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# **User's Manual**

## **CA850 Ver. 3.20**

### **C Compiler Package**

### **Link Directives**

---

### **Target Device V850 Series**

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## INTRODUCTION

|                       |   |
|-----------------------|---|
| <b>Target Devices</b> | The V850 Series C compiler packages create the object codes for NEC Electronics's V850 Series RISC microcontrollers.  |
| <b>Readers</b>        | This manual is intended for user engineers who wish to develop application systems using the V850 Series C compiler package.  |
| <b>Purpose</b>        | This manual explains the Link Directives specifications supported by the linker (ld850) included in the package.  |
| <b>Organization</b>   | <p>This manual contains the following information:</p> <ul style="list-style-type: none"><li>• OVERVIEW</li><li>• INSTALLATION</li><li>• STARTING AND EXITING</li><li>• GENERATION METHOD</li><li>• WINDOW REFERENCE</li><li>• MESSAGES</li></ul> |



**Related Documents**

Read this manual together with the following documents.

The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

**Documents related to development tools (user's manuals)**

| Document Name                                    |  | Document No. |
|--|--|--------------|
| CA850 Ver. 3.20 C Compiler Package               | Operation  | U18512E      |
|  | C Language                                       | U18513E      |
|  | Assembly Language                                | U18514E      |
|  | Link Directives                                  | This manual  |
| PM+ Ver. 6.30 Project Manager                    |  | U18416E      |
| ID850 Ver. 3.00 Integrated Debugger              | Operation  | U17358E      |
| ID850NW Ver. 3.10 Integrated Debugger            | Operation  | U17369E      |
| ID850QB Ver. 3.20 Integrated Debugger            | Operation  | U17964E      |
| SM+ System Simulator                             | Operation  | U17246E      |
|  | User Open Interface                              | U18212E      |
| SM850 Ver. 2.50 System Simulator                 | Operation  | U16218E      |
| SM850 Ver. 2.00 or Later System Simulator        | External Part User Open Interface Specifications | U14873E      |
| RX850 Ver. 3.20 or Later Real-Time OS            | Basics   | U13430E      |
|  | Installation                                     | U17419E      |
|  | Technical  | U13431E      |
|  | Task Debugger                                    | U17420E      |
| RX850 Pro Ver. 3.21 Real-Time OS                 | Basics   | U18165E      |
|  | Internal Structure                               | U18164E      |
|  | Task Debugger                                    | U17422E      |
| RX850V4 Ver. 4.22 Real-Time OS                   | Functionalities                                  | U16643E      |
|  | Internal Structure                               | U16644E      |
|  | Task Debugger                                    | U16811E      |
| AZ850 Ver. 3.30 System Performance Analyzer      |  | U17423E      |
| AZ850V4 Ver. 4.10 System Performance Analyzer    |  | U17093E      |
| TW850 Ver. 2.00 Performance Analysis Tuning Tool |  | U17241E      |

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# CHAPTER 1 OVERVIEW

## 1.1 Functional Outline

In an embedded application system, many considerations must be given in allocating memory in order to satisfy the specifications of the target device, such as allocating program codes and data to or separating them from certain addresses.

The Link Directive Generator (LDG) is a tool that automatically generates or edits a link directive file through a GUI in which such memory allocation information (including section information) is described.

By using the functions of the LDG that visually display the address space of the target device and image of allocation of the addresses of the executable object file output by a linker, a link directive file can be generated and edited smoothly and efficiently.

The major functions of the LDG are as follows:

- **Graphical mapping display**

Graphically displays the physical memory mapping and section mapping of the target device to be used, object file names included in each section, and the section-related symbol names, as one view.

- **Automatic generation/editing of link directive file through GUI operation**

By dragging a section name, object file name, or symbol name with the mouse, allocation and assignment of it can be visually edited.

- **Re-editing/updating existing link directive file**

A link directive file that was created by a tool other than the LDG can also be read.

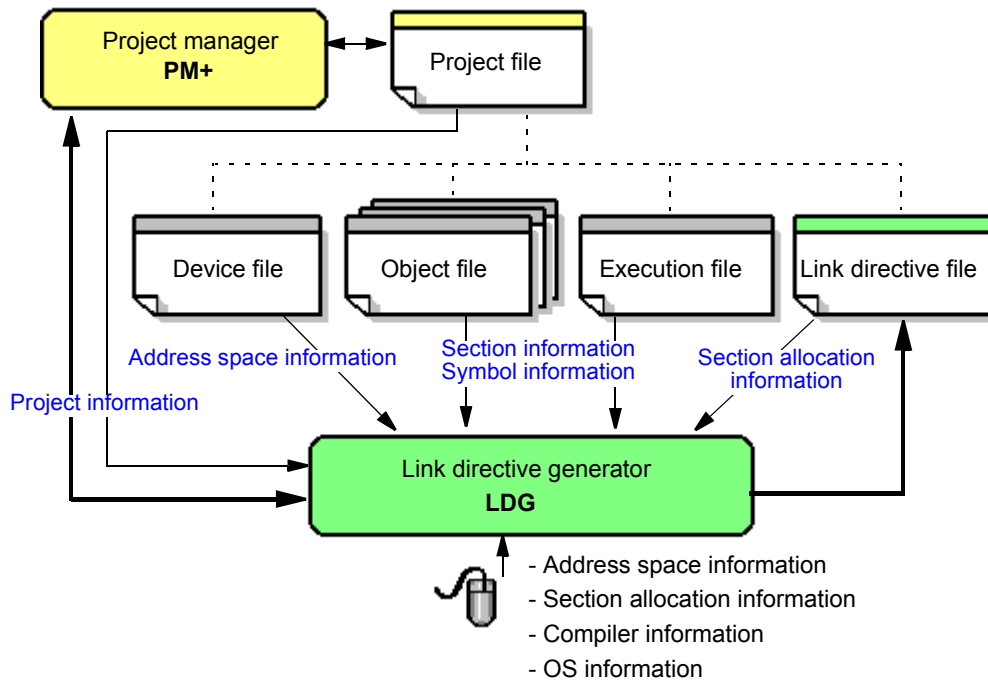


## 1.2 System Configuration

The LDG obtains address space information from a device file, and section information/symbol information from an object file/execution file (ELF format).

An example of the system configuration of the LDG is illustrated below.

Figure 1-1 System Configuration Example



**[Remark]** The LDG can also operate by itself, without coordinating with the PM+.

## 1.3 Operating Environment

The following environments are required in order to use LDG.

### (1) Host machine

|        |   |
|--------|---|
| CPU    | : Pentium II™ 400MHz or higher                                    |
| Memory | : 128 Mbytes or more  |
| OS     | : Windows® 2000, Windows XP Professional, Windows XP Home Edition |

**[Caution]** Regardless of which OS is used, higher and the latest Service Pack must be installed.

### (2) Software

- Compiler  
CA850 Ver.3.00 or later
- Device file  
Device file of the target device to be used
- Development tool (if necessary)  
PM+ Ver.6.00 or later

## CHAPTER 2 INSTALLATION

### 2.1 Installing LDG

LDG is included with a compiler package (CA850).

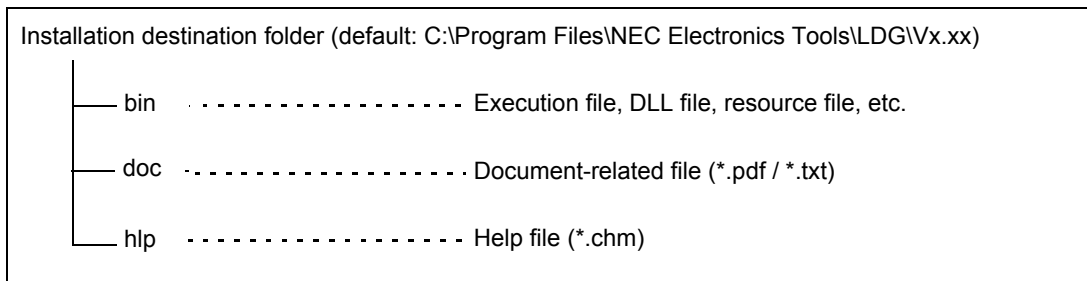
When CA850 is installed, LDG can be also installed if necessary, as it is supplied in the same package.

For the details on how to install the CA850, refer to "CA850 C Compiler Package Operation User's Manual".

### 2.2 Folder Configuration

The folders are configured as a result of installing the LDG are as follows.

Figure 2-1 Folder Configuration



A shortcut for the LDG (default: [Program] -> [NEC Electronics Tools] -> [LDG] -> [Vx.xx] -> [LDG Vx.xx]) is automatically added to the Windows start menu.

### 2.3 Uninstalling LDG

To uninstall LDG, start "Add or Remove Programs" ("Add/Remove Programs" in Windows other than Windows XP) on the Control Panel of Windows and select the following items.

- NEC EL LDG Vx.xx
- NEC EL LDG Vx.xx Documents

## CHAPTER 3 STARTING AND EXITING

### 3.1 Starting LDG

The LDG can be started in the following three ways.

**(1) Starting from the shortcut in the Windows start menu**

Select Windows start menu -> [Program] -> [NEC Electronics Tools] -> [LDG] -> [Vx.xx] -> [LDG vx.xx] (default).

**(2) Starting from PM+**

Select the [Tool] menu -> [Startup LDG] from the main window of the PM+.

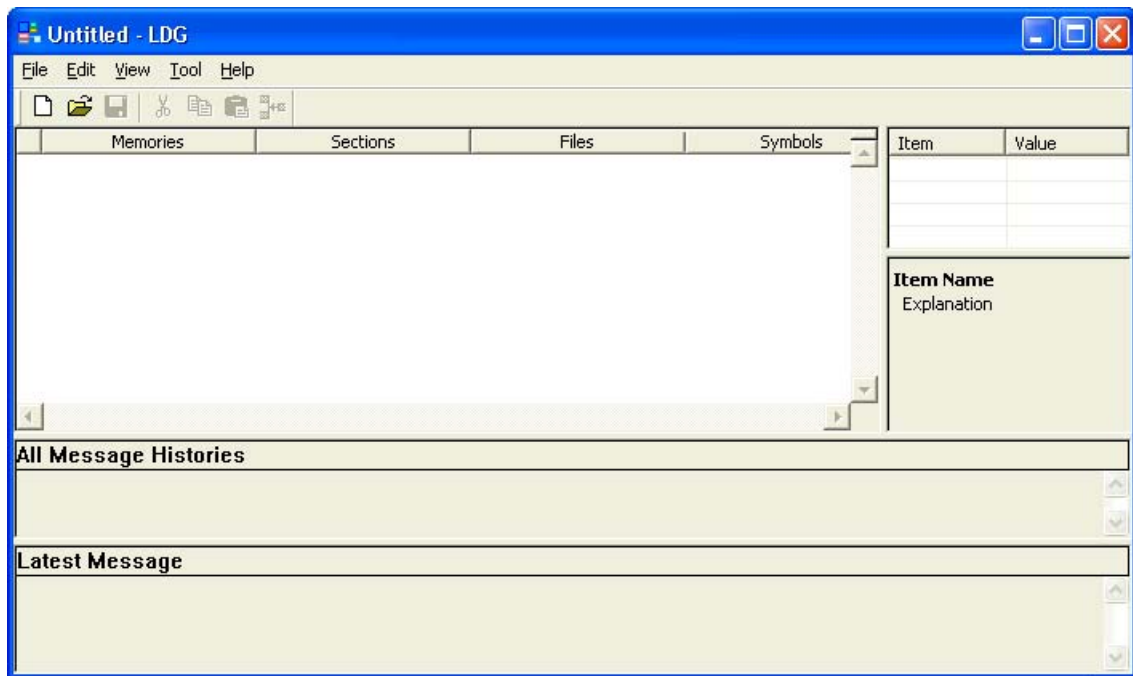
**(3) Double-clicking execution file of LDG**

Directly double-click the execution file of the LDG as follows:

C:\Program Files\NEC Electronics Tools\LDG\Vx.xx\bin\LDG.exe (default)

When the LDG is started, the following [Main window](#) is opened.

Figure 3-1 Main Window on Starting LDG



**[Caution]** If the LDG is not started from PM+, "project information" (information of object files, etc., that configure a project) set on PM+ cannot be used with the LDG.

### 3.2 Exiting

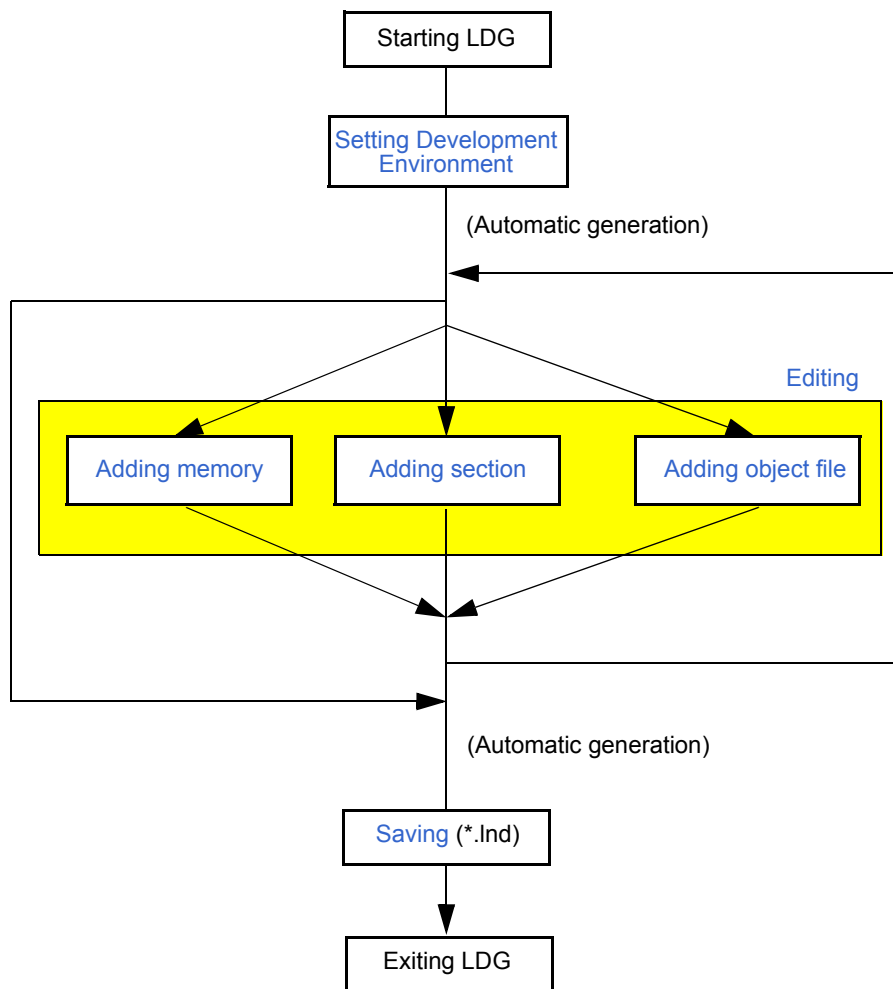
To exit the LDG, select the [File] menu -> [Exit] from the [Main window](#).

# CHAPTER 4 GENERATION METHOD

## 4. 1 Generation Procedure

The procedure to generate a link directive file by using the LDG is illustrated below.

Figure 4-1 Generation Procedure of Link Directive File



## 4. 2 Setting Development Environment

Set the development environment of the link directive file to be created or edited.

### 4. 2. 1 Creating new link directive file

Create a new link directive file in the following procedure.

**(1) Select [File] menu -> [New...].**

Open the [\[New Link Directive\] dialog box](#) by selecting the [File] menu -> [New...] from the [Main window](#).

**(2) Set the details of the development environment.**

Specify the name of the device and compiler to be used, and, as necessary, the name of the real-time OS.

**(3) Click [OK] button.**

After completing the necessary setting, click the [OK] button.

The internal ROM/RAM area corresponding to the specified device and allocation of sections that are absolutely necessary and sections necessary for the real-time OS will be reflected in the [Main window](#).

**[Remark]** If the LDG is started from PM+, the [\[New Link Directive\] dialog box](#) is opened with the development environment of PM+ (project information) reflected.

### 4. 2. 2 Editing existing link directive file

Edit an existing link directive file that was created with a tool other than the LDG in the following procedure.

**(1) Select [File] menu -> [Open...].**

Open the [\[Open\] dialog box](#) by selecting the [File] menu -> [Open...] from the [Main window](#), and select a link directive file to be edited.

**(2) Set the details of the development environment.**

Next, specify the name of the device and the name of the compiler to be used in the [\[Select Development Environment\] dialog box](#) that is automatically opened.

**(3) Click [OK] button.**

After completing the necessary setting, click the [OK] button.

The internal ROM/RAM area corresponding to the specified device and allocation of sections that are absolutely necessary and sections necessary for the real-time OS will be reflected in the [Main window](#).

**[Remark]** If the LDG is started from PM+, a link directive file is opened with the development environment of PM+ (project information) automatically reflected (the [\[Select Development Environment\] dialog box](#) is not opened).

## 4. 3 Editing

### 4. 3. 1 Adding memory

If a memory other than the internal memory of the device is to be used, add the new memory in the following procedure.

**(1) Select [Edit] menu -> [Add] -> [Memory].**

Open the [\[Add Memory\] dialog box](#) by selecting the [Edit] menu -> [Add] -> [Memory] from the [Main window](#).

**(2) Set detailed information for the memory.**

Specify the type (ROM/RAM), start address, size, and alignment of the memory to be newly added, and then click the [OK] button.

### 4. 3. 2 Adding section

Allocate a new section, if necessary, in the following procedure.

**(1) Select [Edit] menu -> [Add] -> [Section].**

Select a memory to which a new section is to be allocated in the [Memory mapping view area](#) in the [Main window](#), and open the [\[Add Section\] dialog box](#) by selecting the [Edit] menu -> [Add] -> [Section].

**(2) Set detailed information for the section.**

Set the access type (read only, read write, or instruction code), section name, allocation method (address specification or allocating following preceding section) to be newly added, and then click the [OK] button.

**[Remark]** If sections are allocated in overlapping areas, allocate the additional section in the mirror area.

The mirror area can be displayed by checking the [View] menu -> [Show Mirror Image] (this is checked by default).

### 4. 3. 3 Adding object file

Add an object file (\*.o) or execution file (\*.out) to be linked in the following procedure.

The LDG reads section information from a specified object file and allocates it to the memory. It also checks the size of the section.

**(1) Select [File] menu -> [Select Object(s)...].**

Open the [\[Open\] dialog box](#) by selecting the [File] menu -> [Select Object(s)...] from the [Main window](#), select an object file (\*.o) or execution file (\*.out) to be linked, and then click the [OK] button.

Two or more object files may be selected.

## 4. 4 Saving

When all of the editing has been completed, save the link directive file in the procedure below.

The LDG saves the link directive file, appending information on the added memory and section.

**(1) Select [File] menu -> [Save As...].**

Open the [\[Save As\] dialog box](#) by selecting the [File] menu -> [Save As...] from the [Main window](#), specify the name of the file to be saved (\*.Ind), and then click the [OK] button.

### 4. 4. 1 Format of link directive file

To the link directive file generated by the LDG, device information, memory information, and comments are added in the comment format.

The character codes are stored as "shift JIS codes" and the carriage return code is stored as "CR+LF".

**[Caution]** If the device information or memory information the LDG has output to the link directive file is edited, the link directive file may not be correctly read.

**[Remark]** Information peculiar to the LDG is not added to a link directive file if the check is removed from the [Output LDG Information] check box in the [\[Save As\] dialog box](#) when the file is generated.



## CHAPTER 5 WINDOW REFERENCE

### 5.1 Overview of Window and Dialog Boxes of LDG

The LDG has the following window and dialog boxes.

Table 5-1 Window and Dialog Boxes of LDG

| Window/Dialog Box                           | Functional Outline  |
|---|---|
| Main window                                 | This window is used for basic operation of the LDG.<br>In this window, the physical memory mapping and section mapping of the target device, object file names included in each section, and related symbol names are displayed and edited. |
| [New Link Directive] dialog box             | Generates a new link directive file.  |
| [Select Development Environment] dialog box | Sets a new environment if an existing link directive file that has been created by a tool other than the LDG is opened.   |
| [Open] dialog box                           | Specifies a file to be read by the LDG.   |
| [Save As] dialog box                        | Saves edited file, giving a name to it.   |
| [Find] dialog box                           | Searches a memory name, section name, or object file name, or searches a character string in a message output by the LDG.   |
| [Select Object File] dialog box             | Adds a new object file.   |
| [Add Memory] dialog box                     | Adds a new memory.  |
| [Add Section] dialog box                    | Adds a new section.   |
| [Add Symbol] dialog box                     | Adds a new symbol.  |
| [Option] dialog box                         | Makes basic setting related to operation and display of the LDG.  |

## 5. 2 Explanation of Window and Dialog Boxes

This section explains the window and dialog boxes of the LDG in the following format.

### Window/dialog box name

The name of the window or dialog box is shown in the frame.

The display image and functional outline of the window or dialog box, and how to open the window or dialog box are explained here.

#### Explanation of each area

Each area of the window or dialog box is explained.

#### Menubar

Menu items that can be pulled down from the concerned item on the menu bar are enumerated and each function is explained.

#### Toolbar

The function of each button on the toolbar is explained.

#### Function buttons

The operation of each button in the dialog box is explained.

#### Others

The special functions of the window or dialog box, if any, and how to use those functions are explained.

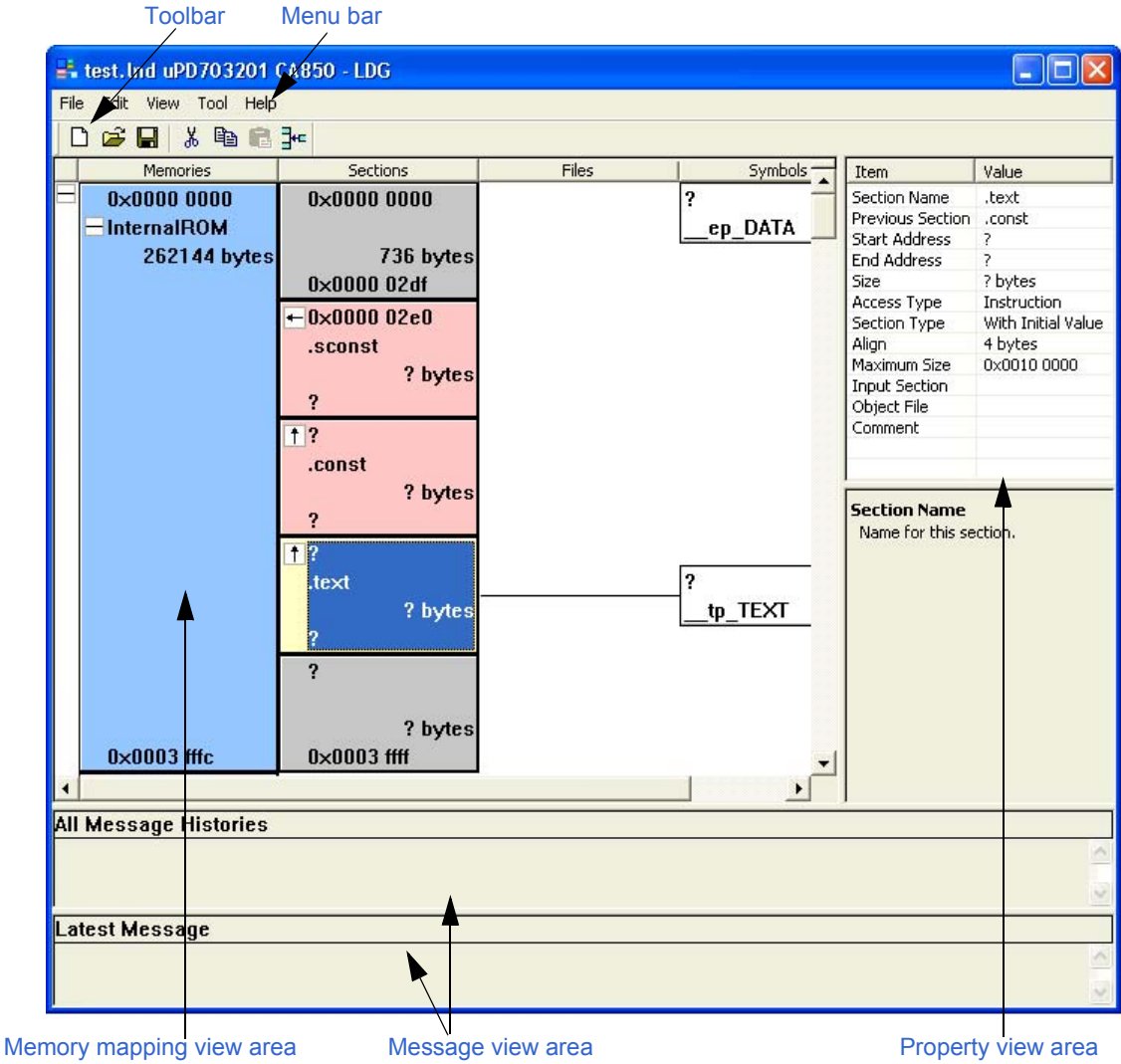
#### Note on operation

Points to be noted when operating the window or dialog box are enumerated.

