this option function is included and therefore, this option cannot be specified.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

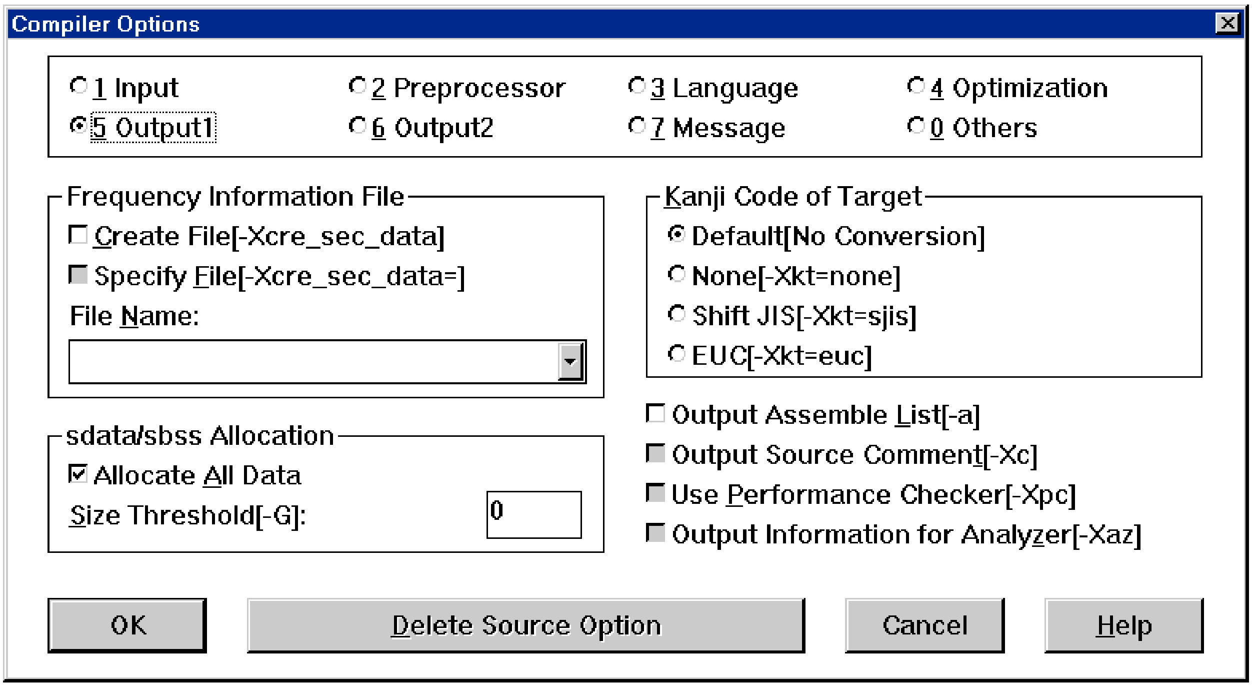
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

◊ **Setting output 1 options** ◊

Figure 2-11. Output 1 Option Settings Dialog



Compiler Options

○ 1 Input ○ 2 Preprocessor ○ 3 Language ○ 4 Optimization

● 5 Output1 ○ 6 Output2 ○ 7 Message ○ 0 Others

Frequency Information File

□ Create File[-Xcre_sec_data]

□ Specify File[-Xcre_sec_data=]

File Name:

Kanji Code of Target

● Default[No Conversion]

○ None[-Xkt=none]

○ Shift JIS[-Xkt=sjis]

○ EUC[-Xkt=euc]

sdata/sbss Allocation

☑ Allocate All Data

Size Threshold[-G]: 0

□ Output Assemble List[-a]

□ Output Source Comment[-Xc]

□ Use Performance Checker[-Xpc]

□ Output Information for Analyzer[-Xaz]

(1) Options

Frequency Information File	Clicking <<Create File>> creates a frequency information file that is necessary for creating a section file that allocates sections by using the section file generator (sf) (refer to page 397). If <<Specify File>> is not clicked, the frequency information file is created under the name with .c of the source file changed to .sec. If <<Specify File>> is clicked, a file name can be specified in the text box. In this case, be sure to specify a file name. This area uses the "drop-down list" type of display to list all files that have been specified at least once (up to 10 files). Either click the desired file or use the arrow keys to select it. * V850

CAUTIONS When specifying an information file name for each of two or more source files, do not specify a file name with an option that is related to all the projects, but specify a file name by using an option that is related to each source file.

This option also outputs the frequency information on the variables in the C source file. It does nothing to the assembler source file.

sdata/sbss Allocation [-G]

Use this area to specify the length of data allocated to the .sdata/.sbss section.

If all data allocations are cancelled, input to the text box for specifying the data length is enabled. Data of the specified size (in bytes) or less is allocated to the .sdata or .sbss section. However, data for which the .sdata or .sbss section is specified by the #pragma section directive[6] or section file (refer to page 408) is allocated to the .sdata or .sbss section regardless of its size.

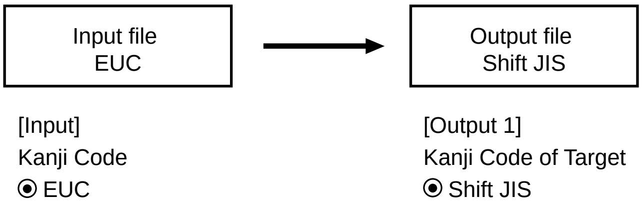
Kanji Code of Target

Japanese character strings are converted into specified codes and output[7]. This conversion is convenient when converting Kanji codes that were used in application development, in the target. Codes are not converted when <<None>> or <<Default>> is specified.

The comment output by the specification of [Output Source Comment] is not converted in spite of this option.

CAUTIONS

If code other than the default (shift JIS) are used in the input file whose code is to be converted by the specification of [Kanji Code of Target], specify the code being used with [Kanji Code] of the [Input] option.



[Input]
Kanji Code
◉ EUC

[Output 1]
Kanji Code of Target
◉ Shift JIS

Unless specified, the code is not converted because the input default is recognized as shift JIS.

Output Assemble List [-a]

The assembly list is output to a file whose extension .c is changed to .v (refer to page 208).

[6] Refer to the data section allocation in the **V800 Series C Compiler Package User's Manual - C Language**.

[7] Refer to the section of the **V800 Series C Compiler Package User's Manual - C Language** that describes character strings and comments in the language specifications.

Output Source Comment [-Xc]

Outputs a C-language source program to the assembler source file to be output as comments. This option can be specified only when [Output Assemble List] is specified.
The comments that are output, however, are only for reference and may not strictly correspond to the codes. For example, the output position of the global variables, local variables, and function declaration may be shifted. In addition, the codes may be deleted and only comments may remain because of optimization.

Use Performance Checker [-Xpc]

This box cannot be selected at present.

Output Information for Analyzer [-Xaz]

This box cannot be selected at present.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

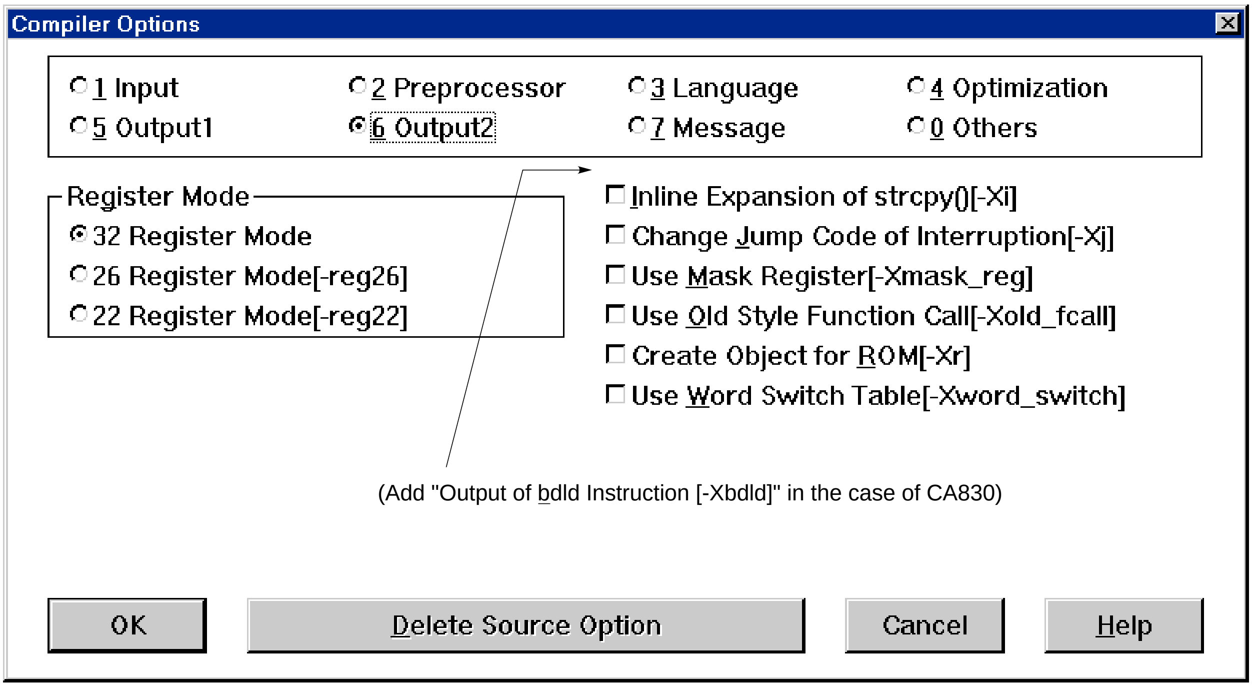
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

◊ **Setting output 2 options** ◊

Figure 2-12. Output 2 Option Settings Dialog



○ 1 Input ○ 2 Preprocessor ○ 3 Language ○ 4 Optimization
○ 5 Output1 ● 6 Output2 ○ 7 Message ○ 0 Others

Register Mode

● 32 Register Mode
○ 26 Register Mode[-reg26]
○ 22 Register Mode[-reg22]

□ Inline Expansion of strcpy()[-Xi]
□ Change Jump Code of Interruption[-Xj]
□ Use Mask Register[-Xmask_reg]
□ Use Old Style Function Call[-Xold_fcall]
□ Create Object for ROM[-Xr]
□ Use Word Switch Table[-Xword_switch]

(Add "Output of bdld Instruction [-Xbdld]" in the case of CA830)

(1) Options

Register Mode

The number of registers used by ca can be set by the user as 26 or 22 only[8]. The default setting is 32 registers.
Because the setting by this option is also recognized by the link editor, the library in an appropriate mode is referred.

Output of bdld Instruction [-Xbdld]

When a 16-byte or larger static structure or external structure variable value, which is allocated to the section for external memory, is substituted as a variable to the .sidata section allocated to internal data RAM, the bdld instruction is generated in assembly language using ca and output (refer to page 166). * V830

[8] This switches the register mode of the software register bank function. Refer to **V800 Series C Compiler Package User's Manual - C Language** for the software register bank function.

Inline Expansion of strcpy () [-Xi]

The function call of the strcpy() function is converted into block transfer. This causes the object execution speed to become higher, but the code size also becomes larger.
However, conversion is performed only when the second argument of strcpy () is a character string. Moreover, the first argument must be 4-byte aligned by the program (as the second argument is a character string, the C compiler has already aligned the second argument).

Change Jump Code of Interruption [-Xj]

This option changes the instruction for branching to the interrupt function from the jr instruction to the jmp instruction (refer to page 157).
When the function itself is in the range where branching from the jr instruction is not possible and ld outputs an error, recompilation is performed using this option.

Use Mask Register [-Xmask_reg]

This option sets the use of the mask register function[9]. Specifying this option automatically sets the check during linking by link editor, and an error results if a mask-register-enabled object and mask-register-disabled object coexist.
This option cannot be selected separately for each source file setting. This option is always set as the overall option.

CAUTIONS

Even in applications where both the C source file and assembler source file are used, or in applications where only the assembler source file is used, [Use Mask Register] must be specified by both the C compiler option and assembler option.

Use Old Style Function Call [-Xold_fcall]

This option outputs the codes that comply with the old-version call specifications of the C compiler. By specifying this option, the specification of [Use Mask Register] becomes invalid. The old style library is referenced automatically in library references by a link editor.
This option cannot be selected separately for each source file setting. This option is always set as the overall option. * V850
This option cannot be specified when using the V850E for the target device.

CAUTIONS

If one wishes to use the old style call specifications, this option must be specified with C compiler option, even in application using both C source files and assembler source files, or only assembler source files, in order to reference the old style library.

[9] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

Create Object for ROM [-Xr]

This option is required when creating an object to be stored in ROM. Following link processing, the processor for ROM writing is started. The generated object file (.out file) contains ROM writing information. The label of the first argument of __rcopy should be designed so as to indicate the first address[10] after the .text section end in the object. In addition, this option indicates that rompcrt.o file and libr.a file are to be linked with ld[11]. This option cannot be selected separately for each source file setting. This option is always set as the overall option.

Use Word Switch Table [-Xword_switch]

This option creates a branch table for the case label in the switch statement in 4 bytes per label. Specify this option if compile errors due to long switch statements occur.
If this option is not specified, the branch table is generated in 2 bytes.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager’s << Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

Ignores the specified items and closes the dialog.

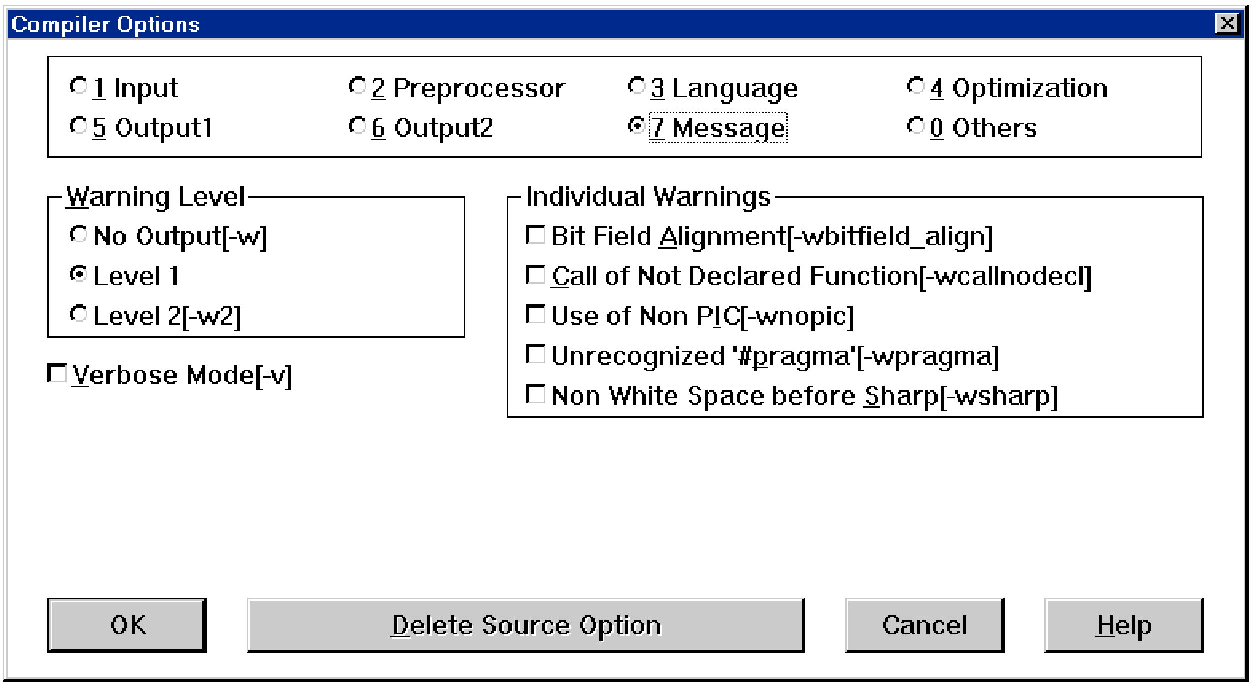
Help

Opens the Help window.

[10] Aligned with 4-byte alignment condition
[11] Refer to page 386.

◊ **Setting message options** ◊

Figure 2-13. Message Option Settings Dialog



Compiler Options

○ 1 Input ○ 2 Preprocessor ○ 3 Language ○ 4 Optimization
○ 5 Output1 ○ 6 Output2 ● 7 Message ○ 0 Others

Warning Level
○ No Output[-w]
● Level 1
○ Level 2[-w2]

□ Verbose Mode[-v]

Individual Warnings
□ Bit Field Alignment[-wbitfield_align]
□ Call of Not Declared Function[-wcallnodecl]
□ Use of Non PIC[-wnopic]
□ Unrecognized '#pragma'[-wpragma]
□ Non White Space before Sharp[-wsharp]

(1) Options

Warning Level
Use this area to set the level of warning messages to be output.

No Output [-w]: Suppress warning messages
Level 1: Output ordinary warning messages (default)
Level 2 [-w2]: Output detailed warning messages

Verbose Mode [-v]
Displays execution status in C compiler.

Individual Warnings
Specifies output or suppression of output of a warning message of each item, regardless of the level. The warning message is output when the check box in this area is checked. The warning message is not output when the check box is displayed in gray.

Bit Field Alignment [-wbitfield_align]
Outputs a warning message if the member of a bit field is allocated from the next boundary because it exceeds the boundary of alignment condition.

Call of Not Declared Function [-wcallnodecl]
Outputs a warning message if a function not declared is called.

Use of Non PIC [-wnopic]
When this box is selected, a warning is output upon initialization of a pointer type external variable which uses a variable's address that is not an automatic variable or which uses a function's address.

Unrecognized ‘#pragma’
[-wpragma]

Outputs a warning message if description of #pragma that cannot be executed is found.

Non White Space before Sharp
[-wsharp]

Outputs a warning message in respect to # character appearing in the middle of the source line.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager’s <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

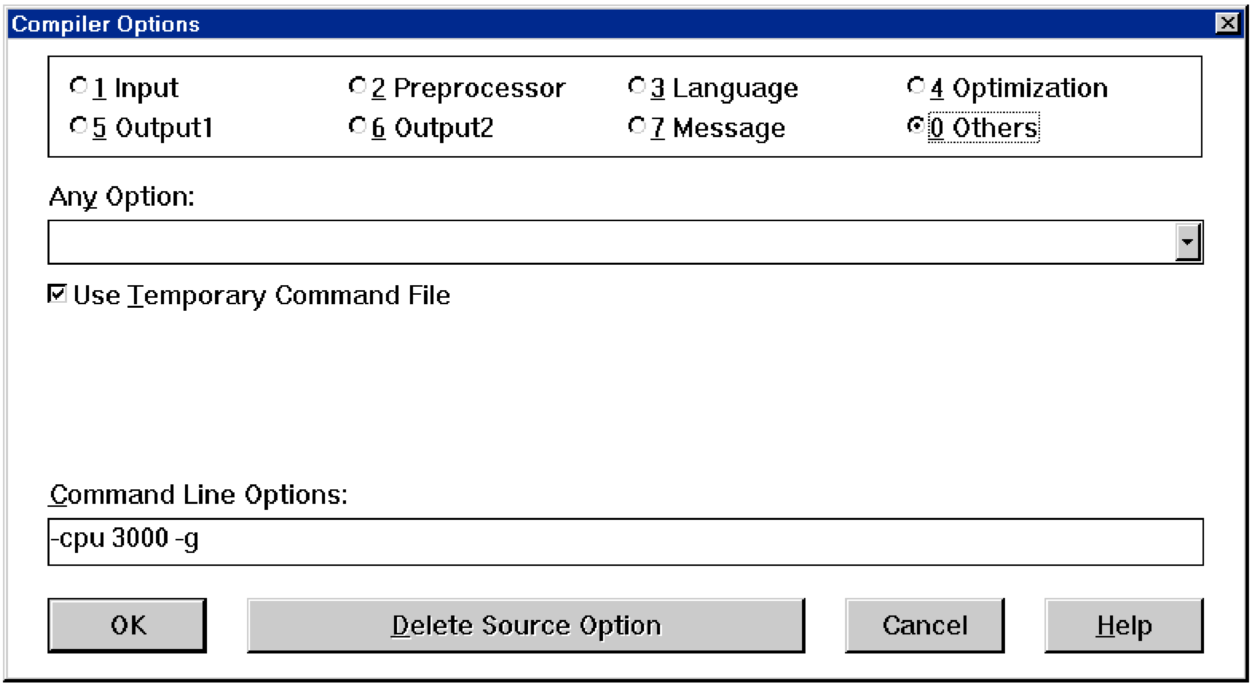
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

◊ **Setting other options** ◊

Figure 2-14. Other Option Settings Dialog (C Compiler)



Compiler Options

○ 1 Input ○ 2 Preprocessor ○ 3 Language ○ 4 Optimization
○ 5 Output1 ○ 6 Output2 ○ 7 Message ● 0 Others

Any Option:

☑ Use Temporary Command File

Command Line Options:

-cpu 3000 -g

(1) Options

Any Option

The following options can be specified in the text box.

Optimization Enhancement Option

To perform the data flow analysis precisely, “-Wi, -O4” can be described[12].

CPU Fault Prevention Option

To prevent CPU faults[13], options:
“-Xnoabcond” (page 157) or “-Xnopldsr” (page 157) in CA830
“-Xv850patch” (page 157) in CA850 can be described.

Options Common to Family

Options are passed to the assembler, because objects are shared in the family[14]. “-Wa, -cn” can be described. In the CA850, the “-Wa, -cnv850e” option can also be described.

[12] Refer to pages 162 and 173.

[13] To check whether the fault that has occurred applies to the CPU used, refer to the documents supplied with the CPU.

[14] Refer to page 205.

Use Temporary Command File

In the Windows environment, the length of character strings used to specify options for command is restricted (to 126 characters). If this check box is selected, the option character string is temporarily output to a command file (refer to page 161), which enables the operation to be completed without observing the restriction on the character string length.
This option is checked as default assumption.

Command Line Options

Displays C compiler options set in each dialog with the command line options. This area is for reference, and writing is disabled.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

Ignores the specified items and closes the dialog.

Help

Opens the Help window.

2.5.2 Setting assembler options

The assembler option setting dialog box for the assembler source file can be displayed by performing either of the following operations after a project has been set with the Project Manager.

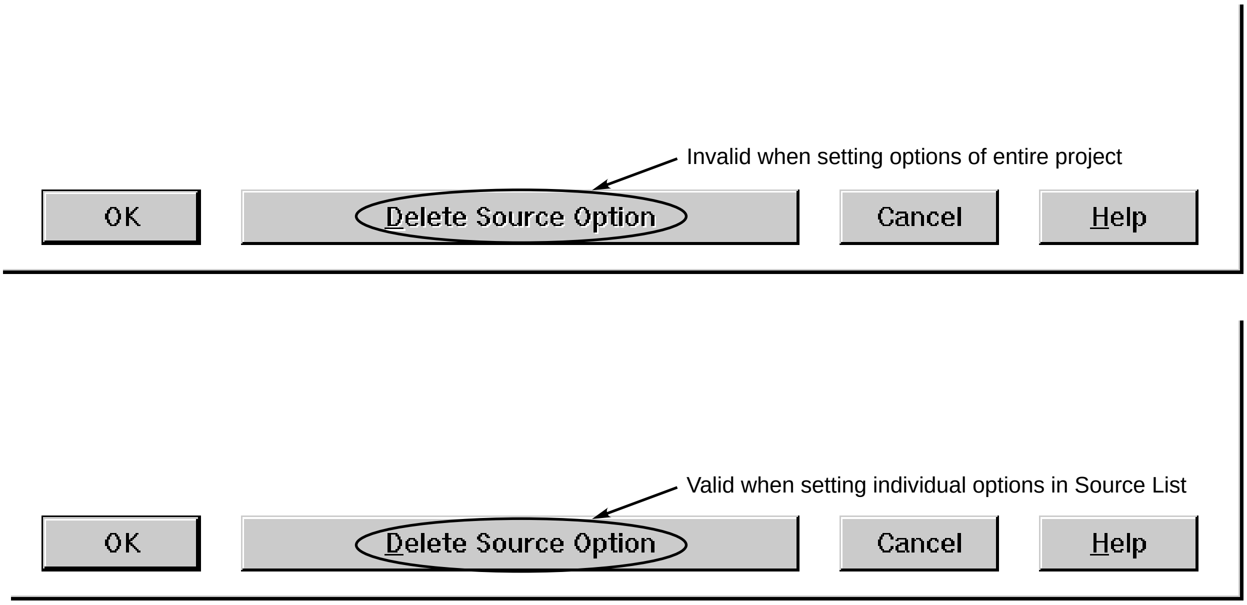
- Click the Option menu
  → Click Assembler Options...

- Click the Option menu
  → Click Source List
  → Click the source file for which options are to be set
  → Click the Options... button

The former is the setting for the assembler source file for the all target projects and the latter is the individual setting for that source file[15]. When source file-specific settings are made, overall option settings become invalid for the particular source file.

If the Delete Source Option button is clicked on the setting dialog of each source, the option set for each source file is deleted, and the option for all the projects set by the former method becomes valid.

Figure 2-15. Delete Source Option Button



Invalid when setting options of entire project

Valid when setting individual options in Source List

[15] "*" mark is appended to the file that is set to the individual option setting in <<Source List>>.

Three option buttons are displayed at the upper part of the assembler option setting dialog. The display of the dialog is changed depending on which option button is selected.

(1) Option buttons for displaying option setting dialogs

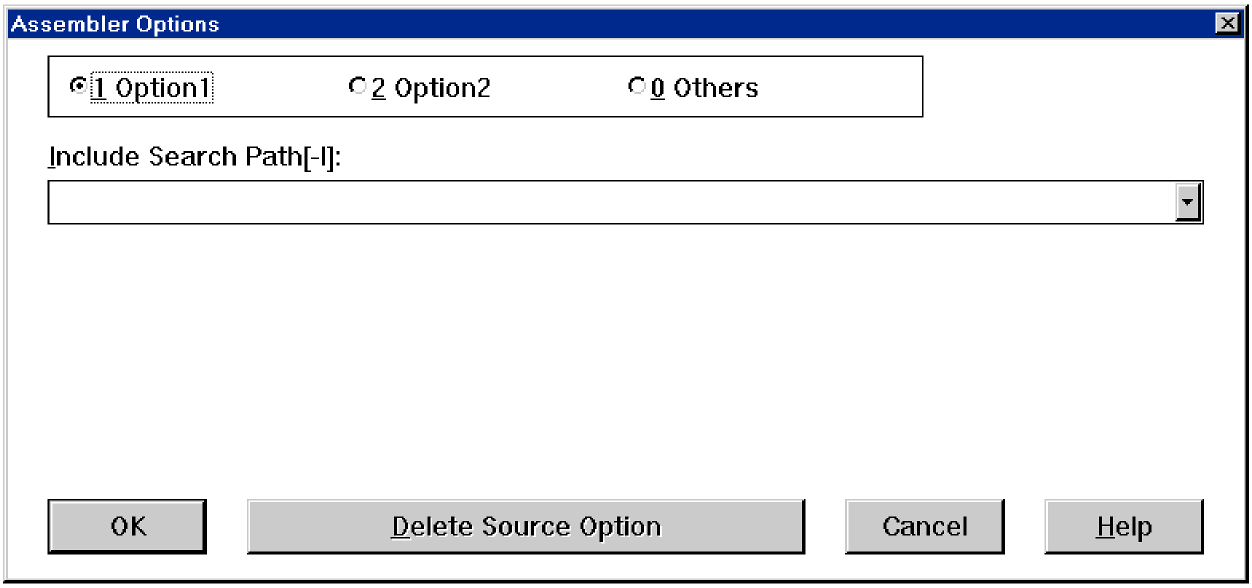
1 Option 1 — Opens the dialog box that is used to set the path of the include file in assembler (refer to page 61).

2 Option 2 — Opens the dialog box that is used to set the ordinary options of the assembler (refer to page 63).

0 Others — Opens the dialog box that is used to set the other parameters (refer to page 66).

◊ Setting option 1 ◊

Figure 2-16. Option 1 Settings Dialog (Assembler)



(1) Options

Include Search Path [-I] — Specifies a directory that is searched for the file specified by the file input directive[16] prior to the directory where the source file is placed. When specifying several paths, use a semicolon ";" to separate the path specifications.
This area uses a "drop-down list" type of display to list all directories that have been specified once (up to 10 files). To select a directory, either click on the desired directory or use the arrow keys to select it.
When this option is omitted, only the directory where the source file is placed is searched.

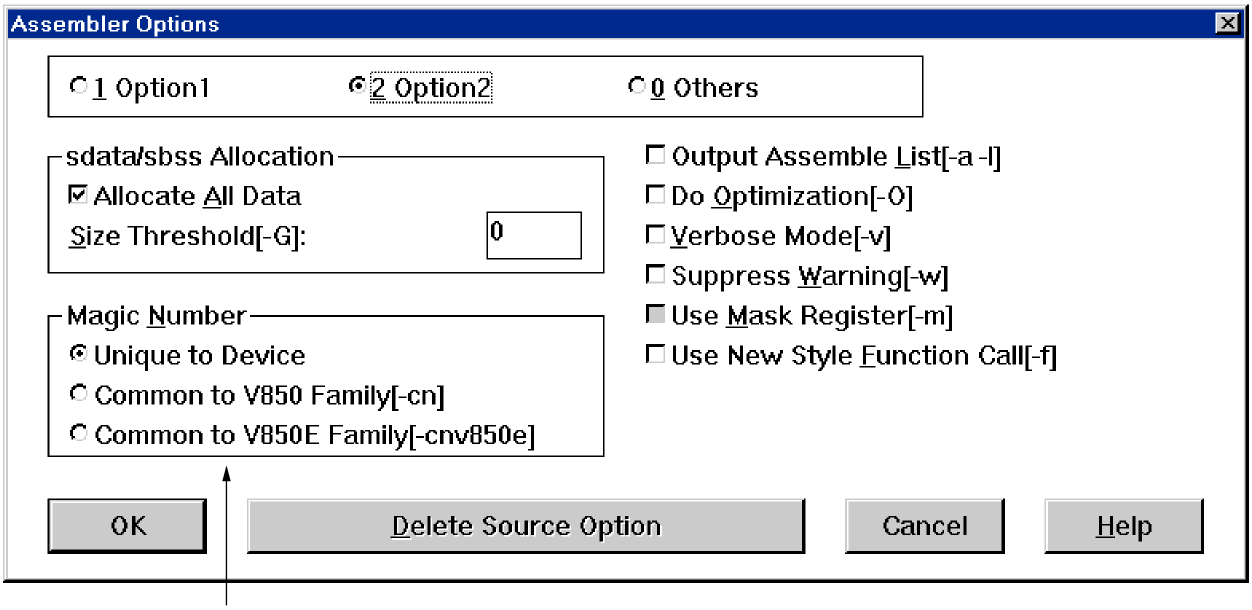
[16] Refer to **User's Manual - Assembly Language** of each family.

(2) Buttons

OK	Enables the specified items and closes the dialog.
Delete Source Option	This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager’s << Source List>> dialog. When it is selected, this button deletes any options specified for a particular source file and applies only overall options.
Cancel	Ignores the specified items and closes the dialog.
Help	Opens the Help window.

◊ **Setting option 2** ◊

Figure 2-17. Option 2 Settings Dialog (Assembler)


Assembler Options

○ 1 Option1 ● 2 Option2 ○ 0 Others

sdata/sbss Allocation

☑ Allocate All Data

Size Threshold[-G]: 0

Magic Number

● Unique to Device

○ Common to V850 Family[-cn]

○ Common to V850E Family[-cnv850e]

□ Output Assemble List[-a -l]

□ Do Optimization[-O]

□ Verbose Mode[-v]

□ Suppress Warning[-w]

▨ Use Mask Register[-m]

□ Use New Style Function Call[-f]

("Unique to Device" and "Common to V830 Family[-cn]" in the case of CA830)

(1) Options

sdata/sbss Allocation [-G]

Generates a machine language instruction on the assumption that all data of the specified size (byte) or smaller are allocated to the sdata/sbss-attribute section in response to external label access[17]. If <<Allocate All Data>> is cancelled, input to the text box for specifying the data length is enabled. On the other hand, for data whose sdata option is specified by the .option pseudo-instruction[18], a machine language instruction is generated on the assumption that the data is allocated to the sdata-attribute section or sbss-attribute section regardless of its size.

Magic Number

Specifies magic number of the object. By selecting <<Common to V850 Family>>, objects that are common in the V850 Family are created. Similarly, by selecting <<Common to V830 Family>>, objects that are common in the V830 Family are created. If <<Common to V850E Family>> is selected, common items are limited to the V850E in the V850 Family[19]. * V850

The default is fixed for the device. If fixed for the device, linking to other objects fixed to the device is impossible.

[17] If as is activated from ca at the VSH command line, the -G*num* option specified for ca will be passed even if this option is not specified for as, but only the settings made via this dialog are valid for assembly source files. This does not affect the <<sdata/sbss Allocation>> setting made via the compiler option settings dialog.

[18] Refer to **User's Manual - Assembly Language**.

[19] Refer to page 202.

Output Assemble List [-a -l]

Outputs the assemble list. Unlike the “-a -l” specification for “as” in the VSH command line base, processing of the “-a” in the ca command is executed (refer to page 157). In other words, the assemble list is output to a file whose extension is changed to “.v”.

Do Optimization [-O]

Executes optimization, which rearranges instructions to avoid register and flag hazards. Optimization by assembler is not compatible with the debugger[20]. When the debug mode (-g option) is specified in the Project Manager [Option] → [Debug] specification; the debug mode is ignored if there is a debug information section in the source file. Optimization is ignored and the debug mode is valid if there is no debug information section.

Verbose Mode [-v]

This displays execution status of assembler.

Suppress Warning [-w]

Warning messages are not output when r1 has been specified as the source register or destination register, when r20 or r21 has been specified as a destination register when the mask register function has been used, when r0 has been specified as the destination register, or when r30 has been specified as the destination register for the mul/mulu/div/divu instructions in V830 Family.

Use Mask Register [-m]

Creates an object file having information that the mask register function[21] is used. When <<Use New Style Function Call>> is specified, this option can be specified. It is valid when an assembler source file created with the old version of the C compiler is used.
This option cannot be selected for each source file and is always selected for all source files.

CAUTIONS In an application where both the C source file and assembler source file are used or in an application where only the assembler source file is used to specify checking during linking, [Use Mask Register] must be specified by both the C compiler option and assembler option.

[20] Refer to -g option on page 202.

[21] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

Use New Style Function Call [-f]

Creates an object file having information of “calling function of new version”.
This option is valid when using an assembler source file created with the old version of the C compiler of the V850 Family, or when using the assembler source file created with the old version of the C compiler of the V810 Family in the V830 Family[22].
When this option is specified, specification of [Use Mask Register] is available.
This option cannot be selected for each source file and is always selected for all source files.

CAUTIONS

In an application where both the C source file and assembler source file are used or in an application where only the assembler source file is used, and if this option is not specified and assembly is executed with the calling specifications of the old version when the V850 Family is used, the “Use Old Style Function Call” option must be specified by the C compiler option to reference the library of the old version.

(2) Buttons

OK

Enables the option that was selected via the dialog and closes the dialog.

Delete Source Option

This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager’s <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel

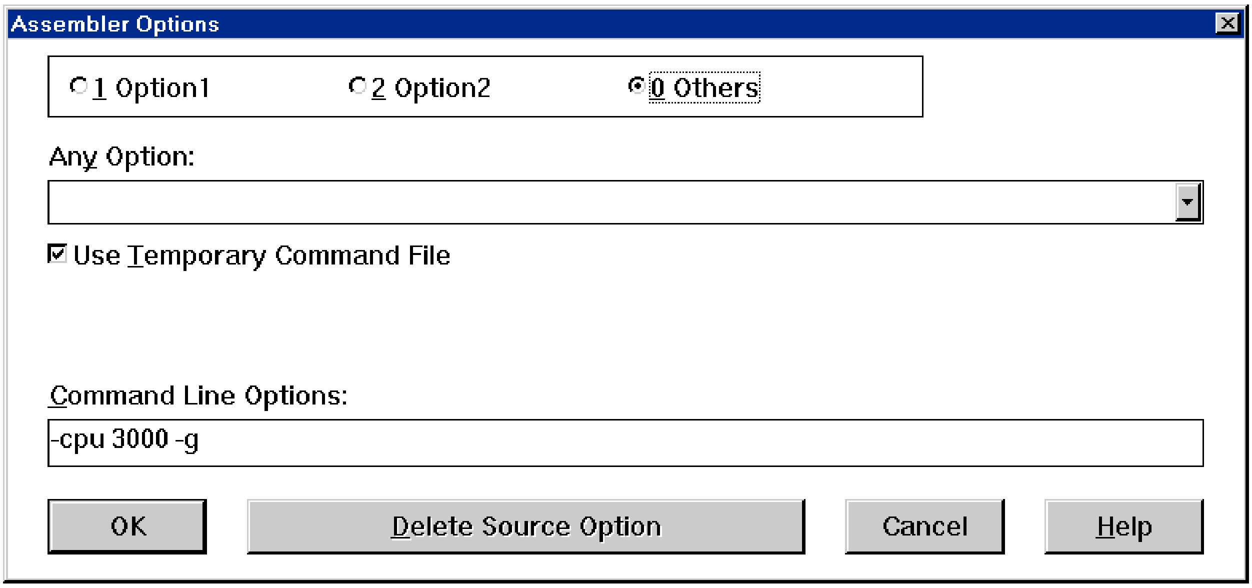
Ignores the specified items and closes the dialog.

Help

Opens the Help window.

[22] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

◊ **Setting other options** ◊



● 0 Others

☑ Use Temporary Command File

Command Line Options: -cpu 3000 -g

Figure 2-18. Other Option Settings Dialog (Assembler)

(1) Options

Any Option

To avoid CPU fault, “-P” option can be described (refer to page 206)[23]. * V850
The other descriptions are not supported at present.

Use Temporary Command File

In the Windows environment, the length of character strings used to specify options for command is restricted (to 126 characters). If this check box is selected, the option character string is temporarily output to a command file (refer to page 161), which enables the operation to be completed without observing the restriction on the character string length.
This option is checked as default assumption.

Command Line Options

Displays assembler options set in each dialog with the command line options. This area is for reference, and writing is disabled.

[23] For whether the fault that has occurred is of the CPU used, refer to the documents supplied with the CPU.

(2) Buttons

OK
Enables the specified items and closes the dialog.

Delete Source Option
This button appears dimmed and cannot be selected when options for the overall project have been specified. It can be selected when options are specified by selecting source files via the Project Manager's <<Source List>> dialog.
When it is selected, this button deletes any options specified for a particular source file and applies only overall options.

Cancel
Ignores the specified items and closes the dialog.

Help
Opens the Help window.

2.5.3 Setting link editor options

The link editor option setting dialog box can be displayed by performing the following operation after a project has been set with the Project Manager.

- Click the Option menu
  → Click Linker Options...

Since the link editor needs to be activated only once per project, there are no file-specific settings.

The names of executable object files that can be output by the link editor is the first filename (minus the extension) shown in the <<Source List>> dialog, to which the extension ".OUT" is added. The output filename cannot be specified (there is no specification method that corresponds to the "-o" specification to activate from the VSH command line).

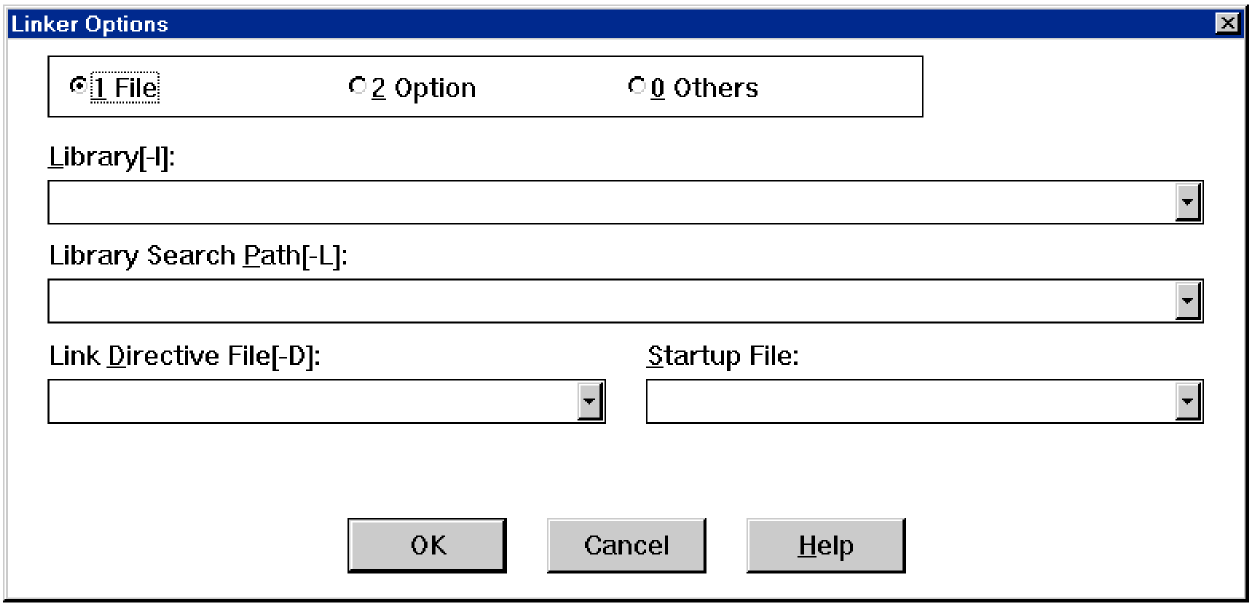
Three option buttons are displayed at the upper part of the link editor option setting dialog. By selecting an option button, the display of dialog is changed.

(1) Option buttons for displaying option setting dialogs

1 File	Opens the dialog box that is used to set the options related to the files to be referenced or linked by the link editor (refer to page 69).
2 Option	Opens the dialog box that is used to set the ordinary options of the link editor (refer to page 71).
0 Others	Opens the dialog box that is used to set the other parameters (refer to page 74).

◊ **Setting files** ◊

Figure 2-19. File Settings Dialog



(1) Options

Library [-l]	Specifies the "*string*" portion of the archive file (library file) lib*string*.a to be accessed. When specifying several files, separate each name with a semicolon (such as "m;usr"). This area uses the "drop-down list" type of display to list all libraries that have been specified once (up to 10 libraries). To select a library, either click the desired library or use the arrow keys to select it. The specified archive file is searched from the standard directory[24] of the directory or library specified by <<Library Search Path>>. The link editor outputs no message and continues linking even if the specified file is not found.

CAUTIONS The standard library ("c") is referenced as default assumption even if it is not specified.

[24] Install directory \libxxx and install directory \libxxx\r32.

Library Search Path [-L]

Specifies the directory where the archive file (library file) to be accessed is stored. When specifying several libraries, separate each name with a semicolon “;”.

This area uses the “drop-down list” type of display to list all directories that have been specified once (up to 10 directories). To select a directory, either click the desired directory or use the arrow keys to select it.

If a directory is specified by this option, the library is searched from the specified directory before the standard directory of the library. If two or more libraries are specified, the library is searched in the sequence in which they have been specified in the text box.

Link Directive File [-D]

This specifies the link directive file to be accessed (refer to page 254). This area uses the “drop-down list” type of display to list all directive files that have been specified once (up to 10 files). Either click the desired directive file or use the arrow keys to select it.

Startup File

This specifies the start-up module’s file[25]. When creating a final object file via the build/rebuild function (in other words, in cases other than when creating a file whose target specification in building is “.o file”), if this start-up file specification is omitted, the supplied start-up module[26] is linked.

This area uses the “drop-down list” type of display to list all files that have been specified once (up to 10 files). Either click the desired file or use the arrow keys to select it.

CAUTIONS

If the path is not specified in the link directive file or start-up module, “project directory” that is specified during project creation is searched. If the file locates in other directory path, specify the absolute path name or relative path name from the project directory.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Cancel

Ignores the specified items and closes the dialog.

Help

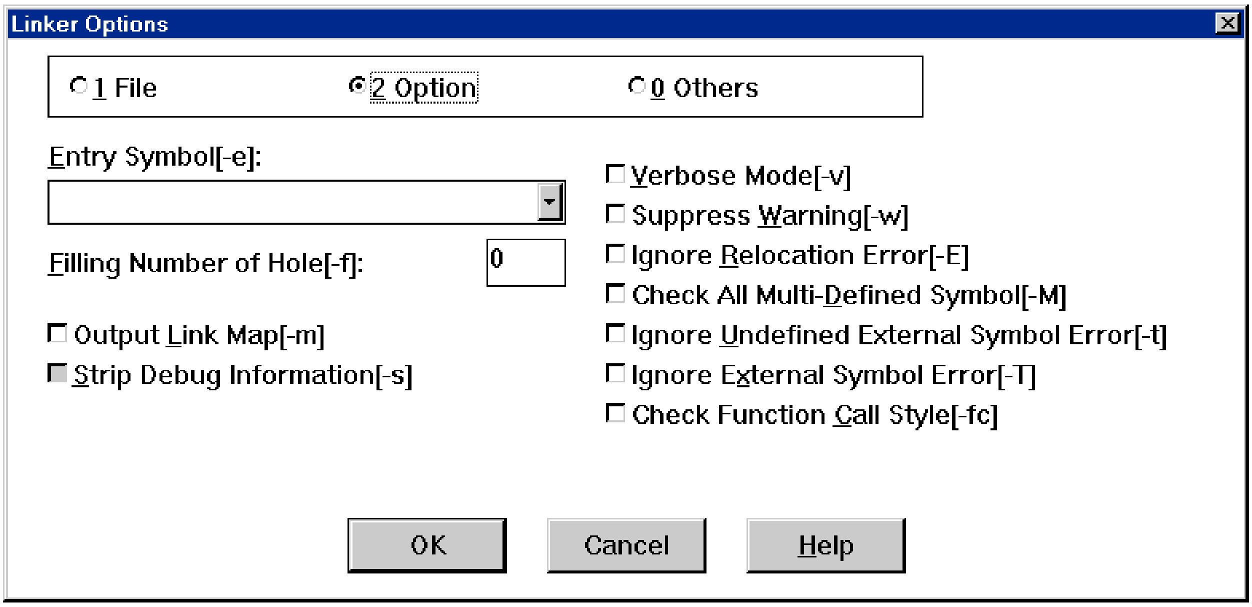
Opens the Help window.

[25] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

[26] Install directory \libxxx\ rxx\crtN.o

◊ **Setting options** ◊

Figure 2-20. Option Settings Dialog (Link Editor)



Linker Options

○ 1 File ● 2 Option ○ 0 Others

Entry Symbol[-e]:

Filling Number of Hole[-f]: 0

□ Output Link Map[-m]

▨ Strip Debug Information[-s]

□ Verbose Mode[-v]

□ Suppress Warning[-w]

□ Ignore Relocation Error[-E]

□ Check All Multi-Defined Symbol[-M]

□ Ignore Undefined External Symbol Error[-t]

□ Ignore External Symbol Error[-T]

□ Check Function Call Style[-fc]

(1) Options

Entry Symbol [-e]

Use this text box to specify a symbol to be set as the entry point address. If the specified symbol is not found, the link editor outputs a message and stops linking.

This area uses the “drop-down list” type of display to list all symbol names that have been specified once (up to 10 symbol names). Either click on the desired symbol name or use the arrow keys to select it.

If this option is not specified, the entry point address value is determined by the following rules.

- Value of symbol `_start` if the symbol exists.
- The first address of the text-attribute section allocated to the lowest part in the object file created if symbol `_start` does not exist.
- 0 if the text-attribute section does not exist.

Filling Number of Hole [-f]

Specifies the filling value of a hole to be created as a 4-digit hexadecimal number (2 bytes). Specification by this option takes precedence over the filling value specified by the link directive file (refer to page 254).

Specify a filling value according to the following rules.

- If the value is of less than 4 digits, prefix as many 0 as required.
- If the size of the hole is less than 2 bytes, take out the necessary number of the low-order digits from the specified filling value.
- If the filling value is omitted, the default value is 0x0000.

Output Link Map [-m]

Outputs a link map (refer to page 318) that shows the allocation of memory space in the input and output sections.

Strip Debug Information [-s]

Creates an object file without the debug information, line number information, and global pointer table. This option can be specified only in the non-debug mode. If Debug is selected from the Option menu, this option appears dimmed and cannot be specified.

Verbose Mode [-v]

Displays the execution status of link editor.

Suppress Warning [-w]

Suppresses output of warnings. Only messages concerning fatal errors will be output.

Ignore Relocation Error [-E]

Ignores errors relating to relocation. When the value resulting from an address calculation for an undetermined external reference is judged as invalid, that value is not entered (i.e. is ignored) and the previous value is left in place.

- The value of the result of address calculation which has been judged invalid is not entered for unresolved external reference that is judged as an error, and the original value remains.
- If this option is omitted, linking is stopped.

Check All Multi-Defined Symbol [-M]

Outputs a message describing all external symbols that have duplicate definitions and stops linkage. If this option is not specified, a message describing only the first external symbol with a duplicate definition that is encountered is output and linkage is stopped.

Ignore Undefined External Symbol Error [-t]

Ignores checking the size and sequence requirements for linkage of undefined external symbols. If this option is omitted, the symbol size and alignment condition are checked. If a difference is found, a warning message is output and linking continues.

! CAUTIONS

The link editor supports multiple definition of undefined external symbols. The defined multiple external symbols are allocated to the .sbss or .bss section after they have been linked. If the symbol size or alignment condition of the symbols to be linked differ, the maximum size of the symbols to be linked is used as the size and the least common multiple of the alignment condition is used as the alignment condition.

Ignore External Symbol Error [-T]

This suppresses checking size when linking undefined external symbols. If this option is omitted, the size is checked. If a difference in size is detected, a warning message is output and linking continues. At this time, the symbol size of a file for which a symbol is actually defined is valid.

Check Function Call Style [-fc]

Checks whether the calling specifications[27] of the old version and the calling specifications of the new version do not exist in mix in all input object files. If this option is not specified, only the object file created from the C source file is checked.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Cancel

Ignores the specified items and closes the dialog.

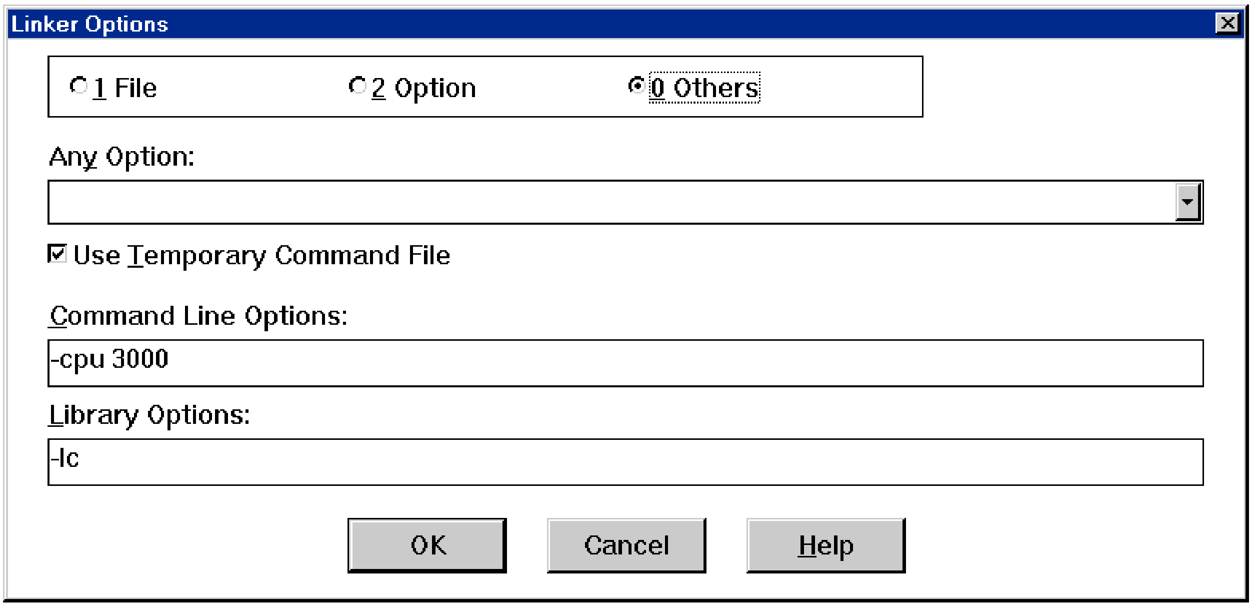
Help

Opens the Help window.

[27] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

◊ **Setting other options** ◊

Figure 2-21. Other Option Settings Dialog (Link Editor)



○ 1 File ○ 2 Option ● 0 Others

Any Option:

☑ Use Temporary Command File

Command Line Options:

-cpu 3000

Library Options:

-lc

(1) Options

Any Option

This is not supported at present.

Use Temporary Command File

In the Windows environment, the length of character strings used to specify options for command is restricted (to 126 characters). If this check box is selected, the option character string is temporarily output to a command file (refer to page 161), which enables the operation to be completed without observing the restriction on the character string length.
This option is checked as default assumption.

Command Line Options

Displays link editor options (excluding library-related options) set in each dialog with the command line options. This area is for reference, and writing is disabled.

Library Options

Displays library-related options set in the file option dialog with the command line options. This area is for reference, and writing is disabled.

(2) Buttons

OK	Enables the specified items and closes the dialog.
Cancel	Ignores the specified items and closes the dialog.
Help	Opens the Help window.

2.5.4 Setting ROM-storing processor options

The ROM-storing processor option setting dialog box can be displayed by performing the following operation after a project has been set with the Project Manager.

- Click the Option menu
  → Click ROM Processor Options...

Since the ROM-storing processor needs to be activated only once per project, there are no file-specific settings.

The name of executable object file that can be output by the ROM-storing processor is the first filename (minus the extension) shown in the <<Source List>> dialog, to which the extension ".OUT" is added, and is the same object file name output by the link editor. The ROM-storing processor is started up by the Project Manager only when <<Create Object for ROM>> has been specified as a C compiler option. At that time, the object file output by the link editor is a temporary file which is deleted when the ROM-storing processor is terminated.

The output object file name cannot be specified (there is no specification method that corresponds to the "-o" specification to activate from the VSH command line).

Two option buttons are displayed at the upper part of the ROM-storing processor option setting dialog. By selecting an option button, the display of dialog is changed.

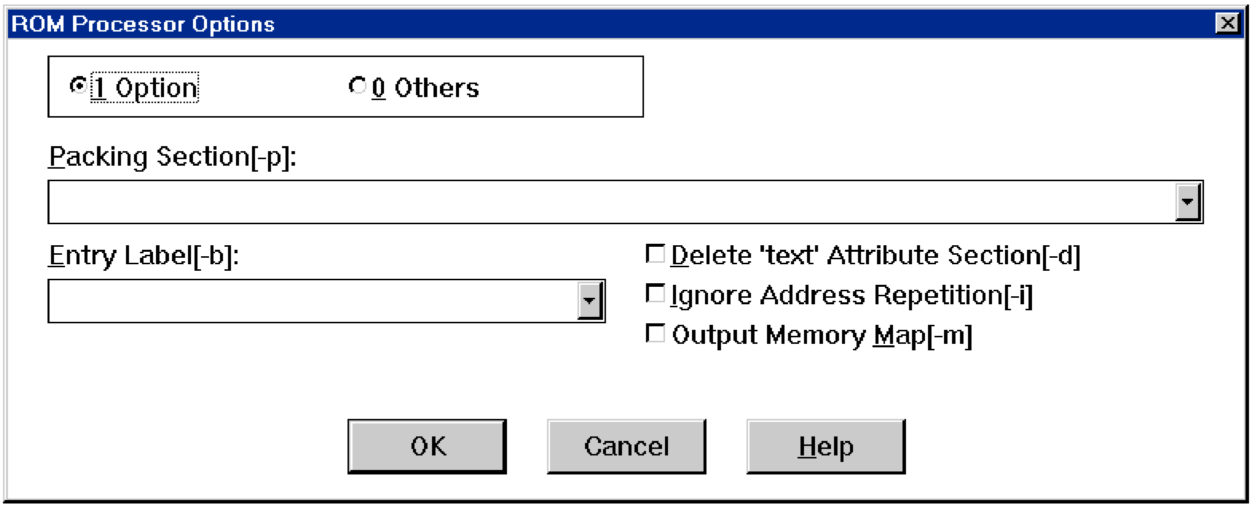
(1) Option buttons for displaying option setting dialogs

1 Option — Opens the dialog box that is used to set the ordinary options of the ROM-storing processor (refer to page 77).

0 Other — Opens the dialog box that is used to set the other parameters (refer to page 79).

◊ **Setting options** ◊

Figure 2-22. Option Settings Dialog (ROM-Storing Processor)



ROM Processor Options

● 1 Option ○ 0 Others

Packing Section[-p]:

Entry Label[-b]:

□ Delete 'text' Attribute Section[-d]

□ Ignore Address Repetition[-i]

□ Output Memory Map[-m]

(1) Options

Packing Section [-p]

The contents of the specified section and the corresponding address and size data are entered in the rompsec section. If the specified section does not exist in the object file, a message is output and processing is stopped. If this option is omitted, it is assumed that all sections that contain a data attribute or sdata attribute have been specified. In addition, for the CA830, the text-attribute section for the interrupt allocated to on-chip instruction RAM and the .itext section is also assumed as being specified.

When several sections have been specified, use a semicolon (;) to separate the specified sections. The specified sections are entered to the rompsec section in the order they were specified.

This area uses the "drop-down list" type of display to list all sections that have been specified once (up to 10 sections). Either click on the desired section or use the arrow keys to select it.

Entry Label [-b]

The specified label value is used as the first address of the created rompsec section. If the specified label does not exist in an object file, a message is output and processing is stopped.

If this option is omitted, it is assumed that __S_romp has been specified.

This area uses the "drop-down list" type of display to list all labels that have been specified once (up to 10 labels). Either click on the desired label or use the arrow keys to select it.

Delete ‘text’ Attribute Section [-d]
This creates an object file that contains only a rompsec section, without entering a section that contains a text attribute in the created file.
If this option is omitted, a section that contains a text attribute is entered.

Ignore Address Repetition [-i]
A duplication check is not performed between the addresses of input files and output files.

Output Memory Map [-m]
A memory map of the created object file is output to standard output.

(2) Buttons

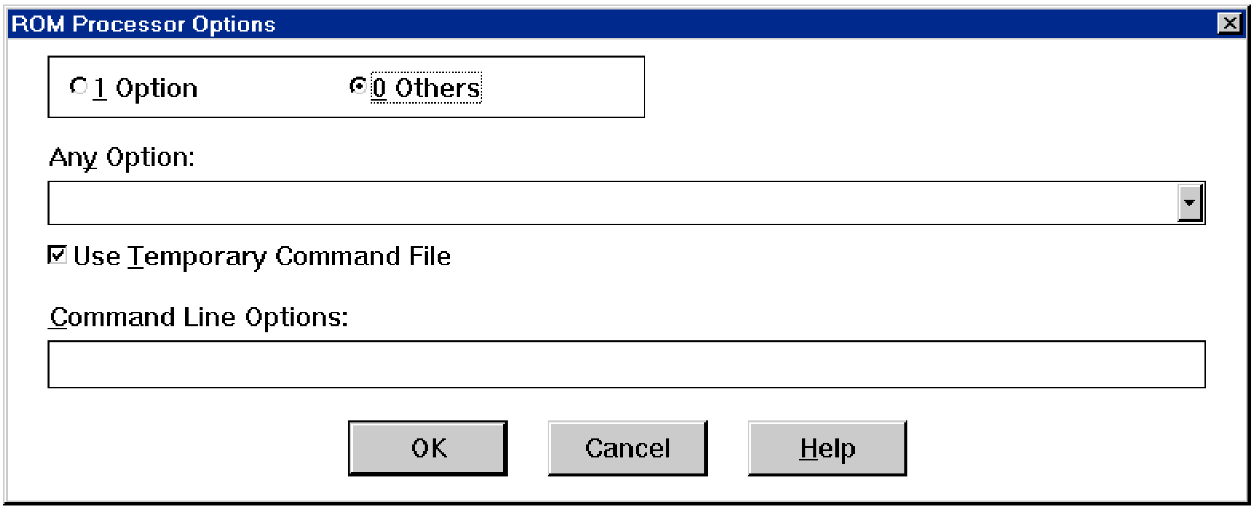
OK
Enables the specified items and closes the dialog.

Cancel
Ignores the specified items and closes the dialog.

Help
Opens the Help window.

◊ **Setting other options** ◊

Figure 2-23. Other Option Settings Dialog (ROM-Storing Processor)



ROM Processor Options

○ 1 Option ● 0 Others

Any Option:

☑ Use Temporary Command File

Command Line Options:

(1) Options

Any Option

This is not supported at present.

Use Temporary Command File

In the Windows environment, the length of character strings used to specify options for command is restricted (to 126 characters). If this check box is selected, the option character string is temporarily output to a command file (refer to page 161), which enables the operation to be completed without observing the restriction on the character string length.
This option is checked as default assumption.

Command Line Options

Displays ROM-storing processor options set in each dialog with the command line options. This area is for reference, and writing is disabled.

(2) Buttons

OK

Enables the specified items and closes the dialog.

Cancel

Ignores the specified items and closes the dialog.

Help

Opens the Help window.

2.6 Creating and Building Make Files

The Project Manager can be used to create make files that incorporate the options specified in each dialog of the C compiler, assembler, link editor, or ROM-storing processor by a menu.

When build of the application load module is specified, the building starts after creating the make file automatically.

For details of the menu items or the build function, refer to **Project Manager User's Manual**.

2.6.1 Using menu to create make files

The following operation will create a make file from a menu of the Project Manager.

- Click the Project menu
  → Click Make a Make File Ctrl+M

If the information required for creating a make file has not been set, the menu item Make a Make File Ctrl+M appears dimmed and cannot be selected.

When Make a Make File Ctrl+M has been selected, a make file is generated based on the option information set via the CA command's option dialog.

While the make file is being generated, the message "Generating make file" is displayed in the status bar, and once the make file has been generated, the status bar message changes to "Make file generation completed."

The filename of the generated make file is "projectname + .MAK". In addition to the make file, another file named "projectname + .SDB" is simultaneously generated for managing information related to the source file.

2.6.2 Auto generation of make file via build function

Make files can be automatically generated by executing “build” from the Project Manager. There are three types of “build” specifications: “build”, “rebuild”, and “build specified target”.

(1) Build

Build can be selected via either of the following operations.

- Click the Run menu
  → Click Build Ctrl+B
- Click the button

When this build function is selected, a make file is generated in the same way as when Make a Make File Ctrl+M is selected. Depending on the make file generated by the build function, C compiler, assembler, link editor, or ROM-storing processor is executed and an executable object file is created as the make target.
A window <<PRJTMAKE>> displaying the build execution conditions and status is opened, and this is where any error messages output by the CA command are displayed. The contents shown in this window are output to a file in the project directory called “(projectname).PLG.”

To abort build, click the “!” mark button in the execution display window <<PRJTMAKE>>, or click the Run menu and Stop Build in the Project Manager.

(2) Rebuild

The rebuild function can be selected via the following operation.

- Click the Run menu
  → Click Rebuild

When the rebuild function is selected, a make file is generated and all objects that are make targets are newly generated. This function is the same as the build function except that make files are generated unconditionally, i.e., regardless of whether or not the source files and option settings have been changed.

(3) Build specified target

This function can be selected via the following operation.

- Click the Run menu
  → Click Build Target...
  → Click target for build using the displayed dialog.
  → Click Build

When “build specified target” has been selected, a make file is generated and only the make target that has been specified (among the several make targets) is newly generated. This function is the same as the build function except that only the specified target is generated unconditionally.

