RX Family C/C++ Compiler Package (CC-RX)

How to Divide Boot and Flash Areas

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Introduction

This document describes the processing necessary to divide a program into boot and flash areas when using the C/C++ compiler for the RX family (CC-RX).

Versions of Tools with which Correct Operation has been Confirmed

The following tools and versions were used for the descriptions in this document.

- C/C++ compiler for the RX family (CC-RX): V3.01.00
- e² studio integrated development environment: V7.3.0
- CS+ for CC integrated development environment: V8.01.00

Contents

1. Overview

1.1 Dividing the Boot and Flash Areas

The purpose of dividing the boot and flash areas is to ensure that only the program in the flash area can be modified without reconfiguring the program in the boot area.

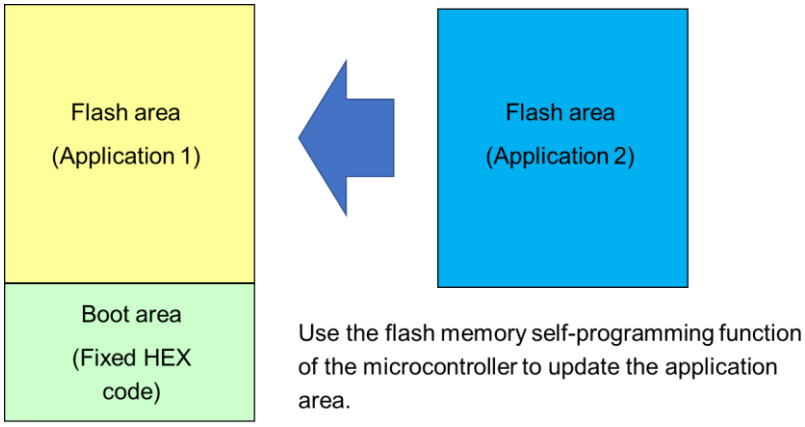


Figure 1 Divided Areas on System

Note: In this document, the boot area is defined as an area that cannot be modified following design of the system while the flash area is defined as an area that can be modified or replaced on the system.

To divide the boot and flash areas, create two projects, one to be used as the boot area project and the other to be used as the flash area project. These projects must satisfy the following conditions.

- The variables and functions in the boot area are accessible from the flash area.
  - The linker option -FSymbol should be used for the boot area project so that externally defined symbols will be output in a file.
  - The above externally defined symbol file should be specified as a target of building in the flash area project.
- The functions in the flash area can be called from the boot area through a function table.
  - When calling functions in the flash area, the boot area project should call the address of each branch instruction for a function that is specified in the function table.
  - A table of branch instructions for functions to be called from the boot area project should be created in the flash area project.

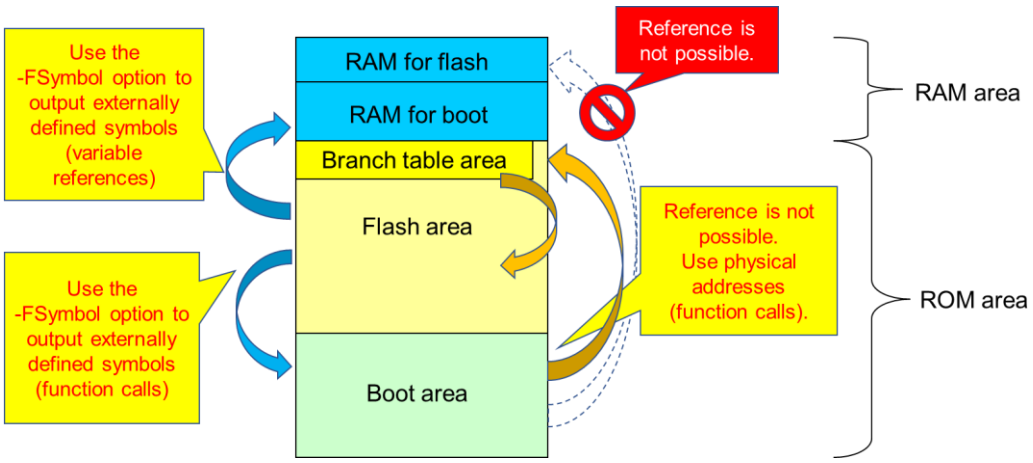


Figure 2 References to Variables and Functions between the Boot and Flash Areas

1.2 Allocating the Boot and Flash Areas

Allocate the boot and flash areas as follows.

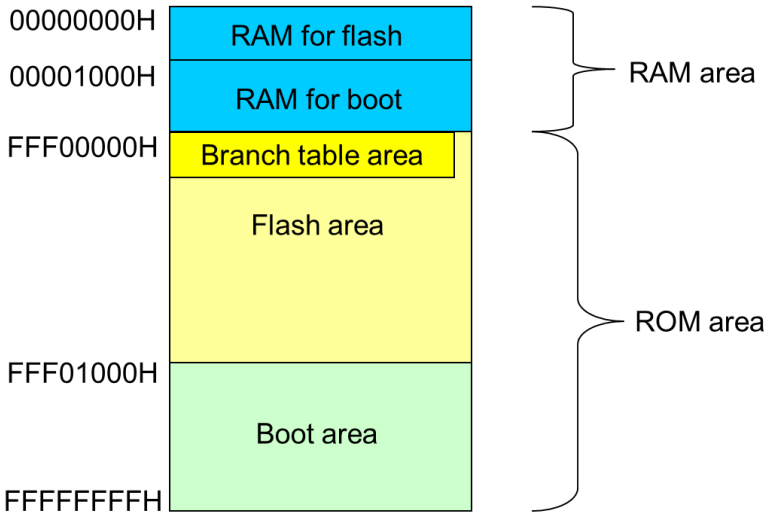


Figure 3 Example of Allocating the Boot and Flash Areas

1.3 Procedures for Creating the Boot Area and Flash Area Projects

Follow the procedures below to create the boot area and flash area projects.

1. Creating the boot area project
   A. Create boot area programs in the source file.
   B. Specify the necessary linker options.
   C. Build the boot area project before the flash area project because the boot area project is required for building the flash area project.
2. Creating the flash area project
   A. Create flash area programs in the source files.
   B. Specify the necessary linker options.

1.4 Overview of Build Processing for the Boot and Flash Areas

Figure 4 shows an overview of build processing for the boot and flash areas.

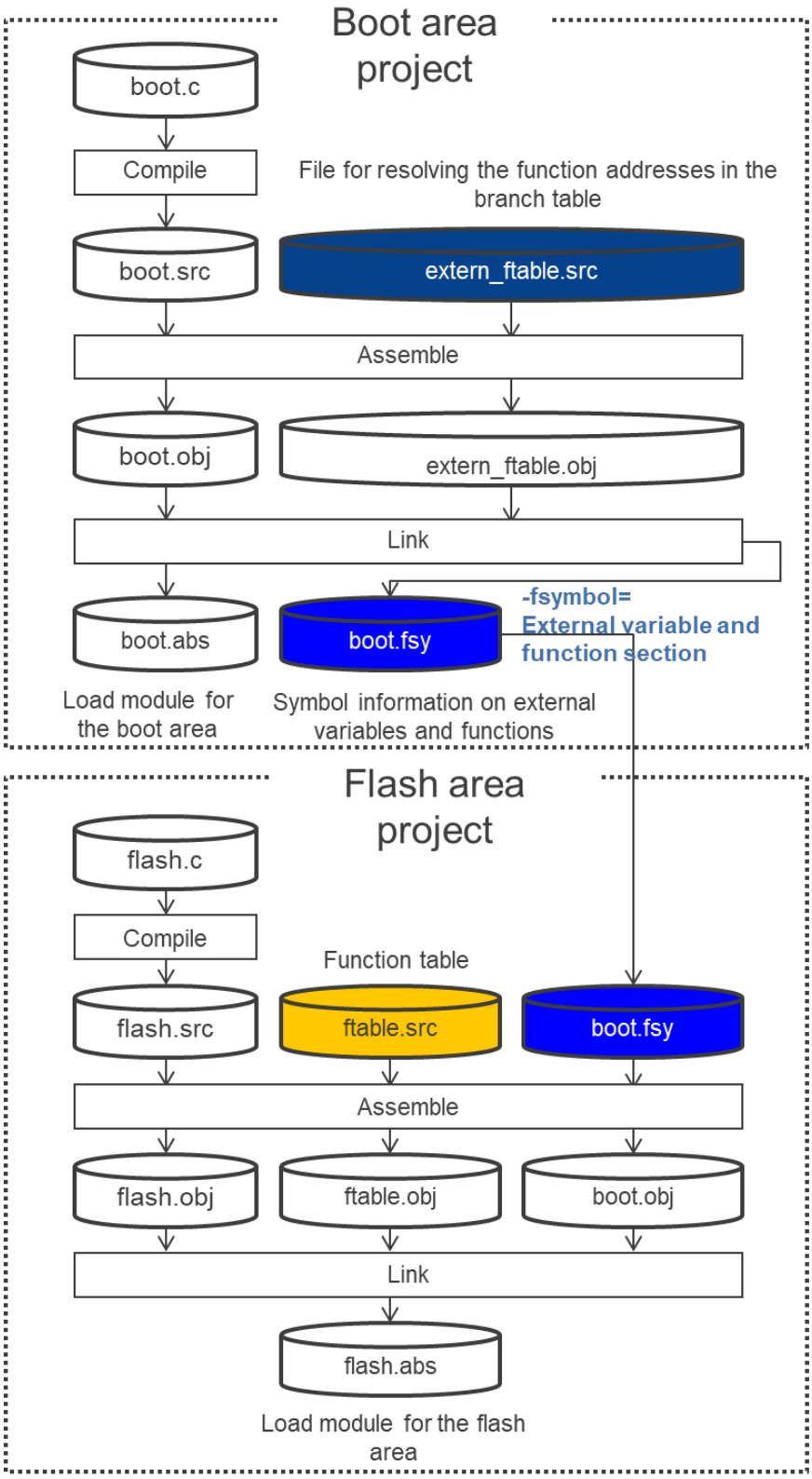


Figure 4 Build Processing for the Boot and Flash Areas

2. Common Processing for the Boot and Flash Areas

2.1 Creating projects

2.1.1 e² studio

1. Create projects

Create a boot area project and a flash area project by following the procedures given in section 1.3, Procedures for Creating the Boot and Flash Areas.

Place a tick in the “boot” checkbox to configure the flash area project to allow reference to the boot area project from the flash area project when the flash area project is built. In such cases, the boot area project is built before the flash area project.