# Main window

This window is automatically opened when the LDG has been started. To use the LDG, start operation from this window.

Figure 5-1 Main Window



The following items are explained below.

- Memory mapping view area
  - (1) Displayed contents of each item
  - (2) Editing through keyboard operation
- Property view area
- Message view area
- Menu bar
  - (1) [File] menu
  - (2) [Edit] menu
  - (3) [View] menu
  - (4) [Tool] menu
  - (5) [Help] menu
- Toolbar

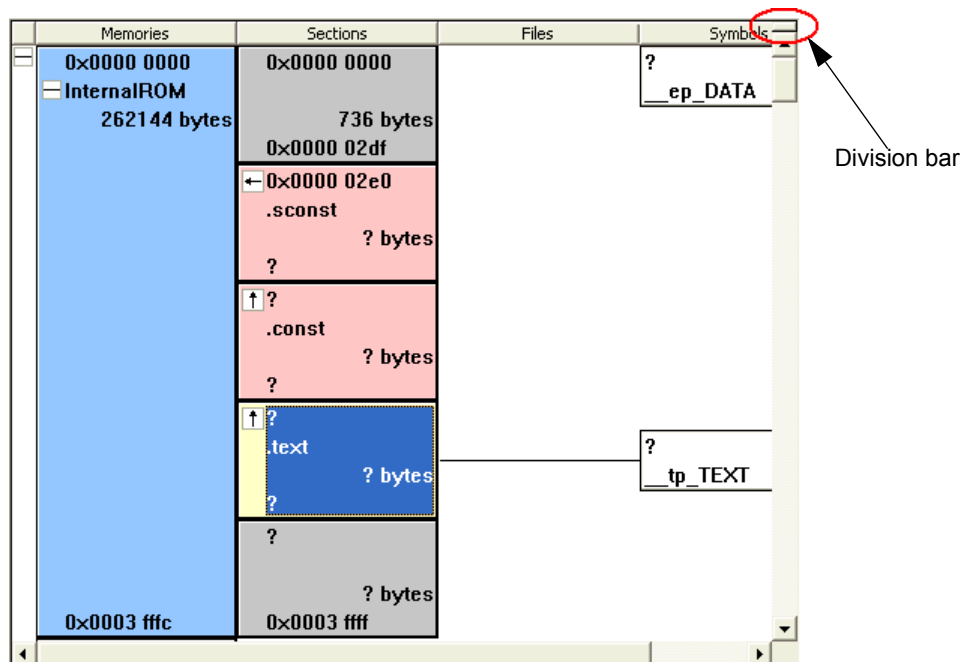
## Memory mapping view area

This area is used to display and edit the physical memory mapping and section mapping of the target device, and object file name included in each section and related symbol name.

The view area can be divided into two parts, upper and lower, by dragging the division bar at the upper part of the vertical scroll bar.

In this area, all the addresses are displayed as hexadecimal numbers. If an address is of less than the specified number of digits, it is padded with "0". One blank is inserted in every 4 digits.

Figure 5-2 Example of Memory Mapping View Area



**(1) Displayed contents of each item****(a) Memory display**

Each memory of each attribute is displayed as a box. In each box, a memory name, size, start address, and end address are displayed.

If a box is clicked, that memory is selected. The detailed information of the selected memory is displayed in the [Property view area](#).

If the mouse cursor is moved onto a memory name, the detailed information of that memory pops up for display (the displayed contents are the same as those displayed in the property view area). The pop-up display time can be changed in the [\[Option\] dialog box](#).

Figure 5-3 Example of Displayed Contents of Memory

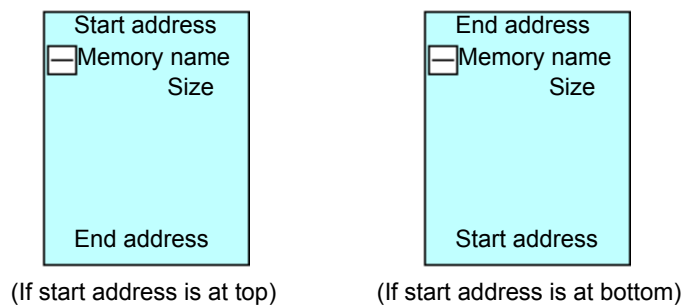


Table 5-2 Displayed Contents of Memory

| Item          | Description  |
|---------------|--|
| Memory name   | Displays a name to identify the memory.  |
|               | These marks are displayed on the left of the memory name if a section is allocated to the memory. "+" mark indicates that the allocated sections are not displayed, and "-" mark indicates that the sections are displayed.  |
|               | By clicking these marks, it can be specified whether the allocated sections are to be displayed or not.  |
| Size          | Displays the size (bytes) of the memory.<br>By default, the size is displayed as a decimal number. It can also be displayed as a hexadecimal number with "0x" prefixed by either of the following methods.<br>- Select [Show Size With Hex] on the context menu that is displayed when the right mouse button is clicked in the box.<br>- Select the box and select [View] menu -> [Show Size With Hex]. |
| Start address | Displays the start address of the memory area as a hexadecimal number with "0x" prefixed.  |
| End address   | Displays the end address of the memory area as a hexadecimal number with "0x" prefixed.  |

If the address space of the target device has mirror images, each mirror image area is displayed as follows.

Figure 5-4 Example of Displayed Contents of Mirror Image (If Each Memory Is Not Displayed)

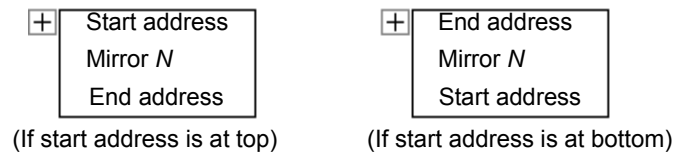




Table 5-3 Displayed Contents of Mirror Image Area







| Item  | Description   |
|---|---|
| Mirror <i>N</i>   | "N" indicates the number (from 0) of a mirror image.  |
|  | These marks indicate whether each memory in the mirror image is displayed. "+" mark indicates that the memory in the mirror image is not displayed, and "-" mark indicates that the memory in the mirror image is displayed. By clicking these marks, it can be selected whether each memory in the mirror image is displayed or not. |
|  |   |
| Start address   | Displays the start address of the mirror image area as a hexadecimal number with "0x" prefixed.   |
| End address   | Displays the end address of the mirror image area as a hexadecimal number with "0x" prefixed.   |

**[Remark]** It can be specified whether the mirror image is to be displayed or not by selecting the [View] menu -> [Show Mirror Image] or [Whole] in the [\[Option\] dialog box](#).

The background color of each box indicates the attribute of the memory.

The relationship between the memory attribute and background color is as follows (default).

Table 5-4 Relationship Between Memory Attribute and Background Color (Default)

| Background Color  | Attribute                             |
|---|---------------------------------------|
|  | External ROM                          |
|  | External RAM                          |
|  | Vacant area                           |
|  | Area where memory cannot be allocated |
|  | Internal ROM                          |
|  | Internal RAM                          |

**[Remark]** The background color and character color of the box can be specified by using [Color] of the [\[Option\] dialog box](#).

**(b) Section display**

A section of each attribute is displayed as a box. In each box, a section name, size, start address, and end address are displayed.

If a box is clicked, that section is selected. The detailed information of the selected section is displayed in the [Property view area](#).

If the mouse cursor is moved onto a section name, the detailed information of that section pops up for display (the displayed contents are the same as those displayed in the property view area). The pop-up display time can be changed in the [\[Option\] dialog box](#).

Figure 5-5 Example of Displayed Contents of Section

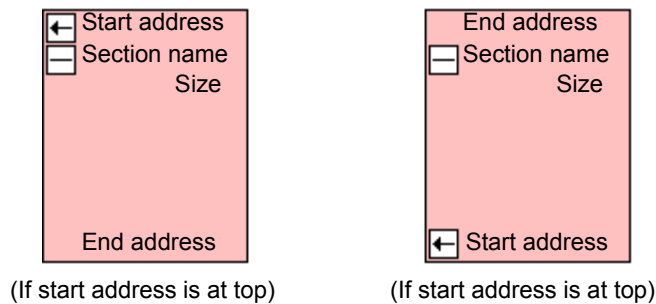






Table 5-5 Displayed Contents of Section

| Item  | Description   |
|---|---|
| Section name  | Displays a section name.  |
|  | These marks are displayed on the left of the section name if an object file is read. "+" mark indicates that the target object file are not displayed, and "-" mark indicates that the target object files are displayed.   |
|  | By clicking these marks, it can be specified whether the target object files are to be displayed or not.  |
| Size  | Displays the size (bytes) of the section.<br>By default, the size is displayed as a decimal number. It can also be displayed as a hexadecimal number with "0x" prefixed by either of the following methods.<br>- Select [Show Size With Hex] on the context menu that is displayed when the right mouse button is clicked in the box.<br>- Select the box and select the [View] menu -> [Show Size With Hex]. |
| Start address   | Displays the start address of the section as a hexadecimal number with "0x" prefixed.<br>If the section is allocated following the preceding section, the start address is displayed in "( )".  |
|  | If the section starts from the start address, this mark is displayed to the left of the start address.  |
|  | If the section follows the preceding section, this mark is displayed to the left of the start address.  |
| End address   | Displays the end address of the section as a hexadecimal number with "0x" prefixed.<br>If the section is allocated following the preceding section, the end address is displayed in "( )".  |

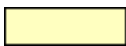




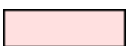
**[Caution]** "?" is displayed instead of the item concerned in the following cases.

- [Size] if the size of the section cannot be obtained
- [Start address] and [End address] if the size of the section cannot be obtained and if the section is allocated following other section
- Size of the contiguous sections adjacent in the direction of the start address or [Size] and [Start address] of a vacant area if the start address is not determined

The background color of each box indicates the attribute of the section.

The relationship between the section attribute and background color is as follows (default).

Table 5-6 Relationship Between Section Attribute and Background Color (Default)

| Background Color   |  | Attribute                |
|--|--|--------------------------|
|  | In Mirror Image  |                          |
|   |   | Instruction code         |
|   |   | Vacant area              |
|  |  | Section other than above |

**[Remark]** The background color and character color of the box can be specified by using [Color] of the [\[Option\] dialog box](#), according to a section type (with or without initial value) or an access type.

### (c) Object file display

The object file names included in each section are displayed in a box.

When an object file name is clicked, that object file is selected. The detailed information of the selected object file is displayed in the [Property view area](#).

If the mouse cursor is moved onto an object file name, the detailed information of that object file pops up for display (the displayed contents are the same as those displayed in the property view area). The pop-up display time can be changed in the [\[Option\] dialog box](#).

Figure 5-6 Example of Displayed Contents of Object File

Object file name 1  
 Object file name 2  
 Object file name 3  
 Object file name 4

**[Caution]** The sequence of displaying the object file affects the sequence of the resolving link.



**(d) Symbol display**

Symbol names related to a section are displayed in a box.

Symbols are displayed only when the linker can generate symbols related to a section.

Each symbol is displayed connected to the related memory and section with lines. A symbol related to two or more memories or sections is displayed connected to those memories and sections with lines.

A symbol that starts from the break of a memory or a section is displayed with the top and bottom sides of the box indicating the memory or section connected with a line.

Figure 5-7 Example of Displayed Contents of Symbol

|             |
|-------------|
| Address     |
| Symbol name |

Table 5-7 Displayed Contents of Section

| Item        | Description   |
|-------------|---|
| Address     | Displays the address of the symbol. If the address cannot be obtained, however, "?" is displayed. If the address of the symbol can be obtained, this box is displayed where the address is. If the address cannot be obtained, it is displayed at the center right of the box of the related memory or section. |
| Symbol name | Displays the name of the symbol.  |

**(2) Editing through keyboard operation****(a) Editing through keyboard operation**

The contents of each item in a memory or section can be directly edited through keyboard input by performing the following operation.

**[Operation]**

Click a box indicating a memory or section. The box will be selected. If an item in the box is clicked in this status again, it can be directly edited.

**[Determining new value]**

A new value is determined when the [Enter] key is pressed or when the item is unselected.

If an illegal value is specified, however, the selection cannot be canceled. In this case, a message is displayed in the [Message view area](#).

The items that can be edited by the above operation and the points to be noted in doing so are listed below.

Table 5-8 Items That Can Be Directly Edited in Mapping View Area and Notes

| Item           | Note  |
|----------------|---|
| <b>Memory</b>  |   |
| Memory name    | The first character must be an alphabetic character.<br>The second character and those that follow must be alphanumeric characters.   |
| Size           | <ul style="list-style-type: none"> <li>- [End address] is changed as necessary.</li> <li>- If the size of memory is reduced, a vacant area is displayed between the memory area of the end address and the adjacent memory area.</li> <li>- If a memory area that overlaps the higher address does not exist after editing, the [Start address] of vacant area is changed.</li> <li>- If a memory area that overlaps the higher address exists after editing, the change is not applied and a message is displayed in the message area.</li> </ul>                |
| Start address  | If the memory area overlaps another memory area as a result of editing, the change is not applied and a message is displayed in the message area.   |
| End address    | <ul style="list-style-type: none"> <li>- [Size] is changed in accordance with the change.</li> <li>- If the lower end address is specified, a vacant area is displayed between the memory area of the end address and the adjacent memory area.</li> <li>- If a memory area that overlaps the higher address does not exist after editing, the [Start address] of vacant area is changed.</li> <li>- If a memory area that overlaps the higher address exists after editing, the change is not applied and a message is displayed in the message area.</li> </ul> |
| <b>Section</b> |   |
| Section name   | None  |
| Start address  | If the section area overlaps another section area as a result of editing, the change is not applied and a message is displayed in the message area.   |

**[Caution]** The values of the internal memory, vacant area, and memory non-allocatable area (such as SFR area) cannot be changed by editing (information of the internal memory is obtained from the device file).

#### (b) Editing via a mouse

The allocation and assignment of the memory, section, object file, and symbol can be visually edited via following function using the mouse operation.

- [Use of context menu](#)
- [Use of drag-and-drop function](#)

#### - Use of context menu

If each box for a memory or section, or an object file name is clicked by the right mouse button, the memory, section, or object file at the clicked position is selected, and the following context menu is displayed.

#### [Memory]

|                              |   |
|------------------------------|---|
| [Show Size With <u>H</u> ex] | Checked : Displays [Size] as a hexadecimal number.<br>Not checked : Displays [Size] as a decimal number (default).  |
| [C <u>u</u> t]               | Cuts the selected memory.<br>At this time, information of the [Start address] and [End address] of the memory that has been cut is lost.<br>However, this item cannot be selected if a vacant memory area is selected.  |
| [C <u>o</u> py]              | Copies the selected memory to the copy buffer.<br>At this time, information of the [Start address] and [End address] of the memory that has been copied is lost.<br>However, this item cannot be selected if a vacant memory area is selected.  |
| [P <u>a</u> ste]             | To paste a memory, the memory must be pasted immediately next to the lower address of the selected memory (if a vacant memory area is selected, paste the memory to the [Start address] of that area).<br>To paste a section, allocate the section in the selected memory.<br>If a memory or section is not copied to the copy buffer, however, this item cannot be selected. |
| [Add <u>M</u> emory...]      | Opens the <a href="#">[Add Memory] dialog box</a> .   |
| [Add <u>S</u> ection...]     | Opens the <a href="#">[Add Section] dialog box</a> .  |
| [Add Sym <u>b</u> ol...]     | Opens the <a href="#">[Add Symbol] dialog box</a> .   |
| [D <u>e</u> lete]            | Deletes the selected memory.<br>However, this item cannot be selected if a vacant memory area is selected.  |

**[Section]**

|                      |   |
|----------------------|---|
| [Show Size With Hex] | Checked : Displays [Size] as a hexadecimal number.<br>Not checked : Displays [Size] as a decimal number (default).  |
| [Cut]                | Cuts the selected section.<br>At this time, information of the [Start address] and [End address] of the section that has been cut is lost.  |
| [Copy]               | Copies the selected section to the copy buffer.<br>At this time, information of the [Section name], [Start address], and [End address] of the section that has been copied is lost.<br>However, this item cannot be selected if a vacant memory area is selected.   |
| [Paste]              | To paste a section, the section must be pasted immediately next to the lower address of the selected section (if a vacant area is selected, paste the section to the [Start Address] of that area).<br>To paste an object file, paste the object file to the selected section.<br>If a section or an object file is not copied to the copy buffer, however, this item cannot be selected. |
| [Add Memory...]      | Opens the <a href="#">[Add Section] dialog box</a> .  |
| [Add Section...]     | Opens the <a href="#">[Select Object File] dialog box</a> .   |
| [Add Symbol...]      | Opens the <a href="#">[Add Symbol] dialog box</a> .<br>gp and tp symbols can be generated (a new ep symbol cannot be generated because only one ep symbol can be generated).  |
| [Delete]             | Deletes the selected section from the memory.<br>However, this item cannot be selected if a vacant memory area is selected.   |
| [Group]              | Groups two or more of the selected sections (treats them as segments).<br>However, this item cannot be selected if two or more sections are not selected.   |
| [Ungroup]            | Cancels grouping of sections.<br>However, this item cannot be selected if grouped sections are not selected.  |

**[Object file]**

|                         |  |
|-------------------------|--|
| [Show Size With Hex]    | Checked : Displays [Size] as a hexadecimal number.<br>Not checked : Displays [Size] as a decimal number (default).   |
| [Cut]                   | Cuts the selected object file.   |
| [Copy]                  | Copies the selected object file to the copy buffer.  |
| [Paste]                 | Pastes an object file.<br>If an object file is not copied to the copy buffer, however, this item cannot be selected. |
| [Select Object File...] | Opens the <a href="#">[Select Object File] dialog box</a> .  |
| [Delete]                | Deletes the selected object file from the section.   |

**- Use of drag-and-drop function**

Each box of a memory or section, or an object file name can be dragged and dropped by using the mouse.

Table 5-9 Editing by Drag-and-Drop Operation

| Dragging Source  | Dropping Destination | Operation  |
|------------------|----------------------|--|
| Memory           | Memory               | <ul style="list-style-type: none"> <li>- Deletes the memory at the dragging source and allocates it before the memory at the dropping destination.</li> <li>However, the internal ROM and RAM cannot be dropped.</li> </ul>  |
| Section          | Memory               | <ul style="list-style-type: none"> <li>- Deletes a section dragged from the memory at the dragging source and allocates it to the memory at the dropping destination.</li> </ul>   |
|                  | Section              | <ul style="list-style-type: none"> <li>- Allocates the section at the dragging source before the section at the dropping destination.</li> </ul>   |
| Object file name | Section              | <ul style="list-style-type: none"> <li>- If a section of the same attribute is at the dropping destination, deletes the dragged object file and allocates it to the section at the dropping destination.</li> <li>- If a section with a different attribute is at the dropping destination, the dragged object file is not deleted and allocated to the section at the dropping destination.</li> </ul>  |
|                  | Object file name     | <ul style="list-style-type: none"> <li>- If an object file with the same attribute is at the dropping destination, the dragged object file is deleted and allocated to the section at the dropping destination.</li> <li>- If an object file with a different attribute is at the dropping destination, the dragged object file is not deleted and allocated to the section at the dropping destination.</li> <li>- If the object file is dropped to other file name on the same section, it is moved from the dragging source position to the dropping destination position. The order in which object files are displayed here affects the order of resolution when the linker is executed.</li> </ul> |
| Symbol           | Section              | <ul style="list-style-type: none"> <li>- If the symbol at the dragging source is generated, related to two or more sections, the section at the dropping destination is added to the relation of the symbol.</li> <li>- If the symbol at the dragging source is generated, related to a single section, the relation of the symbol is switched to the section at the dropping destination.</li> </ul> <p><b>[Target]</b> tp symbol and gp symbol</p>   |

**[Caution]** The tp symbol can be dropped only to a section of text attribute, and the gp symbol can be dropped only to a section with a data attribute.

The ep symbol cannot be dropped because the address cannot be resolved, related to a section or memory other than SIDATA and internal RAM.

**[Remark]** Two or more memories, sections, and object files can be selected.

If items are clicked with the [Ctrl] key held down, the clicked items are selected one after another. If an item is selected and another item is clicked with the [Shift] key held down, the items from the item selected first to the one that is clicked are selected.

## Property view area

This area is used to display or edit the detailed information of an item (memory, section, or object file) selected in the [Memory mapping view area](#).


The detailed setting not displayed in the Memory mapping view area can be directly edited in this area.

Figure 5-8 Property View Area (When Section Is Selected)

| Item             | Value              |
|------------------|--------------------|
| Section Name     | .text              |
| Previous Section | .const             |
| Start Address    | ?                  |
| End Address      | ?                  |
| Size             | ? bytes            |
| Access Type      | Instruction        |
| Section Type     | With Initial Value |
| Align            | 4 bytes            |
| Maximum Size     | 0x0010 0000        |
| Input Section    |                    |
| Object File      |                    |
| Comment          |                    |

|                        |
|------------------------|
| <b>Section Name</b>    |
| Name for this section. |



Explanation and notes on the selected item are displayed.

The displayed contents of the item selected in the Memory mapping view area, and whether the item can be edited are shown below.

Table 5-10 Displayed Contents in Property View Area and Editing Availability (When Memory Is Selected)

| Selected Item | Displayed Contents  | Editing Availability |
|---------------|---|----------------------|
| Memory        | Memory Name (The first character must be alphabetic and the second character and those that follow must be alphanumeric.) | OK                   |
|               | Start Address   | OK                   |
|               | End Address   | OK                   |
|               | Size  | OK                   |
|               | Type (ROM, RAM, vacant area, or memory non-allocatable area)  | OK                   |
|               | Align (1 byte, 2 bytes, 4 bytes, or 8 bytes)  | OK                   |
|               | Comment   | OK                   |

**[Caution]** The values of internal memory, vacant area, and memory non-allocatable area (such as an SFR area) cannot be directly changed by editing (information of the internal memory is obtained from the device file).

Table 5-11 Displayed Contents in Property View Area and Editing Availability (When Section Is Selected)

| Selected Item            | Displayed Contents   | Editing Availability |
|--------------------------|--|----------------------|
| Section<br>(not grouped) | Section Name   | OK                   |
|                          | Preceding section (preceding section name or none)                   | OK                   |
|                          | Start Address<br>"?" is displayed if no start address is determined. | OK                   |
|                          | End Address<br>"?" is displayed if no end address is determined.     | -                    |
|                          | Size<br>"?" is displayed if no size is determined.                   | -                    |
|                          | Access Type (instruction code, read only, or read/write)             | OK                   |
|                          | Section Type (with initial value or without initial value)           | OK                   |
|                          | Align (1 byte, 2 bytes, 4 bytes, or 8 bytes)                         | OK                   |
|                          | Maximum Size   | OK                   |
|                          | Input Section  | OK                   |
|                          | Object File  | -                    |
|                          | Comment  | OK                   |

Table 5-12 Displayed Contents in Property View Area and Editing Availability (When Group Is Selected)

| Selected Item                                      | Displayed Contents  | Editing Availability |
|--|---|----------------------|
| Group<br>(sections grouped and treated as segment) | Group Name<br>However, the group name of a segment defined by the CA850 cannot be edited. | OK                   |
|  | Preceding section (preceding section name or none)  | OK                   |
|  | Start Address<br>"?" is displayed if no start address is determined.                      | OK                   |
|  | End Address<br>"?" is displayed if no end address is determined.                          | -                    |
|  | Size<br>"?" is displayed if no size is determined.  | -                    |
|  | Access Type (instruction code, read only, or read/write)                                  | OK                   |
|  | Align (1 byte, 2 bytes, 4 bytes, or 8 bytes)  | -                    |
|  | Maximum Size  | OK                   |
|  | Section   | -                    |
|  | Comment   | OK                   |

Table 5-13 Displayed Contents in Property View Area and Editing Availability (When Object File Is Selected)

| Selected Item | Displayed Contents  | Editing Availability |
|---------------|---|----------------------|
| Object file   | File Name   | -                    |
|               | Start Address<br>"?" is displayed if no start address is determined.            | -                    |
|               | End Address<br>"?" is displayed if no end address is determined.                | -                    |
|               | Size<br>"?" is displayed if no size is determined.                              | -                    |
|               | Section Type (with initial value or without initial value)                      | -                    |
|               | Path  | -                    |
|               | Library<br>Not displayed if the object file is not included in the library file | -                    |
|               | Comment   | OK                   |

Table 5-14 Displayed Contents in Property View Area and Editing Availability (When Symbol Is Selected)

| Selected Item | Displayed Contents   | Editing Availability |
|---------------|--|----------------------|
| Symbol        | Symbol Name  | OK                   |
|               | Symbol Type (TP symbol, GP symbol, or EP symbol)                         | OK                   |
|               | Address  | OK                   |
|               | Align (1 byte, 2 bytes, 4 bytes, or 8 bytes)                             | OK                   |
|               | Base Symbol<br>Not displayed if [Symbol type] is other than "GP symbol". | OK                   |
|               | Reference Sections   | -                    |
|               | Comment  | OK                   |

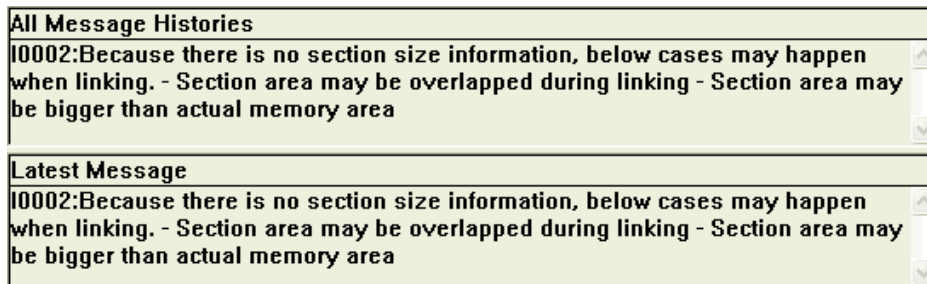


## Message view area

This area displays messages to the user.