CHAPTER 3 USE OF COMMAND SHELL

This chapter describes how to operate the VSH command shell and activate the VSH internal command and CA command.

3.1 What is VSH?

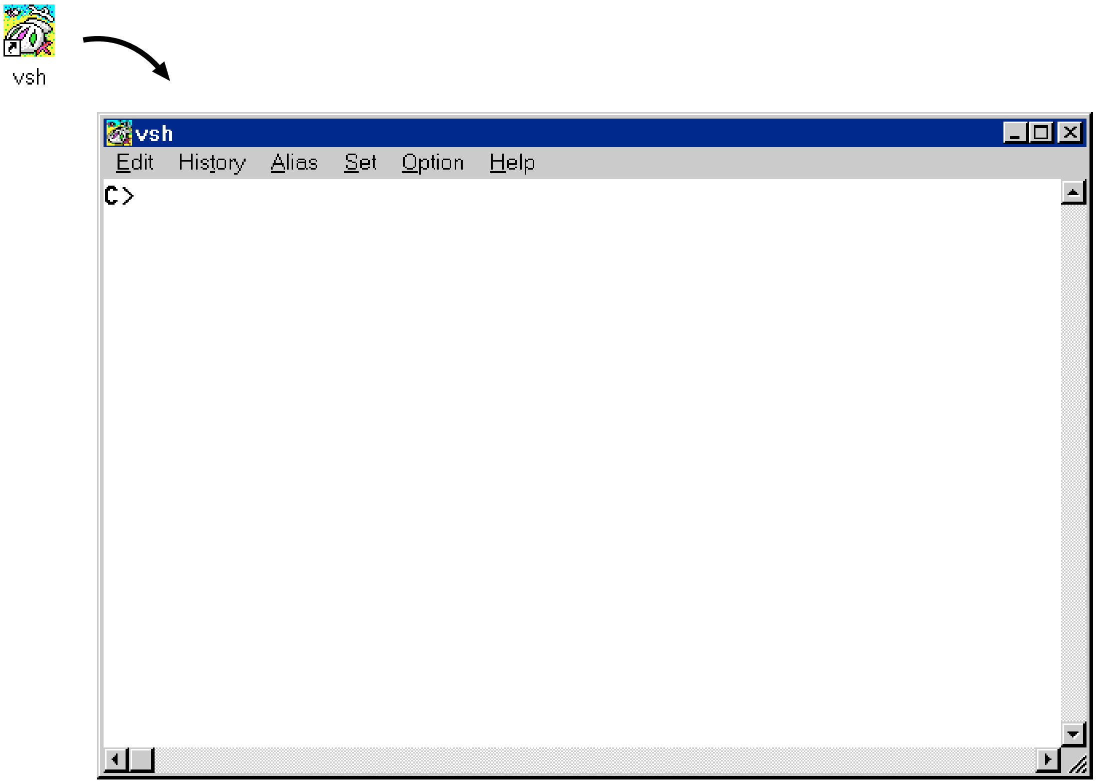
VSH is a utility that is provided for activating the CA commands, which are applications, by the command line interface on Windows.

Activate VSH on the Windows to open the VSH window, and the CA commands, internal commands of VSH, and execution commands of Windows can be used on the command line.

3.2 Activation of VSH

To activate VSH, click the VSH icon twice that was registered when this compiler package was installed.

Figure 3-1. VSH Window



```
C>
```

It is not possible to activate more than one VSH shell at the same time.

3.3 Function of VSH

VSH includes the following features.

- Enables command line editing
- Enables displays that can be scrolled vertically and horizontally
- Includes a history function to recall previous input
- Includes an alias function to assign aliases for command names
- Supports 31 types of internal commands (refer to page 102)
- Supports commands from MS-DOS applications that include Windows-type executable files and PIF (program information files) as external commands

Note that although VSH is a shell like a command.com of MS-DOS, it is a Windows-based utility, which means that MS-DOS commands cannot be activated directly from the VSH shell.

3.3.1 Command line editing function

When the VSH window is displayed, internal commands, execution commands of Windows, and CA commands can be input via the command line interface at the blinking cursor position.

From the VSH window, ordinary character keys and several edit keys can be used for command line editing. Table 3-1 lists the edit keys.

CAUTIONS

- Command line editing's scope is limited to the client area. Therefore, it is not possible to edit beyond the client area.
- If the window is resized during an editing operation, the editing operation will be cancelled.

Table 3-1. Edit Key Lists

Keys	Function
← , CTRL + B	Moves character cursor one character forward.
→ , CTRL + F	Moves character cursor one character backward.
BS , CTRL + H	Deletes the character before the character cursor position.
DEL , CTRL + D	Deletes the character at the character cursor position.
CTRL + K	Deletes all characters from the character cursor position to the end of the current line.
INS	Toggles between insert and overwrite modes. When in insert mode, the character cursor is the same size as the characters and when in overwrite mode the character cursor is an underscore mark. When the VSH is activated, insert mode is set.
HOME , CTRL + A	Moves the character cursor to the start of the current line.
HELP , CTRL + E	Moves the character cursor to the end of the current line.

3.3.2 Scroll functions

(1) Vertical scroll

When the display of the entered command line or command output cannot fit in the client area, a vertical scroll bar appears in the VSH window so that the display can be scrolled back to view previous output. When scrolling back, the character cursor is temporarily deleted. Pressing a character key or edit key returns the display to the original position to enable ordinary input and editing operations.

The vertical scroll bar can also be operated from the keyboard.

Table 3-2 lists the scroll keys.

Table 3-2. Keys for Operating Vertical Scroll Bar

Keys	Function
↓	Scrolls one line downward
↑	Scrolls one line upward
ROLL DOWN	Scrolls one page downward
ROLL UP	Scrolls one page upward
CTRL + HOME	Scrolls to top of scroll area
CTRL + HELP	Scrolls to bottom of scroll area

(2) Horizontal scroll

When the entire width of the contents cannot be displayed in the window, such as when the window is resized to a narrower width, a horizontal scroll bar appears in the VSH window to enable the hidden contents to be viewed.

When scrolling backward, the character cursor is temporarily deleted. Pressing a character key or edit key returns the display to the original position to enable ordinary input and editing operations.

The horizontal scroll bar cannot be operated from the keyboard.

3.3.3 History function

The history function enables commands previously input from the command line to be recalled and reactivated.

This function can be executed from the keyboard or via a menu.

The following describes the keyboard operation for executing this function. The menu-based operation is described in page 90.

Table 3-3 lists the keyboard operations.

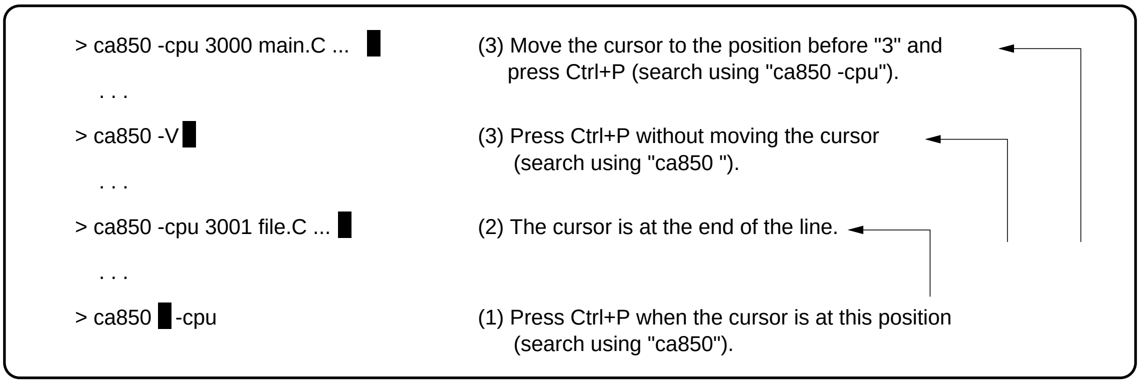
Table 3-3. Keys for Operating History Function

Keys	Function
CTRL + P	Displays the history contents. If the character cursor is at the start of the command line, the immediately previous command input contents are shown. If the character cursor is not at the start of the command line, the same command input contents in which the character cursor is at the start of the command line are selected from among the previous command input contents listed in the history information.
CTRL + N	This shows the next command input contents in the history information. This operation can be used when the user has gone back beyond the desired command input contents in the history information. If the character cursor is at the start of the command line, the next command input contents are displayed. If the character cursor is not at the start of the command line, the same command input contents in which the character cursor is at the start of the command line are selected from among the next command input contents listed in the history information.

When searching the history information for command input contents in which the character cursor is not at the start of the command line, when the target history information is found it is displayed with the character cursor at the end of the command line.

In subsequent searches, if the character cursor position is not moved, the character string range used in the subsequent search operation will be the same range as was used in the previous search rather than the character string that goes to the end of the line. If the character cursor position is moved, the range of characters over which it was moved becomes the character string that is used in the subsequent search.

Figure 3-2. History Search Examples



```
> ca850 -cpu 3000 main.C ... █
   . . .
> ca850 -V█
   . . .
> ca850 -cpu 3001 file.C ... █
   . . .
> ca850 █-cpu
```

(3) Move the cursor to the position before "3" and press Ctrl+P (search using "ca850 -cpu").

(3) Press Ctrl+P without moving the cursor (search using "ca850 ").

(2) The cursor is at the end of the line.

(1) Press Ctrl+P when the cursor is at this position (search using "ca850").

3.3.4 Alias function

The alias function enables other names (aliases) to be established for commands (including arguments). Frequently used commands thus can be activated using abbreviated character strings.

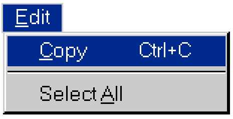
Aliases are set up via menus. The setup method is described in page 91.

3.3.5 Menus

This section describes the menus supported by the VSH window.

(1) Edit

Edits the line displayed on the VSH command line.



Copy Ctrl+C

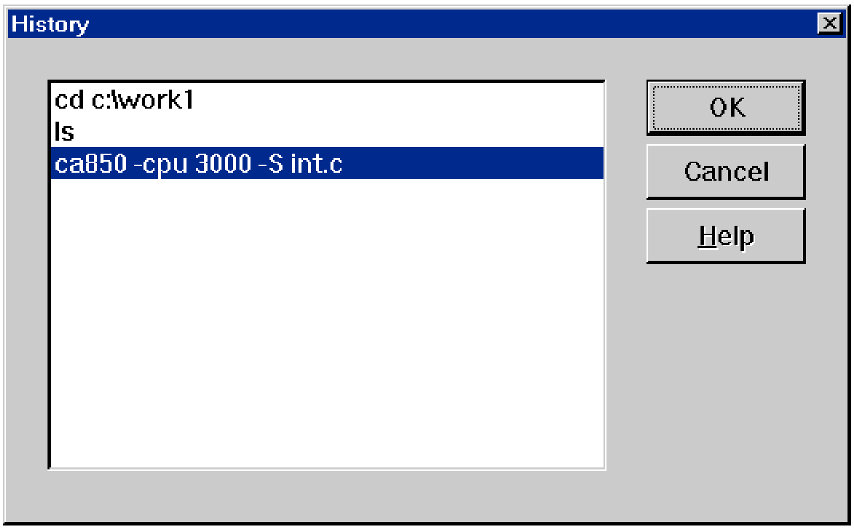
Copies the selected portion to the clipboard. This option is valid when any line is selected on the command line.

Select All

Select all the lines displayed on the VSH.

(2) History

Opens a dialog box to display the history information.



```
cd c:\work1
ls
ca850 -cpu 3000 -S int.c
```

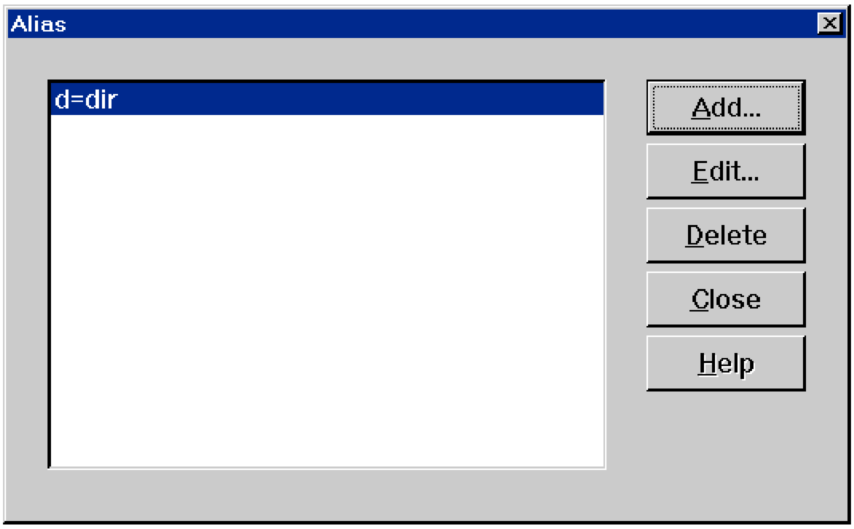
Operation

To select history information...

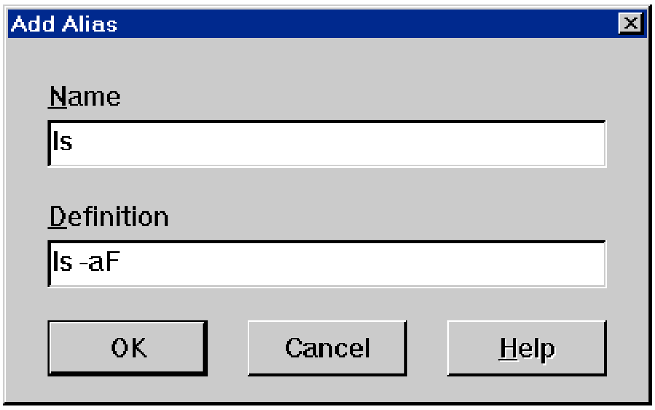
Double-click a history information (to highlight) or select it to click the OK button. The dialog box is closed and the selected history item is displayed on the command line. Click Cancel to close the dialog box without selecting the history item.

(3) Alias

Opens a dialog box to display a list of aliases.



Add... Opens the dialog box for setting up aliases.



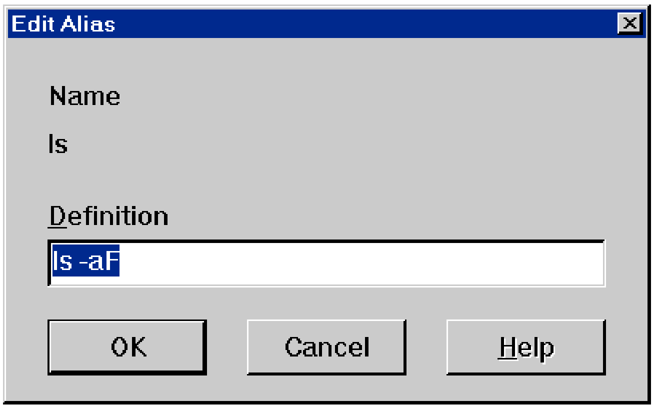
Name

ls

Definition

ls -aF

Edit... After clicking the item to be changed from among the items listed, click the Edit... button to open the dialog box for changing the name.



Name

ls

Definition

ls -aF

Delete	Click this button to delete the highlighted alias.
Close	Click this button to confirm the displayed alias and close the alias dialog.
Help	Opens the Help window.

Operation

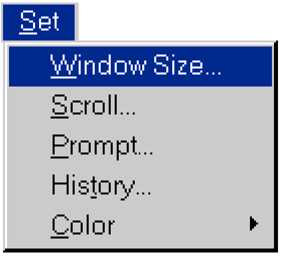
When setting up an alias...

In the dialog box opened via the Add... button, which is in the dialog box that had been opened via the Alias menu, enter an alias in the text box under <<Name>> and enter the corresponding command (including arguments) in the text box under <<Definition>>. Click the OK button to set the alias and close the dialog box.
In the dialog box opened via the Edit... button, enter corresponding command (including arguments) in the text box under <<Definition>>. Click the OK button to set the alias and close the dialog box.
Click the Cancel button to close the dialog box without making a selection.

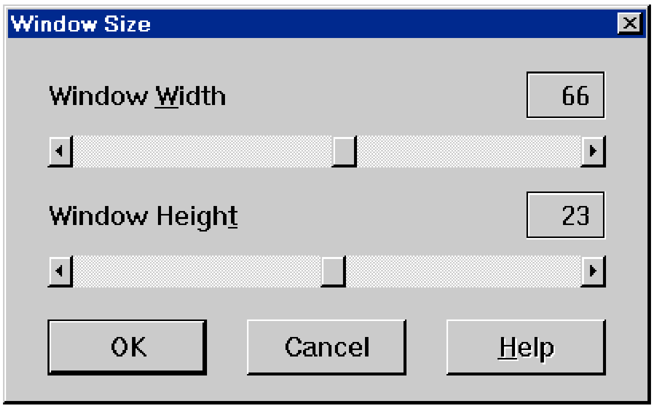
CAUTIONS

- Alias specifications are case-sensitive.
- To use an existing alias instead of entering a new alias, enter a blank space at the start of the text box.

(4) Set



Window Size... Opens the dialog box for setting the window size.



Window Width 66

Window Height 23

Operation

To change the VSH window size...

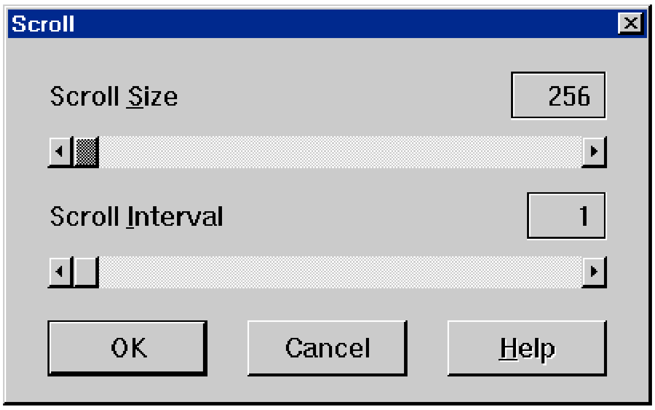
Drag the width/height scroll button to the desired setting. Or, from the keyboard, use arrow keys to change the setting incrementally. The unit of measurement is the number of characters. Click the OK button to change the VSH window size and close the dialog box. Click the Cancel button to close the dialog box without changing the VSH window size.

CAUTIONS

If the VSH window size has been maximized, its size cannot be changed via this dialog box.

Scroll...

Opens the dialog box for setting the number of lines to scroll backward and for setting the scroll interval.



Operation

To set up scrolling...

Drag the scroll button used for the scroll size and interval to the desired setting. Or, from the keyboard, use arrow keys to change the setting incrementally. The unit of measurement is the number of lines.

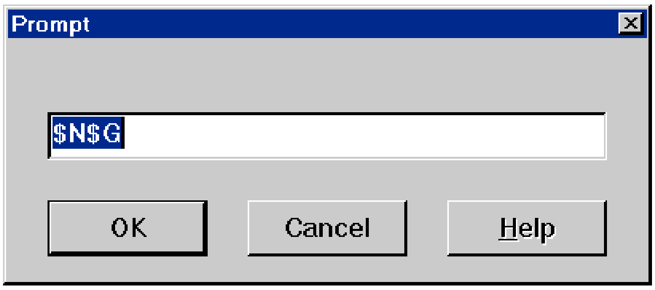
Click the OK button to change the scrollable number of lines and the scroll interval before closing the dialog box. Click the Cancel button to close the dialog box without making any changes.

CAUTIONS

These scroll settings are ignored when copying or moving an internal command or when executing an external command. In such cases, scrolling is always one line at a time.

Prompt...

Opens the dialog box for changing the VSH window's prompt.



NG

Operation

To change the prompt...

Enter a character string from the keyboard to the dialog box's command line.

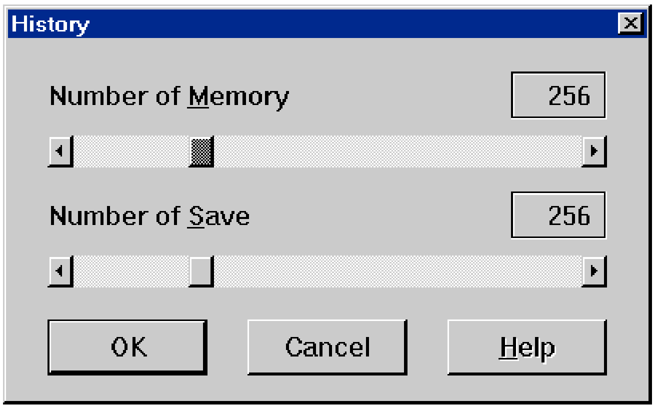
Click the OK button to change the prompt and close the dialog box. The new prompt will be shown starting from the next input line. Click the Cancel button to close the dialog box without changing the prompt.

In addition to ordinary characters such as alphanumeric characters, the character string can include special character strings that automatically convert to other meanings. Special character strings are listed below. The default character string is "NG".

$$	:	"$" character
$B	:	"|" character
$D	:	Current date (according to computer)
$G	:	">" character
$H	:	Backspace
$L	:	"<" character
$N	:	Current drive
$P	:	Current directory in current drive
$Q	:	"=" character
$T	:	Current time (according to computer)

History...

Opens the dialog box for setting the history memory size (the maximum number of commands to be shown in the history information in VSH activated) and the history save size (the number of histories to be saved to activate VSH next time) (refer to page 90).



Number of Memory 256

Number of Save 256

Operation

To set the memory size...

Drag the scroll button to the desired setting. Or, from the keyboard, use arrow keys to change the setting incrementally. The unit of measurement is the number of commands. Click the OK button to change to the specified memory size and close the dialog box. Click the Cancel button to close the dialog box without making any changes.

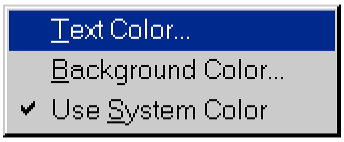
Operation

To set the save size...

Drag the scroll button to the desired setting. Or, from the keyboard, use arrow keys to change the setting incrementally. The unit of measurement is the number of commands. However, more histories than the number of histories specified by memory size cannot be saved. Click the OK button to change to the specified save size and close the dialog box. Click the Cancel button to close the dialog box without making any changes. To actually save histories, it is necessary to select <<Save Exit Status>> from the Option menu and then <<Save History>> (refer to page 97).

Color

Sets character color and background color.

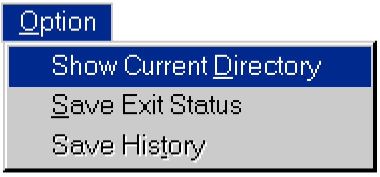


If use of the system color is selected, however, the specified character color and background color are not used, but the system color of Windows is used. If use of the system color is selected, "√" mark appears. Use of the system color is specified in toggle mode (i.e., the system color is alternately selected and cancelled each time the button is clicked).

(5) Option

The option menu executes the commands related to display of VSH. A check mark "√" is shown to the left of commands displayed in a language other than English, when they are displayed.

These commands are toggled (switched between select/cancel modes).



Show Current Directory

This displays the current directory name in the title bar.

Save Exit Status

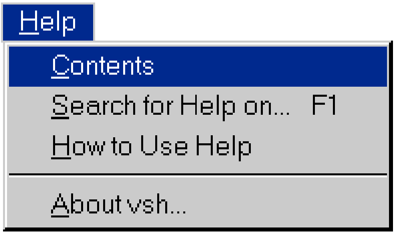
Saves settings such as the window size/position settings when exiting. The same settings will be used the next time the window is opened.

Save History

Saves the history. When VSH is activated next time, the current history contents are saved by the number specified on the setting menu. This can be set only when <<Save Exit Status>> is set.

(6) Help

Uses the help function. For details of using Windows-based help functions, refer to **Microsoft Windows Operating System Function Guide**.

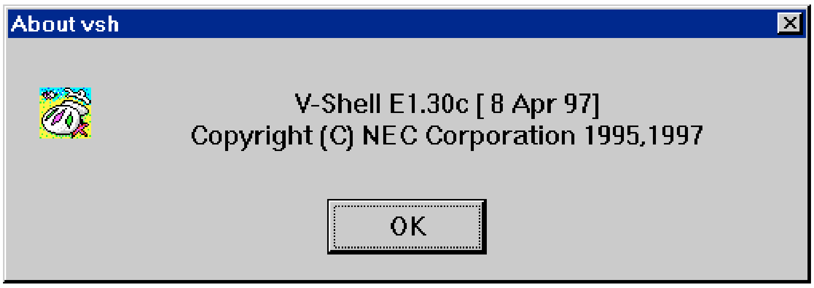


Contents — Displays a list of help topics.

Search for Help on...   F1 — Opens a dialog box to search for a particular topic.

How to Use Help — Opens descriptions of how to use the help function. Select this item when first using the on-line help function.

About vsh... — Opens a dialog box displaying the VSH version and copyright information[28].



V-Shell E1.30c [8 Apr 97]
Copyright (C) NEC Corporation 1995,1997

[28] This dialog is just an example; it does not show the actual version number.

3.4 Activation of Commands from VSH

This section describes the VSH particular methods for activating various commands from the command line.

In this description, operations are divided into three categories: (1) operations related to internal commands only, (2) operations related to external commands only, and (3) operations relating to internal commands, external commands, and CA commands.

See the Windows Manual concerning operations relating to external commands that are not covered in this chapter. For operations relating to CA commands that are not covered in this chapter, see the various command descriptions in Volume 3 and subsequent volumes.

3.4.1 Operations related to internal commands only

(1) Delimiters for options and directories

In internal commands, options are preceded by "/", "-", or "+".

Option specifications that begin with "/" are not case-sensitive but those (except ATTRIB) that begin with "-" or "+" are case-sensitive.

When specifying a command that does not have any option specifications that begin with "/", "/" can be used as the delimiter for directories.

(2) Option specification sequence

The sequence in which options for internal commands are specified is not significant unless otherwise stated in a caution note.

If a function activated by an option specification conflicts with another function, only the most recently specified option is valid.

(3) Wild cards

"Wild cards" can be used when specifying file names in cases where the internal command can be specified for several files.

This "wild card" function is the same as that implemented in MS-DOS.

*	...	Indicates "any character string"
?	...	Indicates "any single character"

3.4.2 Operations related to external commands only

(1) Command input method

Executable files that operate under Windows and PIF files (with .pif extension) that operate under MS-DOS can be specified as external commands.

Specifications are not case-sensitive. Also, “/” can be used as the delimiter for directories.

The input format for external commands is shown below[29].

```
[drive_name:] [path_name] filename [ △ command_parameters]...
```

3.4.3 Operations related to all commands

(1) Forced termination of command execution

During the execution of a command from VSH, if a mouse pointer is displayed in the VSH window, pressing the following keys will force termination of the command being executed.

PC-9800 Series	:	STOP , CTRL + C
IBM PC/AT compatibles	:	Ctrl + Break , Ctrl + C

For a table of correspondences with keys in other types of computers, see the Windows Manual.

(2) Temporary pause of command output

During the execution of a command from VSH, if a mouse pointer is displayed in the VSH window, pressing the following keys will temporarily pause output to the VSH window from the command being executed. This output can be restarted by pressing the same key again.

PC-9800 Series	:	CTRL + S
IBM PC/AT compatibles	:	Ctrl + S

For a table of correspondences with keys in other types of computers, see the Windows Manual.

[29] The contents in brackets can be omitted. △ indicates one or more blank spaces.

(3) Command files

Files that are specified directly after parameters that begin with "@" are handled as command files. However, use of command files is not possible for the ECHO command.

For details of command files, refer to the description on page 161.

(4) Redirect

The following specification methods redirect the contents output by a command to VSH so that those contents can be handled as a file.

>filename	...	The contents output to VSH are output to the file specified by "filename" as contents beginning at the start of the file.
>>filename	...	The contents output to VSH are output to the file specified by "filename" as contents appended to the end of the file.

Note that input redirect and pipe operations are not supported.

Example:

```
A> ca830 -cpu 5100 -lm -v file.c > logfile      ← ca830's output contents are output to logfile
```

Note that, within VSH, there is no distinction in output between standard output and standard error output. Therefore, when redirecting output contents to a file, the command output may become mixed with messages. To avoid mixing the command output and messages, such as when using "hx", specify an output destination with command option instead of using the redirect operation (refer to page 138).

(5) Windows-based device files

"NUL" is supported as a device file[30], which is when a peripheral device is handled as a file. Other device file names are not supported.

When specifying "NUL", the command's output contents are not output to any destination.

[30] In this case, device files indicate destinations for input and output under Windows, and thus these device files are different from devices files that are "machine-dependent data files" read by ca.

3.5 VSH Internal Commands

This section describes the functions of VSH internal commands.
Table 3-4 contains a list of internal commands.

Table 3-4. List of VSH Internal Commands

Command	Description	Page
ATTRIB	Change/view file attributes	104
CAT	Concatenate files	105
CD	Change/display current directory	106
CHDIR	Change/display current directory	107
COPY	Copy file	108
CP	Copy file	109
DATE	Display date	110
DEL	Delete file	111
DELTREE	Delete file/directory	112
DIR	Display file list	113
DIRS	Display directory stack	115
DUMP	File binary dump	116
ECHO	Display character string	117
ERASE	Delete file	118
EXIT	Exit VSH	119
LS	Display file list	120
MD	Create directory	121
MKDIR	Create directory	122
MOVE	Move file	123
MV	Move file	125
POPD	Pop directory stack	126
PUSHD	Save/push directory stack	127
PWD	Display current directory	128
RD	Remove directory	129
REN	Rename file	130
RENAME	Rename file	131
RENDIR	Rename directory	132
RM	Remove file	133
RMDIR	Remove directory	134
TIME	Display time	135
TYPE	Display contents of text file	136

These commands are described in alphabetical order on the following pages.
Note that internal command names are not case-sensitive.

Each internal command description uses the following format.

COMMAND NAME Description of command **COMMAND NAME**

COMMAND NAME

Summary

A summary description of each command's function is given.

Synopsis

Each command's specification syntax is given.

Options

Options are listed.

Description

A more detailed description of each command function is given.

Examples

An example is given.

The following symbols are used in Synopsis.

[ ] : Text enclosed in square brackets can be omitted
| : Indicates a delimiter between option arguments
... : Indicates that the previous pattern can be repeated
△ : Indicates one or more blank spaces

ATTRIB

Summary

Change/view file attributes

Synopsis

ATTRIB[△ option]...[△ [drive:][path]filename]...

Options

+A Sets archive file attribute to ON.
-A Sets archive file attribute to OFF.
+H Sets hidden file attribute to ON.
-H Sets hidden file attribute to OFF.
+R Sets read-only file attribute to ON.
-R Sets read-only file attribute to OFF.
+S Sets system file attribute to ON.
-S Sets system file attribute to OFF.
/S Applies processing to all files included in all directories in the path.
None Displays file attributes.

Description

Changes or displays the attribute set in the file.
When the filename is omitted, the specified change/view attributes are applied to all files in the current directory.

The following characters are used when displaying file attributes.

A	Archive file
H	Hidden file
R	Read-only file
S	System file

Examples

```
A> ATTRIB C:\KEY.TBL ↵               ← Indicates KEY.TBL attribute of C drive.
A        C:\KEY.TBL
A> ATTRIB +R C:\KEY.TBL ↵            ← Adds R attribute to KEY.TBL of C drive.
```

CAT

Summary

Concatenate files

Synopsis

CAT[△ option]... △ [drive:][path]filename...

Options

-b Assigns line numbers to all lines except blank lines.

-e Assigns “$” to the end of each line as an addition to the -v option.

-n Assigns line numbers to all lines.

-s Outputs several continuous blank lines as a single blank line.

-t Outputs “^I” for each tab character as an addition to the -v option.

-v Outputs all non-printing characters except tab characters and line feed characters as identifiable characters.

Description

This command concatenates (links) files for output.

Examples

```
A> CAT -n A.C B.C > C.C ↵
```

← Links A.C and B.C, assigns line numbers, and outputs both as C.C.

CD

Summary

Change/display current directory

Syntax

(1) CD △ [drive:]path

(2) CD

Description

When using (1) in Synopsis, this command changes the current directory to the directory in the specified path.

When using (2) in Synopsis, this command displays the absolute path in the current directory.

The Synopsis (1) and (2) are the same as those in the CHDIR command.

The Synopsis (2) is the same as the one in the PWD command.

Examples

```
A> CD B: ↵                  ← Changes the current directory to the root directory in the
                              drive B.
A> CD B:\WORK ↵             ← Changes the current directory to the \WORK directory in
                              the drive B.
B> CD                       ← Displays the current directory.
B:\WORK
```

CHDIR

Summary

Change/display current directory

Synopsis

(1) CHDIR △ [drive:]path

(2) CHDIR

Description

When using (1) in Synopsis, this command changes the current directory to the directory in the specified path.

When using (2) in Synopsis, this command displays the absolute path in the current directory.

The Synopsis (1) and (2) are the same as those in the CD command.

The Synopsis (2) is the same as the one in the PWD command.

Examples

```
A> CHDIR B: ↵                ← Changes the current directory to the root directory in the
                               drive B.
A> CHDIR B:\WORK ↵           ← Changes the current directory to the \WORK directory in
                               the drive B.
B> CHDIR ↵                   ← Displays the current directory.
B:\WORK
```

COPY

Summary

Copy file

Synopsis

(1) COPY[△ option] △ [drive:][path]filename1 △ [drive:][path]filename2
(2) COPY[△ option] △ [drive:]path1 △ [drive:]path2
(3) COPY[△ option] △ [drive:][path]filename... △ [drive:]path

Options

/Y	Replaces existing file(s) without prompting for confirmation.
/-Y	Opens a dialog box to prompt for confirmation before replacing existing file(s) (default setting).

Description

When using (1) in Synopsis, this command copies filename1 to filename2.
When using (2) in Synopsis, this command copies all files in the directory specified by path1 to the directory specified by path2.
When using (3) in Synopsis, this command copies the specified file(s) to the directory specified by “path”.

Examples

```
A> COPY FILE.C B:\WORK ↵
```

← Copies FILE.C in the current directory to the \WORK directory in the drive B.

CP

Summary

Copy file

Synopsis

(1) CP[△ option]... △ [drive:][path]filename1 △ [drive:][path]filename2
(2) CP[△ option]... △ [drive:]path1 △ [drive:]path2
(3) CP[△ option]... △ [drive:][path]filename... △ [drive:]path

Options

-R Same as the -r option
-i Opens a dialog box to prompt for confirmation before replacing existing file(s).
-p Suppresses updating the “last revised” time for the copied file.
-r Recursively copies the contents of the source subdirectory. Valid only for the Synopsis (2).

Description

When using (1) in Synopsis, this command copies filename1 to filename2.
When using (2) in Synopsis, this command copies all files in the directory specified by path1 to the directory specified by path2. If the -r option (or -R option) has been specified, the contents of all subdirectories in the directory specified by path1 are recursively copied to the directory specified by path2.
When using (3) in Synopsis, this command copies the specified file(s) to the directory specified by “path”.

Examples

```
A> CP \WORK B:\WORK2 ↵
```
← Copies all files in the \WORK directory to the \WORK2 directory in the drive B.

```
A> CP -p \WORK\FILE1.C \WORK2 ↵
```
← Copies FILE1.C in the \WORK directory to the \WORK2 directory in the drive A. The last revised time is not updated.

DATE

Summary

Display date

Synopsis

DATE

Description

Displays the current date.

Examples

```
A> DATE ↵                        ← Displays the current date.
Current date is Wed 05-24-1995.
```

DEL

Summary

Delete file

Synopsis

DEL[△ option] △ [drive:][path]filename...

Options

/Y	Deletes without opening a dialog box to prompt for confirmation.
/-Y	Opens a dialog box to prompt for confirmation before deleting (default).

Description

This command deletes the specified file(s).

The DEL command contains the same function as the ERASE command does.

Examples

```
A> DEL \WORK\FILE.C ↵               ← Deletes FILE.C in the \WORK directory.
A> DEL /Y B:\WORK\FILE.C ↵          ← Deletes FILE.C in the \WORK directory of the drive B.  A
                                      dialog box does not open to prompt for confirmation before
                                      deleting.
```

DELTREE

Summary

Delete file/directory

Synopsis

(1) DELTREE[△ option] △ [drive:]path
(2) DELTREE[△ option] △ [drive:][path]filename...

Options

/Y	Deletes without opening a dialog box to prompt for confirmation.
/-Y	Opens a dialog box to prompt for confirmation before deleting (default).

Description

When using (1) in Synopsis, this command deletes the directory specified by “path”. All files in the specified directory and its subdirectories will be deleted.
When using (2) in Synopsis, this command deletes the specified file.

Examples

```
A> DELTREE \WORK ↵                    ← Deletes all files under the \WORK directory.
A> DELTREE \WORK\FILE.C ↵             ← Deletes FILE.C file in the \WORK directory.
```

DIR

Summary

Display file list

Synopsis

(1) DIR[△ option]...[△ [drive:]path]
(2) DIR[△ option]...[△ [drive:][path]filename...]

Options

/A: (attribute) Displays only the filename(s) or directory name(s) with the specified attribute. The specifiable attributes are listed below. Several can be specified at the same time.

A	File for which the archive file attribute is set.
-A	File for which the archive file attribute is not set.
D	Subdirectory(ies).
-D	File(s).
H	File for which the hidden file attribute is set.
-H	File for which the hidden file attribute is not set.
R	File for which the read-only file attribute is set.
-R	File for which the read-only file attribute is not set.
S	File for which the system file attribute is set.
-S	File for which the system file attribute is not set.

/B Displays only filename(s) or directory name(s).
/L Displays using lowercase letters.

/O: (Classification sequence) Specifies the sequence in which the filenames and directory names are classified when displayed. The specifiable classification sequences are listed below. Several classification sequences can be specified at the same time.

D	Sequence of date and time, with earliest first.
-D	Sequence of date and time, with latest first.
E	Alphabetic order by extension.
-E	Reverse alphabetic order by extension.
G	Group directories before files.
-G	Group files before directories.
N	Alphabetic order by filename or directory name.
-N	Reverse alphabetic order by filename or directory name.
S	Size, with smallest first.
-S	Size, with largest first.

/S Displays directory and all files in subdirectory.
/W Displays several filenames or directory names in one line.

Description

When using (1) in Synopsis, this command displays a list of the directories specified by “path”. If the path specification is omitted, it displays a list of all files and directories in the current directory.

When using (2) in Synopsis, this command displays a list of specified filenames. If the filename specification is omitted, it displays a list of all files and directories in the current directory.

If no options are specified for the Synopsis (1) and (2), this command displays the name, size, and last revised date and time for one file or directory per line.

Examples

```
A> DIR /A:R /O:N ↵
Directory is A:\
DBLSPACE BIN    65270 95-01-12 06:20
IO       SYS    65536 95-01-12 06:20
MSDOS    SYS    39664 95-01-12 06:20
```

← Displays a alphabetical list of read-only files in the current directory.

DIRS

Summary

Display directory stack

Synopsis

DIRS

Description

This command displays the contents of the directory stack[31].

Examples

```
A> DIRS ↵                          ← Displays the directory stack.
a:/windows c:/work/tmp
```

[31] The output is displayed in lowercases.

DUMP

Summary

File binary dump

Synopsis

DUMP[△ option] △ [drive:][path]filename[△ startaddress[△ endaddress]]

Options

/D Regards the address specification as a decimal number.
If omitted, the address specification is regarded as a hexadecimal number.

Description

This command displays file contents using numbers and ASCII characters.

When addresses are specified, the contents within the specified address range are displayed. If a start address is specified, an end address specification cannot be omitted.

Examples

```
A> DUMP A.OUT ↵                       ← Displays the complete contents of the A.OUT file in the
00000000  7F 45 4C 46 01 01 ...          current directory.
A> DUMP /D MAIN.o 80 ↵                ← Displays (using decimal numbers) the contents from address
00000050  00 30 06 50 23 FF ...          80 to the end of the MAIN.O file in the current directory.
```

ECHO

Summary

Display character string

Synopsis

ECHO character string...

Description

This command displays the specified character string.

Examples

```
A> ECHO ABCde ↵                    ← Displays “ABCde”.
ABCde
```

ERASE

Summary

Delete file

Synopsis

ERASE[△ option] △ [drive:][path]filename...

Options

/Y Deletes without opening a dialog box to prompt for confirmation.

/-Y Opens a dialog box to prompt for confirmation before deleting (default).

Description

This command deletes the specified file(s).

The ERASE command contains the same function as the DEL command does.

Examples

```
A> ERASE B:\WORK\FILE.C ↵      ← Deletes FILE.C in the \WORK directory of the drive B.
A> ERASE /Y \WORK\FILE.C ↵     ← Deletes FILE.C in the \WORK directory of the drive A.  A
                                 dialog box does not open to prompt for confirmation before
                                 deleting.
```

EXIT

Summary

Exit VSH

Synopsis

EXIT

Description

This command exits the VSH shell to close the VSH window.
It closes the VSH window.

Examples

```
A> EXIT ↵                              ← Exits VSH.
```

LS

Summary

Display file list

Synopsis

(1) LS[△ option]...[△ [drive:]path]
(2) LS[△ option]...[△ [drive:][path]filename]...

Options

-A Also displays file for which the hidden file attribute is set.
-F Adds a “/” after each directory name and a “*” after each executable filename in the output list.
-R Recursively displays the contents of the subdirectory.
-a Also displays the contents of hidden files and directory names that include “.” or “..”.
-l Displays the name, attribute(s), size, and last revised date and time for one file or directory per line.
-r Displays filenames in reverse alphabetic order. If the -t option is also specified, -t has priority.
-t Displays filenames with most recently revised files first.

Description

When using (1) in Synopsis, this command displays a list of directories specified by “path”. If “path” is omitted, it displays a list of all files and directories under the current directory.

When using (2) in Synopsis, this command displays a list of specified filenames. If the filename(s) specification is omitted, it displays a list of all files and directories under the current directory.

If all options are omitted for the Synopsis (1) and (2), this command displays (on one line) several filenames or directory names.

Examples

```
A> LS ↵                                  ← Displays a list of files in the current directory.
 a.bat    main.c    test.sdb    test3.prj
 a.s      main.o    test1.mak   test3.sdb
          ...
```

```
A> LS -l -r \WORK ↵                      ← Displays a detailed list of files in the \WORK directory, arranged
                                           in reverse alphabetic order.
¯rw¯rw¯rw¯ 1 root     12009 Apr 13 09:43 /work/win.ini
¯rw¯rw¯rw¯ 1 root      1818 Oct  3 13:09 /work/test4.sdb
          ...
```

MD

Summary

Create directory

Synopsis

MD[△ drive:]path...

Description

This command creates a directory in the specified path.
The MD command contains the same function as the MKDIR command does.

Examples

```
A> MD \TMP ↵                  ← Creates the \TMP directory in the drive A.
A> MD B:\WORK\TMP ↵           ← Creates the \WORK\TMP directory in the drive B.
```

MKDIR

Summary

Create directory

Synopsis

MKDIR[△ drive:]path...

Description

This command creates a directory in the specified path.
The MKDIR command contains the same function as the MD command does.

Examples

```
A> MKDIR B:\TMP ↵                ← Creates the \TMP directory in the drive B.
A> MKDIR \TMP\SRC ↵              ← Creates the \TMP\SRC directory in the drive A.
```

MOVE

Summary

Move file

Synopsis

(1) MOVE[△ option] △ [drive:][path]filename1 △ [drive:][path]filename2
(2) MOVE[△ option] △ [drive:]path1 △ [drive:]path2
(3) MOVE[△ option] △ [drive:][path]filename... △ [drive:]path
(4) MOVE[△ option] △ [drive:]path1 △ path2
(5) MOVE[△ option] △ [drive:][path]filename1 △ filename2

Options

/Y	Replaces existing file(s) at move destination without prompting for confirmation.
/-Y	Opens a message box to prompt for confirmation before replacing existing file(s) at move destination (default setting).

Description

When using (1) in Synopsis, this command moves the specified filename1 to filename2.
When using (2) in Synopsis, this command moves all of the files in the directory specified by “path1” to the directory specified by “path2”.
When using (3) in Synopsis, this command moves the file specified by “filename” to the directory specified by “path”.
When using (4) in Synopsis, this command changes the directory name specified by “path1” to “path2” in the same drive.
When using (5) in Synopsis, this command changes the file specified by “filename1” to “filename2” in the same drive and the same path.
When using (5) in Synopsis, this command is the same as the RENAME and REN commands.

Examples

```
A> MOVE FILE1.C \TMP\FILE2.C ↵      ← Moves FILE1.C to FILE2.C in the \TMP directory.
A> MOVE B:\WORK \TMP ↵              ← Moves all files in the \WORK directory of the drive B to the
                                      \TMP directory of the drive A.
A> MOVE B:\WORK\FILE.C \TMP ↵       ← Moves FILE.C in the \WORK directory of the drive B to the
                                      \TMP directory of the drive A.
A> MOVE \WORK \TMP ↵                ← Changes the \WORK directory in the drive A to \TMP directory
                                      in the same drive.
A> MOVE \WORK\FILE1.C FILE2.C ↵     ← Changes FILE1.C in the \WORK directory of the drive A to
                                      FILE2.C in the same directory.
```

MV

Summary

Move file

Synopsis

(1) MV[△ option] △ [drive:][path]filename1 △ [drive:][path]filename2
(2) MV[△ option] △ [drive:]path1 △ [drive:]path2
(3) MV[△ option] △ [drive:][path]filename... △ [drive:]path
(4) MV[△ option] △ [drive:]path1 △ path2
(5) MV[△ option] △ [drive:][path]filename1 △ filename2

Options

-f Forcibly moves file even when move destination file is a read-only file.
-i Opens a dialog box to prompt for confirmation before replacing existing file(s) at move destination.

Description

When using (1) in Synopsis, this command moves the specified filename1 to filename2.
When using (2) in Synopsis, this command moves all of the files in the directory specified by “path1” to the directory specified by “path2”.
When using (3) in Synopsis, this command moves the file specified by “filename” to the directory specified by “path”.
When using (4) in Synopsis, this command changes the directory name specified by “path1” to “path2”.
When using (5) in Synopsis, this command changes the file specified by “filename1” to “filename2”.

Examples

`A> MV FILE1.C \TMP\FILE2.C` ↵	← Moves FILE1.C to FILE2.C in the \TMP directory.
`A> MV B:\WORK \TMP` ↵	← Moves all files in the \WORK directory of the drive B to the \TMP directory in the drive A.
`A> MV -f B:\WORK\FILE.C \TMP` ↵	← Forcibly moves FILE.C in the \WORK directory of the drive B to the \TMP directory in the drive A.
`A> MV \WORK \TMP` ↵	← Changes the \WORK directory in the drive A to \TMP directory in the same drive.
`A> MV -i B:\FILE1.C FILE2.C` ↵	← Changes FILE1.C in the root directory of the drive B to FILE2.C in the same drive and the same directory. If FILE2.C already exists, it opens a dialog box to prompt for confirmation before replacing existing file(s).

POPD

Summary

Pop directory stack

Synopsis

POPD[△ option]

Options

+*n* Pops (removes) the contents of the *n*th stack. Specify a decimal integer value of 1 or greater as *n*.
If this option is omitted, the contents of the first stack are popped.

Description

This command pops the contents of a directory stack and changes the current directory to the path of the first stack following the one that was popped. It also displays the contents of the current directory and stack[32].

Examples

```
A> POPD ↵                          ← Pops the contents of the first directory stack.
a:/tmp a:/work a:/nectools            Changes the current directory.
A> POPD +2 ↵                       ← Pops the contents of the second directory stack.
a:/tmp a:/work                        Changes the current directory.
```

[32] The output is displayed in lowercases.

PUSHD

Summary

Save and push directory stack

Synopsis

(1) PUSHD[△ [drive:]path]

(2) PUSHD[△ option]

Options

+*n*	Pushes (enters) the contents of the *n*th stack to the start of the stack. Specify a decimal integer value of 1 or greater as *n*.

Description

When using (1) in Synopsis, this command pushes the specified path to the start of the directory stack and changes the current directory to the directory specified by “path”.

When using (2) in Synopsis, this command replaces the stack contents and changes the current directory to the path of the new start of the stack.

If both “path” and “option” are omitted, the current directory contents are pushed onto the start of the stack and the current directory is changed. In either case, this command displays the current directory and stack contents[33].

Examples

```
A> PUSHD +2 ↵                      ← Changes the current directory to the contents of the second
c:/work a:/tmp a:/windows             directory stack.
A> PUSHD a:\WORK ↵                 ← Changes the current directory to the \WORK directory in
a:/work c:/work a:/tmp a:/windows     the drive A.
```

[33] The output is displayed in lowercases.

PWD

Summary

Display current directory

Synopsis

PWD

Description

This command displays the current directory's absolute path.
This command is the same as Synopsis (2) of the CD and CHDIR commands[34].

Examples

```
A> PWD ↵                                ← Displays the absolute path in the current directory.
a:/windows
```

[34] Note that the output in the PWD command is displayed in lowercases.

RD

Summary

Remove directory

Synopsis

RD △ [drive:]path...

Description

This command removes the directory specified by “path”.
However, the directory to be removed must be empty. The directory where the system file or hidden attribute file exists cannot be removed. The current directory cannot be removed, either.
This command contains the same function as the RMDIR command does.

Examples

```
A> RD \TMP ↵                     ← Removes the empty \TMP directory in the drive A.
A> RD B:\TMP ↵                   ← Removes the empty \TMP directory in the drive B.
```

REN

Summary

Rename file

Synopsis

REN △ [drive:][path]filename1 △ filename2

Description

This command changes the specified “filename1” to “filename2”.
This command contains the same function as the RENAME command and Synopsis (5) of the MOVE command.

Examples

```
A> REN OLD.C NEW.C ↵              ← Renames the filename OLD.C as the filename NEW.C.
A> REN B:\WORK\OLD.C NEW.C ↵      ← Renames the filename OLD.C in the \WORK directory of
                                    the drive B as the filename NEW.C in the same location.
```

RENAME

Summary

Rename file

Synopsis

RENAME △ [drive:][path]filename1 △ filename2

Description

This command changes the specified “filename1” to “filename2”.
This command is the same as the REN command and the Synopsis (5) of the MOVE command.

Examples

```
A> RENAME OLD.C NEW.C ↵              ← Renames the filename OLD.C as the filename NEW.C.
A> RENAME B:\WORK\OLD.C NEW.C ↵      ← Renames the filename OLD.C in the \WORK directory of
                                        the drive B as the filename NEW.C in the same location.
```

RENDIR

Summary

Rename directory

Synopsis

RENDIR △ [drive:]path1 △ path2

Description

This command changes the specified “path1” to “path2”.

Examples

```
A> RENDIR DIR DIR2 ↵           ← Renames the directory name DIR as DIR2.
A> RENDIR C:\DIR DIR2 ↵        ← Renames the directory name DIR in drive C as DIR2.  The
                                 drive is not changed.
```

RM

Summary

Delete file

Synopsis

(1) RM[△ option] △ [drive:][path]filename...

(2) RM △ -r[△ option] △ [drive]path

Options

-f Forcibly removes read-only files. No error message is output if the specified file does not exist.

-i Opens a dialog box to prompt for confirmation of removal.

-r Recursively removes subdirectory contents.

Description

When using (1) in Synopsis, this command removes the file specified by “filename”.

When using (2) in Synopsis, this command removes the entire contents of the directory specified by “path”. To do this, the -r option must be specified.

Examples

```
A> RM -f TMP\FILE.C ↵          ← Forcibly removes FILE.C from the TMP directory.
A> RM -r B:\TMP ↵              ← Removes the entire contents of the \TMP directory in the
                                 drive B including any subdirectories.
```

RMDIR

Summary

Remove directory

Synopsis

RMDIR △ [drive:]path...

Description

This command removes the directory specified by “path”.
However, the directory to be removed must be empty. The directory where the system file or hidden attribute file exists cannot be removed. The current directory cannot be removed, either.
This command contains the same function as the RD command does.

Examples

```
A> RMDIR \TMP ↵                   ← Removes empty \TMP directory in drive A.
A> RMDIR B:\TMP ↵                 ← Removes empty \TMP directory in drive B.
```

TIME

Summary

Display time

Synopsis

TIME

Description

This command displays the current time.

Examples

```
A> TIME ↵                          ← Displays the current time.
Current time is 17:05:09.00
```

TYPE

Summary

Display contents of text file

Synopsis

TYPE △ [drive:][path]filename

Description

This command displays the contents of the specified text file.

Examples

```
A> TYPE FILE.C ↵             ← Outputs the contents of FILE.C.
A> TYPE B:\WORK\FILE.C ↵     ← Outputs the contents of FILE.C in the \WORK directory of
                               the drive B.
```

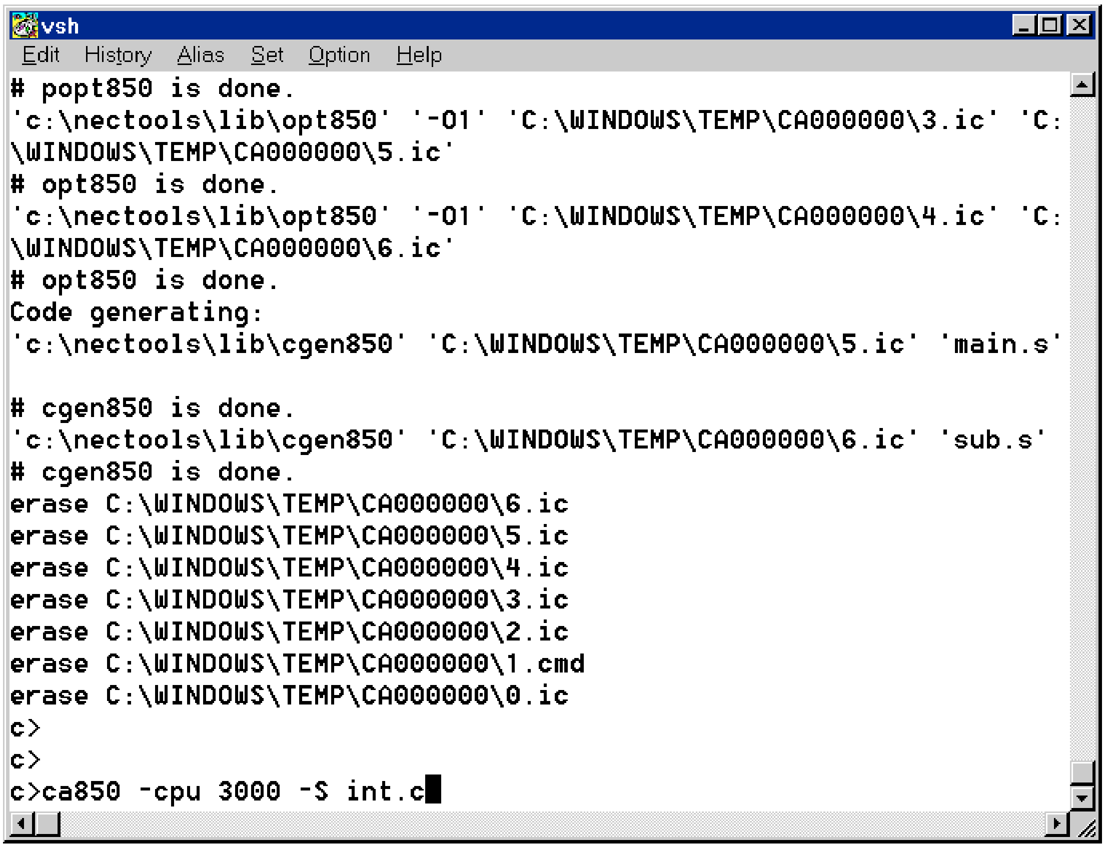
3.6 Activation of CA Commands

This section describes how to activate the commands included in this compiler package (i.e., CA commands) from the VSH shell.

3.6.1 Activation from command line

CA commands can be activated using the command line in the VSH window.

Figure 3-3. Example of CA Command Activation from VSH



```
# popt850 is done.
'c:\nectools\lib\opt850' '-O1' 'C:\WINDOWS\TEMP\CA000000\3.ic' 'C:
\WINDOWS\TEMP\CA000000\5.ic'
# opt850 is done.
'c:\nectools\lib\opt850' '-O1' 'C:\WINDOWS\TEMP\CA000000\4.ic' 'C:
\WINDOWS\TEMP\CA000000\6.ic'
# opt850 is done.
Code generating:
'c:\nectools\lib\cgen850' 'C:\WINDOWS\TEMP\CA000000\5.ic' 'main.s'

# cgen850 is done.
'c:\nectools\lib\cgen850' 'C:\WINDOWS\TEMP\CA000000\6.ic' 'sub.s'
# cgen850 is done.
erase C:\WINDOWS\TEMP\CA000000\6.ic
erase C:\WINDOWS\TEMP\CA000000\5.ic
erase C:\WINDOWS\TEMP\CA000000\4.ic
erase C:\WINDOWS\TEMP\CA000000\3.ic
erase C:\WINDOWS\TEMP\CA000000\2.ic
erase C:\WINDOWS\TEMP\CA000000\1.cmd
erase C:\WINDOWS\TEMP\CA000000\0.ic
c>
c>
c>ca850 -cpu 3000 -S int.c
```

For details of CA command options, etc., refer to the command-specific descriptions in Volume 3 and later volumes.

3.6.2 Output file specification in VSH

When a command output to the VSH is redirected (refer to page 101) to a file, a command message is also output to the standard output[35]. The commands that the result is output to the standard output by default contain the result and message together.

Therefore, when executing file output to reference or use command output results to VSH, the following should be done with regard to ca preprocessing and hx output.

- Specify -P when outputting results of ca preprocessing only to a file.

  Example

  ```
  ca830 -P file.c                  ← Outputs results of preprocessing only to file.i.
  ```

- Specify -o when outputting hx results to a file.

  Example

  ```
  hx830 -o file.hx a.out           ← Outputs hx results to file.hx.
  ```

[35] Unlike in UNIX-based systems, there is no standard error output.

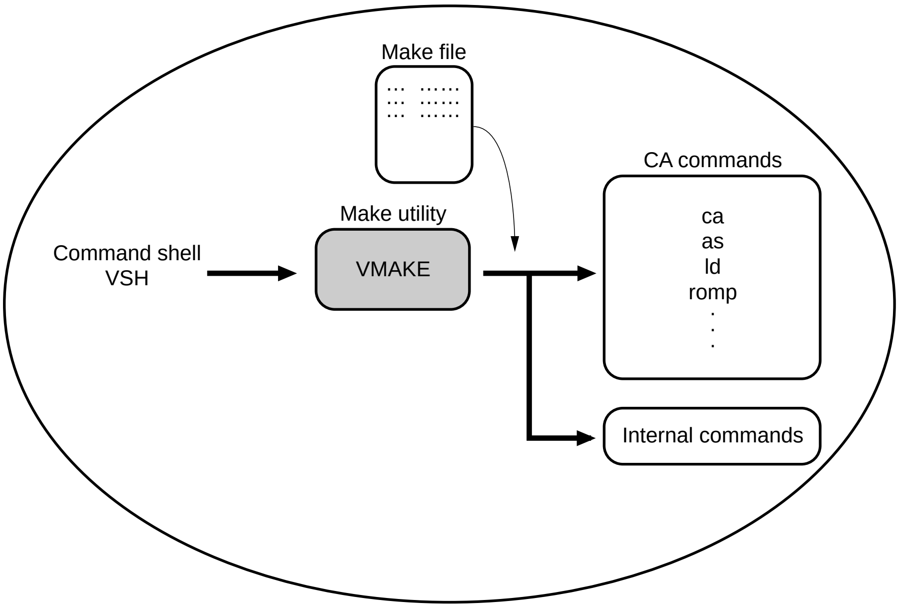
CHAPTER 4 USE OF MAKE UTILITY

This chapter describes how to use VMAKE and how to enter make file descriptions.

4.1 What is VMAKE?

VMAKE is a utility that operates in the VSH shell and is used for managing, updating, and regenerating application programs. This utility references make-related script files (called “make files”) and automatically activates programs such as the C compiler (ca), assembler (as), link editor (ld), or ROM-storing processor (romp) according to the rules specified in the make files.

Figure 4-1. Position of VMAKE



4.2 Features of VMAKE

VMAKE includes the following features.

- Includes a command interpreter to enable direct execution of CA commands and internal commands.
- Supports description and macros for basic dependencies.

4.3 Operation

This section describes how to use VMAKE.
VMAKE is activated from the VSH window’s command line.

4.3.1 VMAKE input syntax

VMAKE[△ option]...[△ target]...[△ macro]...

[ ] : Text enclosed in square brackets can be omitted
... : Indicates that the previous pattern can be repeated
△ : Indicates one or more blank spaces

In the above synopsis, “target” specifies the name of the object file or source file to be generated by the command that is activated from VMAKE. This name is specified in a make file.

Examples

```
A> vmake -f make.org userlm         ← References the make.org file and generates the target
                                       userlm.
```

```
A> vmake userlm                     ← References the makefile file and generates the target
                                       userlm.
```

4.3.2 List of options

The types of options and their functions are listed below.

Option	Specification	Function
-V	-V	This displays the VMAKE version. It is not executed.
-d	-d	This displays the reason for generating a target.
-f	-f △ *file*	This specifies the file “file” as a make file. If this option is omitted, the specification “makefile” is assumed.
-i	-i	This generates a target without referring to the activated command’s termination status. If this option is omitted, it refers to the termination status.
-n	-n	This displays the command for generating the target. It is not executed.
-p	-p	This displays all macro definitions and command descriptions. It is not executed. If this option is omitted, execution is performed without displaying macro definitions and command descriptions.
-q	-q	This returns a “0” if the target has been revised and returns a “1” if it has not been revised. It is not executed.
-s	-s	This performs execution without displaying the command.

Specify the name of the target to be generated as “target”. If this specification is omitted, the first target written in the make file is generated.

For “macro”, enter the macro to be defined, using the syntax “macro=macrocharacterstring”.

However, when defining a macro from the command line, blank characters cannot be included in macro character strings (for example, “CA=ca830 -g” is invalid). Use a make file to make such definitions (refer to page 144).

4.4 Make Files

This section describes the rules for describing make files that are used by VMAKE.

Note that VMAKE is not able to use make files that were generated via the Project Manager.

4.4.1 Comments

The “#” symbol is used to indicate comments.

Lines that begin with “#” are regarded as comments, which are ignored during execution. When a “#” appears anywhere in a line, the rest of the line is regarded as a comment.

4.4.2 Continuation of lines

“\(¥)” is used to indicate continuation of a line.

If a “\(¥)” appears at the end of a line (other than a comment line), the line is regarded as being continued onto the next line. In such cases, any blank spaces before the “\(¥)” in the first continuation line, the “\(¥)” itself, and any blank spaces in the next line are converted to a single blank space.

4.4.3 Description of targets

The dependency among targets to be generated is described in the following syntax.

```
target[△target]...[△]: △dependent_filename [△dependent_filename]...
```

The command line described in page 144 is entered after the above line.

For “dependent_filename”, specify the filename needed to generate the desired target.

When specifying several targets, it is assumed that all of the described targets will be generated from the same file.

Example

```
object :  main.o func.o usrlib.a
          (Command line in page 144)
```

Note the following caution points.

- Do not enter a tab character at the start of the above line.
- It is not possible to use different rules when making several specifications of the same target.
- It is not possible to recursively describe a target and a dependent file.

[Special-function targets]

Unlike ordinary targets, the following targets can be used to provide special functions.

- .IGNORE:
  The target is generated without regard to the activated command's termination status. This is the same as the -i option.

  Example>
  ```
  .IGNORE :

  a.o     : a.c
            ca850 -cpu 3000 -0 -c a.c
  ```

- .SILENT:
  Execution is performed without displaying the command.
  This is the same as the -s option.