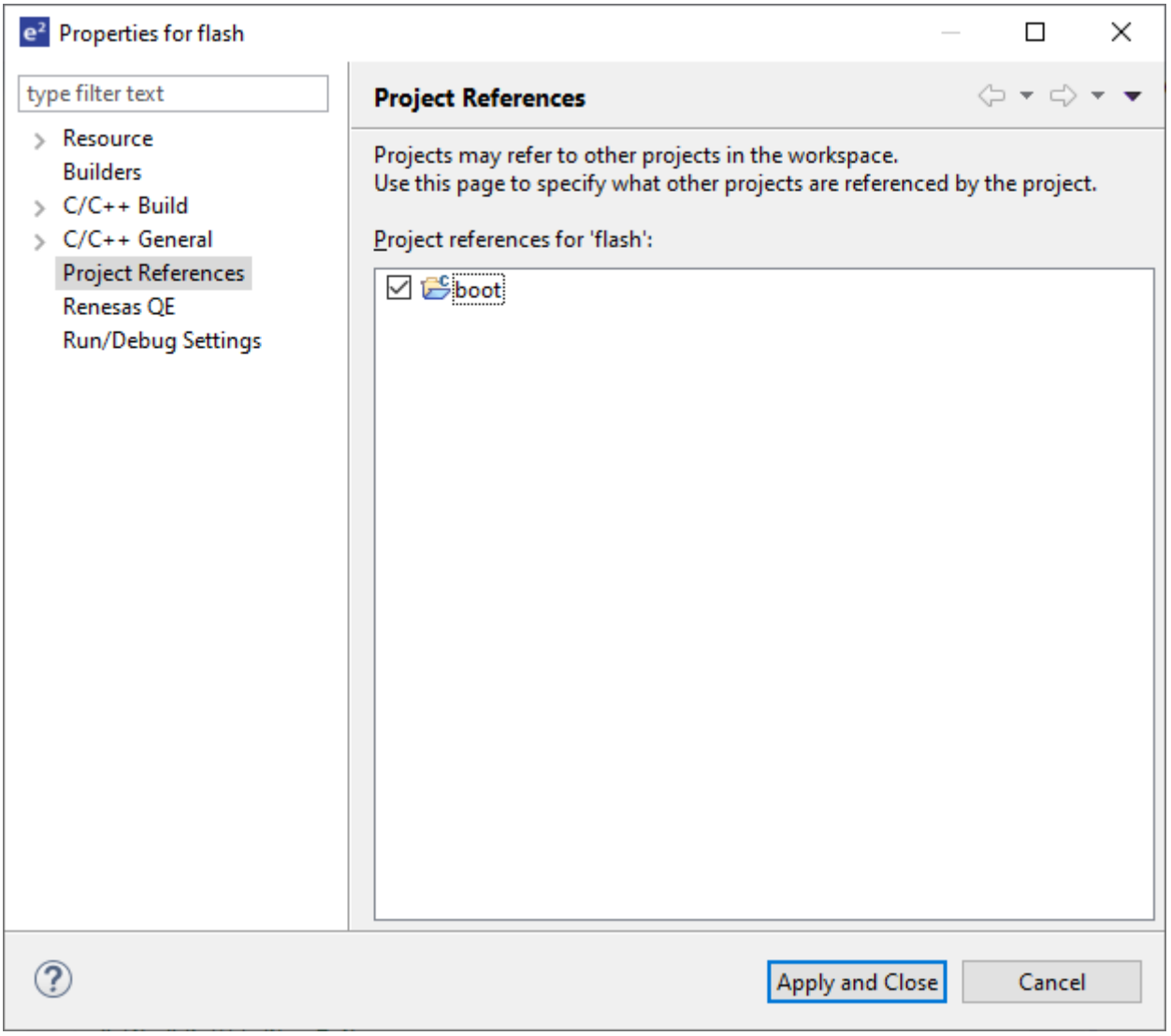


Figure 5 Setting the Flash Area Project to Allow Reference to the Boot Area Project

2. Exclude the automatically generated files from the targets of building

Exclude the following files from the flash area project.

- intprg.c
- sbrk.c
- sbrk.h
- stacksct.h
- vect.h
- vecttbl.c

3. Add files as targets of building

A. Add the following files to the boot area project as targets of building.

- extern_ftable.src
- ftable.inc

B. Add the following files to the flash area project as targets of building.

- boot.fsy (this file is generated after the boot area project is built)
- ftable.src
- ftable.inc
- int.c
- sub_mot.txt

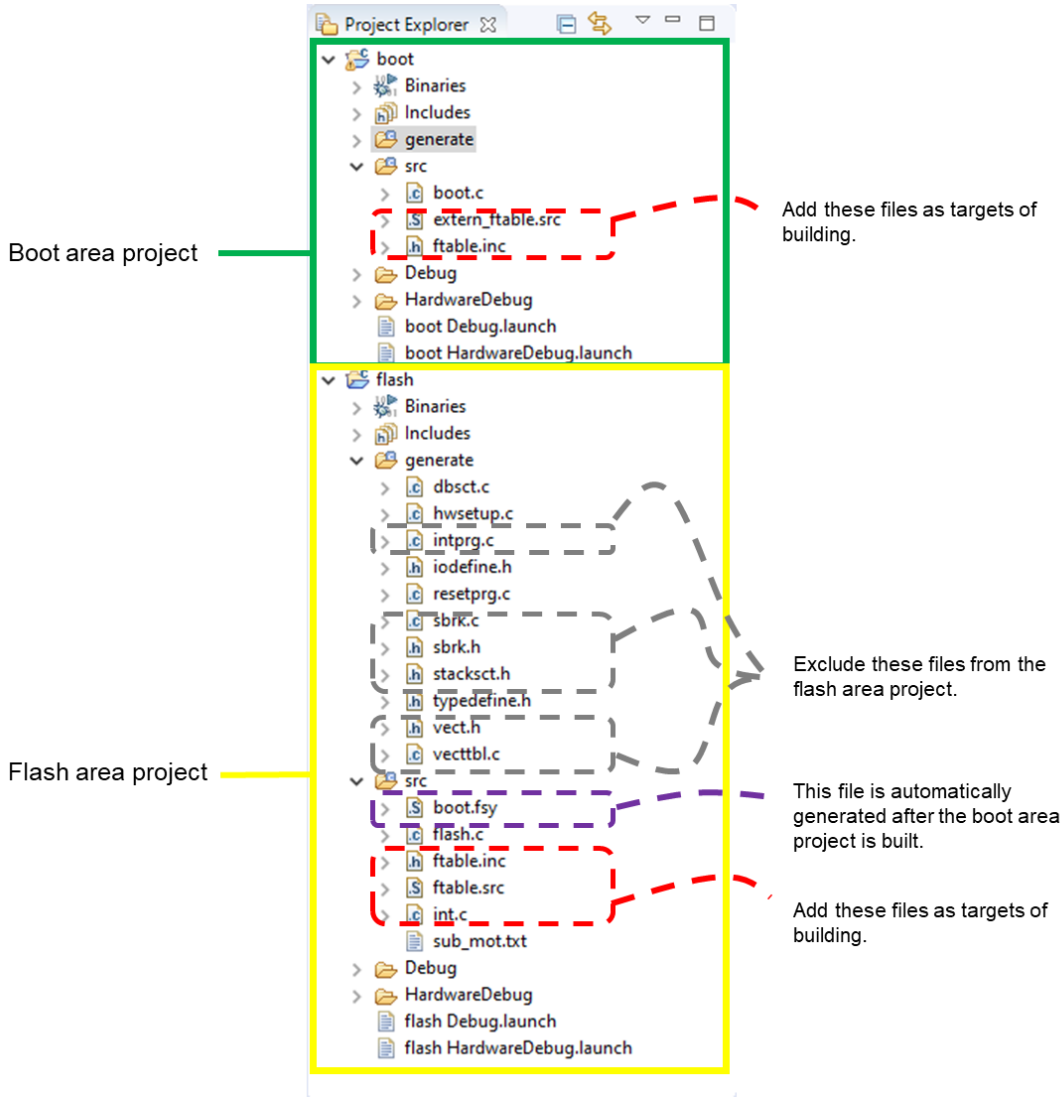


Figure 6 Example of Creating Projects with the e² studio

2.1.2 CS+

1. Create projects

Create the flash area project as the main project and the boot area project as a sub-project*.

Note: The build order in CS+ should be [Sub-project] -> [Main project].
The boot area program will not be modified once it is created. Therefore, when creating the second- or a later generation flash area project, the sub-project can be deleted.

2. Exclude the automatically generated files from the targets of building

Exclude the following files from the flash area project.

- intprg.c
- sbrk.c
- sbrk.h
- stacksct.h
- vect.h
- vecttbl.c

3. Add files as targets of building
   A. Add the following files to the boot area project.
      - extern_ftable.src
      - ftable.inc
   B. Add the following files to the flash area project.
      - ftable.src
      - ftable.inc
      - int.c
      - boot.fsy