It is divided into two areas: one that displays history of all the messages that have been displayed (All Message Histories) and the other that displays the latest message (Latest Message) (the size of these areas can be changed by using the mouse).

Figure 5-9 Example of Message View Area



If the right mouse button is clicked on this area, the area below the mouse cursor is selected, and the following context menu is displayed.

|         |   |
|---------|---|
| [Clear] | Clears the displayed message.<br>If the latest message area is selected, this item cannot be selected.                      |
| [Copy]  | Copies a selected character string to the copy buffer.<br>If no character string is selected, this item cannot be selected. |
| [Find]  | Opens the <a href="#">[Find] dialog box</a> that is used to search a character string from the message log.                 |

## Menu bar

### (1) [File] menu

|                         |   |            |
|-------------------------|---|------------|
| [N]ew...                | Opens the <a href="#">[New Link Directive] dialog box</a> to create a new link directive.<br>While a link directive is being edited, a message asking you whether it is saved to a file is displayed. If "Save" is selected at this time, the operation is the same as [Save].  | [Ctrl]+[N] |
| [O]pen...               | Opens the <a href="#">[Open] dialog box</a> .<br>If a link directive file created by a tool other than the LDG is used or if the link directive file of a compiler that cannot describe comments in a link directive file is used, the <a href="#">[Select Development Environment] dialog box</a> is opened.<br>If the LDG has been started from PM+, however, the link directive file is opened in the environment set on PM+ (for details of how the LDG files are read, refer to the description of the <a href="#">[Open] dialog box</a> .<br>If a file is being edited, a message asking you whether the file is to be saved is displayed. If "Save" is selected at this time, the operation is the same as [Save]. | [Ctrl]+[O] |
| [S]ave                  | Overwrites and saves a file.<br>If a file that has been newly created has never been saved, the operation is the same as [Save As...].  | [Ctrl]+[S] |
| [S]ave A[s]...          | Opens the <a href="#">[Save As] dialog box</a> .<br>The format of the file to be saved is *.Ind.  | -          |
| [S]elect O[b]ject(s)... | Opens the <a href="#">[Select Object File] dialog box</a> that is used to select an object file in order to select object file(s) or execution file to be linked.<br>The type of the file that can be read is as follows.<br>- Execution file (*.out)<br>- Object file (*.o)<br>- Library (*.a)<br>While a file is being edited, a message asking you whether the file is saved is displayed. If "Save" is selected at this time, the operation is the same as [Save].  | -          |
| [H]istory File Name     | Displays history of up to four files that have been used.<br>By selecting a file name, that file can be opened.   | -          |
| [E]xit                  | Quits the LDG.  | -          |

**(2) [Edit] menu**

|            |  |   |            |
|------------|--|---|------------|
| [U]ndo]    | Restores the editing operation immediately before.<br>However, this item cannot be selected if the operation cannot be restored.   |   | [Ctrl]+[Z] |
| [Cu]t]     | Cuts the selected item.  |   | [Ctrl]+[X] |
| [C]opy]    | Copies the selected item to the copy buffer.<br>The name information of the copy source will be lost.  |   | [Ctrl]+[C] |
| [P]aste]   | Pastes the contents of the copy buffer to a selected position.<br>If the memory to be pasted does not have a name, name "NewMemory" is assumed.<br>If the section to be pasted does not have a name, name "NewSection.section type" is assumed.<br>If the same name already exists, a decimal number (0 to 4,294,967,295) is suffixed to the specified name. |   | [Ctrl]+[V] |
| [A]dd]     | Displays the following cascade menu to add an item to the <a href="#">Memory mapping view area</a> .<br>To add an object file, select the [File] menu -> [Select Object (s)...].   |   | -          |
|            | [M]emory]  | Opens the <a href="#">[Add Memory] dialog box</a> that is used to add a memory.   | -          |
|            | [S]ection]   | Opens the <a href="#">[Add Section] dialog box</a> that is used to add a section. | -          |
|            | [S]ymbol]  | Opens the <a href="#">[Add Symbol] dialog box</a> that is used to add a symbol.   | -          |
| [D]elete]  | Deletes the selected item.   |   | [Del]      |
| [G]roup]   | [G]roup]   | Groups the selected sections.   | -          |
|            | [U]ngroup]   | Cancels the grouping of the sections.   | -          |
| [J]oint]   | Combines selected memories and treats them as one memory.  |   | -          |
| [F]ind...] | Opens the <a href="#">[Find] dialog box</a> that is used to search a section, object file, or a character string in the message log.   |   | [Ctrl]+[F] |

**(3) [View] menu**

|                           |  |   |
|---------------------------|--|---|
| [T]oolbar                 | Checked: Displays the toolbar (default).<br>Not checked: Does not display the toolbar.   | - |
|                           | The checked status is saved when the LDG is terminated and is restored when the LDG is started the next time.  |   |
| [S]how Size With Hex      | Checked: Displays the memory size as a hexadecimal number.<br>Not checked: Displays the memory size as a decimal number (default).   | - |
|                           | The checked status is saved when the LDG is terminated and is restored when the LDG is started the next time.  |   |
| [U]pside D[O]wn           | Checked: Displays the memory map with the start address at bottom.<br>Not checked: Displays the memory map with the start address at top (default).  | - |
|                           | The checked status is saved when the LDG is terminated and is restored when the LDG is started the next time.  |   |
| [S]how M[ir]ror Image     | Checked: Displays the mirror image (default).<br>Not checked: Does not display the mirror image.   | - |
|                           | The checked status is saved when the LDG is terminated and is restored when the LDG is started the next time.  |   |
| [S]how A[ll] Memory Space | Checked: Checked: Linearly displays the whole memory area.<br>Sections are displayed only at the addresses where they are allocated.<br>Not checked: The mirror image can be expanded or folded (default). | - |
|                           | The checked status is saved when the LDG is terminated and is restored when the LDG is started the next time.  |   |
| [C]lear Messages          | Clears the message displayed in the <a href="#">Message view area</a> .  | - |

**(4) [Tool] menu**

|             |   |   |
|-------------|---|---|
| [O]ption... | Opens the <a href="#">[Option] dialog box</a> that is used to make various setting of the LDG (such as font and color of memory mapping). | - |
|-------------|---|---|








**(5) [Help] menu**

|                                     |   |    |
|-------------------------------------|---|----|
| [LDG H]elp                          | Opens the on-line help of the LDG.  | F1 |
| [N]EC Electronics Microcomputer Web | Opens a NEC Electronics microcontroller-related Website.  | -  |
| [A]bout...                          | Displays the version information of the LDG.<br>Displays "LDG version number [day month year]". | -  |

## Toolbar

On the toolbar, buttons of menu items that are used relatively frequently are displayed. By selecting the button of a menu item, the item can be executed.

Table 5-15 Toolbar of Main Window

| Button  | Function  |
|---|---|
|  | Function same as selecting the [File] menu -> [New...]  |
|  | Function same as selecting the [File] menu -> [Open...] |
|  | Function same as selecting the [File] menu -> [Save]    |
|  | Function same as selecting the [Edit] menu -> [Cut]     |
|  | Function same as selecting the [Edit] menu -> [Copy]    |
|  | Function same as selecting the [Edit] menu -> [Paste]   |
|  | Function same as selecting the [Edit] menu -> [Add]     |

## [New Link Directive] dialog box

This dialog box is used to set information of a target device, compiler, and real-time OS to create a new link directive.

This dialog can be opened by either of the following operations.


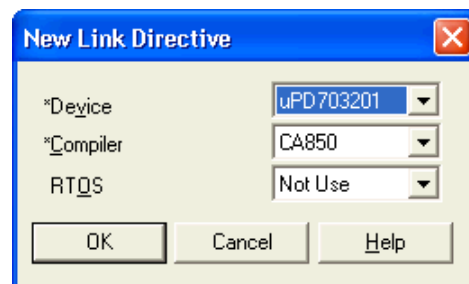
- Selecting the [File] menu -> [New...]
- Clicking  button

Figure 5-10 [New Link Directive] Dialog Box



This section explains the following items. This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### (1) Device

Select the name of a device to be used from the pull-down menu.

The LDG will determine the address space and internal memory area.

Specifying this item must not be omitted.

### (2) Compiler

Select the name of a compiler to be used from the pull-down menu.

With this version of the LDG, only "CA850" can be selected.

Specifying this item must not be omitted.

### (3) RTOS

Select the name of a real-time OS to be used from the pull-down menu.

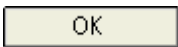


The LDG will add the necessary sections.

When no real-time OS is used, select "Not Use".

**[Remark]** If the LDG is started from PM+, each of the items are displayed reflecting the setting of the project.

## Function buttons

Table 5-16 Function Buttons of [New Link Directive] Dialog Box

| Button  | Function   |
|---|--|
|  | Creates a new link directive file with the specified contents. |
|  | Ignores the setting and closes the dialog box.                 |
|  | Displays the on-line help of this dialog box.                  |

## [Select Development Environment] dialog box

This dialog box is used to set a target device and compiler information when an existing link directive file (a link directive file created by a tool other than the LDG or a link directive file that was saved with the check of [Output LDG Information] on the [\[Save As\] dialog box](#) removed) is opened.

This dialog box can be opened by either of the following operations.


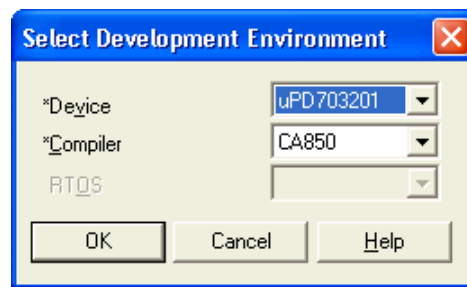
- Selecting the [File] menu -> [Open...] and then specifying an existing link directive file
- Clicking  button and then specifying an existing link directive file

Figure 5-11 [Select Development Environment] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)



## Explanation of each area

### (1) Device

Select the name of a device to be used from the pull-down menu.

The LDG will determine the address space and internal memory area.

Specifying this item must not be omitted.

### (2) Compiler

Select the name of a compiler to be used from the pull-down menu.

With this version of the LDG, however, only "CA850" can be selected.

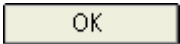
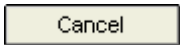
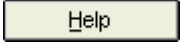
Specifying this item must not be omitted.

### (3) RTOS

This area is always invalid.

## Function buttons

Table 5-17 Function Buttons of [Select Development Environment] Dialog Box

| Button  | Function   |
|---|--|
|   | Creates a new link directive file with the specified contents. |
|  | Ignores the setting and closes the dialog box.                 |
|  | Displays the on-line help of this dialog box.                  |

## [Open] dialog box

This dialog box is used to select a file to be newly opened.

This dialog box can be opened by either of the following operations.


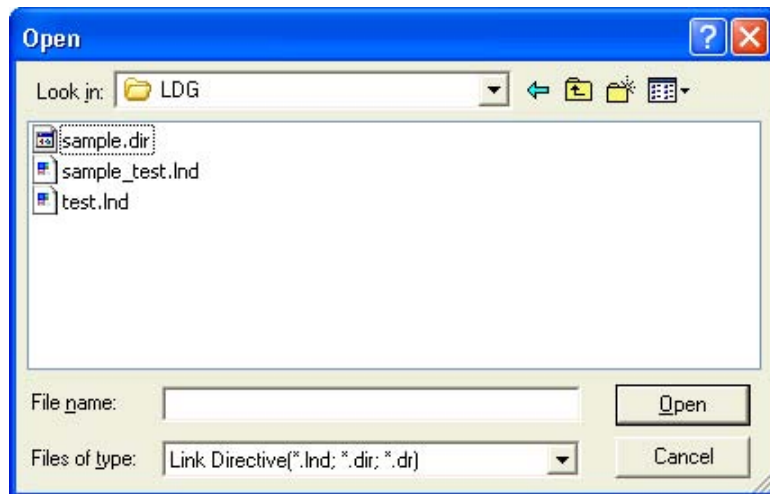
- Selecting the [File] menu -> [Open...]
- Clicking  button

Figure 5-12 [Open] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)
- [Notes on Operation](#)

## Explanation of each area

### (1) Look in:

Select a drive or folder where the specified file exists, from the drop-down list. In the area below this field, the files in the specified drive or folder are displayed.

### (2) File name:

Input a file name from the keyboard.

If a file name is selected from the area above this field, the select file name is displayed in this field.

### (3) Files of type:

The following types of files can be selected.

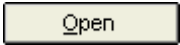
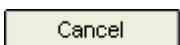
- Link directive file (\*.Ind, \*.dir)

|       |  |
|-------|--|
| *.Ind | File saved by the LDG including comment  |
| *.dir | Standard link directive file of CA850<br>Link directive file used as sample of RX850 Pro |

**[Caution]** If a file with extension ".dr" is opened, the specified file is opened if the contents of the file are a link directive file of the CA850. If they are not a link directive file of the CA850, an error message is displayed and the specified file cannot be opened.

## Function buttons

Table 5-18 Function Buttons of [Open] Dialog Box

| Button  | Function   |
|---|--|
|  | Opens the specified file and closes this dialog box. |
|  | Ignores the setting and closes this dialog box.      |

## Notes on Operation

- If a link directive file that has not been created by the LDG is specified, the [\[Select Development Environment\] dialog box](#) is opened (set a new development environment in this dialog box).

If the LDG is started from PM+, however, the link directive file is opened in the environment set by PM+.

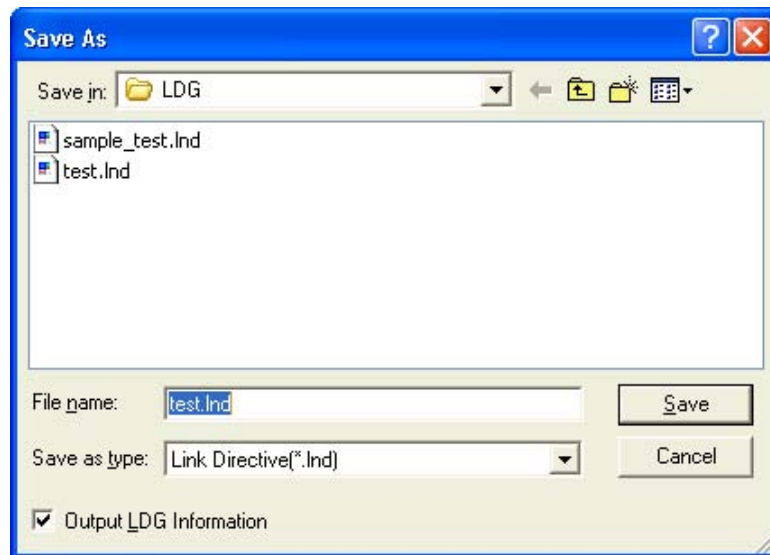
## [Save As] dialog box

This dialog box is used to save a specified file by giving it a name.

This dialog box can be opened by the following operation.

- Selecting the [File] menu -> [Save As...]

Figure 5-13 [Save As] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

### Explanation of each area

#### (1) Save in:

Select a drive or folder to which the file is to be saved, from the drop-down list. In the area below this field, the files in the specified allocation are displayed.

#### (2) File name:

Input the name of the file to be saved from the keyboard.

If a file name is selected from the area above, the selected file name is displayed.

#### (3) Save as type:

Specify the type of the file to be saved, from the drop-down list.

However, the LDG can save only files with extension ".lnd".

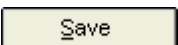
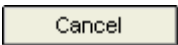
**(4) Output LDG information**

Check this check box as necessary.

|             |  |
|-------------|--|
| Checked     | <p>Outputs information peculiar to the LDG and saves the specified file as a link directive file (default).</p> <p>If the file that has been saved in this way is read next time by the LDG, all the information before the file is save is restored.</p>  |
| Not checked | <p>Saves the link directive file without outputting information peculiar to the LDG, to improve the legibility of the file.</p> <p>To read the file saved in this way the next time by the LDG, the following points must be noted.</p> <ul style="list-style-type: none"> <li>- Memory information is not restored to the original status.</li> <li>- Device information is not restored to the original status (must be re-selected).</li> <li>- Regarding sections that were added before saving the file and were not grouped (into a segment), a segment is read and displayed because the segment was automatically created when the file was saved.</li> </ul> <p><b>[Example]</b></p> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">↑ ?</div> <div>.text</div> </div> <div style="text-align: right; margin-top: 10px;">? bytes</div> </div> <div style="margin-left: 10px;">-&gt; File output</div> <div style="border: 1px solid black; padding: 5px; margin-left: 10px;"> <pre>SEGMENT.text : !LOAD ?RX H0x0 F0x0 A0x8 { .text = \$PROGBITS ?AX A0x8; };</pre> </div> </div> <p style="text-align: center; margin-top: 20px;"><u>Display when file is read again</u></p> <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">↑ ?</div> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">+ SEGMENT.text</div> </div> <div style="text-align: right; margin-top: 10px;">? bytes</div> </div> <div style="margin-right: 10px;">→</div> <div style="border: 1px solid black; padding: 5px;"> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">↑ ?</div> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">- SEGMENT.text</div> </div> <div style="text-align: right; margin-top: 10px;">? bytes</div> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">↑ ?</div> <div>.text</div> </div> <div style="text-align: right; margin-top: 10px;">? bytes</div> </div> </div> </div> <p style="text-align: center; margin-top: 10px;">Click "+".</p> |

**Function buttons**

Table 5-19 Function Buttons of [Save As] Dialog Box

| Button  | Function   |
|---|--|
|  | Saves the file with the specified name and closes this dialog box. |
|  | Ignores the setting and closes this dialog box.                    |

## [Find] dialog box

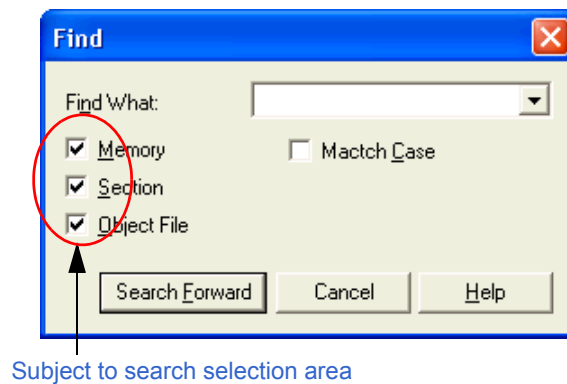
This dialog box is used to search for a character string from a memory name, section name, or object file name displayed in the [Memory mapping view area](#), or from the messages in the [Message view area](#).

If a specified character string is found, the allocation where it has been found is selected and displayed in the area.

This dialog box can be opened by either of the following operations.

- Selecting the [Edit] menu -> [Find]
- Clicking right mouse button in [Message view area](#)  
-> selecting the [Find] context menu

Figure 5-14 [Find] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### (1) Find What:

Specify a character string to be searched for.

Up to five character strings that have been searched after the LDG was started can be selected from the pull-down menu.

### (2) Subject to search selection area

This area is displayed only when the [Memory mapping view area](#) is selected.

In this area, select subject(s) (memory, section, or object file) for a search.

Only the checked subject(s) will be target for a search.

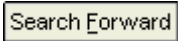
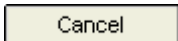
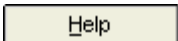
When this dialog box is opened for the first time after the LDG has been started, all the items are checked. When the dialog box is opened the next time, the previous status is retained.

### (3) Match Case

When this box is checked, only the upper and lower characters which exactly match the character string that is designated in [Find What:] are searched for.

## Function buttons

Table 5-20 Function Buttons of [Find] Dialog Box

| Button  | Function  |
|---|---|
|  | Searches for the specified character string.    |
|  | Ignores the setting and closes this dialog box. |
|  | Displays the on-line help of this dialog box.   |

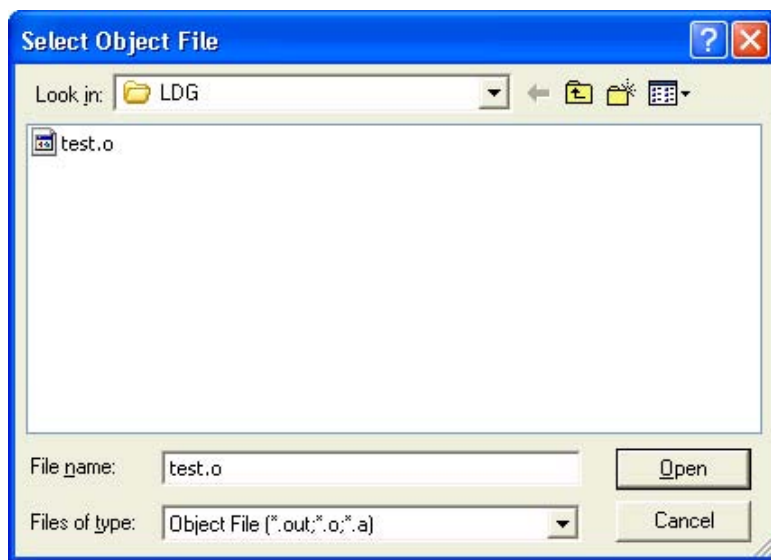
## [Select Object File] dialog box

This dialog box is used to select an object file to add a new object file.

This dialog box can be opened by either of the following operations.

- Selecting the [File] menu -> [Select Object(s)...]
- Clicking right mouse button on section in the [Memory mapping view area](#)  
-> selecting the [Select Object File...] context menu

Figure 5-15 [Select Object File] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)



## Explanation of each area

### (1) Look in:

Select a drive or folder where the specified file exists, from the drop-down list. In the area below this field, the files in the specified drive or folder are displayed.

### (2) File name:

Input the name of a file to be specified from the keyboard.

If a file name is selected from the area above, the selected file name is displayed in this field (two or more object files may be selected).



### (3) Files of type:

The following types of files may be selected.

- Execution file (\*.out)
- Object file (\*.o)
- Library file (\*.a)

## Function buttons

Table 5-21 Function Buttons of the [Select Object File] Dialog Box

| Button  | Function   |
|---|--|
|  | Adds the specified object file and closes this dialog box. |
|  | Ignores the setting and closes this dialog box.            |

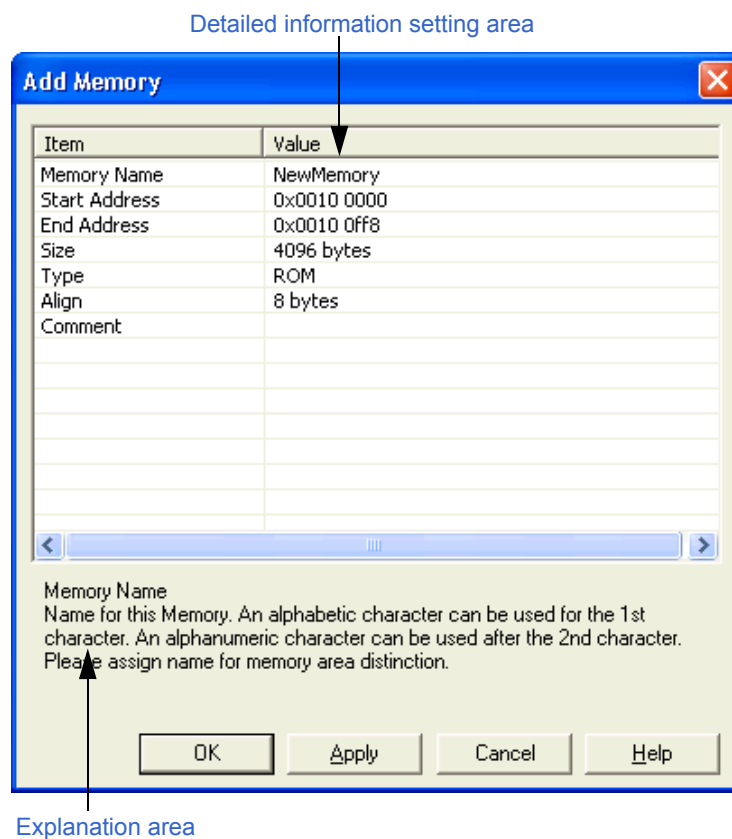
## [Add Memory] dialog box

This dialog box is used to add a new memory to the [Memory mapping view area](#) in the [Main window](#).

This dialog box can be opened by either of the following operations.