  Example>
  ```
  .SILENT :

  a.o     : a.c
            ca850 -cpu 3000 -0 -c a.c
  ```

As shown in the above examples, command lines cannot be described for the .IGNORE and .SILENT targets.

4.4.4 Command lines

The activation commands that are used to generate targets are described via the following syntax. Be sure to begin each command line with a tab character.

```
tab_character[△][-|@|-@|@-]command[△option]...
```

- ... Ignores command termination status.
@ ... Command is not displayed unless the -n option in VMAKE has been specified.

Example

```
(Target description)
      ca850 -cpu 3000 main.c -0s -Wl, -D, ldir
```

4.4.5 Macros

Macros can be defined and referenced in make files.

(1) Macro definitions

Macro definitions are described via the following synopsis.

```
macro_name[△]=[△]macro_character_string
```

The following can be specified as “macroname” (all are half-size characters).

- English alphabet
- Numerals
- Periods
- Underscore

The blank spaces before and after the equal sign (=) between “macro_name” and “macro_character_string” are removed during make execution.

Example

```
CA = ca850 -cpu 3000 -g -0 -v -c
```

Note the following caution points.

- Do not enter a tab character at the start of the above line.
- It is not possible to recursively describe a target and a dependent file.

(2) Macro references

Macro references can be described using any of the following synopsis.

(a) $macro_name
(b) $(macro_name)
(c) ${macro_name}

Example

```
$(CA) main.c
```

The operation is the same for all synopsis.

However, the synopsis (a) can only be specified when “macro_name” has only one character.

(3) Internal macros

VMAKE includes the following two internal macros to facilitate description of rules for generating targets. Note that internal macros are valid only in command lines.

(a) $@

Indicates the complete target name of the target being revised.

Example

```
object : file.c
         $(CA) file.c -o $@   ← “$@” indicates object
```

(b) $?

Indicates a list of files requiring revision among the dependent files of the target being revised.

In other words, this basically lists the files that must be regenerated to enable revision of the target.

Example

```
lib.a  : file1.o file2.o file3.o
         ar850 rv $@ $?       ← The “$?” indicates a file list updated following lib.a
                                in file1.o through file3.o during make execution.
```

[MEMO]

VOLUME 3

HANDLING C COMPILER

CHAPTER 1 OVERVIEW

This volume explains the outline, operation, and output messages of the C compiler (ca) included in this compiler package.

1.1 Flow of Operation

The ca creates relocatable object files and object files executable on the target system from C source programs described in C source files. The ca plays a role of the driver of the modules included in the package and performs operations such as macro expansion, comment processing, merging intermediate-language files, optimization, creation and conversion of assembly-language source programs into machine language instructions, and linking object files. The ca performs processing in the following sequence[1] (refer to **Figure 1-1**).

(1) The front end (cafe) performs macro expansion and comment processing of a C source program, and converts the program into an intermediate-language, OPTIC program.

(2) The pre-optimizer (popt) re-arranges the functions in the intermediate-language OPTIC program. If this command is activated from the VSH command line, and if size-priority or execution speed-priority optimization is specified, two or more intermediate-language OPTIC programs are merged into one[2]. If execution speed-priority optimization is specified, inline expansion of the functions in the intermediate-language OPTIC program is executed.

(3) The global optimization module (opt) optimizes the intermediate-language OPTIC program.

(4) The code generation module (cgen) converts the intermediate-language OPTIC program into an assembly-language source program.

(5) The machine-dependent optimization module (impr) optimizes the assembly-language source program.

(6) The assembler (as) converts the assembly-language source program into machine language instructions and creates a relocatable object file.

(7) The link editor (ld) links the relocatable object file, and creates an executable object file[3].

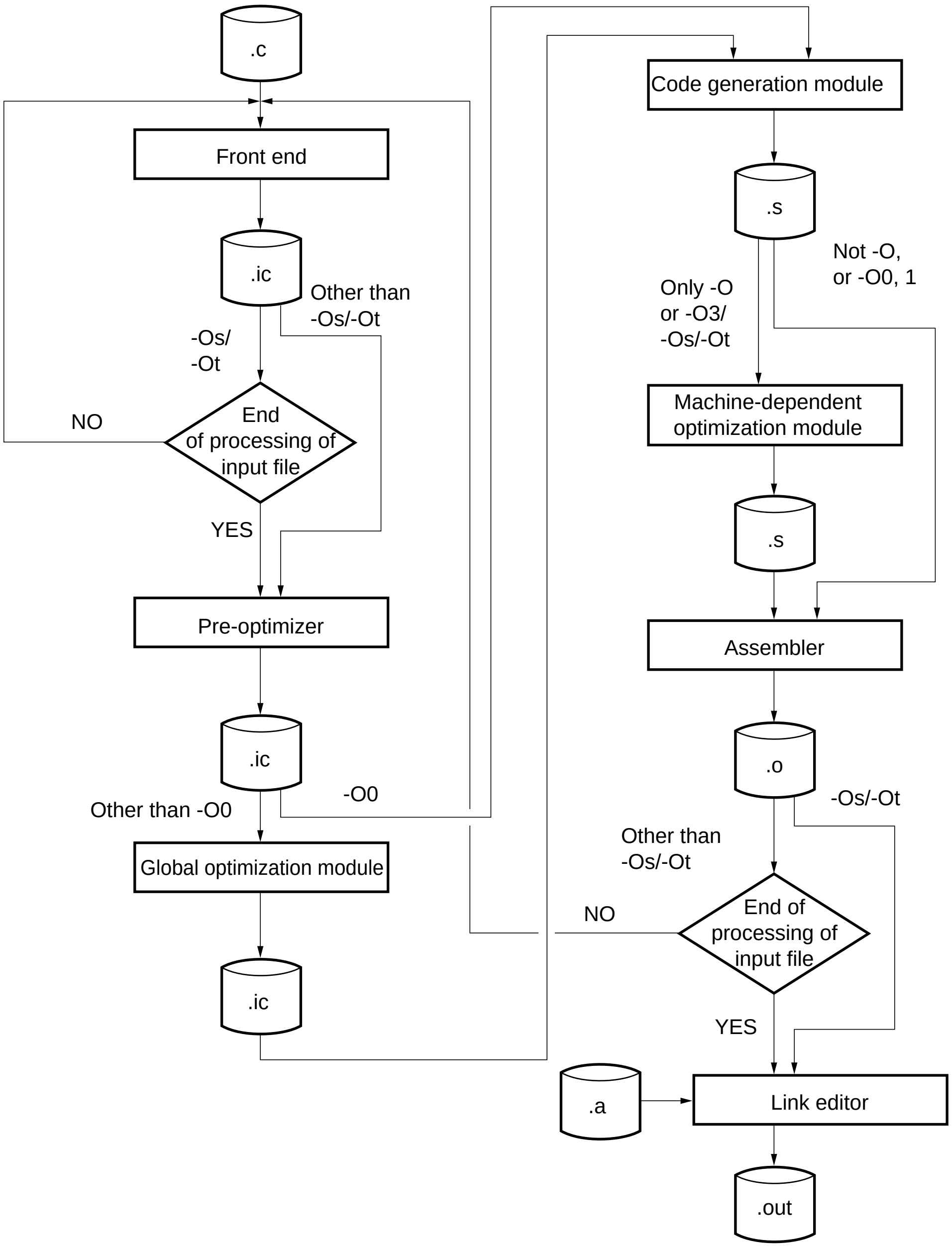
[1] The processing flow slightly differs depending the specified optimization level, as shown in Figure 1-1.

[2] Because one file is compiled at a time when it is compiled from the Project Manager, files are not merged.

[3] When created from the Project Manager, the object file becomes the name which is omitted the suffix of the first file of the source list and is added ".OUT". When created from VSH command start, it becomes a.out at the default. The -o option can be used if the name of an object file is desired to be specified when started from VSH (refer to page 160).

The global optimization module and the machine-dependent optimization module are called only when the optimization option is specified (refer to **Figure 1-1**). It is assumed that the modules of (1) front end (cafe) through (5) machine-dependent optimization module (impr) are started from the ca. If any of these modules is started alone, therefore, the operation is not guaranteed.

Figure 1-1. Operation Flow of ca



1.2 Handling File

The ca can specify the following files as input files.

file.c	... C source file	(called .c file)
file.ic	... OPTIC file	(called .ic file)
file.s	... assembler source file	(called .s file)
file.o	... object file	(called .o file)
file.a	... archive file	(called .a file)

- If only one of the .c, .ic, or .s files is specified on starting the ca, the ca links the relocatable object file that has been internally generated for that file, by using the ld and then deletes the relocatable object file.

- If multiple .c, .ic, or .s files are specified on starting the ca, the ca links the relocatable object file that has been internally generated for that file, by using the ld and preserves this file as a file from the name of the input file (by replacing .c, .ic, or .s with .o). However, if compiling is executed by specifying options of size priority optimization or execution speed priority optimization, the ca shares the information of the specified multiple .c and .ic files. If even one of the specified .c and .ic files is changed or modified, all the files must be re-compiled.

- The .s file is passed to the as as it is (a source program directly described in an assembly language does not go through the machine-dependent optimization module).

- All the files other than .c, .ic., and .s files, such as the a. file and .o file are all passed as ld.

Caution The input file names supported by Windows can be specified. However, ‘@’ cannot be used at the head of a file name with the CA because it is judged as a command option.

1.3 Execution Object Creating Pattern

As explained in 1.1, the ca can read a C source file and create an executable object file all at once because it start as and ld. Besides the processing can be stopped before the as and ld are started by specifying VSH command line option and can output a compiler code or create a relocatable object file before linking.

The former is suitable when an option specification is not complicated at the start from VSH command line. The latter is suitable when a lot of options are specified for the as and ld, or independent .o files is desired to create in order.

In Project Manager, normally <<Build>>/<<Rebuild>> of execution menu starts to ld and employs the method of which the build specifying ".o file" by <<Target specification build>> creates an individual object (-c option of command line). (Refer to VOLUME 2 and User's Manual of Project Manager) Awareness of the start of as or ld is not required as in VSH but an option stopping before as start is not supported in compiler option on the Project Manager.

Examples of start from VSH command line are shown below (Refer to the next chapter on details of option).

(1) To execute everything from ca[4]

```
> ca850 -cpu 3000 file.c obj.o
```

Reads file.c and obj.o to create executable object file a.out. At this time, crtN.o is linked as the start-up module and libc.a is referenced.

```
> ca850 -cpu 3000 -R org_crt.o file.c obj.o
```

Reads file.c and obj.o to create executable object file a.out. At this time, org_crt.o is linked as the start-up module and libc.a is referenced.

[4] For the start-up module in the above example, refer to **V800 Series C Compiler Package User's Manual - C Language**.

(2) To start from ca to as, and to start ld alone

```
> ca850 -cpu 3000 -c file.c asm.s
```

Reads file.c and asm.s to create relocatable object files file.o and asm.o.

```
> ld850 org_crt.o file.o asm.o obj.o -lc
```

Links org_crt.o, file.o, asm.o, and obj.o to create executable object file a.out. At this time, libc.a is referenced.

(3) To start ca, as, and ld alone

```
> ca850 -cpu 3000 -c file.c
```

Reads file.c to create relocatable object file file.o.

```
> as850 -cpu 3000 asm.s
```

Reads asm.s to create relocatable object file asm.o.

```
> ld850 org_crt.o file.o asm.o -lc
```

Links org_crt.o, file.o, and asm.o to create executable object file a.out. At this time, libc.a is referenced.

This chapter explains how to operate the ca.

2.1 Command Input Format from VSH Command Line

ca [△ option] ... △ file name [△ file name or option] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists the options of the ca.

When starting from VSH, if an option not listed in this table is given, that option is regarded as the option of the ld, and is passed to the ld as it is.

"-Wl" must be specified to pass the options marked "**" in the option list of the ld on page 222 from the ca to the ld as they are.

Below listed options are available which are not existed in option dialog in Project Manager. Specify ca from VSH when these option specification is required.

(1) Input options

These specifications set options related to ca input.

Specification Format	Feature
–Xk=*code*	This option specifies the character code to be used for Japanese comments or character strings in input files[5]. An error message is output if a code other than the specified code exists. The following can be specified as *code*. `e	euc` EUC `n	none` Code is not guaranteed `s	sjis` Shift JIS The "|" indicates that either left or right of it must be specified. If this option is omitted, shift JIS is assumed.
–Xsec_file=*file* *V850	This option specifies the name of the section file (refer to page 408) that is used to specify section allocation of data when the C compiler is started. Be sure to specify this file name. This option can be specified several times and several section files can be input.

[5] Refer to the section of the **V800 Series C Compiler Package User's Manual - C Language** that describes character strings and comments in the language specifications.

(2) Preprocessing options

These specifications set options related to preprocessing during compilation.

Specification Format	Feature
–D*name*[=*def*]	When this option is specified, it is assumed that #define *name def* is entered before the C source program. If the =*def* specification is omitted, *def* is assumed to be 1.
–I*dir*	This option specifies searching first in the directory *dir* and then in the standard directory[6] when searching for the header file[7]. If this option is omitted, only the standard directory is searched.
–U*name*	When this option is specified, it is assumed that #undef *name* is entered before the C source program.
–Xcxxcom	In addition to ordinary comments, this interprets all characters that appear after "//" and before the end of the line as comments (C++ comment style).
–Xm*num*	This option specifies an upper limit for the number of macro identifiers. A decimal value up to 32767 can be specified as *num*. A default value of 2047 is used if this option is omitted.
–t	This option replaces a trigraph sequence[8].

[6] The installation directory is /incxxx directory.

[7] When the file name is enclosed in double quotation marks ("), the directory where the source file exists is searched first. For details of file searching to fetch header files, refer to **V800 Series C Compiler Package User's Manual - C Language**.

[8] This is a three-character (trigraph) sequence that is replaced by single characters as stipulated in the ANSI standard. Refer to the documents related to the ANSI standard.

(3) Language options

These specifications set options related to switches available in the C language.

Specification Format	Feature
–Xbitfield=*string*	This option specifies whether specifications in int type bit fields that do not indicate the type specifier (signed or unsigned) are regarded as signed or unsigned specifications. The following can be specified as *string*. `s` Regarded as signed `signed` Regarded as signed `u` Regarded as unsigned `unsigned` Regarded as unsigned A warning message is output when the specification is regarded as unsigned. The specification is regarded as signed if this option is omitted.
–Xchar=*string*	This option specifies whether char type specifications that do not indicate the type specifier (signed or unsigned) are regarded as signed or unsigned specifications. The following can be specified as *string*. `s` Regarded as signed `signed` Regarded as signed `u` Regarded as unsigned `unsigned` Regarded as unsigned The specification is regarded as signed if this option is omitted.
–Xe * V850	This option specifies that a runtime library[9] ___mul/___mulu or ___div/___divu will be used instead of the mulh and divh instructions for integers corresponding to data that is 16 bits or less. This option slows the processing speed but strictly complies with the multiplication and division processing under the ANSI standard. The mulh and divh instructions are used if this option is omitted.
–ansi	This option outputs an error message or warning message corresponding to the returned symbol so that ca's processing strictly complies with the ANSI standard. All extensions other than the _asm extension are recognized[10]. Specifying this option defines the macro name `__STDC__`. Strict ANSI compliance cannot be guaranteed if this option is omitted[11].

[9] The CA850's runtime library is used as a standard library for this compiler to meet the ANSI standard for instructions that are not included in the V850 Family architecture. For details of the runtime library, refer to **V800 Series C Compiler Package User's Manual - C Language**.

[10] For details of how processing of the supplied extension symbol and the defined macro name differs according to whether or not this option has been specified, refer to **V800 Series C Compiler Package User's Manual - C Language**.

[11] To maintain compatibility with previous C language specifications, a warning message is output and processing continues.

(4) Optimization option

These specifications set options related to the optimization levels and items.

Specification Format	Feature
–O[*c*]	This option specifies the optimization level. Numbers and characters that can be specified as *c* are as follows[12]. `0` No optimization `1` Optimizes within basic block `2` Also starts machine-dependent optimization module `3` Also starts interfunctional optimization and optimization by as (refer to page 201) `s` Optimizes based on object size `t` Optimizes based on execution speed `l` Forcibly optimizes code scheduling and redundant instruction elimination (valid at level 2 or above) Note that this slows the compilation speed. If the *c* specification is omitted, *c* is assumed to be 3. If this option is omitted, -O1 is assumed as the specified value.

(5) Output options

These specifications set options related to assembly language output by ca.

Specification Format	Feature
–G*num*	Data that is less than *num* bytes[13] is allocated to the .sdata section or the .sbss section. If this option is omitted, all data is allocated to the .sdata section or the .sbss section. However, any data that is specified for a .sdata or .sbss section in a `#pragma section` directive[14] or a section file (refer to page 408) is allocated to the .sdata or .sbss section regardless of the data size.
–Xbdld * V830	If the values for static structures or external structure variable exceeding 16 bytes that are allocated to sections in external memory are substituted with values of .sidata section variables from RAM, the bdld instruction will be output when ca performs an assembly language creation (refer to page 166).
–Xc	This option outputs the C language source programs as comments to the assembler source file to be output[15].
–Xcre_sec_data [=*file*] * V850	This option outputs a variable frequency data file used with section file generator (refer to page 397)[16]. If =*file* is specified, the specified file name is output. If =*file* is omitted, the same file name is output, but with .sec as the extension instead of .c. When several C source files exist, and a frequency information file is to be created with a file name specified for each file, the Project Manager opens the option dialog for each C source file from the source file list, and specifies a file name when the frequency information file is created. The VSH specifies this option with =*file* for each C source file. The C source file is compiled one at a time (with -c specified).

[12] For details of using the optimization function, refer to page 162.

[13] Specify a decimal number as the *num* value. The range of values that can be specified as *num* are output by the ld "-A" option.

[14] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

[15] The output comments are for reference only and do not necessarily correspond exactly to the code. For example, comments concerning global variables, local variables, function declarations, etc., may be output to incorrect positions. If the optimization level is 1, the code may be deleted and only the comment will remain.

[16] Frequency data for variables in C source files is output. Nothing is done to an assembler source file.

Specification Format	Feature
–Xi	This option sets a four-byte alignment condition for arrays (including character strings) and structures and converts `strcpy()` function calls to block transfers[17]. This increases the object's execution speed but it also increases the code size.
–Xj	This option uses the jmp instruction to perform a branch for an ordinary interrupt function defined in C language or for the RTOS interrupt handler[18]. If the number of functions is in the range that cannot be branched by the jr instruction, and ld outputs an error, this option can be used to restart compilation. The jr instruction is used if this option is omitted.
–Xkt=*code*	This option converts and outputs Japanese character strings to the specified code. This is valid for converting kanji code used when developing an application to a different code in a target application (refer to Caution on page 161). The following can be specified as *code*. `e | euc` EUC `n | none` No code conversion `s | sjis` Shift JIS The "`|`" indicates that either left or right of it must be specified. Comments output by specifying -Xc are not converted regardless of this option's specification. If this option is omitted, code is not converted.
–Xmask_reg	This option specifies use of the mask register function[19]. When this option has been specified, -m is automatically set for the as.
–Xnoabcond *V830	This option does not output ab*cond* instruction during assembly language creation by ca[20].
–Xnopldsr *V830	This option outputs two nop instructions immediately before the ldsr instruction during assembly language creation by ca[20].
–Xold_fcall *V850	This option outputs code according to an old version's function call specification[19]. If the V850E is used as the target device, this option cannot be specified.
–Xr	The label of the first argument for _rcopy specifies the first address (aligned according to the four-byte alignment condition) that exceeds the end of the .text section in the object. When ld is started by ca, the rompcrt.o file and libr.a file are specified to be linked by ld[21].
–Xv850patch [=*num*] *V850	This option specifies the -p[*num*] option for as850 according to the *num* specification for an assembler source file output by the ca850 to output a code corresponding to a CPU fault (refer to page 206). The specifiable range for *num* is 1 to 3.
–Xword_switch	This option creates one four-byte branch table per case label in a switch statement. Specify this option to prevent compile errors that would otherwise occur when the switch statement is long. Two-byte branch tables are created if this option is omitted.
–a	This option outputs an assemble list to a file whose extension .c is changed to .v (refer to page 208).
–g	This option outputs information for the source debugger. When as is started by ca, specifying this option is handled the same as when -g has been specified for as[22]. This is equivalent to specifying "Debug" from the Option menu when the Project Manager is used.
–reg*n*	This option limits the number of registers used by ca as *n* registers[23]. `22` 22 registers `26` 26 registers 32 registers are specified if this option is omitted.

[17] This conversion is performed only when the second argument in `strcpy()` is a character string. In addition, the first argument may required four-byte alignment by the program (the C compiler aligns the second argument since it is a character string).

[18] Refer to the descriptions of interrupt/exception handlers and RTOS interrupt handlers in **V800 Series C Compiler Package User's Manual - C Language**.

[19] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

[20] This option is intended to prevent CPU faults. Refer to the CPU documents to determine whether or not the CPU is susceptible to such faults.

[21] This option is used to store the object file to ROM. For details of using this option, refer to page 386.

[22] If an assembler source file is input when ca is started, assembler source debugging is performed by the debugger.

[23] This option switches the register mode of the software register bank function. For details of the software register bank function, refer to **V800 Series C Compiler Package User's Manual - C Language**.

(6) Message options

These specifications set options related to messages that are output during compilation.

Specification Format	Feature
–Xd	This option outputs a warning message in response to initialization of a pointer type external variable which uses a variable address that is not an automatic variable or which uses a function address.
–v	This option displays ca's execution status.
–w	This option suppresses output of warning messages.
–w*num*	This option specifies the level of the warning message. The following numbers can be specified as *num*. `0` Suppress message (same as -w) `1` Output ordinary warning message `2` Output detailed warning message The -w1 specification is assumed if this option is omitted.
–w*string*+ –w*string*-	This option specifies outputting or suppressing a warning message for each parameter regardless of the level. A warning message is output when "+" has been specified or is suppressed when "-" has been specified. The following character strings can be specified as *string*. `bitfield_align` When bit field members have exceeded the boundary set by the alignment condition and have been allocated starting from the next boundary `callnodecl` When calling an undeclared function `nopic` When using a variable address that is not an automatic variable or a function address to initialize a pointer type external variable `pragma` When a non-executable `#pragma` description appears `sharp` When a sharp symbol (#) appears in a source line An error occurs if neither "+" nor "-" has been specified. The specification is according to the -w*num* level if this option is omitted.

(7) Other options

These specifications set other options.

These options specify ca's operation stage, reference files, etc.

Specification Format	Feature
–C	This option includes source program comments in C language source program preprocessing output. This option can be specified only when either the -E option or the -P option has been specified. This option can be specified only when starting from VSH.
–E	This option executes preprocessing only for a C language source program and outputs the results to standard output. The results include the line number display and file name display of the source program. This option can be specified only when starting from VSH.
–L*dir*	This option searches the library starting in the directory *dir*, then in the standard directories[24, 25]. Only the standard directories are searched if this option is omitted.
–P	This option executes preprocessing only for a C language source program and outputs the results to a file whose name is the C source file name plus .i as the extension instead of .c. The source program's line number display and file name display are not output. This option can be specified only when starting from VSH.
–R △ *file*	When startup goes as far as ld, the startup module[26] to be used is indicated to ld as *file.* If this option is omitted, crtN.o in the standard directory[27] is used as the startup module. This option is equivalent to the "file" option of the ld when started from the Project Manager.
–S	This option outputs a created assembly language source program without executing any modules after startup of as. The output file name is the C source file name plus .s as the extension instead of .c. Modules after startup of as will be executed if this option is omitted. This option can be specified only when starting from VSH.
–V	This option outputs this compiler package's version number to standard output. It does not execute compilation. This option can be specified only when starting from VSH.
–W*c,arg1*[*,arg2*] ...	This option passes arguments *arg1*, *arg2*, and so on, to module *c*[28]. The following can be specified as module *c*. p Pre-optimizer o Global optimization module i Machine-dependent optimization module a Assembler l Link editor
–c	This option outputs the object file as a file whose extension is .o instead of .c or .s without starting the ld. The ld is started if this option is omitted. When the Project Manager is used, this option is automatically specified for all compilation. Accordingly, ld is not started if an individual ".o" file is specified in <<Build Target>> specification.
–cpu △ *devicename*	This option specifies the target device[29]. When using the Project Manager, this is equivalent to specifying the device during a project setup. If this option is omitted and nothing has been specified by the `#pragma` directive, compilation is stopped.

[24] These are the \lib*xxx* directory and the \lib*xxx*\r32 directory, both of which are under the installation directory. However, if register mode has been specified, the r22 or r26 directory is searched in the same order instead of the r32 directory.

[25] Refer to the description of the -L option for the ld.

[26] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

[27] Installation directory \lib*xxx*\r32 (r26, r22)

[28] Refer to page 172 for a description of the option that enables arguments to be passed to each module.

[29] This has the same function as "`#pragma cpu` *devicename*".
There are two methods: specification by the -cpu option or specification by the `#pragma` directive. If both are specified but have different contents, the specification by the -cpu option takes priority.
Refer to the device file's User's Manual for description of device types that can be specified as *devicename.*
For details of the `#pragma` directive, refer to **V800 Series C Compiler Package User's Manual - C Language**.

Specification Format	Feature
–devpath=*dir*	This option searches for the device file starting in the directory *dir*, then in the standard directories[30]. Only the standard directories are searched if this option is omitted. When the command is started from the option dialog, the device file's installation directory is automatically set for this option, so this option can be specified only when starting from VSH.
–help	This option outputs a description of option to standard error output.
–l*string*	This option specifies the archive file that is referenced by the ld[31]. Nothing is referenced if this option is omitted[32].
–m	This option only executes the front end, creates an .ic file, and then terminates processing. If this option is omitted, modules after the front end are also executed. This option can be specified only when starting from VSH.
–o △ *outfile*	This option specifies the object file name for outputting *outfile*. When there are several output files, this option is ignored. If this option is omitted, a.out is regarded as the executable object file name[33]. This option can be specified only when starting from VSH.
–temp=*dir*	This option specifies the working directory for creating temporary files that are used internally (refer to page 29). This option can be specified only when starting from VSH.
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

Cautions 1. Some of the above mentioned options become invalid if specified simultaneously with another option.

Of the following options, those on the right of ">" become invalid if they are specified with the options shown on the left of ">".

- -E > -P
- -U > -D
- -E/P > -G/L/O/R/S/W*c*/a/c/l/m/o

  Because execution is terminated after preprocessing has been performed, the options related to the modules following the front end are invalid.
- -S > -L/R/W/[a|l]/a/c/l/o

  Because execution is terminated at the machine-dependent optimization module, the options related to the modules following the as are invalid.
- -V/help

  The option that is specified later is invalid. Furthermore, if this option is specified, all the other options become invalid.
- -c > -L/R/Wl/l/o

  Because execution is terminated at the as, the options related to the modules following the ld are invalid.
- -m > -G/L/O/R/S/W*c*/a/c/l/o

  Because execution is terminated at the front end, the options related to the modules following pre-optimizer are invalid.
- -O [0-3st]

  The option that is specified later is valid.
- -w/w[1|2]

  The option specified first is invalid.

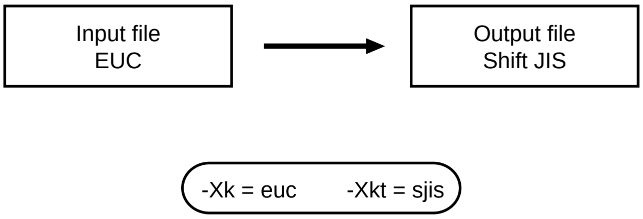
[30] ca handles the directory at the ..\dev position from the ca's installation directory as the standard directory of the device file.

[31] Refer to the description of the library specification (-l) option for the ld.

[32] When ld is started from ca, ca automatically passes the standard library link (-lc) specification to ld.

[33] The executable object file name to be output cannot be specified from the Project Manager's option dialog. Instead, the ".out" extension is added to the first file in the source list, from which the suffix has been removed.

2. If a code other than the default code (shift JIS) is used in the input file to be code-converted by specifying the -Xkt option, then use the -Xk option to specify the code to be used.
If the code to be used is not specified, the default code (shift JIS) will be used and the code will not be converted.



3. A command file does not specify options and file names for commands as the arguments of the command line, but specifies them by describing them in a file. The ca treats the contents of the command file as if they were the arguments of the command line. In the command file, the arguments to be specified can be described over multiple lines. However, options and file names must not be described over more than one line. The command file cannot be nested.

Example of command file

```
-Dtest    ... Describes #define test.
-o object ... Specifies object file name.
a.c       ... Specifies file to be compiled.
```

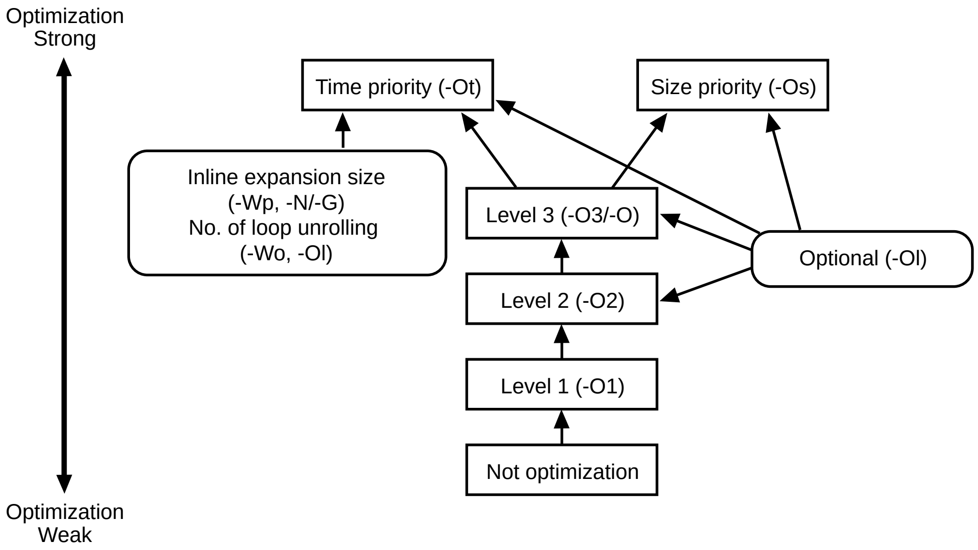
Example of specifying command file

```
> cat cfile
   -cpu 3000 -c -0s file.c ← Contents of command file
> ca850 @cfile             ← Same operation as ca732 -cpu 3000 -c -0s file.c
```

2.2.2 Efficient use of optimization

The optimization levels that can be specified by the -O option are described below along with instructions on using optimization efficiently.

Figure 2-1. Optimization Levels and Parameters



0 : Does not execute optimization.

1 : Executes optimization in the basic block[34].
Optimization in basic block is to execute optimization by using the information that can be obtained in the basic block. This includes constant folding, simplify expressions, common subexpression elimination in the basic block, and copy propagation in the basic block.
<Example> To replace an operation expression of only constants with the constants of the result upon compiling.

2 : In addition to the above, invokes the machine-dependent optimization module.
Optimization such as deleting unreferenced labels, redundant instruction elimination, and peephole optimizations (replacing instruction sequence with more efficient ones) is executed to an assembly-language source program output by the code generation module.
<Example> To delete meaningless branch instructions.

3 : In addition, executes interfunctional optimization and optimization by the as. Optimization, such as copy propagation in a function, common subexpression elimination, redundant assignment elimination, loop invariant motion, operation strength reduction, induction variable substitution, and code hoisting, is performed by using the information that can be grasped in a function.
In addition, sophisticated register allocation that gives consideration to the frequency of referencing variables is performed by using coloring technique.
Moreover, optimization by the as is also executed (refer to page 201).
<Example> To move a substitution statement whose value in a loop is not changed to outside the loop.

[34] Maximum instruction arrangement that is always executed from the first instruction and from which execution does not branch from any instruction other than the last instruction.

s : Executes object size-priority optimization. This is the most valid optimization in the normal application. Executes interfunctional optimization by merging two or more files, re-arranging functions in merged files, and information on optimized functions, in addition to optimization by -O3. Also suppresses 4-byte alignment at the label or beginning of function. Although inline expansion or loop unrolling that increases the size is not performed, the loop that is executed only once is expanded to prevent overhead of the end condition judgment.

t : Executes execution speed-priority optimization. However, the size increases.
In addition to -O3 optimization, executes interfunctional optimization of -Oz, and also executes tail recursion optimization, inline expansion, and loop unrolling.
If the return statement at the end of a function calls the function itself, tail recursion optimization converts the function into a loop to reduce the stack required for calling the function.
Inline expansion expands the entity of a function at a part calling the function, increasing the possibility of optimization and decreasing the overhead from the call.
Loop unrolling expands the entity of a loop two or more times, increasing the possibility of optimization and decreasing the overhead from condition judgment and branch.
Although the code size increases when inline expansion and loop unrolling are executed, the execution speed is expected to increase.
If -Ot is specified and a function including the `asm` statement[35] which defines label is used, the same label is defined in the definition of the function and at the part where inline expansion is executed. In this case, a label multiple defined error occurs.
The functions specified by `#pragma block-interrupt`, `#pragma interrupt`, `#pragma rtos_interrupt`, `#pragma rtos_task`, `#pragma text`, and `#pragma itext`[35] do not execute inline expansion. At this time, messages are not output.

l : Executes optional optimization.
Execute powerful optimization such as code scheduling and redundant instruction elimination. However, the compile speed drops.
-Ol is valid when specified with optimization level 2 or above.

> **Caution** Source file are compiled from the Project Manager one file at a time. Therefore, the source files are not merged and optimized even if size-priority (-Os) or execution time-priority (-Ot) optimization is specified.
> On the other hand, when source files are compiled from the VSH command line with -Os or -Ot specified with two or more source files input, the files are merged and optimized. In other words, the sequence of the functions of the other files are re-arranged, and the functions of the other files are expanded in line. To merge files, compile the files on the VSH command line.

As shown above, although there are many levels and parameters involved in optimization of ca, the basic methods when specifying optimization are as follows.

- Emphasize size.
- Emphasize execution speed, even at the expense of size.

Although nearly all of the optimization functions both reduce size and increase execution speed, for some functions the user must decide a trade-off between size and execution speed.

Among the options described above, “-Os” and “-Ot” are used to make this specification.

[35] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

(1) Size-priority optimization: -Os -Ol

Specify both the “size priority” option (-Os) and the “optional optimization” option (-Ol). The system will specify the stronger optimization option. Among the types of optimization supported by ca, all types of optimization that do not increase the code size should be performed so as to keep the code size as small as possible.

Depending on the application, the following functions may be used in addition to the options described above to further strengthen the optimization.

- Specify -Wi, -O4 (refer to page 173)

  This performs a data flow analysis to further strengthen optimization. However, this may result in a much longer compilation time.
- Use mask register function

  If the application includes a lot of mask code for processing of unsigned char and unsigned short types, using the mask register function[36] can reduce the code size.

  However, using the mask register function means that two fewer registers will be available to be used for register variables.
- Use a section file

  The code size can be reduced and the execution speed increased by allocating data between on-chip memory and the section referenced by gp/r0 for one instruction. If the section allocation[36] of data is not performed by the program, it will be allocated during compilation by the section file[37] as [tidata] (* V850), [sidata], [sedata], [sconst], [sdata].

(2) Execution time-priority optimization: -Ot, -Ol

Specify both the “time priority” option (-Ot) and the “optional optimization” option (-Ol). To have the application (such as a data processing application) shorten the execution time even at the expense of the code size, use the -Ot option to perform inline expansion and loop unrolling. In this case also, optimization is further strengthened by specifying the optional optimization option.

Caution If using the execution time-priority optimization option causes the code size to become much too big, use the “-Wp, -G*num*” or “-Wo, -Ol” option (refer to page 172) to adjust the inline expansion and/or loop unrolling results.

To specify inline expansion of specified functions only regardless of the options, use `#pragma inline`[36]. This will continue to specify “size-priority” but will still give priority to fast execution times for the specified function calls only.

Depending on the application, the mask register function may be used as in “(1) Size-priority optimization” to strengthen optimization. In addition, the following function may be used to further strengthen execution time-priority optimization.

- Expansion of strcpy()

  If the target application makes frequent use of the strcpy() function for copying character strings, specifying the -Xi option to perform “expansion of strcpy” can shorten execution time. However, it will increase the code size.

[36] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

[37] Refer to page 408.

(3) Reducing code size during execution time-priority optimization: -Ot -Wp, -r

In some cases, merging of source files during inline expansion results in the generation of unnecessary functions. In such cases, specifying the "-Wp, -r" options (refer to page 172) can reduce unnecessary functions and thereby reduce the code size.

2.2.3 Effects of debugging on optimization

Note with caution that optimization can have the following effects when using the source debugger.

[Optimization level 1 (-O1)]

(1) Copy propagation and common subexpression elimination can eliminate "variable references" where they appear in the source program and have an effect on the debugging information that the debugger uses.

[Optimization level 2 (-O2)]

(1) The line number information is also changed for lines which contained statements that have been deleted or rearranged. The variables' range of existence[38] and positions[39] may have changed, which can have an effect on the debugging information that the debugger uses.

[Optimization level 3 (-O3)/ Execution time-priority optimization (-Ot)/ Size-priority optimization (-Os)]

(1) Break points cannot be set for statements where deletions have occurred.

(2) The transfer, splitting, and merging of statements may have rearranged the sequence of executable instructions[40], in which cases the lines between lines which have been rearranged may be handled as a single line for which break points, step execution, etc., can no longer be set.

(3) If the sequence of executable instructions for if-else statements has been rearranged or if loop unrolling has caused a sequence of executable instructions to be rearranged, step execution may no longer be possible, as in (2) above.

(4) The entire function is regarded as the valid range (scope) for all automatic variables. However, if automatic variables have been allocated to registers, even when they are within the scope, they can be deleted or otherwise rendered invisible by optimization. This can be due to the variables being used as "local variables" within the scope or being assigned as local variables as a result of optimization.

Example)

```
int f(){
        int a; ← Valid within function
        ...
    (Address 1)
        ...    ← a is used only in the range from address 1 to address 2
    (Address 2)
        ...
}
```

[38] The range in the program within which the variables can be referenced

[39] Position in a register or in memory

[40] The address of an executable instruction within a line of source code may be smaller than the address of an executable instruction in a previous line or may be greater than the address of an executable instruction in a subsequent line.

In the above example, the scope of “a” is the entire function f(). However, “a” is used only between address 1 and address 2. In this case, if “a” is allocated to a register and optimization causes it to be deleted from the stack frame, “a” will become invisible outside of the area between address 1 and address 2. This phenomenon occurs in order to make more efficient use of registers by making the register where “a” has been allocated available (except for the section between address 1 and address 2) for allocation of other variables.

(5) Note that since the debugger does not support optimization results from the assembler, such results cannot be used as information for debugging.

(6) During compilation, the processing of debugging information uses a large amount of memory, which may cause an “`out of memory`” condition to occur.

(7) Step execution cannot be performed when using sections that have been merged into one line during inline expansion.

(8) Step execution cannot be performed when using sections that have been merged into one main loop section during loop unrolling. Also, the merging of loops into one main loop section means that the number of loops that exist after expansion rather than the number of loops that had existed before expansion.

2.2.4 Output of bdld instruction * V830

When the -Xbdld option has been specified, static structures or external structure variable values greater than 16 bytes, which have been allocated to a section in external memory, are assigned to variables in the .sidata section allocated in on-chip data RAM, and output bdld instructions during ca’s assembly language creation.

This results in the following effects.

- The size of the command code needed for transferring is reduced.
- If the external memory data to be transferred is not in a cache, it can be transferred more quickly.
- If the target data size is a multiple of 16 bytes, the cache contents do not change.

[Description example of bdld instruction output using option]

```
struct data {
     int i[4];
};
struct test {
     struct data image;
};

#pragma section sidata begin
struct data a; ← Transfer destination (allocated to .sidata section by C compiler)
#pragma section sidata end

struct test b;

void
func(){
     a = b.image;
}
```

[Output assembly language]

```
        .sbss
        .com     _b, 16, 16
        .sidata
        .align   16
        .globl   _a, 16
_a:
        .space   16
        .text
_func:
         ...
        movea    !_a, zero, r10
        movea    $_b, gp, r11
        bdld     [r11], [r10]
         ...
```

Cautions

- When this option has been specified, not only static structures and external structures that are at least 16 bytes long but also static arrays and external arrays that are at least 16 bytes long are aligned into 16-byte segments. Accordingly, some of the data area is wasted, which may increase the overall code size.
- If all of the external memory data to be transferred is in the cache, specifying this option will slow down the transfer speed.
- If the data size is not a multiple of 16 bytes, the ld/st instruction will be output to transfer the fractional parts. Since the ld instruction performs caching to access cacheable external memory, the cache contents will change.
- Assignments that use pointers are not subject to bdld instruction output.

[Description example in which use of pointer excludes bdld instruction output]

```
struct data {
    int i[4];
};
struct test {
    struct data image;
};

#pragma section sidata begin
struct data a;
#pragma section sidata end

struct test *b;     ← Pointer variable

void
func(){
    a = b->image;  ← Assigned by pointer
}
```

[Output assembly language]

```
        .sbss
        .com     _b, 16, 16
        .sidata
        .align   16
        .globl   _a, 16
_a:
        .space   16
        .text
_func:
          ...
        movea    !_a, zero, r10
        ld.w     $_b, r11
        ld.w     [r11], r12
        st.w     r12, [r10]
        ld.w     4[r11], r13
        st.w     r13, r[r10]
        ld.w     8[r11], r14
        st.w     r14, 8[r10]
        ld.w     12[r11], r15
        st.w     r15, 12[r10]
          ...
```

- When structures are nested and the members have not been aligned into multiples of 16 bytes, those members are not subject to bdld instruction output.

[Description example in which nesting of structures excludes bdld instruction output]

```
struct data {
    int i[4];
};
struct test {
    char header;
    struct data image;    ← Member image is not aligned into 16-byte segments
};

#pragma section sidata begin
struct data a;
#pragma section sidata end

struct test b;

void
func(){
    a = b.image;
}
```

[Output assembly language]

```
        .sbss
        .com      _b, 20, 16
        .sidata
        .align    16
        .globl    _a, 16
_a:
        .space    16
        .text
_func:
          ...
        movea     !_a, zero, r11
        ld.w      $_b+4, gp, r12  ← Member image is displayed as offset from the fourth byte
                                    of the structure
        ld.w      [r12], r13
        st.w      r13, [r11]
        ld.w      4[r12], r14
        st.w      r14, r[r11]
        ld.w      8[r12], r15
        st.w      r15, 8[r11]
        ld.w      12[r12], r16
        st.w      r16, 12[r11]
          ...
```

2.2.5 Argument of -W option

This section explains the option to be passed by the ca as an argument to each module.

For the options of the assembler (as) and link editor (ld)[41], refer to the explanation on the options on page 201 and page 222.

- Pre-optimizer (popt: -Wp)

  -D : Reduces the capacity of the memory used for compiling.

  -G*num* : Limits the stack size of the function subject to inline expansion to the size *num* in intermediate language, and does not execute inline expansion of a function greater than *num*. For the criterion of *num*, refer to the explanation on the -l option below. If this option is not specified, -G32 is assumed.

  -N*num* : Limits the intermediate language size of the function subject to inline expansion to *num*, and does not execute inline expansion of a function greater than *num*.
  For the criterion of *num*, refer to the explanation of the -l option below.
  If this option is not specified, -N128 is assumed.

  -S : Unconditionally executes inline expansion of static functions that are referenced only once.

  -l : Displays information on functions.
  The displayed information serves as the criteria of the values specified by the -G and -N options mentioned above.
  For example, if the stack size of a called function is less than the value specified by -G, inline expansion is executed. If the code size of a called function is less than the value specified by -N, inline expansion is executed.

  -r[*funcname*]: Using function *funcname* as an entry function, deletes the unnecessary functions of those called from the entry function after expansion.
  Specify *funcname* by prefixing “_” to a function name.
  If *funcname* is not specified, “_main” is assumed.
  (Caution)
  Note that the function called only by an assembler statement is not recognized to be called, as a result, the function is deleted as an unnecessary function.

[41] To start the ld from the ca, -lc is passed to the ld as default assumption, even if it is not specified by the -W option.

- Global optimization module (opt: -Wo)

-Ol[*num*] : Expands a loop such as for and while *num* times[42, 43].
Execution of a loop which is executed N times (N is a constant) is converted into execution of a loop including both the execution of a code the number of times equal to the result of N ÷ *num* and the codes expanded *num* times.
If 0 or 1 is specified as *num*, expansion is suppressed[44]. If *num* is not specified, 4 is assumed.

<Example> To expand 4 times a loop which is executed 10 times.

```
i=0;
while(i<10) {
   (processing)
   ++i;
}
      ↓
i=0;
(processing)
i=1;
(processing)
i=2;
while(i<10) {
   (processing)
   ++i;
   (processing)
   ++i;
   (processing)
   ++i;
   (processing)
   ++i;
}
```

- Machine-dependent optimization module (impr: -Wi)

-D : Can reduce the memory capacity required for compiling.

-O4 : Executes data flow analysis precisely and enhances optimization. However, compiling speed drops. Specify only when enhanced data flow analysis is required after -Ol specification.

-P : Suppresses optimization of aligning labels. This can reduce the code size.

[42] Specify *num* in decimal number.

[43] A complicated loop such as the one that internally includes another loop may not be expanded.

[44] This is useful for not executing loop unrolling with optimization level t specified.

2.3 Cautions on Specifying Options

The following specification sequence is applied to the options specified when starting the compiler.
The options specified with -W option are allocated at the end of a command line other than the -W option[45].

Example>

```
> ca850 -cpu 3000 file.o -Wl, -D, dfile, -ol
    Arguments are passed as follows upon starting ld.
    ld850 \nectools\lib850\r32\crtN.o -o a.out file.o -lc -D dfile -ol
    (However, it is assumed that ld850 is placed in \nectools\bin.)
```

Caution Since the mathematical library references the standard library, make sure that “-lc” is placed after “-lm”[46].

2.4 Example

Here are some examples of using the ca.

- To start from ca to ld to create an executable object
  ca850 -cpu 3000 -Utest -o object a.c
  C source file a.c is compiled and executable object file object is created. At this time, it is assumed that #undef test is described before the C source program in a.c. The V851 is used as the target device.
  ca850 -cpu 3000 -Wl, -D, dirc file.c -lm
  C source file file.c is compiled and executable object file a.out is created. At this time, directive file dirc is instructed to the ld, and mathematical library libm.a is linked.

- To start from ca to as, but not ld, to create relocatable object file
  ca850 -cpu 3000 -c file.c
  C source file file.c is compiled and relocatable object file file.o is created.

[45] To start ld from ca in VSH, -lc is passed to the ld as the default assumption, even if it is not specified by the -W option.
To start ld from ca, start-up module crtN.o is passed to the ld as the default assumption unless -R is specified.

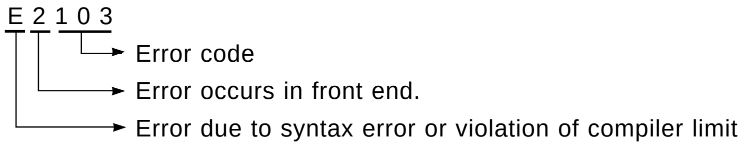
[46] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

CHAPTER 3 MESSAGES

This chapter explains the messages output by the ca.

3.1 Message Format

Example


E 2 1 0 3
Error code
Error occurs in front end.
Error due to syntax error or violation of compiler limit

The name of the module responsible for the error is appended to the error message output by the ca.

If the name of a file or the number of the line where the error occurred can be identified, the file name and line number are appended also along with a message number.

The message number indicates the level of the error that has occurred, and the module in which the error occurred.

The meaning of the initial character of a message number indicating the error level is as follows:

F ... Fatal error. Compiling is always stopped.
Example> Memory capacity runs short.

E ... Error due to violation of syntax or compiler limit. If errors of this type occur exceeding the specified number, compiling is stopped.
Example> Undefined variable.

W ... Warning. Compiling continues.
Example> A variable is referenced before a value is set to it.

The number following the above-mentioned characters indicates the module where the error occurred.

1	... ca driver module (ca)
2	... front end (cafe)
5	... global optimization module (opt)
6	... code generation module (cgen)
7	... pre-optimizer (popt)

3.2 Messages

This section lists the error messages in the alphabetical order of the error number level from the lowest error number toward the highest.

Note that some messages are not output depending on the family used.

The italic characters in the output messages and explanatory statements are determined during command processing.

E1305: cannot remove temporary directory '*dir*'
The work directory *dir* prepared for creating a temporary file cannot be deleted.

E1307: cannot unlink temporary file '*file*'
Temporary file *file* cannot be deleted.

E2103: illegal header name
The character string of the header name specified by `#include` is incorrect.

E2104: cannot find include file '*file*"
The file *file* specified by the `#include` directive cannot be found.

E2111: illegal token '*token*'
An illegal token *token* is recognized.

E2113: unexpected EOF
The file ends at a position not permitted by syntax.

E2114: non-terminated comment
"*/" that closes the comment is missing.

E2116: illegal expression syntax
The description of the expression in preprocessing control is incorrect.

E2117: compiler limit: too long identifier '*name* ...' [*num*]
The name of the identifier is too long. The maximum value of this processing system is 1023 in the case of the internal identifier and 1022 in the case of the external identifier.

E2118: compiler limit: too many characters in string literal [*num*]
The character string literal is too long. The maximum value of this processing system is 4045.

E2123: compiler limit: too many macro parameters [*num*]
Too many macro parameters are used. The maximum value of this processing system is 31.

E2124: illegal macro name '*name*'
The macro name *name* is incorrect.

E2125: System reserved macro '*name*' must not be redefined.
Macro *name* must not be re-defined because it is reserved for the system.

E2126: System reserved macro '*name*' must not be undefined.

Macro *name* definition reserved for the system cannot be canceled.

E2129: illegal macro parameter '*name*'

The parameter *name* of the macro is incorrect.

E2130: macro '*name*': mismatch number of parameters

The number of parameters of macro *name* does not agree.

E2131: macro '*name*': missing ')'

")" is missing from the macro *name* definition that has a parameter.

E2133: illegal operand for '#' operator

Something other than a parameter is specified for the '#' operator in macro definition.

E2134: compiler limit: too long stringizing result [*num*]

The character string is too long.

The maximum value of this processing system is 4045.

E2135: illegal operand for '##' operator

The description of connection of tokens in macro definition is incorrect.

E2136: illegal pasting result

The result of connection tokens is incorrect.

E2137: compiler limit: too long pasting result [*num*]

The result of connection tokens is too long.

The maximum value of this processing system is 4045.

E2151: illegal preprocessing directive

The description of the preprocessing directive is wrong.

E2152: illegal number '*name*' in conditional inclusion.

name that is not an integer must not be specified in an expression following `#if`.

E2155: compiler limit: too many conditional inclusion nestings [*num*]

The number of times of nesting between "`#if`" and "`#endif`" exceeds the limit.

The maximum value of this processing system is 255.

E2156: misplaced '`#else`' or '`#elif`'

The position of "`#else`" or "`#elif`" is inappropriate.

E2157: misplaced '`#endif`'

The position of "`#endif`" is inappropriate.

E2159: illegal include directive syntax

The description of `#include` is not correct.

E2170: **illegal integral/floating constant**
The notation of the integer/floating-point constant is incorrect.

E2171: **constant out of range**
The range in which a constant value can be expressed is exceeded.

E2173: **illegal octal digit**
The description of an octal number is incorrect.

E2174: **illegal hexadecimal digit**
The description of a hexadecimal number is incorrect.

E2175: **octal digit out of range**
The range that can be expressed in octal number is exceeded.

E2177: **empty character constant**
The character constant is vacant.

E2180: **Code of file '*file*' is not *code* (*data*).**
Code in file *file* is not code *code*. A character that is illegal as a Japanese character code exists.

E2210: ***name*: not defined**
name is not defined.

E2211: **redeclaration of *name***
name is re-declared.

E2213: **Declarator not specified**
No declarator is specified.

E2214: **Void object is not allowed.**
void object is not allowed.

E2220: **Both ‘signed’ and ‘unsigned’ are specified.**
Both “`signed`” and “`unsigned`” are specified.

E2221: **illegal type specifier combination**
The combination of type-specifiers is incorrect.

E2236: **Typedef declaration must not have initializer.**
typedef declaration must not include an initializer.

E2237: **too many initializers**
Too many initializers are used.

E2238: **illegal initializer**
The initializer is incorrect.

E2240: **Local static function is not allowed.**
The static function must not be declared in local scope.

E2250: **Array size is not given.**
The size of the array is not given.

E2251: **Array size must not be zero.**
The size of the array must not be zero.

E2252: **Array type has incomplete element type.**
The type of the array element is incomplete.

E2260: **compiler limit: complicated type modifiers [*num*]**
Too many derivative modifiers are used.
The maximum value of this processing system is 16.

E2261: **illegal storage class specifier combination**
The combination of storage class specifiers is incorrect.

E2262: **illegal use of ‘enum’**
Type specifier “`enum`” is incorrectly used.

E2263: **illegal use of ‘*struct*’**
Type specifier “`struct`” is incorrectly used.

E2265: **illegal use of ‘union’**
Type specifier “`union`” is incorrectly used.

E2266: **illegal use of ‘auto’**
Storage area class specifier “`auto`” is incorrectly used.

E2267: **illegal use of ‘static’**
Storage area class specifier “`static`” is incorrectly used.

E2269: **illegal use of ‘register’**
Storage area class specifier “`register`” is incorrectly used.

E2270: **illegal use of ‘extern’**
Storage area class specifier “`extern`” is incorrectly used.

E2280: **Void function cannot return value.**
A return value is specified for a void type function.

E2281: **Function has illegal storage class.**
The storage class specified for the function is incorrect.

E2282: **Array of function is now allowed.**
An array of functions is disallowed.

E2283: illegal return type: function

The return value of a function must not be used as a function type.

E2284: illegal return type: array

The return value of a function must not be used as an array type.

E2285: 'Void' in parameter list

void type is specified within the arrangement of the argument declaration of the function declaration. void type can be used only singly.

E2286: Function requires return value.

No return value is specified for a function having a return value.

E2288: return type mismatch *type1* (*type2*)

The type of return value *type2* indicated by the return statement does not match return type *type1* of the function.

E2290: argument type mismatch *type1* (*type2*)

The type of actual argument *type 2* does not match the type of dummy argument *type1* at the time of the function declaration.

E2292: Argument *name* is missing.

Dummy argument name *name* declared in the function definition cannot be found.

E2296: illegal first argument '...', requires a named argument

"..." cannot be used as the first argument of a function.

E2300: 'Struct'/'union' size must not be zero.

The size of a structure/union must not be zero.

E2301: illegal bit-field type

A type which must not be specified for a bit field is specified.

E2303: illegal bit-field size

The value of a constant expression that specifies the width of a bit field must not exceed the number of bits constituting the object of the specified type.

E2304: '*name*' has incomplete type.

The type of *name* is incomplete.

E2305: Field '*name*' declared as a function.

The type of member *name* is a function type.

E2401: syntax error

The syntax is incorrect.

E2402: Label '*label*' not defined

Label *label* is not defined.

E2411: ***label* is not in switch**

The case label or default label is missing from the switch statement.

E2412: **duplicate ‘case *num*:’ in switch**

The case label *num* in the switch statement is duplicated.
num may be expanded as a numeric value.

E2413: **duplicate ‘default:’ in switch**

The default label is duplicated in the switch statement.

E2414: **‘break’ not in loop nor switch**

“`break`” is outside a repeat statement or a switch statement.

E2415: **‘continue’ not in loop**

“`continue`” is outside a repeat statement.

E2420: **argument *num* expected for function call *function***

The argument following *num* is not specified in function call *function*.

E2421: **unexpected argument *num* for function call *function***

Excess argument is specified after *num* in function call *function*.

E2422: **undefined static function ‘*function*’**

Called static function *function* is not defined in a file.

E2510: **cannot cast: *type1* to *type2***

Casting from *type1* to *type2* cannot be executed.

E2511: ***expression* must be arithmetic or pointer type.**

expression must be of arithmetic or pointer type.

E2512: ***expression* must be arithmetic type.**

expression must be of arithmetic type.

E2513: ***expression* must be pointer type or zero.**

expression must be of pointer type or zero.

E2515: ***expression* must be integral type.**

expression must be of integer type.

E2516: ***expression* must be constant expression.**

expression must be a constant expression.

E2517: **One of the operands for ‘[ ]’ must be pointer type and the other must be of integral type.**

One of the operands for “[ ]” must be of pointer type and the other must be of integer type.

E2518: **illegal operand for unary ‘&’**

The operand of the unary operand “&” is incorrect.

E2519: exception has occurred at compile time.

Exception *exception* related to floating-point operation occurred during compiling.

E2522: *name* is not a member.

name is not a member of a set.

E2523: illegal LHS of '*operator*' operator (must be modifiable L value)

An illegal substitution destination is described to the left of operator *operator*.

E2524: illegal type combination for '*operator*' (*type1*, *type2*)

The combination of types for the operator *operator* (*type1* and *type2*) is incorrect.

E2526: Operands of '*operator*' operator must have same type (*type1*, *type2*).

Use the same type (*type1* and *type2*) for the right and left of the operator *operator*.

E2530: Operand of '( )' must be function type.

The operand of the "( )" operator must be a function.

E2532: Operand of '*operator*' must be pointer type.

The operand of the operator *operator* must be of pointer type.

E2533: Operand of '.' must be 'struct'/'union' object.

Use the "`.`" operator for a structure or union.

E2535: Operand of '->' must be pointer to 'struct'/'union' object.

Use the "`->`" operator for the pointer to a structure or union.

E2550: Operand of 'sizeof' must not be function nor bit-field.

The operand of "`sizeof`" cannot specify a function or bit field.

E2551: unknown size ('struct', 'union' or array)

A set whose size is unknown is specified for an operator requiring object size.

E2552: unknown size (function)

A function whose size is unknown is specified for an operator requiring for object size.

E2553: cannot convert non-L value array to pointer

An array which is not a left-side value cannot be converted into a pointer.

E2630: unrecognized interrupt request name '*name*'

An illegal interrupt request is specified by the `#pragma` directive.

E2631: Interrupt request name '*name*' is already specified.

Interrupt request name *name* has already been specified.

E2632: illegal directive '#pragma interrupt', function name must be specified

A function name is necessary for declaration of an interrupt handler by the `#pragma` directive.

E2633: cannot specify interrupt attribute ‘direct’, function ‘*function*’ is already defined.

An interrupt handler cannot be directly located and specified after function definition.

E2636: Multiple interrupt request names are specified for function ‘*function*’, ‘direct’ cannot be specified.

Two or more interrupt requests are specified for function *function*.

Direct location (*direct*) cannot be specified for a function for which two or more interrupts are specified.

E2638: Interrupt function must be void type.

The return type of a function declared as an interrupt must be of void type.

E2639: illegal function type for software interrupt function, must be void (unsigned int).

A function declared as a software exception interrupt (trap interrupt) can only have one unsigned int type as the argument.

E2640: illegal function type for interrupt function, must be void (void)

A function declared as an interrupt (except software exception) cannot have an argument.

E2641: cannot call interrupt function

A function declared as an interrupt cannot be called.

E2642: Function ‘*function*’ is already defined, ‘block_interrupt’ must be specified before function definition.

Interrupts cannot be disabled after the function definition.

E2644: Function ‘*function*’ is already defined without ‘_interrupt’.

Although function *function* is specified as an interrupt handler, *function* has been already defined without interrupt specification.

E2646: Both interrupt and RTOS interrupt attributes are specified.

The normal interrupt and RTOS interrupt must not be specified at the same time.

E2647: Specifying interrupt name ‘*name*’ is not allowed.

RESET and RST must not be specified as an interrupt request name.

E2648: unknown cpu type, cannot use interrupt request name

An interrupt request name cannot be used because no device is specified.

E2649: Interrupt function ‘*function*’ with ‘direct’ is undefined.

Function *function* that is specified to be located directly is not defined in the file.

E2650: illegal directive ‘#pragma section’, section name must be specified

A section name is not specified in section allocation by the `#pragma` directive.

E2651: illegal directive ‘#pragma section’, unrecognized section name ‘*name*’

An illegal section name *name* is specified in section allocation by the `#pragma` directive.

E2652: illegal directive ‘#pragma section’, ‘begin’ or ‘end’ must be specified

“begin” and “end” are necessary for section allocation by the `#pragma` directive.

E2653: Directive '#pragma section' is nested.

Section allocation specification by the `#pragma` directive is nested.

E2654: inconsistent section for '*symbol*'

The section contradicts symbol *symbol*.

E2655: misplaced '#pragma section *section* end'

The position of "`#pragma section` *section* `end`" is inappropriate.

E2660: cannot write, read only I/O register '*regname*'

Data cannot be written to internal peripheral function register *regname* that has only a read attribute.

E2661: cannot read, write only I/O register '*regname*'

Data cannot be read from internal peripheral function register *regname* that has only a write attribute.

E2662: cannot access for I/O register bit number '*regname*'

A position that cannot be accessed is specified in the description of the bit access to internal peripheral function register *regname*.

E2663: I/O register bit number must be integral type.

Describe the specification of the bit position for an internal peripheral function register with an integer value.

E2664: Specifying bit number for I/O register '*regname*' is not allowed.

Bit access cannot be specified for a bit of internal peripheral function register *regname*.

E2665: unknown cpu type, cannot use I/O register

The internal peripheral function register cannot be used because the target device is unknown.

E2666: illegal operand (I/O register '*regname*') for unary '&'

The address of internal peripheral function register *regname* cannot be obtained.

E2670: unexpected EOF, missing '#pragma endasm'

Specification of the final assembler insertion cannot be found.

E2680: illegal argument for __set_il (unsigned int)

The argument of the function that sets an interrupt level is wrong.
Specify only one integer type as an argument. *V830

E2681: First argument for __set_il is out of range.

The value of an interrupt level exceeds the range that can be specified.
An integer of 0 to 16 can be set as an interrupt level. *V830

E2681: First argument for __set_il is out of range.

The value of an interrupt level exceeds the range that can be specified.
An integer of –1 to 8 can be specified as an interrupt level. *V850

E2682: Second argument for __set_il must be string literal.

Specify a character string indicating an interrupt request name as the second argument of the function that sets an interrupt level. * V850

E2685: illegal argument for __set_il (int, char*)

The argument of the function that sets an interrupt level is wrong. Specify an integer type as the first argument, and an interrupt request name as the second argument. * V850

E2692: Both interrupt attribute and 'rtos_task' are specified.

An RTOS task and an interrupt cannot be specified for a function at the same time.

E2693: Function '*function*' is already defined, 'rtos_task' must be specified before function definition.

A function must not be specified as an RTOS task after the function definition.

E2694: Function '*function*' is already defined without '__rtos_interrupt'.

Although function *function* is specified as an interrupt handler, *function* has been already defined without interrupt specification for RTOS.

E2695: cannot call rtos_task function

A function that is specified as an RTOS task cannot be called.

E2696: Rtos system call '*function*' is already defined, cannot specify '#pragma *kind*'

A function having the same name as function *function* has already been defined or declared.
The RTOS system call cannot be validated by the pragma specification of the RTOS function.

E2697: Rtos system call '*name*' is called in the function, for which rtos interrupt attribute is not specified.

RTOS system call *name* is called by a function for which an RTOS interrupt is not specified.
name is regarded as a normal function call.

E2698: cannot call rtos_interrupt function

A function that is specified as an RTOS interrupt handler cannot be called.