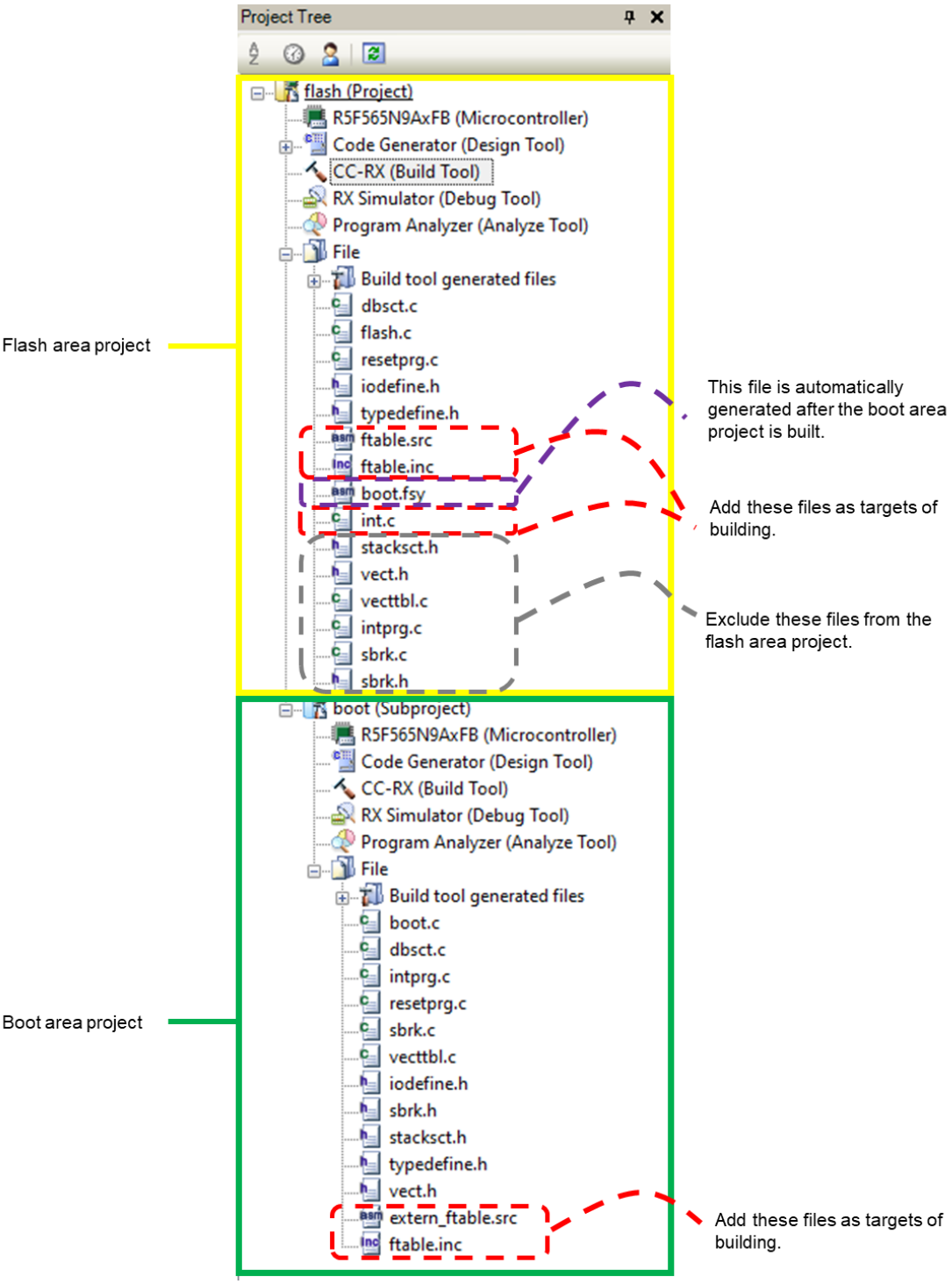


Figure 7 Example of Creating Projects with CS+

2.2 Creating a common program for the boot and flash areas

2.2.1 Address definition file for the branch table (assembly language)

- Create ftable.inc, which is the address definition file for the branch table for reference from both the boot and flash areas.
  - FLASH_TABLE: Start address of the branch table
  - INTERRUPT_OFFSET: Size of the interrupt area in the branch table

Example: ftable.inc

```
FLASH_TABLE        .EQU  0FFF00000H
INTERRUPT_OFFSET   .EQU  100H
```

2.3 Hex files for the boot and flash areas

File names used in this document are listed below (output procedures are described later).

- Hex file for the boot and flash areas combined: boot_flash.mot
- Hex file for the flash area: flash_fff00000_fff01000.mot
- Hex file for the boot area: boot_fff01000_ffffffff.mot

Note: A load module file (*.abs) is separately generated for each of the boot and flash areas.

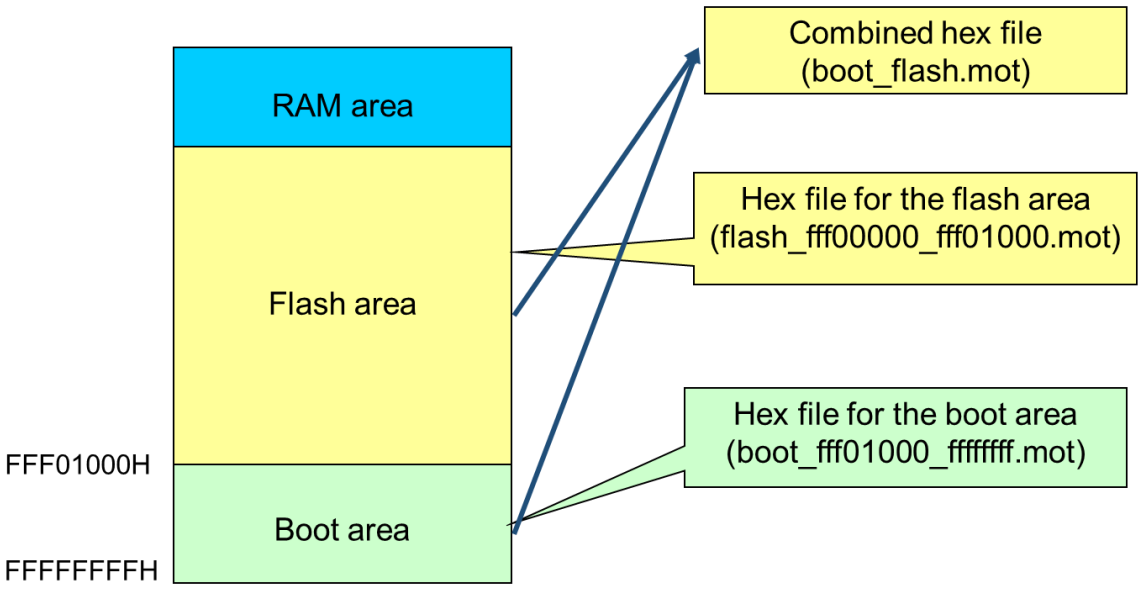


Figure 8 Hex Files for the Boot and Flash Areas

2.4 Initialization procedure

Figure 9 shows the initialization procedure.

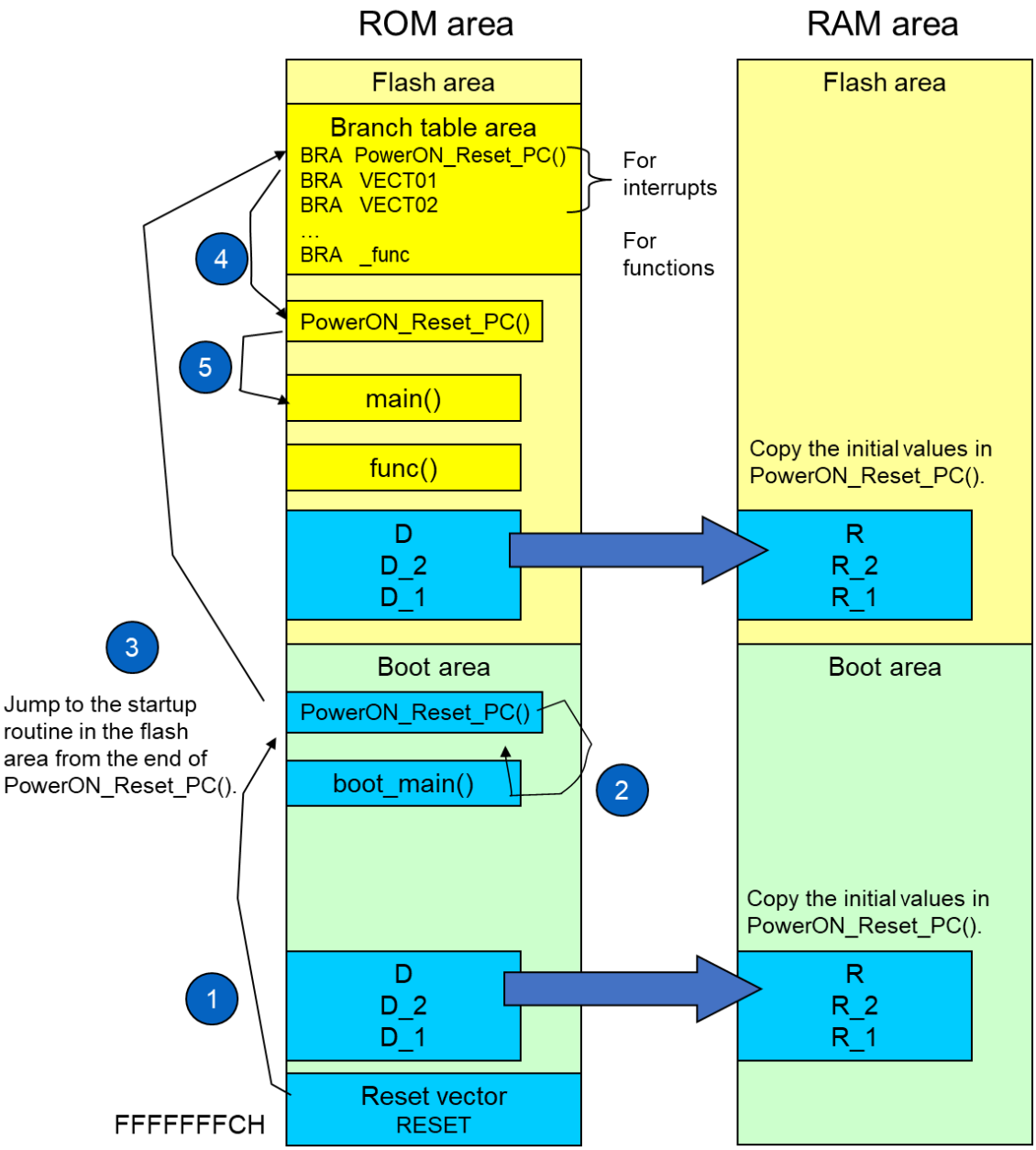


Figure 9 Initialization Procedure

3. Boot Area

3.1 Creating boot area programs

The following steps are required for boot area programs.

- Modifying the startup routine
- Modifying dbsct.c
- Creating a file for resolving the function addresses in the branch table

3.1.1 Modifying the startup routine (resetprg.c)

Use #pragma inline_asm to add a branch to the startup routine (resetprg.c) as shown below.

Example: Modifying resetprg.c (1/2)

```
#pragma inline_asm jump_flash
static void jump_flash(void) {
  BSR 0FFF00000H          ; FLASH_TABLE
}
```

Modify the main function call to the call to the main function for the boot area, and add a branch instruction to the flash area startup routine.

Example: Modifying resetprg.c (2/2)

```
  boot_main();
  jump_flash();
```

3.1.2 Modifying dbsct.c

Modify the section name to exclude it from the target of the -FSymbol option (which is used to output externally defined symbols).

Example: Modifying dbsct.c

```
#pragma section C BOOTC

/*
** CTBL prevents excessive output of L1100 messages when linking.
** Even if CTBL is deleted, the operation of the program does not change.
*/
_UBYTE * const _CTBL[] = {
```

3.1.3 Creating a file for resolving the function addresses in the branch table (extern_ftable.src)

- Define symbols for resolving the addresses for the branch table to be used to call functions in the flash area from the C source.
- Register this file in the project.

Example: Creating extern_ftable.src

```
        .INCLUDE  ftable.inc
        .GLB      _f1
_f1     .EQU      (FLASH_TABLE + INTERRUPT_OFFSET + (0 * 4))
        .GLB      _f2
_f2     .EQU      (FLASH_TABLE + INTERRUPT_OFFSET + (1 * 4))

        .END
```

3.2 Specifying boot area options

Make the following option settings for the boot area.

- Output of a file for the externally defined symbols
- Specify the section allocation
- Specify a vector for branching to the interrupt function in the flash area
- Specify hex file output only to the boot area address range

3.2.1 Output of a file for the externally defined symbols

The externally defined symbols need to be output to a file so that the flash area project has access to the variables and functions in the boot area.