- Selecting the [Edit] menu -> [Add] -> [Memory]
- Clicking right mouse button on memory in the Memory mapping view area  
-> selecting the [Add Memory] context menu

Figure 5-16 [Add Memory] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### **(1) Detailed information setting area**

In this area, specify the value of each of the following items.

#### **(a) Memory Name**

Specify the name of the memory to be added.

The memory name must start with an alphabetic character. The second character and those that follow may be alphanumeric characters.

By default, "NewMemory" is specified. If a memory of the same name already exists, a decimal number (0 to 4,294,967,295) is suffixed to the specified name.

#### **(b) Start Address**

Specify the start address of the memory to be added as a hexadecimal number with "0x" prefixed or a decimal number.

If a memory is selected in the [Memory mapping view area](#), an address to be added immediately before the selected memory is specified by default.

If no memory is selected in the Memory mapping view area, an address to be added to the beginning of a vacant address is specified by default.

In any of the following cases, the input value is assumed as illegal and a message is displayed.

- If the specified number of address digits is exceeded
- If [Start Address] is higher than [End Address]
- If the specified address overlaps other memory

#### **(c) End Address**

Specify the end address of the memory to be added as a hexadecimal number with "0x" prefixed or a decimal number.

If a memory is selected in the [Memory mapping view area](#), an address to be added immediately before the selected memory is specified by default.

If no memory is selected in the Memory mapping view area, an address to be added to the beginning of a vacant address is specified by default.

If the value of size is edited, the end address is automatically changed according to that value.

In any of the following cases, the input value is assumed as illegal and a message is displayed.

- If the specified number of address digits is exceeded
- If [Start Address] is higher than [End Address]
- If the specified address overlaps other memory

**(d) Size**

Specify the size of the memory to be added as a hexadecimal number with "0x" prefixed or a decimal number. By default, "0x1000 bytes" is specified. If the vacant area is less than 0x1000 bytes, however, the size of the vacant area is specified.

If the value of [Start Address] or [End Address] is edited, the size is automatically changed according to that value.

**(e) Type**

Specify either "ROM" or "RAM" as the type of the memory to be added.

"ROM" is specified by default.

**(f) Align**

Specify "1 byte", "2 bytes", "4 bytes", or "8 bytes" as align.

By default, "8 bytes" is specified.

**(g) Comment**

Specify a comment.

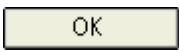

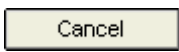

This field is blank by default.

**(2) Explanation area**

This area displays explanation of the item selected in the [Detailed information setting area](#).

**Function buttons**

Table 5-22 Function Buttons of [Add Memory] Dialog Box

| Button  | Function   |
|---|--|
|  | Adds new memory of the specified contents and closes this dialog box.          |
|  | Adds new memory of the specified contents, but does not close this dialog box. |
|  | Cancels the specified contents.  |
|  | Displays the on-line help of this dialog box.                                  |

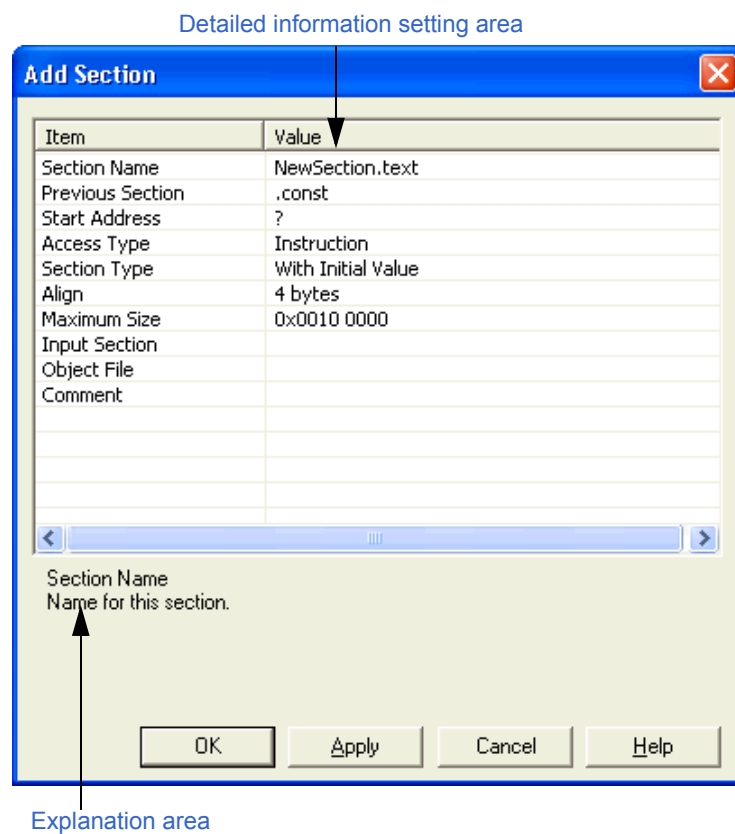
## [Add Section] dialog box

This dialog box is used to add a new section to the [Memory mapping view area](#) on the [Main window](#).

This dialog box can be opened by either of the following operations.

- Selecting the [Edit] menu -> [Add] -> [Section]
- Clicking the right mouse button on memory or section in the Memory mapping view area  
-> selecting the [Add Section...] context menu

Figure 5-17 [Add Section] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### (1) Detailed information setting area

In this area, specify the value of each of the following items.

#### (a) Section Name

Specify the name of the section to be added.

Depending on the item selected in the [Memory mapping view area](#), one of the following names is specified by default.

| Selected Item | Section Name (default)                            |
|---------------|---|
| Memory (RAM)  | NewSection.data                                   |
| Memory (ROM)  | NewSection.text                                   |
| Section       | NewSection. <i>type of first section selected</i> |
| None          | NewSection.data                                   |

If a section of the same name already exists, a decimal number (0 to 4,294,967,295) is suffixed to the name of that section.

#### (b) Previous Section

Specify the section preceding the section to be added.

If a section other than the first section of contiguous sections is selected in the [Memory mapping view area](#), the preceding section is specified by default.

Otherwise, this field will be blank by default.

If [Start Address] is edited, the value of this item is changed to "None".

#### (c) Start Address

Specify the start address of the section to be added as a hexadecimal number with "0x" prefixed or a decimal number.

If a memory is selected in the [Memory mapping view area](#), the address to be added to the beginning of the vacant area of the selected memory is specified by default.

If the first section of contiguous sections is selected in the Memory mapping view area and if there is a vacant area before that section, the address to be added immediately before the selected section is specified by default.

Otherwise, this field will be blank by default.

If [Previous Section] is edited, the value of this item is "?".

In any of the following cases, the input value is assumed as illegal and a message is displayed.

- If the specified number of address digits is exceeded
- If the specified address overlaps other memory
- If an address to which no memory is allocated is specified

**(d) Access Type**

Specify "Instruction", "Read Only", or "Read Write" as an access type.

One of the following access types are specified by default, depending on the item selected in the [Memory mapping view area](#).

| Selected Item | Access Type (Default)                     |
|---------------|---|
| Memory (RAM)  | Read Write                                |
| Memory (ROM)  | Instruction                               |
| Section       | Access type of the first section selected |

**(e) Section Type**

Specify either "With Initial Value" or "Without Initial Value" as a section type.

One of the following section types is specified by default, depending on the item selected in the Memory mapping view area.

| Selected Item | Section Type (Default)                     |
|---------------|--|
| Memory        | With Initial Value                         |
| Section       | Section type of the first section selected |

**(f) Align**

Specify "1 byte", "2 bytes", "4 bytes", or "8 bytes" as align.

If a memory is selected in the [Memory mapping view area](#), a value same as the align of the memory is specified by default.

**(g) Maximum Size**

Specify the maximum size of the section to be added as a hexadecimal number with "0x" prefixed or a decimal number.

By default, "0x100000 bytes" is specified.

If a value exceeding the address digit is specified, it is assumed as an illegal input value and a message is displayed.

**(h) Input Section**

Specify an input section.

This field is blank by default.

**(i) Object File**

Sections having the same attribute as the output section to be created are extracted from the specified object and are then output.

**(j) Comment**

Specify a comment.

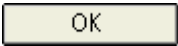

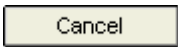
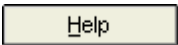
This field is blank by default.

**(2) Explanation area**

This area displays explanation of the item selected in the [Detailed information setting area](#).

**Function buttons**

Table 5-23 Function Buttons of [Add Section] Dialog Box

| Button  | Function   |
|---|--|
|  | Adds a new section of the specified contents and closes this dialog box.         |
|  | Adds a new section of the specified contents but does not close this dialog box. |
|  | Cancels the specified contents.  |
|  | Displays the on-line help of this dialog box.                                    |



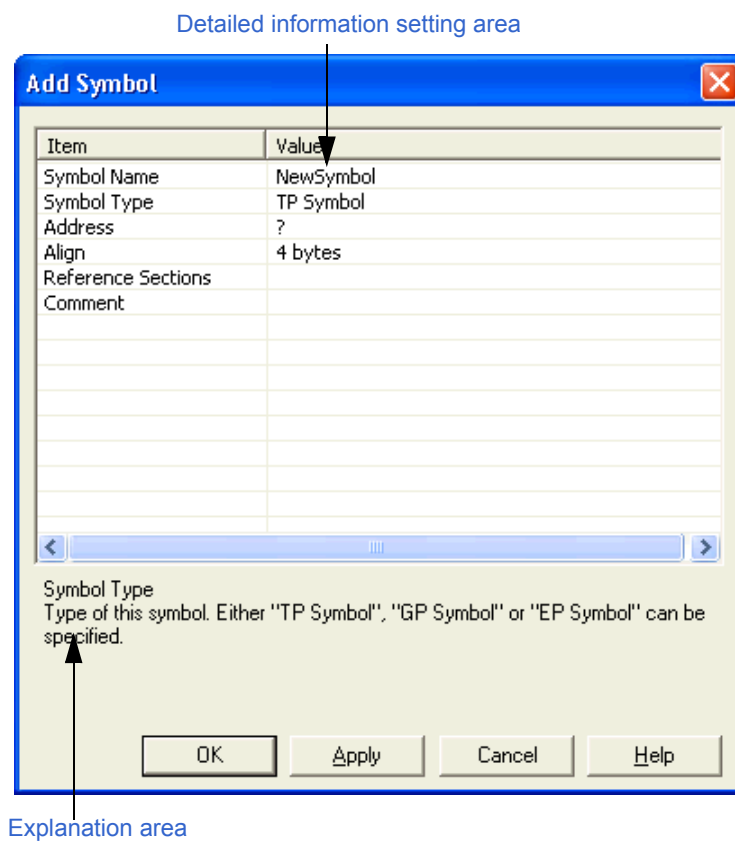
## [Add Symbol] dialog box

This dialog box is used to add a new symbol to the [Memory mapping view area](#) on the [Main window](#).

This dialog box can be opened by either of the following operations.

- Selecting the [Edit] menu -> [Add] -> [Symbol]
- Clicking right mouse button on memory or section in memory mapping view area  
-> selecting the [Add Symbol] context menu

Figure 5-18 [Add Symbol] Dialog Box



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### **(1) Detailed information setting area**

In this area, specify the value of each of the following items.

#### **(a) Symbol Name**

Specify the name of a symbol to be added.

By default, "NewSymbol" is specified.

If a symbol of the same name exists, a decimal number (0 to 4,294,967,295) is suffixed to the name of the specified symbol.

#### **(b) Symbol Type**

Specify "TP Symbol", "EP Symbol", or "GP Symbol" as a symbol type.

By default, "TP Symbol" is specified.

**[Caution]** Two or more ep symbols cannot be generated.

#### **(c) Address**

Specify an address at which the symbol is to be allocated.

By default, "?" is displayed.

#### **(d) Align**

Specify "1 byte", "2 bytes", "4 bytes", or "8 bytes" as align.

By default, "4 bytes" is specified.

#### **(e) Base Symbol**

Specify a base symbol.

When specifying a base symbol, all the TP symbols can be selected.

This item is displayed only if "GP Symbol" is specified as [Symbol Type].

#### **(f) Reference Sections**

A list of section names to which the symbol to be created references is displayed.

#### **(g) Comment**

Specify a comment.



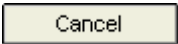
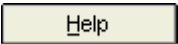
This field is blank by default.

### **(2) Explanation area**

This area displays explanation of the item selected in the [Detailed information setting area](#).

## Function buttons

Table 5-24 Function Buttons of [Add Symbol] Dialog Box

| Button  | Function  |
|---|---|
|  | Adds a new symbol of the specified contents and closes this dialog box.         |
|  | Adds a new symbol of the specified contents but does not close this dialog box. |
|  | Cancels the specified contents.   |
|  | Displays the on-line help of this dialog box.                                   |

## [Option] dialog box

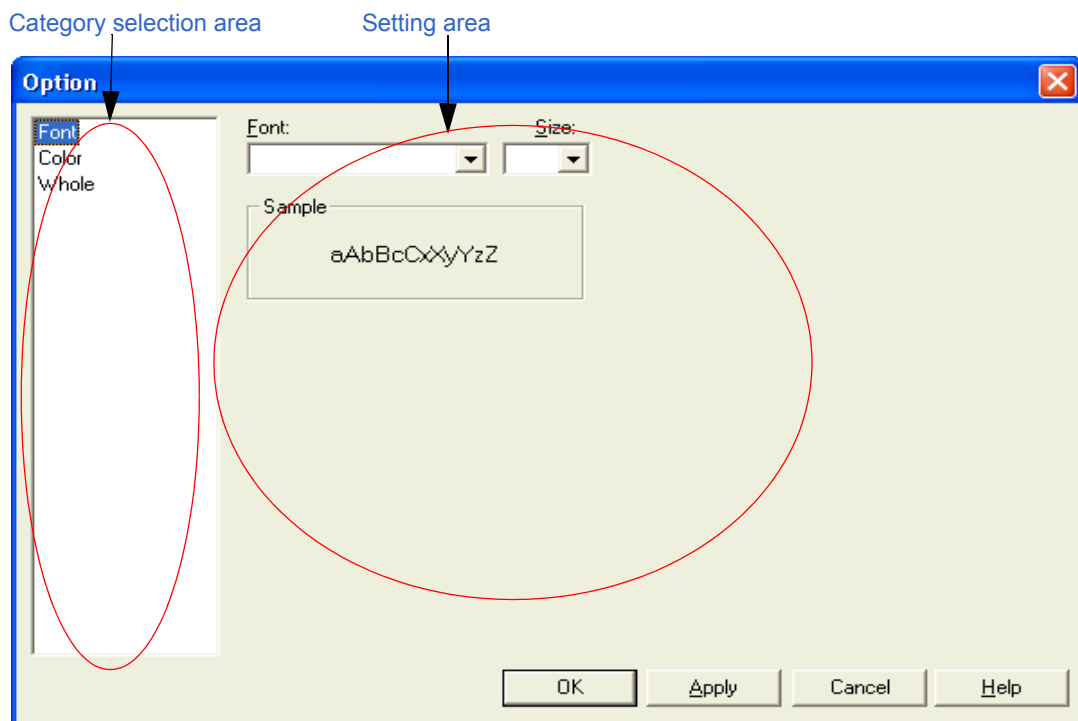
This dialog box is used for basic settings related to the operation and display of the LDG.

When the LDG is started next time, it is started in the status set in this dialog box (status when the LDG was terminated before).

This dialog box can be opened by the following operation.

- Selecting the [Tool] menu -> [Option]

Figure 5-19 [Option] Dialog Box (When [Font] Is Selected)



This section explains the following items.

- [Explanation of each area](#)
- [Function buttons](#)

## Explanation of each area

### (1) Category selection area

Select a category to be set from the following categories.

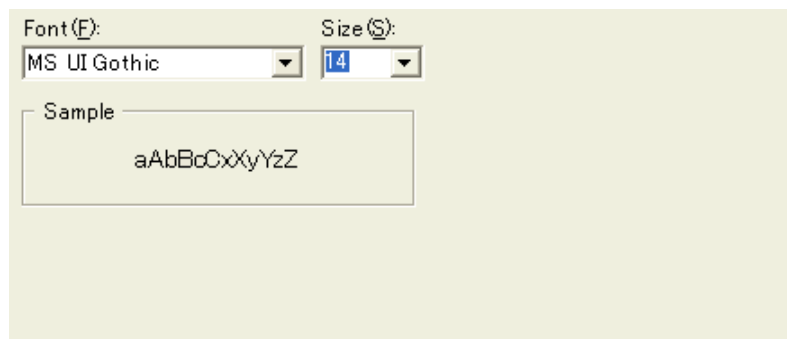
Table 5-25 Categories in [Option] Dialog Box

| Category | Setting  |
|----------|--|
| Font     | Changes font and size displayed in the <a href="#">Memory mapping view area</a> .                      |
| Color    | Changes the color of the items (such as memory and section) displayed in the Memory mapping view area. |
| Whole    | Changes the setting, such as the pop-up display time and whether the mirror image is displayed or not. |

### (2) Setting area

#### (a) If [Font] is selected

Figure 5-20 Setting of [Font] in [Option] Dialog Box



#### [Font]

Select font-type to be displayed in the [Memory mapping view area](#) from the pull-down menu.

#### [Size]

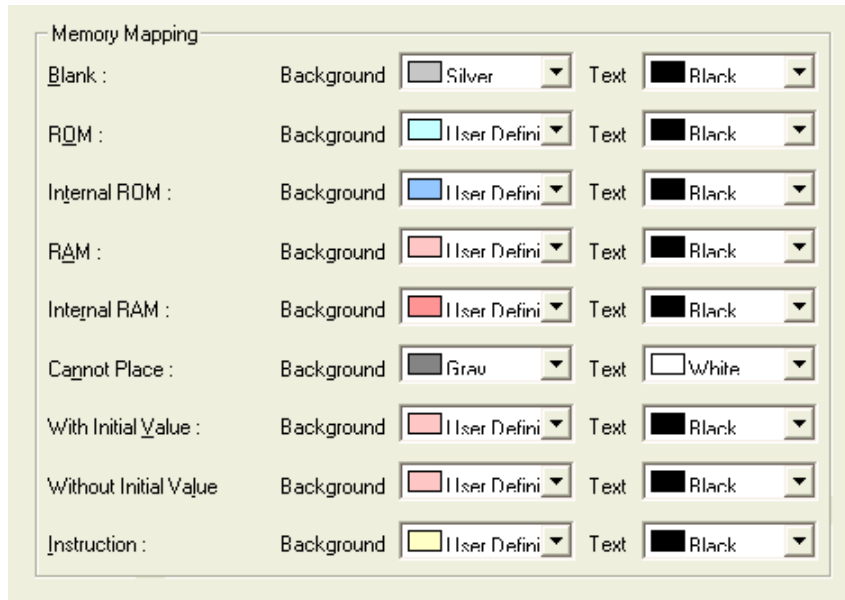
Select font-size to be displayed in the [Memory mapping view area](#) from the pull-down menu.

#### [Sample]

This area displays sample of characters depending on the specification of [Font] and [Size].

**(b) If [Color] is selected**

Figure 5-21 Setting of [Color] in [Option] Dialog Box

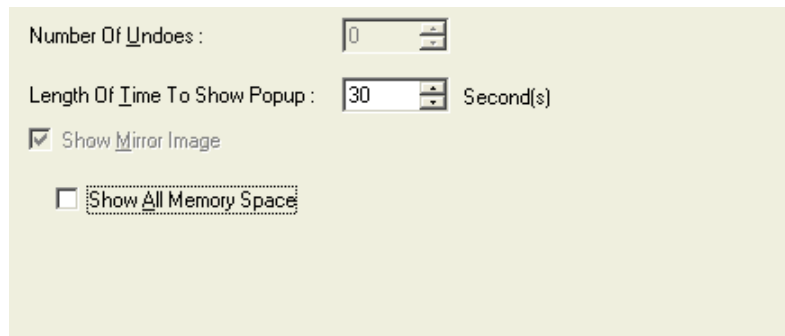


Select the background color and character color of the item (such as memory and section) to be displayed in the [Memory mapping view area](#), from the pull-down menu.

If [User Definition] is selected from the pull-down menu of each item, [Color] dialog box of Windows is opened, and any color can be selected or created.

**(c) If [Whole] is selected**

Figure 5-22 Setting of [Whole] in [Option] Dialog Box

**[Number Of Undoes]**

This version of the LDG does not support this function.

**[Length Of Time To Show Popup]**

The time for which a pop-up menu that is used to display each item in details in the [Memory mapping view area](#) can be selected from a pull-down menu.

By default, "30" seconds is specified.

A value of 0 to 4,294,967,295 can be specified.

**[Show Mirror Image]**

Whether the mirror image is displayed or not in the [Memory mapping view area](#) can be specified.

This item can be selected only if the target device has a mirror image function.

Checked: Displays the mirror image (default).

Not checked: Does not display the mirror image.

**[Show All Memory Space]**

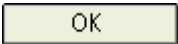
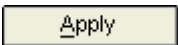
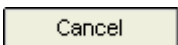
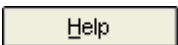
This item can be selected only if [Show Mirror Image] is checked.

Checked: Linearly displays the whole memory area.  
Sections are displayed only at the addresses where they are allocated, and not at addresses that are mirrored.

Not checked: The mirror image can be expanded or folded (default).

**Function buttons**

Table 5-26 Function Buttons of [Option] Dialog Box

| Button  | Function  |
|---|---|
|  | Sets operation of the LDG of the specified contents and closes this dialog box. |
|  | Cannot be selected with this version.   |
|  | Cancels the specified contents.   |
|  | Displays the on-line help of this dialog box.                                   |

# CHAPTER 6    MESSAGES

## 6. 1   Display Format





The messages output by the LDG are displayed in the message dialog box shown in [Figure 6-1](#).

There are four types of messages. When a message is displayed, an icon and a character identifying the type of the message are also displayed. The meaning of each message type is as shown in [Table 6-1](#).

Figure 6-1   Example of Message Dialog Box



Table 6-1   Message Types

| Icon  | Character | Type                                |
|---|-----------|-------------------------------------|
|  | E         | <a href="#">Error Message</a>       |
|  | W         | <a href="#">Warning Message</a>     |
|  | Q         | <a href="#">Question Message</a>    |
|  | I         | <a href="#">Information Message</a> |



## 6. 2 Error Message

The number and the contents displayed as an error message are as follows.

The character string in " " indicates the character string of the contents shown in " ".

Table 6-2 List of Error Message

| Number | Message   |
|--------|---|
| E0001  | Cannot find message file (File Name). Please re-install.  |
| E0002  | Could not read"File Name"correctly. Select environment in the [Select Environment Dialog Box].                                      |
| E0900  | There are no device files installed. Please install device file by the device file installer.                                       |
| E0901  | Cannot get address space by read error of device file for "Device name" Please re-install device file by the device file installer. |

## 6. 3 Warning Message

The number and the contents displayed as a warning message are as follows.

The character string in " " indicates the character string of the contents shown in " ".

