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April 1st, 2010
Renesas Electronics Corporation

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This document explains how to migrate the sample project created in M16C to RX.

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1. Overview of the M16C sample project

The M16C sample project ‘M16C_Sample’ can be broadly divided into pre- and post-processing such as for initialization, and main processing to perform central processing. This edition shows how to migrate the main processing to perform central processing to an RX project, and check its operation. The following table shows the files that comprise main processing.

<table>
<thead>
<tr>
<th>No</th>
<th>Processing</th>
<th>File name</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Depends on integer promotion specifications for the char type</td>
<td>M16C_extended_integer.c</td>
<td>2.7.1</td>
</tr>
<tr>
<td>2</td>
<td>Depends on size of int type</td>
<td>M16C_int_size.c</td>
<td>2.7.2</td>
</tr>
<tr>
<td>3</td>
<td>Depends on structure member placement</td>
<td>M16C_struct_member.c</td>
<td>2.7.3</td>
</tr>
<tr>
<td>4</td>
<td>Depends on size of double type</td>
<td>M16C_double_size.c</td>
<td>2.4.1</td>
</tr>
<tr>
<td>5</td>
<td>Depends on pragma BITADDRESS</td>
<td>M16C_pragma_BITADDRESS.c</td>
<td>2.4.2</td>
</tr>
<tr>
<td>6</td>
<td>Depends on pragma ROM</td>
<td>M16C_pragma_ROM.c</td>
<td>2.4.3</td>
</tr>
<tr>
<td>7</td>
<td>Depends on pragma PARAMETER</td>
<td>M16C_pragma_PARAMETER.c</td>
<td>2.4.4</td>
</tr>
<tr>
<td>8</td>
<td>Depends on inline keywords</td>
<td>M16C_inline_keyword1.c</td>
<td>2.4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M16C_inline_keyword2.c</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Main function</td>
<td>M16_Sample_main.c</td>
<td>--</td>
</tr>
</tbody>
</table>
2. Migrating the M16C sample project to RX

2.1 Creating the RX project

Create a new RX project workspace for the migration destination of the M16C sample project.
This section explains how to generate sample project in the project generator (launched from HEW by choosing the File menu and then New workspace), according to the following procedures.

(1) Creating a new workspace
Select the “Application” project type.

![New Project Workspace](image)

Figure 1-1
(2) Selecting a CPU

Leave this set to the default value, and proceed.
(3) Setting options

Leave this set to the default value, and proceed.
(4) Set up generated files
Select “Use I/O library”.
Specify “20” for “I/O stream count”.

Figure 1-5
(5) Set up the standard library

Leave this set to the default value, and proceed.

Figure 1-6
(6) Set up the stack space

Leave this set to the default value, and proceed.

Figure 1-7
(7) Set up vectors

Leave this set to the default value, and proceed.

![Image of New Project-7/10-Setting the Vector dialog box]

Figure 1-8
(8) Set up the debugger
Select “RX600 Simulator”.

Figure 1-9
(9) Set the debugger options

Select “Initial session”.

![New Project-9/10-Setting the Debugger Options](image)

Figure 1-10

(10) Check the generated file names

Click “Finish”.

![New Project-10/10-Changing the File Names to be Created](image)

Figure 1-11
(11) Set up the simulator

Click “OK”.

Figure 1-12
2.2 Migrating source files for main processing

Copy, and register with the created RX project, the files comprising main processing for the M16C sample project, as explained in 1.Overview of the M16C sample project.

(1) Copy files from the M16C sample project folder

Copy to the RX project the 10 files explained in 1. Overview of the M16C sample project.

![Diagram showing file structure comparison between M16C Sample project and RX project](image)
(2) Register the copied files with the project

Register the copied files with the created RX project. In HEW, choose Project and then Add files, and then select the following in the displayed dialog box.

![Add files to project 'RX test M16C'](image)

- **Select the files to be registered**
- **Click the Add button after selection**

**Figure 1-14**
(3) Unregistering unnecessary files

Delete the ‘RX_test_M16C.c’ file generated by the project generator for the main function. It is no longer necessary, because the main function file was copied from the M16C sample project.

In HEW, choose Project and then Delete files, and then select the following in the displayed dialog box.