Register all target sections with the -FSymbol option.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Linker]→[Section]→[Symbol file]
→[The specified section that outputs externally defined symbols to the file]

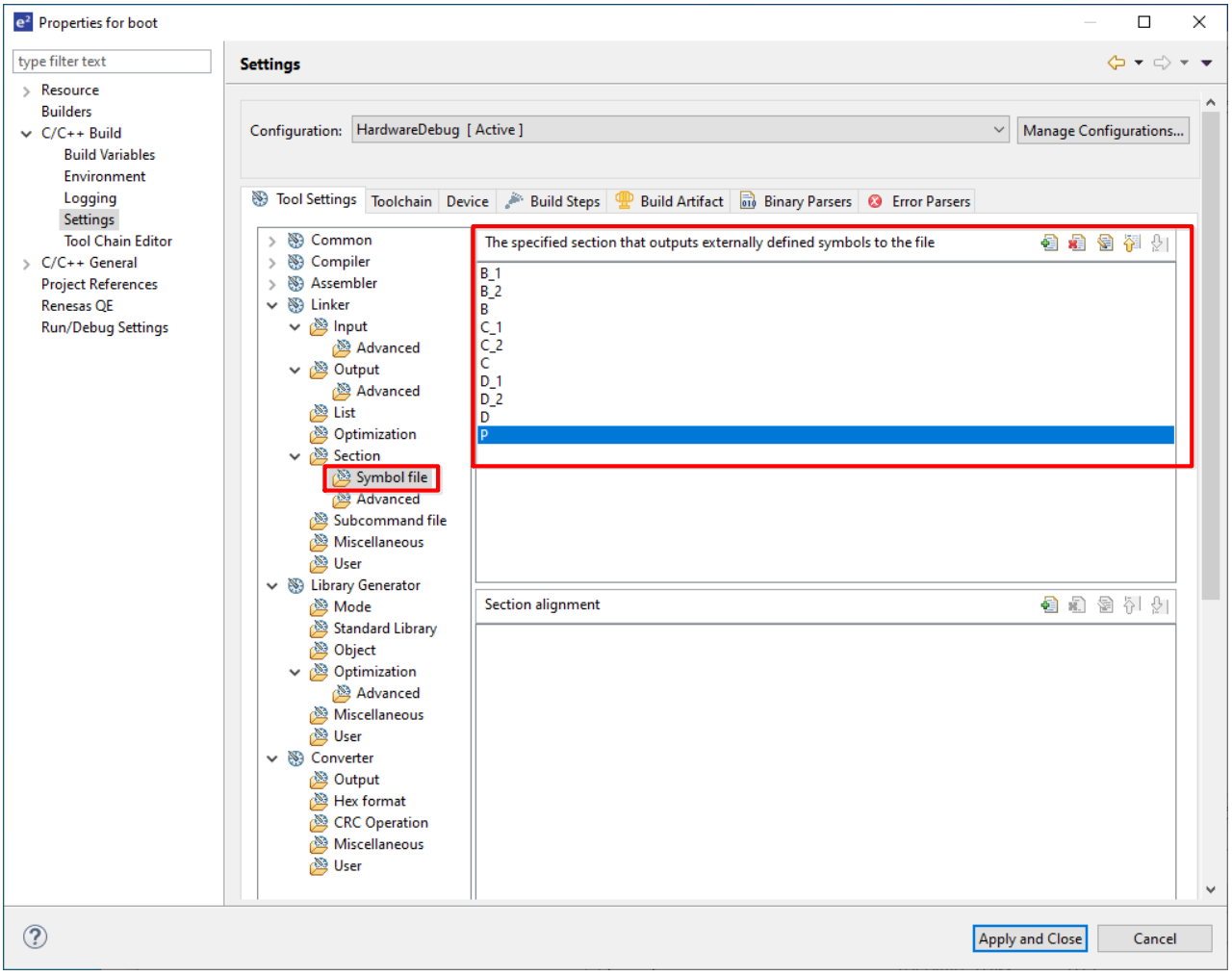


Figure 10 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Link Options] tabbed page

→[Section]→[The specified section that outputs externally defined symbols to the file]

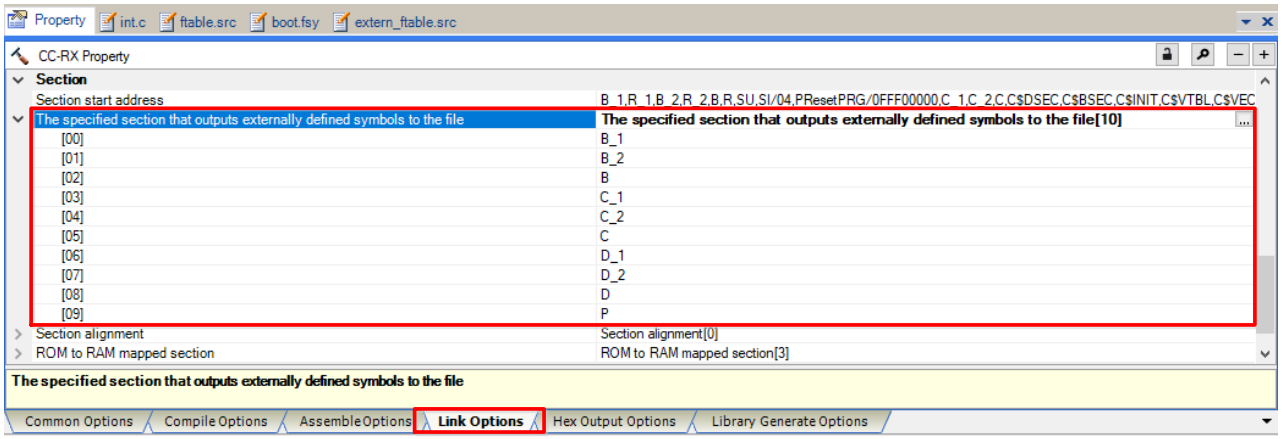


Figure 11 Example of Option Setting with CS+

3.2.2 Specifying the section allocation

Specify the section allocation in the boot area with the linker option -start. Make sure that the sections do not overlap those in the flash area.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Linker]→[Section]→[Section Viewer]

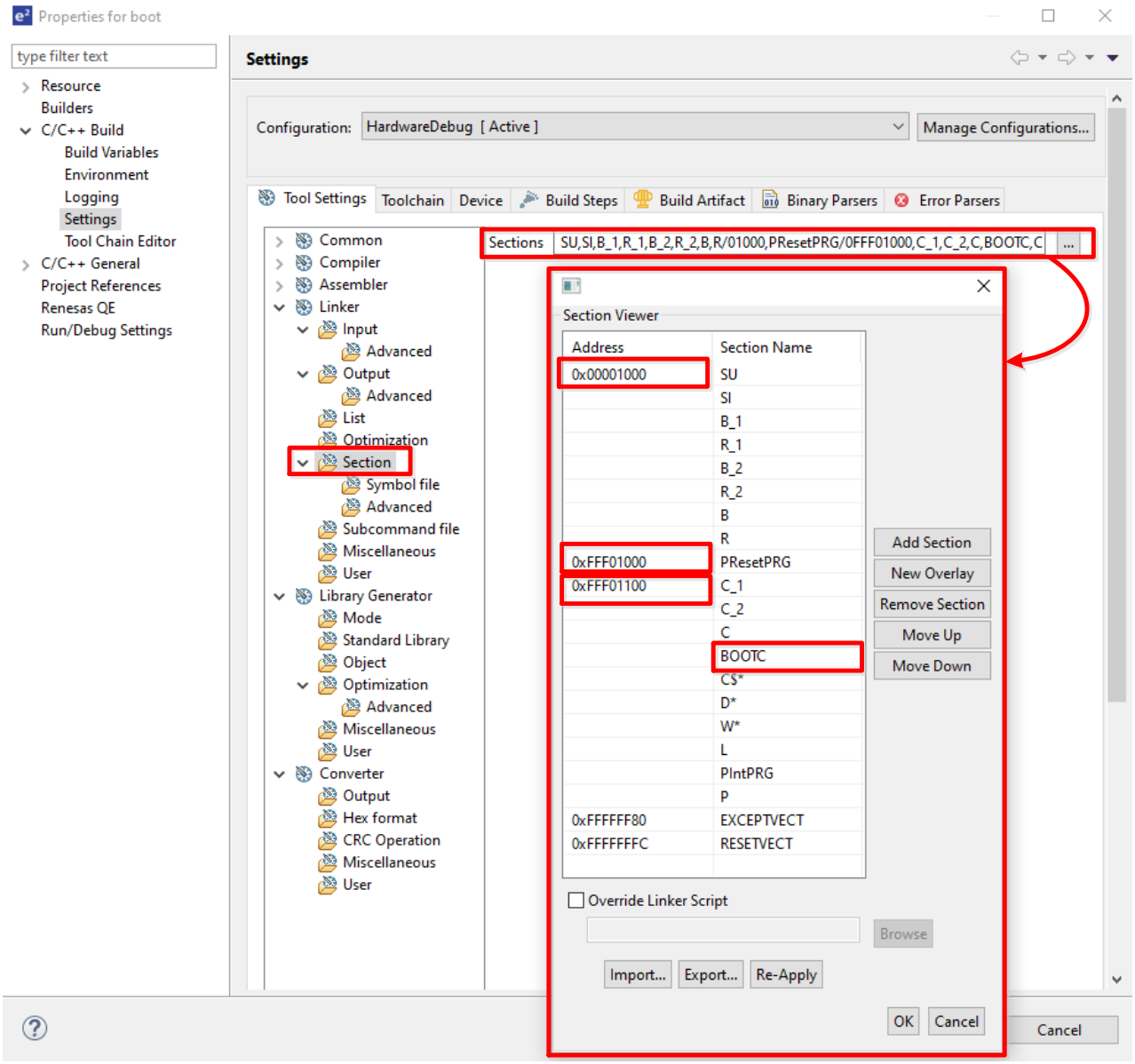


Figure 12 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Link Options] tabbed page

→[Section]→[Section start address]

