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April 1st, 2010
Renesas Electronics Corporation

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R8C Family

Using Memory Beyond the 64K Boundary

Introduction

The first releases of the R8C were for products that never exceeded 64K of memory space. Since this meant that all memory accesses were in the “near” space the compiler for the R8C did not support the commands LDE and STE. These commands are used to load and store data to extended memory areas. For data within the 64K boundary the MOV command is used, however, for data accesses beyond this limit the LDE and STE must be used. The linker also had to place all program code and constant data in the “near” space since that was all that was available.

Target Device

Applicable MCU: R8C/2X Devices

Contents

1. R8C/2X Compiler Option and Locating Constants

Some of the new R8C/2X devices now support memory beyond the 64K address boundary. When this happened a compiler switch was added which restored the LDE and STE commands since they were necessary. This switch could be set in HEW by going to the Build>>Renesas M16C Standard Toolchain menu item then selecting the “Generates code for R8C/Tiny R8C/2X) series” option under the CPU tab as shown below.

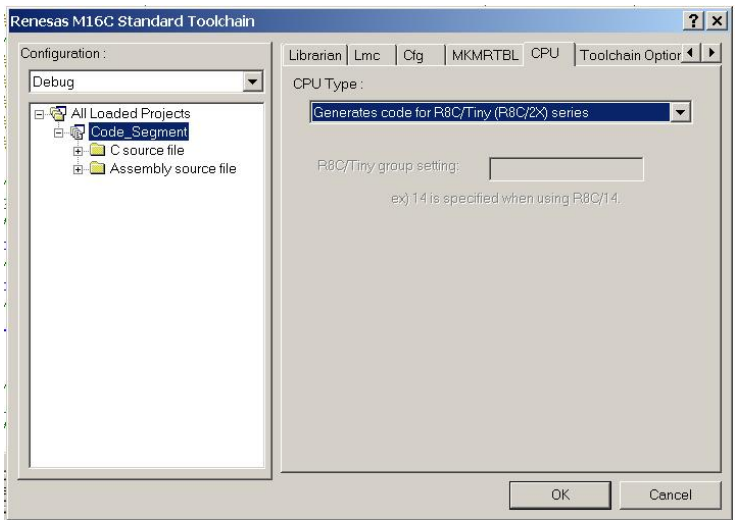


Figure 1 R8C/2X Compiler Option

This option will restore the LDE and STE commands needed to access Far data and will also result in the default location for constant data to be in the Far space. Though this is not a problem it does result in less efficient access to this constant data and means all pointers that would access that data must be declared as Far pointers. For devices that do not have any memory past the 64K boundary (even if it is a R8C/2X part) it is easiest to select the "Generates code for the R8C/Tiny" option for CPU Type. This will result in all constants being mapped to Near Memory space.

In most cases it is recommended that the constant data be located in Near Memory since it is more efficient (since pointers are only 16 bits and the MOV command can be used rather than the LDE and STE). There is no penalty paid for code in Far Memory since the program counter can directly access the 20 bit memory space.

The simple way to have constants linked to the Near Memory space is to change the default ROM data setting so it is in Near Memory space rather than Far Memory space. This is done by going to the Build>>Renesas M16C Standard Toolchain menu and under the Compiler tab select Code Modification and check the –fnROM option. This is shown below in Figure 2.