![Figure 1-15](image_url)

Select the file to be deleted

Click the Delete button after selection

Figure 1-15
2.3 Building and checking M16C compatibility

Build the RX project for which the main processing file was copied and registered. When a build is performed in HEW, since the M16C compatibility check functionality is enabled, option specifications and source code that may impact compatibility can be checked. This section explains how to enable M16C compatibility check functionality and perform a build, and then check the displayed compatibility confirmation messages.

(1) Set up M16C compatibility check functionality

In HEW, choose Build and then RX Standard Toolchain, and then select the following in the displayed dialog box.

![Select the Compiler tab](Figure 1-16)
(2) Building

In HEW, choose Build and then Build to start the build. A message is displayed during the build, in the output window.

Figure 1-17

Figure 1-18

Output window
(3) Checking compatibility check messages

The C1801 warning is displayed in the messages output to the output window, indicating that this area poses a compatibility problem with M16C.

Figure 1-19
2.4 Handling compatibility check instructions

The following explains how to check and deal with C1801 messages affecting compatibility, as given in 2.3 Building and checking M16C compatibility. The target messages are as follows.

<table>
<thead>
<tr>
<th>No</th>
<th>Messages affecting compatibility</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Using &quot;dbl_size=4&quot; function at influence the code generation of &quot;NC&quot; compiler</td>
<td>2.4.1</td>
</tr>
<tr>
<td>2</td>
<td>Using &quot;BITADDRESS&quot; function at influence the code generation of &quot;NC&quot; compiler</td>
<td>2.4.2</td>
</tr>
<tr>
<td>3</td>
<td>Using &quot;PARAMETER&quot; function at influence the code generation of &quot;NC&quot; compiler</td>
<td>2.4.3</td>
</tr>
<tr>
<td>4</td>
<td>Using &quot;ROM&quot; function at influence the code generation of &quot;NC&quot; compiler</td>
<td>2.4.4</td>
</tr>
<tr>
<td>5</td>
<td>Using &quot;inline&quot; function at influence the code generation of &quot;NC&quot; compiler</td>
<td>2.4.5</td>
</tr>
</tbody>
</table>

2.4.1 Specifying the size of double type variables

The message ‘Using "dbl_size=4" function at influence the code generation of "NC" compiler’ indicates that a compatibility problem exists with the specified “dbl_size=4” option. With M16C-family compilers, the size of the double type is 8 bytes, whereas with RX-family compilers, the size of the double type is 4-byte because dbl_size=4 is specified in default. Since the size of the double type is required to be 8 bytes based on how “M16C_double_size.c” was coded in the sample program, if the “dbl_size=4” option is specified, the operation results will differ from M16C.

“M16C_double_size.c” in the sample program

```c
Source code
double d1 = 1E30;
double d2 = 1E20;

void double_size(void)
{
    d1 = d1 * d1;
    d2 = d2 * d2;

    printf("(5) double type size : ");

    if (d1 > d2) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

When migrating to RX a program created with the requirement that the size of the double type is 8 bytes, specify the “dbl_size=8” option. For details about specifying this option, see compiler users manual. Also, change the options specified in the created RX project.
2.4.2 Specifying #pragma BITADDRESS

The message 'Using "BITADDRESS" function at influence the code generation of "NC" compiler' indicates that a compatibility problem exists with #pragma BITADDRESS in the source. M16C-family compiler support #pragma BITADDRESS, but RX-family compilers do not.

Since "pragma_BITADDRESS.c" in the sample program contains code with #pragma BITADDRESS, it will not operate as expected on RX. Programs using #pragma BITADDRESS can be migrated to RX replacing bit access processing with structure bit fields. The following shows source code using #pragma BITADDRESS, and the same source code migrated to RX.
(Note that since the memory map differs between M16C and RX, absolutely specified addresses need to be changed as appropriate. Use the following as an example.)

"pragma_BITADDRESS.c" sample program

```
M16C source code
#pragma ADDRESS bit_data 410H
int bit_data;
#pragma BITADDRESS bit 0,410H
Bool bit;
void pragma_bitaddress(void)
{
    printf("(6) pragma BITADDRESS : ");
    bit_data = 1;
    if (bit == 1) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}