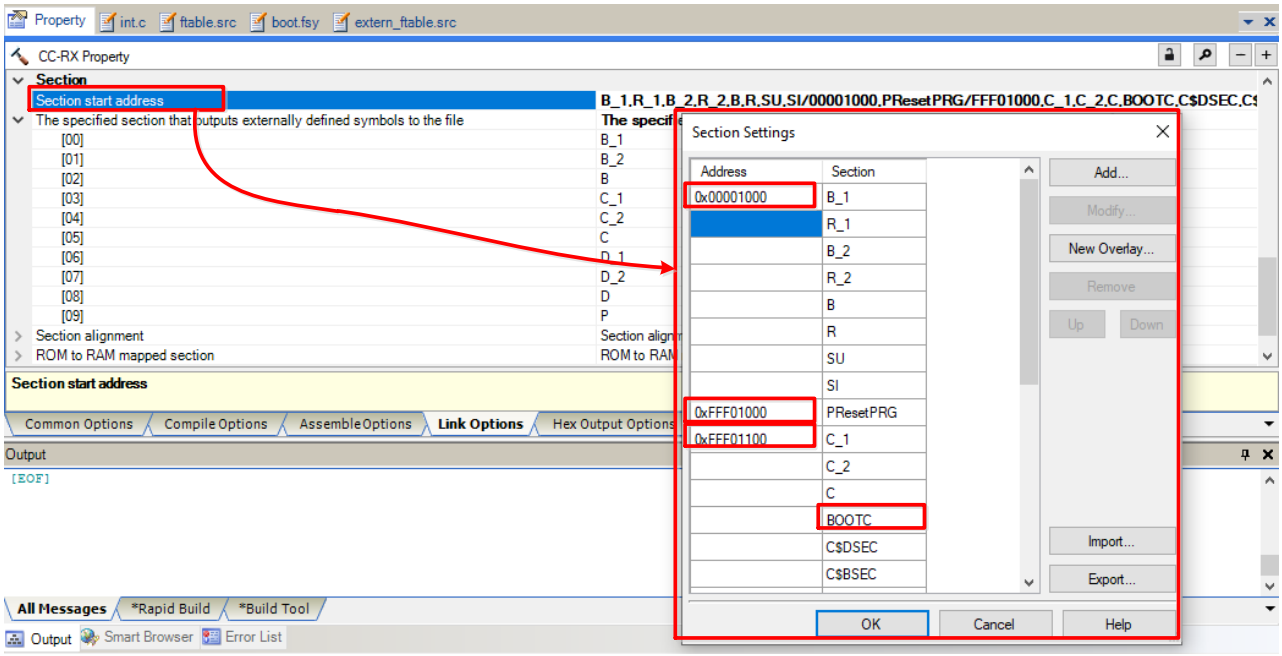


Figure 13 Example of Option Setting with CS+

3.2.3 Specifying a vector for branching to the interrupt function in the flash area

Specify the address in the branch table with the linker option -VECTN.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Linker]→[Output]→[Address setting for specified area of vector table]

→3=FFF0000C (to specify 0xFFF0000C for address 3)

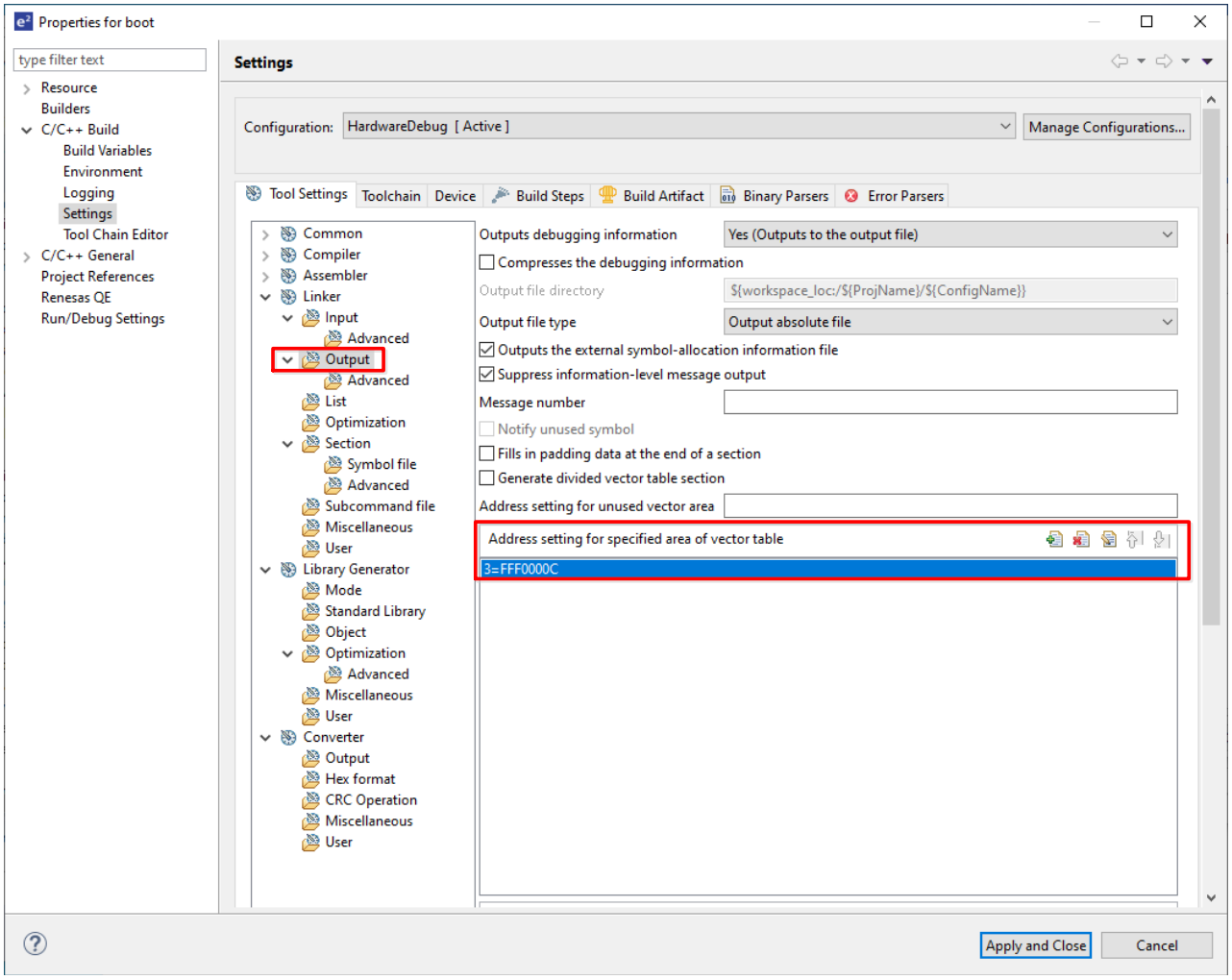


Figure 14 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Link Options] tabbed page

→[Output]→[Address setting for specified vector number]

→3=FFF0000C (to specify 0xFFF0000C for address 3)

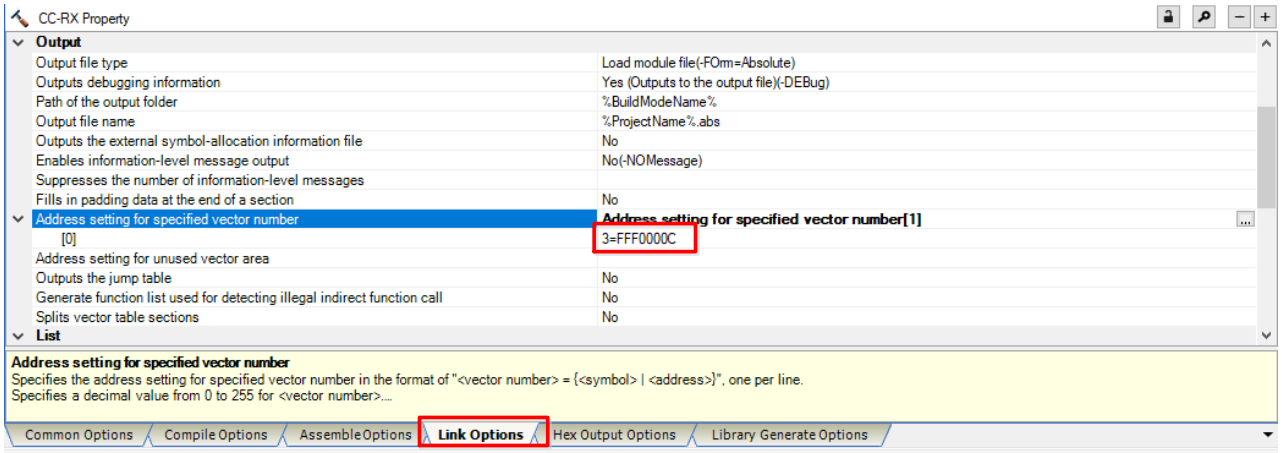


Figure 15 Example of Option Setting with CS+

3.2.4 Specifying hex file output only to the boot area address range

Specify the output file name and output addresses.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Converter]→[Output]

→Select the [Output hex file] checkbox.

→Select [Motorola S format file] as the output file format.

→Specify the output file name and output addresses in [Division output file].

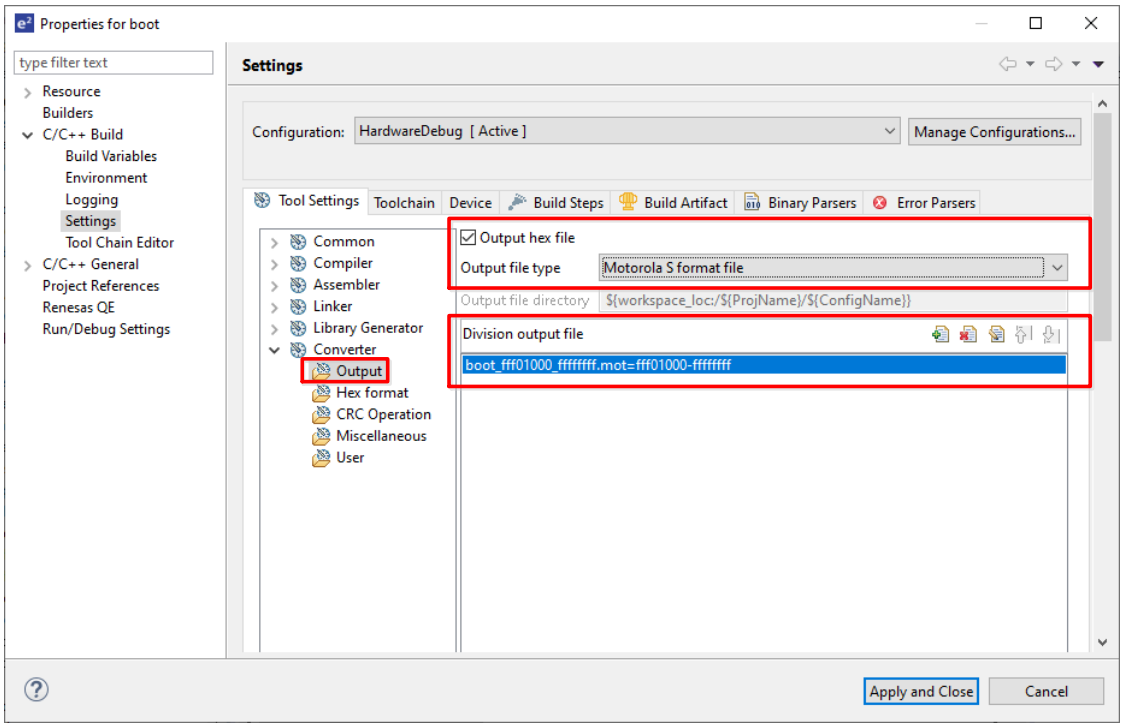


Figure 16 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Hex Output Options] tabbed page

→[Output File]→Specify the output file name and output addresses in [Division output file].