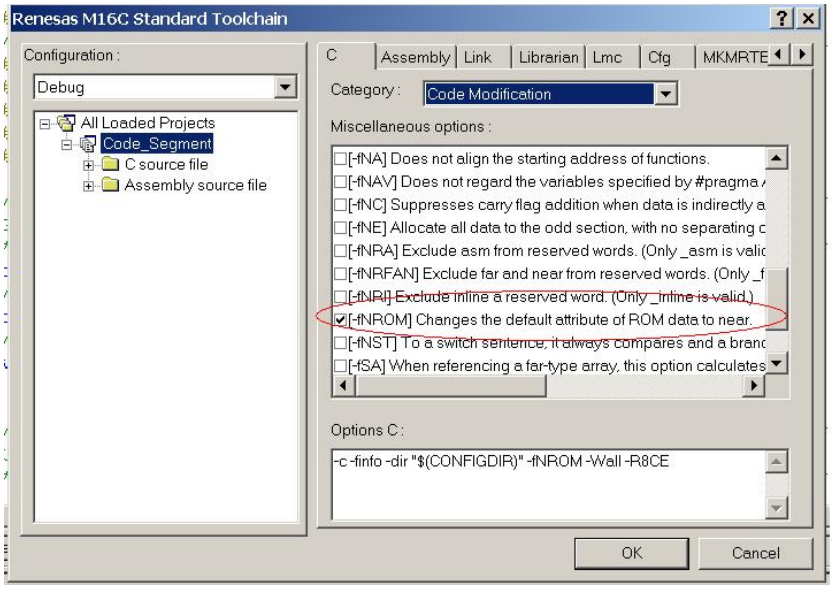
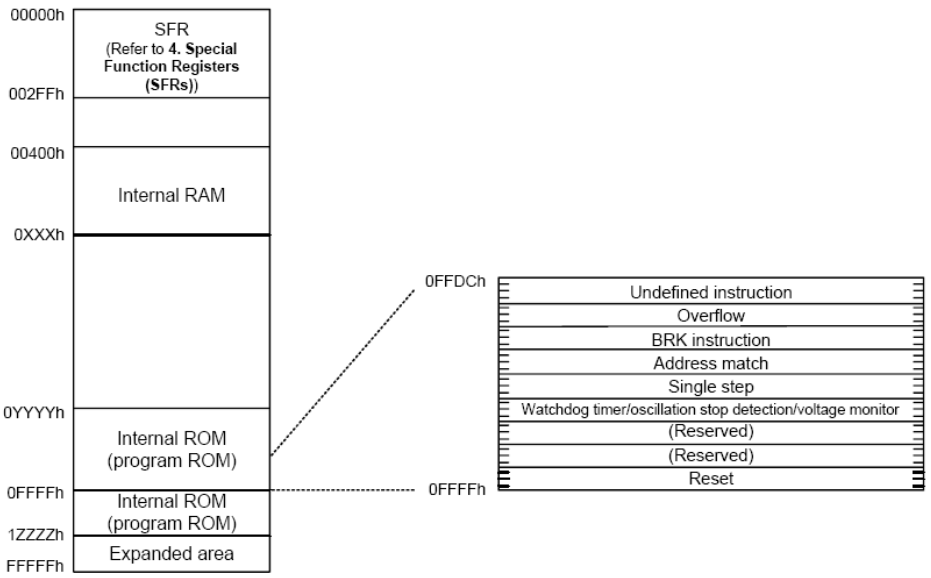


Figure 2 Putting Constants in Near Memory

2. Using the Expanded Memory with Assembly Startup Files

One issue with the R8C/2X devices that have memory beyond the 64K limit is the Special Fixed vectors are located at 0FFDCh to 0FFFFh as shown in the memory map below. Since the expanded memory area is not contiguous with the internal program space shown in the map below the linker cannot directly utilize the expanded area to store code. If the start of ROM is indicated as 04000h in the startup files the linker will begin at that location and fill the memory up to the fixed vector area. The linker cannot automatically "jump around" the fixed vector area and start utilizing the expanded area.



NOTE:
1. The blank regions are reserved. Do not access locations in these regions.

Part Number	Internal ROM			Internal RAM	
	Size	Address 0YYYYh	Address 1ZZZZh	Size	Address 0XXXXh
R5F21244SNFP, R5F21244SDFP	16 Kbytes	0C000h	-	1 Kbyte	007FFh
R5F21246SNFP, R5F21246SDFP	32 Kbytes	08000h	-	2 Kbytes	00BFFh
R5F21247SNFP, R5F21247SDFP	48 Kbytes	04000h	-	2.5 Kbytes	00DFFh
R5F21248SNFP, R5F21248SDFP	64 Kbytes	04000h	13FFFh	3 Kbytes	00FFFh

Figure 3 Memory Map of R8C/24 Group

Using this expanded area is not difficult and the attached project workspace (R8C_Expanded_Memory) is a good example of how to set it up.