E2701: Duplicated GP symbol for RTOS interrupt function '*function*'

Another gp symbol has already been allocated to function *function* specified as an RTOS interrupt handler.

E2702: Specifying interrupt name '*name*' is not allowed for rtos_interrupt.

name must not be specified as an interrupt request name.

E2712: unexpected end-of-line (missing ']')

Enclose a section name in a section file with "[ ]".

E2713: unexpected character(s) '*token*'

An unnecessary token *token* exists in the section file. Check the format of the section file.

E2714: Variable, function or file name is missing.

The description of the variable information of the section file is illegal.

E2715: **illegal function/variable name ‘*symbol*’**
Symbol *symbol* is an illegal function name or variable name.

E2716: **Section name is not specified.**
A section name is not specified.

E2717: **unrecognized section name ‘*section*’**
Illegal section name *section* is specified.

E2745: **Both ‘text’ and ‘itext’ are specified.**
Both text and itext section allocation cannot be specified for a function. * $\boxed{\text{V830}}$

E2746: **Too long section name [256]**
The section name is too long. Specify the name with 256 characters or shorter.

E2747: **inconsistent section name for ‘*symbol*’**
The section name contradicts symbol *symbol*.

E7201: **multiple defined symbol ‘*symbol*’**
Multiple-defined symbol *symbol* exists.

E7202: **redeclaration of ‘*symbol*’**
symbol is re-declared.

E7203: **undefined symbol ‘*symbol*’**
symbol is undefined.

E7204: **undefined label (.L*num*)**
The label .L*num* is undefined.

E7205: **Argument type mismatch is detected where ‘*caller*’ calls ‘*callee*’.**
The argument types of *caller* and *callee* differ during inline expansion.

E7206: **Return value type mismatch is detected where ‘*caller*’ calls ‘*callee*’.**
The types of the return values of *caller* and *callee* differ during inline expansion.

E7207: **interrupt request ‘*name*’ already specified.**
Interrupt request name *name* has already been specified.

E7208: **inconsistent section for ‘*symbol*’**
The section contradicts *symbol*.

F1001: **out of memory**
The memory capacity has run short.

F1002: **cannot recover from previous errors**
Processing cannot continue as a result of an error that previously occurred.

F1102: invalid argument of option '*option*'

The argument of option *option* is illegal.

F1103: nested command file '*file*'

Command file *file* is nested. It must not be nested.

F1104: Argument of -reg option requires 26 or 22.

Specify either 26 or 22 as the argument of the -reg option.

F1105: cannot use '*option1*' option with '*option2'* option

Options *option1* and *option2* must not be specified at the same time.

F1106: cannot specify output file name of –Xcre_sec_data with many source files.

When inputting two or more source files, the output file name of option –Xcre_sec_data must not be specified. * V850

F1201: fork failed

The fork of the process failed.

F1202: *module*: not found

module *module* that must be started cannot be found.

F1203: *module*: exec failed

Execution of module *module* has failed.

F1292: too long argument

Arguments exceed 128 bytes when starting module.

The arguments must be command file.

F1302: '*file*': illegal output file name

The output file name *file* specified by the -o option must not be the same as an input file name. Change *file*.

F1303: cannot open file '*file*'

File *file* cannot be opened.

F1304: cannot create temporary directory

A work directory for creating the temporary file cannot be created.

F1306: cannot open temporary file '*file*'

Temporary file *file* cannot be opened.

F1309: '*file*': illegal output file name of –Xcre_sec_data

The output file name *file* specified by option –Xcre_sec_data must not be the same as an input file name. Change *file*. * V850

F2001: illegal command path

The specified command path is incorrect.

F2002: compiler limit: too long command path [*num*]

Compiler limit: The length of the specified path exceeds the limit.

The maximum value of this processing system is 1024.

F2003: out of memory

The memory capacity has run short.

F2004: too many errors

Compiling has stopped because errors exceeding the specified number of times have occurred.

F2005: cannot open output file '*file*'

Output file *file* cannot be opened.

F2006: cannot open input file '*file*'

Input file *file* cannot be opened.

F2007: cannot write file '*file*' (errno=*num*)

Error of error number *num* occurs while file *file* is written.

F2010: illegal option '*option*'

The specification of option *option* is not correct.

F2011: compiler limit: too many *option* options [*num*]

The number of times option *option* is specified exceeds the limit.

The maximum value of this processing system is *num*.

F2020: compiler limit: scope level too deep [*num*]

The depth of the scope level exceeds the limit.

The maximum value of this processing system is 50.

F2040: compiler limit: too many parameters [*num*]

The number of the dummy arguments of the function is too many.

The maximum value of this processing system is 255.

F2105: compiler limit: too long file name '*file*' [*num*]

The name of the file *file* is too long.

The maximum value of this processing system is 1024.

F2106: Non empty file must end in new-line character.

A file that is not vacant must be terminated with a carriage return.

F2110: unknown character '*character*'

An illegal character *character* is used.

F2112: compiler limit: too many characters in logical source line [*num*]

The number of characters in the logical source line exceeds the limit.

The maximum value of this processing system is 4047.

F2115: non-terminated string literal

"″" closing a character string is missing.

F2120: compiler limit: preprocessor token buffer overflow [*num*]

The length of the expanded character string in macro definition exceeds the limit (the buffer capacity has run short by *num* characters).

F2121: compiler limit: too many macro definitions [*num*]

The number of macro definitions exceeds the limit.

The maximum value of this processing system is *num*.

F2122: compiler limit: too long macro name '*name*' [*num*]

The length of the macro name *name* is too long.

The maximum value of this processing system is 1023.

F2128: redeclared macro parameter '*name*'

The parameter *name* of a macro is re-defined.

F2153: unexpected non-whitespace before preprocessing directive

A character other than a blank character space exists before a preprocessing directive.

F2154: undefined control

The description of the preprocessing directive following "#" is incorrect.

F2158: compiler limit: too many include nestings [*num*]

The number of times of nesting of the `#include` directive exceeds the limit.

The maximum value of this processing system is 50.

F2160: *errmsg*

The error indicated by *errmsg* has occurred.

This message is displayed if the `#error` directive is used in the source program.

F2230: compiler limit: initialization nests too deep [*num*]

The nesting of the initializer list is too deep.

The maximum value of this processing system is 100.

F2410: compiler limit: too many case labels [*num*]

The number of case labels in the switch statement exceeds the limit.

The maximum value of this processing system is 1025.

F2608: cannot recover from earlier errors

The processing cannot continue as a result of the error that previously occurred.

F2620: unknown cpu type, cannot compile

Compiling cannot be executed because a target device is not specified.

F2622: duplicated cpu type

A target device specifications is duplicated by an option or the `#pragma` directive.

F2623: cannot find device file

A device file corresponding to the specified target device is not found, or a wrong target device has been specified.

F2624: device file read error

Reading of the device file has failed.

The device file may have been destroyed.

F2625: illegal placement '#pragma cpu'

The position of the `#pragma` directive that specifies a device name is illegal.

Describe the device specification before the syntax of the C language.

F2626: illegal cpu type: *type*

Correspondence of device specification is not established.

Specify a device corresponding to the C compiler that is used.

F5001: unknown option '*option*'

An illegal option *option* is specified.

F5005: invalid argument of option '*option*'

The argument of option *option* is illegal.

F5104: out of memory

The memory capacity has run short.

F5106: exception *exception* occurred at compile time.

An exception *exception* related to floating-point operations occurred during compiling.

F5901: cannot open file '*file*'

File *file* cannot be opened.

F5902: cannot write file '*file*' (errno=*num*)

Error of error number *num* occurs while file *file* is written.

F6000: cannot open file '*file*'

File *file* cannot be opened.

F6002: cannot unlink file '*file*'

File *file* cannot be deleted.

F6005: cannot write file '*file*' (errno=*num*)

Error of error number *num* occurs while file *file* is written.

F6203: out of memory

The memory capacity has run short.

F6300: '-Xold_fcall' option is not supported for V850E.

-Xold_fcall option is invalid for the V850E. * V850

F7000: **too many errors**

Compiling has stopped because errors exceeding the specified limit have occurred.

F7001: **unknown option '*option*'**

An illegal option '*option*' has been specified.

F7002: **invalid argument of option '*option*'**

The argument of the option *option* is illegal.

F7003: **nested command file '*file*'**

The command file *file* is nested. It must not be nested.

F7004: **no input file**

No input file is specified.

F7005: **cannot open file '*file*'**

File *file* cannot be opened.

F7006: **archive symbol table and archive member mismatch**

An abnormality occurred in the archive symbol table.

F7007: **unknown file type '*file*'**

The file type of *file* is not known.

F7009: **out of memory**

The memory capacity has run short.

F7010: **multiple defined symbol '*symbol*'**

Multiple-defined symbol *symbol* exists.

F7011: **duplicated cpu type**

A target device is specified in duplicate by an option or the `#pragma` directive.

F7012: **cannot write file '*file*' (errno=*num*)**

Error of error number *num* occurs while file *file* is written.

W1111: **sorry, not implemented option '*option*', ignored**

Option *option* is not supported. It is ignored.

W1112: **-G option needs size (>=0): ignored**

Size must be specified for the -G option.
It is assumed that ∞ has been specified.

W1114: **file '*file*' with unknown suffix passed to ld**

File *file* is a file with an unknown suffix. It is passed to ld.

W1116: **sorry, '*suffix*' file not supported, ignored**

File with suffix *suffix* is not supported. It is ignored.

W1119: ***option1* option overrides *option2* option.**

Option *option2* becomes invalid because option *option1* is specified.

W1120: ***option1* option obsolete, use *option2* instead**

Option *option1* is an option of the old version.
Use option *option2*.

W1122: **–Ol option is valid only when optimization level is –O2 or higher.**

The –Ol option is valid only if the optimization level is 2 or higher.

W1308: **output file of *option1* overrides output file of *option2***

The output file of option *option1* is overwritten because the output file of option *option2* is specified.

W2042: **illegal argument for _rcopy()**

The argument of copy routine _rcopy() is illegal.

W2127: **redefined macro name '*name*'**

Macro name *name* is re-defined.
The name defined later is valid.

W2132: **macro recursion '*name*'. Macro is expanded only one time.**

Macro recursion is found.
The macro is expanded only once.

W2150: **unexpected character(s) following directive '*directive*'**

An unnecessary token is found after preprocessing directive *directive*.
The unnecessary token is ignored.

W2161: **unexpected non-whitespace before preprocessing directive**

A character other than a blank character space exists before a processing directive.

W2162: **unrecognized pragma directive '#pragma *directive*', ignored**

`#pragma` *directive* is not recognized.
This pragma directive is ignored.

W2172: **constant out of range**

The constant value exceeds the range in which it can be expressed.
It is assumed that only the lower valid number of digits has been specified.

W2176: **hexadecimal digit out of range**

The range in which a hexadecimal value can be expressed is exceeded.
The last two characters are valid with this processing system.

W2212: **Declaration of *name* hides parameter.**

Because a symbol *name* identifical to that of the argument exists, the symbol is assumed to be valid, and declaration of the argument is hidden.
This warning message is error message E2211 when the -ansi option is specified.

W2215: Undeclared function '*function*' is called.

Function *function* that is not declared is called.

W2222: Plain int bit field is treated as unsigned int.

The bit field of plain int is regarded as unsigned int.

W2231: Initialization of non-auto pointer using non-number initializer is not position independent.

The code for an initialization directive using an initial value other than that of a pointer variable that is not automatic variable is not position-independent.

W2244: 'Asm declaration' used out of function is not supported completely.

Use of assembler description *asm* described outside the function, and the assembler description between `#pragma asm` and `#pragma endasm` is limited[47].

W2245: If you want to use asm statement, use __asm( ).

_asm must not be used for description of an assembler instruction when the –ansi option strictly conforming to the language specifications is used. Use __asm.

W2268: illegal use of 'static'

Storage area class specifier "`static`" is not correctly used.

W2287: Function requires return value.

No return value is specified for a function having a return value.
It is assumed that 0 is specified as the return value.

F2289: return type mismatch *type1* (*type2*)

Type *type2* of the return value indicated by the return statement does not agree with the return type *type1* of the function.

W2291: argument type mismatch *type1* (*type2*)

Type *type2* of an actual argument does not agree with *type1* of the dummy argument upon declaration of a function.

W2293: Type specifier of argument *name* is missing.

The type specifier of dummy argument *name* declared in the function definition is omitted. int type is assumed.
This warning message is error message E2292 when the -ansi option is specified.

W2302: illegal bit-field type

A type that cannot be specified with the ANSI specifications is specified for a bit field.
Padding is executed under the alignment condition of the specified type.
This warning message is error message E2301 when the -ansi option is specified.

W2306: The bit-field object '*name*' is put into the next unit.

Bit field *name* is located in the next area because it exceeds the boundary.

[47] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

W2520: Immediate for shift operator is out of range.

The immediate value specified for the shift instruction exceeds the value of the range that can be specified.

It is assumed that only the lower valid digits have been specified.

W2521: division by zero

Division by zero is executed during the operation of a constant expression that is executed upon compiling.

It is assumed that 0 is specified for the constant expression.

W2525: illegal type combination for '*operator*' (*type1*, *type2*)

The combination of types (*type1*, *type2*) for operator *operator* is not correct. Type-conversion is executed and processing continues.

This warning message is error message E2524 when the -ansi option is specified.

W2527: Operands of '*operator*' operator must have same type (*type1*, *type2*).

The types to the left and the right of operator *operator* must be the same (*type1*, *type2*).

W2554: cannot convert non-L value array to pointer

An array that is not at the left side cannot be converted into a pointer.

This warning message is error message E2553 when the -ansi option is specified.

W2555: *expression* expression must have enumeration type.

expression must be enum type.

W2600: ignored option '*option*'

Option *option* is ignored.

W2601: *category* is not supported now.

The feature indicated by *category* is not supported at present.

W2606: Wide-character is not supported.

The wide character is not supported and is ignored.

W2607: Multibyte-character is not supported.

The multi-byte character is not supported and is ignored.

W2621: duplicated cpu type, command line option is used

A target device is specified in duplicate. The target device specified by the -cpu option is valid.

W2634: Interrupt attribute is specified for function '*function*', previously specified 'block_interrupt' is ignored.

Function *function* that is disabled from interrupts is specified as an interrupt handler.

Because the interrupt handler is disabled from interrupt, unnecessary interrupt prohibition specification is ignored.

W2635: Interrupt attribute is already specified for function '*function*', 'block_interrupt' is ignored.

Function *function* has been already declared as an interrupt handler.

Because the interrupt handler is disabled from interrupt, unnecessary interrupt prohibition specification is ignored.

W2637: Interrupt function cannot be inlined, ‘inline’ is ignored.

“`inline`” must not be specified for a function declared as an interrupt. The inline specification is ignored.

W2643: Interrupt attribute is specified for function ‘*function*’, previously specified ‘inline’ is ignored.

Function *function* for which inline was specified is specified as an interrupt handler. The inline specification is ignored.

W2671: Function ‘*function*’ is already defined, directive ‘#pragma inline’ is ignored.

The inline specification must be described before the function definition.
The inline specification is ignored.

W2672: ‘#pragma itext function-name’ must be placed before the function’s definition. ‘#pragma itext *function*’ is ignored.

The itext specification must be described before the function definition.
The itext specification is ignored. *$\boxed{\text{V830}}$

W2673: Function specified as ‘direct’ can not be allocated in itext. ‘#pragma itext *function*’ is ignored.

Function specified as an interrupt handler in direct location cannot be allocated to .itext section.
The itext specification is ignored. *$\boxed{\text{V830}}$

W2674: Function allocated in itext can not be specified as ‘direct’. Previously specified ‘#pragma itext *function*’ is ignored.

Function specified as itext is specified as an interrupt handler in direct location.
The itext specification is ignored. *$\boxed{\text{V830}}$

W2675: Function allocated in itext can not be inlined. ‘#pragma inline *function*’ is ignored.

inline cannot be specified for a function specified as itext.
The inline specification is ignored. *$\boxed{\text{V830}}$

W2676: Function allocated in itext can not be inlined. Previously specified ‘#pragma inline *function*’ is ignored.

itext is specified to a function specified as inline.
The inline specification is ignored. *$\boxed{\text{V830}}$

W2683: Second argument ‘*name*’ for __set_il is not interrupt request name.

name specified as the second argument of a function that sets an interrupt level is not an interrupt request name.
The interrupt level is not set.

W2684: cannot set interrupt level for ‘*name*’

An interrupt level cannot be set for interrupt request name *name*.
The interrupt level is not set.

W2690: ‘Rtos_task’ is specified for function ‘*function*’, previously specified ‘inline’ is ignored.

A function for which inline is specified is specified as a task for the RTOS. The inline specification is ignored.

W2691: Startup routine for RTOS task cannot be inlined, 'inline' is ignored.

Inline expansion must not be specified for a function specified as a task for the RTOS. The inline specification is ignored.

W2699: Function '*function*' is undefined, previously specified GP symbol for rtos_interrupt is ignored.

The function specified as an interrupt handler with a gp symbol specified is not defined in the file. The interrupt handler specification is invalid.

W2700: cannot specify gp symbol, function '*function*' is already defined

The gp symbol cannot be specified for a function already defined. The gp symbol specification is ignored.

W2703: GP symbol is not specified for RTOS interrupt function '*function*'

A gp symbol is not specified for a function *function* specified as an RTOS interrupt handler.

W2704: Function '*function*' is undefined, previously specified 'rtos_task' is ignored.

Function *function* specified as an RTOS task is not defined in the file. The rtos_task specification is invalid.

W2710: Section '*section1*' is already specified for '*symbol*'. '*section2*' is ignored.

section1 has been already specified in a section file for symbol *symbol*. *section2* that has been specified later is ignored.

W2711: Different section is specified for '*symbol*' in source file (*section1*) and section file (*section2*). Source file specification is ignored.

Section specification (*section1*) for the source file and section specification (*section2*) for the section file for symbol *symbol* differ. The section specification (*section1*) for the source file is ignored.

W2730: Block interrupt function cannot be installed, 'inline' is ignored.

"`inline`" must not be specified for a function declared to disable interrupts. inline specification is ignored.

W2731: Block interrupt attribute is specified for function '*function*', previously specified 'inline' is ignored.

Function *function* specified as "`inline`" is specified to disable interrupts. inline specification is ignored.

W2740: '#pragma text function-name' must be placed before the function's definition. '#pragma text *function*' is ignored.

The text section must be specified before the function definition. The text section specification for a function *function* is ignored.

W2741: Function specified as 'direct' can not be allocated in text. '#pragma text *function*' is ignored.

The text section cannot be specified for a function specified as interrupt in direct location (direct). The text section specification for a function *function* is ignored.

W2742: Function allocated in text can not be specified as 'direct'. Previously specified '#pragma text *function*' is ignored.

Function specified as text section cannot be specified as interrupt in direct location (direct). The text section specification for a function *function* already specified is invalid.

W2743: Function allocated in text can not be inlined. '#pragma inline *function*' is ignored.

"`inline`" cannot be specified for a function specified as text section.
The inline specification for a function *function* is ignored.

W2744: Function allocated in text can not be inlined. Previously specified '#pragma inline *function*' is ignored.

text section is specified to a function specified as inline.
The inline specification for a function *function* already specified is invalid.

W2748: Section name is not specified.

The section name is not specified between " " " when specifying the section name of `#pragma section`. It is assumed that no section name is specified, and allocated to the reserved section of the specified attribute.

W5009: sorry, not implemented option '*option*', ignored

Option *option* is not supported at present and is ignored.

W6101: immediate for shift operator is out of range

The value of the immediate value specified for the shift instruction exceeds the range of the value that can be specified.
It is assumed that only the lower valid digits have been specified, and processing continues.

W6102: first argument of _rcopy() is illegal

The first argument of copy routine _rcopy() is illegal.

W7101: sorry, not implemented option '*option*', ignored

Option *option* is not supported at present and ignored.

W7102: redeclaration of '*symbol*'

symbol is re-declared.

W7103: Symbol '*symbol*' has different size (*num1* and *num2*).

Different sizes (*num1* and *num2*) of data symbol *symbol* are merged.

W7104: Symbol '*symbol*' has different alignment size (*num1* and *num2*). Changed to least common multiple value (*num3*).

Different alignment size (*num1* and *num2*) of data symbol *symbol* is merged. The size is changed to the maximum common multiple *num3*.

W7105: cannot hide symbol '*symbol*'

Symbol *symbol* cannot be hidden.

W7106: Argument type mismatch is detected where '*caller*' calls '*callee*'.

The types of the arguments of *caller* and *callee* differ during inline expansion.
If the types can be changed, they are converted into the types for definition; if not, the inline expansion is ignored.

W7107: Return value type mismatch is detected where '*caller*' calls '*callee*'.

The types of the return values of *caller* and *callee* differ during inline expansion.

If the type of callee can be changed, it is converted into the type of caller; if not, the inline expansion is ignored.

VOLUME 4

HANDLING ASSEMBLER

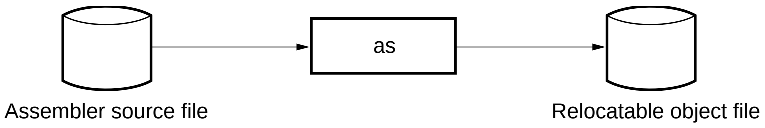
CHAPTER 1 OVERVIEW

This volume explains the outline, operation, assemble list, and output messages of the assembler (as) included in this compiler package.

1.1 Flow of Operation

The as assembles an assembly-language source program in a specified assembler source file and creates a relocatable object file (refer to **Figure 1-1**).

Figure 1-1. Flow of Operation of as



1.2 Handling File

With the as, the following file can be specified as an input file.

file.s ... assembler source file (called .s file)

- The relocatable object file created by the as has a name created from the name of the input file[1] (by replacing .s with .o).
- If the relocatable object file created by the as includes an unresolved external reference, the relocation for it remains unresolved.
- An executable object file resolving all relocations (called execution format) is created by linking the relocatable object file by using the link editor (ld) included in this compiler package.

[1] If the specified file is not an .s file, .o is suffixed to the name of the specified file.

CHAPTER 2 OPERATION

This chapter explains how to operate the as.

2.1 Command Input Format from VSH Command Line

The as is started from the ca as the default assumption. It can also be started in the following format.
as [△ option] ... △ file name

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists the options of the as.

To pass the following options from the ca to as as they are, "-Wa" must be specified with the ca when starting from VSH.

Some options, which are listed on the following options but not present in the option dialog in the Project Manager, exist. When such options are required to be specified, start the as from VSH.

(1) Optimization option

This specification sets option related to optimization.

Specification Format	Feature
–O	Performs optimization to rearrange instructions while avoiding hazards related to registers and flags (refer to -g option).

(2) Output options

These specifications set options related to object code that is output by the assembler.

Specification Format	Feature
–E * V830	This option specifies inheritance of V810 Family instructions for assembly. The output instruction code is the same as the V810 Family's floating-point operation instruction and bit string instruction and an emulation library is used for processing. If this option is omitted, the V810 Family's floating-point operation instruction and bit string instruction produce an error. This option can be specified only when starting from VSH.
–G*num*	This option specifies that machine-language instructions are created[5] based on the assumption that "all data whose size is no larger than *num* bytes[2] is allocated either to an sdata-attribute section[3] or a sbss-attribute section[4]" when accessing external labels. If this option is omitted, *num* is regarded as infinity (∞). However, in the case of data for which the sdata option has been specified by the .option pseudo-instruction[6], this option specifies that machine-language instructions are created based on the assumption that all data, regardless of its size, is allocated either to an sdata-attribute section or a sbss-attribute section.
–a	This option creates an assemble list. However, if the -O option has also been specified, the code scheduling may produce unreliable results in at least part of the output assemble list.
–cn	This option embeds a family's "common magic number" value as the magic number for the object being created. This means that the object can be used as a common object within that family (refer to page 205). If this option is omitted, the object becomes fixed as a device type so a magic number defined for a specific model will be embedded.
–cnv850e * V850	This option embeds a "common magic number" value for the V850E as the magic number for the object being created. This means that the object can only be used as a common object belonging to the V850E (refer to page 205). If this option is omitted, the object becomes fixed as a device type so a magic number defined for a specific model will be embedded.
–f	This option creates an object file that includes the information "this is a function call for a new format". This is valid when using an assembler source file that was created for the V850 Family by an old version of the C compiler or when using an assembler source file that was created for the V850 Family by an old version of the C compiler under the V810 Family[7].
–g	This option outputs information for the debugger. This option is ignored if the -O option has also been specified and if the source file contains debugging information sections[8]. If it does not contain debugging information sections, this option is valid but the -O option is ignored. This is equivalent to specifying "Debug" from the Option menu when the Project Manager is used.

[2] Specify a decimal number for *num*.

[3] Section having section type PROGBITS and section attribute AWG

[4] Section having section type NOBITS and section attribute AWG

[5] If activated from the C compiler (ca), the -G*num* option that was specified during C compiler startup is passed.

[6] Refer to **User's Manual - Assembly Language**.

[7] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

[8] The sections are defined by the pseudo-instructions .**vline**, .**vdebug**, and .**vdbstrtab** (refer to **User's Manual - Assembly Language**). Debugging information sections are always created for assembler source that are output by ca by specifying the -g option. as ignores the -g option and regards the -O option as valid when the assembler source code has been output by ca or includes intentionally defined debugging information sections. In all other cases, the -O option is ignored and the -g option is regarded as valid.

Specification Format	Feature
–m	This option creates an object file that contains information that a mask register function[7] is being used. This is valid when using an assembler source file that was created by an old version of the C compiler.
–p[*num*] * V850	This option outputs code that avoids CPU faults. The type of code that can be output is specified as *num* (refer to page 206). If *num* is omitted, output of all three types of code is set by default. The -O option is ignored when this option has been specified.

(3) Message options

These options are set for messages output during assembly.

Specification Format	Feature
–V	This option outputs the as's version number to standard output and then terminates processing. This option can be specified only when starting from VSH.
–v	This option outputs the as's execution status.
–w	This option does not output warning message when r1 has been specified as the source register or the destination register, when r0 has been specified as the destination register, when r20 or r21 has been specified as the destination register when using the mask register function, or, under as830, when r30 has been specified as the destination register for the mul, mulu, div, or divu instruction.

(4) Other options

These specifications set other options.

Specification Format	Feature
–F △ *devpath*	This option sets the device file search to begin in the *devpath* directory before going to the standard directories[9]. If this option is omitted, the search goes directly to the standard directories. If the as is started from the ca, ca's -devpath is specified. When the command is started from the option dialog, the device file's installation directory is automatically set for this option, so this option can be specified only when starting from VSH.
–I △ *dir*	This option sets a search for any file input by the .include or .binclude pseudo-instruction[10] to begin in the *dir* directory before going to the directory where the source files are placed. If this option is omitted, only the directory where the source files are placed is searched.
–cpu △ *devicename*	This option specifies the target device. When using the Project Manager, this is equivalent to specifying the device during a project setup. If this option is omitted, assembly is stopped unless this option has been specified by the .option pseudo-instruction[11].
–l △ *lfile*	*lfile* specifies the name of a file which receives the assemble list that is created when the -a option has been specified. If the -a option has not been specified, this option is invalid. If this option is omitted and the -a option has been specified, the created assemble list is output to standard output.
–o △ *ofile*	This is the name of the object file from which *ofile* is created. If this option is omitted, the extension .s is replaced by .o so that the created object file name is created from the name of the input file[12]. This option can be specified only when starting from VSH.
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

[9] The as handles the directory at the ..\dev position from the as's installation directory as the standard directory of the device file.

[10] Refer to **User's Manual - Assembly Language**.

[11] This option can be specified by the -cpu option or the .option pseudo-instruction. If both are specified but have different contents, specification by the -cpu option takes priority. For details of pseudo-instructions, refer to **C Compiler Package User's Manual - Assembly Language** of each family.
Refer to the device file's User's Manual for description of devices that can be specified as *devicefile*.

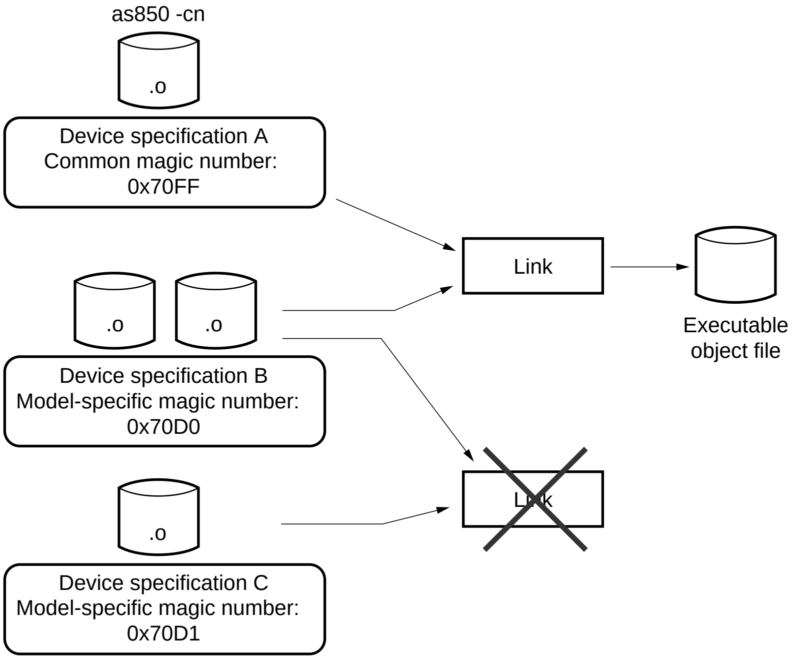
[12] The output object name cannot be specified from the Project Manager's option dialog. The file name is always created from the name of input file by replacing the .s extension with .o.

[-cn option]

Information indicating the target devices for an object are automatically embedded into objects created by the assembler. A “model-specific magic number” is embedded if only a particular type of device is the target device. If an entire family of devices can serve as target devices, then a “common magic number” is embedded.

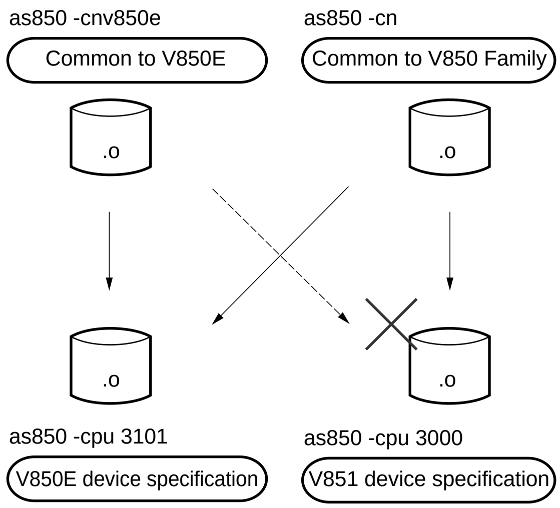
An object that has been assembled by as when the -cn option has been specified contains a common magic number and therefore can be linked to other objects for which a different device type has been specified as long as the specified device belongs to the same family (ld does not output an error when they are linked). Consequently, any object that is created after the -cn option has been specified can be used as an object common to any device in the specified device’s family.

Figure 2-1. Image of Creating Common Object with as



Cautions

- It is not possible to link only these types of objects to create an “executable” object file. An executable object file must contain an object file that includes a model-specific magic number.
- Common (same-family) magic numbers and model-specific magic numbers are defined for various device files to establish relationships among the device files. The as references the device files and embeds the magic numbers.
- Object files that operate device-specific peripheral function registers, etc., should not be used as common files within the same family.
- The V850E is upwardly compatible with the V850 Family. Source files that are used with the V850 Family (such as the V853) can be used with the V850E CPU (such as the V850E/MS1).
  In such cases, specify the “-cn” option or the “-cnv850e” option before creating an object. The created object can be linked with a device-specific object whose target device is a V850E.
  Note that an object that is created with “-cnv850e” cannot be linked with a device-specific object whose target device is anything other than a V850E.



[–p option] *V850

The CA850 supplies –Xv850patch option to the ca850 and –p option to the as850 to avoid the faults of the V850 Family CPU. If the –Xv850patch option is specified with the ca850 when starting the as850 from the ca850, the –p option having the same *num* is automatically set by the as850 to the assembler source file output by the ca850.

Cautions

- For whether the fault that has occurred is of the CPU used, refer to the documents supplied with the CPU.
- If the –p option and –O option for optimization of the as are specified at the same time, –p takes precedence, and –O is ignored.
- If a code pattern that generates a fault straddles over different sections, the function of this option is invalid.

The type and meaning of *num* are as follows.
For the instructions and registers, refer to the manual of each CPU.

1 (–Xv850patch = 1 → –p1)

Insert a nop instruction immediately after the first ld.w in respect to the combination of "ld.w instruction + (st.[b|h|w]/sst.[b|h|w] instruction + ld.[b|w]/sld.[b|w] instruction) + branch instruction".

Example>

```
ld.w         ld.w
ld.w    →    nop
jarl         ld.w
             jarl
```

2 (–Xv850patch = 2 → –p2)

Insert a nop instruction between the load/store instruction and branch instruction in respect to the combination of "ld.w/sld.w/st.w/sst.w instruction + branch instruction".

Example>

```
ld.w         ld.w
jarl    →    nop
             jarl
```

If the pattern of *num* = 1 is processed at the same time, the pattern of *num* = 2 is searched and processed first. An unnecessary nop instruction needs not to be inserted.

3 (–Xv850patch = 3 → –p3)

Insert the clr1 instruction in respect to the corresponding interrupt control register immediately before the reti instruction.

Example>

```
reti    →    clr1 5, P0IC0
             reti
```

None (–Xv850patch → –p)

Inserts each code to all the types 1 through 3.

2.3 Example

Here are some examples of using the as:

- To create assemble list

  ```
  as850 -cpu 3000 -a -l afile a.s
  ```

  Assembler source file a.s is assembled and object file a.o is created. At this time, an assemble list is created and included in a file named afile. The V851 is used as the target device.

- To specify created object file name

  ```
  as850 -cpu 3000 -o aobj a.s
  ```

  Assembler source file a.s is assembled and object file aobj is created.

CHAPTER 3 ASSEMBLE LIST

This chapter explains the assemble list output by the as.

The as outputs an assemble list by specifying a option.

When specifying with option dialog, the assemble list is output to the file which has the file name with its extension replaced with .v. When starting from VSH, if -l option is specified, the assemble list is output to the file specified by -l option. If -l option is not specified, the assemble list is output to standard output.

Figure 3-1 shows an example of the assemble list that is output by compiling C source program “`main(){int a;}`” and then assembling the output assembly-language source program.

Figure 3-1. Example of Output Assemble List

```
(1)    (2)     (3)          (4)           (5)
                          :
A-X- 00000000               16          .file   "a.c"
A-X- 00000000               17          .align  4
A-X- 00000000               18          #@BF
A-X- 00000000               19          .frame  _main, .F2
A-X- 00000000               20          .globl  _main
A-X- 00000000               21 _main:
A-X- 00000000 0C8A          22          jbr     .L4
A-X- 00000002               23 .L5:
A-X- 00000002 4001          24          mov     r0, r10
A-X- 00000004 E3CF0000      25          ld.w    –4+.F2[sp], lp
A-X- 00000008 6444          26          add     .F2, sp
A-X- 0000000A 1F18          27          jmp     [lp]   --1
A-X- 0000000C               28 .L4:
A-X- 0000000C               29          sub     .F2, sp
A-X- 0000000C 2440            -- mov    0x4,r1
A-X- 0000000E 6108            -- sub    r1,sp
A-X- 00000010 E3DF0000      30          st.w    lp, -4+.F2[sp]
A-X- 00000014 EE8B          31          jbr     .L5
A-X- 00000016               32          #@FUNC_ARG
```

The following information is indicated in the assemble list.

(1) Section attribute

The section attribute of the section to which the codes created for the source program on a given line are stored (refer to **Table 3-1**).

Table 3-1. Section Attributes and Their Meanings

Section Attribute	Meaning
A	Section occupying memory
W	Section that can be written
X	Executable section
G	Section allocated to memory range that can be referenced by using global pointer (gp) and 16-bit displacement

(2) Value of location counter

The value of the location counter for the beginning of the code created for the source program on a given line.

(3) Code

The code[13] created for the source program on a given line with each byte expressed as a 2-digit hexadecimal number.

(4) Line number

The line number of a given line in decimal number.

(5) Source program

The source program on a given line. If instruction expansion[14] is executed to the instruction on that line, the result of disassembling the instruction string of the machine language instructions created as a result of the instruction expansion is indicated following – –.

[13] Machine language instruction or data

[14] Refer to **C Compiler Package User’s Manual - Assembly Language** of each family.

CHAPTER 4 MESSAGES

This chapter lists the messages output by the as in alphabetical order. Some messages are not output depending on the family used. The italic characters in the output messages and explanatory statements are determined during command processing.

4.1 Message Format

The as outputs the messages in the following formats.

as: ***file name***
message

4.2 Messages

$ must be followed by defined symbol
An identification name other than a symbol or undefined symbol name is specified after “$”.

.else unexpected
The pseudo-instruction corresponding to the .else pseudo-instruction does not exist.

.endif unexpected
The pseudo-instruction corresponding to the .endif pseudo-instruction does not exist.

.endif unmatched
The pseudo-instruction corresponding to the conditional assemble pseudo-instruction does not exist.

.endm unexpected
The pseudo-instruction corresponding to the .endm pseudo-instruction does not exist.

.exitm not in .repeat/.irepeat
The .exitm pseudo-instruction is not enclosed by repetitive assemble pseudo-instructions.

.exitma not in .repeat/.irepeat
The .exitma pseudo-instruction is not enclosed by repetitive assemble pseudo-instructions.

.if, .ifn, etc. too deeply nested
A conditional assemble pseudo-instruction is nested 17 times or more.

.option volatile not found
The assembler control pseudo-instructions `.option volatile (nooptimize)` and `.option novolatile (optimize)` are not used in correct correspondence.

.tidata size overflow
The total size of the .tidata.byte section, .tidata.word section, and .tidata section exceeds 256 bytes. * V850

.tidata.byte size overflow

The size of the .tidata.byte section exceeds 128 bytes. * V850

.tidata.word size overflow

The size of the .tidata.word section exceeds 256 bytes. * V850

can not find device file

Either the device file corresponding to the specified target device is missing, or the specified device is wrong. Or, no device is specified.

can not open file *file*

File *file* cannot be opened.

close error

The file cannot be closed.
The chances are that the disk capacity has run short.

duplicated cpu type

A target device is specified in duplicate by an option or pseudo-instruction.

duplicated cpu type, ignored .option cpu

The target device specified by the -cpu option differs from that specified by the .option pseudo-instruction. The -cpu option takes precedence, and the target device specified by the .option pseudo-instruction is ignored.

floating exception (*function*)

An error of a floating-point operation occurs in the function *function* of the floating-point operation library internally used by the as.

illegal alignment value

The specification of the alignment condition contains an error.

illegal bit width

The bit width specified by the .byte, .hword, or .word pseudo-instruction is wrong.

illegal character

A character that cannot be handled appears.

illegal expression

The syntax of the expression is incorrect.

illegal expression (*string*)

The element *string* of the expression is erroneous.

illegal expression (-label)

An expression in the format of (-label) is used.

illegal expression (-label -label)

An expression in the format of (-label -label) is used.

illegal expression (-label or symbol -label)

An expression in the format of (-label) or (symbol - label) is used.

illegal expression (label + label)

An expression in the format of (label + label) is used.

illegal expression (labels have different reference types)

An operation is specified between label references of different formats (#label, label, and $label).

illegal expression (labels in different sections)

An operation is specified between labels belonging to different sections.

illegal expression (labels must be defined)

Define an operation between labels in the same file.

illegal expression (not + nor –)

An operation other than + and – is used.

illegal operand (cannot use r0 as destination in V850E mode)

When the target device is V850E, the zero register (r0) cannot be used for the destination register.

illegal operand (inconsistent bit position)

The bit position is inconsistent.

illegal operand (*identifier* is reserved word)

Reserved word *identifier* is used as a name.

illegal operand (label - label)

An expression in the format of (label - label) is specified for a branch instruction.

illegal operand (label not allowed)

A label is specified for an instruction for which a label must not be specified as an operand.

illegal operand (label not allowed for setf/shl ...)

A label is specified for the setf or shift instruction.

illegal operand (label reference for jmp must be #label)

Absolute address reference (#label) is not specified for the jmp instruction.

illegal operand (must be evaluated positive or zero)

The result of evaluating an expression is negative.

illegal operand (must be even displacement)

An odd displacement is specified.

illegal operand (must be immediate, label or symbol for hi/lo/hi1)

Immediate, label, or symbol is not specified for hi, lo, and hi1.

illegal operand (must be register)

A register is not specified.

illegal operand (needs base register)

A base register must be specified.

illegal operand (range error in displacement)

The value specified as displacement exceeds the range of the value that can be specified.

illegal operand (range error in immediate)

The value specified as immediate exceeds the range of the value that can be specified.

illegal origin value (*value*)

The value specified (*value*) for the .org pseudo-instruction is wrong.

illegal section

An instruction that must not be described in the current section is described.

illegal section kind

The specified type of the section of the .section pseudo-instruction is wrong.

illegal size value

The specified size is wrong.

illegal symbol reference ($symbol)

“$” is specified for a symbol.

illegal symbol reference (#symbol)

“#” is specified for a symbol.

include nest over

The .include statements are nested nine times or more.

***identifier* is reserved word**

Reserved word *identifier* is used at a location where reserved words must not be used.

label *identifier* redefined

Label *identifier* is defined more than once.

memory allocation fault

The memory capacity runs short.

memory allocation fault (icode)

Allocating an internal data area (intermediate code) has failed.

memory allocation fault (icode table)

Allocating an internal data area (intermediate code table) has failed.

memory allocation fault (section list)

Allocating an internal data area (section list) has failed.

memory allocation fault (section name buffer)

Allocating an internal data area (section name buffer) has failed.

memory allocation fault (section table)

Allocating an internal data area (section table) has failed.

memory allocation fault (source file buffer)

Allocating an internal data area (source file buffer) has failed.

memory allocation fault (string table)

Allocating an internal data area (string table) has failed.

memory allocation fault (symbol table)

Allocating an internal data area (symbol table) has failed.

nested command file *file*

Command file *file* is nested.
It must not be nested.

overflow error (exprtab)

The work area for processing an expression has run short.
Simplify the expression.

overflow error (too many expression items)

The work area for processing an expression has run short.
Simplify the expression.

parameter mismatch

The number of actual parameters is insufficient for macro call.

parameter table overflow

More than 33 actual parameters are used.

read error

The file cannot be read.

seek error

The file cannot be sought.

symbol already defined as label

The specified symbol has been already defined as a label.

syntax error

The syntax is wrong.

syntax error *string*

The syntax of *string* is wrong.

token too long

The length of the token exceeds the limit. The limit value is 1024.

too many files

Two or more files must not be specified.

***identifier* undefined**

Undefined identifier *identifier* is referenced.

unexpected EOF in .macro

The corresponding .endm pseudo-instruction does not exist.

unexpected EOF in .repeat/.irepeat

The corresponding .endm does not exist.

unknown cpu type

Assembly cannot be executed because no target device is specified.

unreasonable macro_call nesting

The currently defined macro in a macro body is called.

usage: as [-cpu cpuname][-F devicefile][-Gnum][-cn][-OVavw][-l listfile][-o output file] file

Input the command line like this.

volatile option must be cleared before section change

Do not execute section change in a range in which volatile or nooptimize is specified.

Warning: base register is ep (r30) only

A register other than ep is specified as the base register of the sld/sst instruction.

Warning: illegal operand (range error in displacement)

The value of the displacement exceeds the range of the value that can be specified.
It is assumed that only the lower valid digits have been specified, and assembly continues.

Warning: illegal operand (range error in immediate)

The value of the immediate exceeds the range of the value that can be specified.
It is assumed that only the lower valid digits have been specified, and assembly continues.

Warning: illegal operand (range error in immediate for setf/shl...)

The value of the immediate specified for the setf or shift instruction exceeds the range of the value that can be specified.
It is assumed that only the lower valid digits have been specified, and assembly continues.

Warning: illegal regID for ldsr

A reserved register number or a register number inhibited from being accessed is specified as the second operand of the ldsr instruction.

Warning: illegal regID for stsr

A reserved register number is specified as the first operand of the stsr instruction.

Warning: mask register r20 or r21 used as destination register

A mask register (r20 or r21) is used as a destination register when the mask register function is used.

Warning: register r0 used as destination register

The zero register (r0) is used as a destination register.

Warning: register r1 used as destination register

An assembler-reserved register (r1) is used as a destination register.

Warning: register r1 used as source register

An assembler-reserved register (r1) is used as a source register.

Warning: register r30 used as destination register of mul/div/mulu/divu instruction

An instruction work register (r30) is used as the destination register of the mul, div, mulu, or divu instruction.
* V830

Warning: sorry, *string* option not implemented, ignored

The *string* option is not implemented and is ignored.

write error

The file cannot be written.

VOLUME 5

HANDLING LINK EDITOR

CHAPTER 1 OVERVIEW

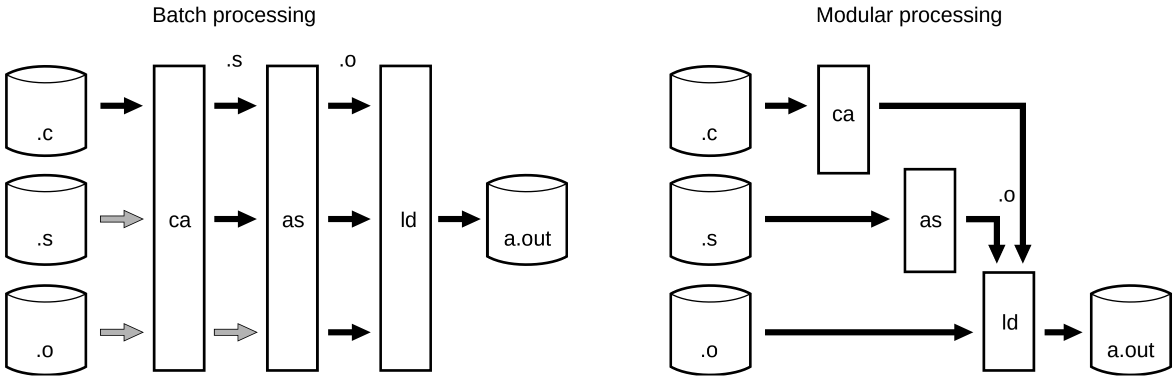
This volume explains the outline, operation, link directive, link map, supplementary information, and output messages of the link editor (ld) included in this compiler package.

1.1 Flow of Operation

Generally, an application program of a certain size is divided into several source files and codes so that it can be easily handled.

Because the ca starts the as and ld internally, an executable object file can be created by inputting two or more source files and (relocatable) object files. However, each source file can also be compiled and assembled without starting the as and ld. When each source file is compiled and assembled, the created object files are linked by starting the ld.

In the Project Manager, normally, <<Build>> or <<Rebuild>> is activated to the ld and the build specifying “o.file” by <<Build Target>> makes each object (refer to Volume 2 and Project Manager User’s Manual). Attention should not be paid as much as when starting from VSH.



The feature of the ld is to link specified object files in accordance with an explicitly specified link directive or the default link directive and a device file, resolve addresses, and create an executable object file.

To resolve an unresolved external reference[1], a specified archive file (library file) is searched, and only the necessary object files are linked to create an executable object file[2], a.out[3] (refer to **Figures 1-1** and **1-2**).

[1] Symbol having the binding class of GLOBAL and the section header table index of UNDEF.

[2] When starting from VSH, a relocatable object file can be also created by using the -r option.

[3] When starting from VSH, the name of the default if a.out, however, creating executable object file name can be specified by using -o option. When starting from Project Manager, the creating executable file name is file name with “.OUT” at the top of <<source list>>.

Figure 1-1. Flow of Operation by ld

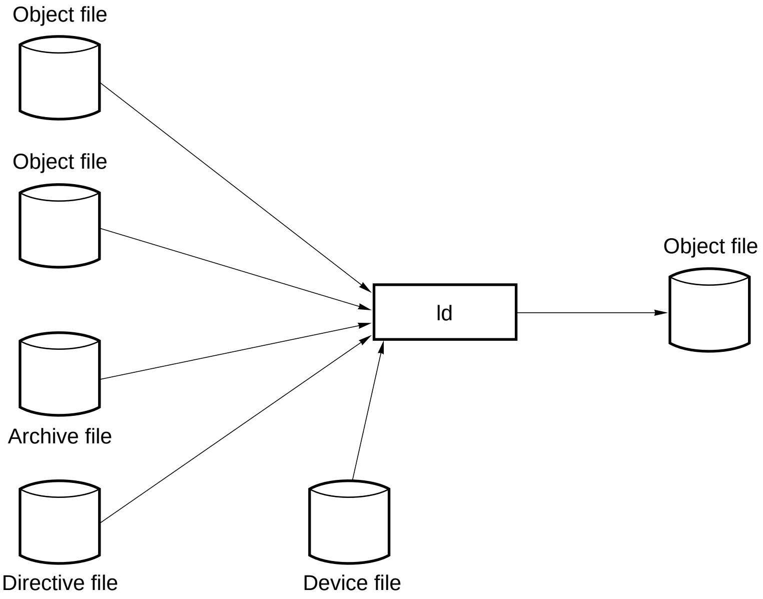
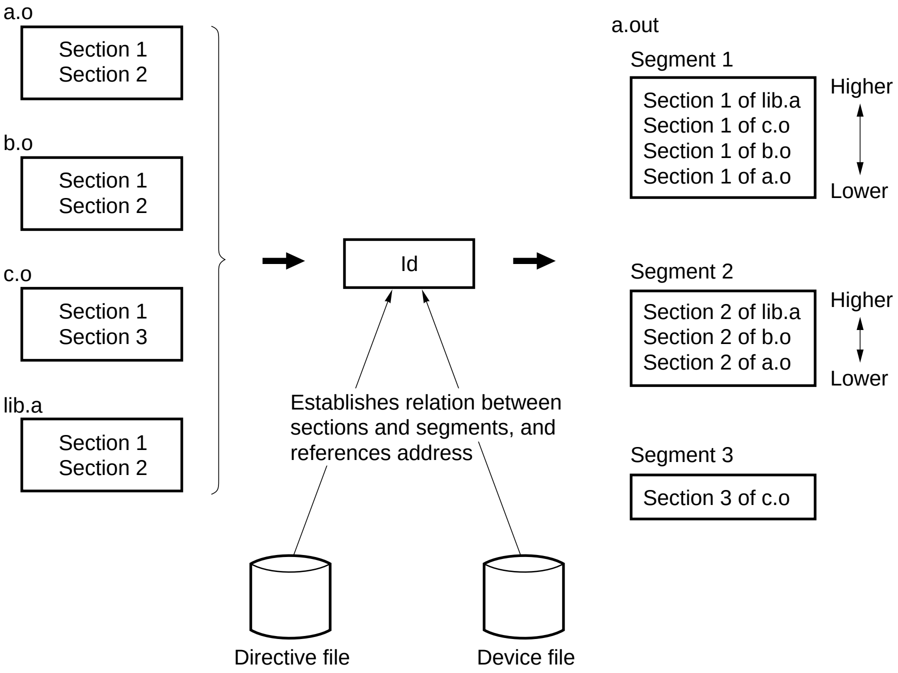


Figure 1-2. Example of Image of Operation by ld

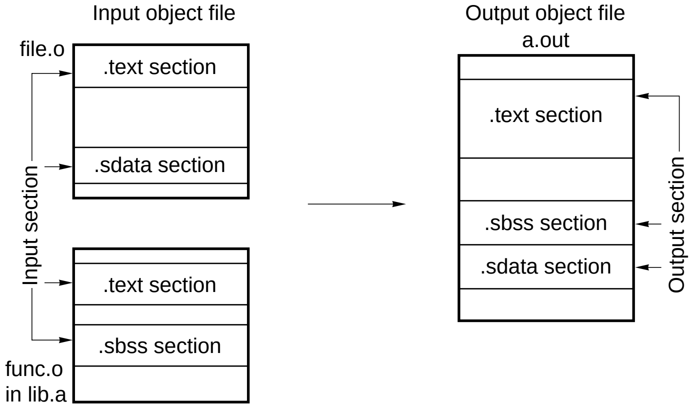
In the case of > ld a.o b.o c.o lib.a



1.1.1 Link procedure

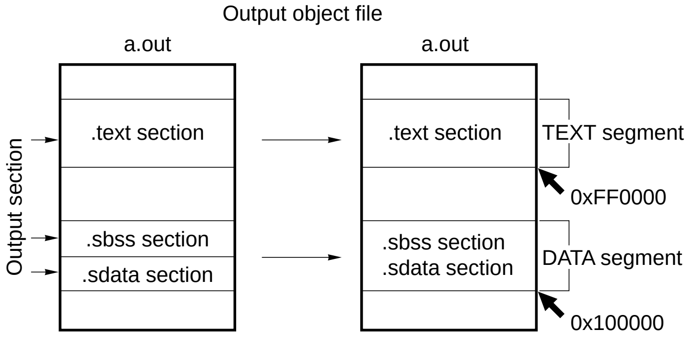
The procedure of link by the ld is as follows:

(1) Links a section (input section) included in a specified object file in accordance with an explicitly specified or default link directive and device file, and creates an output section organizing an object file to be created (refer to 3.5 on page 278).



(2) Links the output section created in the above mentioned step in accordance with an explicitly specified or default link directive and creates a segment[4] (refer to 3.4 and 3.5 on pages 264 and 278).

(3) Allocates the segment created in the above mentioned step to the memory space of the target machine in accordance with an explicitly specified or default link directive and device file (refer to 3.4 on page 264).



[4] The minimum unit for loading a program to memory, it is reflected in the program header of the created object file.

(4) Resolves unresolved external reference in the output section.

(5) Creates the following three types of symbols for the subject segment in accordance with an explicitly specified or default link directive[5] (refer to 3.6 on page 290):

- Text pointer symbol having an address value to be set to the text pointer (tp)
- Global pointer symbol having an address value to be set to the global pointer (gp), or an offset value from the text pointer (tp) of the address value to be set
- Element pointer symbol having an element pointer (ep *V850) as the address value to be set

(6) Creates reserved symbols having the values of the first address of each output section, the first address (aligned under a 4-byte alignment condition) that exceeds the end of each output section, and the first address (aligned under a 4-byte alignment condition) that exceeds the end of the created and executable object file (refer to 5.2 on page 320).

[5] These symbols are used to set appropriate values to the text pointer (tp), global pointer (gp), and element pointer (ep) before executing the codes created by this compiler package (e.g., in the start-up module). The element pointer symbol is set by the ld by reading the values peculiar to the target device from a specified device file.

This chapter explains how to operate the ld.

2.1 Command Input Format from VSH Command Line

ld [△ option]... △ file name[△ file name]...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists the options of the ld.

For the details of each option, refer to 2.2.2 on page 226.

The options marked “**” require “-Wl” to be specified for the ca when the ld is started from the ca by VSH command line or when these options are to be passed from the ca to ld (refer to page 153).

Some options, which are listed on the following options but not present in the option dialog in the Project Manager, exist. When such options are required to be specified, start the ld from VSH.

(1) File options

These specifications set options related to files referenced by the ld.

Specification Format	Feature
–D △ dfile**	When this option has been specified, links are made according to the link directive in the directive file *dfile*. If this option is omitted, the default link directive is used.
–F △ *devpath*	This option sets the device file search to begin in the *devpath* directory before going to the standard directories[6]. If this option is omitted, the search goes directly to the standard directories. If the ld is started from the ca, the ca's -devpath is specified. When the command is started from the option dialog, the device file's installation directory is automatically set for this option, so this option can be specified only when starting from VSH.
–L*dir*	If the -l option is specified with this option (or after this option in the case of VSH), the archive file (also called library file) specified by the -l option is searched for in the directory *dir* first and then in the standard directories[7]. If this option is omitted, only the standard directories are searched.
–cpu △ *devicename*	This option specifies that the device file for the target device specified by *devicename* will be read[8]. When using the Project Manager, this is equivalent to specifying the device during a project setup. If this option is omitted, the device file for the target device specified when the .o file was created will be read.
–l*string*	When resolving an unresolved external symbol reference, this option references archive file lib*string*.a. If several archive files are specified by this option, the files are searched in the order of their specification[9].
–ol * V850	This option references the library containing old function call specifications[10]. If this option is omitted, it references the library containing new function call specifications. This option can be specified only when starting from VSH.
@cfile**	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

[6] ld handles the directory at the ..\dev position from the ld's installation directory as the standard directory of the device file.

[7] ld handles all directories from the ld's installation directory to the directory at the ..\lib*xxx* position and the directory at the ..\lib*xxx*\r32 position as the standard directories for libraries.

[8] Refer to the device file's User's Manual for description of device types that can be specified as *devicename*.

[9] Specify library links after the object file links. Also, specify the "-lc" link for standard libraries after the "-lm" link for mathematical libraries (in the order of "m;c" in the option dialog).

[10] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

(2) Check options

These specifications set check-related options for linking.

Specification Format	Feature
–E**	This option ignores several kinds of errors that occur during relocation processing. If this option is omitted, a message is output and link processing stops.
–M	This option outputs a message to all external symbols defined in duplicate and stops link processing. If this option is omitted, a message is output to the first external symbol defined in duplicate and link processing is stopped.
–T	This option does not check symbol size and alignment condition during linkage of external symbols.
–fc	This option checks whether or not old call specifications[11] are mixed with new call specifications in all input object files. If this option is omitted, only the object files created from the C source files are checked.
–mc	This option checks whether or not the files that use the mask register function[11] are mixed with files that do not use this function when linking the object files created from the C source files. Link processing is stopped if they are found to be mixed. This option can be specified only when starting from VSH.
–t**	This option does not check symbol size and alignment condition during linkage of undefined external symbols[12].

(3) Message options

These options are set in relation to messages output during linkage.

Specification Format	Feature
–v	This option outputs ld's execution status.
–w	This option does not output a warning message.

[11] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

[12] Symbols having the binding class of GLOBAL and section header table index of GPCOMMON or COMMON

(4) Other options

These specifications set other options.

Specification Format	Feature
–A	This option outputs to standard output information that can be used as a criterion for setting *num* in the -G*num* option that can be specified for ca and as when compiling and assembling source files[13]. This option can be specified only when starting from VSH.
–V**	This option outputs ld’s version number to standard output and then terminates processing. This option can be specified only when starting from VSH.
–e △ *symbol***	This is the entry point address value for the object file from which a symbol value *symbol* is created. If this option is omitted, the symbol ___start value or the lowest address value from the created object file is used as the entry point address value.
–f △ *num*	This option uses a two-byte *num* value (a four-digit hexadecimal number) as a filling value for any holes that occur in created object files. If this option is omitted, 0x0000 is assumed.
–help**	This option outputs a description of options to standard output. This option can be specified only when starting from VSH.
–m**	This option outputs a link map showing the location of sections to standard output.
–o △ *ofile*	This option specifies *ofile* as the name of the object file to be created. If this option is omitted, a.out is assumed[14]. This option can be specified only when starting from VSH.
–r	This option creates a relocatable object file. If this option is omitted, an executable object file is created. This option can be specified only when starting from VSH.
–reg*num*	This option specifies the register mode[15] of the library to be referenced. The following numbers can be specified as *num*. 22 22-register mode 26 26-register mode If this option is omitted, the 32-register mode library is referenced.
–s	This option creates an object file, removing the debug information, line number information, and global pointer table, in creating the object file.

[13] If started from the ca, the -A option that was specified during ca startup is passed.

[14] The executable object file name to be output cannot be specified from the Project Manager’s option dialog. Instead, the “.out” extension is added to the first file in the source list, from which the suffix has been removed.

[15] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

2.2.2 Using options

This section explains how to use each option.

(1) A: Output of information on -G*num* option for compiler and assembler

Format

-A

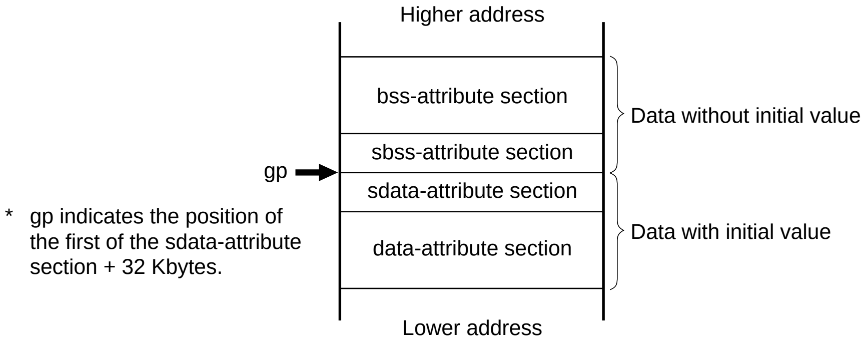
- This option can be specified only at the start from VSH.

Feature

Outputs to the standard output the information that can be used as criteria on the value to be set to *num* of the -G*num* option that can be specified for ca and as when the source file[16] is compiled and assembled.

- The ca and as included in this compiler package generates machine language instructions as follows:
  - For data to be allocated to the sdata-attribute section[17] or sbss-attribute section[18] (called sdata/sbss-attribute section), generates a machine language instruction that is assumed to be allocated to a memory range that can be referenced by using the global pointer (gp) and 16-bit displacement.
  - For data to be allocated to the gp relative section[21] of the data-attribute section[19] or bss-attribute section[20] (called data/bss-attribute section), generates a machine language instruction that is assumed to be allocated to a memory range that can be referenced by using the global pointer (gp) and 32-bit displacement (consisting of two or more instructions).

Figure 2-1. Image of Memory Location of gp Offset Reference Section



Therefore, the more the data are allocated to the sdata/sbss-attribute section that can be referenced with a single instruction, the higher is the execution efficiency of the generated machine language instruction and the object efficiency. However, because a memory range that can be referenced by using 16-bit displacement is limited (totalling 64 Kbytes), if the sdata/sbss-attribute section is allocated exceeding that range[22], the assumption of ca and as is not satisfied.

[16] C source file or assembler source file used to create a specified object file

[17] Section having section type PROGBITS and section attribute AWG

[18] Section having section type NOBITS and section attribute AWG

[19] Section having section type PROGBITS and section attribute AW

[20] Section having section type NOBITS and section attribute AW

[21] For example, .data and .bss sections. .sconst, etc., of r0 relative are excluded.

[22] In this case, the ld outputs no special message. For confirmation, use the link map, etc. (refer to Chapter 4 on page 318). The ld outputs a message during relocation and stops linking if data allocated to an area exceeding this range is referenced.

- To solve this problem, the ca allocates data of less than *num* bytes to the sdata/sbss-attribute section when the -G*num* option is specified, and the as generates a machine language instruction that assumes that data of more than *num* bytes is allocated to the sdata/sbss-attribute section.

  By using this feature, as many data as possible can be allocated to the sdata/sbss-attribute section if all data cannot be allocated to that section.

  If this option is specified, the ld outputs information that can be used as the criteria upon setting *num*. By using this information, you can reduce the number of trials and errors, and enhance the efficiency for the series of processes.

<u>Explanation on output information</u>

An example of output information where this option is specified when creating an executable object file (without the -r option specified) and an example of output information when this option is specified when a relocatable object file (with the -r option specified) is created are shown below.