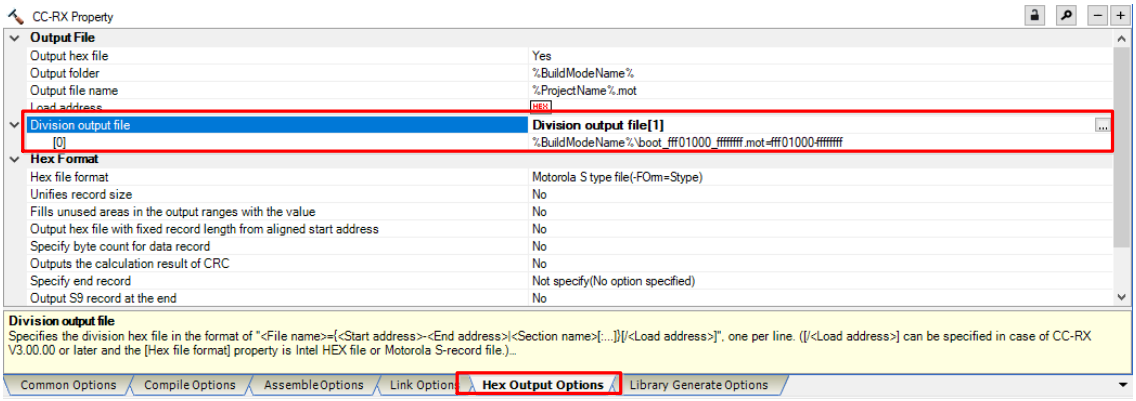


Figure 17 Example of Option Setting with CS+

4. Flash Area

4.1 Creating flash area programs

The following steps are required for flash area programs.

- Modifying the startup routine
- Creating a branch table program
- Defining an interrupt function

4.1.1 Modifying the startup routine (resetprg.c)

Comment out the initial settings. These initial settings are only to be made in the boot area startup routine; they are not to be made again in the flash area.

1. Comment out #pragma entry.

Example: resetprg.c (1/3)

```
//#pragma entry PowerON_Reset_PC

void PowerON_Reset_PC(void)
```

2. Comment out the inclusion of the stack size definition and the stack pointer settings.

Example: resetprg.c (2/3)

```
//#include  "stacksct.h"    // Stack Sizes (Interrupt and User)
   ~ Omitted ~
#if (__RX_ISA_VERSION__ >= 2) || defined(__RXV2)
// set_extb(__sectop("EXCEPTVECT"));
#endif
// set_intb(__sectop("C$VECT"));
```

3. Comment out the initial register settings.

Example: resetprg.c (3/3)

```
// set_fpsw(FPSW_init | _ROUND | _DENOM);
   ~ Omitted ~
// set_psw(PSW_init);          // Set Ubit & Ibit for PSW
```

4.1.2 Creating a branch table program (ftable.src)

At the addresses called from the boot area, write instructions for branching to the function addresses in the flash area.

Example: ftable.src

```
    .INCLUDE ftable.inc

    .GLB    _PowerON_Reset_PC
    .GLB    _f1
    .GLB    _f2
    .GLB    _int_INTP0

    .SECTION JP,CODE
    .ORG    FLASH_TABLE
    BRA.A   _PowerON_Reset_PC    ; RESET
    .LWORD  0FFFFFFFFH           ; vect=1
    .LWORD  0FFFFFFFFH           ; vect=2
    BRA.A   _int_INTP0           ; vect=3
    .LWORD  0FFFFFFFFH           ; vect=4

    .SECTION JP2,CODE
    .ORG    (FLASH_TABLE+INTERRUPT_OFFSET)
    BRA.A   _f1
    BRA.A   _f2

    .END
```

For interrupts

For functions

4.1.3 Defining an interrupt function

- The interrupt vector should be defined in the boot area project.
- Do not specify the vector address (vect) with the #pragma interrupt directive in the flash area.

Example: int.c

```
#include "iodefine.h"
#pragma interrupt int_INTP0
volatile char f;
void int_INTP0(void)
{
  f = 1;
}
```

4.2 Specifying flash area options

Make the following option settings for the flash area.

- Register the externally defined symbol file with the project
- Specify the section allocation
- Specify hex file output only to the flash area address range
- Combine the hex files for the boot and flash areas

4.2.1 Registering the externally defined symbol file with the project

Register the externally defined symbol file (boot.fsy) created in the boot area with the project to allow access to the variables and functions in the boot area.

Example: e² studio

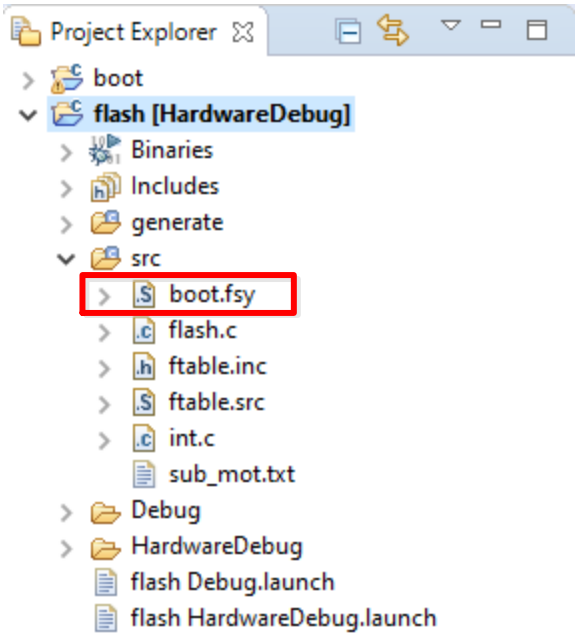


Figure 18 Example of Option Setting with the e² studio

Example: CS+

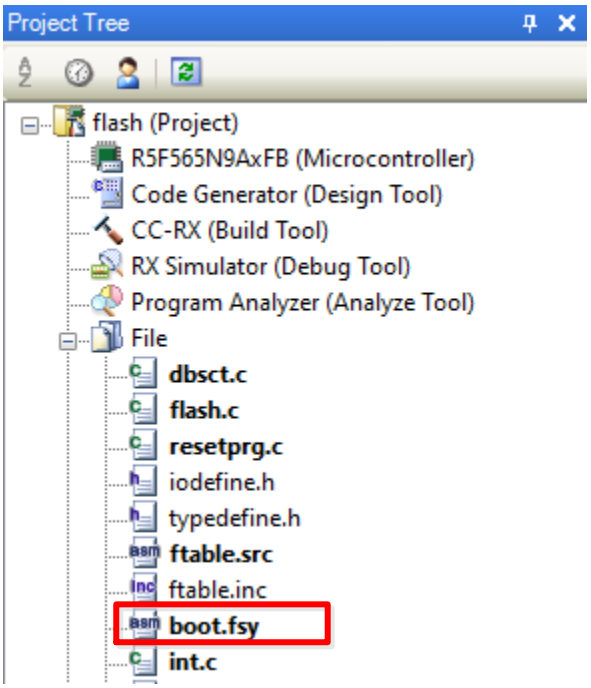


Figure 19 Example of Option Setting with CS+

4.2.2 Specifying the section allocation

Specify the section allocation in the flash area with the linker option -start.

- Make sure that the sections do not overlap those in the boot area.
- Do not allocate anything to the branch table area.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Linker]→[Section]→[Section Viewer]

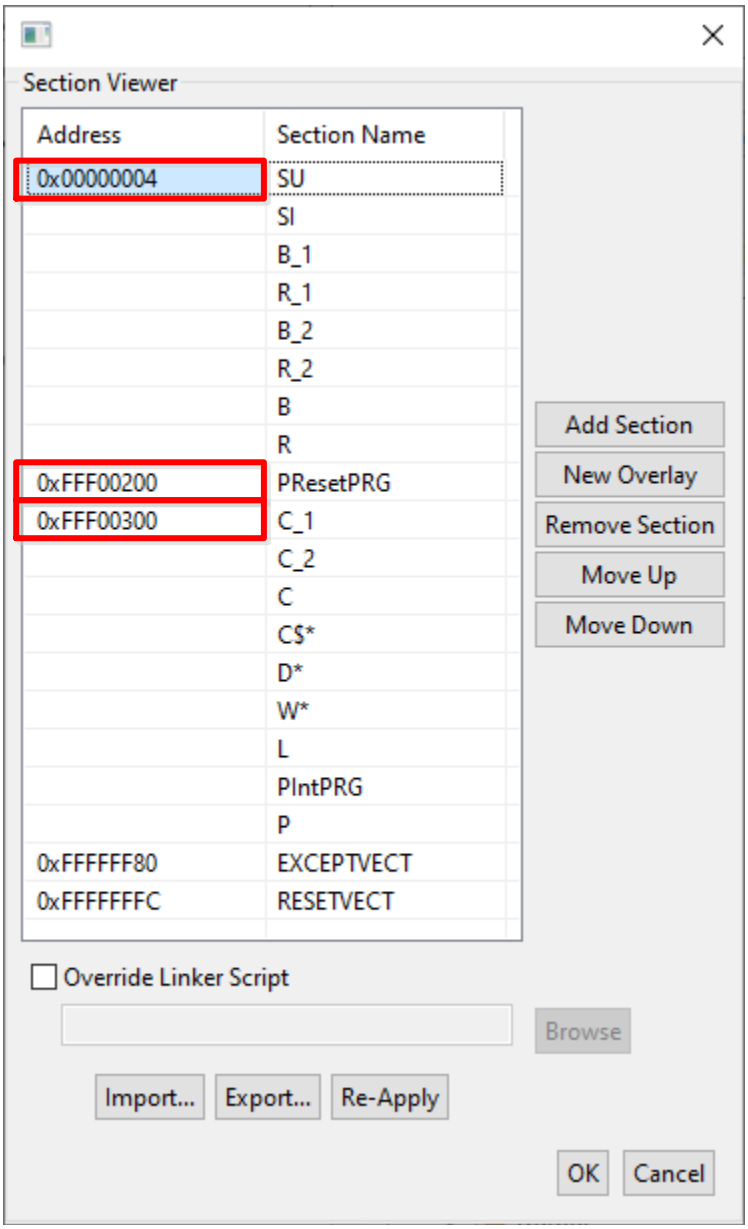


Figure 20 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Link Options] tabbed page

→[Section]→[Section start address]

