Abstract

To ensure safety, Europe requires that household appliances comply with the IEC 60730 safety standard. IEC 60730 Annex H provides three software classifications for automatic electronic controls.

Class A: Control functions, which are not intended to be relied upon for the safety of the equipment. Examples: Timers, switches, and lighting controls.

Class B: Control functions, which are intended to prevent unsafe operation of the controlled equipment. Examples: Washing machines, dishwashers, dryers, and refrigerator controls.

Class C: Control functions, which are intended to prevent special hazards. Example: Burner controls.

Renesas recommends the following self-tests be performed for end products included in class B.

- Stack fault diagnostics for the MCU and program counter
- Anomaly diagnostics for interrupt periods
- Anomaly diagnostics for MCU clock frequencies
- Anomaly diagnostics for ROM/RAM
- Anomaly diagnostics for external interfaces (communication)

This application note describes a method for diagnosing anomalies in the ROM. When starting up the M16C/60 Series and M16C/50 Series MCUs, read the SUM value in the program ROM 1 area, and ascertain if a an anomaly has occurred.

In this application note, the Flash Development Toolkit (hereinafter FDT) is used to calculate the SUM value. For details on using the FDT, refer to chapter 6 Application Example.

Products

MCUs: M16C/63 Group, M16C/64A Group, M16C/64C Group, M16C/65 Group, M16C/65C Group, M16C/66 Group, M16C/5LD Group, M16C/56D Group, M16C/5L Group, M16C/56 Group, M16C/5M Group, M16C/57 Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.
<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Specifications</td>
<td>3</td>
</tr>
<tr>
<td>2. Operation Confirmation Conditions</td>
<td>4</td>
</tr>
<tr>
<td>3. Reference Application Note</td>
<td>4</td>
</tr>
<tr>
<td>4. Hardware</td>
<td>4</td>
</tr>
<tr>
<td>4.1 Pins Used</td>
<td>4</td>
</tr>
<tr>
<td>5. Software</td>
<td>5</td>
</tr>
<tr>
<td>5.1 Operation Overview</td>
<td>5</td>
</tr>
<tr>
<td>5.2 Required Memory Size</td>
<td>6</td>
</tr>
<tr>
<td>5.3 Constants</td>
<td>6</td>
</tr>
<tr>
<td>5.4 Functions</td>
<td>6</td>
</tr>
<tr>
<td>5.5 Function Specifications</td>
<td>7</td>
</tr>
<tr>
<td>5.6 Flowcharts</td>
<td>8</td>
</tr>
<tr>
<td>5.6.1 Main Processing</td>
<td>8</td>
</tr>
<tr>
<td>5.6.2 ROM Area Determination</td>
<td>9</td>
</tr>
<tr>
<td>6. Application Example</td>
<td>10</td>
</tr>
<tr>
<td>6.1 Creating an FDT Project</td>
<td>10</td>
</tr>
<tr>
<td>6.2 Verifying the Checksum Value</td>
<td>16</td>
</tr>
<tr>
<td>6.3 Checksum Value Setting</td>
<td>20</td>
</tr>
<tr>
<td>7. Sample Code</td>
<td>25</td>
</tr>
<tr>
<td>8. Reference Documents</td>
<td>25</td>
</tr>
</tbody>
</table>
1. Specifications

Use the FDT to calculate the checksum in advance, and write the result to a data flash area. When the MCU starts up, sequentially read the data in the program ROM 1 area in 1-byte units from the start address (1) to the end address (FFFFFh). Then calculate the SUM value of the data read. Ascertain if the SUM value in the program ROM 1 area and the checksum prewritten to the data flash area match. If the values match, the program ROM 1 area is determined to be accurate. This document describes an example using the M16C/65 Group.

Note:
1. The start address varies with the ROM size.

Figure 1.1 shows the checksum address, and the address of the internal ROM (program ROM 1) checked when the MCU starts up.