Table 6-3 List of Warning Message

| Number | Message   |
|--------|---|
| W0001  | "File Name"is read-only. To save a copy, click [OK], then give the file new name in the [Save As Dialog Box]. |
| W0002  | "Drive" becomes full while writing to the disk.<br>Please make enough free space or save to another disk.     |
| W0003  | Selected plural executable files. "File Name"[, "File Name"...]   |
| W0004  | "File Name"is changed. Does it save?  |
| W0005  | Format of "File Name" is illegal.   |
| W0006  | Cannot exchange "Character string" to integer.  |
| W0007  | Cannot edit internal memory.  |
| W0008  | Cannot edit blank area.   |
| W0009  | Cannot edit "Memory or Section Name".   |
| W000A  | Cannot edit "Property Name" of "Memory or Section Name".  |
| W000B  | "Memory Name or Section Name" overlaps with "Memory or Section Name".   |
| W000C  | That address is without memory.   |
| W000D  | That name is too long. Please name by less than "Number" characters.  |
| W000F  | Start address of "Memory Name" is out of address space.   |
| W0010  | End address of "Memory Name" is out of address space.   |
| W0011  | Start address of "Memory Name" is out of "Memory Name".   |

| Number | Message   |
|--------|---|
| W0012  | End address of "Memory Name" is out of "Memory Name".   |
| W0013  | "Memory Name" has different mirror number between start address to end address.   |
| W0014  | Size of "Memory or Section Name" is negative.   |
| W0015  | Size is too large to drop to "Memory Name".   |
| W0017  | Cannot place data section to ROM.   |
| W0018  | Cannot decide start address because previous section "Section Name" dose not have resolved end address. Please set start address.                 |
| W0019  | Cannot create name. Please name another to "Memory or Section Name"-"Memory or Section Name4294967295".   |
| W001A  | Cannot find "Character string".   |
| W001B  | Cannot access "File Name".Please check if file exists. Please check permission of file and drive.   |
| W0900  | Please set maximum size larger than the size.<br>This message is displayed if a value smaller than the current value was set to the maximum size. |
| W0901  | "Link directive file name" " Line number" : ';' is expected at end of directive.  |
| W0902  | "Link directive file name" " Line number" : '}' is expected at end of region.   |
| W0903  | "Link directive file name" " Line number" : name is expected at beginning of directive.   |
| W0904  | "Link directive file name" " Line number" : section name is expected at beginning of section directive.   |
| W0905  | "Link directive file name" " Line number" : ' ', '=' or '@' is expected to follow name.   |
| W0906  | "Link directive file name" " Line number" : '=' is expected to follow section name.   |
| W0907  | "Link directive file name" " Line number" : too many '}'.   |
| W0908  | "Link directive file name" " Line number" : illegal character "Character code".   |
| W090A  | "Link directive file name" " Line number" : "Character string" is illegal in segment directive.   |
| W090B  | "Link directive file name" " Line number" : "Character string" is illegal in section directive.   |
| W090C  | "Link directive file name" " Line number" : "Character string" is illegal in symbol directive.  |
| W090D  | "Link directive file name" " Line number" : "Character string" is illegal in file specification field.  |
| W090E  | "Link directive file name" " Line number" : "Character string" is illegal in segment name specification field.                                    |
| W090F  | "Link directive file name" " Line number" : "Character string" specified to segment "Segment Name" more than once in same or other directive.     |
| W0910  | "Link directive file name" " Line number" : "Character string" specified to section "Section Name" more than once in same or other directive.     |
| W0911  | "Link directive file name" " Line number" : "Character string" specified to symbol "Symbol Name" more than once in same or other directive.       |
| W0912  | "Link directive file name" " Line number" : segment "Segment Name" already defined.   |
| W0913  | "Link directive file name" " Line number" : section "Section Name" already defined line "Line number".  |

| Number | Message  |
|--------|--|
| W0914  | "Link directive file name" " Line number" : symbol "Symbol Name" already defined line "Line number".   |
| W0915  | "Link directive file name" " Line number" : illegal segment type "Character string".   |
| W0916  | "Link directive file name" " Line number" : illegal section type "Character string".   |
| W0917  | "Link directive file name" " Line number" : illegal attribute character "Character".   |
| W0918  | "Link directive file name" " Line number" : %s in segment directive of non LOAD segment "Character string" is illegal.   |
| W0919  | "Link directive file name" " Line number" : aligned odd value ("specified Number") to be even value ("Number").  |
| W091A  | "Link directive file name" " Line number" : segment directive of segment "Segment Name" needs "Character string".  |
| W091B  | "Link directive file name" " Line number" : section directive of section "Section Name" needs "Character string".  |
| W091C  | "Link directive file name" " Line number" : symbol directive of symbol "Symbol Name" needs "Character string".   |
| W091D  | "Link directive file name" " Line number" : unknown symbol kind "Character string".  |
| W091E  | "Link directive file name" " Line number" : symbol kind "Character string" specified more than once in same or other directive.  |
| W091F  | "Link directive file name" " Line number" : section attribute "Character which indicates an attribute" of section "Section Name" and segment attribute "Character which indicates an attribute" of segment "Segment Name" do not much. |
| W0920  | "Link directive file name" " Line number" : start address ("Address") of section "Section Name" overflowed start address ("Address") of segment "Segment Name".  |
| W0921  | "Link directive file name" " Line number" : Character string needs effective parameter.  |
| W0922  | "Link directive file name" " Line number" : "Character string" specified in EP symbol directive, ignored.  |
| W0923  | "Link directive file name" " Line number" : "Character string" specified to section "Section Name" more than once in same or other directive.  |
| W0924  | "Link directive file name" " Line number" : illegal section type "Character string".   |

## 6. 4 Question Message

A number and contents displayed as a question message are as follows.

Table 6-4 List of Question Message

| Number | Message  |
|--------|--|
| Q0001  | After "Showing All Memory Space", it cannot be canceled. In the case of placing sections to same physical address, select this. Does it perform? |

## 6. 5 Information Message

A number and contents displayed as an information message are as follows.

The character string in " " indicates the character string of the contents shown in " "

Table 6-5 List of Information Message

| Number | Message  |
|--------|--|
| I0001  | Added "Memory Name"("Start Address" - "End Address").<br>[Note] If allocation of a section is not on the internal memory when a link directive file that was created by a tool other than the LDG is read, a memory is automatically added and this message is displayed.  |
| I0002  | Because there is no section size information, below cases may happen when linking.<br>[Note] This message is displayed if an object file is not read when a link directive file is saved. This is because, if an object file is not read, the size information of the section is missing and therefore, the area of the section cannot be checked. |
| I0003  | Applied alignment to be "Start Address after alignment" to the "specified Start Address" of "Memory Name" (Property Name).   |
| I0004  | There are no previous sections. Set "Address" as start address of "Section Name".  |
| I0005  | "Memory, Section or Object File Name" is already exist.  |
| I0007  | Cannot get information for "Object File Name", because cannot find that file.  |
| I0900  | Added attribute R to segment "Segment Name".   |
| I0901  | Added attribute A to section "Section Name".   |
| I0902  | Address for section "Section Name" was applied to address for segment "Segment Name".  |

# APPENDIX A LINK DIRECTIVE

## A. 1 Overview

This chapter describes the items required for link directives and the link directive file description method.

In an embedded application, caution is required when allocating code to memory, such as when allocating program code from a certain address or partitioning code to be allocated.

To achieve the expected results for such memory allocation, the linker must be directed to allocation information about the program code and data. The various bits of directed information are called "link directives" and the file that contains the link directives is called "link directive file".

The linker determines the memory allocation according to the contents of the link directive file, then creates a load module.

### A. 1. 1 Specification Items

Items specified in the link directive generally fall into the following two categories.

#### - Segment directives and mapping directives

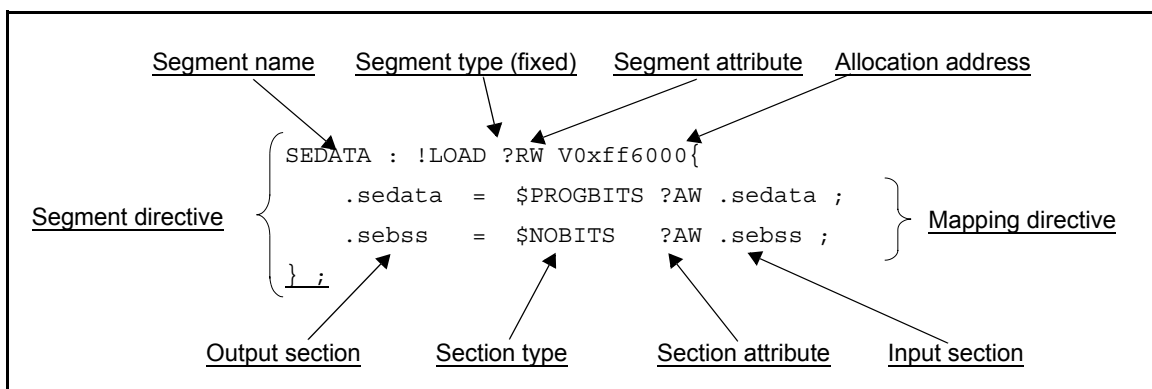
Link directives that gather information on sections where programs and data are allocated into information on segments for certain types and attributes, and that determine the corresponding allocation address.

A link directive that contains description of section information is called a "mapping directive" and a link directive that contains description of segment information is called a "segment directive".

The following shows examples of a segment directive and mapping directives that are contained in a link directive file.

For further description of the link directive format, refer to "[A. 4 Link Directive Format](#)".

Figure A-1 Segment Directives and Mapping Directives



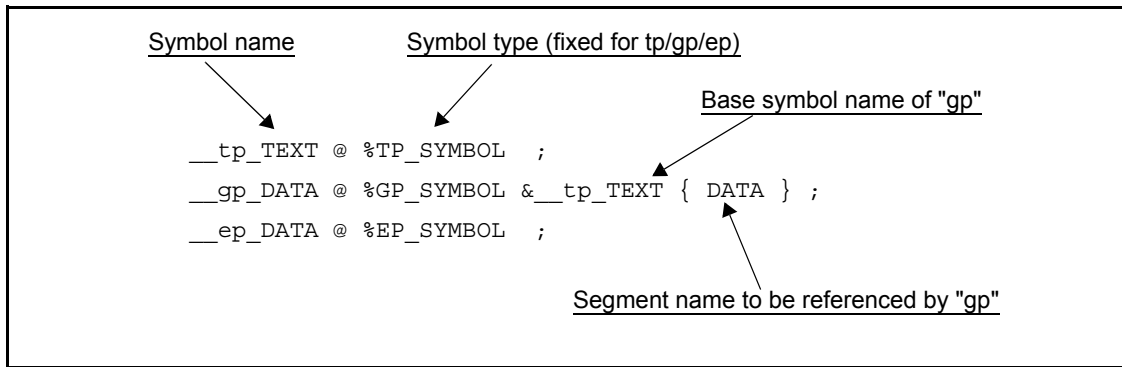
**- Symbol directive**

Link directives that create "symbols" which generate tp (text pointers), gp (global pointers), and ep (element pointers): this symbol-related information is called a "symbol directive".

The following shows an example of a symbol directive that is contained in a link directive file.

For further description of the link directive format, refer to "[A. 4 Link Directive Format](#)".

Figure A-2 Symbol Directive



## A. 2 Sections and Segments

This section describes the sections and segments.

### A. 2. 1 Sections

A section is the basic unit making up programs (area to which programs or data are allocated). For example, program code is allocated to a text-attribute section and variables that have initial values are allocated to a data-attribute section. In other words, different types of information are allocated to different sections.

Section names can be specified within application. In C language, they can be specified using a `#pragma section` directive or `#pragma text` directive and in assembly language they can be specified using a `.section` pseudo-operation.

Even if the `#pragma` directive is not used to specify a section, however, allocation by the compiler to a particular section may already be set as the default setting in the program code or data (variables).

For details of these specifications, refer to the "CA850 C Compiler Package C Language User's Manual" or "CA850 C Compiler Package Assembly Language User's Manual".

### A. 2. 2 Segments

A segment is the basic unit in which programs and data are loaded to memory. Sections that have the same attribute or the same type are gathered into one section group which is called segment. In other words, the general idea is that a segment is a collection of similar sections.

A segment name, attribute, and address to which a program is loaded can be freely specified by a link directive.

**[Caution]** Some characters cannot be specified in segment names and attributes. For details, refer to ["A. 4. 3 Segment directive"](#).

The following shows code extracted from a link directive file that allocates the read-enabled (R) and executable (X) segment "TEXT1" to address 0x100000.

```
TEXT1!LOAD ?RX V0x100000{
    :
    (Mapping directive)
    :
} ;
```

Since a segment is the basic unit for loading to memory, the segment is also the unit for allocating program code and data. In other words, to allocate a certain section to a specified memory area, the section information is coded in a mapping directive and then a segment that includes the mapping directive is created. Next, the segment's allocation address is determined.

**[Caution]** Although the allocation address for a mapping directive can be directly specified in a section, addresses are usually specified with segment units.

**[Example :** Allocate variable "i" to the sdata area and function "func1" to 0x120000.]

```
[test1.c]

#pragma section sdata begin
i = 10 ;
#pragma section sdata end

#pragma text "f1.text" func1

void
func1( ){
    :
    return ;
}
```

```
[Link directive (partial)]

TEXT2 : !LOAD ?RX V0x120000{
    text1= $PROGBITS ?AX f1.text ;
} ;

DATA  : !LOAD ?R V0x200000{
    .data = $PROGBITS ?AW ;
    .sdata = $PROGBITS ?AWG ;
    .sbss = $NOBITS ?AWG ;
    .bss = $NOBITS ?AW ;
} ;

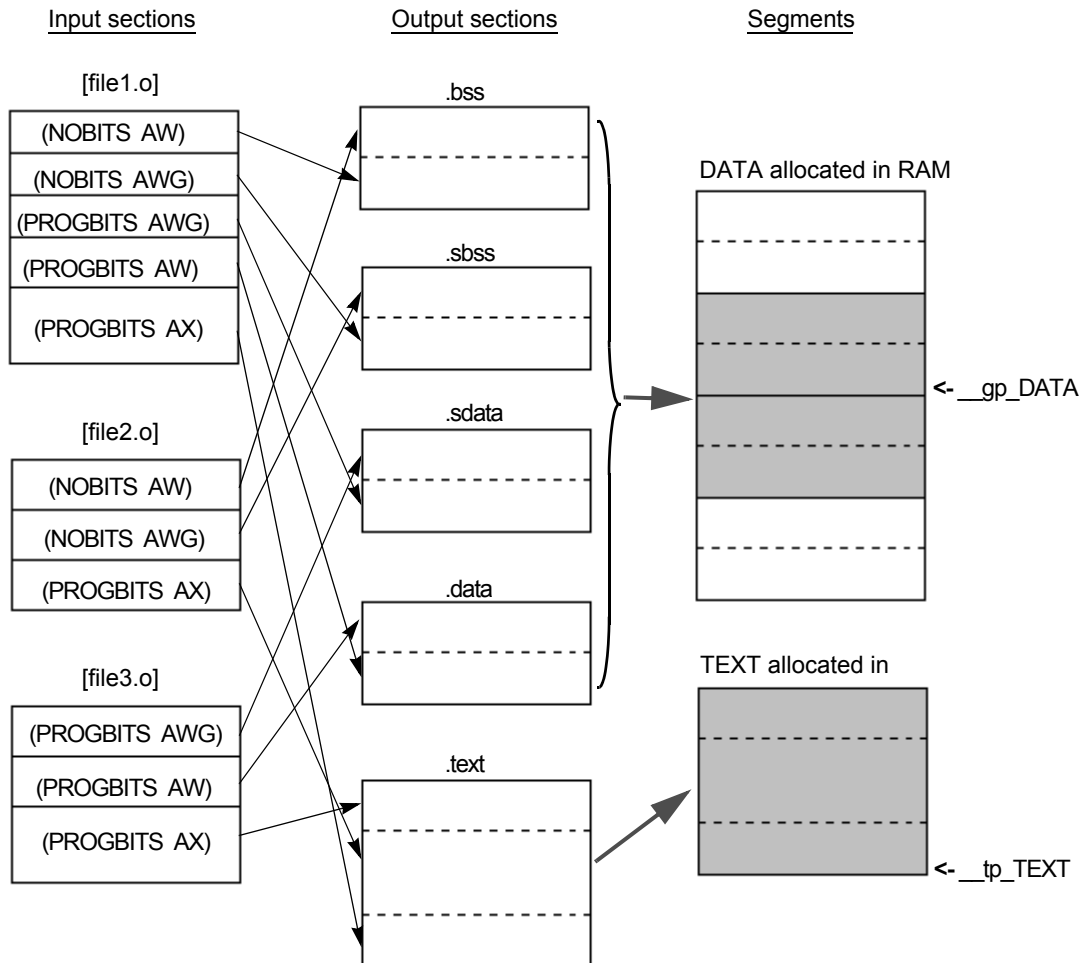
:
```



### A. 2. 3 Relationship between segments and sections

The following shows a mapping image of the relation between segments and sections.

Figure A-3 Relation Between Segments and Sections



Sections that are included in objects (file1.o, file2.o, file3.o) are called "input sections". These sections are gathered in the same attribute. Sections that are grouped and output are called "output sections". Output section groups are also gathered in corresponding segments (DATA segment and TEXT segment) and are mapped to appropriate areas (if there is no explicit address specification).

The text pointer (tp) symbol "**\_\_tp\_TEXT**" and the global pointer (gp) symbol "**\_\_gp\_DATA**" are set according to certain rules.

### A. 2. 4 Types of sections

The following describes the types of sections that can be handled by the CA850.

[Table A-1](#) lists the section types that can specify the allocations, and their features.

Data for which allocation to a section is not specified by this format or section file is allocated by the CA850 to the .sdata section, .data section, .sbss section, or .bss section according to sizes specified by the CA850's options settings

(Note1).

Data for which the type qualifier const has been specified and character string constants are allocated by the CA850 to the .const section or .sconst section according to sizes specified by the CA850's options settings (Note2).

Allocation to sections can also be specified via section files (Note3).

**[Note1]** The default setting is for all data to be allocated to the .sdata or .sbss sections.

Refer to the description of the ca850's -G option in the "CA850 C Compiler Package User's Manual Operation".

**[Note2]** Refer to the description of the ca850's -Xsconst option in the "CA850 C Compiler Package User's Manual Operation".

**[Note3]** Refer to the description of the section file generator (sf850) in the "CA850 C Compiler Package User's Manual Operation".

Table A-1 CA850 Allocation Section Types

| Type  | Feature   | Specified Character String           |
|---|---|--------------------------------------|
| .tidata.byte section<br>.tidata.word section<br>.tibss.byte section<br>.tibss.word section<br>(tiny internal data /<br>tiny internal bss) | <p>This sections can be referenced from ep (element pointer) with 1 instruction toward higher addresses.</p> <p>These sections are accessed with 1 instruction in the same manner as sdata/sibss attribute sections, but differ in terms of the assemble instruction to be used. sdata/sibss attribute sections use the 4-byte "st/ld" instruction for store/reference, whereas tidata/tibss attribute sections use the 2-byte "sst/sld" instruction to perform access. In other words, their code efficiency is better than that of sdata/sibss attribute sections. However, the range in which sst/sld instruction can be applied is small. so it is not possible to allocate a large number of variables.</p> <p>Data with initial values are allocated to the tidata (tidata.byte, tidata.word) attribute section, and data without initial values are allocated to the tibss (tibss.byte, tibss.word) attribute section.</p> <p>Specify the tidata.byte/tibss.byte attribute to allocate byte data, and specify the tidata.word/tibss.word attribute to allocate word data. To select automatic byte/word judgment by the CA850, specify the tidata/tibss attribute.</p> | tidata<br>tidata_byte<br>tidata_word |
| .data section<br>.bss section<br>(data / bss)   | <p>These sections can be reference from gp (global pointer) with 2 instructions.</p> <p>Since access (with ld/st instruction) is performed after address generation, the code becomes correspondingly longer and the execution speed also drops, but the entire 32-bit space can be accessed. In other words, these sections can be allocated anywhere as long as it is in RAM.</p> <p>Data with initial values are allocated to the data attribute section, and data without initial values are allocated to the bss attribute section.</p>  | data                                 |

| Type  | Feature  | Specified Character String |
|---|--|----------------------------|
| .sdata section<br>.sbss section<br>(sdata / sbss)                               | <p>These sections can be referenced from gp (global pointer) with 1 instruction (ld/st instruction), and must be allocated within +/- 32K-byte from gp (64K-byte total).</p> <p>Data with initial values are allocated to the sdata attribute section, and data without initial values are allocated to the sbss attribute section.</p> <p>The CA850 first attempts to generate the code to be allocated to these sections. If the code exceeds the upper limit of these attribute sections, however, code to be allocated in data/bss attribute section is generated.</p> <p>To increase the amount of data to be allocated to sdata/sbss attribute section, the upper size limit for the data to be allocated can be specified with the "-G" option of the CA850 so that data in excess of this upper limit is not allocated to the sdata/sbss attribute section.</p>                        | sdata                      |
| .sedata section<br>.sebss section<br>(small extended data/small extended bss)   | <p>This sections can be referenced from ep (element pointer) with 1 instruction (ld/st instruction), and they are accessed from ep toward lower addresses. In other words, theses sections are allocated within 32K-byte toward lower addresses from ep.</p> <p>Data with initial values are allocated to the sedata attribute section, and data without initial values are allocated to the sebss attribute section.</p> <p>If variables that exceed the upper limit of sdata/sbss attribute section that can be accessed from gp with 1 instruction, but which one wants to access with 1 instruction still exist, they can be allocated in the range that can be accessed with 1 instruction using ep. sidata/sibss attribute section is section for access toward higher addresses from ep, but sedata/sebss attribute section is section for access toward lower addresses from ep.</p>   | sedata                     |
| .sidata section<br>.sibss section<br>(small internal data / small internal bss) | <p>This sections can be referenced from ep (element pointer) with 1 instruction (ld/st instruction), and they are accessed from ep toward higher addresses. In other words, theses sections are allocated within 32K-byte toward higher addresses from ep.</p> <p>Data with initial values are allocated to the sidata attribute section, and data without initial values are allocated to the sibss attribute section.</p> <p>If variables that exceed the upper limit of sdata/sbss attribute section that can be accessed from gp with 1 instruction, but which one wants to access with 1 instruction still exist, they can be allocated in the range that can be accessed with 1 instruction using ep. sidata/sibss attribute section is section for access toward higher addresses from ep, but sedata/sebss attribute section is section for access toward lower addresses from ep.</p> | sidata                     |

| Type                                  | Feature  | Specified Character String |
|---------------------------------------|--|----------------------------|
| .sconst section<br>(small const data) | <p>This section can be referenced from r0 (i.e. address 0) with 1 instruction (ld/st instruction), and must be allocated within +/- 32K-byte from address 0. Basically, data that can be fixed into ROM is allocated to this section.</p> <p>In the case of V850 microcontrollers with internal ROM, in many cases the internal ROM is assigned from address 0, and data that one wishes to reference with 1 instruction and that can be fixed to ROM is allocated as the sconst attribute section. In the case of devices without internal ROM, when the ROM-less mode is specified, such data is allocated to the external memory.</p> <p>Variables/data declared by adding the const modifier are subject to allocation to sconst/const attribute section. If the data exceeds the upper limit of these attribute sections, it is allocated to the const attribute section.</p> <p>To increase the amount of data to be allocated to sconst attribute section, the upper size limit for the data to be allocated can be specified with the "-Xsconst" option of the CA850 so that data in excess of this upper limit is not allocated to the sconst attribute section (refer to the "CA850 C Compiler Package User's Manual Operation" for details on the options).</p> | sconst                     |
| .const section<br>(const data)        | <p>This section can be reference from r0 (i.e. address 0) with 2 instructions. Since access (with ld/st instruction) is performed after address generation, the code becomes correspondingly longer and the execution speed also drops, but the entire 32-bit space can be accessed. Data that can be fixed into ROM that exceeds the upper limit of the sconst attribute section, or data that one wishes to allocate in external ROM in the case of ROM-less devices of the V850 microcontrollers, is allocated to the const attribute section.</p>  | const                      |

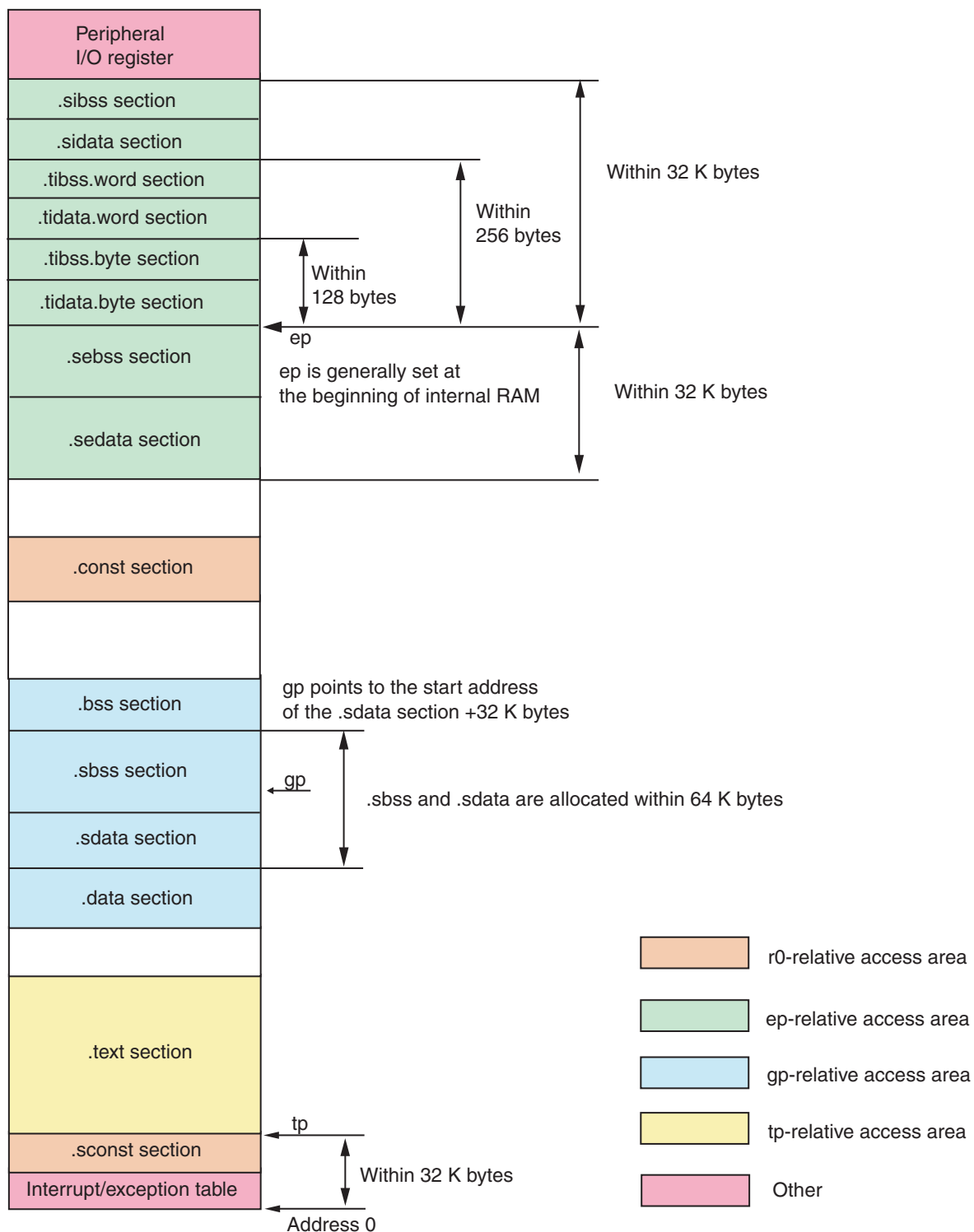
In the above table, "2 instructions" refer to the two instructions that are generated by assembler's instruction expansion function.