Example of output information on executable object file>

```
             ******** LINK EDITOR GP INFORMATION ********

GP SYMBOL    SECTION      SECTION      SECTION           GP
NAME         NAME         SIZE(REAL)   SIZE(ASSUMED)     NUMBER

_gp_DATA
             .sdata       0x000af10
                                       0x00002000        4      *OK*
                                       0x00003450        8      *OK*
                                       0x00004430        12     *OK*
                                       0x000050a8        16     *OK*
                                       0x00007b40        20     *OK*
                                       0x0000a010        24
                                       0x0000af10        32
             .sbss        0x00012050
                                       0x00000050        4      *OK*
                                       0x00002050        16     *OK*
                                       0x00007050        512    *OK*
                                       0x00010050        1024

(a)           (b)            (c)           (d)              (e)    (f)
```

Example of output information on relocatable object file[23]>

```
             ******** LINK EDITOR GP INFORMATION ********

GP SYMBOL    SECTION      SECTION        SECTION          GP
NAME         NAME         SIZE(REAL)     SIZE(ASSUMED)    NUMBER

*(NOT AVAILABLE)*
             .sdata       0x000af10
                                         0x00002000       4      *OK*
                                         0x00003450       8      *OK*
                                         0x00004430       12     *OK*
                                         0x000050a8       16     *OK*
                                         0x00007b40       20     *OK*
                                         0x0000a010       24
                                         0x0000af10       32
             .sbss        0x00002050
                                         0x00000050       4      *OK*
                                         0x00002050       16     *OK*
             *GpCommon*   0x00010000
                                         0x00005000       512    *OK*
                                         0x00010000       1024

(a)           (b)            (c)              (d)            (e)    (f)
```

The meaning of each item of the output information is as follows:

(a) Name of global pointer symbol
The name of the global pointer symbol (refer to 3.6 on page 290) used for link. If the created object file is relocatable, “*(NOTAVA ILABLE)*” is displayed.

(b) Section name
The name of the sdata/sbss-attribute section to which data are allocated. Because a relocatable object file cannot determine allocation of an undefined external symbol to a section, the ld internally creates a virtual section “*GpCommon*” and temporarily allocates the data to this section.

(c) Actual size of section
The actual size of the section for which the area of the hole generated due to data alignment is considered.

(d) Assumed size of section
The size of the section that is assumed if the ca is started with the -G*num* option specified with the value shown in the column at the right to this column is specified as *num*. Because the calculation of this size assumes an alignment condition of more than 4 bytes without taking the actual alignment condition into consideration, the value shown in this column does not necessarily agree with the actual size of the section actually created.

[23] Object file with the -r option specified

(e) Value of *num* of -G*num* option assumed

The value of the -G*num* option *num* upon starting ca and as that is assumed as a result of calculating “assumed size of section” shown on the column at the left to this column.

(f) Judgment result

Result of judgment as to whether the size of the section falls in a range of 15 bits (0x0 to 0x7fff) if the ca is started with the -G*num* option specified with the value shown in the column at the left to this column as specified as *num*[24]. If the size falls in the range, “*OK*” is displayed; if it does not, nothing is displayed.

Default assumption

Does not output.

Caution

- The information output by this option is only a criterion, and the result of the judgment may not be correct, for example, in the following cases:
  - If a section that creates a hole is specified by a link directive, etc.
  - If an address is directly specified for a global pointer symbol.
  - If data is allocated to the .sdata/.sbss section by the `#pragma section` directive[25].

Example

- ld850 -A file1.o file2.o

  file1.o and file2.o are linked and information that can be used as a criterion upon setting *num* of the -G*num* option that can be specified for the ca or as upon compiling or assembling is output to the standard output.

[24] Because this compiler package usually assumes that the sections to which data are allocated are allocated from the lower address in the order of data/sdata/sbss/bss-attribute sections, and that the global pointer (gp) is set by the start-up module so that it indicates it can be considered first address of the sbss-attribute section + 32 Kbytes, if this judgment results in OK that the sdata/sbss-attribute section is allocated to a memory range that can be referenced by using 16-bit displacement.

[25] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

(2) D: Specifies link directive

Format

-D △ *dfile*

- -D must be followed by a blank space.

Feature

Links object files in accordance with the link directive in directive file *dfile*.

- For the feature and configuration of the link directive, refer to Chapter 3 on page 254.

Default assumption

Links object files in accordance with the default link directive (refer to pages 306, 310, and 312) of each family.

Example

- ld850 -D dfile file1.o file2.o
  Links object files file1.o and file2.o in accordance with the link directive in directive file dfile.

(3) E: Specifies ignoring error during relocation

Format

-E

Feature

A message such as that shown below is output and linking continues if the value resulting from calculation of an address of an unresolved external reference is illegal, or if the relation between the value and the located section is illegal.

```
warning: relocated value (value) of relocation entry
(file: file, section: section, offset: offset, type: relocation type)
overflowed relocation field.
```

- The value resulting from an address calculation that is judged to be illegal is not used for an unresolved external reference that is considered as an error, and the original value remains.

Default assumption

Outputs a message and stops linking if the above mentioned error occurs.

Example

- ld850 -E file1.o file2.o

  Outputs a message in response to a relocation error in the linking of file1.o and of file2.o and continues the link processing.

(4) F: Specifies directory from which device file is searched

Format

-F △ *devpath*

- -F must be followed by a blank space.
- The number of characters of *devpath* should be less than 512.
- This option can be specified only at the start from VSH.

Feature

Searches directory *devpath* and the standard directory[26], in that order, for a device file specified by the -cpu option.

- If this option is specified more than once, the directories are searched in the order in which they are specified.
- When starting command from the option dialog, the device files are searched only in standard directory. This option does not function in this start.

Default assumption

The standard directory is searched.

Example

- ld850 -cpu 3000 -F dev file1.o file2.o

  Object files file1.o and file2.o are linked. At this time, the directory dev below the current directory first is searched for device file corresponding to device name 3000 (V851). If the device file is not found there, the standard directory is searched.

[26] The ld treats the directory at the ..\dev position from the directory to which the ld has been installed as the standard directory of the device file.

(5) L: Specifying directory from which archive file is searched

Format

-L*dir*

- -L must not be followed by a blank space.
- The number of characters of *dir* should be less than 512.

Feature

If the -l option is specified with this option, directory *dir* and then the standard directory[27] are searched in that order for the archive file (also called a library file) specified by the -l option.

- If the ld is started from VSH command line, this option must be specified before the -l option.
- If this option is specified more than once, the directories are searched in the order in which they are specified.

Default assumption

The standard directory is searched.

Example

- ld850 -Llib file1.o file2.o -lc

  Object files file1.o and file2.o, and (as necessary) the object file in archive file libc.a are linked. At this time, the directory lib below the current directory is searched for archive file libc.a. If the archive file is not found there, the standard directory is searched.

[27] The ld treats the directory at the ..\libxxx position from the directory to which the ld has been installed and the directory at the ..\libxxx\r32 position from the install directory as the standard directory for the library.

(6) M: Specifies output of message to all multiple-defined external symbols

Format

-M

Feature

Outputs the following message to all the multiple-defined external symbols and stops linking[28].

```
      error: multiple defined symbol.
symbol            defined file            previous defined file
symbol            file_name               file_name
```

Default assumption

Outputs the message only to the first multiple-defined external symbol and stops linking.

Example

- ld850 -M file1.o file2.o
  Outputs the message to all the multiple-defined external symbols in the linking of object files file1.o and file2.o, and stops linking.

[28] The object file is not created.

(7) T: Does not specify checking the external symbol size

Format

-T

Feature

Does not check the size of external symbols when they are linked.

Default assumption

Checks the size of external symbols when they are linked. If a difference in size is detected, the following message is output and linking continues normally. At this time, the symbol size of the file to which a symbol is actually defined is valid.

```
warning: symbol “symbol” has different size in file “file”.
```

Example

- ld850 -T file1.o file2.o
  Does not check the multiple-defined external symbol in linking object files file1.o and file2.o.

(8) V: Outputs version number

Format

-V

- This option can be specified only at the start from VSH.

Feature

Outputs the version number of the ld to the standard output.

Default assumption

Does not output.

Example

- ld850 -V
  Outputs the version number of the ld850 to the standard output.

(9) cpu: Specifies target device

Format

-cpu △ *devicename*

- -cpu must be followed by a blank space.

Feature

Reads the contents of the device file of the target device specified by *devicename* and uses them for processing such as memory allocation.

- Linking is stopped if a target device is specified different from that specified by the -cpu option of the ca or as, the `#pragma cpu` directive in the C source file, or .option pseudo-instruction in the assembler source file.
- When using the option dialog in the project manager, this is equivalent to the device specification performed in project setting.
- For the device type that can be specified as *devicename*, refer to the User's Manual of each device file.

Default assumption

Reads the device file of the target device specified upon creating the .o file.

Example

- ld850 -cpu 3000 file1.o file2.o
  Links object files file1.o and file2.o. At this time, the contents of the device file corresponding to device name 3000 (V851) are read.

(10) e: Sets entry point address

Format

-e △ symbol

- -e must be followed by a blank space.

Feature

Uses the value of symbol *symbol* as the entry point address value[29] of the object file to be created.

- If the specified symbol *symbol* is not found, the ld outputs the following message and stops linking.

```
fatal error: can not find entry point symbol “symbol” specified
with “-e” option.
```

Default assumption

The entry point address value of the object file to be created is determined by the following convention.

- The value of symbol __start if the symbol exists.
- First address of a text-attribute[30] section allocated to the lowest address of the object file to be created if __start does not exist.
- 0 if a text-attribute section does not exist.

Example

- ld850 -e __my_start file1.o file2.o
  Uses the value of symbol __my_start as the entry point address value of the object file to be created after linking object files file1.o and file2.o.

[29] This value is used as an entry address value by the hex converter (hx) included in this compiler package.

[30] Section having section type PROGBITS and section attribute AX

(11) f: Sets filling value

Format

-f △ *num*

- -f must be followed by a blank space.

Feature

Uses a 2-byte value specified by 4-digit hexadecimal number *num* as the filling value of the hole[31] created in the object file to be created. The specification by this option takes precedence over the filling value specified by a link directive.

- If *num* is of less than 4 digits, it is assumed that as many 0s as the deficient digits are specified at the beginning.
- If the size of the hole is less than 2 bytes, only the necessary number of digits is taken out from the lower part of the specified filling value for initialization.

Default assumption

0x0000 is assumed.

Example

- ld850 -f 0xffff file1.o file2.o
  Object files file1.o and file2.o are linked with a filling value of 0xffff.

[31] Includes both the hole created to satisfy the alignment condition of a segment and section and the hole explicitly specified to be created by a link directive.

(12) fc: Checks mixing of calling specifications

Format

-fc

Feature

Checks all the input object files whether the old calling specifications[32] and new calling specifications exists in mix.

Default assumption

Only checks the object file created from the C source file.

Example

- ld850 -fc file1.o file2.o
  Checks mixing of calling specifications when object files file1.o and file2.o are linked, regardless of whether they have been created from a C source file or assembler source file.

[32] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

(13) help: Explains options

Format

-help

- This option can be specified only at the start from VSH.

Feature

Outputs the explanation of the options of the ld to the standard output.

Default assumption

Does not output.

Example

- ld850 -help

  Outputs the explanation of the options of the ld850.

(14) l: Specifies archive file

Format

-l*string*

- -l must not be followed by a blank space.

Feature

References archive file lib*string*.a to resolve an unresolved external symbol reference.

- If the -L option is specified before this option, the ld searches the directory specified by the -L option for archive file (also called a library file) lib*string*.a. If the archive file is not found in that directory, the ld searches the standard directory[33]. If the -L option is not specified before this option, the ld searches the standard directory.
- If the archive file specified by using this option is not found in the above mentioned directories, the ld outputs no message and continues linking.

Default assumption

Does not reference.

Caution

- The ld references only the archive file specified for an external reference that is not resolved at the point where this option is specified. Therefore, specify this option after the object file that references the specifying archive file when starting from the VSH command.
- The mathematical library supplied by this compiler references libc.a of the standard library. Therefore, when command is started from VSH, specify "-lc" that specifies reference of the standard library after "-lm" specifying reference of the mathematical library. In the option dialog, specify in the order of "m;c".

Example

- ld850 file1.o file2.o -lc
  Links object files file1.o and file2.o, and the object file in archive file libc.a (necessary for resolving an unresolved external reference in file1.o and file2.o) placed in the standard directory[34].

[33] The ld treats the directory at the ..\libxxx position from the directory to which the ld has been installed, and the directory at the ..\libxxx\r32 position from the install directory as the standard directory for the library.

[34] This is equivalent to directly specifying archive file libc.a in the standard directory without using this option.

(15) m: Outputs link map

Format

-m

Feature

Outputs to the standard output the link map that indicates allocation of the section (input section) included in the specified object file to a memory space, and the allocation of a section (output section) that constitutes an object file created by linking the input file to a memory space (refer to Chapter 4 on page 318).

Default assumption

Does not output.

Example

- ld850 -m file1.o file2.o

  Links object files file1.o and file2.o and outputs the link map of the input and output sections to the standard output.

(16) mc: Checks mixing of mask register function

Format

-mc

- This option can be specified only at the start from VSH.

Feature

Checks whether a file using the mask register function[35] and a file not using the mask register function exist in mix in the object file created from the C source file.

Default assumption

Does not check.

Example

- ld850 -mc file1.o file2.o
  Checks whether a file using the mask register function and a file not using the mask register function exist in mix when object files file1.o and file2.o are linked.

[35] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

(17) o: Specifies name of object file to be created

Format

-o △ *ofile*

- *ofile* must be permitted by the Windows as a file name.
- -o must be followed by a blank space.
- This option can be specified only at the start from VSH.

Feature

Uses *ofile* as the name of the object file to be created.

The option dialog does not have this option. The name always becomes the name which is omitted the suffix of the first file in source list and is added ".OUT".

Default assumption

Assumes that a.out is specified.

Example

- ld850 -o ofile file1.o file2.o
  Links object files file1.o and file2.o and uses ofile as the name of the object file to be created.

(18) ol: Library reference of old function calling specifications *V850

Format

-ol

- This option can be specified only at the start from VSH.

Feature

References the library of the old function calling specifications[36].

Default assumption

References the library of the new function calling specifications.

Example

- ld850 -ol file1.o file2.o -lc
  References the standard library of the old function calling specifications and links object files file1.o and file2.o.

[36] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

(19) r: Specifies retention of relocation information

Format

-r

- This option can be specified only at the start from VSH.

Feature

Creates a relocatable object file.

- If this option is specified, the ld does not output a message and normally terminates linking, even if an unresolved external reference remains after linking.

Default assumption

Tries to create an executable object file.

- If an unresolved external reference remains after linking, the ld outputs the following message and stops linking. If this happens, the object file is not created.

```
fatal error: undefined symbol.
symbol       referenced in "file"
```

Caution

- To specify an object file created by the ld for re-linking by the ld, specify this option to create the object file to be re-linked.
- If the -r option is specified, only the type/attribute of the mapping directive part of the link directive is valid, and the others are ignored.
- If the -r option is specified, the ld does not create reserved symbols.

Example

- ld850 -r file1.o file2.o

  Links object files file1.o and file2.o to create a relocatable object file.

(20) reg: Specifies register mode for referencing libraries

Format

-regnum

- 22 or 26 can be specified as *num*.
- -reg must not be followed by a blank space.

Feature

Searches specified register mode[37] directory to reference the supplied library.

Default assumption

Searches the 32-register mode directory.

Example

- ld850 -reg22 file1.o file2.o -lc
  References standard library for 22-register mode and links object files file1.o and file2.o.

[37] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

(21) s: Specifies deletion of debug information, line number information, and global pointer table

Format

-s

Feature

Creates an object file from which the debug information, line number information, and global pointer table are deleted.

Default assumption

Creates an object file in which the debug information, line number information, and global pointer table remain.

Example

- ld850 -s file1.o file2.o
  Links object files file1.o and file2.o to create an object file from which the debug information, line number information, and global pointer table are deleted.

(22) t: Does not specify checking of size and alignment condition in linking undefined external symbols

Format

-t

Feature

Does not check the symbol size and alignment condition in linking undefined external symbols[38].

Default assumption

Checks the symbol size and alignment condition in linking undefined external symbols. If a difference is found, either of the following messages is output and linking continues normally.

```
warning: symbol “symbol” has different size in file “file”.
warning: symbol “symbol” has different align-size in file “file”.
```

Caution

- The ld supports multiple definition of undefined external symbols. The multiple-defined undefined external symbols are allocated to the .sbss section[39] or .bss section[40] after link. If the symbol size or alignment condition to be linked differs, the maximum size of the symbol among those to be linked is assumed as the size, and the maximum common multiple of the alignment condition of the symbols having the same name of the symbols to be linked is assumed as the alignment condition.

Example

- ld850 -t file1.o file2.o
  Does not check the size and alignment condition in linking undefined external symbols while linking object files file1.o and file2.o .

[38] Symbol having a binding class of GLOBAL and section header table index of GPCOMMON or COMMON

[39] Reserved section having a section name of .sbss, section type of NOBITS, and section attribute of AWG

[40] Reserved section having a section name of .bss, section type of NOBITS, and section attribute of AW

(23) v: Outputs execution status

Format

-v

Feature

Outputs the version number and execution status of the ld.

Default assumption

Does not output.

Example

- ld850 -v file1.o file2.o
  Outputs the version number of the ld850 and the execution status of linking of object files file1.o and file2.o.

(24) w: Suppresses output of warning message

Format

```
-w
```

Feature

Does not output warning messages. Outputs only fatal error messages.

Default assumption

Outputs warning messages.

Example

- ld850 -w file1.o file2.o
  Does not output warning messages while linking object files file1.o and file2.o.

(25) @: Specifies command file

Format

@cfile

- @ must not be followed by a blank space.
- Arguments to be specified can be described over two or more lines in the command file (refer to page 161), but options and file names must be described on one line.

Feature

Treats *cfile* as the command file.

- Describes the character string specified on the command line in the command file, and specifies according to this command file.

Default assumption

Assumes that a command file is not specified.

Example

- ld850 @cfile

  Links cfile as a command file.

  The contents of cfile are as follows:

  ```
  -o ofile file1.o file2.o
  ```

CHAPTER 3 LINK DIRECTIVE

This chapter explains the link directives that can be used as instructions to the ld.

3.1 Feature of Link Directive

A link directive[41] can be used to give the following information to the ld.

(1) Configuration and attribute of an output section that is created by linking input sections (sections included in specified object files or in the corresponding object file in a specified archive file) and constitutes an output object file.

(2) Configuration and attribute of a segment created by linking the output sections created in the above step.

(3) Address and alignment condition used to allocate the segment created in the above step to the memory space of the target machine.

(4) Size of the hole created (as necessary) when sections and segments are allocated to a memory space.

(5) Filling value of the hole that is created during allocation of sections and segments.

(6) Creation of a text pointer symbol having an address value to be set to the text pointer (tp), a global pointer symbol having the address value to be set to the global pointer (gp) or the offset value of the address value to be set from the text pointer (tp), and an element pointer symbol having the address value to be set to the element pointer (ep * V850).

Reference

This compiler package includes the file of sample link directive (refer to 3.7 on page 305) as follows.

Installation directory \smpxxx\caxxx\*.dir

When describing the link directive, refer to the sample link directive.

[41] A link directive is explicitly specified by using the -D option upon starting the ld.

3.2 Configuration of Link Directive

Link directives are divided into three types: segment directives, mapping directives, and symbol directives. Information item (1) explained above is given by a mapping directive; (2), (4), and (5) are given by a segment directive and mapping directive; (3) is given by a segment directive; and (6) is given by a symbol directive.

- To specify a segment name, section name, file name, and symbol name for a link directive, use the following characters.
  - Numerals (0 to 9)
  - Uppercase characters (A to Z)
  - Lowercase characters (a to z)
  - Underscore (_)
  - Dot (.)
  - Back slash, yen mark (\, ¥)
  - Colon (:)
- “#” in the link directive indicates the beginning of a comment. A comment starts with “#” and ends at the end of the line.

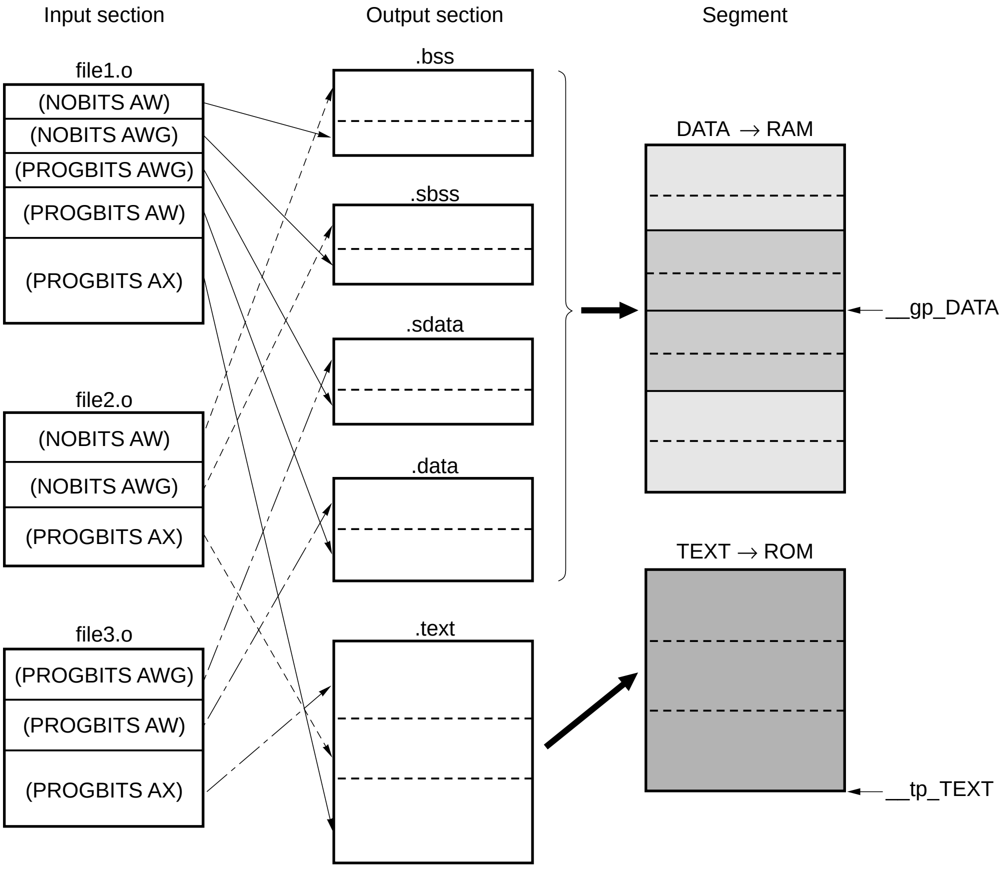
3.3 Section and Segment

Here, let's discuss the types and attributes of the "sections" and "segments" handled by the ld. For the internal configuration of a section, refer to **APPENDIX B**. For the details of section allocation by program, refer to **V800 Series C Compiler Package User's Manual - C Language/Assembly Language**.

Section Basic unit configuring a program. Sections (input sections) included in two or more object files and having the same type and attribute are linked and sections (output sections) constituting a segment are created. A section name, attribute, and address to which a program is loaded can be freely specified by a link directive.

Segment A cluster of sections having the same attribute and type, and is a basic unit in which a program is loaded to memory. A segment name, attribute, and address to which a program is loaded can be freely specified by a link directive.

Figure 3-1. Section and Segment



3.3.1 Type of section

Sections come in six types depending on the combination of a section type (refer to page 281) and section attribute (refer to page 282).

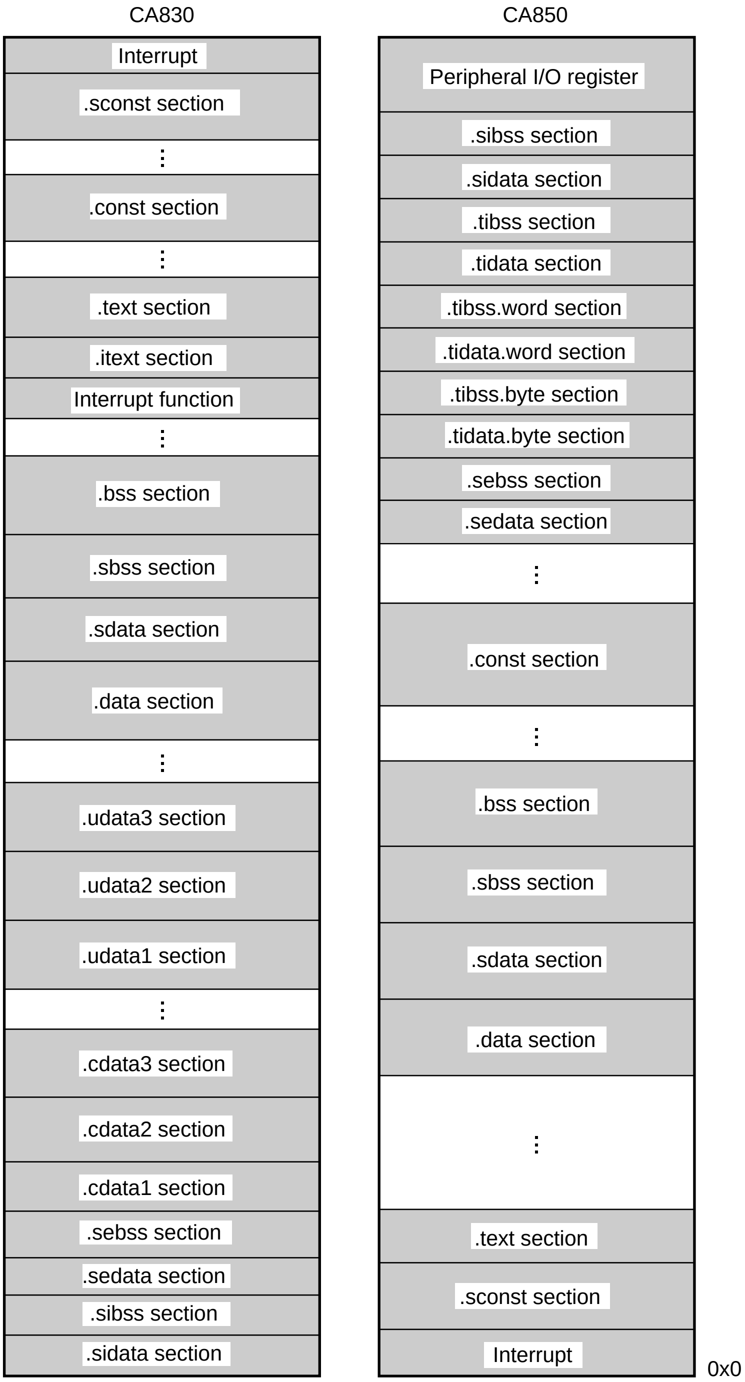
Each type of section has a reserved section name. Some reserved sections can be used commonly with all the families, and the others are peculiar to a specific family.

Table 3-1. Types of Sections

Type of Section	Meaning	Corresponding Reserved Section Name
bss (bss-attribute section)	Section having section type NOBITS and section attribute AW	.bss, .sebss, .sibss .tibss, .tibss.byte, .tibss.word
const (const-attribute section)	Section having section type PROGBITS and section attribute A	.sconst, .const
data (data-attribute section)	Section having section type PROGBITS and section attribute AW	.data, .sedata .sidata .cdata1, .cdata2, .cdata3, .udata1, udata2, .udata3 .tidata, .tidata.byte, .tidata.word
sbss (sbss-attribute section)	Section having section type NOBITS and section attribute AWG	.sbss
sdata (sdata-attribute section)	Section having section type PROGBITS and section attribute AWG	.sdata
text (text-attribute section)	Section having section type PROGBITS and section attribute AX	.text .itext

Figure 3-2 shows the memory location of sections having reserved section names. For the nature of each section, refer to the explanation of data allocation to sections in **V800 Series C Compiler Package User's Manual - C Language**.

Figure 3-2. Memory Location of Reserved Section



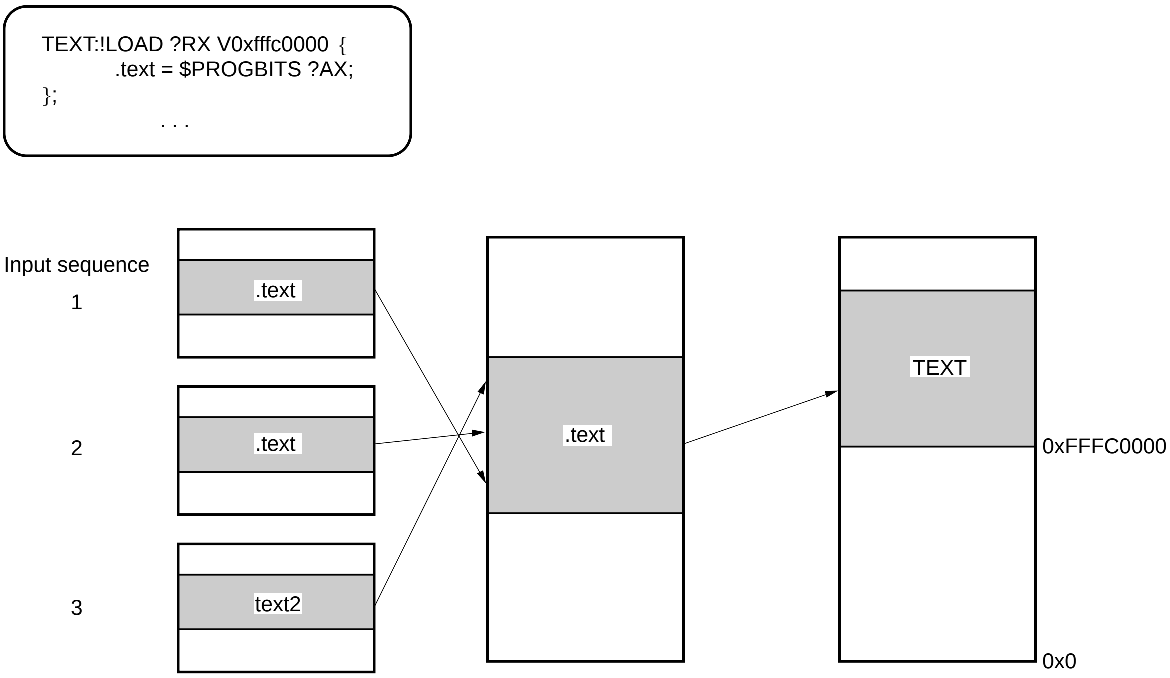
3.3.2 Examples of mapping image

Here, examples of mapping image by link directives are shown. For the specific description rules, refer to 3.3.3 and following sections.

(1) In an application where sections having the same type and same attribute are mapped as one segment

If sections having the same type are combined into one, the input section name and file name need not be specified by using the mapping directive, except a section whose correspondence between an I/O section name and a segment name is fixed (section such as .sconst and .sedata. Refer to pages 266/ 279).

Figure 3-3. Example of Mapping Image 1



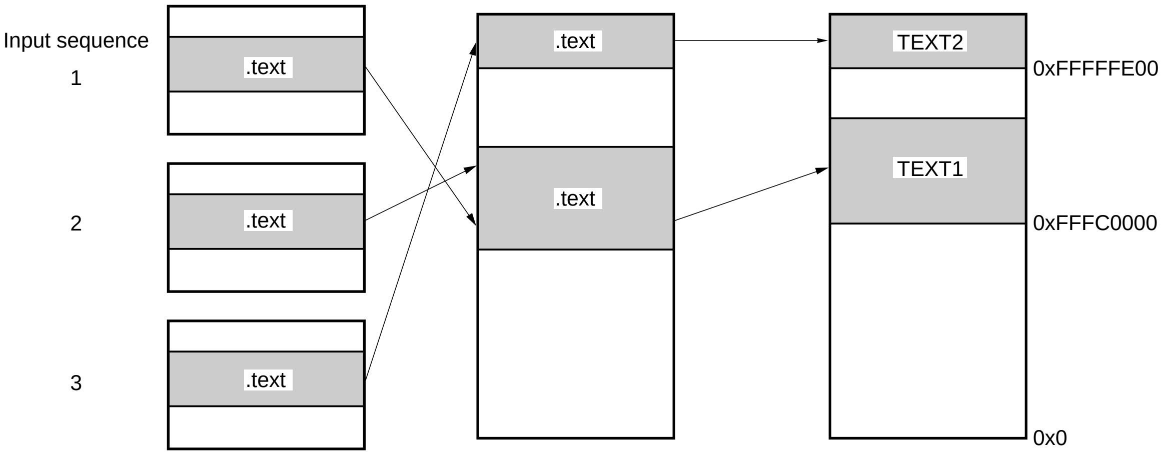
```
TEXT:!LOAD ?RX V0xfffc0000 {
        .text = $PROGBITS ?AX;
};
                . . .
```

(2) In an application where sections having the same type and attribute have the same section name in all object files but cannot be combined into one segment

Specify a file name by using the mapping directive to allocate a section in a certain object file to another segment when the assembly-language program does not have a description specifying a section name, even though the method in (1) allocates sections to the same segment.

Figure 3-4. Example of Mapping Image 2

```
TEXT1:!LOAD ?RX V0xfffc0000 {
        .text = $PROGBITS ?AX {file1.o file2.o};
};

TEXT2:!LOAD ?RX V0xfffffe00 {
       .text = $PROGBITS ?AX {file3.o};
};
                   . . .
```

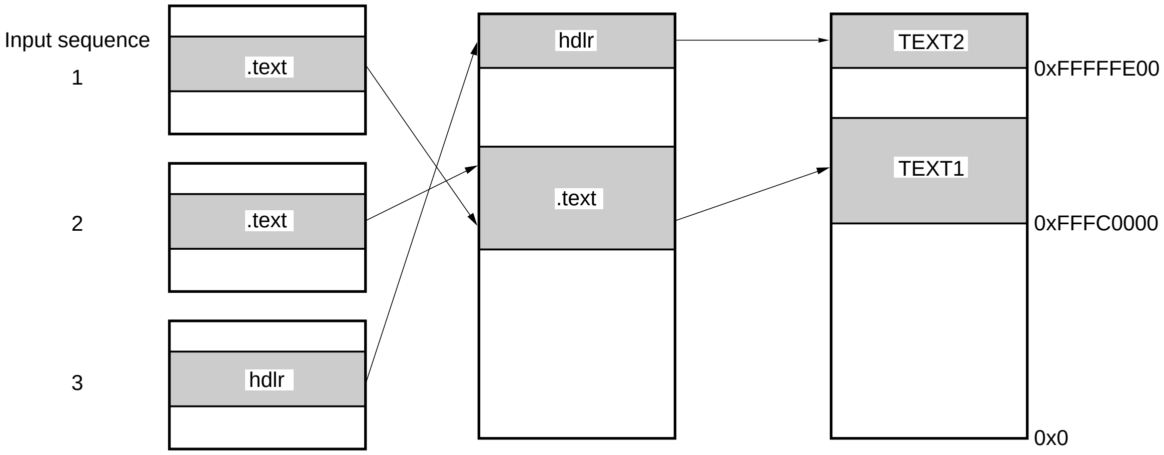


(3) In an application where a section having a different name exists among the sections having the same type and same attribute, and the sections cannot be combined into one segment

Specify a section name by using the mapping directive to allocate that section to a segment different from the one to which the sections having the same type and same attribute are allocated when the assembly-language program has description specifying a section name.

Figure 3-5. Example of Mapping Image 3

```
TEXT1:!LOAD ?RX V0xfffc0000 {
        .text = $PROGBITS ?AX .text:
};

TEXT2:!LOAD ?RX V0xfffffe00 {
       hdlr = $PROGBITS ?AX hdlr:
};
                   . . .
```



(4) When one symbol is created in an application to set values to tp and gp

If the tp and gp need not be changed during application execution, one each of the tp and gp symbols is created by specifying two or more segments or omitting specification of a segment by using the symbol directive.

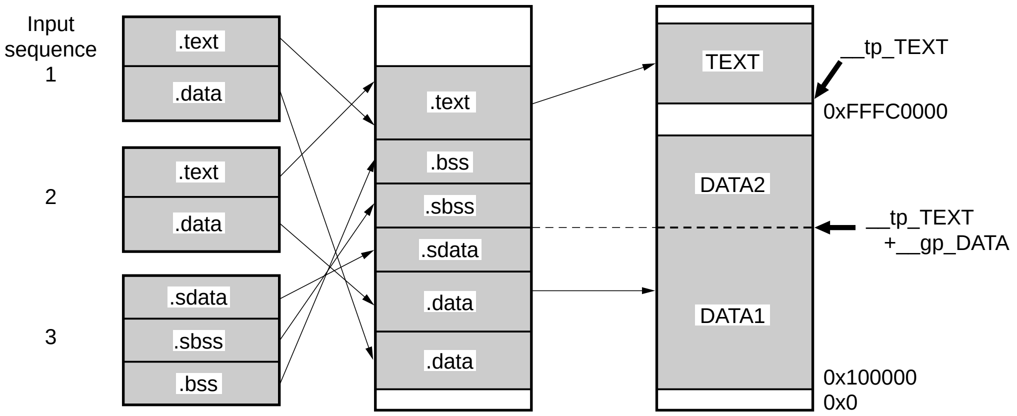
The created symbol is used to set tp and gp upon starting the program (by the start-up routine, etc.).

If a section of data/bss attribute and r0 or ep relative reference, such as .sedata section, exits in the application, and if a segment name are omitted in creating the gp symbol, the segments to which that section is to be allocated are subjected to the gp symbol creation, and an unexpected value is set to the gp symbol.

To prevent this error, specify the targeted segment name in directing creation of the gp symbol.

Figure 3-6. Example of Mapping Image 4

```
              . . .
DATA1:!LOAD ?RW V0x100000 {
        .data   = $PROGBITS ?AW;
        .sdata = $PROGBITS ?AWG;
};
DATA2:!LOAD ?RW {
        .sbss = $NOBITS ?AWG;
        .bss   = $NOBITS ?AW;
};

TEXT:!LOAD ?RX V0xfffc0000 {
        .text = $PROGBITS ?AX;
};
              . . .
__tp_TEXT@% TP_SYMBOL;
__gp_DATA@% GP_SYMBOL &__tp_TEXT   {DATA1 DATA2 };
```

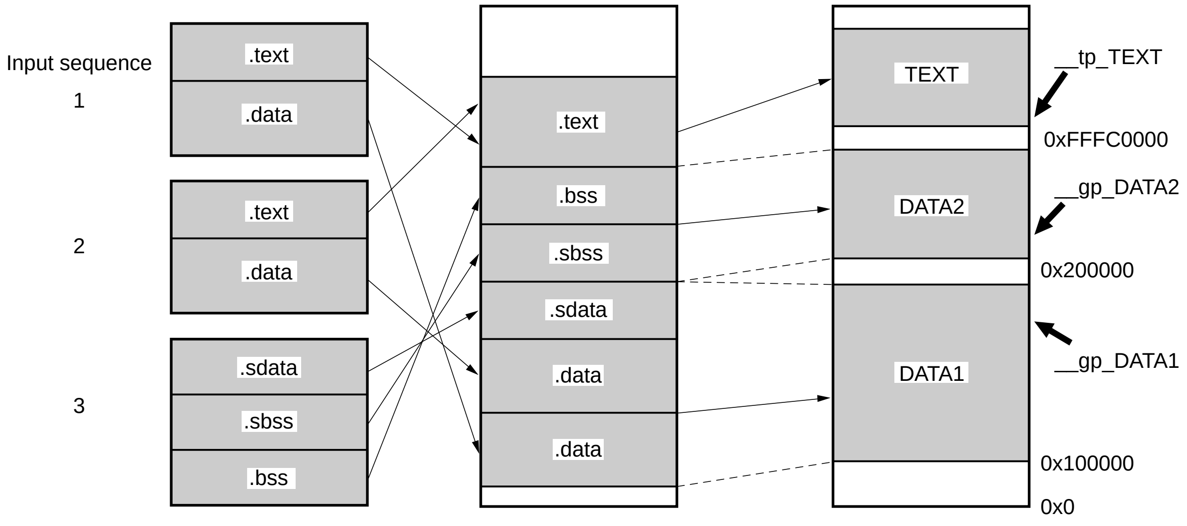


(5) To create a symbol for each segment to set values to tp and gp

If it is necessary to change the tp and gp during application execution, specify a segment by the symbol directive to create two or more tp and gp symbols. The tp and gp are changed by program by using the created symbol.

Figure 3-7. Example of Mapping Image 5

```
                . . .
DATA1:!LOAD ?RW  V0x100000  {
          .data   = $PROGBITS ?AW;
          .sdata = $PROGBITS ?AWG;
};
DATA2:!LOAD ?RW  V0x200000  {
          .sbss  = $NOBITS ?AWG;
          .bss    = $NOBITS ?AW;
};

TEXT:!LOAD ?RX V0xfffc0000  {
        .text = $PROGBITS ?AX;
};
              . . .
__tp_TEXT @% TP_SYMBOL ;
__gp_DATA1 @% GP_SYMBOL  {DATA1};
__gp_DATA2 @% GP_SYMBOL  {DATA2};
```



3.4 Segment Directive

This section explains the feature, configuration, and usage of the segment directive.

3.4.1 Feature of segment directive

The segment directive can be used to specify the following items.

- Configuration and attribute of a segment created by linking sections
- Address and alignment condition for allocating a segment to a memory space
- Size of the hole created (as necessary) for allocating a segment to a memory space
- Filling value of the hole created as a result of allocating a segment or a hole explicitly specified to be created

3.4.2 Configuration of segment directive

The configuration of the segment directive is as follows:

Figure 3-8. Configuration of Segment Directive

```
segment name: !segment type △ ?segment attribute[ △ V address]
                   [ △ L maximum memory size][ △ H hole size][ △ F filling value]
                   [ △ A alignment condition]{mapping directive ...};
```

- Sequentially describe the segment directives from the directive for the segment that is allocated to the lowest address to the directive for the segment that is allocated to the highest address.
- The items that can be specified for a segment directive and their specification formats are shown in Table 3-2.

Table 3-2. Items That Can Be Specified and Their Specification Formats

Item	Specification Format
Segment name	Segment name
Segment type	!LOAD
Segment attribute	?[R] [W] [X]
Address	V address
Maximum memory size	L maximum memory size
Hole size	H hole size
Filling value	F filling value
Alignment condition	A alignment condition

- These items are delimited by a blank space.

  Example[42]>

```
SEG : !LOAD ?RX V0x0 L0xffffffff H0x0 A0x8 {};
```

- Specification of a segment type and segment attribute must not be omitted.
- The other items may be omitted. If an item is omitted, the ld executes linking by using the default value shown in Table 3-3.
- Be sure to end a segment directive with ";".

Table 3-3. Default Value of Each Item

Item	Default Value
Address	Address 0x0 for first segment, and values following end of segment for other segments
Maximum memory size	0x100000
Hole size	0x0
Filling value	0x0000
Alignment condition	0x8

[42] In some examples of the segment directive given later, specification of the mapping directive is omitted. This is only for simplifying the explanation. In actuality, if the mapping directive was not specified, the segment directive would be ignored.

3.4.3 Explanation of each item that can be specified for segment directive

(1) Segment name

Specify the name of a segment to be created.

- Because the address allocated to a segment is dependent on the sequence in which the segment is described, it is recommended that, if the segment name to be described is that of a segment whose address is fixed, the sequence be the same as the segment sequence of the default link directive (refer to pages 307 through 313).

- To specify addresses for segments, sequentially describe them from the allocated one to the lowest one (refer to page 269).

- An identifier of an appropriate length consisting of appropriate characters shown on page 255 can be used for a segment name.

- A segment name does not remain as information in the output object file.

- The segment names for the segments to which the following reserved sections are allocated are fixed. The other segment names must not be used.

.sidata section, .sibss section, .tidata section, .tibss section, .tidata.byte section, .tibss.byte section, .tidata.word section, .tibss.word section	→	SIDATA segment
.sedata section, .sebss section	→	SEDATA segment
.sconst section	→	SCONST segment
.const section	→	CONST segment
.cdata1 section	→	CDATA1 segment
.cdata2 section	→	CDATA2 segment
.cdata3 section	→	CDATA3 segment
.udata1 section	→	UDATA1 segment
.udata2 section	→	UDATA2 segment
.udata3 section	→	UDATA3 segment
.itext section	→	ITEXT segment

For the details of the section type, refer to page 257, **V800 Series C Compiler Package User's Manual - C Language**, and **C Compiler Package User's Manual - Assembly Language** of each family.

(2) Segment type

Specify the segment type of a segment to be created.

- The segment type that can be specified is only LOAD that is the segment type loaded to memory. If any other segment type is specified, the ld outputs the following message and stops linking.

  ```
  syntax error: line num: illegal segment type "string".
  ```

- Specification of a segment type must not be omitted. If omitted, the ld outputs the following message and stops linking.

  ```
  fatal error: segment directive of segment "segment" needs SEGMENT TYPE.
  ```

- Start specifying a segment type with "!".

- "!" must not be followed by a blank space.

- The uppercase and lowercase characters are not distinguished in specifying a segment type. Therefore, LOAD can be uppercase or lowercase characters.

(3) Segment attribute

Specify the segment attribute of a segment to be created.

- Table 3-4 shows the segment attributes that can be specified and their meanings.

Table 3-4. Segment Attributes and Their Meanings

Segment Attribute	Meaning
R	Segment that can be read
W	Segment that can be written
X	Executable segment

- Specification of a segment attribute must not be omitted. If omitted, the ld outputs the following message and stops linking.

```
fatal error: segment directive of segment "segment" needs SEGMENT ATTRIBUTE.
```

- Start specifying a segment attribute with "?".

- "?" must not be followed by a blank space.

Example>

```
SEG : !LOAD ?RX {};
```

- R, W, or X can be specified in any sequence.
- R, W, or X can be specified more than once when specifying a segment attribute once. In terms of meaning, however, it is the same as specifying R, W, or X only once.

Example>

```
SEG : !LOAD ?RXRX {};
```

- If a segment attribute is specified more than once in one segment directive, the ld outputs the following message and stops linking.

```
syntax error: line num: SEGMENT ATTRIBUTE specified to segment
"segment" more than once in same or other directive.
```

Mistake example>

```
SEG : !LOAD ?RX ?RW {};
```

(4) Address

Specify an address from which the created segments are allocated to a memory space. Sequentially specify addresses starting from the lower address. Describe the segments from the allocated one to the lowest address.

Specifying addresses can be omitted. If omitted, the segments are allocated to a memory space starting from address 0x0 in the sequence in which the segments are described in the directive file. If the address for the second segment or those that follow is omitted, the segments are allocated starting from the end address of the immediately preceding segment.

The segments for which addresses are fixed, such as those in the internal memory and those of r0 relative that referenced by one instruction, must be allocated to addresses in the same manner as the memory location of the microprocessor. Specify the addresses and attributes of these segments by referring to the User's Manuals of the microprocessor and device files, and default directive (refer to 3.7 on page 305).

[Example of segment requiring address specification or with fixed description location]

- To create SCONST segment to be allocated to internal ROM with V851 with internal ROM as the target device

  Allocates the segments to the internal ROM by specifying an address less than address 0x7fff or by describing the segments before. If described at the beginning without specifying an address, and if the interrupt processing to be executed at reset or start-up module is not located at address 0x0, the data of the SCONST segment is allocated to handler address 0x0.

```
SCONST : !LOAD ?R V0x160{
        .sconst = $PROGBITS ?A .sconst;
};
```

- To create DATA segment to be allocated to external memory with V851 with internal ROM as the target device

  Specify the first address of the external memory, 0x100000.

```
SCONST : !LOAD ?RW V0x00000{
        .data  = $PROGBITS ?AW;
        .sdata = $PROGBITS ?AWG;
        .sbss  = $NOBITS ?AWG;
        .bss   = $NOBITS ?AW;
};
```

- To create SCONST segment of r0 relative and referenced by one instruction with the V830 Family

  Set address 0xffff8000 within –32 KB from r0.

```
SCONST : !LOAD ?R V0xffff8000{
        .sconst = $PROGBITS ?A .sconst;
};
```

If two or more segments exist, and an address is specified for one of them, the segment for which an address is specified is allocated from the specified address, unless the specified address overlaps the address of the previously specified segment. If overlapping occurs, the ld outputs the following message and stops linking.

```
    fatal error: start address (number1) of segment “segment” overlaps previous
    segment ended before address (number2).
```

Specify the address in the following format.

- Specify an even address. If an odd address is specified, the ld outputs the following message and continues linking, assuming that an address of the specified address plus 1 is specified.
  ```
  warning: line num: aligned odd value (number1) to be even value (number2).
  ```

- Start specifying an address with “V”.

- “V” must not be followed by a blank space.

- “V” may be uppercase or lowercase.

- Do not use an expression to specify an address.

[Automatic location of interrupt handler]

The ld adds a link directive to allocate an interrupt handler to the specified directive file in accordance with the interrupt request name defined in the device file.

If an interrupt handler is specified by the “`#pragma`” directive or “`#pragma rtos_interrupt`” directive[43] in the C source file, or a section that specifies an interrupt request name by using the “`.section`” pseudo-instruction[44] is defined in an assembler source, the section defined as an interrupt handler is allocated to the address stipulated by the device file.

At this time, locating the interrupt handler takes precedence over locating the other segments.

```
#pragma interrupt INTP00 func  ← Branch to func becomes INTP00 section

.section ''INTP01'', text      ← Defines INTP01 section

(Internally added directive)
INTP00 : !LOAD ?R V0x120{
        INTP00 = $PROGBITS ?AX INTP00;
};
INTP01 : !LOAD ?R V0x130{
        INTP01 = $PROGBITS ?AX INTP01;
};
```

In the above example, if `direct` is specified for the `#pragma interrupt`, the function becomes the `INTP00` section instead of branching to the function `func`.

[43] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

[44] Refer to **User’s Manual - Assembly Language** of each family.

(5) Maximum memory size

Set the maximum value of the memory size of the segment to be created.

If the memory size specified for the segment to be created exceeds the maximum memory size, the link editor outputs the following message and stops linking.

```
fatal error: memory size (number1) of segment "segment" overflowed specified or
default maximum memory size (number2).
```

- Specifying the maximum memory size can be omitted. If omitted, 0x100000 is used as the default value (refer to **Table 3-3** on page 265).
- Start specifying the maximum memory size with “L”.
- “L” must not be followed by a blank space.
- “L” may be uppercase or lowercase.
- Do not use an expression to specify the maximum memory size.

The maximum memory size must not exceed the intended size. If the actual size is less than the specified maximum memory size, the address of the segment located relatively rearward immediately follows the address to which the preceding segment is actually allocated.

(6) Hole size

Specify the size of the hole to be created. The specified hole is created at the end of the specified segment[45]. Specify the hole size in the following format.

- Specifying the hole size can be omitted. If omitted, 0x0 is used as the default value (refer to **Table 3-3** on page 265).
- Start specifying the hole size with “H”.
- “H” must not be followed by a blank space.
- “H” may be uppercase or lowercase.
- Do not use an expression to specify hole size.

[45] A hole area is appended to the specified segment.

(7) Filling value

Specify a value (called a filling value) used to fill the hole area of the hole which is created in allocating segments or is explicitly specified to be created[46]. Specify the filling value in the following format.

- Specifying a filling value can be omitted. If omitted, 0x0000 is used as the default value (refer to **Table 3-3** on page 265).
- If the filling value (-f) is specified, the ld outputs the following message, ignores the filling value specified by the link directive, and continues linking.

```
warning: line num: FILLING VALUE is illegal when “-f” option specified,
ignored.
```

- Specify the filling value as a 2-byte 4-digit hexadecimal number.
- If the filling value is of less than 4 digits, the higher digits are assumed to be 0.
- If the hole is less than 2 bytes, the required digits are taken out of the lower value of the specified filling value.
- Start specifying the filling value with “F”.
- “F” must not be followed by a blank space.
- “F” may be uppercase or lowercase.
- Do not use an expression to specify a filling value.

[46] This filling value is used if a filling value is not explicitly specified for a section to be allocated to that segment.

(8) Alignment condition

Specify the alignment condition of the specified segments in allocating the segments to a memory space. The alignment condition can be omitted. If omitted, 0x8[47] is used as the default value (refer to **Table 3-3** on page 265).
Specify the alignment condition in the following format.

- Specify an alignment condition as an even number. If an odd number is specified, the ld outputs the following message, assumes that the specified alignment condition plus 1 is specified, and continues linking.

  `warning: line` *num*`: aligned odd value (`*number1*`) to be even value (`*number2*`).`

- If an address is specified, the specified address takes precedence, and the specified alignment condition is ignored.

- Start specifying an alignment condition with “A”.

- “A” must not be followed by a blank space.

- “A” may be uppercase or lowercase.

- Do not use an expression to specify an alignment condition.

(9) Mapping directive

Specify allocation of the input section to a segment.
For the details of the mapping directive, refer to 3.5 on page 278.

- If the mapping directive is not specified for the segment directive, the ld ignores the segment directive[48].

[47] 8-byte boundary (double-word boundary)
[48] It is assumed that the segment directive is not specified.

3.4.4 Using segment directive

(1) Allocating segment to specified address

When allocating a segment to a memory space by specifying an address, specify the address by using the segment directive that defines the segment.

For segments other than those for which addresses are fixed such as the segments to be placed in the internal ROM, any address in the memory space can be specified if all the segments are allocated within the memory space without overlapping.

Figure 3-9 shows the general format of allocation with an address specified.

Figure 3-9. General Format of Allocation with Address Specified

```
segment name : !LOAD△?segment attribute△V address {
                    mapping directive
};
```

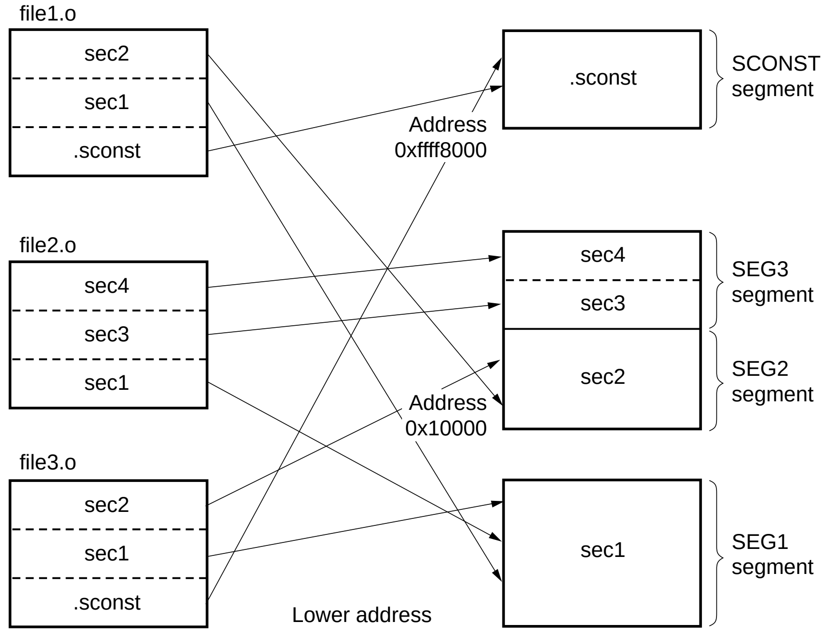
For example, if object files file1.o, file2.o, and file3.o including the sections in the sequence shown in Figure 3-11 are linked with the directive shown in Figure 3-10 specified, segment[49] SEG1 to which section sec1 is to be allocated is allocated from address 0 , segment SEG2 to which section sec2 is to be allocated is allocated from address 0x10000, and segment SEG3 to which sections sec3 and sec4 are to be allocated is allocated immediately after the preceding segment SEG2 (refer to **Figure 3-11**).

Figure 3-10. Example of Allocation Display with Address Specified

```
SEG1 : !LOAD ?RX {
       sec1 = $PROGBITS ?AX sec1 { file1.o file2.o file3.o };
};

SEG2 : !LOAD ?RW V0x10000 {
       sec2 = $PROGBITS ?AW sec2 {file1.o file3.o };
};
SEG3 : !LOAD ?RW {
       sec3 = $PROGBITS ?AWG sec3 { file2.o };
       sec4 = $NOBITS ?AW sec4 { file2.o };
};

SCONST : !LOAD ?R V0xffff8000{
       .sconst = $PROGBITS ?A .sconst;
};

__tp_TEXT @ %TP_SYMBOL { SEG1 };
__gp_DATA @ %GP_SYMBOL &__tp_TEXT { SEG2 SEG3 };
```

[49] For allocation of a section to a segment, refer to 3.5.4 on page 286.

Figure 3-11. Example of Allocation with Address Specified



(2) Allocating segment with specified alignment condition satisfied

To allocate a created segment to a memory space with the alignment condition of n-byte boundary (n is a multiple of 2), specify n as an alignment condition by using the segment directive that defines the segment.

Figure 3-12 shows the general format of allocation with an alignment condition specified.

Figure 3-12. General Format of Allocation with Alignment Condition Specified

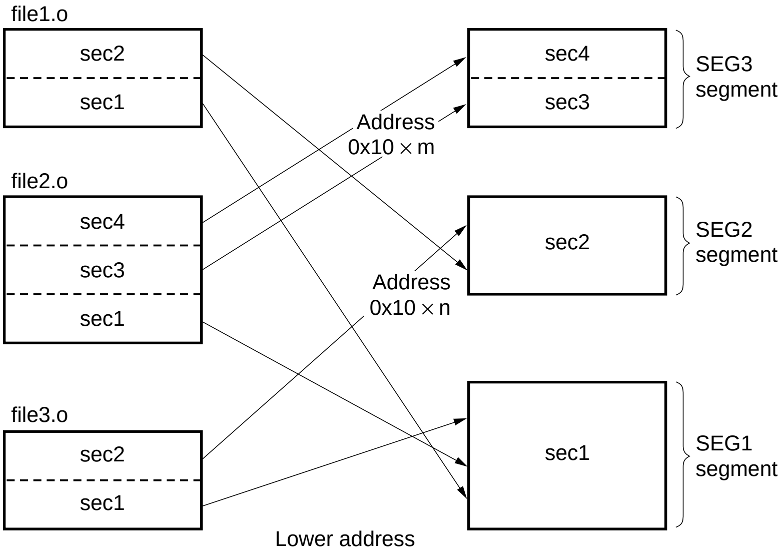
```
segment name: !LOAD △ ?segment attribute △ A alignment condition {
                    mapping directive
};
```

For example, when object files file1.o, file2.o, and file3.o including the sections in the sequence shown in Figure 3-14 are linked with the directive shown in Figure 3-13 specified, segments SEG2 and SEG3 are allocated with the alignment condition of 0x10 satisfied (refer to **Figure 3-14**).

Figure 3-13. Example of Allocation Display with Alignment Condition Specified

```
SEG1 : !LOAD ?RX {
        sec1 = $PROGBITS ?AX sec1 { file1.o file2.o file3.o };
};

SEG2 : !LOAD ?RW A0x10 {
        sec2 = $PROGBITS ?AW sec2 { file1.o file3.o };
};
SEG3 : !LOAD ?RW A0x10 {
        sec3 = $PROGBITS ?AW sec3 { file2.o };
        sec4 = $NOBITS ?AW sec4 { file2.o };
};

__tp_TEXT @ %TP_SYMBOL { SEG1 };
__gp_DATA @ %GP_SYMBOL &__tp_TEXT { SEG2 SEG3 };
```

Figure 3-14. Example of Allocation with Alignment Condition Specified



(3) Creating hole

Creating a certain area (called a hole) between segments[50] and filling that area with a certain value (called a filling value[51]) is called “creating a hole”.

To create a hole between segments, specify the hole size and, as necessary, a filling value by using the segment directive that defines the segment with the address lower than that of the created hole.

Figure 3-15 shows the general format of allocation with creating a hole specified.

Figure 3-15. General Format of Allocation with Creating Hole Specified

```
segment name : !LOAD △ ? segment attribute △ H hole size {
                    mapping directive
};
```

For example when object files are linked with the directive shown in Figure 3-16 specified, a hole of 0x50 bytes is created after segment TEXT, and segment DATA is allocated after the hole.

Figure 3-16. Example of Allocation with Creating Hole Specified

```
TEXT : !LOAD ?RX V0x0 H0x50 {
        .text = $PROGBITS ?AX;
};

DATA : !LOAD ?RW A0x8 {
        .data  = $PROGBITS ?AW;
        .sdata = $PROGBITS ?AWG;
        .sbss  = $NOBITS   ?AWG;
        .bss   = $NOBITS   ?AW;
};

__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT;
```

[50] A hole can be also created between sections (refer to page 283).

[51] The default filling value is 0x0000.

3.5 Mapping Directive

This section explains the feature, configuration, and usage of the mapping directive.

3.5.1 Feature of mapping directive

The mapping directive is used to instruct the following item of information.

- Configuration and attribute of an output section constituting the object file created by linking input sections (sections included in specified object files or in object files within a specified archive file)

3.5.2 Configuration of mapping directive

The configuration of the mapping directive is shown below.

Figure 3-17. Configuration of Mapping Directive

```
section name = $ section type △ ? section attribute [ △ section name]
                   [ △ V address][ △ H hole size][ △ A alignment condition]
                   [{file name[ △ file name] ... }];
```

- The items that can be specified by the mapping directive and their formats are shown in Table 3-5.

Table 3-5. Items That Can Be Specified and Their Specification Formats

Item	Specification Format
Section name	Section name
Section type	$PROGBITS or $NOBITS
Section attribute	?[A] [W] [X] [G]
Address	V address
Hole size	H hole size
Alignment condition	A alignment condition
File name	File name

  – Delimit each of these items from the others by a blank space.

  – Specifying of a section type and a section attribute must not be omitted.

  – If the same item is specified more than once for the same output segment, the ld stops linking.

- Be sure to end the mapping directive with “;”.

3.5.3 Explanation of each item that can be specified for mapping directives

(1) Section name

Specify the name of a section (output section) to be included in the created object file on the left of "=". On the right of "=", specify the name of an input section to be allocated to the specified output section (section included in the specified object files and the object files in the specified archive file). Note, however, that an input section name starting with V/v/H/h/A/a must not be specified.

- If the section name (input section name) on the right of "=" is omitted, all the sections having the specified section type and section attribute are allocated to the section (output section) on the left of "=".

- The section name on the left of "=" (output section name) must not be omitted. If omitted, the ld outputs the following message, and stops linking.

```
syntax error: line num: section name is expected at the beginning of section
directive.
```

- The same output section name must not be specified for two or more mapping directives. If specified, the ld outputs the following message and stops linking.

```
syntax error: line num: section "section" already defined at line (num).
```

- The correspondence between the section name on the left of "=" (output section name) and the section name on the right of "=" (input section name) is fixed for the following section names. For example, do not allocate the .sedata section to an output section with a different name.

.tidata section	→	`.tidata`
.tibss section	→	`.tibss`
.tidata.byte section	→	`.tidata.byte`
.tibss.byte section	→	`.tibss.byte`
.tidata.word section	→	`.tidata.word`
.tibss.word section	→	`.tibss.word`
.sidata section	→	`.sidata`
.sibss section	→	`.sibss`
.sedata section	→	`.sedata`
.sebss section	→	`.sebss`
.sconst section	→	`.sconst`
.const section	→	`.const`
.cdata1 section	→	`.cdata1`
.cdata2 section	→	`.cdata2`
.cdata3 section	→	`.cdata3`
.udata1 section	→	`.udata1`
.udata2 section	→	`.udata2`
.udata3 section	→	`.udata3`
.itext section	→	`.itext`

For example, if “data” is specified as the section type, such as by `“.section “sec”, data”`, by the .section pseudo-instruction of the assembly language, this “`sec`” section must not be allocated to the .sedata section. If there is no mapping directive for “`sec`” section, “`sec`” section appears first in the directive, and is allocated to the data-attribute section for which no input section name is specified.
To allocate a section to a segment area the same as the .sedata section, a mapping directive must be added for “`sec`” section.