RX source code
#pragma address bit_data 0x2000
int bit_data;
struct bit_address {
    unsigned char b0:1;
    unsigned char b1:1;
    unsigned char b2:1;
    unsigned char b3:1;
    unsigned char b4:1;
    unsigned char b5:1;
    unsigned char b6:1;
    unsigned char b7:1;
};
#define bit (((struct bit_address*)0x2000)->b0)
void pragma_bitaddress(void)
{
    printf("(6) pragma BITADDRESS : ");
    bit_data = 1;
    if (bit == 1) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

Notes

In addition to #pragma BITADDRESS, "pragma_BITADDRESS.c" also uses the "_Bool" type, which poses a problem for ANSI-standard C89. To use the "_Bool" type in RX, specify the "lang=c99" option to use ANSI-standard C99. For details about specifying this option, see compiler users manual.
2.4.3 Specifying #pragma PARAMETER

The message ‘Using "PARAMETER" function at influence the code generation of "NC" compiler’ indicates that a compatibility problem exists with #pragma PARAMETER in the source code. M16C-family compilers support #pragma PARAMETER, but RX-family compilers do not.

Since “M16C_pragma_PARAMETER.c” in the sample program contains code with #pragma PARAMETER, it will not operate as expected on RX. Programs using #pragma PARAMETER can be migrated to RX by changing the argument interface of the assembler function specified by #pragma PARAMETER to conform to C/C++ generation rules.

For details about function interfaces, see compiler users manual.

Since #pragma PARAMETER is disregarded by RX compilers, “M16C_pragma_PARAMETER.c” does not need to be changed.

Sample assembler source code

Since “M16C_pragma_PARAMETER_asm.a30” in the assembler source code of the M16C sample project cannot be migrated as is to the RX project, a new assembler source file needs to be created, and assembler code for RX needs to be added and registered. Since the M16C sample project contains the “RX_pragma_PARAMETER_asm.src” file with assembler code for RX already coded, register it with the RX project.
2.4.4 Specifying #pragma ROM

The message ‘Using "ROM" function at influence the code generation of "NC" compiler’ indicates that a compatibility problem exists with #pragma ROM in the source code. M16C-family compilers support #pragma ROM, but RX-family compilers do not. Since “M16C_pragma_ROM.c” in the sample program contains code with #pragma ROM, it will not operate as expected on RX. To migrate this to RX, specify const keywords for variable declarations for which #pragma ROM is specified.

“M16C_pragma_ROM.c” sample program

<table>
<thead>
<tr>
<th>M16C source code</th>
<th>RX source code</th>
</tr>
</thead>
<tbody>
<tr>
<td>#pragma ROM rrr</td>
<td>const unsigned short rrr = 100;</td>
</tr>
<tr>
<td>unsigned short rrr = 100;</td>
<td>void pragma_rom(void)</td>
</tr>
<tr>
<td>void pragma_rom(void) {</td>
<td>void pragma_rom(void) {</td>
</tr>
<tr>
<td>printf(&quot;(7) pragma ROM : &quot;);</td>
<td>printf(&quot;(7) pragma ROM : &quot;);</td>
</tr>
<tr>
<td>if (rrr == 100) {</td>
<td>if (rrr == 100) {</td>
</tr>
<tr>
<td>printf(&quot;OK\n&quot;);</td>
<td>printf(&quot;OK\n&quot;);</td>
</tr>
<tr>
<td>} else {</td>
<td>} else {</td>
</tr>
<tr>
<td>printf(&quot;NG\n&quot;);</td>
<td>printf(&quot;NG\n&quot;);</td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
</tbody>
</table>

Assembler source code

| .SECTION rom_FE,ROMDATA,align |
| _rrr: |
| .glb _rrr |
| .word 0064H |

Assembler source code

| .SECTION C_2,ROMDATA,ALIGN=2 |
| _rrr: |
| .glb _rrr |
| .word 0064H |

; static: rrr
2.4.5 Specifying inline keywords

The message 'Using "inline" function at infl
uence the code generation of "NC" compiler' indicates that a compatibility problem exists with inline keywords in the source code. M16C-family compilers support inline keywords, but RX-family compilers is specified lang=c by default, and, the way things are going, cannot recognize the inline keyword. Do not.

Since “M16C_inline_keyword2.c” in the sample program contains code with inline keywords, if it is built as is on the ANSI-standard C89 for RX, a compiler error will occur. There are two ways to migrate programs with inline keywords to RX:

- When performing builds with ANSI-standard C89, change inline code to #pragma inline.
- Perform builds with ANSI-standard C99.