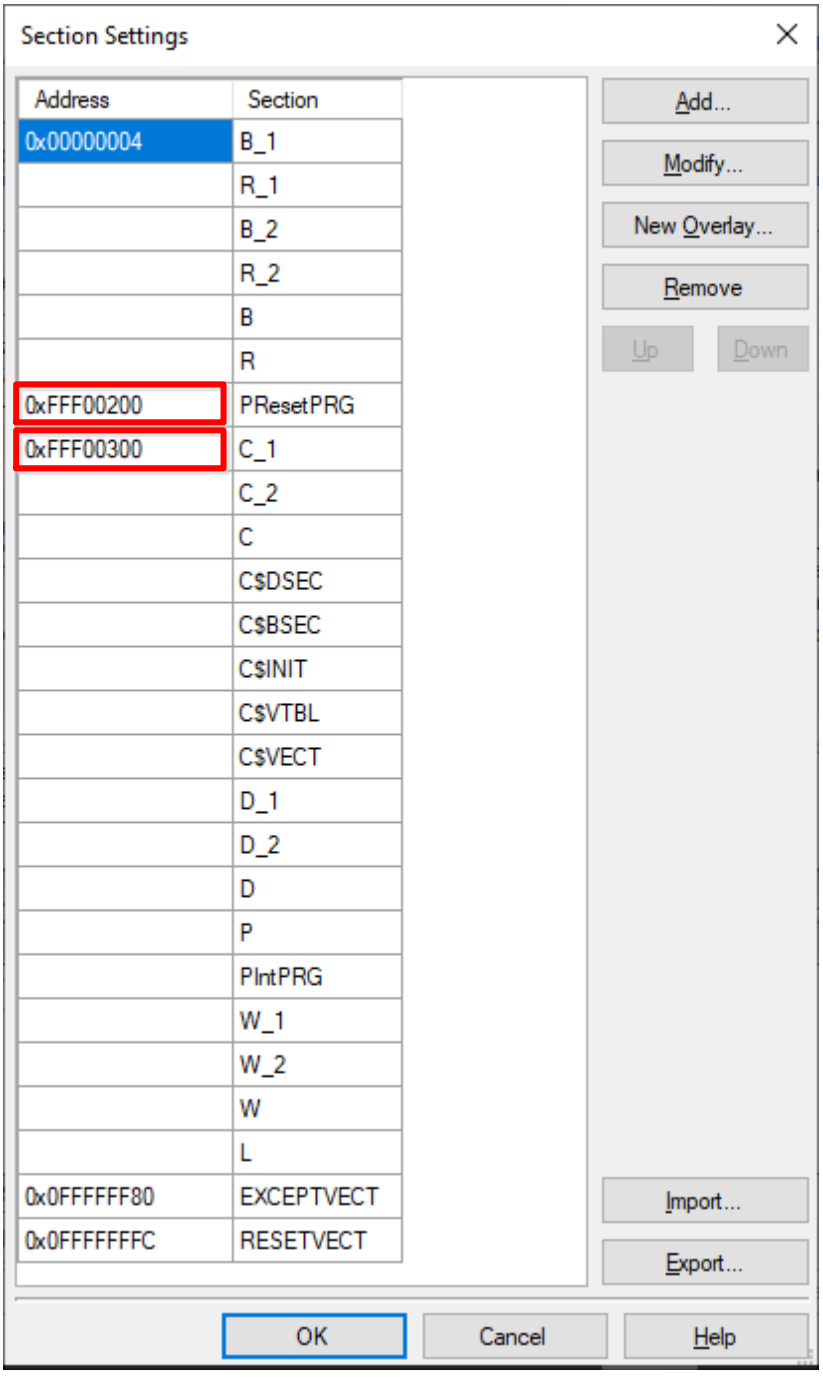


Figure 21 Example of Option Setting with CS+

4.2.3 Specifying hex file output only to the flash area address range

Specify the output file name and output addresses.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Tool Settings] tabbed page

→[Converter]→[Output]

→Select the [Output hex file] checkbox.

→Select [Motorola S format file] as the output file format.

→Specify the output file name and output addresses in [Division output file].

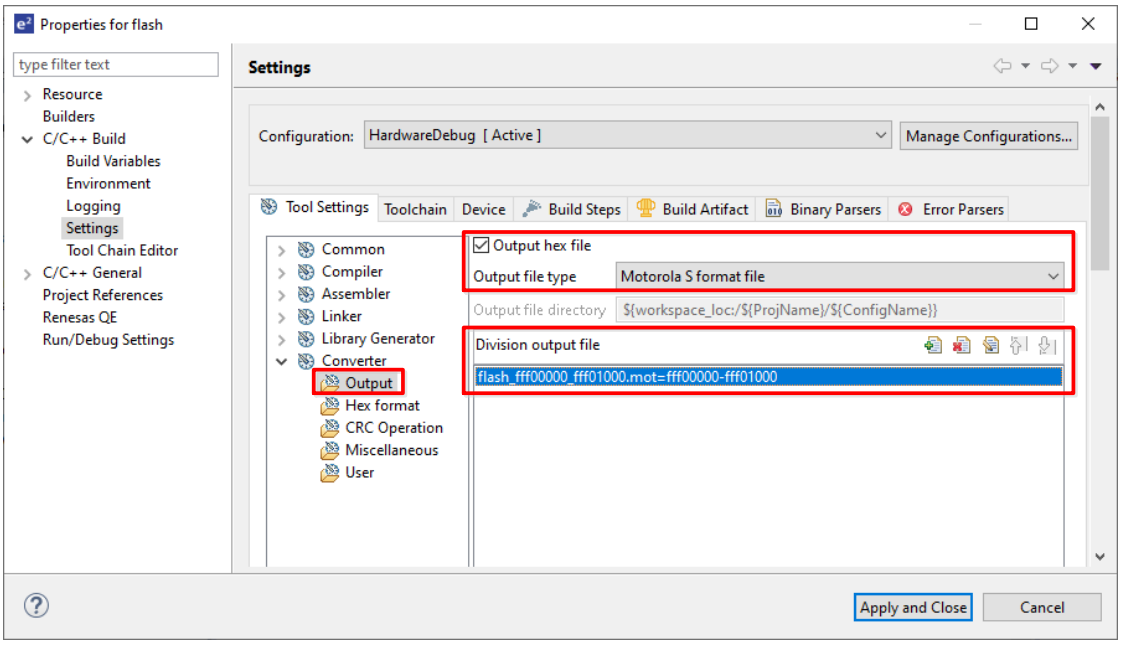


Figure 22 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Hex Output Options] tabbed page

→[Output File]→Specify the output file name and output addresses in [Division output file].

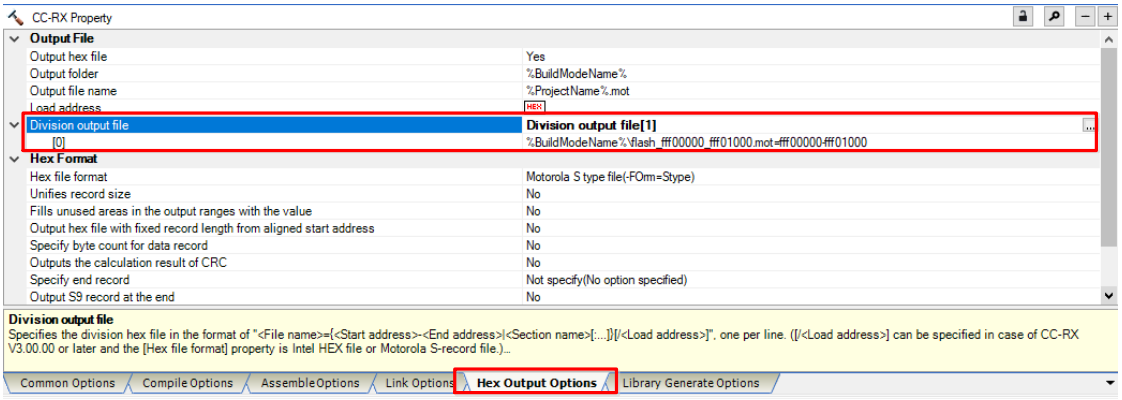


Figure 23 Example of Option Setting with CS+

4.2.4 Combining the hex files for the boot and flash areas

To combine the hex files for the boot and flash areas into one file, add the linker execution step after the build processing.

Example: e² studio

[Properties]→[C/C++ Build]→[Settings]→[Build Steps] tabbed page→[Post-build steps]
→Add the command to execute the linker (rlink.exe -subcommand=..¥src¥sub_mot.txt) to [Command(s):].

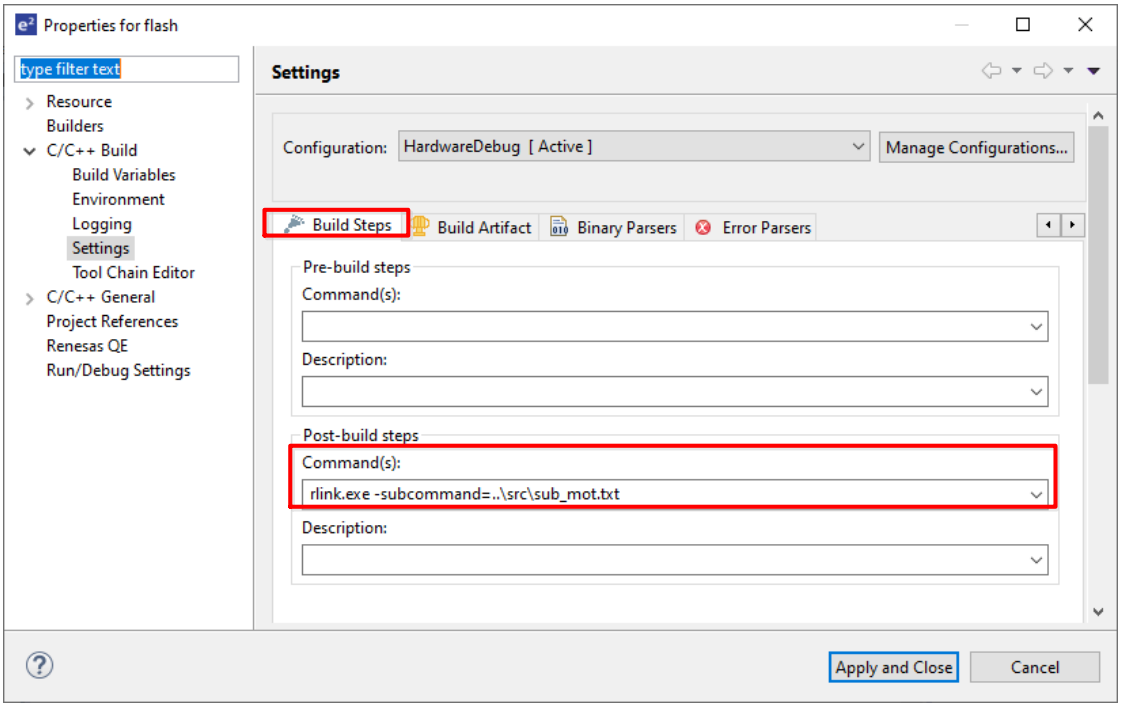


Figure 24 Example of Option Setting with the e² studio

Example: CS+

[CC-RX (Build Tool)]→[Common Options] tabbed page→[Others]
→Add the command to execute the linker ("%MicomToolPath%¥CC-RX¥V3.01.00¥bin¥rlink.exe" -subcommand=sub_mot.txt) to [Commands executed after build processing].