<table>
<thead>
<tr>
<th>Internal RAM</th>
<th>Size</th>
<th>Address XXXXh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 KB</td>
<td>033FFh</td>
</tr>
<tr>
<td></td>
<td>20 KB</td>
<td>053FFh</td>
</tr>
<tr>
<td></td>
<td>31 KB</td>
<td>07FFh</td>
</tr>
<tr>
<td></td>
<td>47 KB</td>
<td>0BFFFh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Program ROM 1</th>
<th>Size</th>
<th>Address YYYYh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>128 KB</td>
<td>E0000h</td>
</tr>
<tr>
<td></td>
<td>256 KB</td>
<td>C0000h</td>
</tr>
<tr>
<td></td>
<td>384 KB</td>
<td>A0000h</td>
</tr>
<tr>
<td></td>
<td>512 KB</td>
<td>80000h</td>
</tr>
<tr>
<td></td>
<td>640 KB</td>
<td>60000h</td>
</tr>
<tr>
<td></td>
<td>768 KB</td>
<td>40000h</td>
</tr>
</tbody>
</table>

Use the FDT to calculate the checksum, and then write the value to a data flash area.

Checksum: 0FFFCh

Calculate the SUM value in the program ROM 1 area by a program.

Ascertained if the SUM value in program ROM 1 area matches the checksum prewritten to the data flash area.

Figure 1.1  Sample Code Address Space in the M16C/65 Group
2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU used</td>
<td>M16C/65 Group</td>
</tr>
<tr>
<td>Operating frequencies</td>
<td>• XIN clock: 8 MHz</td>
</tr>
<tr>
<td></td>
<td>• CPU clock: 32 MHz (PLL clock is divided by 2, then multiplied by 8)</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>3.3 V</td>
</tr>
<tr>
<td>Integrated development environment</td>
<td>Renesas Electronics Corporation</td>
</tr>
<tr>
<td></td>
<td>High-performance Embedded Workshop Version 4.08</td>
</tr>
<tr>
<td>C compiler</td>
<td>Renesas Electronics Corporation</td>
</tr>
<tr>
<td></td>
<td>M16C Series, R8C Family Compiler V.5.45 Release 01</td>
</tr>
<tr>
<td></td>
<td>Compile options</td>
</tr>
<tr>
<td></td>
<td>-c -finfo -dir &quot;$(CONFIGDIR)&quot;</td>
</tr>
<tr>
<td></td>
<td>(Default setting is used in the integrated development environment.)</td>
</tr>
<tr>
<td>Operating mode</td>
<td>Single-chip mode</td>
</tr>
<tr>
<td>Sample code version</td>
<td>Version 1.00</td>
</tr>
</tbody>
</table>

3. Reference Application Note

The application note associated with this application note is listed below. Refer to this application note for additional information.

- M16C/63, 64A, 64C, 65, 65C, 6C, 5LD, 56D, 5L, 56, 5M, 57 Groups
- ROM Verification Using CRC-CCITT During Self-Test on MCU Start-Up (R01AN0706EJ)

4. Hardware

4.1 Pins Used

Table 4.1 lists the Pins Used and Their Functions.

Table 4.1 Pins Used and Their Functions

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>I/O</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4_0</td>
<td>Output</td>
<td>High is output when the values match.</td>
</tr>
<tr>
<td>P4_1</td>
<td>Output</td>
<td>High is output when the values do not match.</td>
</tr>
</tbody>
</table>
5. Software

5.1 Operation Overview

In the sample code, steps (1) to (3) of the self-test are performed in order when the MCU starts up. Figure 5.1 shows Sample Code Operation.

(1) Initialize the MCU after it starts up.
(2) Verify the ROM area.
   (2.1) Read the program ROM 1 area data in 1-byte units from the start address to the end address. Calculate the SUM value from the data read.
   (2.2) Compare that SUM value and the checksum value prewritten to the data flash area. If the values match, store the OK result in the variable. If the values do not match, store the NG result in the variable.
(3) Perform processing for each result.
   Output high from port P4_0 when the values match.
   Output high from port P4_1 when the values do not match.

![Figure 5.1 Sample Code Operation](image-url)
5.2 Required Memory Size
Table 5.1 lists the Required Memory Size.

Table 5.1 Required Memory Size

<table>
<thead>
<tr>
<th>Memory Used</th>
<th>Size</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>217 bytes</td>
<td>In the r01an0705_src.c module</td>
</tr>
<tr>
<td>RAM</td>
<td>0 bytes</td>
<td>In the r01an0705_src.c module</td>
</tr>
<tr>
<td>Maximum user stack usage</td>
<td>20 bytes</td>
<td></td>
</tr>
<tr>
<td>Maximum interrupt stack usage</td>
<td>0 bytes</td>
<td></td>
</tr>
</tbody>
</table>

The required memory size varies depending on the C compiler version and compile options.