The following gives an example of code using #pragma inline. Change the RX sample project as follows.

“M16C_inline_keyword2.c” sample program

<table>
<thead>
<tr>
<th>M16C source code</th>
<th>RX source code</th>
</tr>
</thead>
<tbody>
<tr>
<td>inline int inline_func(void)</td>
<td>#pragma inline inline_func</td>
</tr>
<tr>
<td>{</td>
<td>: int inline_func(void)</td>
</tr>
<tr>
<td>return 4;</td>
<td>{</td>
</tr>
<tr>
<td>}</td>
<td>: return 4;</td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
<tr>
<td>int get_value()</td>
<td>int get_value()</td>
</tr>
<tr>
<td>{</td>
<td>:</td>
</tr>
<tr>
<td>return inline_func();</td>
<td>: return inline_func();</td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
</tbody>
</table>

Notes

To use inline keywords without modifying the source, specify the “lang=c99” option to enable ANSI-standard C99. For details about how to specify this option, see compiler users manual.

Note that C99 inline keywords require precaution due to the following two traits:

- Inline expansions are not always performed, such as when the “noinline” option is specified, or conditions are not met for the “inline” option.
- The function specified by an inline keyword is internally linked, and therefore subject to deletion.

Since “M16C_inline_keyword2.c” in the sample program satisfies the above two conditions, when compilation is performed with the “lang=c99” option, the definition of the inline_func function is deleted regardless of whether inline expansion is performed. As such, a link error will occur because the inline_func function is undefined. Perform one of the following as a workaround.

- Replace inline keywords with #pragma inline, and perform unconditional inline expansion.
- Add inline functions to the extern specification, to be linked externally.

Example of changing inline functions to external linkage

<table>
<thead>
<tr>
<th>RX source code</th>
</tr>
</thead>
<tbody>
<tr>
<td>extern inline int inline_func(void)</td>
</tr>
<tr>
<td>{ return 4; }</td>
</tr>
<tr>
<td>int get_value()</td>
</tr>
<tr>
<td>{ return inline_func(); }</td>
</tr>
</tbody>
</table>
2.5 Rebuilding

Once the specified options and source code causing compatibility problems have been changed as shown in 2.4 Handling compatibility check instructions, rebuild the project as shown in 2.3(2) Building. When the following dialog box is displayed for a successful build, click Yes, and then download the load module.

![Confirmation Request](image)

Figure 1-20

2.6 Running the simulator

Execute the rebuilt load module in the simulator.

(1) Setting up I/O simulation

The program outputs the execution results to the standard output. The I/O Simulation window needs to be enabled to display the standard output. From HEW, choose View, then CPU, and then I/O simulation to display the I/O Simulation window.

![I/O Simulation window](image)

Figure 1-21
(2) Running the simulator

From HEW, choose Debug and then Run after reset to run the program in the simulator, and display the program standard output in the I/O Simulation window. Once the results are displayed, (1), (2), and (3) can be checked to see whether the values are invalid.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>integer extend</td>
<td>NG</td>
</tr>
<tr>
<td>2</td>
<td>int type size</td>
<td>NG</td>
</tr>
<tr>
<td>3</td>
<td>struct member offset</td>
<td>NG</td>
</tr>
<tr>
<td>4</td>
<td>double type size</td>
<td>OK</td>
</tr>
<tr>
<td>5</td>
<td>inline keyword</td>
<td>OK</td>
</tr>
<tr>
<td>6</td>
<td>pragma BITADDRESS</td>
<td>OK</td>
</tr>
<tr>
<td>7</td>
<td>pragma ROM</td>
<td>OK</td>
</tr>
<tr>
<td>8</td>
<td>pragma PARAMETER</td>
<td>OK</td>
</tr>
</tbody>
</table>

Invalid execution results
2.7 Handling invalid execution results

Run the migrated sample project, check the contents of any invalid results, and troubleshoot any compatibility problems for invalid results as shown in the following table.