Example>

```
SEDATA : !LOAD ?RW {
       .sedata = $PROGBITS ?AW .sedata;
       sec     = $PROGBITS ?AW sec;      ← directive to allocate sec section
};
```

For the contents of section type, refer to page 257, **V800 Series C Compiler Package User’s Manual - C Language**, and **C Compiler Package User’s Manual - Assembly Language** of each family.

(2) Section type

Specify the section type of the input section to be allocated to the output section.

- Either of the following section types can be specified.

  PROGBITS : section type of the section having the actual value in the object file (= data with text and initial value)

  NOBITS : section type of the section not having the actual value in the object file (= data without initial value)

  If any section type other than these is specified, the ld outputs the following message and stops linking.

  `syntax error: line` *num*`: illegal section type "`*string*`".`

- The section type must not be omitted. If omitted, the ld outputs the following message and stops linking.

  `syntax error: line` *num*`: section directive of section "`*section*`" needs SECTION TYPE.`

- Be sure to start specifying a section type with "$". If only "$" is specified, however, the ld stops linking.

- "$" must not be followed by a blank space.

(3) Section attribute

Specify the section attribute of the input section to be allocated to the output section.

- Table 3-6 shows the section attributes that can be specified and their meanings.

Table 3-6. Section Attributes and Their Meanings

Section Attribute	Meaning
A	Section occupying memory
W	Section that can be written
X	Executable section
G	Section allocated to memory range that can be referenced by using global pointer (gp) and 16-bit displacement

- The section attribute must not be omitted. If omitted, the ld outputs the following message, and stops linking.

```
syntax error: line num: section directive of section "section" needs SECTION
ATTRIBUTE.
```

- If this mapping directive is specified in a segment directive, the specified section attribute must match the section attribute specified in that segment directive[52]
- Start specifying the section attribute with "?".
- "?" must not be followed by a blank space.

Example>

```
   sec = $PROGBITS ?AX
```

- A, W, X, and G can be specified in any sequence.

- A, W, X, or G can be specified more than once in specifying an section attribute once. In terms of meaning, however, it is the same as when specifying A, W, X, or G only once.

Example>

```
sec = $PROGBITS ?AXAX;
```

- If a section attribute is specified more than once in one mapping directive, the ld outputs the following message and stops linking.

```
syntax error: line num: SEGMENT ATTRIBUTE specified to section "section" more
than once in same or other directive.
```

Mistake example>

```
sec = $PROGBITS ?AX ?AW;
```

[52] Ignore section attribute G, and section attributes A, W, and X must match segment attributes R, W, and X.

(4) Address

Specify the address from which allocating of the specified output section is started.

Usually, an address is specified for each segment, but a specific section can be allocated to a specific address.

The address specification format conforms to the address specification format of the segment directive (refer to page 270).

Automatic location of interrupt handler

> The ld adds a link directive to allocate an interrupt handler to the specified directive file in accordance with the interrupt request name defined in the device file.
> Refer to page 270 for details.

(5) Hole size

Specify the size of the hole to be created. The specified hole is created at the end of the specified section[53].

Specification format of the hole size conforms to specification format of the hole size of the segment directive (refer to page 271).

(6) Alignment condition

Specify the alignment condition that must be satisfied when the specified section is allocated[54].

The alignment condition can be omitted. If omitted, the default values are as follows.

.tidata.byte/.tibss.byte section:	0x1 bytes * V850
.text section:	0x4 bytes * V830
.text section:	0x2 bytes * V850
Others:	0x4 bytes

The specification format of the alignment condition conforms to the specification format of the alignment condition of the segment directive (refer to page 273). However, odd-numbered values can be specified in alignment conditions for the .tidata.byte/.tibss.byte section only. These odd values are not compensated to become even values.

(7) File name

Specify an object file that includes an input section to be allocated to the output section. If a file name is specified, only the input section that is included in the specified file and has the corresponding section type and section attribute is allocated to the output section.

- In specifying a file name, enclose the object file name to be specified in “{” and “}”.
- To specify two or more file names, delimit each from the others by a blank space.

Example>

```
    sec = $PROGBITS ?AX { file1.o file2.o file3.o };
```

[53] A hole area is appended to the specified section.

[54] If the specified alignment condition value differs from a previously set alignment condition for the specified section, the least common multiple of the both values is taken as the alignment condition.

- To specify an object file in an archive file (.a file), enclose the archive file name including a path in "()". The path must be the same as the one specified by the path specification (-L) option of the library (if no path is specified, the path of the standard directory is assumed).

  Example>

  ```
  sec = $PROGBITS ?AX { strcmp.o(a:\nectools\lib850\r32\libc.a) };
  ```

- Specifying of a file name may be omitted.

  Example>

  ```
  sec = $PROGBITS ?AX;
  ```

- If the file name is omitted, the ld assumes that all the object files are specified.
  For example, the above example is equivalent to the example below if the ld is started with object files file1.o, file2.o, file3.o, and file4.o specified.

  Example>

  ```
  sec = $PROGBITS ?AX { file1.o file2.o file3.o file4.o };
  ```

  In the next example, the section with section type `$PROGBITS` and section attribute `?AX` in all the files is equivalent to sec1, and section sec2 is not created.

  Example>

  ```
  sec1 = $PROGBITS ?AX;
  sec2 = $PROGBITS ?AX {file1.o};
  ```

If two or more file names are specified, the specified file names are allocated from the lower address toward the higher address in the sequence in which the file names are specified.
If the sequence of the files specified by arguments on starting the ld differs from the sequence specified by the link directive, the file name sequence specified by the argument takes precedence.

Example of sequence specified by argument that takes precedence>

```
link directive
    sec = $PROGBITS ?AX {file1.o file2.o file3.o};

command specification
    ld732 file3.o file2.o file1.o
              ↓
        file3.o, file2.o, and file1.o are allocated in that order starting from the lower address
```

[Caution]

If allocation to an expected section is not carried out even when an object file name or archive file name is described, the link map is referenced.

Output the link map by using an option of the link editor, describe a name exactly the same as the file name displayed on the link map, including the path name, to the directive file, and execute linking again.

3.5.4 Using mapping directive

(1) Mapping of sections

- Specify the section type, section attribute and (as necessary) section name, and file name of the section to be allocated in a mapping directive that is specified in a segment directive.
  For example, to allocate a section having section type PROGBITS and section attribute AX in object files file1.o and file2.o to segment SEG, the following directive can be used.

  Example>

  ```
  SEG : !LOAD ?RX {
   sec = $PROGBITS ?AX { file1.o file2.o };
  };
  ```

  To allocate a section having section type PROGBITS, section attribute AX, and section name usrsec in object files file1.o and file2.o to segment SEG, the following directive can be used.

  Example>

  ```
  SEG : !LOAD ?RX {
   usrsec = $PROGBITS ?AX usrsec { file1.o file2.o };
  };
  ```

- Two or more mapping directives can be specified in one segment directive[55].
  For example, to allocate data-attribute section[56] and bss-attribute section[57] in object files file1.o and file2.o to segment SEG, the following directives can be used.

  Example>

  ```
  SEG : !LOAD ?RW {
          sec1 = $PROGBITS ?AW { file1.o file2.o };
          sec2 = $NOBITS ?AW { file1.o file2.o };
  };
  ```

  To allocate data-attribute section and sdata-attribute section[58] in object files file1.o and file2.o to segment SEG, the following directives can be used.

  Example>

  ```
  SEG : !LOAD ?RW {
          .data = $PROGBITS ?AW { file1.o file2.o };
          .sdata = $PROGBITS ?AWG { file1.o file2.o };
  };
  ```

[55] If a section having section type NOBITS is specified before a section having section type PROGBITS, a portion that does not have an actual value is sandwiched between these sections in the object file. Consequently, the contents of the segment cannot be loaded by using the value of the program header table entry. If it is necessary to load the segment contents by using the program header table entry value, specify the section having section type NOBITS after the section having section type PROGBITS.

[56] Section having section type PROGBITS and section attribute AW

[57] Section having section type NOBITS and section attribute AW

[58] Section having section type PROGBITS and section attribute AWG

- If the same section type, section attribute, input section name (can be omitted), and input file name (can be omitted) are specified for two or more segments, and if the corresponding section exists, the section is allocated to the segment specified first.
  For example, if no input file name is specified or if the same file name is specified for two segments, and if the same section types and section attributes are specified for both the segments, the sections are allocated to the segment specified first, and not to the segment specified last. At this time, the ld outputs no message.
  For example, if the following directive is specified, sections are allocated to segment TEXT1, but not to segment TEXT2[59].

Example>

```
TEXT1 : !LOAD ?RX {
        .text1  = $PROGBITS ?AX { file1.o file2.o };
};
TEXT2 : !LOAD ?RX
        .text2  = $PROGBITS ?AX { file1.o file2.o };
};                ← Because section types, section attributes, and input file names
                    are the same as TEXT1, TEXT2 is not created.

DATA :  !LOAD ?RW {
        .data  = $PROGBITS ?AW;
        .sdata = $PROGBITS ?AWG;
        .sbss  = $NOBITS   ?AWG;
        .bss   = $NOBITS   ?AW;
};

__tp_symbol @ %TP_SYMBOL;
__gp_symbol @ %GP_SYMBOL &__tp_symbol;
__ep_DATA   @ %EP_SYMBOL;
```

[59] Segment TEXT2 is not created.

(2) Linking object files

To link two or more object files in section units, use the mapping directive to specify the file names of the object files to be linked, and the section names to be linked.

To link all the sections having the same type and same attribute in two or more object files in the sequence in which they are included in the files, the section names need not be specified (refer to **Figure 3-3** on page 259).

The linking sequence is in accordance with the sequence specified by the mapping directive, and from the lower address toward the higher address. If the sequence of the file names specified by an argument upon starting the ld is different from the sequence specified by the mapping directive, the sequence specified by the argument takes precedence.

Figure 3-18. General Format to Link Object Files

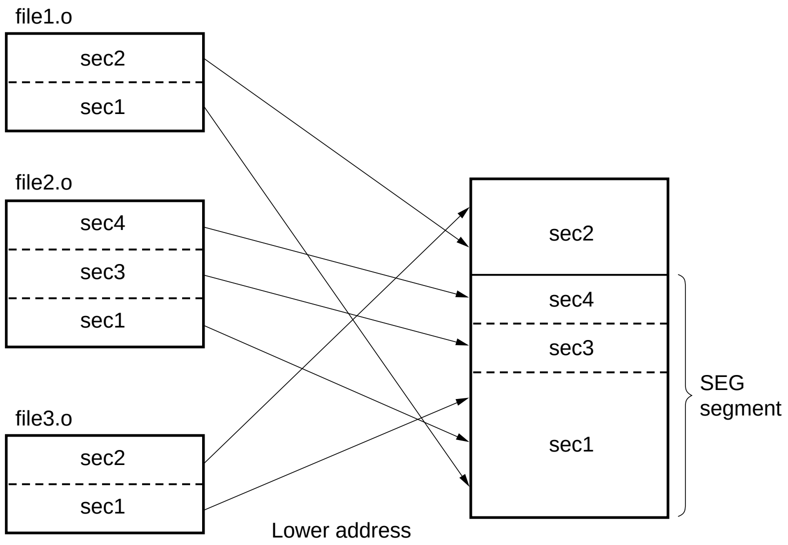
```
output section name = section type △ section attribute △ input section name
                              {file name[ △ file name]...};
```

For example, when object files file1.o, file2.o, and file3.o that include the sections in the sequence shown in Figure 3-20 are linked by specifying the directive shown in Figure 3-19, the object files are linked in the format shown in Figure 3-20[60].

Figure 3-19. Example of Commands for Linking Object Files

```
SEG : !LOAD ?RW {
      sec1 = $PROGBITS ?AW  sec1 { file1.o file3.o file2.o };
      sec3 = $PROGBITS ?AWG sec3 { file2.o };
      sec4 = $NOBITS   ?AW  sec4 { file2.o };
};
```

Figure 3-20. Example of Linking Object Files



[60] A segment is not created for section sec2 but is linked after segment SEG in the sequence in which it appears.

3.6 Symbol Directive

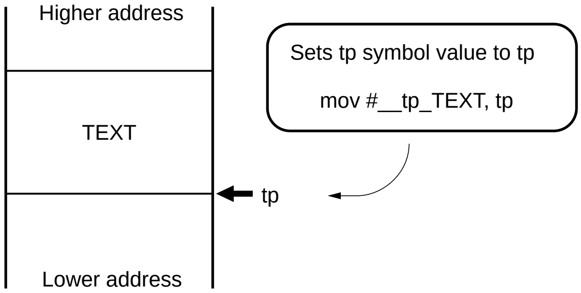
This section explains the feature, configuration, and usage of the symbol directive.

3.6.1 Feature of symbol directive

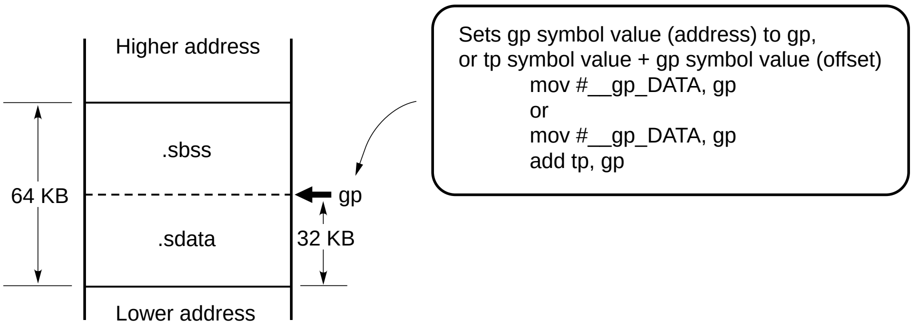
The symbol directive can be used to instruct the following item of information.

Note that the element pointer (ep) exists only in the V850 Family.

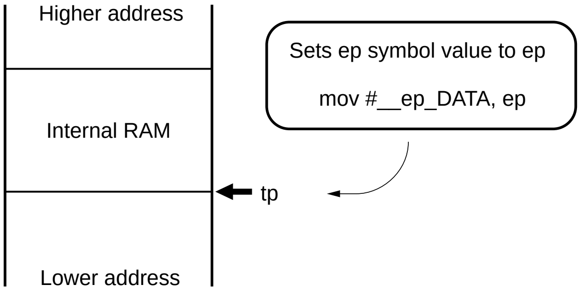
- Creating a text pointer symbol (tp symbol) having the address value to be set to the text pointer (tp) as a value



- Creating a global pointer symbol (gp symbol) having the address value to be set to the global pointer (gp) or the offset value from the address to be set to the text pointer (tp) of the address to be set



- Creating an element pointer symbol (ep symbol) having the address value to be set to the element pointer (ep) * V850



The tp symbol, gp symbol, and ep symbol are used to set appropriate values to the text pointer, global pointer, and element pointer by using the start-up routine that is started before execution of the program. This compiler package assumes that a reference not dependent on the position of the text (position-independent) is executed by using the text pointer. Data are also referenced independently[61] of position by using the offset value from the global pointer.

In referencing data, the data can be referenced at high speeds or the codes can be reduced by using gp relative access that places data[62] in “the sdata-attribute section and sbss-attribute section in the range that can be referenced by using the global pointer and one instruction” and by using ep relative access (* V850) that places data in “the .tidata.byte, .tibss.byte, .tidata.word, .tibss.word, .tidata, and .tibss sections in the range that can be referenced by the element pointer and a load/store instruction[63] with a short instruction length”.

Cautions

- One each tp symbol and gp symbol is always created internally by the ld to resolve addresses, and values must be set to tp and gp by using these symbols upon starting the program.
- The ld850 reads the contents of the device file used and automatically sets the first address of the internal RAM to the element pointer (ep) of the V850 Family. Therefore, only whether a symbol is created or not is specified for the ep symbol.

  Addresses or alignment conditions cannot be specified for the ep symbol.

[61] If a section allocated to a segment in the internal RAM or internal ROM is used, the position-independent code is not used because the addresses to which the section is allocated are fixed.

[62] Allocate data to each section by describing #pragma section (refer to **V800 Series C Compiler Package User’s Manual - C Language**) or section definition pseudo-instruction (refer to **User’s Manual - Assembly Language** of each family), or by specifying the size with the -G option of ca (refer to page 156). The data can also be allocated with a section file (refer to page 408).

[63] sld/sst instruction

3.6.2 Configuration of symbol directive

The configuration of the symbol directive is as follows.

Figure 3-21. Configuration of Symbol Directive

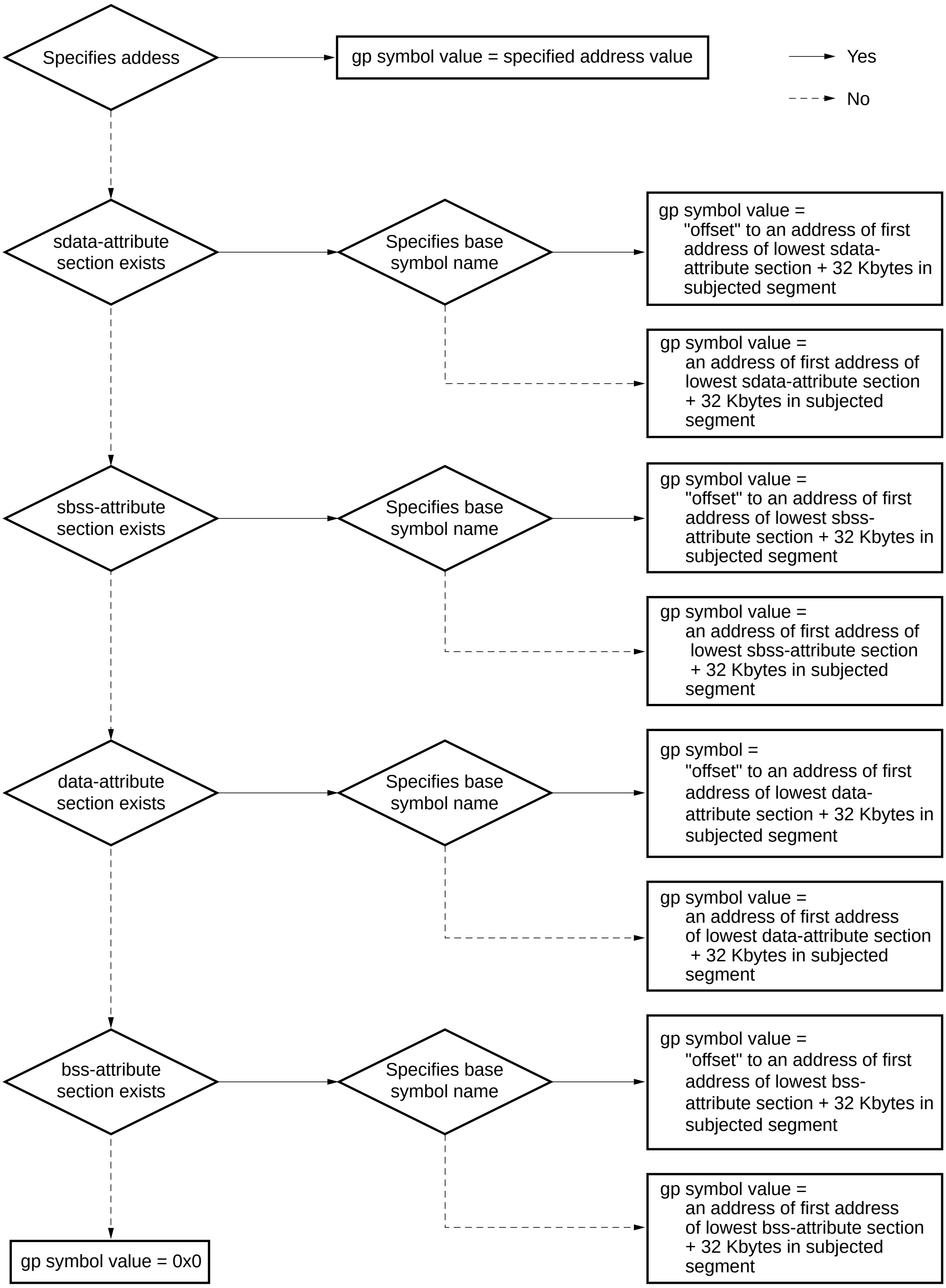
```
symbol name @ %symbol type [&base symbol name][△V address]
                    [△A alignment condition][{segment name[△segment name] ... }];
```

- The value of the created gp symbol is determined by the following rules (refer to **Figure 3-22**).
  - – Specified address if an address is specified.
  - – Offset from the address specified by the following rules from an address indicated by a tp symbol if an address is not specified, if the tp symbol is specified by specification of a base symbol name, and if the specified tp symbol exists
    - * An address of the first address of an sdata-attribute section[64] + 32 Kbytes allocated to the lowest address of the subjected segment if the sdata-attribute section exists in the segment
    - * An address of the first address of an sbss-attribute section[65] + 32 Kbytes allocated to the lowest address of the subjected segment if the above condition is not satisfied and if the sbss-attribute section exists in the segment
    - * An address of the first address of a data-attribute section[66] + 32 Kbytes allocated to the lowest address of the subjected segment if the above condition is not satisfied and if the data-attribute section exists in the segment
    - * An address of the first address of a bss-attribute section[67] + 32 Kbytes allocated to the lowest address of the subjected segment if the above condition is not satisfied and if the bss-attribute section exists in the segment
    - * 0x0 if none of the sbss-, bss-, sdata-, and data-attribute sections exist
  - – Address determined by the above five rules if no address is specified and if the tp symbol is not specified by specification of a base symbol name or if the tp symbol does not exist even if it is specified

- Be sure to end the symbol directive with “;”.

[64] Section having section type PROGBITS and section attribute AWG
[65] Section having section type NOBITS and section attribute AWG
[66] Section having section type PROGBITS and section attribute AW
[67] Section having section type NOBITS and section attribute AW

Figure 3-22. Rules to Determine gp Symbol Value


Specifies addess
gp symbol value = specified address value
Yes
No
sdata-attribute section exists
Specifies base symbol name
gp symbol value = "offset" to an address of first address of lowest sdata-attribute section + 32 Kbytes in subjected segment
gp symbol value = an address of first address of lowest sdata-attribute section + 32 Kbytes in subjected segment
sbss-attribute section exists
Specifies base symbol name
gp symbol value = "offset" to an address of first address of lowest sbss-attribute section + 32 Kbytes in subjected segment
gp symbol value = an address of first address of lowest sbss-attribute section + 32 Kbytes in subjected segment
data-attribute section exists
Specifies base symbol name
gp symbol = "offset" to an address of first address of lowest data-attribute section + 32 Kbytes in subjected segment
gp symbol value = an address of first address of lowest data-attribute section + 32 Kbytes in subjected segment
bss-attribute section exists
Specifies base symbol name
gp symbol value = "offset" to an address of first address of lowest bss-attribute section + 32 Kbytes in subjected segment
gp symbol value = an address of first address of lowest bss-attribute section + 32 Kbytes in subjected segment
gp symbol value = 0x0

3.6.3 Explanation of each item that can be specified for symbol directives

(1) Symbol name

Specify the name of the created tp symbol, gp symbol, or ep symbol (*V850).

- An identifier consisting of appropriate characters shown on page 255 and with any length can be used for a symbol name.
- This symbol name is in the symbol table of the output object file.

(2) Symbol type

Specify whether the tp symbol, gp symbol, or ep symbol (*V850) is to be created.

- The type of symbol that can be specified is only TP_SYMBOL that is the symbol type of the tp symbol, GP_SYMBOL that is the symbol type of the gp symbol, or EP_SYMBOL that is the symbol type of the ep symbol.
- Specification of the symbol type must not be omitted.

(3) Base symbol name

Specify the tp symbol that is used to determine the gp symbol value in creating the gp symbol.

- If the base symbol name is omitted, the gp symbol value is the address determined by the rules on page 292.
- If a base symbol name is specified in creating the tp symbol, the ld outputs no message and ignores the specification.

(4) Address

Specify the tp symbol or gp symbol value. Address specification may be omitted. If omitted, the tp symbol value is the first address of the text-attribute section[68] allocated to the lowest address in the subjected segment if a text-attribute section exists in the segment. If the text-attribute section does not exist in the segment, the ld outputs a message and stops linking. For the gp symbol value when address specification is omitted, refer to the explanation on page 292.

The address specification format conforms to the address specification format of the segment directive (refer to page 270).

(5) Alignment condition

This is used to specify the alignment condition for setting the value of the tp symbol or gp symbol. Specification of the alignment condition may be omitted.

If omitted, 0x4 is assumed as the default alignment condition.

The alignment condition specification format conforms to the alignment condition specification format of the segment directive (refer to page 273).

[68] Section having section type PROGBITS and section attribute AX
The reserved section includes the .text section and .itext section (CA830).

(6) Segment name

This is used to specify the segment to be created in creating the tp symbol or gp symbol.

- Specify a segment of gp relative reference as the subjected segment name of the gp symbol.
  For example, do not specify a segment that allocates the .sedata/.sebss section.
- Specification of the subjected segment may be omitted. If omitted, all the sdata/data/sbss/bss-attribute sections in the object file are subjected.
  If omitted, and if a section of data/bss-attribute such as .sedata/.sebss section, and r0 relative or ep relative reference is created, that segment is also subjected to gp symbol creation, and the value of the gp symbol can differ from that that has been expected.
  When creating a section other than that of gp relative, be sure to specify an appropriate segment as the subjected segment name of the gp symbol.
- To specify two or more segment names, delimit each from the others by a blank space.

3.6.4 Using symbol directive

The tp symbol and gp symbol are created as follows.

- One each of the symbols is created for two or more segments.
- A segment is specified for one each of the symbols, and one each of the symbols is created for each of those segments.

Only one ep symbol is created because it is an address of the internal RAM.

Figure 3-23. General Format to Create tp/gp/ep Symbols

```
symbol name @ %TP_SYMBOL [ △ V address]
                    [ △ A alignment condition][{segment name[ △ segment name] ... }];

symbol name @ %GP_SYMBOL [ △ & base symbol name][ △ V address]
                    [ △ A alignment condition][{segment name [ △ segment name]...}];

symbol name @ %EP_SYMBOL;
```

(1) To create a symbol subjected to two or more segments

To create one each of the tp, gp, and ep symbols in an output object file, specify two or more segments in the symbol directive, or omit specification of the segment name.

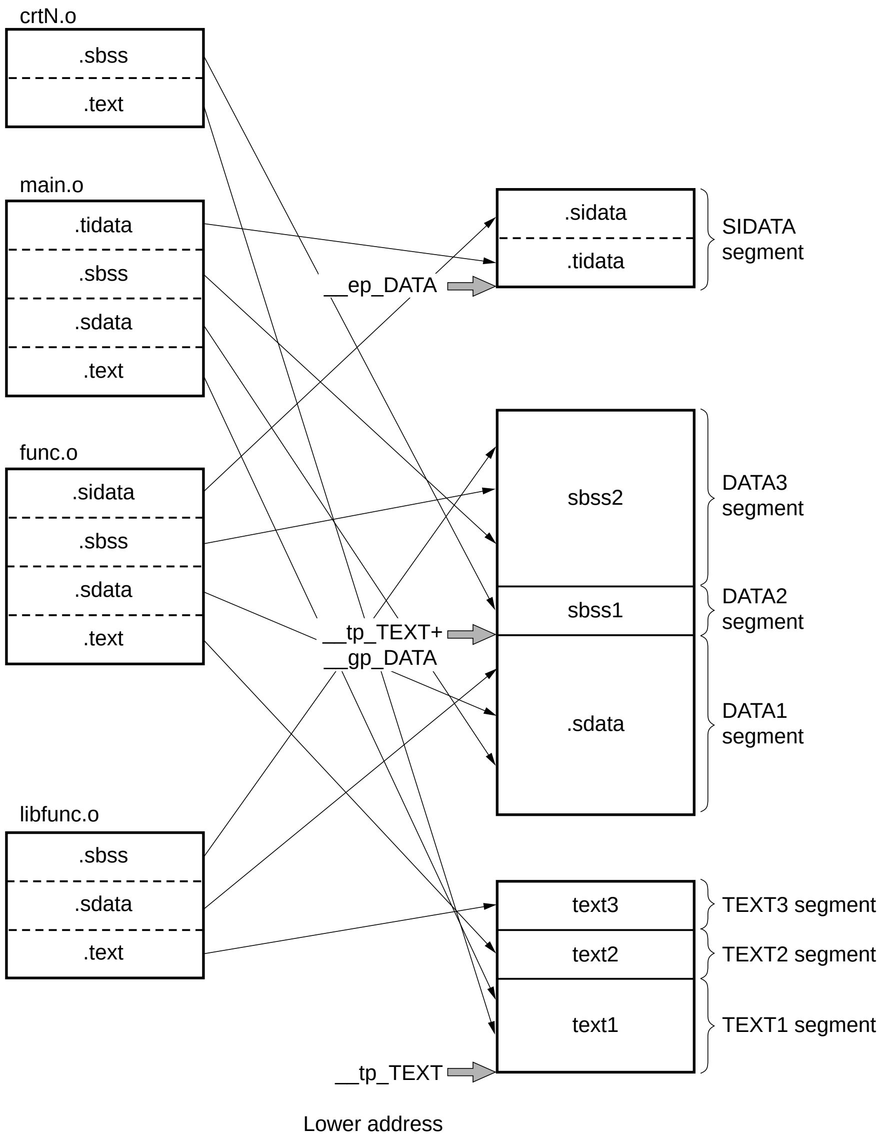
For example, if object files crtN.o, main.o, and func.o, and object file libfunc.o in archive file a:\usrlib\libusr.a are linked by specifying the directive shown in Figure 3-24, one tp symbol __tp_TEXT is created for three segments, TEXT1, TEXT2, and TEXT3, and one gp symbol __gp_DATA is created for three segments DATA1, DATA2, and DATA3 (refer to **Figure 3-25**).

Note that the example in Figure 3-25 is for the CA850 and that the SIDATA segment is subject to the ep symbol.

Figure 3-24. Example of Commands for Creating One Each of tp/gp/ep Symbols

```
TEXT1 : !LOAD ?RX {
        text1  = $PROGBITS ?AX { crtN.o main.o } ;
};
TEXT2 : !LOAD ?RX {
        text2 = $PROGBITS ?AX { func.o };
};
TEXT3 : !LOAD ?RX {
        text3  = $PROGBITS ?AX { libfunc.o(a:\usrlib\libusr.a) };
};

DATA1 : !LOAD ?RW {
        sdata  = $PROGBITS ?AWG;
};
DATA2 : !LOAD ?RW {
        sbss1  = $NOBITS   ?AWG { crtN.o };
};
DATA3 : !LOAD ?RW {
        sbss2  = $NOBITS   ?AWG;
};

SIDATA : !LOAD ?RW {
        .tidata = $PROGBITS ?AW .tidata;
        .sidata = $PROGBITS ?AW .sidata;
};

__tp_TEXT @ %TP_SYMBOL{ TEXT1 TEXT2 TEXT3 };
__gp_DATA @ %GP_SYMBOL &__tp_TEXT { DATA1 DATA2 DATA3 };

__ep_DATA @ %EP_SYMBOL;
```

Figure 3-25. Example of Creating One Each of tp/gp/ep Symbols



(2) Creating a symbol with each segment specified

To create the tp and gp symbols for each of two or more segments, specify each of the segment names by the symbol directive.

For example, when object files crtN.o, main.o, and func.o, and object file libfunc.o in archive file a:\usrlib\libusr.a are linked with the directive shown in Figure 3-26, tp symbols __tp_symbol1, __tp_symbol2, and __tp_symbol3 are created for the three segments, TEXT1, TEXT2, and TEXT3, and gp symbols __gp_symbol1, __gp_symbol2, and __gp_symbol3 are created for another three segments, DATA1, DATA2, and DATA3 (refer to **Figure 3-27**).

Note that the example in Figure 3-27 is for the CA850, and that the SIDATA segment is subjected to the ep symbol.

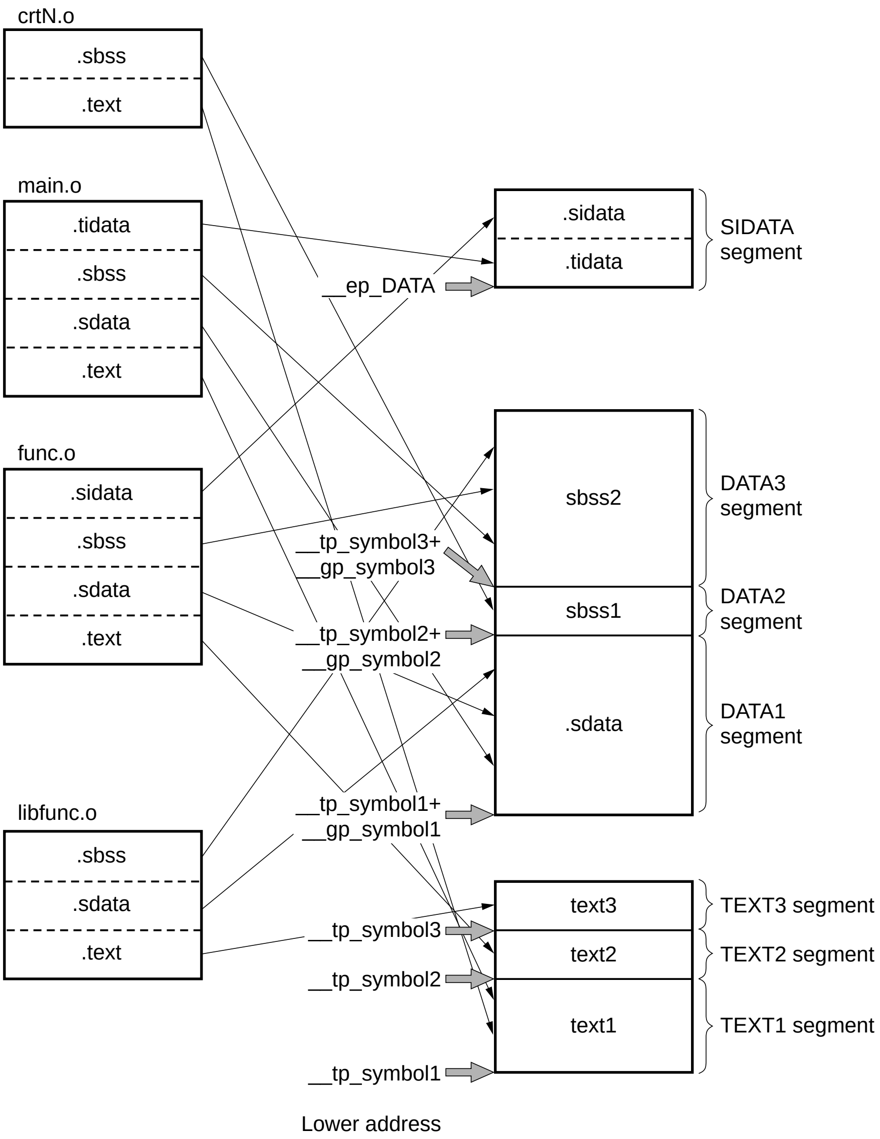
To create two or more symbols, normally the tp and gp values must be explicitly changed by the application program. When the RTOS is used as the target environment, the RTOS changes the gp value[69].

[69] Refer to **V800 Series Real-Time Operating System User's Manual**.

Figure 3-26. Example of Commands for Creating Two or More tp/gp Symbols

```
    TEXT1 : !LOAD ?RX {
            text1  = $PROGBITS ?AX { crtN.o main.o };
    };
    TEXT2 : !LOAD ?RX {
            text2  = $PROGBITS ?AX { func.o };
    };
    TEXT3 : !LOAD ?RX {
            text3  = $PROGBITS ?AX { libfunc.o(a:\usrlib\libusr.a) };
    };

    DATA1 : !LOAD ?RW {
            sdata  = $PROGBITS ?AWG;
    };
    DATA2 : !LOAD ?RW {
            sbss1  = $NOBITS   ?AWG { crtN.o };
    };
    DATA3 : !LOAD ?RW {
            sbss2  = $NOBITS   ?AWG;
    };

    SIDATA : !LOAD ?RW {
            .tidata = $PROGBITS ?AW .tidata;
            .sidata = $PROGBITS ?AW .sidata;
    };

    __tp_symbol1 @ %TP_SYMBOL { TEXT1 };
    __tp_symbol2 @ %TP_SYMBOL { TEXT2 };
    __tp_symbol3 @ %TP_SYMBOL { TEXT3 };

    __gp_symbol1 @ %GP_SYMBOL &__tp_symbol1 { DATA1 };
    __gp_symbol2 @ %GP_SYMBOL &__tp_symbol2 { DATA2 };
    __gp_symbol3 @ %GP_SYMBOL &__tp_symbol3 { DATA3 };

    __ep_DATA    @ %EP_SYMBOL;
```

Figure 3-27. Example of Creating Two or More tp/gp Symbols



3.6.5 tp symbol offset in label reference

The C compiler (ca) assumes that the text pointer (tp) has the first address of the segment to which the text-attribute section is allocated (for example, the TEXT segment of the default link directive) as a value. Therefore, the following code is output when a label defined in the text-attribute section is referenced (referencing the switch table, etc.).

```
movea _label, tp, r10
```

Usually, the assembler (as) and link editor (ld) set an offset in the label in the section where the label is defined as a label value for a label reference[70] without a symbol such as $ or % appended as shown above. However, if the label is defined in the text-attribute section, and if the tp symbol is created by the link directive for the segment to which the section is allocated, the offset from the tp symbol is set as a label value.

In other words, a label reference in a segment where the tp symbol is created is processed as a tp symbol offset, rather than as an offset in a section.

Figure 3-28 shows an example of a link directive that references the tp symbol offset.

Figure 3-28. Example of Link Directive Where label Reference is tp Symbol Offset

```
TEXT1 : !LOAD ?RX {
        text1  = $PROGBITS ?AX text1 { a.o };
        text2  = $PROGBITS ?AX text2 { b.o };
        text3  = $PROGBITS ?AX text3 { c.o };
};

TEXT2 : !LOAD ?RX {
        .text  = $PROGBITS ?AX .text;
};

__tp_TEXT @ %TP_SYMBOL { TEXT1 TEXT2 };
```

At this time, suppose that the assembler codes of the object files a.o through c.o specified for the mapping directive in the example in Figure 3-28 are as shown in Figure 3-29.

[70] Refer to **C Compiler Package User's Manual - Assembly Language** of each family.

Figure 3-29. Example of Assembler Codes of a.o through c.o

```
a.s:
   .section "text1"
  ...
   movea  _label1, tp, r10
  ...
_label1:  .word 0x10

b.s:
   .section "text2"
  ...
   movea  _label2, tp, r10
  ...
_label2:  .word 0x20

c.s:
   .section "text3"
  ...
   movea  _label3, tp, r10
  ...
_label3:  .word 0x30
```

Because tp symbol “__tp_TEXT” is created for the TEXT1 segment to which text1 through text3 sections are allocated in Figure 3-28, the values of _label1 through _label3 in Figure 3-29 are the offsets from the value of the tp symbol “__tp_TEXT” to the definition position of each label. This makes it possible to access the labels in text1 through text3 sections with one tp symbol “__tp_TEXT”.

On the other hand, if the TEXT1 segment is not specified for creating the tp symbol “__tp_TEXT” in Figure 3-28, the values of labels _label1 through _label3 are the offsets from the first address of each section, and access by the tp symbol cannot be executed.

[Caution]

The processing that uses a label reference (without a symbol) as the tp symbol offset, instead of as an offset in a section, is always executed if the label in the text-attribute section allocated to the segment that creates the tp symbol is label-referenced. Therefore, if a register other than those to which the tp symbol value is set is used in combination with a label reference in an assembly-language source program, the correct value cannot be obtained.

Mistake example>

```
(link directive)
TEXT1 : !LOAD ?RX {
    text1 = $PROGBITS ?AX text1 {a.o};
    text2 = $PROGBITS ?AX text2 {b.o};
    text3 = $PROGBITS ?AX text3 {c.o};
};
        ...
__tp_TEXT @% TP_SYMBOL{ TEXT1 TEXT2 };

(b.s)
        .section "text2"
start : mov   #start, r10
        ld.w  t_lab[r10], r20
        ...
t_lab : .word   0x20      ← Value of t_lab is offset from __tp_TEXT.
```

In the above example, the value of t_lab is not an offset from the first address of the text2 section, but an offset from the __tp_TEXT value. Therefore, the program cannot run correctly as it is. In this case, either of the following corrections must be made.

- Exclude b.o from the TEXT1 segment and allocate it to a segment that does not create the tp symbol.

```
(link directive)
TEXT1 :  !LOAD ?RX {
    text1 = $PROGBITS ?AX text1 {a.o};
    text3 = $PROGBITS ?AX text3 {c.o};
};
         ...
TEXTB : !LOAD ?RX {
    text2 = $PROGBITS ?AX text2 {b.o};
};
         ...
__tp_TEXT @% TP_SYMBOL{ TEXT1 TEXT2 };
```

- Reference by combining a register to which the corresponding tp symbol value is set and the label reference

```
(b.s)
        .section "text2"
start : mov    #__tp_TEXT, r10
        ld.w   t_lab[r10], r20
        ...
t_lab : .word  0x20
```

The ca always outputs codes by using a label reference that uses tp as a base for the label reference in the text-attribute section. In the case of a C source program, therefore, the above error does not occur as long as the tp symbol is created for the segment to which that section is allocated by the link directive.

3.7 Default Link Directive

If the link directive is not specified upon starting the ld, the ld links object files by using the default link directive the ld has as internal information.

This compiler package includes the sample file of default link directive as a reference for creating link directive.

- Installation directory \smpxxx\caxxx\*.dir file

Each segment described in the default link directive is created, allocated starting from the lower addresses in the sequence in which the corresponding input sections, if any, appear.

Some segments are allocated to addresses in the sequence in which the segments are described by the link directive, and the others are allocated in accordance with the contents of the device file[71] or the ld's internal information.

If an interrupt handler is defined by using an interrupt request name defined in the device file, a link directive that allocates the function to predetermined handler addresses is automatically created inside the ld, regardless of whether the default directive or a specified directive is used.

Caution

The *.dir file shown above is only a sample file. This file is not actually referenced by the ld if no link directive has been specified. If no link directive has been specified, the ld references the device file and follows the default memory addresses allocation that is defined for each target device.

[71] For the details of the device file, refer to the User's Manual of the device file.

(1) With CA830

- Segments are sequentially allocated starting from address 0x0, in the sequence described by the default link directive. The address of the default link directive is determined by referencing the device file (Figure 3-30 shows an example of the V830).
- The CA830 includes v830def.dir file for a sample, which is the default directive when the target device is the V830.

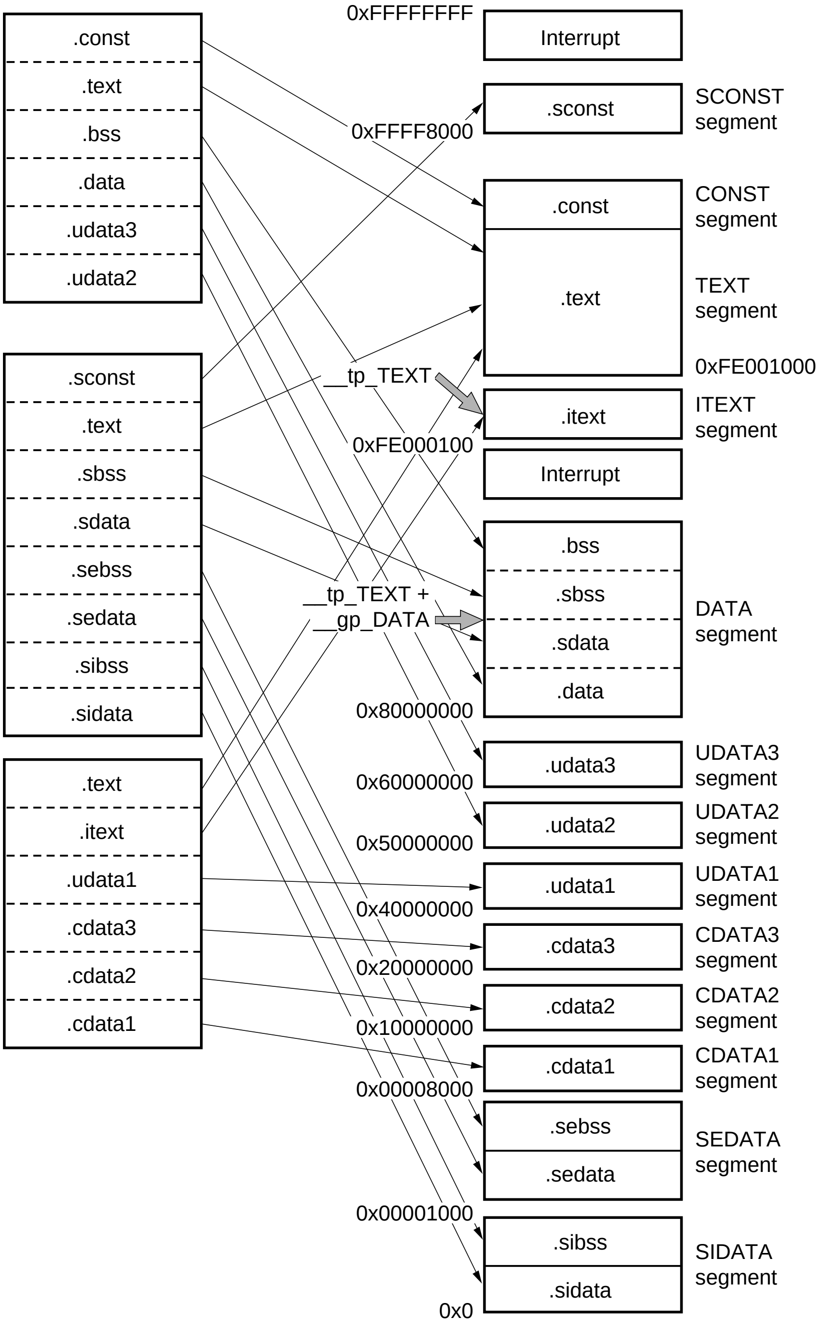
Figure 3-30. Default Link Directive (CA830: V830) (1/2)

```
SIDATA  : !LOAD ?RW V0x0{
        .sidata = $PROGBITS ?AW .sidata;
        .sibss  = $NOBITS ?AW .sibss;
};
SEDATA  : !LOAD ?RW V0x1000{
        .sedata = $PROGBITS ?AW .sedata;
        .sebss  = $NOBITS ?AW .sebss;
};
CDATA1  : !LOAD ?RW V0x8000{
        .cdata1 = $PROGBITS ?AW .cdata1;
 };
CDATA2  : !LOAD ?RW V0x10000000{
        .cdata2 = $PROGBITS ?AW .cdata2;
 };
CDATA3  : !LOAD ?RW V0x20000000{
        .cdata3 = $PROGBITS ?AW .cdata3;
 };
UDATA1  : !LOAD ?RW V0x40000000{
        .udata1 = $PROGBITS ?AW .udata1;
 };
UDATA2  : !LOAD ?RW V0x50000000{
        .udata2 = $PROGBITS ?AW .udata2;
 };
```

Figure 3-30. Default Link Directive (CA830: V830) (2/2)

```
UDATA3 : !LOAD ?RW V0x60000000{
       .udata3 = $PROGBITS ?AW .udata3;
 };
DATA   : !LOAD ?RW V0x80000000{
       .data  = $PROGBITS ?AW;
       .sdata = $PROGBITS ?AWG;
       .sbss  = $NOBITS   ?AWG;
       .bss   = $NOBITS   ?AW;
};
ITEXT  : !LOAD ?RX V0xfe000100{
       .itext  = $PROGBITS ?AX .itext;
};
TEXT   : !LOAD ?RX V0xfe001000{
       .text  = $PROGBITS ?AX;
};
CONST  : !LOAD ?R {
       .const = $PROGBITS ?A .const;
};
SCONST : !LOAD ?R V0xffff8000{
       .sconst = $PROGBITS ?A .sconst;
};
__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA};
```

Figure 3-31. Memory Location by Default Link Directive (CA830)



(2) **With CA850**

- If the SIDATA segment is created (refer to **Figure 3-33** on page 311)
  - The SIDATA segment is allocated to the first address of the internal RAM.
  - The DATA segment is allocated to an address suitable for the type of the device in accordance with the device file.
    For example, in the V851 that has an internal ROM, the DATA segment is allocated to the first address of the external memory.
  - The SEDATA segment is allocated to an address lower than the first address of the internal RAM.
  - The CA850 includes v850def.dir file for a sample, which is the default directive when the target device is the V851.
- If the SIDATA segment is not created (refer to **Figure 3-35** on page 313)
  - The DATA segment is allocated to the first address of the internal RAM.
  - The CONST segment is allocated to an address suitable for the type of the device in accordance with the device file.
    For example, in the V851 that has an internal ROM, the CONST segment is allocated to the first address of the external memory.
  - The SEDATA segment is allocated to an address lower than the first address of the internal RAM.
  - The CA850 includes v850def2.dir file for a sample, which is the default directive when the target device is the V851.

The segments other than mentioned above are allocated to addresses in the sequence in which the segments are described.

Figure 3-32. Default Link Directive with SIDATA (CA850: V851)

```
SCONST : !LOAD ?R {
       .sconst = $PROGBITS ?A .sconst;
};
TEXT   : !LOAD ?RX {
       .text  = $PROGBITS ?AX;
};
DATA   : !LOAD ?RW V0x100000{
       .data  = $PROGBITS ?AW;
       .sdata = $PROGBITS ?AWG;
       .sbss  = $NOBITS   ?AWG;
       .bss   = $NOBITS   ?AW;
};
CONST  : !LOAD ?R {
       .const = $PROGBITS ?A .const;
};
SEDATA : !LOAD ?RW V0xff6000 {
       .sedata = $PROGBITS ?AW .sedata;
       .sebss  = $NOBITS   ?AW .sebss;
};
SIDATA : !LOAD ?RW V0xffe000{
       .tidata.byte = $PROGBITS ?AW .tidata.byte;
       .tibss.byte  = $NOBITS   ?AW .tibss.byte;
       .tidata.word = $PROGBITS ?AW .tidata.word;
       .tibss.word  = $NOBITS   ?AW .tibss.word;
       .tidata      = $PROGBITS ?AW .tidata;
       .tibss       = $NOBITS   ?AW .tibss;
       .sidata      = $PROGBITS ?AW .sidata;
       .sibss       = $NOBITS   ?AW .sibss;
};
__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA};
__ep_DATA @ %EP_SYMBOL;
```

Figure 3-33. Memory Location by Default Link Directive (CA850: with internal ROM)

If SIDATA segment is created

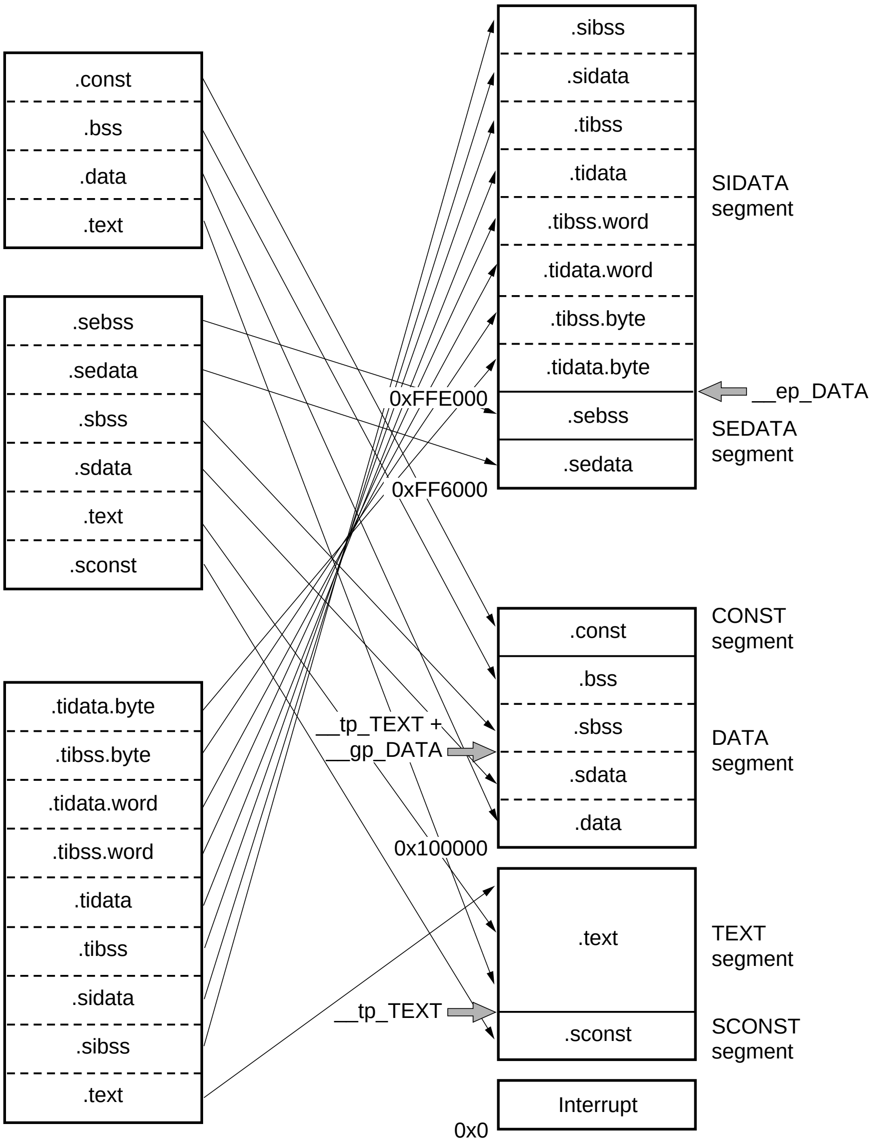
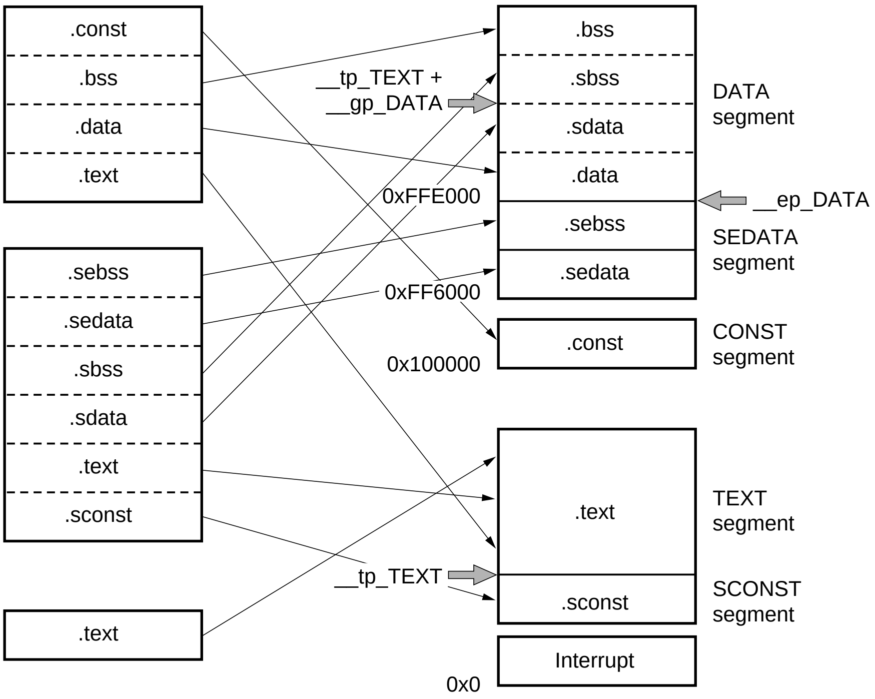


Figure 3-34. Default Link Directive without SIDATA (CA850: V851)

```
SCONST : !LOAD ?R {
       .sconst = $PROGBITS ?A .sconst;
};
TEXT   : !LOAD ?RX {
       .text  = $PROGBITS ?AX;
};
CONST  : !LOAD ?R V0x100000 {
       .const = $PROGBITS ?A .const;
};
SEDATA : !LOAD ?RW V0xff6000 {
       .sedata = $PROGBITS ?AW .sedata;
       .sebss  = $NOBITS   ?AW .sebss;
};
DATA   : !LOAD ?RW V0xffe000 {
       .data  = $PROGBITS ?AW;
       .sdata = $PROGBITS ?AWG;
       .sbss  = $NOBITS   ?AWG;
       .bss   = $NOBITS   ?AW;
};
__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT { DATA };
__ep_DATA @ %EP_SYMBOL;
```

Figure 3-35. Memory Location by Default Link Directive (CA850: with internal ROM)

If SIDATA segment is not created



Each family performs the following processing by using the default link directive.

- If only the symbol directive of the link directives specified upon starting the ld is specified, linking is executed by using the segment directive section of the default directive and the specified symbol directive.
- If the symbol directive is not specified by the link directive specified upon starting the ld, the default text pointer symbol (__tp_TEXT), global pointer symbol (__gp_DATA), and element pointer symbol (__ep_DATA) are not created[72].
- The directive for an interrupt handler is automatically created and added to the default link directive, based on the information read from the device file.
- If an interrupt handler is specified by the “#pragma” directive[73] in the C source program, or an interrupt handler is specified by the “.section” pseudo-instruction[74] in the assembly-language source program, the interrupt handler is allocated in accordance with the added directive.
- The default link directive specifies the following output section names corresponding to the following segment. Sections having other names are not allocated to each segment.

.sconst section	→	SCONST segment
.const section	→	CONST segment
.sedata, .sebss section	→	SEDATA segment
.sidata section, .sibss section, .tidata section, .tibss section, .tidata.byte section, .tibss.byte section, .tidata.word section, .tibss.word section	→	SIDATA segment
.cdata1 section	→	CDATA1 segment
.cdata2 section	→	CDATA2 segment
.cdata3 section	→	CDATA3 segment
.udata1 section	→	UDATA1 segment
.udata2 section	→	UDATA2 segment
.udata3 section	→	UDATA3 segment
.itext section	→	ITEXT segment

The output sections other than the above are allocated to the TEXT segment or DATA segment by the section type and section attribute.

In the above segments, the input section names are fixed to the same names of the output sections.

[72] In the example of the start-up module (crtN.s) included in this compiler package, the text pointer symbol (__tp_TEXT), global pointer symbol (__gp_DATA), and element pointer symbol (__ep_DATA) created by the default link directive are used.

[73] Refer to **V800 Series C Compiler Package User’s Manual - C Language**.

[74] Refer to **User’s Manual - Assembly Language** of each family.

3.8 Using Default Link Directive

In describing a link directive, some items must be described in the same manner as the default link directive (refer to page 305).

The items of each family are explained below.

(1) With CA830

The valid address range is fixed for the segment corresponding to the internal memory or chip select signal. The address range of the default directive conforms to the memory location of the V830.

When creating and specifying a directive file, specify an address suitable for the memory location of the microprocessor as the address of the segment to be created, by referring to the User's Manual of the microprocessor used, or the User's Manual of the device file.

For example, when creating the ITEXT segment with the V830 as the target device, specify address 0xfe000100.

The input/output section names for SEDATA, CONST, SCONST, SIDATA, CDATA1, CDATA2, CDATA3, UDATA1, UDATA2, UDATA3, and ITEXT are fixed to the same name as the default names and must not be omitted.

(2) With CA850

The valid address range is fixed for the segment placed in the internal memory or the segment that is placed at an address determined by the ld850, such as SEDATA. When creating and specifying a directive file, specify an address suitable for the memory location of the microprocessor as the address for the segment to be created, by referring to the User's Manual of the microprocessor used or device file.

For example, if the V851 with internal ROM is used as the target device and if the SIDATA segment is to be created, specify 0xffe000 as the address.

The input/output section names of SEDATA, CONST, SCONST, and SIDATA are fixed to the same name as the default names and must not be omitted.

[Caution]

If the SIDATA segment is not created and, for example, a data segment such as the DATA segment for the default directive is allocated to the internal RAM, a warning message indicating that "the DATA segment does not fit in the internal RAM area" is output almost every time if the start-up module or library supplied with this compiler package are used.

In this case, specify an external memory address for the segment by using the directive file, and allocate the DATA segment to the external memory.

3.9 Syntax of Link Directive

The syntax of the link directive when described by the BNF method is as shown below.

```
<directive_file>        ::= Not described
                        |   <directives>
<directives>            ::= <segment_directive>
                        |   <section_directive>
                        |   <symbol_directive>
                        |   <directives>
<segment_directive>     ::= Not described
                        |   <segment_name> <segdir_specifier> <segment_type>
                            <memory_attribute> <seg_parameters> <directive_end>
<seg_parameters>        ::= Not described
                        |   <seg_parameters>
                        |   <address>
                        |   <alignment>
                        |   <hole_size>
                        |   <fill>
                        |   <length>
                        |   <region_begin> <section_map> <region_end>
<section_map>           ::= Not described
                        |   <section_map>
                        |   <section_directive>
<section_directive>     ::= Not described
                        |   <output_section_name> <scndir_specifier> <section_type>
                            <section_attribute> <scn_parameters> <directive_end>
<scn_parameters>        ::= Not described
                        |   <scn_parameters>
                        |   <address>
                        |   <alignment>
                        |   <hole_size>
                        |   <input_section_name>
                        |   <region_begin> <files> <region_end>
<symbol_directive>      ::= Not described
                        |   <symbol_name> <symdir_specifier> <symbol_type>
                            <symbol_parameters> <directive_end>
<symbol_parameters>     ::= Not described
                        |   <symbol_parameters>
                        |   <region_begin> <names> <region_end>
<address>               ::= [‘V’|‘v’]<value>
<alignment>             ::= [‘A’|‘a’]<value>
<hole_size>             ::= [‘H’|‘h’]<value>
<fill>                  ::= [‘F’|‘f’]<value>
<length>                ::= [‘L’|‘l’]<value
<memory_attribute>      ::= ‘?’<seg_attribute>
<section_attribute>     ::= ‘?’<scn_attribute><target_own_attr>
<segment_type>          ::= ‘!’["LOAD"|"load"]
```

```
<section_type>        ::= '$'["PROGBITS"|"progbits"|"NOBITS"|"nobits"|]
<symbol_type>         ::= '%'<target_own_type>
<output_section_name> ::= <section_name>
<input_section_name>  ::= <section_name>
<seg_attribute>       ::= Not described
                      |   ['R'|'r']
                      |   ['W'|'w']
                      |   ['X'|'x']
                      |   <seg_attribute>
<scn_attribute>       ::= Not described
                      |   ['A'|'a']
                      |   ['W'|'w']
                      |   ['X'|'x']
                      |   <scn_attribute>
<target_own_attr>     ::= Not described
                      |   ['G'|'g']
<target_own_type>     ::= ["TP_SYMBOL"|"tp_symbol"|"GP_SYMBOL"|"gp_symbol"
                          |"ep_symbol"|"EP_SYMBOL"]
<files>               ::= Not described
                      |   <files>
                      |   <file_name>
<names>               ::= Not described
                      |   <names>
                      |   <segment_name>
<segment_name>        ::= Legal segment name character string
<section_name>        ::= Legal section name character string
<file_name>           ::= Legal file name character string
<symbol_name>         ::= Legal symbol name character string
<value>               ::= Legal octal/decimal/hexadecimal number character string
<segdir_specifier>    ::= ':'
<scndir_specifier>    ::= '='
<symdir_specifier>    ::= '@'
<region_begin>        ::= '{'
<region_end>          ::= '}'
<directive_end>       ::= ';'
```

CHAPTER 4 LINK MAP

This chapter explains the link map output by the ld.

If the ld is started with the display option (-m) of the link map specified, it outputs a link map indicating the locations of sections to the standard output.

Figure 4-1 shows an output example of the link map that is output if object files crtN.o, main.o, and func.o are linked with specified reference of archive file libc.a.