In addition, section types that are allocated to "external memory" can be used in cases where external memory has been mounted in the target system.

**[Note]** For details on ".tidata.byte" or ".tidata.word", refer to the "CA850 C Compiler Package Assembly Language User's Manual".

The following shows an image of memory allocation to various sections in the V852.

Figure A-4 Example of Memory Allocation to Various Sections by CA850 (With Internal ROM)



## A. 2. 5 Relationship between types and attributes of sections

The following describes the relation between types and attributes of sections.

These types and attributes are needed when coding section information in mapping directives.

The section types are categorized as shown below.

Table A-2 Section Types

| Section Type | Meaning   |
|--------------|---|
| PROGBITS     | Section that has actual values in an object file<br>--> Text or data (variable) with initial value      |
| NOBITS       | Section that does not have actual values in an object file<br>--> Data (variable) without initial value |

The section attributes are categorized as shown below.

Table A-3 Section Attributes

| Section Attribute | Meaning  |
|-------------------|--|
| A                 | Section that occupies a memory area (corresponds to entire section): memory-resident section   |
| W                 | Write-enable section (section allocated in RAM)  |
| X                 | Executable section (mainly text section)   |
| G                 | Section that is allocated within a memory area that can be referenced using a global pointer (gp) with 16-bit displacement<br>(.sdata and .sbss section) |

Sections are categorized into the following six groups according to their types and attributes.

Table A-4 Types of Sections

| Section Attribute | Section Type<br>Section Attribute |          | Corresponding Reserved<br>Section                        |
|-------------------|-----------------------------------|----------|--|
| bss attribute     | Section type                      | NOBITS   | .bss .sebss,<br>.sibss<br>.tibss.byte<br>.tibss.word     |
|                   | Section attribute                 | AW       |  |
| const attribute   | Section type                      | PROGBITS | .const .sconst   |
|                   | Section attribute                 | A        |  |
| data attribute    | Section type                      | PROGBITS | .data .sedata<br>.sidata<br>.tidata.byte<br>.tidata.word |
|                   | Section attribute                 | AW       |  |
| sbss attribute    | Section type                      | NOBITS   | .sbss  |
|                   | Section attribute                 | AWG      |  |
| sdata attribute   | Section type                      | PROGBITS | .sdata   |
|                   | Section attribute                 | AWG      |  |
| text attribute    | Section type                      | PROGBITS | .pro_epi_runtime<br>.text                                |
|                   | Section attribute                 | AX       |  |

**[Caution]** In cases where a specific section name is created within the application, the user must check the attribute for that section as shown in [Table A-4](#), and specify the section type and section attribute in the mapping directive.

Section names that start with "V/H/A" which is followed by numeric characters cannot be created due to link directive format restrictions.

## A. 3 Symbols

The CA850 uses the following pointers for operation of applications.

- Text pointer (tp)
- Global pointer (gp)
- Element pointer (ep)

Each pointer value relates to the position of a segment and a means to determine these pointer values is required in the link directive.

A link directive contains symbol definitions that are used to determine pointer values. A defined symbol's value is determined by the linker and that value is copied to the pointer in the application to determine the pointer value. A link directive is sometimes called a "symbol directive" because it defines symbols used for pointers.

This section describes the role of each pointer and how pointer values are determined.

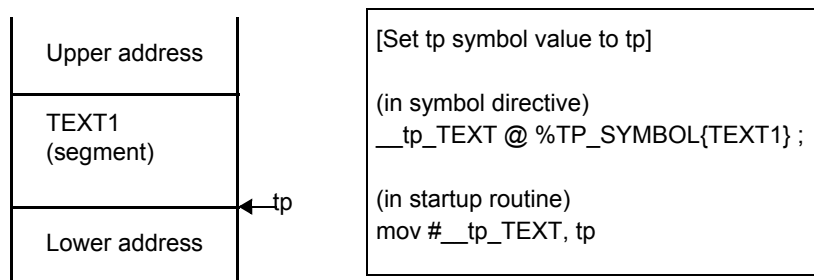
### A. 3. 1 Text pointer (tp)

When referencing a text area in an application, the text pointer (tp) is provided to enable access independent of the allocation position (PIC : Position Independent Code). In other words, the text is referenced with tp-relative. Since the compiler outputs the code on the assumption that the tp has correctly set to the start of the text, the pointer value must be correctly.

In addition to creating a single tp for an application, several tps can be created for various segments.

When several tps have been created, however, the switching of tps must be explicitly performed by the application.

Figure A-5 Example of tp Setting



In the above example, the link directive is used so that the tp symbol value specifies the start of TEXT1 segment. Since the tp symbol name is "\_\_tp\_TEXT", the start address of TEXT1 segment which is determined when linking is set to the symbol "\_\_tp\_TEXT".

To set this value to the tp, a startup routine (or other means) includes code (format: `mov #__tp_TEXT, tp`) that assigns the value of "\_\_tp\_TEXT" to the variable "tp". This correctly sets the text pointer value to the tp.



### A. 3. 2 Global pointer (gp)

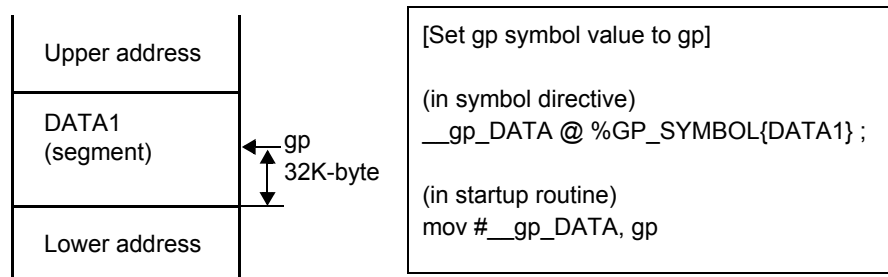
Data that is globally declared in an application is allocated to memory. When referencing (loading or storing) this data that has been allocated to memory, the global pointer (gp) is provided to enable access independent of the allocation position (PID : Position Independent Data).

Globally declared data is referenced with gp-relative. In V850 core devices, such data can be referenced using either "gp and one instruction" or "gp and two instructions". Compared to the "gp and two instructions" method, the "gp and one instruction" method speeds up applications and reduces the code size.

The sections that can be referenced using the gp and one instruction (ld/st instruction) method are the sections that have either the sdata attribute or the sbss attribute, while those that can be referenced using the gp and two instructions (movhi+ld/st instruction) method are the sections that have either the data attribute or the bss attribute. This means there are a total four attributes of sections that can be referenced with the gp-relative. The sections that have either the sdata attribute or sbss attribute are allocated within 32K-byte higher and lower the gp position, so that data (variables) allocated this range can be accessed using only one instruction, which is high-speed access with more reduced code size.

In addition to creating a single gp for an application, several gps can be created for various segments. When several gps have been created, however, the switching of gps must be explicitly performed by the application program.

Figure A-6 Example of gp Setting (When Specifying Segment)



In the above example, the link directive is used to set so that the gp symbol value references the DATA1 segment. Since the gp symbol name is "`__gp_DATA`", the address that is 32K-byte away from the start of the DATA1 segment which is determined when linking is set to the symbol "`__gp_DATA`" (refer to "Figure A-4").

To set this value to the gp, a startup routine (or other means) includes code (format: `mov #__gp_DATA, gp`) that assigns the value of "`__gp_DATA`" to the variable "gp". This correctly sets the global pointer value to the gp.

In addition to address, a gp symbol can also be specified by using an offset address value from tp symbol.

Offset specification for gp symbol values is described next.

#### [Offset specification for gp symbol values]

As was described in the above, a typical method for specifying gp symbol values is the method that specifies the target segment for gp referencing.

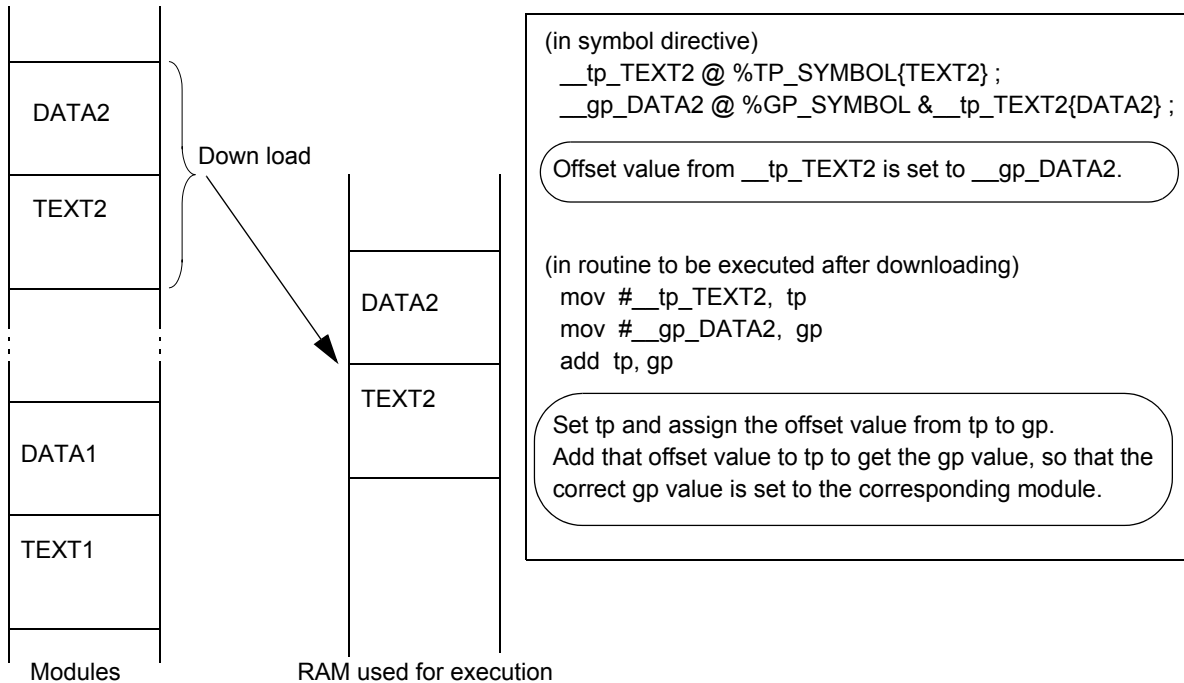
Other methods include directly specifying the gp symbol's address, and determining the base symbol and assigning a gp symbol value that is offset from the base symbol. The latter method is described below (for the former method, refer to "[Rules for determining gp symbol values]").

A tp symbol is specified as the base symbol for a gp symbol.

When creating a gp symbol, if a tp symbol is specified as a base symbol, the value determined by the link directive as the gp's symbol value is the offset value from the tp symbol value.

In this way, the gp symbol value can be easily calculated based on the tp symbol value as "tp symbol value + offset value from tp symbol", which is useful for creating position-independent applications. For example, this method is helpful for copying an executable module to RAM (and then executing it) from an application that has multiple executable modules. In such cases, when determining the tp and gp values, once the tp value is known, the gp symbol value is simply added to that address (as the offset value from tp) to determine the gp value.

Figure A-7 Example of gp Setting (When Specifying Offset from tp)



#### [Rules for determining gp symbol values]

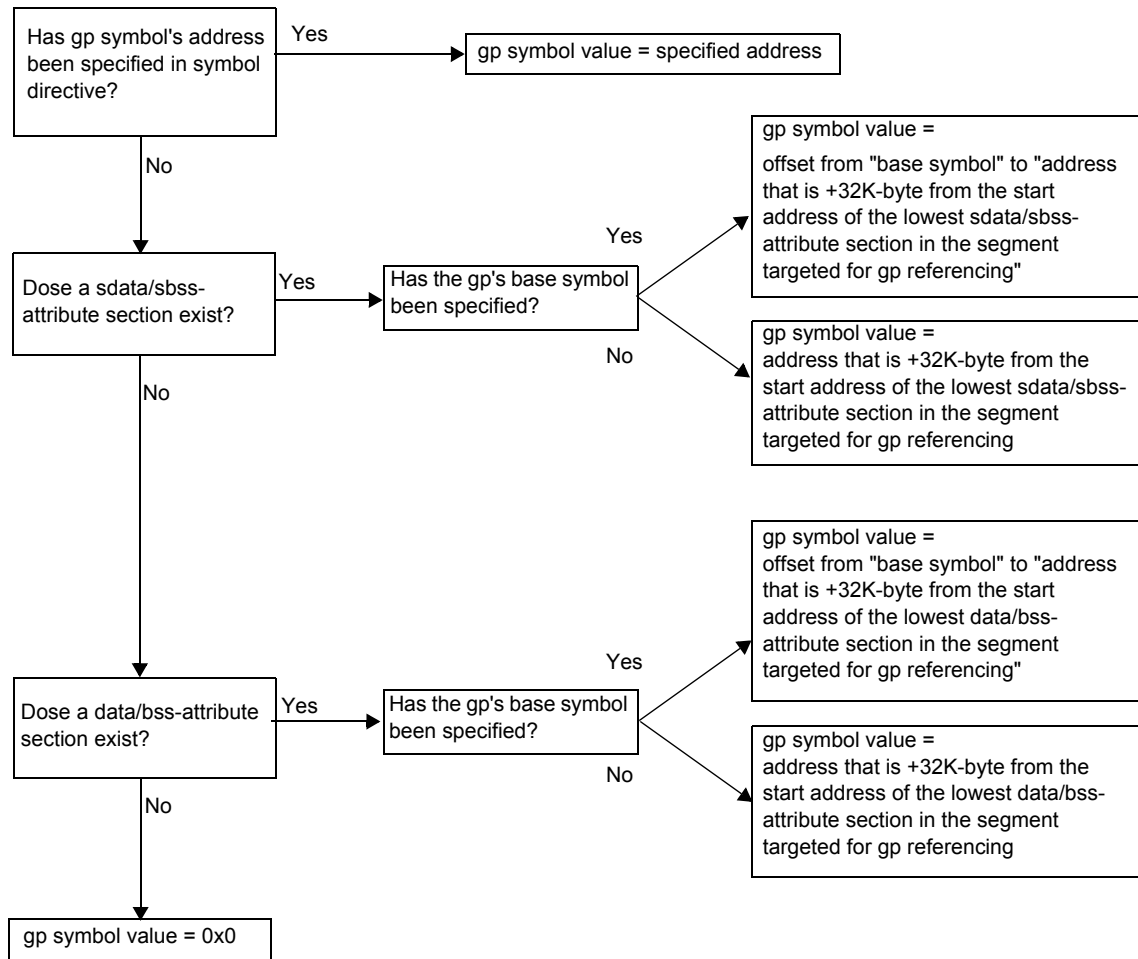
The following factors are involved in determining gp symbol value.

- Whether or not an address has been specified in the symbol directive
- Whether or not sdata/sbss/data/bss-attribute sections exist
- Whether or not a base symbol has been specified

The linker checks for these factors in the link directive file and determines the gp symbol value.

The following figure illustrates the rules for determining gp symbol values.

Figure A-8 Rules for Determining Global Pointer Values



### A. 3. 3 Element pointer (ep)

The element pointer is a pointer that is provided to realize faster access (loading and storing) by allocating data (variables) that are globally declared within an application to RAM area in V850 core device.

Data (variables) that is globally declared and allocated to internal RAM area is referenced with ep-relative.

Although this reference uses the "ep and one instruction" combination, the attributes of sections are determined based on whether the one instruction is an sld/sst instruction or an ld/st instruction.

**- The sections that can be referenced by "ep + sld/sst instruction" are:**

tidata.byte attribute, tibss.byte attribute, tidata.word attribute, or tibss.word attribute

**- The sections that can be referenced by "ep + ld/st instruction" are:**

sidata attribute, sibss attribute, sedata attribute, or sebss attribute

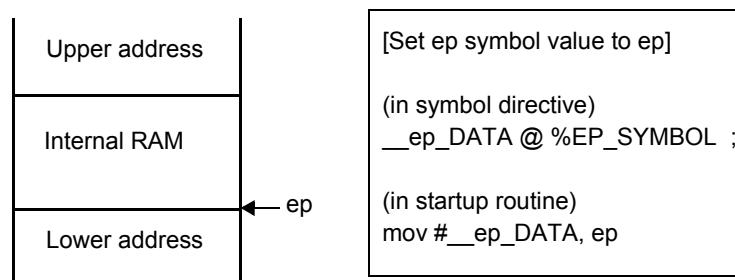
However, the sections with sedata/sebss attribute are not within internal RAM but within external RAM that is accessible via ep-relative referencing.

Generally, internal RAM capacity is too limited to store large amounts of data (variables), but storing certain data (variables) for which high-speed access is desired within the above area where "ep and one instruction" access is possible can be expected to improve the speed of the applications and reduce the code size. The sld/sst instruction is especially useful for reducing code size since its instruction length is two bytes compared to the ld/st instruction's four bytes.

If a creation of ep symbol has been specified in the link directive file's symbol directive, the linker automatically sets the ep symbol at the start of the internal RAM area according to the device file information that is provided for each device being used.

Note that only one ep symbol can be created within an application: it is not possible to create several per application.

Figure A-9 Example of ep Setting



In the above example, the link directive is used to declare the creation of an ep symbol. Since the ep symbol name is "\_\_ep\_DATA", the linker sets the start address of internal RAM to "\_\_ep\_DATA".

To set this value to the ep, a startup routine (or other means) includes code (format: mov #\_\_ep\_DATA, ep) that assigns the value of "\_\_ep\_DATA" to the variable "ep". This correctly sets the element pointer value to the ep.

**[Note]** The application's RAM usage can be set completely within internal RAM (not at all in external RAM), by creating only the ep symbol and not creating any gp symbols. However, if the runtime library will be used, gp symbols must be created since runtime functions reference data (variables) with gp-relative.

**[Rules for determining ep symbol values]**

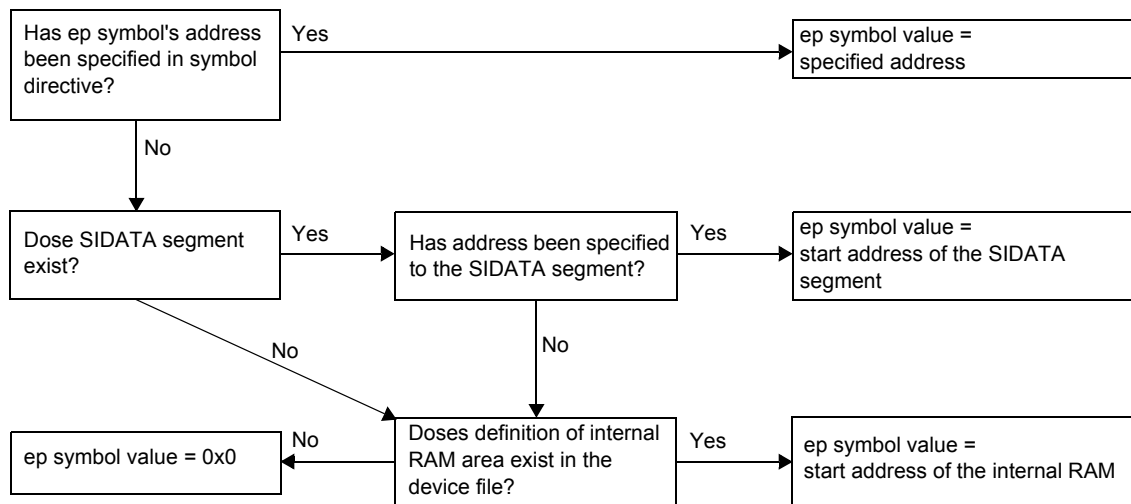
The following factors are involved in determining ep symbol value.

- Whether or not an address has been specified in the symbol directive
- Whether or not SIDATA segment exist
- Whether or not an internal RAM area has been defined in the device file

The linker checks for these factors and determines the ep symbol value.

The following figure illustrates the rules for determining ep symbol values.

Figure A-10 Rules for Determining Element Pointer Values



## A. 4 Link Directive Format

This section describes the format of the link directive file for each following item:

- Segment directive
- Mapping directive
- Symbol directive

The following is an outline of the link directive's format. An editor can be used to enter these directives in text format.

```
Segment directive1{
    Mapping directive ;
} ;

Segment directive2{
    Mapping directive ;
} ;

Segment directive3{
    Mapping directive ;
} ;

Segment directive4{
    Mapping directive ;
} ;

tp symbol directive ;
gp symbol directive ;
ep symbol directive ;
```

**[Caution]** It is recommended to describe segment directive starting from the lowest address.

### A. 4. 1 Characters used in link directive file

The following characters can be used in the link directive file.

- Numerals (0 to 9)
- Uppercase characters (A to Z)
- Lowercase characters (a to z)
- Underscore (\_)
- Dot (.)
- Forward slash (/)
- Back slash (\)
- Colon (:) )
- Shift-JIS code (can be used only for file name; available only in the Japanese system)
- One-byte Japanese character (can be used only for file name; available only in the Japanese system)
- "#" (for comments)

A "#" in the link directive file indicates the start of a comment. Text that starts with "#" and ends at end of the line is handled as a comment.

## A. 4. 2 Link directive file name

Any file name can be assigned to a link directive file as long as the characters used are all valid characters for the link directive file. Note, however, that an extension is necessary; "dir" is recommended. Also note with caution that if an especially long file name is used, it may exceed the number of characters that can be handled during linkage (depending on the OS), which would preclude successful linkage.

If linkage is performed via command line entry, specify a link directive file with the "-D" option.

When using the PM+, specify the link directive file name with the [Link Directive File:] field on the [Link Directive] tab in the [Compiler Common Options] dialog box, which is opened by selecting the PM+'s [Tool] menu -> [Compiler Common Option Settings...].

## A. 4. 3 Segment directive

This section describes the format of the segment directive for each following item:

(1) [Specification items](#)

(2) [Segment directive specification example](#)

### (1) Specification items

The items that are specified in the segment directive are listed below.

Table A-5 Items Specified in Segment Directive

| Item                                | Cording Format              | Description   | Omittable? |
|-------------------------------------|-----------------------------|---|------------|
| <a href="#">Segment name</a>        | <i>segment name</i>         | Name of segment to be created   | No         |
| <a href="#">Segment type</a>        | <i>!LOAD</i>                | Type (fixed) loaded to memory   | No         |
| <a href="#">Segment attributes</a>  | <i>?[R][W][X]</i>           | Specifies whether the segment to be created will have "read-enabled(R)" attribute, "write-enabled(W)" attribute, and/or "executable(X)" attribute (several can be specified). | No         |
| <a href="#">Address</a>             | <i>Vaddress</i>             | Start address of segment to be created  | Yes        |
| <a href="#">Maximum memory size</a> | <i>Lmaximum memory size</i> | Upper limit of memory area occupied by segment to be created  | Yes        |
| <a href="#">Hole size</a>           | <i>Hhole size</i>           | Size of hole to be created after segment (blank space between segment and next segment)   | Yes        |
| <a href="#">Fill value</a>          | <i>Ffill value</i>          | Value used to fill hole area  | Yes        |
| <a href="#">Alignment condition</a> | <i>Aalignment condition</i> | Alignment condition for memory allocation   | Yes        |

A specific example of the segment directive's format is shown below.

```

segment name : !segment type ?segment attribute Vaddress Lmaximum memory size
                Hhole size Ffill value Aalignment condition{
                :
                (Mapping directive)
                :
                } ;

```

A blank space is used to separate these items from each other. A semicolon (;) must be added at the end of each segment directive. For details on the mapping directive, refer to "[A. 4. 4 Mapping directive](#)".

The omissible specification items are "Vaddress", "Lmaximum memory size", "Hhole size", "Ffill value", and "Aalignment condition". Default values are used for these items when they are omitted. These default values are listed below.

Table A-6 Default Values for Omitted Segment Directive Specification Items

| Specification Item  | Default Value  |
|---------------------|--|
| Address             | Address 0x0 for first segment, and the value continued from the end of the previous segment for other segments |
| Maximum memory size | 0x100000 (bytes)   |
| Hole size           | 0x0 (bytes)  |
| Fill value          | 0x0000   |
| Alignment condition | 0x8 (bytes)  |

**[Caution]** It is recommended to describe segment directive starting from the lowest address.

#### (a) Segment name

Specify the name of the segment to be created.

When creating a segment, specification of the segment name cannot be omitted.

The characters listed under "[A. 4. 1 Characters used in link directive file](#)" can be used to specify the segment name, and there is no restriction on the length of the character string. However, the name of segments which assign reserved sections listed in "[Table A-7](#)" are fixed. Names other than those listed cannot be used for these segments.