<table>
<thead>
<tr>
<th>No</th>
<th>Invalid result</th>
<th>Compatibility problem</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>integer extend</td>
<td>Integer promotion specification</td>
<td>2.7.1</td>
</tr>
<tr>
<td>2</td>
<td>int type size</td>
<td>Size of the int type</td>
<td>2.7.2</td>
</tr>
<tr>
<td>3</td>
<td>struct member offset</td>
<td>Placing structure members</td>
<td>2.7.3</td>
</tr>
</tbody>
</table>

2.7.1 Integer promotion specification

Under the ANSI standard, when char type data (such as signed char, unsigned char types) are evaluated, they are always promoted to the int type. The RX specification conforms to the ANSI-standard, but to improve ROM efficiency, M16C does not promote char type data to the int type when evaluating it. This may cause different results, such as code that would cause an overflow while calculating char type data in M16C no longer doing so due to int type promotion after migration to RX. Code that relies on an overflow occurring during calculation of char type data in M16C needs to be checked during migration to RX.

“M16C_extended_integer.c” sample program

```
M16C source code
void extended_integer(void)
{
    char c1;
    char c2 = 200;
    char c3 = 200;
    c1 = (c2+c3)/2;
    printf("(1) integer extend : ");
    if (c1 != 200) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

```
RX source code
void extended_integer(void)
{
    char c1;
    char c2 = 200;
    char c3 = 200;
    c1 = ((char)(c2+c3))/2;
    printf("(1) integer extend : ");
    if (c1 != 200) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

Notes

M16C provides the following two options to promote char type data to the int type during evaluation. If either of these options is specified, the difference in integer promotion specifications discussed here will not occur.

- `-fansi`
- `-fextend_to_int`
2.7.2 Size of the int type

With M16C-family compilers, the size of the int type is 2 bytes, whereas with RX-family compilers, the size of the int type is 4 bytes. Since “M16C_int_size.c” in the sample program contains code based on the requirement that the size of the int type is 2 bytes, the results of operation will differ from M16C.

“M16C_int_size.c” sample program

```c
typedef union {
    long data;
    struct {
        int dataH;
        int dataL;
    } s;
} UN;

void int_size(void) {
    UN u;
    u.data = 0x7f6f5f4f;
    printf("(2) int type size : ");
    if (u.s.dataH == 0x5f4f && u.s.dataL == 0x7f6f) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

To migrate to RX programs created based on the requirement that the size of the int type is 2 bytes, specify the “int_to_short” option. For details about specifying this option, see 1.3 Specifying the size of int type variables in C/C++ Compiler Package for the RX Family Application Notes: RX Migration Guide, M16C Edition. Also, change the options specified for the created RX project.
2.7.3 Placing structure members

If 1-byte, 2-byte, and 4-byte members are mixed within a structure (as with shared structures and classes), free space may occur between the placement of each member, according to each alignment count. M16C-family compilers place structure members using alignment count 1, whereas RX-family compilers place structure members using the maximum alignment count. This means that programs created based on M16C structure placement may not operate properly when migrated to RX.

Since “M16C_struct_member.c” in the sample program contains code that requires a structure alignment count of 1, it will not operate properly as-is on RX. Perform one of the following to migrate the sample program to RX.

- Specify the “pack” option.
- Specify #pragma pack for structures.

For details about how to specify this option, see compiler users manual.

“M16C_struct_member.c” sample program

```c
#include <stdio.h>
#include <stddef.h>
void struct_member(void) {
    struct s {
        char c;
        short s;
    } ss;

    printf("(3) struct member offset : ");
    if (offsetof(struct s, s) == 1) {
        printf("OK\n");
    } else {
        printf("NG\n");
    }
}
```

Specify the “pack” option for the created RX project.
After changing the options and code, perform rebuild as shown in 2.3(2) Building, and run the simulator as shown in 2.6 Running the simulator to get the following execution results, and complete migration to the RX project.

| (3) struct member offset : NG |
| (4) double type size : OK      |
| (5) inline keyword : OK       |
| (5) pragma BITADDRESS : OK    |
| (7) pragma ROM : OK           |
| (8) pragma PARAMETER : OK     |

| (1) integer extend : OK       |
| (2) int type size : OK        |
| (3) struct member offset : OK |
| (4) double type size : OK     |
| (5) inline keyword : OK       |
| (5) pragma BITADDRESS : OK    |
| (7) pragma ROM : OK           |
| (8) pragma PARAMETER : OK     |
Web site and support <website and support>
Web site for Renesas Technology
http://japan.renesas.com/

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Revision history<revision history,rh>

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