5.3 Constants
Table 5.2 lists the Constants Used in the Sample Code.

Table 5.2 Constants Used in the Sample Code

<table>
<thead>
<tr>
<th>Constant Name</th>
<th>Setting Value</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>0</td>
<td>The SUM values match.</td>
</tr>
<tr>
<td>NG</td>
<td>FFh</td>
<td>The SUM values do not match.</td>
</tr>
<tr>
<td>ROM_TOP</td>
<td>80000h</td>
<td>Start address of the program ROM 1 area (the sample code uses a starting address that assumes the ROM capacity to be 512 KB).</td>
</tr>
<tr>
<td>ROM_END</td>
<td>FFFFFFFh</td>
<td>End address of the program ROM 1 area.</td>
</tr>
<tr>
<td>SUM_DF_ADR</td>
<td>0FFFCh</td>
<td>Address where the checksum is saved (the sample code saves this to the data flash area last).</td>
</tr>
</tbody>
</table>

5.4 Functions
Table 5.3 lists the Functions.

Table 5.3 Functions

<table>
<thead>
<tr>
<th>Function Name</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>mcu_init</td>
<td>CPU initial setting</td>
</tr>
<tr>
<td>rom_check</td>
<td>ROM area determination</td>
</tr>
</tbody>
</table>
5.5 Function Specifications

The following tables list the sample code function specifications.

### mcu_init

<table>
<thead>
<tr>
<th>Outline</th>
<th>CPU initial setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>None</td>
</tr>
<tr>
<td>Declaration</td>
<td>void mcu_init(void)</td>
</tr>
<tr>
<td>Explanation</td>
<td>Set the PLL clock (divided by 2 and multiplied by 8) as the CPU clock.</td>
</tr>
<tr>
<td>Argument</td>
<td>None</td>
</tr>
<tr>
<td>Returned value</td>
<td>None</td>
</tr>
<tr>
<td>Remark</td>
<td></td>
</tr>
</tbody>
</table>

### rom_check

<table>
<thead>
<tr>
<th>Outline</th>
<th>ROM area determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>None</td>
</tr>
<tr>
<td>Declaration</td>
<td>unsigned char rom_check(void)</td>
</tr>
<tr>
<td>Explanation</td>
<td>Calculate the SUM value in the program ROM 1 area, and ascertain if it matches the checksum prewritten in the data flash area.</td>
</tr>
<tr>
<td>Argument</td>
<td>None</td>
</tr>
</tbody>
</table>
| Returned value| • If the values match: OK (0)  
                  • If the values do not match: NG (FFh) |
| Remark       |                       |
5.6 Flowcharts

5.6.1 Main Processing

Figure 5.2 shows the Main Processing.

```
main
    Initialize ROM area determine variable
    CPU initial setting
        mcu_init()
        Set the PLL clock (divided by 2, then multiplied by 8) as the CPU clock.
    Port P4 initial setting
        Bits P4_1 to P4_0 ← 00b: Low level
        PD4 Register
            Bits PD4_1 to PD4_0 ← 11b: Output mode
    ROM area determination
        rom_check()
        ROM area determination OK ?
            Yes
                Processing when ROM area determination is OK
                    P4 register
                        P4_0 bit ← 1
            No
                Processing when ROM area determination is NG
                    P4 register
                        P4_1 bit ← 1
```

Figure 5.2 Main Processing
5.6.2 ROM Area Determination

Figure 5.3 shows the ROM Area Determination.

![Flowchart](image-url)

Note:
1. When $2.7 \leq VCC1 \leq 3.0\, V$, and $f(BCLK) \geq 16\, MHz$, or when $3.0\, V < VCC1 \leq 5.5\, V$ and $f(BCLK) \geq 20\, MHz$, 1 wait is necessary for executing a program on the data flash or for reading data. Set the PM17 bit in the PM1 register to 1 (wait state (1 wait)), or set the FMR17 bit in the FMR1 register to 0 (1 wait).
6. Application Example

This application note uses the FDT. This chapter describes how to create a new project, verify the checksum value, and set the checksum value in the FDT. For details on the FDT, refer to the FDT manual.