Figure 4-1. Output Example of Link Map

```
              ******** LINK EDITOR ALLOCATION MAP ********

OUTPUT     INPUT      VIRTUAL         SIZE            INPUT
SECTION    SECTION    ADDRESS                         FILE

.text                 0x00000000      0x00000082
           .text      0x00000000      0x0000001a      crtN.o
           .text      0x0000001c      0x0000002c      main.o
           .text      0x00000048      0x00000018      func.o
           .text      0x00000060      0x00000022      strcmp.o(..\lib830\r32\libc.a)

.sdata                0x00000088      0x0000000e
           .sdata     0x00000088      0x0000000e      main.o

.sbss                 0x00000098      0x00000008
           .sbss      0x00000098      0x00000004      func.o
           .sbss      0x0000009c      0x00000004      *(nil)*

.symtab               0x00000000      0x000001a0
           .symtab    0x00000000      0x000001a0      *(nil)*

.strtab               0x00000000      0x000000b5
           .strtab    0x00000000      0x000000b5      *(nil)*

.shstrtab             0x00000000      0x0000002e
           .shstrtab  0x00000000      0x0000002e      *(nil)*
  (1)         (2)          (3)             (4)            (5)
```

To this link map, the following items of information are output.

(1) Output section

Name of the output section constituting the object file to be created.

(2) Input section

Name of the input section allocated to each output section.

(3) Address

First address of the output section and the input section.

(4) Size

Size of the output section and the input section.

(5) Input file

Name of the object file to which the input section belongs.

The section created with the ld as well as .symtab, .strtab, and .shstrtab created by the as included in this compiler package are marked “*(nil)*”.

If the object file to which the input section belongs is an object file in the archive file, the name of the archive file is also displayed in the format “object file name (archive file name)”.

CHAPTER 5 SUPPLEMENT

This chapter explains the supplementary information on the ld.

5.1 Using Archive File

The archive file is created by linking two or more object files with the archiver (ar).

The ld searches the archive file for an unresolved external reference at the point where the archive file has been specified[75], and links only the necessary object files.

The archive file can be also specified in the mapping directive of the link directive. If the archive file is also specified in the mapping directive, it is searched for unresolved external reference at that specified point, and only the necessary object files[76] are linked.

5.2 Reserved Symbols

In processing linking, the ld creates reserved symbols having the first address of each output section, the first address (aligned under a 4-byte alignment condition) exceeding the termination of each output section, and first address (aligned under a 4-byte alignment condition) exceeding the termination of a created and executable object file as values.

If the user defines a symbol having the same name as any of these reserved symbols, the ld uses the defined symbol, and does not create its own symbol.

As the reserved symbol that has the first address of a section as a value, a symbol having the name constituted by prefixing "__s" to the name of the output section is used. If this section name begins with ".", "." is taken out and then "__s" is prefixed as a symbol name.

As the reserved symbol that has the first address (aligned under a 4-byte alignment condition) exceeding the termination of a section as a value, a symbol name with "__e" prefixed to the name of that output section is used. If the section name begins with ".", however, " ." is taken out and then "__e" is prefixed as a symbol name.

As the reserved symbol having the first address (aligned under a 4-byte alignment condition) exceeding the termination of a created executable object file, __end is used.

[75] The archive file has a symbol table of the symbols belonging to the object files of the archiver, and the archive file is repeatedly searched until the unresolved external reference is no longer resolved.

[76] Object file defining a referenced symbol

The default link directive of the ld uses the following reserved sections as output sections:

.text, .data, .sdata, .sbss, .bss, .sconst, .const, .sedata, .sebss, .sidata, .sibss (both families)
.itext, .cdata1, .cdata2, .cdata3, .udata1, .udata2, .udata3 (CA830 only)
.tidata, .tibss, .tidata.byte, .tibss.byte, .tidata.word, tibss.word (CA850 only)

Therefore, the ld usually creates the following reserved symbols.

Table 5-1. Special Symbols in Normal Object File

__end		
__ebss	__sbss	
__ecdata1	__scdata1	*V830
__ecdata2	__scdata2	*V830
__ecdata3	__scdata3	*V830
__econst	__sconst	
__edata	__sdata	
__eitext	__sitext	*V830
__esbss	__ssbss	
__esconst	__ssconst	
__esdata	__ssdata	
__esebss	__ssebss	
__esedata	__ssedata	
__esibss	__ssibss	
__esidata	__ssidata	
__etext	__stext	
__etibss	__stibss	*V850
__etibss.byte	__stibss.byte	*V850
__etibss.word	__stibss.word	*V850
__etidata	__stidata	*V850
__etidata.byte	__stidata.byte	*V850
__etidata.word	__stidata.word	*V850
__eudata1	__sudata1	*V830
__eudata2	__sudata2	*V830
__eudata3	__sudata3	*V830

5.3 File Name in Link Directive

Even if an object file or archive file to be allocated to a section is specified in the directive file, they may not be allocated to the expected sections depending on how the file name is described.

In this case, specify the directive file with the file name displayed on the link map and with the identical name including the path name for re-linking, while referring to the link map (-m).

5.4 Link between V850 Family Object File and V850E Object File

The V850E is upward-compatible with the other V850 Family microprocessors. The source program used in the V850 Family can be used in the V850E. In this case, create the V850 Family object file as an object file common to the family with the as option (refer to page 205).

The object file created as “common within V850E” cannot link with the object file other than the V850E (refer to Cautions on page 205).

CHAPTER 6 MESSAGES

This chapter explains the messages output by the ld. The italic characters in the output messages and explanatory statements are determined during command processing.

6.1 Message Format

The ld outputs the following two types of messages.

With file name displayed
ld "*file name*": *level*: *message*

Without file name
ld: *level*: *message*

level in the above formats indicates the type of the error that has occurred. The correspondence between the type of *level* and the remedial action performed by the ld is shown below.

warning
Warning[77]. The ld continues linking normally.

fatal error
Fatal error. The ld stops linking.

syntax error
Error concerning syntax of link directive. The ld stops linking.

[77] The ld does not output the messages of this type if it has been started with the -w option specified.

6.2 Messages

The messages output by the ld are shown below in alphabetical order. Note that some messages are not displayed depending on the family used.

'-' is illegal.
Only "-" cannot be specified.

can not allocate hash table.
Allocating the hash table has failed.

can not allocate memory (*number*).
Allocated memory of *number* bytes has failed.

can not allocate memory (builtin new error).
Allocating of a memory area has failed.

can not allocate symbol table entry page.
Allocating of a symbol table entry page has failed.

can not allocate vector table.
Allocating of a vector table has failed.

can not create output file "*file*".
Output file *file* cannot be created.

can not find archive file "*file*".
Archive file *file* cannot be found.

can not find archive member at offset (*offset*) specified in archive symbol table entry.
An archive member is not found at the position of the offset *offset* specified by the archive symbol table entry. The chances are that the contents of the archive symbol table have been destroyed.

can not find devicefile.
The device file cannot be found.

can not find entry point symbol "*symbol*" specified with "-e" option.
Symbol *symbol* specified by entry point address specification option (-e) cannot be found.

can not find output section needed in deciding TP (GP) symbol's symbol value in segment "*segment*".
The output section necessary for determining the value of the tp (gp) symbol for segment *segment* is not found.

can not find *number*th symbol table entry for relocation of reference at offset (*offset*) in "*section*" section, this relocation is ignored.
The *number*th symbol table entry to relocate a reference existing in offset *offset* of section *section* is not found. This relocation is ignored.

can not get raw data of section "*section*".

Getting the raw data of section *section* has failed.

can not get size of directive file "*file*".

Getting the size of directive file *file* has failed.

can not link mask reg using objects with mask reg not using objects. "*file*" is mask reg using object.

An object file using the mask register and an object file not using the mask register cannot be linked.

File *file* is an object file using the mask register.

can not link new_fcall objects with old_fcall objects. "*file*" is new_fcall object.

An object file of the new function calling specifications and an object file of the old function calling specifications cannot be linked.

File *file* is an object file of the new function calling specifications.

This message is output when option -ol that specifies linking of the library of the old version is specified. * V850

can not link old_fcall objects with new_fcall objects. "*file*" is old_fcall object.

An object file of the new function calling specifications and an object file of the old function calling specifications cannot be linked.

File *file* is an object file of the old function calling specifications.

can not link V850E common objects with V850 objects. "*file*" is V850E common object.

A common object file for the V850E Family cannot be linked with an object file whose target device is fixed as the V850.

The file *file* is a common object file for the V850E Family.

A common object file for the V850E Family can be linked with an object file whose target device is fixed as the V850E or with an object file that is common to both the V850 and V850E Families. * V850

can not open command file "*file*".

Command file *file* cannot be opened.

can not open directive file "*file*".

Directive file *file* cannot be opened.

can not open input file "*file*".

Input file *file* cannot be opened.

can not open output file "*file*".

Output file *file* cannot be opened.

can not read directive file "*file*".

Directive file *file* cannot be read.

can not seek output file "*file*".

Output file *file* cannot be sought.

can not truncate output file "*file*" to have size (*number*).

The size of output *file* cannot be changed to *number* bytes.

can not write output file "*file*".

Output file *file* cannot be written.

duplicated cpu type

A target device is specified in duplicate.
Different target devices are specified in the object files to be linked.

EP symbol is needed for using SIDATA/SEDATA segment.

The ep symbol is not created. Create the ep symbol to use the SIDATA or SEDATA segment. * V850

Error Number (*number*).

An error of error number *number* occurs in the object file I/O library internally used by the ld.
The chances are that the contents of the object file are illegal or destroyed.
This message is also output if a work memory area cannot be allocated in this library.

failed to get section header.

Getting a section header has failed.

failed to get section name string.

Getting a section name has failed.

failed to get section name string table section.

Getting the string table section of the section name has failed.

fail to get symbol name string.

Getting a symbol name character string has failed.

fail to get symbol name string table section.

Getting a string table section has failed.

failed to get *number*th symbol name string.

Getting the *number*th symbol name character string has failed.

ignored -ol option. all object files follow new_fcall convention.

All the input files are of the new function calling specifications. The -ol option that specifies linking of libraries of the old specifications is ignored. * V850

illegal character (*number*) in filling value field.

Illegal character *number* (ASCII code) is used to specify a filling value.

illegal ELF file type, must be relocatable or shared library file.

The file types of the object file that can be treated as an input file are only the relocatable object file or library file.

illegal ELF version.

The ELF version of the specified object file is not the version that can be handled by the ld.

illegal linkage status (*number*)

Illegal linkage status *number* occurs.

The chances are that the symbol type of the symbol table entry is illegal.

illegal operand (access width mismatch)

An internal peripheral function register with a different access width is specified as the operand.

illegal operand (cannot read I/O register which does not have read access)

The internal peripheral function register specified as the operand is inhibited from being read.

illegal operand (cannot use bit I/O register)

A flag bit of an internal peripheral function register must not be specified as an operand.

illegal operand (cannot write I/O register which does not have write access)

The internal peripheral function register specified as the operand is inhibited from being written.

illegal operand (inconsistent bit position)

The bit position specified by the bit manipulation instruction contradicts.

illegal target machine byte order.

The byte order of the input file is not the byte order that can be handled by the ld.

illegal target machine class.

The class of the input file cannot be handled by the ld.

illegal target machine type.

The type of the input file cannot be handled by the ld.

***string* in segment directive of non LOAD segment is illegal.**

string must not be specified in the segment directive that does not specify LOAD as the segment type.

input files have different register modes.

A file with a different register mode is input.

library path is too long. path maximum size is 576.

The path for search is too long. The path for specification should be 576 characters or less.

line *num*: '}' is expected.

"}" is necessary.

line *num*: ':', '=' or '@' is expected to follow name.

The name that begins a directive must be followed by ":", "=", or "@".

line *num*: ';' is expected at the end of directive.

";" is necessary at the end of the directive.

line *num*: '=' is expected to follow section name.

"=" is necessary at the end of an output section name.

line *num*: aligned odd value (*number1*) to be even value (*number2*).

Odd value *number1* is aligned to even value *number2*.

line *num*: illegal character (*number*)

An illegal character (*number*) exists in the link directive.

line *num*: illegal section attribute ‘*character*’.

character that must not be specified as a section attribute is specified.

line *num*: illegal section type “*string*”.

string that must not be specified as a section type is specified.

line *num*: illegal segment type “*string*”.

string that must not be specified as a segment type is specified.

line *num*: *string* in section directive is illegal when “-r” option specified, ignored.

string must not be specified in the section directive and is ignored if the -r option is specified.

line *num*: *string* in segment directive is illegal when “-r” option specified, ignored.

string must not be specified in the segment directive and is ignored if the -r option is specified.

line *num*: *string* is illegal in file name field.

string must not be specified in the portion that specifies a file name.

line *num*: *string* is illegal in section directive.

string must not be specified in the section directive.

line *num*: *string* is illegal in segment directive.

string must not be specified in the segment directive.

line *num*: *string* is illegal in segment name field.

string must not be specified in the portion that specifies a segment name.

line *num*: *string* is illegal in symbol directive.

string must not be specified in the symbol directive.

line *num*: *string* is illegal when “-f” option specified, ignored.

string must not be specified and is ignored when the filling value specification option (-f) is specified.

line *num*: name is expected at the beginning of directive.

Start a directive with a name.

line *num*: section “*section*” already defined at line (*number*).

Section *section* has been already defined on the *numberth* line.

line *num*: section directive of section “*section*” needs *string*.

Section directive needs *string*.

line *num*: section name is expected at the beginning of section directive.

Start a section directive with a section name.

line *num*: segment "*segment*" already defined.

Segment *segment* has been already defined.

line *num*: *string* specified in EP symbol directive, ignored.

string must not be specified in ep symbol directive and is ignored. * V850

line *num*: *string* specified to section "*section*" more than once in same or other directive.

string has been specified more than once in the same section directive or another section directive for section *section*.

line *num*: *string* specified to segment "*segment*" more than once in same or other directive.

string has been specified more than once in the same segment directive or another segment directive for segment *segment*.

line *num*: *string* specified to symbol "*symbol*" more than once in same or other directive.

string has been specified more than once in the same symbol directive or another symbol directive for symbol *symbol*.

line *num*: symbol "*symbol*" already defined at line (*number*).

Symbol *symbol* has been already defined on the *numberth* line.

line *num*: symbol directive of symbol "*symbol*" needs *string*.

string is necessary for the symbol directive of symbol *symbol*.

line *num*: symbol kind "*string*" specified more than once in same or other directive.

Symbol-type *string* has been defined more than once in the same or another directive.

line *num*: too many '}'.

Too many "}" are specified for "{".

line *num*: unknown symbol kind "*string*".

string that must not be specified as a symbol type is specified.

linking of symbol "*symbol*" in sdata or sbss attribute section in "*file1*" and in other attribute section in "*file2*" is attempted.

Symbol *symbol* allocated to the sdata- or sbss-attribute section in *file1* and symbol *symbol* allocated to a section other than the sdata- and sbss-attribute section in *file2* are linked.

memory size (*number1*) of segment "*segment*" overflowed specified or default maximum memory size (*number2*).

Memory size *number1* of segment *segment* exceeds the explicitly specified maximum memory size or default maximum memory size.

multiple inclusion of same file attempted, ignored.

The same file is specified more than once as an input file.

nesting of command file "*file*" in command file is not supported.

Command file *file* is specified in a command file.
Nesting of command files is not supported.

no archive symbol table, ignored this archive file.

An archive symbol table does not exist in the specified archive file.
Specification of this archive file is ignored.

no GP symbol for relocation by relocation entry (section: *section*, offset: *offset*, type: *relocation type*), GP symbol's symbol value (0x0) is assumed.

The gp symbol that serves as a basis by a calculating the relocation value in relocation by a relocation entry (section *section*, offset *offset*, and relocation type *relocation type*) is not specified.
Calculation is performed assuming that the gp symbol value is 0x0.

no LOAD segments exist for mapping input section "*section*" in file "*file*", this section is mapped to non-LOAD *DUMMY* segment with no program header.

A segment having segment type LOAD to which section *section* in file *file* can be allocated does not exist.
This section is allocated to the dummy segment that does not have a program header and cannot be loaded.

number specified in filling value field must begin with "0x" or "0X".

Start the number to be specified as a filling value with either 0x or 0X.

"*string*" option ignored.

string option is ignored.

"*string1*" option is illegal when "*string2*" option specified, ignored.

string1 option must not be specified when *string2* option is specified.
string1 option is ignored.

"*string*" option must be specified before files.

Specify *string* option before specifying a file.

"*string*" option needs argument, ignored.

string option needs an argument and is ignored.

relocated value (*value*) of relocation entry (file: *file*, section: *section*, offset: *offset*, type: *relocation type*) for branch command become odd value.

Value *value* relocated by the branch relocation entry (file *file*, section *section*, offset *offset*, relocation type *relocation type*) is an odd number.

relocated value (*value*) of relocation entry (file: *file*, section: *section*, offset: *offset*, type: *relocation type*) overflowed relocation field.

The value *value* relocated by a relocation entry (file *file*, section *section*, offset *offset*, relocation type *relocation type*) exceeds the range of the relocation field.
The chances are that the sdata/sbss-attribute section is allocated exceeding the memory range that can be referenced by 16-bit displacement (refer to page 226).

relocation entry in relocation section "*section1*" used to relocate section "*section2*" has illegal r_offset (*offset*), ignored.

The entry in relocation information section *section1* used for relocation of section *section2* has illegal relocation offset *offset*.

This entry is ignored.

relocation entry in section "*section*" has unknown relocation type (*number*), ignored this entry.

The relocation entry in section *section* has an illegal relocation type *number*. This entry is ignored.

section attribute '*attribute*' of section "*section*" and segment attribute '*attribute*' of segment "*segment*" do not match.

The section attribute *attribute* of section *section* does not agree with the segment attribute of segment *segment* to which this section is specified to be allocated[78].

section "*section*" has unknown section type (*number*).

Section *section* has illegal section type *number*.

section "*section*" with section type (*section type*) not supported, ignored.

Section with section name *section* having section type *section type* is not supported by the ld and is ignored.

segment directive of segment "*segment*" needs *string*.

string is necessary for the segment directive of segment *segment*.

segment "*segment*" (*number1* - *number2*) must be in EP-relative-address-able range (*number3* - *number4*).

The area to which segment *segment* is specified to be allocated (*number1* - *number2*) exceeds the range that can be referenced by ep relative (*number3* - *number4*)[79]. * V850

segment "*segment*" (*number1* - *number2*) must be in r0-relative-address-able range (*number3* - *number4*).

The area to which segment *segment* is specified to be allocated (*number1* - *number2*) exceeds the range that can be referenced by r0 relative (*number3* - *number4*)[79].

segment "*segment*" overflowed highest address of target machine.

The area to which segment *segment* is specified to be allocated exceeds the range of the internal memory of the target machine.

segment "*segment*" (*number1* - *number2*) overflowed highest or lowest address of internal memory (*number3* - *number4*).

The area to which segment *segment* is specified to be allocated (*number1* - *number2*) exceeds the range of the internal memory of the target machine (*number3* - *number4*).

segment "*segment*" (*number1* - *number2*) overlaps guarded area (*number3* - *number4*).

The area to which segment *segment* is specified to be allocated (*number1* - *number2*) overlaps the guard (use prohibited) area (*number3* - *number4*).

segment "*segment1*" overlaps previous segment "*segment2*".

The area to which segment *segment1* is specified to be allocated overlaps the area to which preceding segment *segment2* is allocated.

[78] Ignore section attribute G, and match section attributes A, W, and X with segment attributes R, W, and X, respectively.

[79] If this message is output, the correct memory address may not be referenced. Be sure to modify to the correct allocation.

sorry, archive file “*file*” in directive not supported.

The feature to specify an archive file in the link directive is not supported.

sorry, “*string*” option not implemented, ignored.

string option is not implemented and is ignored.

sorry, shared library not supported.

A shared library is not supported.

start address (*number1*) of section “*section*” overlaps previous section ended before address (*number2*).

The first address *number1* of section *section* overlaps the area of the section allocated up to address *number2*.

start address (*number1*) of segment “*segment*” overlaps previous segment ended before address (*number2*).

The first address *number1* of segment *segment* overlaps the area of the segment allocated up to address *number2*.

string buffer overflow.

The area of the string buffer has run short.

symbol “*symbol*” has different align-size in file “*file*”.

Link occurs in symbol *symbol* but differs in alignment condition from the symbol having the same name defined in *file*.

symbol “*symbol*” has different size in file “*file*”.

Link occurs in symbol *symbol* but differs in size from the symbol having the same name defined in *file*.

symbol “*symbol*” has incompatible type in file “file”.

Link occurs in symbol *symbol* but differs in type from the symbol having the same name defined in *file*.

symbol “*symbol*” has unknown binding class (*number*).

Symbol *symbol* has illegal binding class *number*.

symbol “*symbol*” multiply defined.

Symbol *symbol* is multiple-defined.

***string* symbol multiply defined, first defined symbol “*symbol*” used.**

string symbol is multiple-defined.
string symbol *symbol* that is defined first is used.

***string* symbol multiply defined to segment “*segment*”, first defined symbol “*symbol*” used.**

string symbol is multiple-defined for segment *segment*. Symbol *symbol* that is defined first is used as *string* symbol for segment *segment*.

symbol table overflow.

The symbol table area has run short.

TP symbol “*symbol1*” specified as GP symbol “*symbol2*” ’s base symbol is not found.

tp symbol *symbol1* specified as the base symbol of gp symbol *symbol2* is not found.

undefined symbol.
***symbol* referenced in "*file*"**

Symbol *symbol* referenced in file *file* is not defined.

unknown cpu type.

Specify a target device.

This message is output if an attempt is made to create an executable object file by linking only the file specifying the -cn option of the as when a relocatable object file is created.

unknown format type file "*file*".

Specified file *file* has an illegal file format.

unknown option "*string*".

Illegal option *string* is specified.

weak symbol "*symbol*" not supported.

Symbol *symbol* having binding class WEAK is not supported.

zero size sbss or bss attribute symbol "*symbol*".

The size of symbol *symbol* to be allocated to the sbss- or bss-attribute section is 0.

[MEMO]

VOLUME 6

HANDLING ARCHIVER

CHAPTER 1 OVERVIEW

This volume explains the outline, operation, and output messages of the archiver (ar) included in this compiler package.

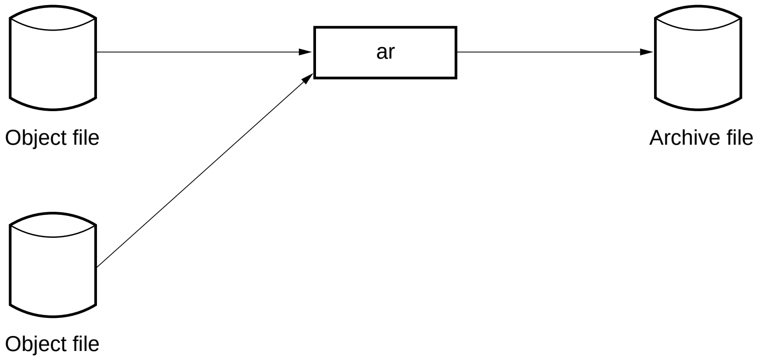
ar starts from the VSH command line.

1.1 Flow of Operation

The ar links specified relocatable object files to create one archive file (also called a library file) (refer to **Figure 1-1**).

If two or more object files whose functions are related to each other are linked to one archive file in an application system, the archive file can be used as an independent library.

Figure 1-1. Flow of Operation of ar



1.2 Handling File

The archive file created by the ar can be specified as an input file for the link editor (ld) included in this compiler package. When an archive file is specified, the ld searches the specified archive file for necessary object files, and links only the object files that have been found.

By linking two or more object files related to each other to one archive file by using the ar, the object files can be treated as one library.

CHAPTER 2 OPERATION

This chapter explains the operations of the ar.

2.1 Command Input Format from VSH Command Line

ar △ key [option][△ member name[1]] △ archive file name[△ member name or file name] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Keys/Options

Only one key can be specified on starting the archiver. Options may be omitted.

2.2.1 Key list

The following table lists keys of the ar.

Specification Format	Feature
V	This option outputs the ar version number to standard output and then terminates processing.
d	This option deletes the specified member from the specified archive file.
m	This option moves the specified member to the end of the specified archive file.
ma △ *member*	This option moves the specified member to the position immediately after the member *member* in the specified archive file. If the *member* is omitted, processing is stopped.
mb △ *member*	This option moves the specified member to the position immediately before the member *member* in the specified archive file. If the *member* is omitted, processing is stopped.
q	This option adds the specified file to the end of the specified archive file[2]. If the specified archive file does not exist, a new archive file is created and contains the specified file.
r	This option exchanges the specified file with the member having the same name in the specified archive file[3].
ra △ *member*	This option exchanges the specified file with the member having the same name in the specified archive file, and then moves the specified file to the position immediately after the member *member*[4]. If the *member* is omitted, processing is stopped.
rb △ *member*	This option exchanges the specified file with the member having the same name in the specified archive file, and then moves the specified file to the position immediately before the member *member*[4]. If the *member* is omitted, processing is stopped.
ru	If the specified file has been updated more recently than the member having the same name in the specified archive file, this option replaces member with the specified file[3].

[1] A file is called a member when it is linked in an archive file. A member has the same name as that before the file is linked.

[2] Whether or not a member with the same name as the specified file exists is not checked.

[3] If the member with the same name as the specified file does not exist in the specified archive file, the specified file is added to the end of the specified archive file. If the specified archive file does not exist, a new archive file is created and contains the specified file.

[4] If the member with the same name as the specified file does not exist in the specified archive file, the specified file is added to the end of the specified archive file.

Specification Format	Feature
t	If a member name has been specified, this option outputs only the member name of member existing in the specified archive file. If a member name has not been specified, this option outputs (to standard output) the member names of all members existing in the specified archive file.
x	If a member name has been specified, and if the specified member exists in the specified archive file, this option extracts that member and creates a file having the same name. If a member name has not been specified, this option extracts all of the members existing in the specified archive and creates files having the same names. The contents of the archive file are not changed.

2.2.2 Option list

The following table lists options of the ar.

Specification Format	Feature
c	This option does not output message.
v	This option outputs this archiver’s execution status using the format “[a|d|q|m|r|x] - file name”. a - file name........ Add d - file name........ Delete q - file name........ Create new m - file name....... Move r - file name .... Replace x - file name .... Extract
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

2.3 Examples of Use

Here are examples of using the ar.

- To update a member

ar850 ru file.a a.o

If object file a.o is updated more recently than the member a.o of archive file file.a, object file a.o replaces member a.o of archive file file.a.

- To extract a member

ar850 xv file.a a.o

Member a.o is extracted from archive file file.a and object file a.o is created. At this time, the execution status is output in the format of `x - a.o`.

CHAPTER 3 MESSAGES

This chapter explains the output messages of the ar (in alphabetical order). The italic characters in the output messages and explanatory statements are determined during command processing.

3.1 Message Format

The ar outputs the messages in the following format.

ar: ***message***

3.2 Messages

bad key *character* - use [dm(a|b)qr(a|b|u)txV]
character must not be specified as a key.

bad option *character* - use [cv]
character must not be specified as an option.

can not close file *file*
File *file* cannot be closed.

can not create file *file*
File *file* cannot be created.

can not find file *file*
File *file* cannot be read.

can not find member *member*
Member *member* does not exist in the archive file.

can not nest command file *file*
Command file *file* is nested. It must not be nested.

can not open file *file*
File *file* cannot be opened.

can not read archive header *file*
The header of archive file *file* cannot be read.

can not read file *file*
Data cannot be read from file *file*.

can not seek file *file*
File *file* cannot be *sought*.

can not write file *file*

File *file* cannot be written.

creating *file*

Archive file *file* is being created.

file name *name* is too long

The length of file name *name* exceeds the limit.

***file* has no member**

No member exists in archive file *file*.

***file* is not archive file**

file is not an archive file.

malformed archive file *file*

The contents of archive file *file* may be destroyed.

memory allocation fault

The memory capacity has run short.

string table error *file*

The contents of the archive string table in archive file *file* may be destroyed.

symbol table error *file*

Creating an archive symbol table in archive file *file* has failed.

symbol table limit error *file* (*number1*) - limit is *number2*

The number of symbols *number1* in archive file *file* exceeds the limit. The limit value is *number2*.

usage: ar [dm(a|b)qr(a|b|u)txV][cv][key-member]archive-file file ...

Input the command line like this.

version error *file*

The version of the format of specified file *file* is not the version that can be handled by this archiver.

VOLUME 7

HANDLING HEX CONVERTER

CHAPTER 1 OVERVIEW

This volume explains the outline, operations, output file format, and output messages of the hex converter (hx) included in this compiler package.

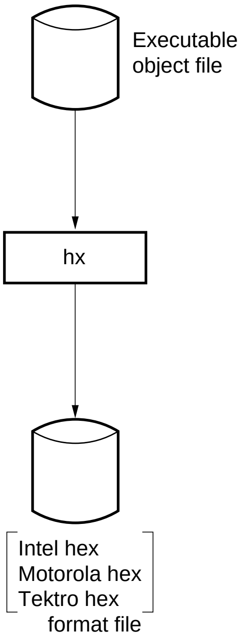
hx starts from the VSH command line.

1.1 Flow of Operation

The hx inputs an executable object file[1] output by the link editor (ld) included in this compiler package, converts the format of that file into a hex format, and outputs the hex-format file to the standard output[2] (refer to **Figure 1-1**).

When loading an application to the target machine, the file format that can be input to an in-circuit emulator, monitor, or ROM writer used for loading may be the hex format only. In this case, convert the object file into a hex-format file by using the hx.

Figure 1-1. Flow of Operation of hx



[1] An object file in which an unresolved external reference does not exist

[2] By using the -o option, the hex-format file can be output to a specified file.

1.2 Handling File

As the hex formats, the following formats can be specified.

(1) Intel hex format
- Intel expanded hex format

(2) Tektro hex format
- Expanded Tek hex format

(3) Motorola hex format
- S type format (standard address)
- S type format (32-bit address)

This chapter explains the operations of the hx.

2.1 Command Input Format from VSH Command Line

hx [△ option] ... △ file name

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists options of the hx.

Specification Format	Feature
–F △ *devpath*	This option searches for the device file first in the directory *devpath*, then in the standard directories[3]. If this option is omitted, only the standard directories are searched.
–I*name*	This option converts and outputs code in the section specified by the section name *name*[4]. If this option is omitted, it converts code in all sections which correspond to a section type other than NOBITS and which have section attribute A[5].
–R	This option sorts and outputs sections in the ascending order of addresses.
–S	This option converts and outputs the symbol table sections. This option is valid only when expanded Tek hex format has been specified (-fT has been specified).
–U*num*	This option converts and outputs all of the code in the ROM area defined by the device file to Intel expanded hex format. Any unused area is filled with *num*. *num* specifies a hexadecimal number that begins with either 0x or 0X. If *num* is omitted, the unused area is filled with 0xff.
–V	This option outputs hx's version number to standard output and then terminates processing.
–b*num*	The decimal number specified as *num* is regarded as the maximum block length value (or, in the case of the Intel expanded hex format or the Motorola S type hex format, the number of code bytes indicated in one data record)[6]. If this option is omitted, the default value[7] for each hex format is used.
–d*num*	This option offsets the address to be output from *num*. For *num*, specify either a decimal number or a hexadecimal number that begins with either 0x or 0X.
–f*c*	This option uses the hex format[8] specified by character *c*. If this option is omitted, the Motorola S type hex format (standard address) is used.

[3] hx handles the directory at the ..\dev position from the hx's installation directory as the standard directory of the device file.

[4] If a section (section having section type NOBITS and section attribute A) is specified for the data for which no initial value has been specified, null characters (\0) are created corresponding to the section's size.

[5] hx converts in section units rather than segment units.

[6] The range of specifiable values is 1 to 255 for Intel expanded hex format, 1 to 251 for Motorola S type hex format (standard address), 1 to 250 for Motorola S type hex format (32-bit address), and 16 to 255 for expanded Tek hex format.

[7] The default value is 31 for Intel expanded hex format, 80 for Motorola S type hex format, and 255 for expanded Tek hex format.

[8] I: Intel expanded hex format, S: Motorola S type hex format (standard address), s: Motorola S type hex format (32-bit address), T: Expanded Tek hex format

Specification Format	Feature
–o △ *ofile*	This option outputs to a file called *ofile*. If this option is omitted, it outputs to standard output.
–x	This option sets local symbols as targets for symbol table conversion and output. This option is valid only when specified with the -S option. If this option is omitted, only global symbols are targets.
–z	This option creates null characters (\0) to fill the section size for section having section type NOBITS and section attribute A (section for data with initial value not specified, such as .bss section and .sbss section).
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

2.3 Examples of Use

Here are examples of using the hx.

- To output converted hex format to a specified file

hx850 –fT –Sxz –o tek.hex a.out

Converts object file a.out to the expanded Tek hex format and outputs the file to file tek.hex. At this time, the symbol table, including the local symbols, is also converted and output. Moreover, as many null characters (\0) as the size of a section for data with no initial value specified (for example, .bss section and .sbss section) are generated.

- To output converted hex format to standard output

hx850 –fI –I.text a.out

Converts the code of the .text section in object file a.out into the Intel expanded hex format, and outputs it to the standard output.

CHAPTER 3 TYPES OF OUTPUT FILES

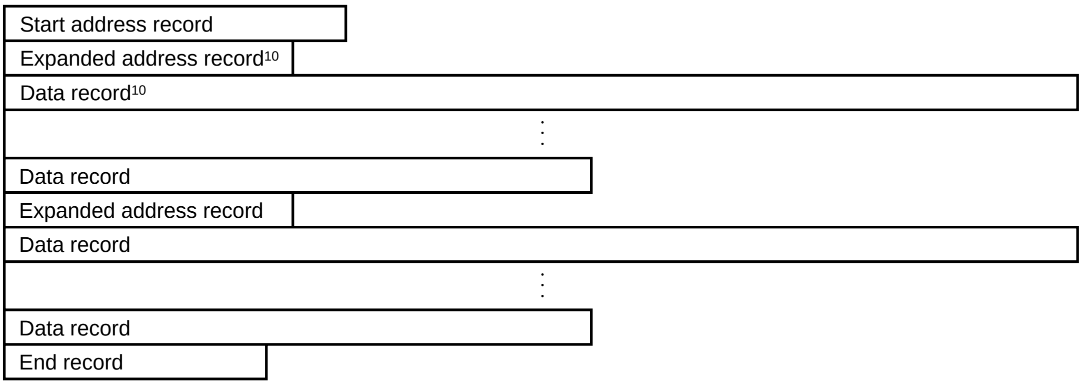
This chapter explains the type of the output files of the hx.

3.1 Intel Expanded Hex Format

A file in the Intel expanded hex format consists of four types of records[9]: start address record, expanded address record, data record, and end record.

Figure 3-1 shows the file configuration in the Intel expanded hex format.

Figure 3-1. File Configuration in Intel Expanded Hex Format



[9] Each record is output in ASCII code.

[10] The expanded address record and data record are repeated.

Each record consists of fields as follows.

```
 :   CC  AAAA   TT    [field] ...  SS    NL
(a)  (b)  (c)   (d)               (e)   (f)
```

(a) ... Record mark

(b) ... Number of bytes (number of bytes that are expressed as 2-digit hexadecimal numbers of [field] ...)

(c) ... Location address

(d) ... Record type[11]

(e) ... Checksum (value expressed as 2-digit hexadecimal number in records (other than :, SS, and NL) sequentially subtracted from initial value 0 and that lower 1 byte expressed as a 2-digit hexadecimal number)

(f) ... New line (\n)

(1) Start address record

Indicates an entry point address.

```
:   04   0000   03   PPPP   OOOO    SS   NL
   (a)   (b)   (c)   (d)     (e)
```

(a) ... Number of bytes is fixed to 04.

(b) ... Fixed to 0000

(c) ... Record type is 03.

(d) ... Paragraph value[12] of entry point address

(e) ... Offset value of entry point address

(2) Expanded address record

Indicates the paragraph value of a load address[13].

```
:   02   0000   02    PPPP   SS   NL
   (a)   (b)   (c)    (d)
```

(a) ... Number of bytes is fixed to 02.

(b) ... Fixed to 000

(c) ... Record type is 02.

(d) ... Paragraph value of segment

[11] 03 ... start address record, 02 ... expanded address record, 00 ... data record, 01 ... end record

[12] The address is calculated by (paragraph value << 4) + offset value.

[13] The paragraph value is output if the segment is renewed at the beginning of a segment (when the data record is output) or when the offset value of the load address of the data record exceeds the maximum value of 0xffff.

(3) Data record

Indicates the value of a code.

```
:  CC    AAAA    00    DD ... DD    SS    NL
   (a)    (b)    (c)      (d)
```

(a) ... Number of bytes[14]
(b) ... Location address
(c) ... Record type is 00.
(d) ... Code (each byte of code expressed as 2-digit hexadecimal number)

Example>

```
:   04    0100    00    3C58E01B    6C    NL
    (a)    (b)    (c)      (d)      (e)
```

(a) ... Number of bytes of 3C58E01B expressed as 2-digit hexadecimal number is 04.
(b) ... Location address is 0100.
(c) ... Record type is 00.
(d) ... Code
(e) ... Check sum is 6C which is the lower 1 byte of 2's complement E6 of 04 + 01 + 00 + 00 + 3C + 58 + E0 + 1B = 194 expressed as a 2-digit hexadecimal number.

(4) End record

Indicates the end of a code.

```
:  00   0000   01   FF   NL
   (a)   (b)   (c)  (d)
```

(a) ... Number of bytes is fixed to 00.
(b) ... Fixed to 0000
(c) ... Record type is 01.
(d) ... Check sum is fixed to FF.

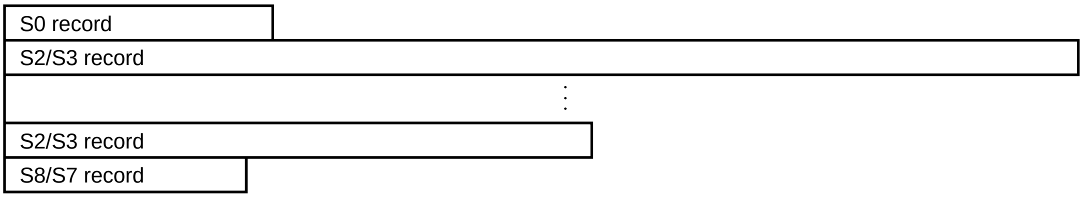
[14] Limited to the range of 0x1 to 0xff (the minimum value of the number of bytes of the code indicated by one data record is 1 and the maximum value is 255).

3.2 Motorola S Type Hex Format

A file in the Motorola S type hex format consists of five records[15]: S0 record as a header record, S2/S3 records as data records, and S8/S7 records as end records[16].

Figure 3-2 shows the file configuration in Motorola S type hex format.

Figure 3-2. File Configuration in Motorola S Type Hex Format



Each record consists of fields as follows:

```
ST  LL    field [field] ...   SS    NL
(a) (b)                       (c)   (d)
```

(a) ... Record type

(b) ... Record length (number of bytes of field [field] ... expressed as 2-digit hexadecimal number + number of bytes expressed by SS[17])

(c) ... Check sum (Lower 1 byte expressed as 2-digit hexadecimal number of 1's complement of total of number of bytes in records (other than ST, SS, and NL) expressed as 2-digit hexadecimal number)

(d) ... New line (\n)

[15] Each record is output in ASCII code.

[16] The Motorola S type hex formats are divided into two types: (24-bit) standard address and 32-bit address types. The format of the standard address type consists of S0, S2, and S8 records, and the format of the 32-bit address type consists of S0, S3, and S7 records.

[17] 1

(1) S0 record

Indicates a file name.

```
S0  LL    FF ... FF   SS   NL
(a)           (b)
```

(a) ... Record type is S0.

(b) ... File name (specified file name indicated in ASCII code)

(2) S2 record

Indicates the value of a code.

```
S2  LL    AAAAAA    DD ... DD    SS    NL
(1)           (2)         (3)
```

(1) ... Record type is S2.

(2) ... Load address (24 bits[18])

(3) ... Code (1 byte expressed as 2-digit hexadecimal number)

(3) S3 record

Indicates the value of a code.

```
S3  LL   AAAAAAAA    DD ... DD    SS   NL
(a)           (b)           (c)
```

(a) ... Record type is S3.

(b) ... Load address (32 bits[19])

(c) ... Code (1 byte expressed as 2-digit hexadecimal number)

(4) S7 record

Indicates an entry point address.

```
S7  LL    AAAAAAAA    SS   NL
(a)            (b)
```

(a) ... Record type is S7.

(b) ... Entry point address (32 bits[20])

[18] Range of 0x0 to 0xffffff

[19] Range of 0x0 to 0xffffffff

[20] Range of 0x0 to 0xffffffff

(5) S8 record

Indicates an entry point address.

```
S8  LL   AAAAAA    SS   NL
(a)        (b)
```

(a) ... Record type is S8.

(b) ... Entry point address (24 bits[21])

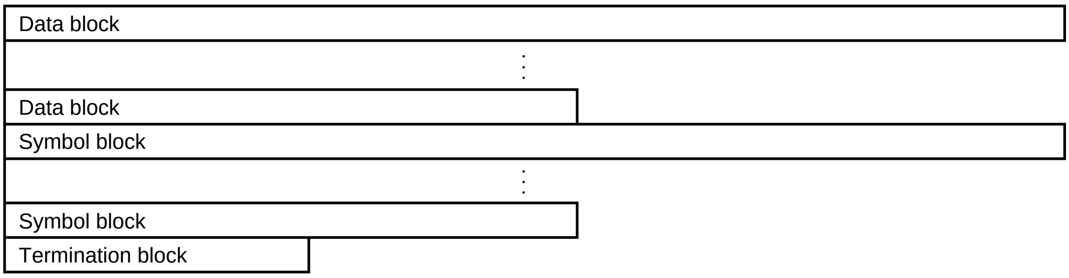
[21] Range of 0x0 to 0xffffff

3.3 Expanded Tek Hex Format

The file in the expanded Tek hex format consists of three types of blocks: data block, symbol block, and termination block.

Figure 3-3 shows the file configuration in the expanded Tek hex format.

Figure 3-3. File Configuration in Expanded Tek Hex Format



Each block consists of fields as follows:

%	LL	T	SS	field [field] ...	NL
(a)	(b)	(c)	(d)		(e)

(a) ... Header character

(b) ... Block length (number of characters in blocks other than % and NL)

(c) ... Type of block[22]

(d) ... Check sum (value of remainder resulting from dividing total value[23] of characters in blocks other than %, SS, and NL, by 256 and expressed as 2-digit hexadecimal number)

(e) ... New line (\n)

[22] 6 ... data block, 3 ... symbol block, 8 ... termination block

[23] The value for each character is determined as follows: 0 to 9 ... 0 to 9, A to Z ... 10 to 35, $ ... 36, % ... 37, ... 38, _ ... 39, a to z ... 40 to 65).

(1) Data block

Indicates the value of a code.

```
%   LL    T    SS   L A ... A    D ... D    NL
         (a)          (b)          (c)
```

(a) ... Block type is 6.
(b) ... Number of digits of load address and the load address
(c) ... Code (1 byte of code expressed as 2-digit hexadecimal number)

Example>

```
 %  15    6    1C     3 100   020202020202     NL
   (a)   (b)  (c)      (d)         (e)
```

(a) ... Block length is 15.
(b) ... Block type is 6.
(c) ... Check sum is 1C which is remainder expressed as 2-digit hexadecimal number resulting from dividing 1 + 5 + 6 + 3 + 1 + 0 + 0 + 0 + 2 + 0 + 2 + 0 + 2 + 0 + 2 + 0 + 2 + 0 + 2 = 28 by 256.
(d) ... Number of digits of load address is 3, and load address is 100.
(e) ... Code

(2) Symbol block

Indicates the value of a symbol.

```
 %  LL    T    SS   L N ... N      [section definition field[24]] (cont'd to next line)
         (a)          (b)                              (A)
                                 symbol definition field [symbol definition field] ...   NL
                                                       (B)
```

(a) ... Block type is 3.
(b) ... Number of characters of the section name and the section name

(A) Section definition field

```
 0     L B ... B     L L ... L
(a)       (b)           (c)
```

(a) ... Indicates that this field is a section definition field.
(b) ... Number of digits of the base address of a section and the base address of the section
(c) ... Number of digits of the length of a section and the length of the section

[24] One section definition field must exist in each section. A section definition field can be followed by or follow any of symbol definition fields.

(B) Symbol definition field

```
T     L S ... S     L V ... V
(a)      (b)           (c)
```

(a) ... Type of symbol[25]
(b) ... Number of characters of symbol and the symbol
(c) ... Number of digits of symbol value and value of symbol

Example 1>

```
%  37   3   60   8SVCSTUFF0    02402C6    22CR1D14OPEN25014READ25815WRITE260   NL
   (a) (b)  (c)     (d)          (e)                    (f)
```

(a) ... Block length is 37.
(b) ... Block type is 3.
(c) ... Check sum is 60.
(d) ... Number of characters of a section is 8 and the section name is SVCSTUFF.
(e) ... Section definition field (number of digits of the base address of the section is 2, the base address of the section is 20, the number of digits of the length of the section is 2, and the length of the section is C6)
(f) ... Symbol definition field (22CR1D/14OPEN250/14READ258/15WRITE260)

Example 2>

```
%  37   3   C8   8SVCSTUFF0   15CLOSE26814EXIT27029BUFLENGTH28013BUF278    NL
   (a) (b)  (c)     (d)                        (e)
```

(a) ... Block length
(b) ... Block type is 3.
(c) ... Check sum
(d) ... Number of characters of section name is 8 and section name is SVCSTUFF.
(e) ... Symbol definition field (15CLOSE268/14EXIT270/29BUFLENGTH280/13BUF278)

[25] 1 ... global address (symbol having binding class GLOBAL and type other than ABS), 2 ... global scalar (symbol having binding class GLOBAL and type ABS), 5 ... local address (symbol having binding class LOCAL and type other than ABS), 6 ... local scalar (symbol having binding class LOCAL and type ABS)

(3) Termination block

Indicates an entry point address.

$$\text{\%} \quad \text{LL} \quad \underset{\text{(a)}}{\underline{\text{T}}} \quad \text{SS} \quad \underset{\text{(b)}}{\underline{\text{L A ... A}}} \quad \text{NL}$$

(a) ... Block type is 8.

(b) ... Number of digits of entry point address and the entry point address

Example>

$$\text{\%} \quad \underset{\text{(a)}}{\underline{\text{08}}} \quad \underset{\text{(b)}}{\underline{\text{8}}} \quad \underset{\text{(c)}}{\underline{\text{1A}}} \quad \underset{\text{(d)}}{\underline{\text{2 80}}} \quad \text{NL}$$

(a) ... Block length is 8.

(b) ... Block type is 8.

(c) ... Check sum is 1A.

(d) ... Number of digits of entry point address is 2, and entry point address is 80.

CHAPTER 4 MESSAGES

This chapter explains the output messages of the hx (in alphabetical order).

The italic characters in the output messages and explanatory statements are determined during command processing.

4.1 Message Format

The message of hx is basically output in the following format.

hx: *message*

However, a command name is not output to the warning message.

4.2 Messages

cannot create HEX rom data, because there is no memory information

ROM data cannot be created because there is no memory information.

cannot find device file

The device file cannot be found.

cannot open file *file*

File *file* cannot be opened.

cannot open output file *file*

Output file *file* cannot be opened.

close error

The file cannot be closed.

expect block length after -b

Specify a block length after -b.

expect disp value after -d

Specify an offset value after -d.

expect format type [ITSs] after -f

Specify I, T, S, or s after -f.

expect input file

Specify an input file name.

expect output file -o

Specify an output file name after -o.

expect section name after -I

Specify a section name after -I.

file name *name* is too long

The length of file name *name* exceeds the limit.

illegal fill value

The filling value is illegal.

illegal option *-character*

-character must not be specified as an option.

***file* is archive file**

File *file* is an archive file and must not be specified.

***file* is not ELF file**

File *file* is not an object file in the ELF format.

memory allocation fault

The memory capacity has run short.

nested command file *file*

Command file *file* is nested. It must not be nested.

***section*: No such section**

Specified section *section* cannot be found.

read error

Data cannot be read from the file.

seek error

The file cannot be sought.

too many input files

Two or more input files must not be specified.

too many output files

Two or more output files must not be specified.

usage: hx[-f[ITSs]][-F dir][-I name][-U[num]][-zxRSV][-b num] [-d num] [-o file] input-file

Input the command line like this.

Warning: -S expect -fT

The -S option is valid only when the expanded Tek hex format is specified (when -fT is specified).

Warning: -U option overrides -f option

The -f option is invalid because the -U option is specified.

Warning: -x expect -S and -fT

The -x option is valid only when specified with the -S and -fT options.

Warning: address is too long

The address exceeds the maximum value of the address that can be expressed in the specified hex format[26].

Warning: block length is set. Length => *length*

The maximum value of the block length is changed from the default value to *length* and processing is continued[27].

Warning: expect command file after @, ignored

Specify command file after @. @ option is ignored.

Warning: symbol block length exceed default value

The block length of the symbol block exceeds the maximum value of the specified block.

Warning: too large block length. Length => *length*

The maximum value of the specified block length is too big.

The value is changed to the maximum value *length* that can be specified and processing is continued.

Warning: too small block length. Length => *length*

The maximum value of the specified block length is too small.

The value is changed to the default value *length* and processing is continued.

[26] This message may be output in the Intel expanded hex format or Motorola S type hex format (standard address). After outputting this message, the hx continues processing, outputting as an address the lower 20 bits in the case of the Intel expanded hex format and the lower 24 bits in the case of the Motorola S type hex format (standard address).

[27] This message is output if a value that can be specified is specified when the -b option is specified.

VOLUME 8

HANDLING DUMP COMMAND

CHAPTER 1 OVERVIEW

This volume explains the outline, operation, display format, and output messages of the dump command (dump) included in this compiler package.

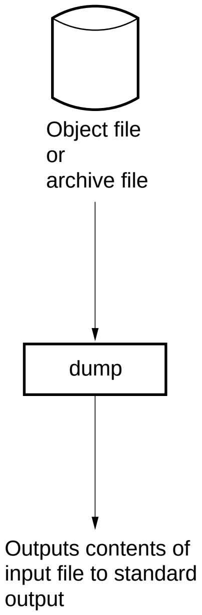
dump starts from the VSH command line.

1.1 Flow of Operation

The dump command displays the contents of a specified object file or archive file[1] in a format easy to see (refer to **Figure 1-1**). The displayed contents can be selected by an option that is specified upon starting the dump command.

This command is used to check the information on a section or segment, such as the address, attribute, and symbol name, by displaying the contents of the section header table or symbol table in a created object file or archive file.

Figure 1-1. Flow of Operation of dump



[1] If a member that is not an object file exists in a specified archive file (except when the -e option is specified), the dump command outputs a warning message and proceeds to the processing of the next member.

CHAPTER 2 OPERATION

This chapter explains the operations of the dump command.

2.1 Command Input Format from VSH Command Line

dump [△ option] ... △ file name [△ file name] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

If no option is specified, it is assumed that the -A option is specified[2].

2.2.1 Option list

The following table lists the option of the dump.

Specification Format	Feature
–A	This option displays the entire contents of the specified object file or archive file.
–T	This option does not display the member update date among the displayed archive header contents.
–V	This option outputs the dump version number to standard output and then terminates processing.
–a	This option displays the archive header contents of all members existing in the specified archive file.
–b	This option displays the contents of debug information.
–c	This option displays the contents of string table.
–d △ *num*	This option displays data from the section indicated by *num*[3].
+d △ *num*	This option displays data up to the section indicated by *num*[3].
–e	This option displays the contents of members (other than archive symbol table, archive string table, and object file) existing in the specified archive file.
–f	This option displays the ELF header contents of all members existing in the specified archive file.
–g	This option displays the external symbol[4] contents of the archive symbol table existing in the specified archive file.
–h	This option displays the contents of all section headers existing in the specified archive file.
–i	This option displays the contents of all program headers existing in the specified archive file.
–k	This option displays the contents of the global pointer table.
–l	This option displays the line number information.
–m	This option displays the contents of strings existing in the archive string table in the specified archive file.
–n △ *name*	This option displays the contents of the section indicated by section name *name*.

[2] Specifying the -A option is equivalent to specifying -abcfghiklmrst.
[3] *num* is the section header table index.
[4] Symbol having binding class of GLOBAL

Specification Format	Feature
–p	This option does not display the title.
–r	This option displays the contents of relocation information.
–s	This option displays the contents of section.
–t △ [*num*]	This option displays the contents of symbol table starting from the *num*th symbol table entry. If *num* is omitted, the display starts from the first symbol table entry.
+t △ *num*	This option displays the contents of symbol table up to the *num*th symbol table entry.
–v	This option displays a value of section attribute, etc., with the character string which indicates meaning of the value rather than a number (refer to page 367).
–z △ *name* △ [*num*]	This option displays contents of line number information for the function *name*, starting from the *num*th line number entry. If *num* is omitted, the display starts from the first line number entry.
+z △ *num*	This option displays contents of line number information, up to the *num*th line number entry.
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

2.3 Examples of Use

Here are examples of using the dump.

- To display contents of object file in meaning

dump850 -ftv a.out

The contents of ELF header and symbol table existing in the object file a.out are displayed with a character which indicates meaning, not a numerical value.

- To specify a section name

dump850 -n .text a.out

The contents of the .text section in the object file a.out are displayed.

CHAPTER 3 DISPLAY FORMAT

This chapter explains the display format of the dump command.

3.1 Archive Header

```
***ARCHIVE HEADER***
```

Displays contents of archive header

Date	Uid	Gid	Mode	Size	Member Name
0x3158DE73	2165	188	0100664	0x2B8	atof.o
Date of updating member	User ID	Group ID	Permission of file	Total number of bytes of member	Member name

3.2 Archive Symbol Table

```
***ARCHIVE SYMBOL TABLE***
```

Displays contents of archive symbol table

Offset	Name
0x1f3c	-abs
Offset in file to member including symbol	Symbol name

3.3 Archive String Table

```
***ARCHIVE STRING TABLE***
```

Displays contents of archive string table

Offset	Name
0x1100	foo.o
Offset	Member name

3.4 ELF Header

```
***ELF HEADER***
```

Displays contents of ELF header

```
Class       Data            Type            Machine          Version
Entry       Phoff           Shoff           Flags            Ehsize
Phentsize   Phnum           Shentsz         Shnum            Shstrndx
1           1               1               070377           1
0x0         0x0             0x2A4           0x84             0x34
0x20        0               0x28            6                5
```

Class	Byte order	Type	Processor	Version number
Entry point address	Offset in file of program header table	Offset in file of section header table	Flag	Size of ELF header
Entry size of program header table	Number of entries of program header table	Entry size of section header table	Number of entries of section header table	Section header table index of string table holding section name

3.5 Program Header Table

```
***PROGRAM HEADER***
```

Displays contents of program header table

```
No.         Type            Offset          Vaddr            Paddr
            Filesz          Memsz           Flags            Align
1.          0               0x0             0x0              0x0
            0x0             0x0             0x0              0x0
```

Index	Segment type	Offset in file	Virtual address	Physical address
	File size	Memory size	Segment attribute	Alignment condition

3.6 Section Header Table

```
***SECTION HEADER***
```

Displays contents of section header table

```
No.     Type          Flags       Addr        Offset       Size    Name
        Link          Info        Adralgn     Entsize
1.      0x1           0x6         0x0         0xB4         0x7556  .text
        0x0           0x0         0x4         0x0
```

Index	Section type	Section attribute	First address	Offset in file	Size	Section name
	Section header table index link	Information	Alignment condition	Size of entry		

3.7 String Table

```
***STRING TABLE INFORMATION***
```

Displays contents of string table

Index	String
0x1	.text
Index	Character string

3.8 Symbol Table

```
***SYMBOL TABLE INFORMATION***
```

Displays contents of symbol table

No.	Value	Size	Bind	Type	Other	Shndx	Name
1.	0x0	0x0	0	3	0	0x1	.text
Index	Value	Size	Binding class	Type	Other	Section header table index	Section name

3.9 Relocation Information

```
***RELOCATION INFORMATION***
```

Displays contents of relocation information[5]

Offset	Sym	Type	Addend
0x20	6	0x23	0x0
Offset	Symbol table index	Relocation type	Addend constant

3.10 Register Mode Information

```
***REGISTER MODE INFORMATION***
```

Displays contents of register mode information

SymIdx	TmpReg	ParReg
0x1	0x5	0x5
Symbol table index	Number of work registers	Number of registers for register variables

[5] Array of relocation entries

3.11 Global Pointer Table

GPTAB INFORMATION

Displays contents of global pointer table

Gnum	Gsize
0x4	0xC
Size of *num*/data of -G*num*	Size when aligned by 0/word

3.12 Line Number Information

LINE NUMBER INFORMATION

Displays contents of line number information

Bfunc	Maddr	Daddr	Pad	Function Name
0x0	0xA2	0xE28	0x0	_main
Beginning of subsection	Address of function	Address of debug information	Padding	Function name
Num	Snum	Offset	Flags	
0x5	0x0	0x0	0x1	
Line number	Position of statement	Offset	Flag	

3.13 Debug Information

DEBUG INFORMATION

Displays contents of debug information

Tag	Attr	Aux
0x0016		
size	0x00000026	
	0x000C	0x00000E1C
Tag	Attribute	Auxiliary information

3.14 PROGBITS Data

PROGBITS DATA in HEX[6]

```
0x00000000 : 40 0E 00 00 21 2E 00 00 ...
```

Displays in hexadecimal number the contents of raw data of section having section type PROGBITS

[6] If the -D option is specified, the result of disassembling the contents of the section is displayed after the title ***TEXT DATA*** for a section having section attribute X.

3.15 Element Values and Meanings

When the -v option has been specified, the following information indicates that character strings are used instead of numerical values to indicate the meaning of the value for some elements.

- ELF header
- Program header table
- Section header table
- Symbol table
- Relocation information
- Debug information

The following table lists the values[7], display when -v is specified, and meaning of those elements which are displayed as character strings when -v has been specified.

(1) “Flags” in ELF headers

Value	Display when -v is specified	Meaning
1	`L_______`	.vline section exists
2	`_D______`	.vdebug section exists
4	`__P_____`	Object is a PIC (Position Independent Code) object
10	`___R____`	Register mode is 22-register mode or 26-register mode
20	`____d___`	Different register modes are mixed
40	`_____r__`	Object is output by romp
80	`______N_`	Default function call specification (call does not use old specification)
100	`_______M`	Uses mask register function

(2) “Type” in program header table

Value	Display when -v is specified	Meaning
1	Load	Segment is loaded into memory
4	Note	Segment including supplemental information

[7] The value is displayed using the number base output by dump.

(3) “Type” in section header table

Value	Display when -v is specified	Meaning
0x1	Progbits	Section that corresponds to an entity that contains an actual value in an object file (machine language instruction and data with initial value)
0x2	Symtab	Symbol table
0x3	Strtab	String table
0x4	Rela	Relocation information
0x8	Nobits	Section that corresponds to an entity that does not contain an actual value in an object file (data without initial value)
0x9	Rel	Relocation information
0x70000000	Gptab	Global pointer table (in which the first entry contains a *num* of -G*num* specified for ca or as, and the 0th, 2nd, and subsequent entries indicate the size when aligned with data size and word)
0x70000001	Regmode	Section that exists in a relocatable object file created using the register mode function[8] (Information concerning the number of registers used internally by the ca is stored)

(4) “Bind” in symbol table

Value	Display when -v is specified	Meaning
0	Local	Symbol that is not used to resolve external reference
1	Global	Symbol that is used to resolve external reference

(5) “Type” in symbol table

Value	Display when -v is specified	Meaning
1	Object	Ordinary object (label)
2	Func	Function name
3	Section	Section
4	File	Ordinary file name
13	Devfile	Device file name

(6) “Shndx” in symbol table

Value	Display when -v is specified	Meaning
0	Undef	Undefined symbol
65280	GpCommon	Undefined external symbol that is referenced by global pointer (gp) and 16-bit displacement
65521	Abs	Symbol indicating constant
65522	Common	Undefined external symbol that is referenced by global pointer (gp) and 32-bit displacement

[8] Refer to -reg option of ca.

CHAPTER 4 MESSAGES

This chapter explains the output messages of the dump command (in alphabetical order).

The italic characters in the output messages and explanatory statements are determined during command processing.

4.1 Message Format

The message of dump is basically output in the following format.

dump: *message*

4.2 Messages

archive string table not exist
The archive string table is missing.

archive symbol table not exist
The archive symbol table is missing.

can not open file *file*
File *file* cannot be opened.

close error
The file cannot be closed.

convert error
Conversion cannot be executed.

empty in archive file
The archive file has no content.

illegal option *string*
string must not be specified as an option.

***file* is not ELF nor archive file**
File *file* is neither an object file nor an archive file.

memory allocation fault
The memory capacity has run short.

nested command file *file*
Command file *file* is nested. It must not be nested.

not enough argument
The argument is insufficient.

not enough argument for *string*

The argument for the option *string* is insufficient.

read error

Data cannot be read from the file.

seek error

The file cannot be sought.

usage: dump [options] file ...

options:

```
        –abcefghiklmprsvxATV
        –d number
        +d number
        –n name
        –t [index]
        +t index
        –z name [number]
        +z number
```

Input the command line like this.

VOLUME 9

HANDLING DISASSEMBLER

CHAPTER 1 OVERVIEW

This volume explains the outline, operation, an output example, and output messages of the disassembler (dis) included in this compiler package.

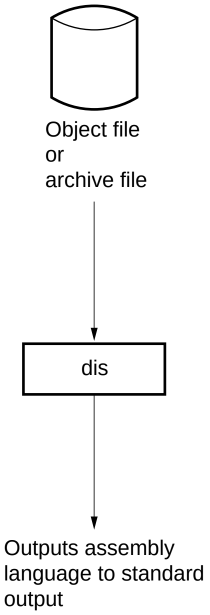
dis starts from the VSH command line.

1.1 Flow of Operation

The dis inputs an object file or archive file, converts the data of text attribute into assembly language codes, and outputs them to the standard output (refer to **Figure 1-1**).

The dis is used to reference the corresponding assembly-language source program from a created object file or archive file.

Figure 1-1. Flow of Operation of dis



CHAPTER 2 OPERATION

This chapter explains the operations of the dis command.

2.1 Command Input Format from VSH Command Line

dis [△ option] ... △ file name [△ file name] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

If no option is specified, the –o option is assumed.

2.2.1 Option list

The following table lists the option of the dis.

Specification Format	Feature
–A	Specifying this option is equivalent to specifying the option -aoptr.
–F △ *devpath*	This option searches for the device file first in the directory *devpath*, then in the standard directories[1]. If this option is omitted, only the standard directories are searched.
–V	This option outputs the dis version number to standard output and then terminates processing.
–a	This option displays addresses.
–c	This option displays code[2].
–e △ *address*	This option specifies an end address. *address* is specified as a decimal number or as a hexadecimal number starting with 0x. If this option is omitted, it is assumed that 0xffffffff has been specified.
–l △ *size*	This option specifies the display size. *size* is specified as a decimal number or as a hexadecimal number starting with 0x. If this option is omitted, it is assumed that 0xffffffff has been specified.
–m	This option displays the assembler source format. If this option is omitted, it is displayed with a symbol offset, etc.
–o	This option displays the offset from symbols. If this option is omitted, symbols are displayed unless the -a option or the -m option has been specified.
–p	This option displays code[3] that has been arranged according to the processor’s instruction format. However, the -c option takes priority if it has been specified.