Copy the folder R8C_Expanded_Memory into the C:\workspace directory created by HEW and open the workspace file 'R8C_Expanded_Memory.hws'. Upon opening the workspace, the 'Assembly Startup' project is set as the default project. If it is not, then switch to it by selecting from the toolbar Project>>Set Current Project.

The first thing that is done is to add an expanded code section, named expanded_program. This is accomplished by adding the following lines to the sect30.inc file (this is located near the bottom of the file)

```
; .section expanded_program,CODE
; .org 10000H
```

The next step is to assign modules or functions to be linked to that section. The easiest implementation assigns all the functions in a C module to that section. This is done with the code in the lcd.c module of the project. The following statement is added to the top of the file

```
; #pragma SECTION program expanded_program
```

This results in all the code in that module being linked to the new section. After linking this module the default program section is used for other modules.

It is also possible to link just one function or one section of a C module. To do this the same statement (#pragma SECTION program expanded_program) is used at the beginning of the code that will be added to the new section. At the end of the function or the functions to be linked the SECTION statement below is used to force the linker to use the default program section:

```
; #pragma SECTION program program
```

The FlashLEDs function from the flashleds.c module has been added to the expanded program space using this method.

Figure 4 is a map that shows the result of the changes that were incorporated. Notice that there is a section starting at 010000h which is a code segment [C]. In this segment are functions which were in the lcd.c file where the #pragma Section command was used to change the link location. There is also the FlashLEDs function where only one function out of a file was placed in the link location. The ToggleLEDs function which is also in the flashleds.c module is in the default (near) program space. You can also see the Constant data ucReplace is located in the rom_NE section.