Table A-7 Reserved Section Names with Fixed Segment Names

| Section Name   | Segment Name |
|--|--------------|
| .sidata .sibss<br>.tidata .tibss<br>.tidata.byte .tibss.byte<br>.tidata.word .tibss.word | SIDATA       |
| .sedata .sebss   | SEDATA       |
| .sconst  | SCONST       |



**[Caution]** The name of the segment for .sconst can be changed, but an error check is not performed to some of the data.

#### (b) Segment type

Specify the type of the segment to be created.

When creating a segment, specification of the segment type cannot be omitted.

At present, only "LOAD" type (segment type that is loaded to memory) can be specified. The linker outputs an error message if another value is specified. The "LOAD" can be specified using either uppercase or lowercase letters.

Start the segment type specification with a "!", which must not be followed by blank space.

#### (c) Segment attributes

Specify the attribute of the segment to be created.

When creating a segment, specification of the segment attribute cannot be omitted.

The specifiable segment attributes and their meanings are listed below.

A segment attribute depends on an attribute of mapping directive belonging to the segment. Therefore, the segment attribute specification must take into account the section attribute to be specified in the mapping directive.

Table A-8 Segment Attributes and Their Meanings

| Segment Attribute | Meaning               |
|-------------------|-----------------------|
| R                 | Read-enabled segment  |
| W                 | Write-enabled segment |
| X                 | Executable segment    |

Several segment attributes can be specified at the same time, with R, W, and X specified in any order with no blank spaces between them. Start each segment attribute specification with a "?", which must not be followed by a blank space.

**[Caution]** If multiple segment attribute specifications are performed in one segment directive, the linker outputs an error message and stops linking.

[Example] : SEG : !LOAD ?RX ?RW {} ;

#### (d) Address

Specify the start address of the segment to be created.

When creating a segment, specification of the address can be omitted. When it is omitted, the address 0x0 is assigned as the start address if the segment is the first segment, otherwise the assigned value for the start address is the value continued from the end of the previous segment (based on the alignment).

Address specifications must be made with consideration given to the way memory is allocated in the target CPU. For example, if the target CPU is a V850 core device, the address 0x0 is used for reset interrupt processing (reset interrupt handler). Therefore, if reset interrupt will be processed, be sure to set addresses so that the

address 0x0 is not assigned to other segments.

Also, since different memory capacities are installed in the various V850 core devices, their internal ROM/RAM uses different start and end addresses. Consequently, the allocation address specification for each segment must take into account which CPU is being used. For description of a particular CPU's memory, refer to the CPU's User's Manual (Hardware Version) and/or the corresponding device file's User's Manual.

Specify even-numbered values as the address values. If an odd-numbered value is specified, the linker outputs a message and continues with linking on the assumption that the "specified address plus one" has been specified.

Start the address specification with a "V" (uppercase or lowercase), which must not be followed by a blank space. Address values can be specified using either decimal or hexadecimal numerals, but when using hexadecimal numerals be sure to add "0x" before the value. Expressions cannot be used in the address specification.

#### **(e) Maximum memory size**

Specify the maximum value for memory size of the segment to be created.

This specification is used not to exceed the segment's intended size. Therefore, if the segment's actual size is less than the specified "maximum memory size", the next segment will follow immediately afterward.

If the segment's actual size exceeds the specified "maximum memory size", the linker outputs an error message and stops linking.

When creating a segment, specification of the maximum memory size can be omitted. The value 0x100000 (bytes) is used as the default value when it is omitted.

Start the maximum memory size specification with a "L" (uppercase or lowercase), which must not be followed by a blank space. Expressions cannot be used in the maximum memory size specification.

#### **(f) Hole size**

Specify the hole size of the segment to be created.

The segment's hole is the space between one segment and the next segment. When a hole size has been specified, the specified hole is created at the end of the target segment.

When creating a segment, specification of the hole size can be omitted. The value 0x0 (bytes) is used as the default value (which specifies that no hole is created) when it is omitted.

Start the hole size specification with an "H" (uppercase or lowercase), which must not be followed by a blank space.

Expressions cannot be used in the hole size specification.

#### **(g) Fill value**

Specify a fill value as the value to be used for filling hole areas that are created either segments are allocated or when explicitly specified via the "H" specification.

When specifying the fill value, specify the "-B" option to perform linking in the 2-pass mode. If the linkage is performed with the fill value specification in the 1-pass mode (default), the linker outputs a message and continues linking in the 2-pass mode.

When creating a segment, specification of the fill value can be omitted. The value 0x0000 is used as the default value (which fills hole areas with zeros) when it is omitted. However, if the "-F" option (linker fill value option) has

been specified, the linker outputs a message and continues linking while ignoring the fill value specified by the link directive.

Start the fill value specification with an "F" (uppercase or lowercase), which must not be followed by a blank space. Specify a two-byte four-digit hexadecimal value as the fill value. If the value does not occupy all four digits, the remaining (higher) digits are assumed to be zeros. If the hole size is less than two bytes, the required digits are taken out of the lower value of the specified fill value. Expressions cannot be used in the fill value specification.

#### (h) Alignment condition

Specify the segment alignment condition (alignment value) to be used for memory allocation of the segment to be created.

When creating a segment, specification of the alignment condition can be omitted. The value 0x8 (bytes) is used as the default value (which sets 8-byte alignment) when it is omitted.

Start the alignment condition specification with an "A" (uppercase or lowercase), which must not be followed by a blank space. Specify even-numbered values as the alignment condition values. If an odd-numbered value is specified, the linker outputs a message and continues with linking on the assumption that the "specified value plus one" has been specified. Expressions cannot be used in the alignment condition specification.

#### (2) Segment directive specification example

A segment specification example is shown below.

Table A-9 Segment Example

| Item                 | Value                    |
|----------------------|--------------------------|
| Segment name         | PROG1                    |
| Segment attribute(s) | Read-enabled, executable |
| Allocation address   | address 0x1000           |
| Maximum memory size  | 0x200000 (bytes)         |
| Hole size            | 0x20 (bytes)             |
| Fill value           | 0xffff                   |
| Alignment condition  | 0x16 (bytes)             |

The segment directive code appears as shown below for above segment.

```
PROG1 : !LOAD ?RX V0x1000 L0x200000 H0x20 F0xffff A0x16{
      :
      (Mapping directive)
      :
    } ;
```

**[Caution]** Basically, there is no problem if segment directives are described in the order of the allocation addresses. The only exception applies to segments that have .sedata/.sebss section (by default, "SEDATA

segment"), only when the allocation address is omitted.

In the CA850, the SEDATA segment is defined as a segment used to reference the area below the internal RAM with 1 ep-relative instruction, and therefore, if the allocation address is omitted, the linker considers that the address obtained by subtracting 0x8000 from the internal RAM start address defined in the device file, has been specified.

The following is an example of this case.

```

SIDATA : !LOAD ?RW V0xffb000{
        .tidata.byte = $PROGBITS ?AW .tidata.byte ;
        .tibss.byte  = $NOBITS   ?AW .tibss.byte  ;
        .tidata.word = $PROGBITS ?AW .tidata.word ;
        .tibss.word  = $NOBITS   ?AW .tibss.word ;
        .sidata      = $PROGBITS ?AW .sidata ;
        .sibss       = $NOBITS   ?AW .sibss ;
    } ;

SEDATA : !LOAD ?RW{
        .sedata      = $PROGBITS ?AW .sedata ;
        .sebss       = $NOBITS   ?AW .sebss ;
    } ;

DATA   : !LOAD ?RW{
        .data        = $PROGBITS ?AW .data ;
        .sdata       = $PROGBITS ?AWG .sdata ;
        .sbss        = $NOBITS   ?AWG .sbss ;
        .bss         = $NOBITS   ?AW .bss ;
    } ;

```

The SEDATA address is omitted and this start address is judged as 0xff2000 (= 0xffb00 - 0x8000) according to device file information. Since SIDATA is defined as being allocated to address 0xffb000, the CA850 moves the SEDATA to the front of SIDATA and links them.

Moreover, since the address of the DATA segment defined after that is omitted, DATA is allocated immediately after the SEDATA.

## A. 4. 4 Mapping directive

This section describes the format of the mapping directive for each following item:

- (1) [Specification items](#)
- (2) [Mapping directive specification example](#)

### (1) Specification items

The items that are specified in the mapping directive are listed below.

Table A-10 Items Specified in Mapping Directive

| Item                                | Cording Format  | Description   | Omittable? |
|-------------------------------------|---|---|------------|
| <a href="#">Output section name</a> | <i>output section name</i>                                | Name of section output to load module   | No         |
| <a href="#">Section type</a>        | \$PROGBITS,<br>\$NOBITS                                   | Type of section to be created   | No         |
| <a href="#">Section attributes</a>  | ?[A][W][X][G]   | Specifies whether the section to be created will have "memory-resident(A)" attribute, "write-enabled(W)" attribute, "executable(X)" attribute, and/or "accessible via gp with 16-bit displacement(G)" attribute (several can be specified). | No         |
| <a href="#">Address</a>             | <i>Vaddress</i>   | Start address of section to be created  | Yes        |
| <a href="#">Hole size</a>           | <i>Hhole size</i>   | Size of hole to be created after section (blank space between section and next section)   | Yes        |
| <a href="#">Alignment condition</a> | <i>Aalignment condition</i>                               | Alignment condition for memory allocation   | Yes        |
| <a href="#">Input section name</a>  | <i>Input section name</i>                                 | Name of input section allocated to output section   | Yes        |
| <a href="#">Object file name</a>    | { <i>object file name</i><br><i>object file name...</i> } | Name of object file that includes the sections to be extracted and used as the input sections (several can be specified; insert spaces between the specifications).   | Yes        |

A specific example of the mapping directive's format is shown below.

```
output section name = $section type ?section attribute Vaddress
Hhole size Aalignment condition input section name
{object file name object file name} ;
```

A blank space is used to separate these items from each other. A semicolon (;) must be added at the end of each segment directive.

The omissible specification items are "*Vaddress*", "*Hhole size*", "*Aalignment condition*", "*input section name*" and "*object file name*". Default values or pre-set conventions are used for these items when they are omitted. These default values and pre-set conventions are listed below.

Table A-11 Default Values/Conventions for Values That Can Be Omitted in Mapping Directive Specification Items

| Specification Item  | Default Value or Pre-set Convention  |
|---------------------|--|
| Address             | Sets according to address that was specified via the segment directive.<br>If there are several sections and this is not the first one, the value is continued from the end of the previous section.<br>If the section is the first section, the value is continued from the start of the segment. |
| Hole size           | 0x0 (bytes)  |
| Alignment condition | .tidata.byte/.tidata.word section : 0x1 (bytes)<br>Other sections : 0x4 (bytes)  |
| Input section       | Sections having the same attribute as the output section to be created are extracted from all objects.<br>If an object file name has been specified, they are extracted from the specified object.   |
| Object file name    | Sections having the same attribute as the output section to be created are extracted from all objects.<br>If an input section has been specified, they are extracted from all the objects that have the same attribute as the output section to be created.  |

These specification items are explained below.

#### (a) Output section name

Specify the name of section to be output to the load module. When creating a section, specification of the output section name cannot be omitted.

The characters listed under "[A. 4. 1 Characters used in link directive file](#)" can be used to specify the output section name, and there is no restriction on the length of the character string.

However, note the fixed correspondence of output section names and input section names listed in the [Table A-12](#). Names other than those listed cannot be used for these sections.

Table A-12 Input Section Names with Fixed Section Names

| Input Section Name       | Output Section 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              |
| .pro_epi_runtime section | .pro_epi_runtime    |

**[Caution]** The name of the section for `.sconst` can be changed, but an error check is not performed to some of the data.

Although two or more mapping directives can be described in the same segment directive, two or more of the same output section names cannot be specified in different segment directive. If two or more of the same output section names are specified, the linker outputs an error message and stops linking.

#### (b) Section type

Specify the type of the output section.

When creating a section, specification of the output section type cannot be omitted.

The specifiable section types and their meanings are listed below.

Table A-13 Section Types

| Section Type | Meaning   |
|--------------|---|
| PROGBITS     | Section that has actual values in an object file<br>--> Text or data (variable) with initial value      |
| NOBITS       | Section that does not have actual values in an object file<br>--> Data (variable) without initial value |

Start the section type specification with a "\$", which must not be followed by a blank space.

If only "\$" is specified, the linker outputs an error message and stops linking.

#### (c) Section attributes

Specify the attribute of the section to be created.

When creating a section, specification of the section attribute cannot be omitted.

The specifiable section attributes and their meanings are listed below.

Table A-14 Section Attributes and Their Meanings

| Section Attribute | Meaning  |
|-------------------|--|
| A                 | Section that occupies a memory area (corresponds to entire section) : memory-resident section  |
| W                 | Write-enable section (section allocated in RAM)  |
| X                 | Executable section (mainly text section)   |
| G                 | Section ( <code>.sdata</code> , <code>.sbss</code> section) that is allocated within a memory area that can be referenced using a global pointer (gp) with 16-bit displacement |

Several section attributes can be specified at the same time, with A, W, X, and G specified in any order with no blank spaces between them. Start each section attribute specification with a "?", which must not be followed by a blank space.

**(d) Address**

Specify the start address of the section to be created.

When creating a section, specification of the address can be omitted. If it is omitted, the address is assigned based on the address specified via the segment directive. If there are several sections and this is not the first one, the value is continued from the end of the previous section.

Normally, section addresses are specified as a group for each segment, but separate address specifications can be made to assign certain addresses to certain sections.

Specify even-numbered values as the address values except for .tdata.byte/.tibss.byte section. If an odd-numbered value is specified, the linker outputs a message and continues with linking on the assumption that the "specified address plus one" has been specified.

Start the address specification with a "V" (uppercase or lowercase), which must not be followed by a blank space. Address values can be specified using either decimal or hexadecimal numerals, but when using hexadecimal numerals be sure to add "0x" before the value. Expressions cannot be used in the address specification.

**(e) Hole size**

Specify the hole size of the section to be created.

The section's hole is the space between one section and the next section. When a hole size has been specified, the specified hole is created at the end of the target section.

When creating a section, specification of the hole size can be omitted. The value 0x0 (bytes) is used as the default value (which specifies that no hole is created) when it is omitted.

Start the hole size specification with an "H" (uppercase or lowercase), which must not be followed by a blank space. Expressions cannot be used in the hole size specification.

**(f) Alignment condition**

Specify the section alignment condition (alignment value) to be used for memory allocation of the section to be created.

When creating a section, specification of the alignment condition can be omitted. If it is omitted, the default value is used, but that value differs among different types of section as shown below.

Table A-15 Section Types and Default Values for Alignment Condition

| Section Name                    | Alignment Condition |
|---------------------------------|---------------------|
| .tdata.byte/.tibss.byte section | 0x1 (bytes)         |
| Other sections                  | 0x4 (bytes)         |

Start the alignment condition specification with an "A" (uppercase or lowercase), which must not be followed by a blank space.

Either even-numbered or odd-numbered values can be specified for .tdata.byte and .tibss.byte sections and only even-numbered values can be specified for all other sections. If an odd-numbered value is specified for any section other than a .tdata.byte or .tibss.byte section, the linker outputs a message and continues with linking on the assumption that the "specified value plus one" has been specified. Expressions cannot be used in the



alignment condition specification.

#### (g) Input section name

Specify the input section information that is the basis for the output section to be created.

When creating a section, specifications of the input section name and object file name can be omitted. If it is omitted, the information output to the output section varies according to the following combinations of specifications.

Table A-16 Output Based on Combination of Input Section and Object File Specifications

| Code Pattern                                | Output  |
|---|---|
| 1) Input section name<br>+ object file name | The specified input section is extracted from the specified object and is then output.  |
| 2) Input section name only                  | The specified input section is extracted from all objects and is then output.   |
| 3) Object file name only                    | Sections having the same attribute as the output section to be created are extracted from the specified object and are then output. |
| 4) No specification                         | Sections having the same attribute as the output section to be created are extracted from all objects and are then output.          |

More specific example are listed below.

Table A-17 Specific Examples of Combined Input Section and Object File Specifications

| Code Example   | Output  |
|--|---|
| <pre>SEG1 : !LOAD ?RX{     sec1 = \$PROGBITS ?AX usrsec1 ; } ;</pre>           | "usrsec1" section is extracted from all objects and is output as "sec1" section.  |
| <pre>SEG1 : !LOAD ?RX{     sec1 = \$PROGBITS ?AX {file1.o file2.o} ; } ;</pre> | Sections having \$PROGBITS type and A and X attributes are extracted from file1.o and file2.o and are output as "sec1" section. |
| <pre>SEG1 : !LOAD ?RX{     sec1 = \$PROGBITS ?AX usrsec1{file1.o} ; } ;</pre>  | "usrsec1" section is extracted from file1.o and is output as "sec1" section.  |
| <pre>SEG1 : !LOAD ?RX{     sec1 = \$PROGBITS ?AX ; } ;</pre>                   | Sections having \$PROGBITS type and A and X attributes are extracted from all objects and are output as "sec1" section.         |

If there is multiple information when allocating sections, sections are allocated using the numbers indicated in the [Code Pattern] column in "Table A-16" as the priority order (in the case of two or more sections with the same priority number, the one with the lowest address has higher priority).

Specify the section name that has been set by the application as the input section name. If the application has not set a section name, a default section name is already defined and should be used here. For details of default section names, refer to the "CA850 C Compiler Package C Language User's Manual" or "CA850 C Compiler Package Assembly Language User's Manual".

As was explained in "(a) Output section name", there is a fixed correspondence between output section names

and input section names. Other section names cannot be specified for section names that are included in this group.

#### (h) Object file name

Enter the object file name specification at the end of the mapping directive and enclose each file name with "{ }". Insert a blank space between file names when specifying several file names (if the file name includes blank spaces, enclose the file name with quotation marks ("")).

When several object files have been specified, they are allocated in the order they are specified, in ascending order from lower to higher addresses. However, if a different allocation order is specified for link directive by the "objects for linking" specification that occurs when the linker is started, the file name sequence specified by that specification's parameters takes priority.

```
Link directive
    sec = $PROGBITS ?AX {file1.o file2.o file3.o}

Linker activation
    ld850 file3.o file1.o file2.o
    --> file3.o, file1.o, and file2.o are allocated in that order, starting from lower address
```

When an object file name is specified in a mapping directive, specify all object file names that include sections having the specified attribute.

For example, the four objects (file1.o, file2.o, file3.o, and file1.4) including text-attribute sections exist. In this case, if the link directive is entered as:

```
TEXT1 : !LOAD ?RX {
    .text1 = $PROGBITS ?AX { file1.o file2.o } ;
} ;
TEXT2 : !LOAD ?RX{
    .text2 = $PROGBITS ?AX { file3.o } ;
} ;
```

and no specific allocation site for the text attribute in the file4.o has been specified, the linker searches and allocates text-attribute sections from file4.o as suitable text-attribute sections. Therefore, the mapping results may not be as expected (if the text-attribute section is not allocated to any section, the linker outputs a message).

Specify a file of the same name located in a different directory as follows by specifying a file name with the path displayed on the link map.

Specify a file of the same name located in a different directory as follows by specifying a file name with the path displayed on the link map.

```
textsec1 = $PROGBITS ?AX { c:\work\dir1\file1.o } ;
textsec2 = $PROGBITS ?AX { c:\work\dir2\file1.o } ;
textsec3 = $PROGBITS ?AX { file1.o } ;
```

In the above case, the file1.o files that exist in the specified directories are allocated to textsec1 and textsec2 respectively, and the other file1.o file is allocated to textsec3. Since the path specification method during such allocation is only the format displayed to the link map, attention is required when making descriptions.

It is also possible to specify input object names for objects in libraries or other type of archive files. For example, the following is entered to specify output of object "lib1.o" in the archive file "libusr.a" to the "usrlib" section.

```
usrlib = $PROGBITS ?AX { lib1.o(a:\usrlib\libusr.a) } ;
```

Moreover, describe as follows to allocate all the objects in the specified library.

```
usrlib = $PROGBITS ?AX { libusr.a } ;
```

In this case, the object in "libusr.a" is allocated to "usrlib" section.

#### (i) If specification duplicates

If the same section type, section attribute, input section name (can be omitted), or input file name (can be typed) is specified for multiple segments and there is a section corresponding to it, an object is assigned to a segment allocated at a lower address.

```
TEXT1 : !LOAD ?RX V0x1000 {
        .text1 = $PROGBITS ?AX.text { file1.o file2.o } ;
    } ;
TEXT2 : !LOAD ?RX V0x2000 {
        .text2 = $PROGBITS ?AX.text { file1.o file2.o } ;
    } ;
```

In the above case, the same section type, section attribute, input section name, and input file name are specified for TEXT1 and TEXT2, the object is assigned to TEXT1, which is allocated at the lower address.

**(2) Mapping directive specification example**

This example shows specifications for the following types of output sections. Two type of sections are created.

Table A-18 Mapping Directive Specification Example

| Item                | Value-1                  | Value-2                  |
|---------------------|--------------------------|--------------------------|
| Output section name | .text                    | textsec1                 |
| Section type        | Text                     | Text                     |
| Section attribute   | Read-enabled, executable | Read-enabled, executable |
| Hole size           | 0x10 (bytes)             | 0x20 (bytes)             |
| Fill value          | 0xffff                   | 0xffff                   |
| Alignment condition | 0x10 (bytes)             | 0x10 (bytes)             |
| Input section name  | .text                    | usrsec1                  |
| Object file name    | main.o                   | -                        |

In the above case, the corresponding mapping directive specification is shown below.

```
.text      = $PROGBITS ?AX H0x10 F0xffff A0x10 .text {main.o} ;
textsec1 = $PROGBITS ?AX H0x20 F0xffff A0x20 usrsec1 ;
```

## A. 4. 5 Symbol directive

This section describes the format of the symbol directive for each following item:

- (1) [Specification items](#)
- (2) [Symbol directive specification example](#)

### (1) Specification items

The items that are specified in the symbol directive are listed below.

**[tp symbol]**

Table A-19 Specifiable Items When Creating tp Symbol

| Item                                | Cording Format                                    | Meaning   | Omittable? |
|-------------------------------------|---|---|------------|
| <a href="#">Symbol name</a>         | <i>symbol name</i>                                | Name of tp symbol to be created   | No         |
| <a href="#">Symbol type</a>         | %TP_SYMBOL  | Type of symbol to be created (fixed)  | No         |
| <a href="#">Address</a>             | <i>Vaddress</i>                                   | Address of tp symbol to be created  | Yes        |
| <a href="#">Alignment condition</a> | <i>Aalignment condition</i>                       | Alignment condition of symbol value   | Yes        |
| <a href="#">Segment name</a>        | { <i>segment name</i><br><i>segment name...</i> } | Name of segment to be referenced by tp symbol to be created (several can be specified; insert blank spaces between the specifications.) | Yes        |

A specific example of the symbol directive's format is shown below.

```
symbol name @ %TP SYMBOL Vaddress Aalignment condition {segment name segment name} ;
```

A blank space is used to separate these items from each other. A semicolon (;) must be added at the end of each specification.

The omissible specification items are "*Vaddress*", "*Aalignment condition*", and "*segment name*". Default values are used for these items when they are omitted. These default values are listed below.

Table A-20 Default Values for tp Symbols

| Specification Item  | Default Value  |
|---------------------|--|
| Address             | If a segment name has been specified, this address is the start address of the text-attribute section that has been allocated to the lowest address in that segment.<br>If a segment name has not been specified, this address is the start address of the text-attribute section that has been allocated to the lowest address in the text-attribute segment existing in the load module. |
| Alignment condition | 0x4 (bytes)  |
| Segment name        | All text-attribute segments exist in objects are targeted.   |

**[gp symbol]**

Table A-21 Specifiable Items When Creating gp Symbol

| Item                | Cording Format                                    | Meaning   | Omittable? |
|---------------------|---|---|------------|
| Symbol name         | <i>symbol name</i>                                | Name of gp symbol to be created   | No         |
| Symbol type         | %GP_SYMBOL  | Type of symbol to be created (fixed)  | No         |
| Base symbol name    | <i>&amp;base symbol name</i>                      | tp symbol name that is specified as the offset value when offsetting the gp symbol from the tp symbol.                                  | Yes        |
| Address             | <i>Vaddress</i>                                   | Address of gp symbol to be created  | Yes        |
| Alignment condition | <i>Aalignment condition</i>                       | Alignment condition of symbol value   | Yes        |
| Segment name        | { <i>segment name</i><br><i>segment name...</i> } | Name of segment to be referenced by gp symbol to be created (several can be specified; insert blank spaces between the specifications.) | Yes        |

A specific example of the symbol directive's format is shown below.

```
symbol name @ %GP_SYMBOL &base symbol name Vaddress Aalignment condition
{segment name segment name} ;
```

A blank space is used to separate these items from each other. A semicolon (;) must be added at the end of each specification.

The omissible specification items are "*Vaddress*", "*Aalignment condition*", and "*segment name*". Default values are used for these items when they are omitted. These default values are listed below.