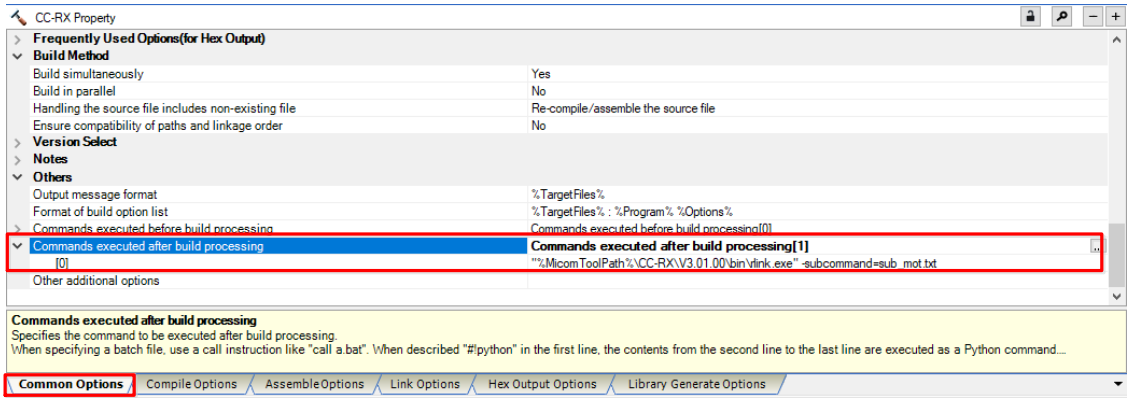


Figure 25 Example of Option Setting with CS+

Specify the input hex files, their format, and the output file name in the subcommand file for input to the linker.

Example: sub_mot.txt (e² studio)

```
-input=..¥..¥boot¥HardwareDebug¥ boot_fff01000_ffffffff.mot
-input=flash_fff00000_fff01000.mot
-form=stype
-output=boot_flash.mot
```

Example: sub_mot.txt (CS+)

```
-input=.¥boot¥DefaultBuild¥boot_fff01000_ffffffff.mot
-input=.¥DefaultBuild¥flash_fff00000_fff01000.mot
-form=stype
-output=.¥DefaultBuild¥boot_flash.mot
```

5. Debugging Tool

5.1 Downloading to Debugging Tool

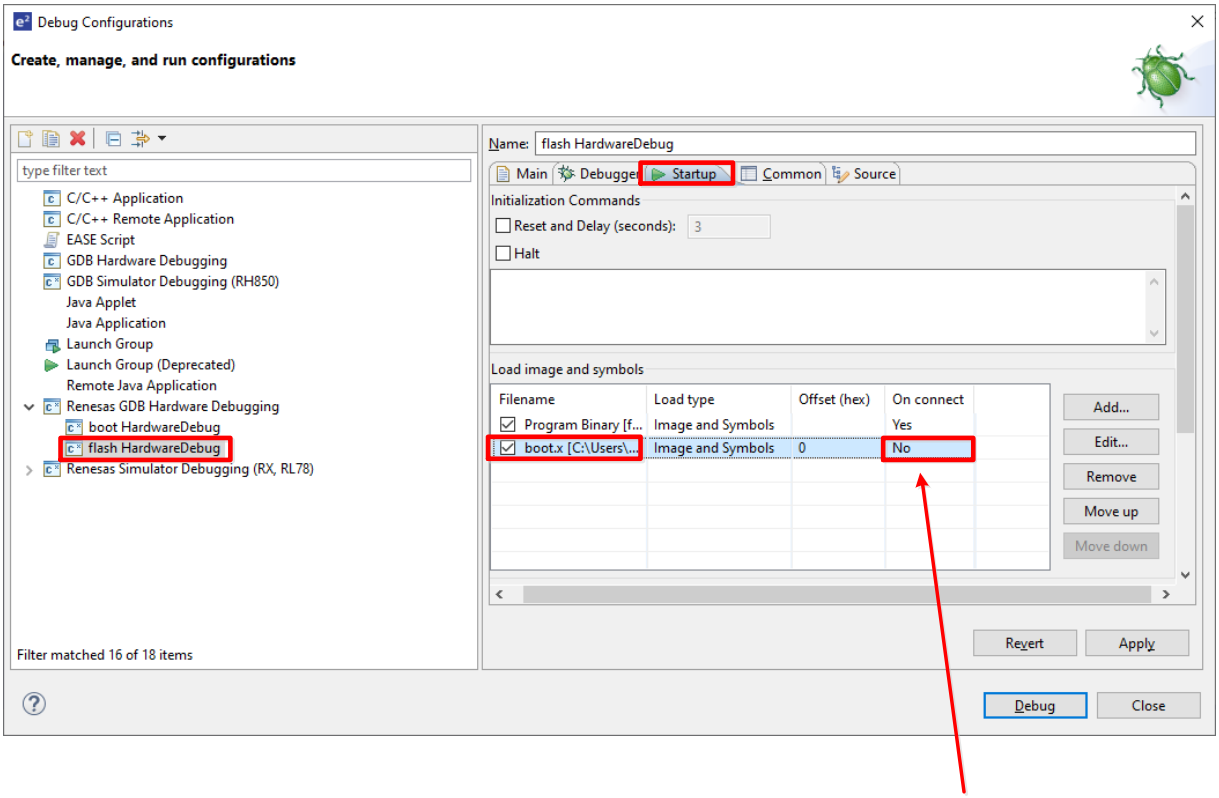
Two load module files (*.abs) are generated; one for each of the boot and flash areas. Download both of the load module files to the debugging tool.

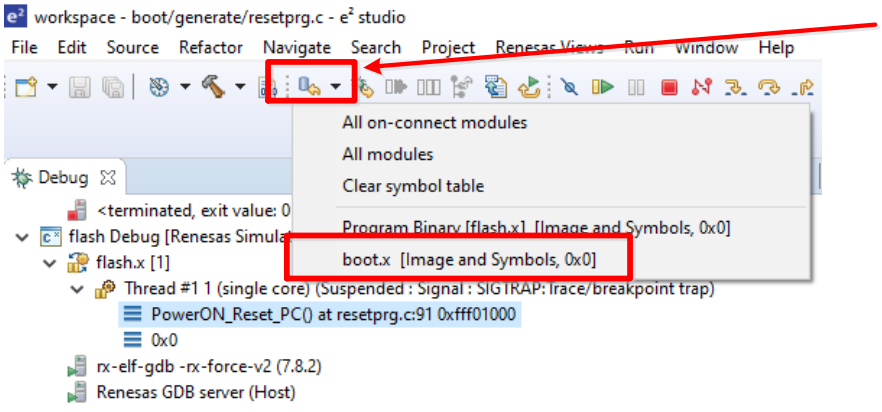
Example: e² studio

[Debug]→[Debug Configurations]→[flash HardwareDebug]→[Startup] tabbed page

→[Load image and symbols]

Add the load module file for the boot area to the project for the flash area.





*Note on e² studio

Set boot.x to "No" when connecting the debugging tool. Download it after connection.

Figure 26 Example of Option Setting with the e² studio

Example: CS+

[RX Simulator (Debug Tool)]→[Download File Settings] tabbed page

→[Download]→[Download files]

Add the load module file for the boot area to the project for the flash area.

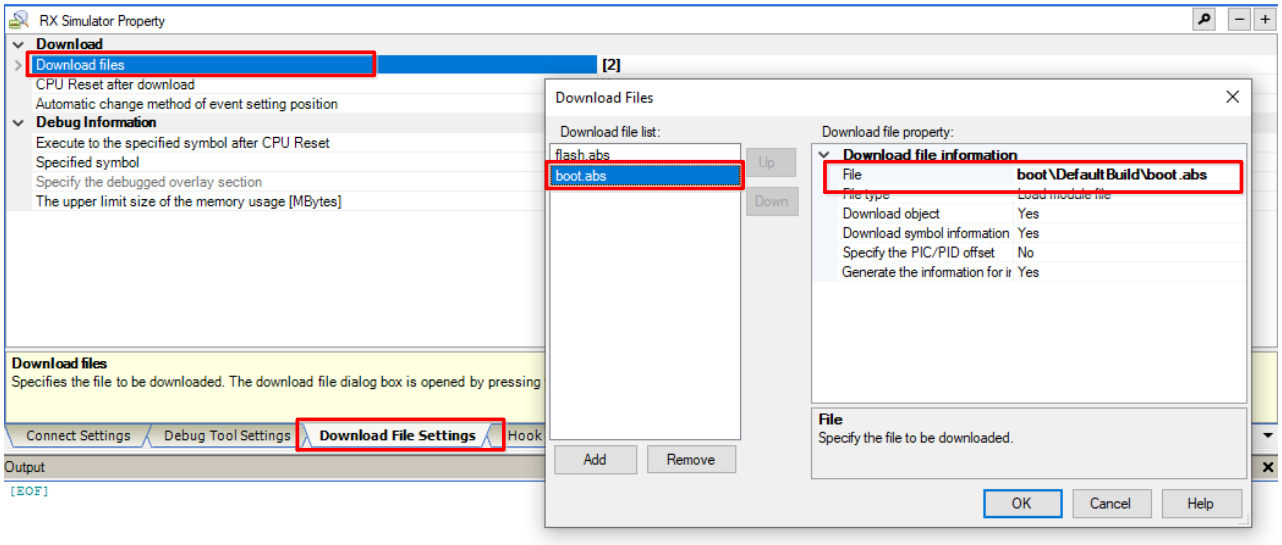


Figure 27 Example of Option Setting with CS+

6. Sample Programs

The following pages show examples of boot and flash area programs that were created through the procedures described in earlier sections.

6.1 Sample program for the boot area (boot.c)

```
#include "iodefine.h"
#pragma interrupt int_boot(vect=4)   /* Interrupt definition in the boot area
*/
int boot_a = 0x12;
int boot_b = 0x34;
extern int f1(int);  /* Prototype declaration of a function in the flash area
*/
extern int f2(int);  /* Prototype declaration of a function in the flash area
*/
void boot_main(void) /* Main function in the boot area  */
{
  /* Main processing in the boot area  */
}
void boot_func(void)
{
  boot_a = f1(boot_a);   /* Call of a function in the flash area */
  boot_b = f2(boot_b);   /* Call of a function in the flash area */
}
void int_boot(void)   /* Interrupt processing in the boot area */
{
  boot_a = 1;
}
```

6.2 Sample program for the flash area (flash.c)

```
#include "iodefine.h"
int flash_a, b;
extern int boot_a, boot_b;     /* Functions defined in the boot area  */
extern void boot_func(void);   /* Function defined in the boot area  */
int f1(int a)
{
  return (++a);
}
int f2(int b)
{
  return (--b);
}
void main(void)       /* Main function in the flash area  */
{
  boot_a++;     /*  Access to a variable in the boot area */
  boot_b++;     /*  Access to a variable in the boot area */
  boot_func();  /*  Access to a variable in the boot area */
}
```

Revision History

Rev.	Date	Description	
		Page	Summary
1.00		-	New release

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
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