[1] dis handles the directory at the ..\dev position from the dis’s installation directory as the standard directory of the device file.
[2] Machine language instruction or data
[3] Machine language instruction or data

Specification Format	Feature
–r	This option displays registers r0, r2, r3, r4, r5, and r31 as zero, hp, sp, gp, tp, and lp. In the V850 Family, r30 is also displayed as ep. *V850 If this option is omitted, all registers are displayed in r*num* format, in which *num* is a value from 0 to 31.
–s △ *address*	This option specifies a start address. *address* is specified as a decimal number or as a hexadecimal number starting with 0x. If this option is omitted, it is assumed that 0x0 has been specified.
–t	This option displays a title indicating the displayed contents.
–v	This option displays comments, etc.
@*cfile*	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

2.3 Cautions

- If labels of the same address exist in the object file, the label appearing latter in the symbol table takes precedence.

- If the program starts from address 0 and if output of the symbol at address 0 is necessary upon output for an object that does not have a symbol indicating address 0, "__*dummy*" may be output as the symbol of address 0.

2.4 Examples of Use

Here are examples of using the dis.

- To display with codes

dis850 -aoct a.out

Inputs object file a.out and displays addresses, offsets from symbols, codes, and titles with assembly language instructions.

- To output version number

dis850 -V

Outputs the version number of the dis850 that has been started to the standard output and terminates the dis850.

2.5 Output Example

Here is an output example of the dis.

```
> dis830 -A a.out
```

← Displays addresses, offsets, codes in accordance with the instruction format, and titles with assembly language instructions, and displays in another name of the register.

```
  Address       Offset       Opecode

                                          _main:
0x00000000 : 0x00000000 : A0200018       movea    0x18, zero, r1
0x00000004 : 0x00000004 : 0861           sub      r1, sp
0x00000006 : 0x00000006 : DFE30014       st.w     lp, 0x14[sp]
0x0000000A : 0x0000000A : 8A48           br       _main + 0x52
0x0000000C : 0x0000000C : D0040060       st.b     zero, 0x60[gp]
0x00000010 : 0x00000010 : 03A0           mov      zero, r29
0x00000012 : 0x00000012 : 4FAA           cmp      0xa, r29
0x00000014 : 0x00000014 : 9C2A           bge      _main + 0x3e
0x00000016 : 0x00000016 : A1440000       movea    0x0, gp, r10
0x0000001A : 0x0000001A : 00CA           mov      r10, r6
0x0000001C : 0x0000001C : A164FE64       movea    -0x19c, gp, r11
0x00000020 : 0x00000020 : 00EB           mov      r11, r7
0x00000022 : 0x00000022 : 011D           mov      r29, r8
0x00000024 : 0x00000024 : AC00008C       jal      _sprintf
0x00000028 : 0x00000028 : A1840060       movea    0x60, gp, r12
0x0000002C : 0x0000002C : 00CC           mov      r12, r6
0x0000002E : 0x0000002E : A1A40000       movea    0x0, gp, r13
0x00000032 : 0x00000032 : 00ED           mov      r13, r7
0x00000034 : 0x00000034 : AC0000C8       jal      _strcat
0x00000038 : 0x00000038 : 47A1           add      0x1, r29
0x0000003A : 0x0000003A : 4FAA           cmp      0xa, r29
0x0000003C : 0x0000003C : 8DDA           blt      _main + 0x16
0x0000003E : 0x0000003E : 40CA           mov      0xa, r6
0x00000040 : 0x00000040 : AC000018       jal      _f
0x00000044 : 0x00000044 : CFA30010       ld.w     0x10[sp], r29
0x00000048 : 0x00000048 : CFE30014       ld.w     0x14[sp], lp
                               ......
```

CHAPTER 3 MESSAGES

This chapter explains the output messages of the dis.

The italic characters in the output messages and explanatory statements are determined during command processing.

3.1 Message Format

dis messages are basically output in the following format.

dis: *message*

3.2 Messages

***file*: bad magic file**

The specified *file* is not an object file of the V800 Series.

can not open file *file*

File *file* cannot be opened.

***file* is not ELF nor archive file**

File *file* is neither an object file in the ELF format nor an archive file.

memory allocation error

The memory capacity has run short.

nested command file *file*

Command file *file* is nested. It must not be nested.

VOLUME 10

HANDLING ROM-STORING PROCESSOR

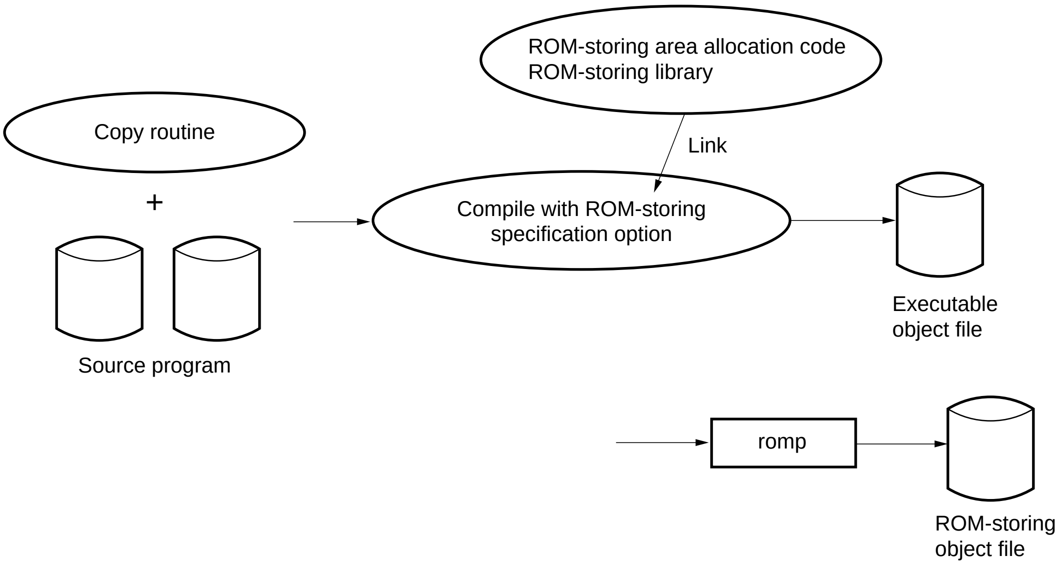
CHAPTER 1 OVERVIEW

This volume explains the outline, procedure of storing to ROM, operation, rompsec section, copy routine, and output messages of the ROM-storing processor (romp) included in this compiler package.

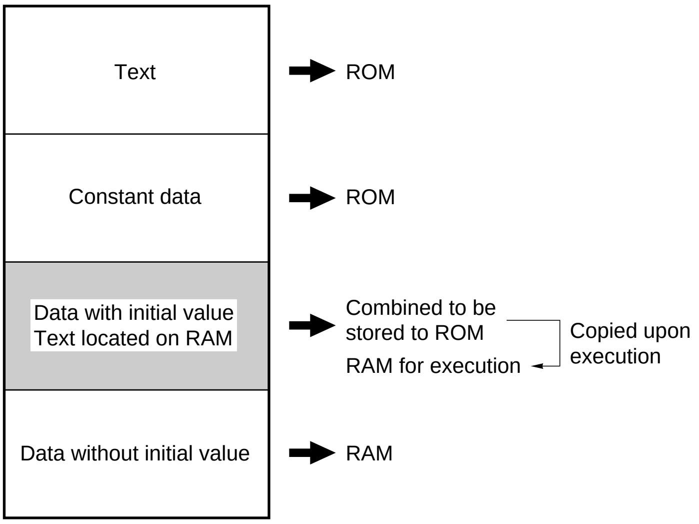
1.1 Flow of Operation

The romp inputs an executable object file whose relocation has been resolved, and creates initialization data to be stored to ROM and an object file having information necessary for the copy routine that is used to store a program to ROM (refer to **Figure 1-1**).

Figure 1-1. Flow of Operation of romp



In the case of an embedded system, an application program that has been debugged is usually written to the ROM area on the target system. In this case, the initialization information on the data that is rewritten by the application processing as well as the instruction to be located on the high-speed internal RAM of the sections that are stored to ROM must be copied to a RAM area on the target.



The romp packs the sections to be located on the RAM of the target system as a rompsec section to store them in ROM and creates initialization information as well as an object file having module-copying processing. Consequently, you do not have to be aware of storing to ROM while developing the application.

The first address of the rompsec section of the object file created by the romp is the address indicated by a specified label or by “__ S_romp”.

1.2 Types of Sections to Be Packed

Data to be packed as a rompsec section are the data allocated to the section having an attribute that can be written[1]. As the types of the sections, the sdata-attribute section and data-attribute section are used (refer to page 257).

With the V830 Family, the section of the module to be located in the internal instruction RAM is packed in addition to the above[2].

Specify the sdata attribute or data attribute in the following reserved section and assembly-language program by using the .section pseudo-instruction. The section created with an arbitrary name given is packed.

Table 1-1. Reserved Sections Packed by romp

CA830	CA850
.data section .sdata section .sedata section .sidata section .cdata1 section .cdata2 section .cdata3 section .udata1 section .udata2 section .udata3 section .itext section	.data section .sdata section .sedata section .sidata section .tidata section .tidata.byte section .tidata.word section

With the CA830, the sections of the interrupt handler located in the internal instruction RAM (addresses 0xfe000000 through 0xfe0000ff) are packed in addition to the above[2].

By referencing the object file created through romp with dump, it can be confirmed that the rompsec section has been created instead of the .data, .sdata, or .itext section.

[1] The bss-attribute section and sbss-attribute section that can be written but do not have an initial value are not packed.

[2] romp830 allows the first address of each section to align in word size when packing the section located in the internal instruction RAM (such as .itext section or interrupt handler). As a result, a padding area may be generated, and the object size may become larger accordingly.

1.3 Procedure of Storing to ROM

The procedure of storing a program to ROM by using the romp is shown below.

(1) Start copy routine _rcopy( ) holding the necessary arguments within the program to be stored to ROM when that program is started (refer to **Figure 1-2** and **CHAPTER 4**).

Figure 1-2. Example of Using Copy Routine _rcopy

```
    #define ALL_COPY (-1)
    extern unsigned long _S_romp;

    main( )
    {
            int ret;

            ret = _rcopy(&_S_romp, ALL_COPY);
                      ...
    }
```

(2) Create an object file by specifying the ROM-storing option of the ca.
- When using the Project Manager, also specify the <<Output 2>> of the C compiler → [Create Object for ROM].
- When using the VSH, also specify the -Xr option of the C compiler

At this time, link the codes that are used to allocate an area for the rompsec section by specifying reference of the ROM-storing library. Also reference the link directive that takes the area for the rompsec section into consideration (refer to **CHAPTER 3**).

(3) By using the romp, create an object file having a section with the data or sdata attribute having an initial value and placed in a RAM, and the rompsec section, instead of the section (such as interrupt handler section and .itext section)[3] placed in the internal instruction RAM (with the V830 Family).

(4) Create hex data by starting the hx from the VSH command line.

(5) Load created hex data to the ROM of the target system (refer to **Figures 1-3** and **1-4**).

[3] Refer to page 380.

Figure 1-3. Image of ROM Storing (example of V830 Family)

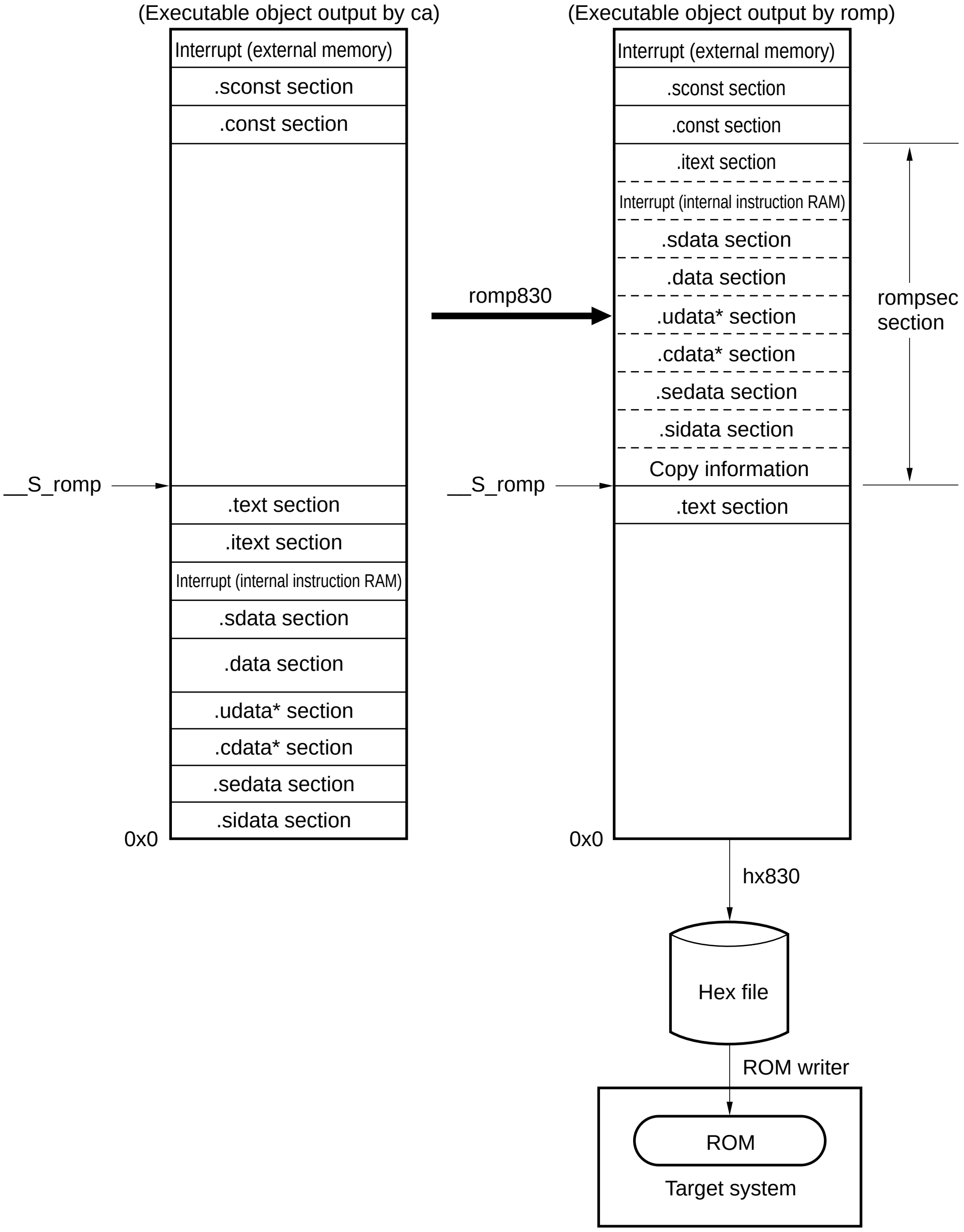
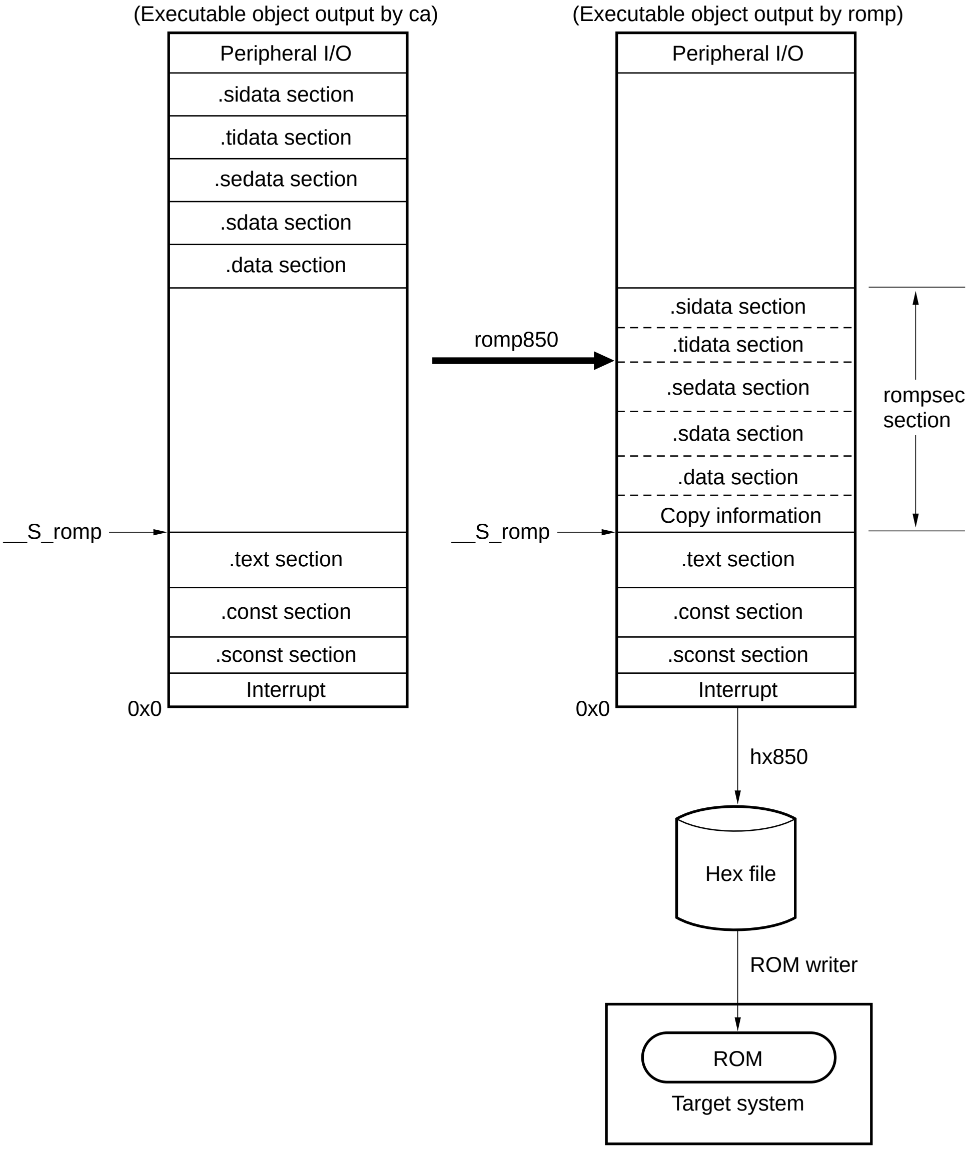


Figure 1-4. Image of ROM Storing (example of V850 Family)



CHAPTER 2 OPERATION

This chapter explains the operations of the romp.

2.1 Command Input Format

romp [△ option] ... △ file name [△ file name] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists the romp options.

(1) Output options

These specifications set options that change the contents of objects output by romp.

Specification Format	Feature
–b △ *label*	The label *label* is used as the first address of the created rompsec section. If the specified label does not exist in the object file, or if the -b option has been specified several times, a message is output and processing is stopped. If this option is omitted, it is assumed that __S_romp has been specified.
–d	This option creates an object file that contains only the rompsec section and does not contain any sections that have the text attribute. If this option is omitted, a section that has the text attribute is also included.
–p △ *section*	This option includes the contents of the section name *section* along with its address and size information in the rompsec section. If this option is specified more than once, these items are included in the rompsec section in the order of their specification. If the specified section does not exist in an object file, a message is output and processing is stopped. If this option is omitted, it is assumed that all of the sections that have the data or sdata attribute, and (with the CA830) the text-attribute section and .itext section for interrupts which have been located to internal instruction RAM have been specified.

(2) Other options

These specifications set other options.

Specification Format	Feature
–F △ *devpath*	This option searches for the device file first in the directory *devpath*, then in the standard directories[4]. If this option is omitted, only the standard directories are searched. This option can be specified only when starting from VSH.
–V	This option outputs the ROM-storing processor's version number to standard output and then terminates processing. This option can be specified only when starting from VSH.
–help	This option outputs a description of options for the ROM-storing processor to standard output. This option can be specified only when starting from VSH.
–i	This option does not check duplication of addresses of input file and output file.
–m	This option outputs the memory map of the object file to be created to standard output.
–o △ *ofile*	This option specifies *ofile* as the name of the created object file. If this option is omitted, it is assumed that romp.out has been specified[5]. This option can be specified only when starting from VSH.
@cfile	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

2.3 Examples of Use

Here are examples of using the romp.

- Basic usage

romp850 a.out

Includes all the data sections having the data or sdata attribute in the a.out file in the rompsec section of the default output file romp.out.

- To specify output file name

romp850 –o new.out a.out

The output file name is assumed to be new.out.

- To specify first label

romp850 –b _romstart a.out

Uses the value of label `_romstart` as the first address of the rompsec section to be created.

- To specify section

romp850 –p data1 –p data3 a.out

Includes the two sections (data1, data3) in the a.out file in the rompsec section of the default output file romp.out.

[4] romp handles the directory at the ..\dev position from the romp's installation directory as the standard directory of the device file.

[5] The output object file name cannot be specified from the Project Manager's option dialog. The file name always becomes the name which is omitted the suffix of the first file in source list and is added ".out" (the same naming convention is used for the ld).

CHAPTER 3 ALLOCATING AREA OF rompsec SECTION AND LINK PROCEDURE

This chapter explains the codes used to create sections to be stored to ROM and how the addresses of ROM-storing objects are resolved.

3.1 Allocation Area of rompsec Section

The romp packs the data section having the initial value in the input section (section having the data or sdata attribute), and the .itext section and interrupt handler section located in the internal instruction RAM (with the CA830), and creates an object file having a text-attribute section named rompsec section that incudes the contents of the above mentioned sections and the address information on these sections (refer to pages 382 and 383).

Here is an example of a code (rompcrt.s)[6] to allocate the area for the rompsec section supplied by this compiler package:

Example of rompcrt.s>

```
         .file      “rompcrt.s”
         .text
         .align     4
         .globl     __S_romp
__S_romp:
```

When the ca is started with the [Create Object for ROM] (-Xr) option specified, a code is generated in the manner that a label called __S_romp indicates the first address[8] exceeding the end of the .text section[7] within the object as an absolute address.

By linking this code lastly, an area for the rompsec section is allocated immediately after the .text section.

When romp is started from the Project Manager, libr.a and rompcrt.o are linked automatically with ld by using the [Create Object for ROM] option of the ca.

Even when starting from VSH, if ld is started from ca, the ca specifies to link libr.a and rompcrt.o with ld by using the -Xr option. In either case, rompcrt.o is linked lastly.

[6] If this code is customized, create a relocatable object (rompcrt.o) by using the assembler (as), and place the object in the directory at the ..\libxxx\r32, ..\libxxx\r26, ..\libxxx\r22 position from the directory to which the C compiler driver (ca) has been installed.

[7] Section name defined in the second line of the above mentioned code

[8] Aligned under a 4-byte alignment condition

3.2 rompsec Section and Link Directive

When storing a program to ROM, a link directive[9] is necessary that takes addition of the rompsec section to the .text section into consideration. Specify addresses suitable for RAM and ROM locations of the target system so that the address range of the memory to which the rompsec section is allocated does not overlap the address range of the next segment or overflow from the segment of the text as a result of the rompsec section.

The size of the rompsec section to be created can be calculated by the following expression (decimal, in byte units).

Size of rompsec section =
8 + 16 × number of sdata/data-attribute sections + size of sdata/data-attribute sections * $\boxed{\text{V850}}$

Size of rompsec section =
8 + 16 × (number of sdata/data-attribute sections + number of sections located in internal instruction RAM[10])
+ size of sdata/data-attribute sections + size of section located in internal instruction RAM + padding size[11]
* $\boxed{\text{V830}}$

For example, if a 50-byte .sedata section, 30000-byte .sdata section, and 10000-byte .data section exist, the size of the rompsec section is as follows:

Size of rompsec section = 8 + 16 × 3 + 50 + 30000 + 10000 = 40106

An example of changing the link directive is shown below.

[9] For the details of the link directive, refer to **CHAPTER 3 LINK DIRECTIVE** in **VOLUME 5 HANDLING LINK EDITOR**.

[10] All sections that are allocated to internal instruction RAM by link directive such as interrupt handler sections corresponding to handler addresses in internal instruction RAM and .itext section

[11] The padding size is from 0 to 6 bytes per section allocated to internal instruction RAM. To add a precise amount of size of rompsec section, first use a directive with an estimated size value to create an object, then execute romp830. Next, use dump830 to check the object file created by romp830, adjust the size in the rompsec section and use another directive with that precisely adjusted size to create another object.

Link directive before ROM-storing processing

```
SEDATA : !LOAD ?RW {
          .sedata = $PROGBITS ?AW .sedata;
};

TEXT   : !LOAD ?RX V0x10000{
          .text = $PROGBITS ?AX;  ← Size of .text is checked by dump
};                                  (e.g., if size is 0x10000)

DATA   : !LOAD ?RW {              ← DATA from address 0x20000
          .data   = $PROGBITS ?AW;
          .sdata  = $PROGBITS ?AWG;
          .sbss   = $NOBITS   ?AWG;
          .bss    = $NOBITS   ?AW;
};

__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA};
```

Link directive for ROM-storing processing

```
SEDATA : !LOAD ?RW {
          .sedata = $PROGBITS ?AW .sedata;
};

TEXT   :  !LOAD ?RX V0x10000{
          .text = $PROGBITS ?AX;  ←  Data is packed after .text section as rompsec
};                                   section

DATA   :  !LOAD ?RW V0x29CAC{     ←  Specify address taking size of rompsec section
          .data   = $PROGBITS ?AW;   into consideration (4-byte alignment)
          .sdata  = $PROGBITS ?AWG;
          .sbss   = $NOBITS   ?AWG;
          .bss    = $NOBITS   ?AW;
};

__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA};
```

A command startup example for creating a rompsec section is shown below.

[Command startup from Project Manager (PM)]

(1) Go to the PM's Option menu and select Compiler Options... .

(2) Select the <<Output 2>> option button.

(3) Check the [Create Object for ROM] box.

☑ Create Object for ROM [-Xr]

(4) When specifying an option for romp, go to the PM's Option menu and select ROM Processor Options... .

(5) After the above options have been set and a build is started from the PM, romp is automatically started after ca, as, and ld, and an object file that contains the ROM-storing information is created. During the build operation, linking of libr.a and rompcrt.o is automatically specified.
The ld's output file is deleted as a temporary file.

Caution
When romp is started from the PM, the output object file name is “the first file name in source list + .out”, which is the same naming convention for the ld. The file name is not “romp.out” which is the default name when romp is started from the VSH.

[Command startup from VSH]

Example in which ld is started from ca>

```
> ls
ldir  sample.c
> ca830 -cpu 5100 -Wl,-D,ldir -Xr sample.c
> ls
a.out  ldir  sample.c
> romp830 a.out
> ls
a.out  ldir  romp.out  sample.c
>
```

If the -c option of the ca is specified, directly link libr.a and rompcrt.o with the ld. In this case, be sure to specify the -Xr option of the ca to call the copy routine (_rcopy) in a C source program.

Example in which ld is started by itself>

```
> ls
ldir  sample.c
> ca830 -cpu 5100 -c -Xr sample.c
> ls
ldir  sample.c  sample.o
> ld830 -D ldir \nectools\lib830\r32\crtN.o sample.o -lr -lc
\nectools\lib830\r32\rompcrt.o
> ls
a.out  ldir  sample.c   sample.o
> romp830 a.out
> ls
a.out  ldir  romp.out sample.c sample.o
>
```

Caution

When romp is started from the VSH, the default name for the output object file is “romp.out”.

CHAPTER 4 COPY ROUTINE

This chapter explains the copy routine (_rcopy) necessary for the program to be stored to ROM.

Outline

_rcopy	– Copies initial value data/RAM text[12]

Format

```
int _rcopy (&label,number)
unsigned long label;
long number;
```

Explanation

_rcopy(&label, number) copies the initial value data and text to be located in the internal RAM (in the rompsec section) indicated by number to an area prior to ROM storing, based on the information in the rompsec section existing at addresses following the address indicated by label. Copying is not executed if a magic number that indicates an object created by the romp does not exist in a 4-byte area following the address indicated by label.

Specify the number of the section[13] to be copied as number. To copy all the sections in the rompsec section, specify –1. If any other number is specified, copying is not executed. Copying is not executed also if overwrite occurs as a result of copying.

Return value

_rcopy returns 0 if copying has been correctly executed. If copying has not been executed, –1 is returned.

[12] Data section with initial value located in RAM, and text section for internal RAM

[13] This section number is a positive integer starting from 1. If the -p option is specified, sections are allocated in the sequence in which they have been specified. If the -p option is not specified, sections are allocated in the sequence in which they appear in the input file.

Cautions

- _rcopy executes copying only in accordance with the information created by the romp. Processing such as to add an offset to the copy destination address cannot be performed upon execution of _rcopy.
- Specify a global label having an absolute value or an absolute address as the first argument label of _rcopy. If any other thing is specified, the result is not guaranteed.

Example of incorrect specification 1>

```
extern unsigned long _S_romp;
char *cp;
func()
{
        int ret;
        cp = &_S_romp;              ← First argument is gp relative value because
        ret = _rcopy(cp, -1);         copying to variable is executed.
}
```

Example of incorrect specification 2>

```
extern unsigned long _S_romp;
int i;
func()
{
        int ret;
        i = 0x100;                  ← First argument is gp relative value because
        ret = _rcopy(i, -1);          copying to variable is executed.
}
```

Example of description

```
extern unsigned long _S_romp;

main()
{
        int ret;
        ret = _rcopy(&_S_romp, –1); ← -Xr specifies global label having
}                                      absolute value.
```

The label references an absolute address when the ROM-storing option of the ca is specified as shown above. Therefore, the compiler makes the following output if _rcopy ( ) is called by an assembly language source[14] program.

Compiler output of above example (with –Xr specified)

```
.extern __S_romp, 4      ← Declared as external label
     ...
mov   #__S_romp, r6      ← Calls _rcopy with absolute address of __S_romp as first
mov   –1, r7               argument and –1 as second argument
jal   __rcopy
         ...
```

[14] When calling from the start-up module

CHAPTER 5 MESSAGES

This chapter explains the output messages of the romp (in alphabetical order). The italic characters in the output messages and explanatory statements are determined during command processing.

5.1 Message Format

romp messages are basically output in the following format.

romp: *message*

5.2 Messages

-option **unknown option**
Option *option* must not be specified.

@ option needs argument, ignored
The argument for the @ option is insufficient. @ option is ignored.

address of *symbol* symbol must be same in all files
The address of *symbol* must be the same in all of the input files.

b option is specified more than once
The -b option is specified more than once.

b option needs one argument
The argument for the -b option is insufficient.

file **bad magic**
The input file (*file*) is illegal and cannot be input.

cannot find device file
The device file cannot be found.

cannot open command file *file*
The command file *file* cannot be opened.

file name *name* is too long
The length of file name *name* exceeds the limit.

file**: illegal input file name**
The input file *file* cannot be input because its name is the same as the output file.

illegal input file type. file (*file*) is archive file
The input file *file* cannot be input because it is an archive file.

memory allocation fault

Allocating of a memory area has failed.

nested command file *file*

The command file *file* is nested. It must not be nested.

***file*: not absolute object**

A relocatable object (*file*) is specified as an input file.

o option needs one argument

The argument for the -o option is insufficient.

p option needs one argument

The argument for the -p option is insufficient.

packing section not found

The specified section is not found in the object file.

processor type must be same in all files

An illegal input file is specified.

***section1* section and *section2* section overlapped**

Sections *section1* and *section2* overlap.

***file*: *section* section can not be packed**

Section *section* in *file* cannot be specified by the -p option.

***section* section is already defined by -p option and therefore this section is ignored**

Section *section* has been already specified by the -p option and is ignored.

***section* section not found**

Section *section* specified by the -p option is not found.

***section* section overflowed highest address of target machine**

section exceeds the upper limit of the memory as a result of creating the rompsec section.

symbol (*start_label*) must be word alignment

Make sure that *start_label* label is at an address of a 4-byte boundary.

***file*: “*symbol*” symbol not found**

Specified *symbol* is not found in object file *file*.

unknown option argument

An argument that must not be specified for the option is specified.

[MEMO]

VOLUME 11

HANDLING SECTION FILE GENERATOR

CHAPTER 1 OVERVIEW

This volume explains the outline of the section file generator (sf) included in this compiler package, sequence to use the section file, sf operation, and output messages.

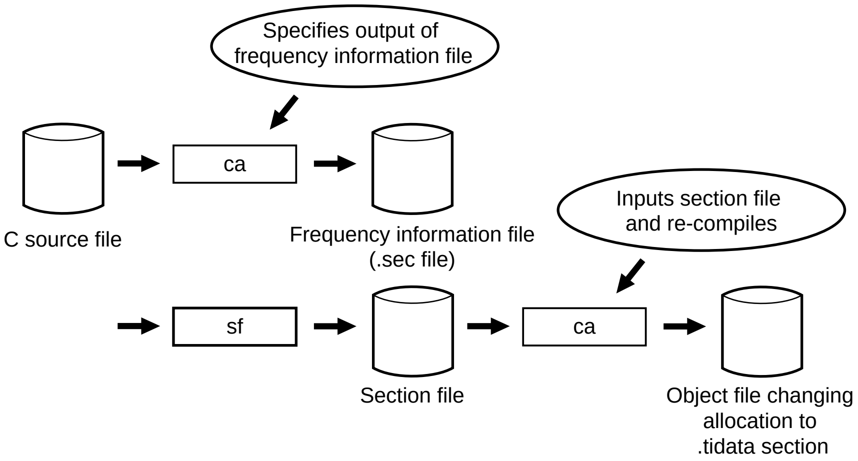
sf is supplied only to the CA850 at present.

Activate sf on the VSH command line.

1.1 Flow of Operation

sf reads the frequency information file (.sec file) output by the ca through option specification, and outputs a section file that is used to allocate variable data that are frequently referenced to the .tidata section that can be referenced at high speed (refer to Figure 1-1)[1].

Figure 1-1. Flow of Operation of sf


Specifies output of frequency information file
ca
C source file
Frequency information file (.sec file)
Inputs section file and re-compiles
sf
Section file
ca
Object file changing allocation to .tidata section

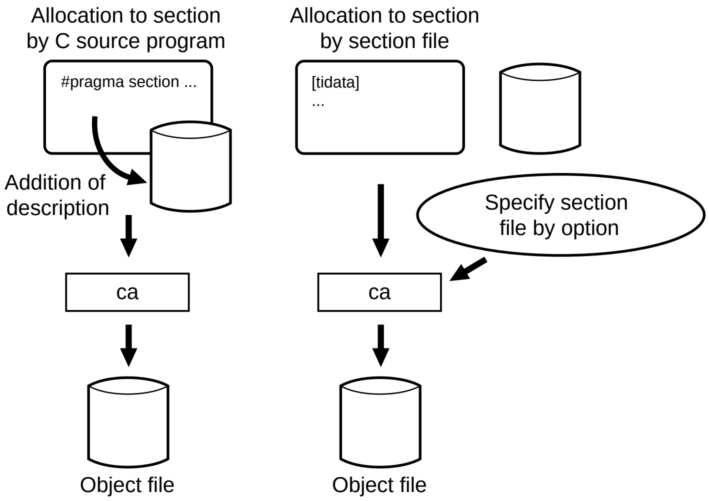
[1] The section file can be output to a specified file by using the -o option.

This compiler package supports the following three methods to specify allocation of data sections for the C source program.

- Specify the size of data to be allocated to the .sdata or .sbss section by using an option (-G) of the C compiler[2].
- Allocate each variable to any section by using the pragma directive[3].
- Change the section allocating the specified variable by using the section file when the C compiler is started.

If a section file satisfies the file format requirements, it can be coded and used freely, but for .tidata section it is useful to use section files output by sf.

For details of the format of output section files, refer to page 408.


Allocation to section by C source program
#pragma section ...
Addition of description
ca
Object file
Allocation to section by section file
[tidata]
...
Specify section file by option
ca
Object file

sf creates a section file according to the frequency at which variables are referenced. The section file is a text file and allocation to the section can be freely changed according to the file format.

If specification of allocation by the pragma directive to a different section exists for the same variable in the C source program, specification by the section file takes precedence.

[2] Refer to <<sdata/sbss Allocation>> on page 51 and -G option on page 156.

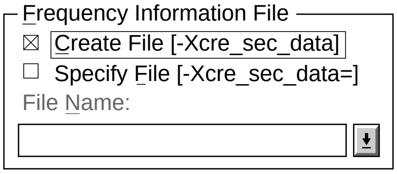
[3] Refer to **V800 Series C Compiler Package User's Manual - C Language**.

1.2 Sequence to Use Section File

The sequence to use the section file by using sf is as follows.

(1) Compile the file by specifying option <<Frequency Information File>> (-Xcre_sec_data) of the C compiler. As a result of compiling, a file with extension .sec (with a specified file name if a file name is specified) having information on the frequency at which each variable in the C source file is referenced is created.

Example of specification from PM[4])



Frequency Information File

☒ Create File [-Xcre_sec_data]

☐ Specify File [-Xcre_sec_data=]

File Name:

Example of activation from VSH[5])

```
>ca850 -Xcre_sec_data a.c b.c c.c
```

(2) When sf is started with the created .sec file input, a section file that specifies section allocation to the .tidata section is created.

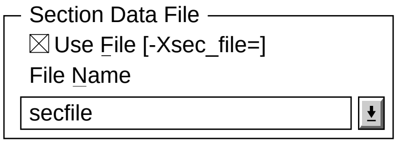
Example of activation from VSH)

```
>sf850 a.sec b.sec c.sec -o secfile
```

(3) Because all variables are allocated to the .tidata section as default assumption, modify the section file as necessary.
If the -O option is specified on activating sf, the variables that can be accommodated in the memory range of the .tidata section can be automatically selected in sequence, starting from the one that is referenced most.

(4) Re-compile the file by specifying option <<Section Data File>> (-Xsec_file) of the C compiler. An object file allocated to the section is created in accordance with the input section file.

Example of specification from PM[6])



Section Data File

☒ Use File [-Xsec_file=]

File Name

secfile

Example of activation from VSH[7])

```
>ca850 -Xsec_file=secfile a.c b.c c.c
```

[4] Refer to <<Frequency Information File>> on page 50.
[5] Refer to _Xcre_sec_data option on page 156.
[6] Refer to <<Section Data File>> on page 42.
[7] Refer to -Xsec_file option on page 153.

[Cautions]

- The variables that can be specified to be located are external variables, static variables in file, and static variables in function. Character string constants are not located.
- When compiling each of two or more C source files and linking them to create an object file, compile each file by specifying its frequency information output, and creating two or more .sec files. When creating a section file, however, .sec files must be input to sf all at once and integrated. Otherwise, the variable information for the external variables will not be integrated, and the valid section file cannot be created.
- The variable specified by the section file is equivalent to specifying "`#pragma section`". Therefore, temporary definition of an external variable is treated as "definition". If the external variable is temporarily defined by two or more files, an error occurs during linking. In this case, extern must be always declared in a file that references external variables.
- sf outputs a section file directing that all variables be allocated to the .tidata section as default assumption. However, because the memory range to which the .tidata section is allocated is 256 bytes, the memory range must be adjusted on judgment of the user in case the section does not fit in the above range.

  If the -O option is specified by sf, however, only variables that can fit in the range of .tidata section are output in the sequence of frequency at which the variables are used (refer to the option list on page 402).
- Only the frequency information file in the status in which it has been output by the ca can be input by sf. If the frequency information file whose contents have been changed is input, the operation is not guaranteed.

CHAPTER 2 OPERATION

This chapter explains the operation of the sf.

2.1 Command Input Format

sf850 [△ option] ... △ file name [△ file name] ...

[ ] : Can be omitted
... : Pattern in [ ] immediately before can be repeated.
△ : One or more blank spaces

2.2 Types and Features of Options

2.2.1 Option list

The following table lists the option of the sf.

Specification Format	Feature
–O	This option specifies that only the number of variables that can be allocated to the .tidata section will be selected in order of highest use frequency and output. The maximum data size that can be allocated to the .tidata section is 256 bytes, which are internally divided into .tidata.byte byte data (128 bytes) and .tidata.word word data. When this option is specified, variables are selected until the total section size of 256 bytes is reached and output to the section file. However, selection is stopped if the byte data have reached 128 bytes. If this option is omitted, all variables that have appeared are output to the section file.
–V	This option outputs the section file generator's version number to standard output and then terminates processing.
–cl △ *num*	This option specifies the comment level of the section file to be output[8]. The following values can be specified as *num*. 0 No comment output 1 Outputs file creation information (date, etc.) and variable information and its explanation. The variable information includes the section name, size, and use frequency. If the section name is not determined by an external variable, "—" is output. 2 Outputs a format guide in addition to level 1. If -O has been specified, variables judged not to fit in the .tidata section are output as comments. If this option is omitted, comment level 1 is assumed.
–h	This option outputs a description of the section file generator's options to standard output and then terminates processing.
–help	This option is the same as the -h option.
–ns	This option arranges variable names in section files to be output in the order they appear instead of sorting them. If this option is omitted, the variable names are arranged in order of highest use frequency. If two variable names have the same amount of use frequency, they are arranged so that the smaller of the two is first.
–o △ *name*	This option specifies the section file name for output of *name*. If this option is omitted, the section file is output to standard output.

[8] For details of comments, refer to page 403.

Specification Format	Feature
–sname	This option arranges the variable names in section files to be output in the order of the dictionary of the variable names. If two variables have the same name, they are arranged in the order of the dictionary of their file names and function names.
–ssection	This option arranges the variable names in section files to be output in the order of the dictionary of the section names where they are allocated. If two variables have the same section name, they are arranged in the order of their highest use frequency.
–ssize	This option arranges the variable names in section files to be output according to their size (smallest first). If two variables have the same size, they are arranged in the order of their highest use frequency.
–v	This option displays the execution process of the section file generator.
*@cfil*e	This option handles *cfile* as a command file (refer to page 161). If this option is omitted, it is assumed that no command file has been specified.

Caution:

Some of the above options are invalid if specified with the other options at the same time.

- If two or more options related to sorting, -o and -cl, are specified, the one specified later is valid and the others are invalid.
- If -V, -h, and -help are specified at the same time, the one specified first is valid, and the others are invalid.
- If -O and an option related to sorting are specified at the same time, -O is valid and the option related to sorting is invalid.

[Contents of comments of sf]

sf outputs comments in the section file as default assumption. The detail level of the comment can be specified by the -cl option.

The meanings of three data of comments output by sf are as follows.

`section`: Section to which allocation of a variable is explicitly indicated
"-" is displayed for a variable not explicitly indicated.

`size`: Size of variable (in bytes)
"0" is displayed if the size is unknown.

`frequency`: Reference frequency of variable
Indicated by the number of times the load/store instructions have appeared for the variable.

Example of section file output by sf

```
// Created by sf850. at Sat Mar  2 17:26:25 1996
[tidata]
// [file:[func:]]variable   // section size frequency
a.c:si1     // data 4 10
a.c:si2     // data 4 8
a.c:f1:sfi1 // - 4 8
i    // - 4 3
j    // - 2 1
```

2.3 Examples of Use

Here are some examples of using the sf.

- To optimize allocation of data to sections so that the .tidata section does not overflow

```
sf850 -O a.sec b.sec c.sec -o secfile
```

Frequency information files output by the C compiler, a.sec, b.sec, and c.sec are input, and the section file whose data allocation is optimized so that the memory range of the .tidata section does not overflow is output. The output file name is secfile.

- To sort variable names by size

```
sf850 -ssize a.sec b.sec c.sec
```

Frequency information files output by the C compiler, a.sec, b.sec, and c.sec are input, and the names of the variables in the section file to be output are arranged in sequence, starting from the variable smallest in size. Because no output file name is specified, the section file is output to the standard output.

CHAPTER 3 MESSAGES

This chapter explains the output messages of the sf (in alphabetical order).

The italic characters in the output messages and explanatory statements are determined during command processing.

3.1 Message Format

The sf messages are basically output in the following format.

sf: *messag*e

3.2 Messages

-cl level out of range (0-2)
The numeric value specified by the -cl option is incorrect.

cannot calculate *nam*e's frequency
The frequency of variabl*e nam*e cannot be calculated.

cannot open input file *fil*e
Input file *fil*e cannot be opened.

cannot open output file *fil*e
Output file *fil*e cannot be created.

not enough memory
The memory capacity runs short.

***optio*n option needs subargument**
Option *optio*n needs an argument.

too many input files
Too many input files are specified.

unknown option *optio*n
Option *optio*n must not be specified.

you use -O option, sorting option ignored
Because the -O option is specified, the sorting option is ignored.

[MEMO]

<APPENDIX>

APPENDIX A SECTION FILES

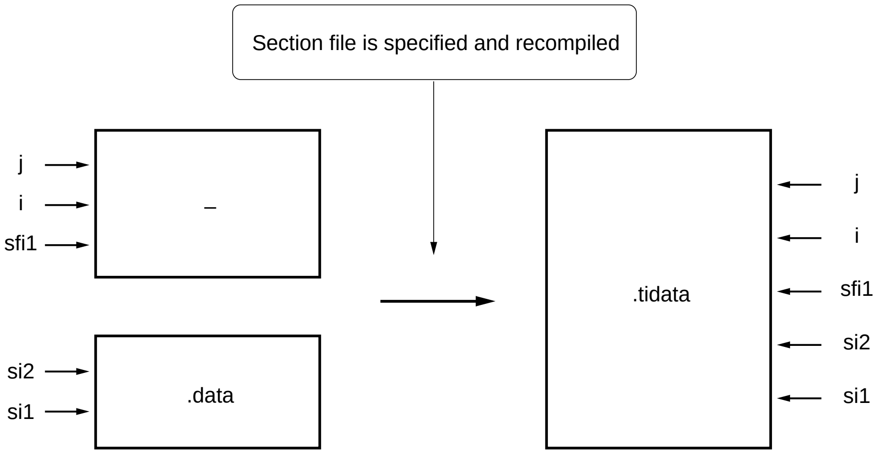
Section files are text files that are input during compilation and that revise sections used for allocating variables. An allocation specification using a section file takes priority over a #pragma section directive in a C language source program.

In the CA850, section files that are output by the sf can be used. The sf merges information from several input files and outputs a single section file as specified by the ca's options.

Example of section file output by sf[9]

```
// Created by sf850. at Sat Mar  2 17:26:25 1996
[tidata]
// [file:[func:]]variable    // section size frequency
a.c:si1     // data 4 10
a.c:si2     // data 4 8
a.c:f1:sfi1 // - 4 8
i    // - 4 3
j    // - 2 1
```

After the section file in the above example has been specified and recompiled, variables si1 and si2, which had been allocated to the .data section, and variables sfi1, i, and j, which had not been allocated to a specific section, are allocated to the .tidata section.



In the CA830, there is no sf, but like the CA850, the CA830 can use section files to revise sections.

The format of section files accepted by the ca830 and ca850 are described below along with some caution points.

[9] For the comment output levels and the meanings, refer to the description of the sf's -cl option.

Table A-1. Format of Section File

```
[Section type]
file name:  function name:  variable name   ← specification of static variable in function
file name:  variable name                   ← specification of static variable in file
variable name                               ← specification of external variable
  // comment
```

The following character strings can be specified as the section type[10].

Table A-2. Section Types Specifiable by CA830

Character String Specifying Type	Allocated Section(s)
`data`	If an initial value has been set, allocated to the .data section. If it has not been set, allocated to the .bss section.
`sdata`	If an initial value has been set, allocated to the .sdata section. If it has not been set, allocated to the .sbss section.
`sedata`	If an initial value has been set, allocated to the .sedata section. If it has not been set, allocated to the .sebss section.
`sidata`	If an initial value has been set, allocated to the .sidata section. If it has not been set, allocated to the .sibss section.
`const`	Allocated to the .const section.
`cdata1`	Allocated to the .cdata1 section.
`cdata2`	Allocated to the .cdata2 section.
`cdata3`	Allocated to the .cdata3 section.
`udata1`	Allocated to the .udata1 section.
`udata2`	Allocated to the .udata2 section.
`udata3`	Allocated to the .udata3 section.

[10] The specifiable section types are the same as the specifiable section types for the `#pragma section`. For details of each section's characteristics, refer to the description of section allocation of data in **V800 Series C Compiler Package User's Manual - C Language**.

Table A-3. Section Types Specifiable by CA850

Character String Specifying Type	Allocated Section(s)
`tidata`	The byte data with the initial value set is allocated to the .tidata.byte section. The data that is more than a half word with the initial value set is allocated to the .tidata.word section. The byte data not setting the initial value is allocated to the .tibss.byte section. The data that is more than a half word not setting the initial value is allocated to the .tibss.word section.
`data`	If an initial value has been set, allocated to the .data section. If it has not been set, allocated to the .bss section.
`sdata`	If an initial value has been set, allocated to the .sdata section. If it has not been set, allocated to the .sbss section.
`sedata`	If an initial value has been set, allocated to the .sedata section. If it has not been set, allocated to the .sebss section.
`sidata`	If an initial value has been set, allocated to the .sidata section. If it has not been set, allocated to the .sibss section.
`const`	Allocated to the .const section.
`sconst`	Allocated to the .sconst section.

[Cautions]

- Do not insert blank spaces before or after a section name when specifying the section name in square brackets ([ ]).
  For example, in the case of `[tidata]`, blank spaces cannot be inserted before or after “`tidata`”.
- Only one variable can be used per line. Two or more variables must not be described on one line. Neither should one variable specification be indicated on two or more lines.
- Do not insert blank spaces before or after ‘:’.
- Do not specify the path when specifying file names.
- If a function or variable definition is included in a header file, the “file name” in the section file is not the header file name, but the C source file name that includes the header file.
- Comments in the form of “`/* */`” or “`// `” can be inserted. However, a section name or variable name must not be delimited by a comment. A blank space is necessary immediately after a variable name.
  ASCII code and EUC (Japanese) code can be used in comments.
- If a variable for which “data” has been specified as the section type in a section file is referenced by another assembler source file, use the .option pseudo-instruction[11] to specify “data” so that the assembler will be notified of the data/bss attribute.
  Also, if a variable for which “sdata” has been specified is referenced by another assembler source file, use the .option pseudo-instruction to specify “sdata” so that the assembler will be notified of the sdata/sbss attribute.

[11] Refer to **User’s Manual - Assembly Language** of each family.

Description examples

(Section file)

```
[data]
a.c:dat1              ←  With initial value, allocation is to .data section.
b.c:dat2              ←  Without initial value, allocation is to .bss section.
[sdata]
a.c:sdat1             ←  With initial value, allocation is to .sdata section.
b.c:sdat2             ←  Without initial value, allocation is to .sbss section.
```

(Assembler source file)

```
  .option data _dat1
  .text
  mov $_dat1, r11     ←  Instruction is expanded, assuming that allocation is to .data section.
  .option data _dat2
  .text
  mov $_dat2, r12     ←  Instruction is expanded, assuming that allocation is to .bss section.
  .option sdata _sdat1
  .text
  mov $_sdat1, r13    ←  Instruction is not expanded, assuming that allocation is to .sdata section.
  .option sdata _sdat2
  .text
  mov $_sdat2, r14    ←  Instruction is not expanded, assuming that allocation is to .sbss section.
```

APPENDIX B FORMAT OF OBJECT FILE

This Appendix explains the format of the object file used with this compiler package.

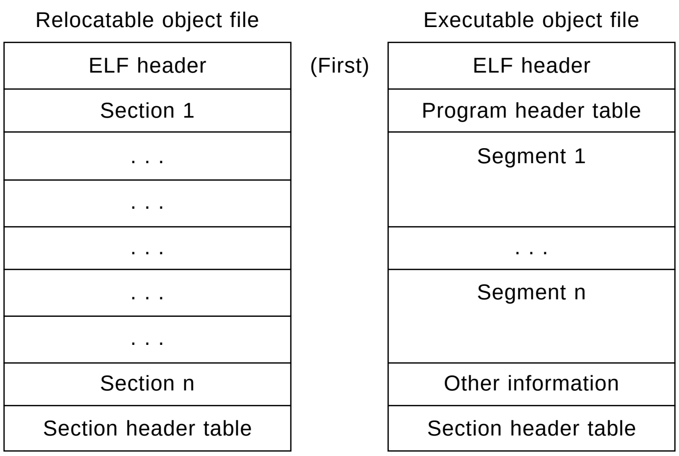
B.1 Structure of Object File

The format of the object file used with this compiler package conforms to the ELF format, which is one of the standard object file formats.

The structure of an object file in this format slightly differs between a relocatable object file and an executable object file (refer to **Figure B-1**). The relocatable object file has the information necessary for creating an executable object file, and the executable object file has the information necessary for executing the object file.

In the sections that follow, the ELF header, program header table, section header table, section, and segment, which are constituents of the object file in the ELF format, are explained.

Figure B-1. Structure of Object File



B.2 ELF Header

This section explains the ELF header that constitutes an object file in the ELF format.

The ELF header is at the beginning of the object file and has the information necessary for interpreting the object file or for accessing the other constituents included in the object file (refer to **Table B-1**).

Table B-1. Constituents of ELF Header and Their Meanings

Constituent	Meaning
ident[CLASS]	Class of this object file
ident[DATA]	Byte order of data in this object file (2MSB in big endian/2LSB in little endian)
type	Type of this object file
machine	Processor to which this object file is subjected
version	Version number of this object file
entry	Entry point address
phoff	Offset in file of program header table
shoff	Offset in file of section header table
flags	Flag peculiar to processor in which this object file runs
ehsize	Byte size of this ELF header
phentsize	Size of entry of program header table
phnum	Number of entries of program header table
shentsize	Size of entry of section header table
shnum	Number of entries of section header table
shstrndx	Section header table index of string table .shstrtab holding section name

B.3 Program Header Table

This section explains the program header table that constitutes an object file in the ELF format.

The program header table is an array of program header table entries having information on all the segments included in the object file (refer to **Table B-2**). An index[12] to this array is called a program header table index, and the program header table entries are referenced by using this program header table index.

Table B-2. Constituents of Program Header Table Entry and Their Meanings

Constituent	Meaning
type	Segment type of corresponding segment (LOAD if segment is loaded to memory/NOTE if segment has auxiliary information)
offset	Offset in file of corresponding segment
vaddr	Virtual address of corresponding segment
paddr	Physical address of corresponding segment
filesz	Size of corresponding segment on file[13]
memsz	Size of corresponding segment on memory
flags	Segment attribute of corresponding segment (R for segment that can be read/W for segment that can be written/X for executable segment)
align	Alignment condition of corresponding segment

[12] Subscript

[13] If a section having section type NOBITS (section not having an actual value in the object file) is allocated to the corresponding segment, a value different from memsz is set (refer to page 287).

B.4 Section Header Table

This section explains the section header table that constitutes an object file in the ELF format.

The section header table is an array of section header table entries having information on all the sections included in the object file (refer to **Table B-3**). An index[14] to this array is called a section header table index, and the section header table entries are referenced by using this section header table index.

Table B-3. Constituents of Section Header Table Entry and Their Meanings

Constituent	Meaning
name	Name of corresponding section (index to string table .shstrtab holding section name)
type	Section type of corresponding section (Refer to **B.4.1**.)
flags	Section attribute of corresponding section (A for section occupying memory/W for section that can be written/X for executable section/G for section that is allocated to memory range that can be referenced by using global pointer (gp) and 16-bit displacement)
addr	First address of corresponding section
offset	Offset in file of corresponding section
size	Size of corresponding section
link	Section header table index link of corresponding section (Refer to **B.4.2**.)
info	Information dependent on section type of corresponding section (Refer to **B.4.2**.)
addralign	Alignment condition of corresponding section
entsize	Size of entry of corresponding section

[14] Subscript

B.4.1 Section type

The section types indicated by constituent type of the section header table and their meanings are shown in Table B-4.

Table B-4. Section Types and Their Meanings

Section Type	Meaning
GPTAB	Global pointer table (size with first entry aligned with *num* of -G*num* specified for compiler and assembler and 0 and second entry and those that follow aligned with size and word of data)
NOBITS	Section for data not having actual value in object file (e.g., data for which no initial value is specified)
PROGBITS	Section for data having actual value in object file (e.g., data for which machine language instruction or initial value is specified)
REGMODE	Section existing in relocatable object file created by using register mode feature[15] (information on number of registers internally used by C compiler is stored)
REL[16]	Relocation information
RELA	Relocation information
SYMTAB	Symbol table (Refer to **B.5.1**.)
STRTAB	String table (Refer to **B.5.2**.)

[15] Refer to the explanation on the -reg option of the ca.

[16] This section is not used with this compiler package at present.

B.4.2 Constituents dependent on section type (link/info)

The meanings of the constituents of the section header table, link and info, that are dependent on section type type, are shown in Table B-5.

Table B-5. Meanings of link and info

Section Type	Meaning of link	Meaning of info
GPTAB	–	Section header table index of section to which corresponding data is allocated
REL[17]	Section header table index of corresponding symbol table	Section header table index of section to be relocated
RELA	Section header table index of corresponding symbol table	Section header table index of section to be relocated
SYMTAB	Section header table index of corresponding string table	Symbol table index of symbol that appears first and is not local

[17] This section type is not used by this compiler package at present.

B.5 Section

This section explains the section that constitutes an object file in the ELF format.

A section is a major constituent of the object file, containing a machine language instruction, data, symbol table, string table, debug information, and line number information as its contents.

A section satisfies the following conditions:

(1) One section header table entry corresponding to the section header table exists in each section.

(2) In some cases, a section for which only the section header table entry exists but that does not have an actual value in the object file exists (section having section type NOBITS).

(3) A section having an actual value in the object file occupies a contiguous area in the object file.

(4) A section does not share an area in the object file. In other words, there is no area that belongs to two or more sections.

B.5.1 Symbol table

This section explains the symbol table that is a type of a section.

The symbol table is a section having section type SYMTAB and is an array of symbol table entries having information on all the symbols included in the object file (refer to **Table B-6**). An index[18] to this array is called a symbol table index, and the symbol table entries are referenced by using this symbol table index[19].

Table B-6. Constituents of Symbol Table Entry and Their Meanings

Constituent	Meaning
name	Name of corresponding symbol (index to string table .strtab)
value	Value of corresponding symbol
size	Size of corresponding symbol
BIND(info)	Binding class of corresponding symbol (GLOBAL for symbol used to resolve external reference/ LOCAL for symbol not used to resolve external reference)
TYPE(info)	Type of corresponding symbol (FILE in case of normal file name/FUNC in case of function name/NOTYPE in case of undefined symbol/OBJECT in case of symbol indicating normal label/ SECTION in case of section name/DEVFILE in case of device file name)
other	–
shndx	Section header table index of section corresponding to corresponding symbol (which takes following value: ABS in case of symbol indicating constant/COMMON in case of undefined external symbol that is referenced by using global pointer (gp) and 32-bit displacement/GPCOMMON in case of undefined external symbol that is referenced by using global pointer (gp) and 16-bit displacement/UNDEF in case of undefined symbol)

[18] Subscript

[19] An entry with symbol table index 0 is reserved, and each constituent has the value of 0.

B.5.2 String table

This section explains the string table which is a type of a section.

The string table is a section having section type STRTAB and consists of a character string that ends with a null character (\0). This character string is referenced by using an index that is an offset from the beginning of the string table[20] (refer to **Figure B-2**).

The object file in the ELF format uses this character string to hold the names of symbols and sections. For example, constituent name of the section header table entry has an index to string table .shstrtab that holds a section name.

Figure B-2. Relationships between Index and Character String in String Table

Index	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0	\0	n	a	m	e	.	\0	V	a	r
10	i	a	b	l	e	\0	a	b	l	e
20	\0	\0	x	x	\0					

Index	Character string
0	*no name*
1	name.
7	Variable
11	able
16	able
24	*null string*

[20] It is stipulated that the first 1 byte expressed by index 0 is a null character.

B.5.3 Reserved section

In the ELF object file format, several sections are reserved as reserved sections. Table B-7 lists the names, section types, and section attributes of the reserved sections.

Table B-7. Reserved Sections

Name[21]	Contents	Section Type	Section Attribute
.bss	.bss section	NOBITS	AW
.cdata1	.cdata1 section	PROGBITS	AW
.cdata2	.cdata2 section	PROGBITS	AW
.cdata3	.cdata3 section	PROGBITS	AW
.const	.const section	PROGBITS	A
.data	.data section	PROGBITS	AW
.gptab*name*	Global pointer table[22]	GPTAB	None
.itext	.itext section	PROGBITS	AX
.regmode	Register mode information	REGMODE	None
.rel*name*	Relocation information	REL	None
.rela*name*	Relocation information	RELA	None
.sbss	.sbss section	NOBITS	AWG
.sconst	.sconst section	PROGBITS	A
.sdata	.sdata section	PROGBITS	AWG
.sebss	.sebss section	NOBITS	AW
.sedata	.sedata section	PROGBITS	AW
.shstrtab	String table holding section name	STRTAB	None
.sibss	.sibss section	NOBITS	AW
.sidata	.sidata section	PROGBITS	AW
.strtab	String table	STRTAB	None
.symtab	Symbol table	SYMTAB	None
.text	.text section	PROGBITS	AX
.tibss	.tibss section	NOBITS	AW
.tibss.byte	.tibss.byte section	NOBITS	AW
.tibss.word	.tibss.word section	NOBITS	AW
.tidata	.tidata section	PROGBITS	AW
.tidata.byte	.tidata.byte section	PROGBITS	AW
.tidata.word	.tidata.word section	PROGBITS	AW
.udata1	.udata1 section	PROGBITS	AW
.udata2	.udata2 section	PROGBITS	AW
.udata3	.udata3 section	PROGBITS	AW
.vdbstrtab	Symbol table for debug information	STRTAB	None
.vdebug	Debug information	PROGBITS	None
.vline	Line number information	PROGBITS	None

[21] *name* of .gptab*name*, .rel*name*, and .rela*name* indicates the names of the sections corresponding to the respective sections.

[22] Information used for the processing of the -A option of the link editor

B.6 Segment

This section explains the segment that constitutes an object file in the ELF format.

A segment is the minimum unit in which a program is loaded to memory and consists of two or more linked sections each having the same attribute (refer to page 264).

INDEX

NEC

Facsimile Message

From:

Name

Company

Tel. FAX

Address

Although NEC has taken all possible steps to ensure that the documentation supplied to our customers is complete, bug free and up-to-date, we readily accept that errors may occur. Despite all the care and precautions we've taken, you may encounter problems in the documentation. Please complete this form whenever you'd like to report errors or suggest improvements to us.

Thank you for your kind support.

North America
NEC Electronics Inc.
Corporate Communications Dept.
Fax: 1-800-729-9288
1-408-588-6130

Europe
NEC Electronics (Europe) GmbH
Technical Documentation Dept.
Fax: +49-211-6503-274

South America
NEC do Brasil S.A.
Fax: +55-11-6465-6829

Hong Kong, Philippines, Oceania
NEC Electronics Hong Kong Ltd.
Fax: +852-2886-9022/9044

Korea
NEC Electronics Hong Kong Ltd.
Seoul Branch
Fax: 02-528-4411

Taiwan
NEC Electronics Taiwan Ltd.
Fax: 02-719-5951

Asian Nations except Philippines
NEC Electronics Singapore Pte. Ltd.
Fax: +65-250-3583

Japan
NEC Corporation
Semiconductor Solution Engineering Division
Technical Information Support Dept.
Fax: 044-548-7900

I would like to report the following error/make the following suggestion:

Document title: ______________________

Document number: ______________________ Page number: ____________

____

____

____

If possible, please fax the referenced page or drawing.

Document Rating	Excellent	Good	Acceptable	Poor
Clarity	❏	❏	❏	❏
Technical Accuracy	❏	❏	❏	❏
Organization	❏	❏	❏	❏