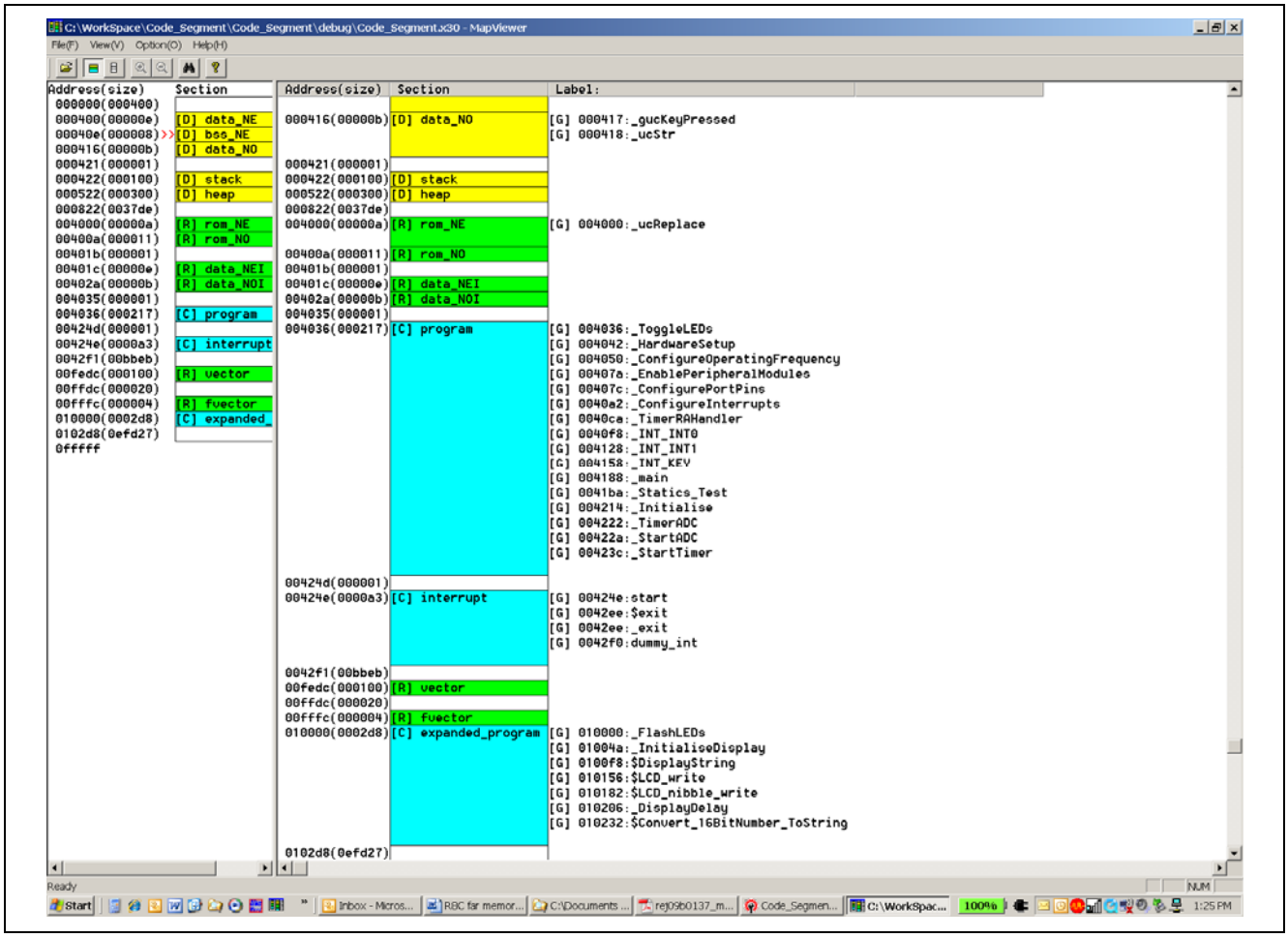


Figure 4 Map with Code in Extended Area & Constants in Near Memory

3. Using the Expanded Memory with C Startup Files

Next we will introduce performing this same operation on the C Startup based project files that are introduced with the NC30 toolchain version 5.40 and later. Using the map view feature of the project, creating and modifying sections, can be accomplished using a graphical interface. This makes it much easier than making the same modification using the assembly startup versions

Using the same workspace, switch to the CStartup_Code project by selecting from the toolbar Project>>Set Current Project.

Once the project is loaded, select from the toolbar View>>Map and the following window will appear:

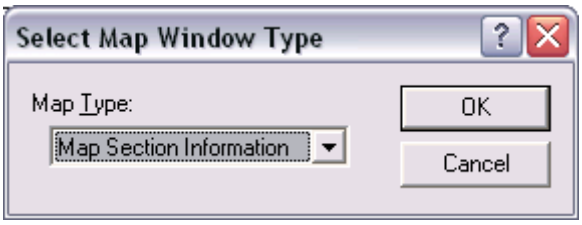


Figure 5 Open Map Section Information

Click 'OK' for the Map Section window to appear in the HEW environment. Note you may have to slide the windows around to view the Map window. The window should look like the one below:

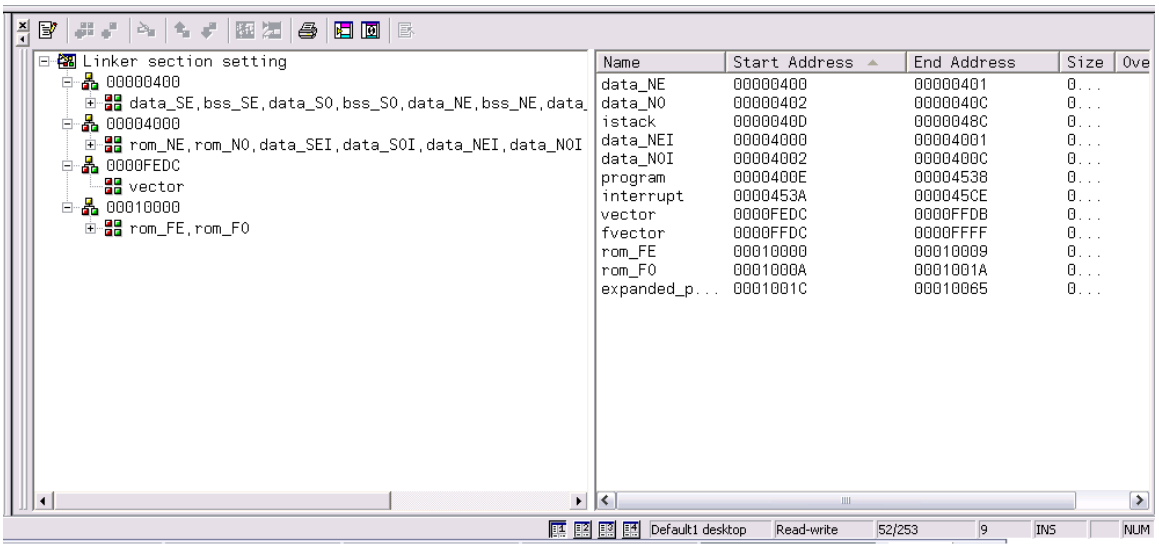


Figure 6 Viewing Map Section Information

Note that you can see the sections of each defined memory area in a graphical list view. To edit/create a new section simply click the edit icon to enter map edit mode.

Next click on the entry that contains 'rom_FE, rom_FO', this will select this section group that starts at address 010000h. Now click Add Section to add a new section to the group. For this example, enter the name 'expanded_program' and click 'Ok'. You will now see your section added to the section group. Expand the section group you have been modifying and move the 'expanded_program' section to the top using Move Up. When done it should look like this:

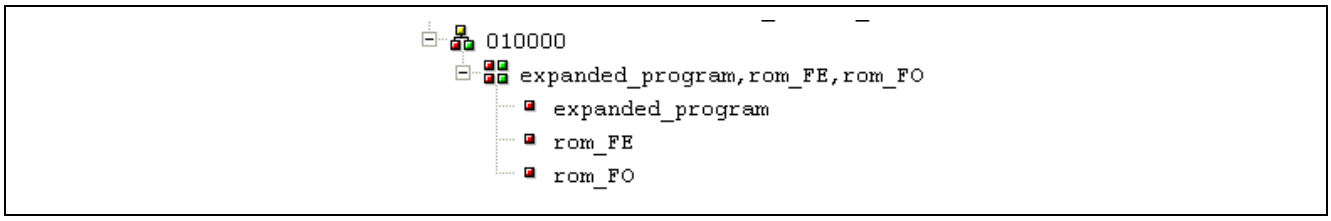


Figure 7 Expanded Section Group

Click to exit the map edit mode and send the updated map info to the linker.

Repeated from above, the next step is to assign modules or functions to be linked to that section. The easiest implementation assigns all the functions in a C module to that section. This is done with the code in the lcd.c module of the project. Uncomment the following statement at the top of the file

```
; #pragma SECTION program expanded_program
```

This results in all the code in that module being linked into the new section. Rebuild this project by using menu item Build>>Build All and note the addition of the section at 010000h in the link window.

It is also possible to link just one function or one section of a C module. To do this the same statement (#pragma SECTION program expanded_program) is used at the beginning of the code that will be added to the new section. At the end of the function or the functions to be linked the SECTION statement below is used to force the linker to use the default program section:

```
; #pragma SECTION program program
```

The FlashLEDs function from the flashleds.c module has been added to the expanded program space using this method.

This example uses the simulator to examine the result of the link process. Use the session pull-down from the toolbar to change from the ‘DefaultSession’ to the ‘SessionM16C_R8C_Simulator’ to view the linked addresses of the code.

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Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Feb.20.09	—	First edition issued

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