Table A-22 Default Values for gp Symbols

| Specification Item  | Default Value   |
|---------------------|---|
| Base symbol name    | Address to be determined as the gp symbol value, not for offset from tp symbol For a description of how to determine, refer to "[Offset specification for gp symbol values]". |
| Address             | According to "[Rules for determining gp symbol values]"   |
| Alignment condition | 0x4 (bytes)   |
| Segment name        | All sections with sdata/data/sbss/bss attributes existing in objects are targeted (refer to "[Offset specification for gp symbol values]").                                   |

**[ep symbol]**

Table A-23 Specifiable Items When Creating ep Symbol

| Item                | Cording Format             | Meaning                              | Omittable? |
|---------------------|----------------------------|--------------------------------------|------------|
| Symbol name         | <i>symbol name</i>         | Name of ep symbol to be created      | No         |
| Symbol type         | %EP_SYMBOL                 | Type of symbol to be created (fixed) | No         |
| Address             | <i>Vaddress</i>            | Address of ep symbol to be created   | Yes        |
| Alignment condition | <i>Alignment condition</i> | Alignment condition of symbol value  | Yes        |

A specific example of the symbol directive's format is shown below.

```
symbol name @ %EP_SYMBOL Vaddress Alignment condition ;
```

A blank space is used to separate these items from each other. A semicolon (;) must be added at the end of each specification.

The omissible specification items are "*Vaddress*" and "*Alignment condition*". Default values are used for these items when they are omitted. These default values are listed below.

Table A-24 Default Values for ep Symbols

| Specification Item  | Default Value   |
|---------------------|---|
| Address             | According to "[Rules for determining ep symbol values]" |
| Alignment condition | 0x4 (bytes)   |

These specification items are explained below.

**(a) Symbol name**

[Specifiable symbols: tp, gp, ep]

Specify the name of the symbol to be generated. When creating a symbol, specification of the symbol name cannot be omitted.

The characters listed under "[A. 4. 1 Characters used in link directive file](#)" can be used to specify the symbol name, and there is no restriction on the length of the character string.

**(b) Symbol type**

[Specifiable symbols: tp, gp, ep]

Specify whether the generated symbol will be a tp symbol, gp symbol, or ep symbol. When creating a symbol, specification of the symbol type cannot be omitted.

Specify "TP\_SYMBOL", "GP\_SYMBOL", or "EP\_SYMBOL" corresponding to the desired type of symbol (tp symbol, gp symbol, or ep symbol). The linker outputs an error message if another value is specified.

Start the symbol type specification with a "%", which must not be followed by a blank space.

**(c) Base symbol name**

[Specifiable symbol: gp]

Specify the tp symbol that will be used to determine the gp symbol value when creating gp symbols. When a base symbol name has been specified, the gp symbol value becomes the offset value from the tp symbol value. When creating a gp symbol, specification of the base symbol name can be omitted. If it is omitted, the address determined according to "[Rules for determining gp symbol values]" becomes the gp symbol value.

Start the base symbol specification with an "&", which must not be followed by a blank space. After the "&", enter the tp symbol name to be used as the base symbol.

**(d) Address**

[Specifiable symbols: tp, gp, ep]

Specify the tp symbol value or gp symbol value (these values are addresses).

When creating a symbol, specification of the address can be omitted. If it is omitted, the address is determined as described below.

Table A-25 Address Specification for tp Symbol and gp Symbol

| Symbol Value | Rule for Determination   |
|--------------|--|
| tp symbol    | <p><u>If a segment name has been specified:</u><br/>start address of the text-attribute section that has been allocated to the lowest address in the specified segment</p> <p><u>If a segment name has not been specified:</u><br/>start address of the text-attribute section that has been allocated to the lowest address in the text-attribute segment existing in the load module</p> |
| gp symbol    | According to "[Rules for determining gp symbol values]"  |
| ep symbol    | According to "[Rules for determining ep symbol values]"  |

Start the address specification with a "V" (uppercase or lowercase), which must not be followed by a blank space.

**(e) Alignment condition**

[Specifiable symbols: tp, gp, ep]

Specify the alignment condition (alignment value) for setting values to the tp symbol, gp symbol, or ep symbol to be created.

When creating a symbol, specification of the alignment condition can be omitted. The default value is used when it is omitted. This default value is 0x4 (bytes).

Start the alignment condition specification with an "A" (uppercase or lowercase), which must not be followed by a blank space. Specify even-numbered values as the alignment condition values. If an odd-numbered value is specified, the linker outputs a message and continues with linking on the assumption that the "specified value plus one" has been specified. Expressions cannot be used in the alignment condition specification.



**(f) Segment name**

[Specifiable symbols: tp, gp]

Specify the name of the segment to be referenced for the tp symbol value or gp symbol value to be created.

In other words, specify the segment that will be referenced by the tp symbol or gp symbol to be created. Several segments can be specified as target segments for referencing.

When creating a symbol, specification of the segment name can be omitted. One of the following values is assumed as the default value when it is omitted.

Table A-26 Segment Names Targeted for Reference by tp Symbol and gp Symbol

| Symbol Value | Rule for Determination  |
|--------------|---|
| tp symbol    | All text-attribute segments exist in objects are targeted.  |
| gp symbol    | All sections with sdata/data/sbss/bss attributes existing in objects are targeted (for determination method, refer to "[Offset specification for gp symbol values]"). |

Specify a segment name that is assumed to be a target for gp-relative referencing as the target segment name for gp symbol referencing.

For example, do not specify a segment that includes .sdata section or .sebss section, which is assumed to be for ep-relative referencing. For details, refer to "A. 3. 2 Global pointer (gp)".

Enter the segment name specification at the end of the symbol directive and enclose the segment name with "{ }". If specifying several segment names, use blank spaces to separate them.

**(2) Symbol directive specification example**

This example shows specifications for the following types of symbols.

Table A-27 Symbol Directive Specification Example

| Symbol    | Specification Item                     | Specified Value |
|-----------|--|-----------------|
| tp symbol | Symbol name                            | __tp_TEXT       |
|           | Name of segment targeted for reference | TEXT1           |
| gp symbol | Symbol name                            | __gp_DATA       |
|           | Offset specification symbol            | __tp_TEXT       |
|           | Name of segment targeted for reference | DATA1, DATA2    |
| ep symbol | Symbol name                            | __ep_TEXT       |
|           | Address                                | 0xFFFFD000      |

In the above case, the corresponding symbol directive specification is shown below.

```
__tp_TEXT @ %TP_SYMBOL{TEXT1} ;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA1 DATA2} ;
__ep_DATA @ %EP_SYMBOL V0xFFFFD000 ;
```

Note with caution that symbols will not be created unless a symbol directive specification has been made.

## A. 5 Defaults

If the user performs linking without creating a link directive file or without specifying a link directive file to reference, the CA850 performs linking by using its own internal default link directive.

If corresponding input sections exist for the segments described in the default link directive, the segments are generated by being allocated in the order in which the sections appear, from the lower address.

Regarding the segment allocation addresses, there are addresses that are allocated in the order described by the link directive, and addresses that are allocated values defined in the device file or linker information.

If an interrupt handler is defined using the interrupt request name defined in the device file, a link directive that will allocate functions to the set handler address is automatically generated inside the linker, regardless of whether the directive is the default directive or a specified directive.

Caution must be exercised when describing a mapping directive using an interrupt request name because this will result in an error caused by redundant section name definition.

### [If SIDATA segment is generated]

- The SIDATA segment is allocated to the start address of the internal RAM.
- The DATA segment is allocated to the suitable addresses for the device type, according to the device file.  
For example, in the case of the V851, which has internal ROM, the DATA segment is allocated to the start address of the external memory.
- The SEDATA segment is allocated to a lower address from the start address of the internal RAM.

### [If SIDATA segment is not generated]

- The DATA segment is allocated to the start address of the internal RAM.
- The CONST segment is allocated to the suitable addresses for the device type, according to the device file.  
For example, in the case of the V851, which has internal ROM, the CONST segment is allocated to the start address of the external memory.
- The SEDATA segment is allocated to a lower address from the start address of the internal RAM.

The addresses of segment other than those mentioned above are allocated in the order in which they are described.

The default link directive is solely provided as a sample, so generally the user should describe a link directive file and use that as the link directive. The contents of the default link directive are provided as samples in the package. Refer to them and rewrite them for your own use.

## A. 6 Link Directive File Coding Examples

The coding examples below show frequently used descriptions.

Note with caution that the priority of section allocation varies according to the code pattern for an input section name specification in mapping directive (refer to "(g) [Input section name](#)").

- (1) When allocating to "segment TEXT" all sections (from all objects) that have the text attribute (section type = PROGBITS, section attribute = AX) and the section name ".text" (default name for .text sections):

```
TEXT !LOAD ?RX{
    .text = $PROGBITS ?AX .text ;
} ;
```

- (2) When allocating to "segment TEXT1" all sections (from object files: "file1.o" and "file2.o") that have the text attribute (section type = PROGBITS, section attribute = AX):

```
TEXT1 !LOAD ?RX{
    sec = $PROGBITS ?AX{file1.o file2.o} ;
} ;
```

- (3) When allocating to "segment USRTEXT" all sections (from object files: "file1.o" and "file2.o") that have the text attribute (section type = PROGBITS, section attribute = AX) and the section name "usrsec":

```
USRTEXT : !LOAD ?RX{
    usrsec = $PROGBITS ?AX usrsec{file1.o file2.o} ;
} ;
```

- (4) Link directive coding method when entering "#pragma text "funcsec1" func1", which is coded in the C source, and when function "func1" has been allocated to the independently generated text-attribute section "funcsec1" (segment name: FUNC1):

```
FUNC1 : !LOAD ?RX{
    funcsec1.text = $PROGBITS ?AX funcsec1.text ;
} ;
```

If the independently specified text-attribute section has been allocated for a certain function via the #pragma text directive, the actually created section name becomes "(specified character string) + .text", and the section name must be entered in the link directive. In this example, the section name becomes "funcsec1.text section". For details, refer to the "CA850 C Compiler Package C Language User's Manual".

- (5) When object files "file1.o", "file2.o", and "file3.o" exist and text from "file1.o" and "file2.o" is allocated to address 0x100000 while text from "file3.o" is separately allocated to address 0x120000:

```
TEXT1 : !LOAD ?RX V0x100000{
    .text1 = $PROGBITS ?AX{file1.o file2.o} ;
} ;
TEXT2 : !LOAD ?RX V0x120000{
    .text2 = $PROGBITS ?AX{file3.o} ;
} ;
```

**[Caution]** Make sure the output section names are not identical.

- (6) When specifying an object of the same name allocated in a different directory:

```
SEG : !LOAD ?RX {
    textsec1 = $PROGBITS ?AX { c:\work\dir1\file1.o } ;
    textsec2 = $PROGBITS ?AX { c:\work\dir2\file1.o } ;
    textsec3 = $PROGBITS ?AX { file1.o } ;
} ;
```

- (7) When allocating to "usrlib" section all objects in library "libusr.a":

```
SEG : !LOAD ?RX {
    usrlib = $PROGBITS ?AX { libusr.a } ;
} ;
```

- (8) When allocating to "usrlib" section object "libobj1.o" in library "libusr.a" (which is under C:\usrlib):

```
SEG : !LOAD ?RX {
    usrlib = $PROGBITS ?AX { libobj1.o(c:\usrlib\libusr.a) } ;
} ;
```

- (9) When allocating to "segment SEG" all sections (from object files: "file1.o" and "file2.o") that have section type PROGBITS and section attributes AW as well as sections that have section type NOBITS and section attributes AW:

```
SEG : !LOAD ?RW{
    sec1 = $PROGBITS ?AW{file1.o file2.o} ;
    sec2 = $NOBITS ?AW{file1.o file2.o} ;
} ;
```

- (10) When allocating to "segment SEG" all sections (from object files: "file1.o" and "file2.o") that have the data attribute (section type = PROGBITS and section attribute = AW) as well as the sdata attribute (section type = PROGBITS and section attribute = AWG):

```
SEG : !LOAD ?RW{
    .data = $PROGBITS ?AW{file1.o file2.o} ;
    .sdata = $PROGBITS ?AWG{file1.o file2.o} ;
} ;
```

- (11) When allocating to "segment DATA" from all objects all data-attribute sections, bss-attribute sections, sdata-attribute sections, and sbss-attribute sections that are targeted for to gp-relative referencing:

```
DATA : !LOAD ?RW{
    .data = $PROGBITS ?AW ;
    .sdata = $PROGBITS ?AWG ;
    .sbss = $NOBITS ?AWG ;
    .bss = $NOBITS ?AW ;
} ;
```

- (12) When using "#pragma section directive" in the C source:

```
#pragma section data "data1" begin
int a = 10 ;
int b ;
#pragma section data "data1" end
```

The link directive cording method when the above has been specified to allocate variables to independently generated data-attribute and bss-attribute sections (under segment name: USRDATA) is shown below.

```
USRDATA : !LOAD ?RW{
    data1.data = $PROGBITS ?AW data1.data ;
    data1.bss = $NOBITS ?AW data1.bss ;
} ;
```

In this case, variable "a" (with initial value) is allocated to "data1.data" section and variable "b" (without initial value) is allocated to "data1.bss" section. Thus, the actually created section names become "(specified character string) + .data" and "(specified character string) + .bss" respectively, and the section names must be specified in the link directive file. For details, refer to the "CA850 C Compiler Package C Language User's Manual".

- (13) When using "#pragma section directive" in the C source:

```
pragma section const "const1" begin
const int c = 10 ;
pragma section const "const1" end
```

The link directive cording method when the above has been specified to allocate variables to independently generated const-attribute section (under segment name: USRCONST) is shown below.

```
USRCONST : !LOAD ?R{
    const1.const = $PROGBITS ?A const1.const ;
} ;
```

In this case, variable "c" is allocated to "const1.const" section. Thus, the actually created section name becomes "(specified character string) + .const", and the section name must be specified in the link directive file. This rule also applies to sconst section. For details, refer to the "CA850 C Compiler Package C Language User's Manual".

- (14) When allocating separately to data/sdata-attribute sections and bss/sbss-attribute sections for all modules and creating one gp symbol:

```
TEXT : !LOAD ?RX V0x1000{
    .text = $PROGBITS ?AX .text ;
} ;
DATA1 : !LOAD ?RW V0x10000{
    .data = $PROGBITS ?AW .data ;
    .sdata = $PROGBITS ?AWG .sdata ;
} ;
DATA2 : !LOAD ?RW V0x12000{
    .sbss = $NOBITS ?AWG .sbss ;
    .bss = $NOBITS ?AW .bss ;
} ;
__tp_TEXT @ %TP_SYMBOL{TEXT} ;
__gp_DATA @ %GP_SYMBOL{DATA1 DATA2} ;
```

- (15) When allocating separately to data/sdata-attribute sections and bss/sbss-attribute sections for all modules and creating one gp symbol each for DATA1 and DATA2:

```
TEXT : !LOAD ?RX V0x1000{
    .text = $PROGBITS ?AX .text ;
} ;
DATA1 : !LOAD ?RW V0x100000{
    .data = $PROGBITS ?AW .data ;
    .sdata = $PROGBITS ?AWG .sdata ;
} ;
DATA2 : !LOAD ?RW V0x12000{
    .sbss = $NOBITS ?AWG .sbss ;
    .bss = $NOBITS ?AW .bss ;
} ;
__tp_TEXT @ %TP_SYMBOL{TEXT} ;
__gp_DATA1 @ %GP_SYMBOL{DATA1} ;
__gp_DATA2 @ %GP_SYMBOL{DATA2} ;
```

- (16) When several text-attribute segments exist among all modules and several segments having sdata-attribute or sbss-attribute sections also exist, and there are a gp and a base symbol for each sdata/sbss-attribute section:

```
TEXT1 : !LOAD ?RX V0x1000{
    text1 = $PROGBITS ?AX{start.o main.o} ;
} ;
TEXT2: !LOAD ?RX{
    text2 = $PROGBITS ?AX{func.o} ;
} ;
TEXT3: !LOAD ?RX{
    text3 = $PROGBITS ?AX{libfunc.o(c:\usr\lib\libusr.a)} ;
} ;
DATA1: !LOAD ?RW V0x100000{
    sdata = $PROGBITS ?AWG ;
} ;
DATA2: !LOAD ?RW{
    sbss1 = $NOBITS ?AWG{start.o} ;
} ;
DATA3: !LOAD ?RW{
    sbss2 = $NOBITS ?AWG ;
} ;
__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} ;
```

Of the variables located in the .sbss section generated in C language, for those for external linkage tentative definition (int i;), two or more temporary definitions are permitted by the ANSI standard, and the linker generates a variable area, selecting the size from that of two or more variables.

This means that specifying the allocation of an .sbss section by using an input file name is difficult, and that, if

input file names are specified for all sbss attributes (\$NOBITS, ?AWG), there are no more sections to be allocated to the area of the variables generated by the linker. In this case, create a section with a !\$NOBITS ?AWG attribute for which an input file name is not specified.

In the above example, this problem does not occur because the section sbss2, in addition to sbss1, is defined and specification of the input section name is omitted.

- (17) When creating segments that use internal RAM (in V850 core device) and that use internal RAM-only sections:

```
SIDATA : !LOAD ?RW V0xffffe000{
    .tidata.byte = $PROGBITS ?AW .tidata.byte ;
    .tibss.byte  = $NOBITS    ?AW .tibss.byte  ;
    .tidata.word = $PROGBITS ?AW .tidata.word ;
    .tibss.word  = $NOBITS    ?AW .tibss.word  ;
    .sidata      = $PROGBITS ?AW .sidata      ;
    .sibss       = $NOBITS    ?AW .sibss       ;
} ;
```

Generally, in this case the specified address is the start address of the device's internal RAM. For details of the start address of the target device's internal RAM, refer to the User's Manual, Hardware.

In the above example, all of the sections that can be specified for internal RAM are specified. Any sections that are not needed can be deleted from the specification.



## (18) Link directive for interrupt handler

## [Example1]

```
#pragma interrupt INTP100 func    <-- INTP100 is branch to func
"Directive added internally at this time"

INTP100 : !LOAD ?RX V0xc0{
    INTP100 = $PROGBITS ?AX INTP100 ;
} ;
```

## [Example2]

```
.section "INTP120", text          <-- defines INTP120 section
"Directive added internally at this time"

INTP120 : !LOAD ?RX V0x100{
    INTP120 = $PROGBITS ?AX INTP120 ;
} ;
```

The allocation of the interrupt handler is automatically performed by the linker, so there is no particular need for the user to specify it in a link directive.

If an interrupt handler has been created using a directive such as "#pragma interrupt directive" in the C source file, and if section definition that uses ".section quasi directive" in the assembler source file to specify the interrupt request name has been made, section which have been defined as interrupt handlers are allocated to the address determined based on information in the device file.

In the above example, if "direct" is specified for "#pragme interrupt", the function itself becomes the INTP100 section instead of branching to the "func" function.

**[Reference example of link directives]**

```
SCONST : !LOAD ?R V0x280{
    .sconst = $PROGBITS ?A .sconst;
};
```

Allocates SCONST segment to internal ROM. Allocated starting from 0x280 (for V853 CPU; different address is required for other CPUs) in order to start allocation after the interrupt handler address.

```
TEXT : !LOAD ?RX {
    .pro_epi_runtime= $PROGBITS ?AX.pro_epi_runtime;
    .text = $PROGBITS ?AX;
};
```

The TEXT segment is allocated immediately after the SCONST segment since a start address has not been specified. In other words, the start address changes according to the size of the SCONST segment. Note with caution, however, that if there is no data to be allocated to the SCONST segment, the TEXT segment is allocated starting immediately after the defined interrupt handler address (address 0x280 is ignored).

```
DATA : !LOAD ?RW 0x100000{
    .data = $PROGBITS ?AW;
    .sdata = $PROGBITS ?AWG;
    .sbss = $NOBITS ?AWG;
    .bss = $NOBITS ?AW;
};
```

In such cases, the address is specified to the TEXT segment.

DATA segment that is targeted for gp-relative referencing is allocated to address 0x100000 (assuming that addresses starting at 0x100000 are in the RAM area).

```
CONST : !LOAD ?R V0x120000{
    .const = $PROGBITS ?A .const;
};
```

CONST segment is allocated (assuming that addresses starting at 0x120000 are in the ROM area).

```
SEDATA : !LOAD ?RW V0xff6000 {
    .sedata = $PROGBITS ?AW .sedata;
    .sebss = $NOBITS ?AW .sebss;
};
```

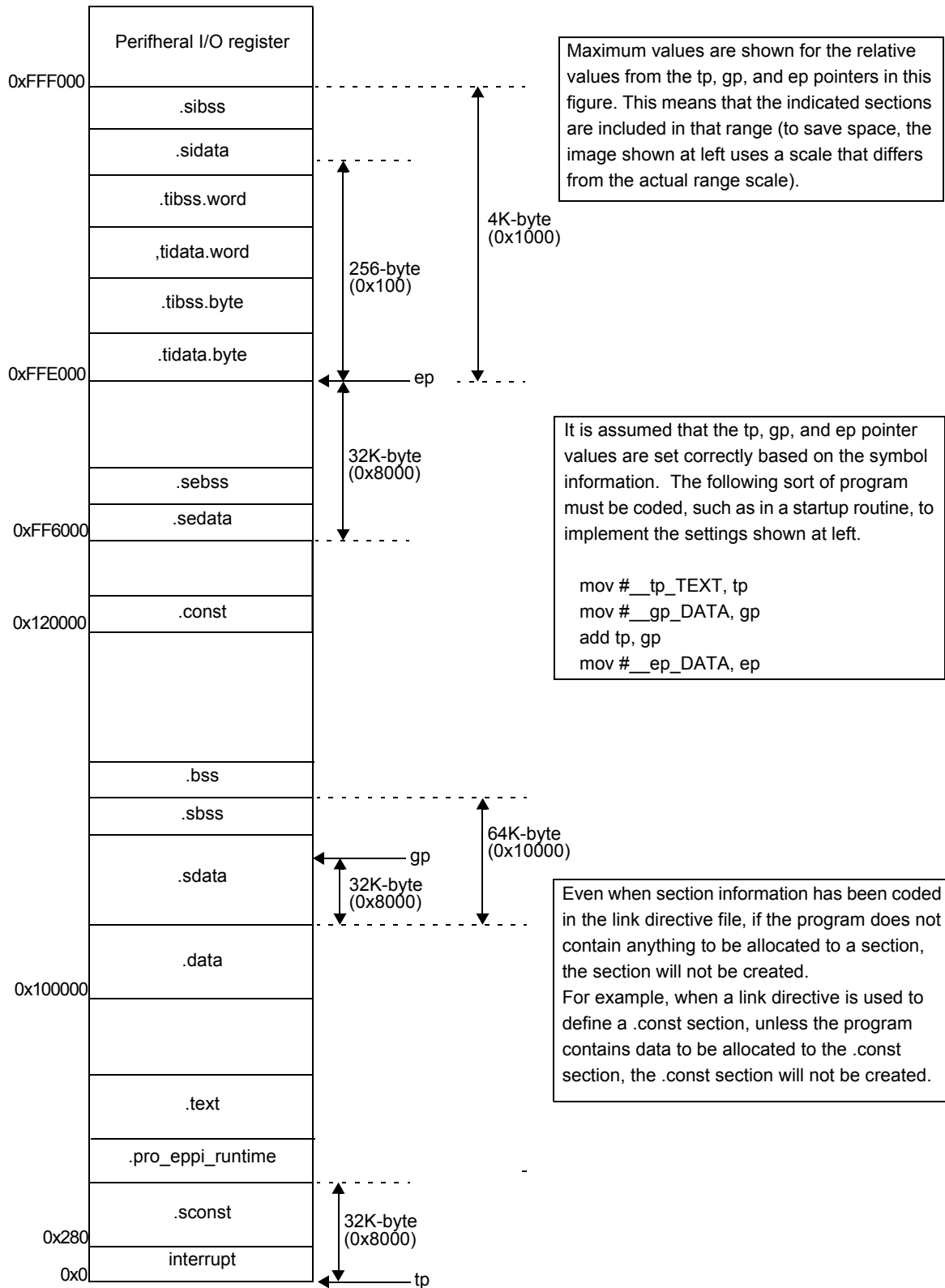
Allocates SEDATA segment that is targeted for ep relative referencing. Allocation is to an area within 32 KB of the internal RAM's start address (assuming that addresses starting at 0xff6000 are in the RAM area).

```
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;
    .sidata = $PROGBITS ?AW .sidata;
    .sibss = $NOBITS ?AW .sibss;
};
```

Allocates SIDATA segment that is targeted for ep relative referencing to the internal RAM area. This segment's start address is usually the internal RAM's start address, which varies according to which CPU is being used.

```
__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL & __tp_TEXT {DATA};
__ep_DATA @ %EP_SYMBOL;
```

This creates the tp, gp, and ep symbol information. In this case, address 0x0 is set to \_\_tp\_TEXT, the ".sdata section's start address - \_\_tp\_TEXT" value is set to \_\_gp\_DATA, and the start address of internal RAM (address 0xffe000) is set to \_\_ep\_DATA.

**[Allocation Image]**

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