6.1 Creating an FDT Project

To verify the checksum value, create an FDT project. When creating a project, it is necessary to designate which MCU will be used. This section shows how to create a project by designating an M16C/65 Group product with a program ROM 1 area of 512 KB.

Figures 6.1 to 6.6 show how to create a project in the FDT.

(1) Select “Create a new project workspace”.

![Figure 6.1 Creating a Project in the FDT (1/6)](image-url)
(2) Input the workspace name.
(3) Select the MCU to be used.
The MCU name will differ depending on the ROM capacity of the MCU used. Select the part number of the MCU to be used.

Figure 6.3 Creating a Project in the FDT (3/6)
(4) Select a communication port.

Figure 6.4  Creating a Project in the FDT (4/6)
(5) Select the connection type.

![Connection Type](image)

The FLASH Development Toolkit can connect to your device in a number of different ways. All the options on this page may be changed after the Project has been created.

- **Select Connection:**
  - ![BOOT Mode](image)
  - ![USER Program Mode](image)
  - ![Kernel already running](image)

In BOOT Program mode the device erases its FLASH prior to connection. The Toolkit downloads programming kernels to the device as required.

The Recommended Speed setting is based on the current device and clock. The user may also input their own, if this is supported by the kernel (and the interface board).

- ![Recommended Speeds: Clock Sync](image)
  - ![Use Default](image)
  - ![User Specified:](image)

**Click the "Next" button.**

---

**Figure 6.5  Creating a Project in the FDT (5/6)**
(6) Set the programming options.

**Figure 6.6 Creating a Project in the FDT (6/6)**

Click the "Finish" button to create the project.
6.2 Verifying the Checksum Value

Figures 6.7 to 6.10 show how to verify the checksum value.

(1) Add the file with the SUM value to be verified to the project.

Select "Add Files" from "Project" in the menu bar.

Figure 6.7 Verifying the Checksum Value (1/4)
(2) Select the file with the SUM value to be verified.

Figure 6.8  Verifying the Checksum Value (2/4)
(3) Right-click on the file added, and select “File Checksum”.

Figure 6.9 Verifying the Checksum Value (3/4)
(4) The results from verifying the SUM value are shown in the bottom window.

Figure 6.10 Verifying the Checksum Value (4/4)
6.3 Checksum Value Setting

Figures 6.11 to 6.15 show how to set the checksum.

(1) Display the file content.

![Figure 6.11 Checksum Value Setting (1/5)](image)

- Double click the file to display the data in the window to the right.
- Select the "Data Flash" tab.
(2) Change the display to little endian.

Figure 6.12  Checksum Value Setting (2/5)
(3) Change the display to double word.

Figure 6.13  Checksum Value Setting (3/5)
(4) Input the checksum value directly into addresses FFFCh to FFFFh.
(5) After inputting the value, save it, and download the MOT file to the MCU.

Figure 6.15  Checksum Value Setting (5/5)
7. **Sample Code**
   Sample code can be downloaded from the Renesas Electronics website.

8. **Reference Documents**
   M16C/63 Group User’s Manual: Hardware Rev.2.00
   M16C/64A Group User’s Manual: Hardware Rev.2.00
   M16C/64C Group User’s Manual: Hardware Rev.1.00
   M16C/65 Group User’s Manual: Hardware Rev.2.00
   M16C/65C Group User’s Manual: Hardware Rev.1.00
   M16C/6C Group User’s Manual: Hardware Rev.2.00
   M16C/5LD, M16C/56D Group User’s Manual: Hardware Rev.1.10
   M16C/5L, M16C/56 Group User’s Manual: Hardware Rev.1.00
   M16C/5M, M16C/57 Group User’s Manual: Hardware Rev.1.01
   The latest versions can be downloaded from the Renesas Electronics website.

   Technical Update/Technical News
   The latest information can be downloaded from the Renesas Electronics website.

   C Compiler Manual
   M16C Series, R8C Family C Compiler Package V.5.45
   C Compiler User’s Manual Rev.2.00
   The latest version can be downloaded from the Renesas Electronics website.

**Website and Support**
Renesas Electronics website
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry
## Revision History

M16C/63, 64A, 64C, 65, 65C, 6C, 5LD, 56D, 5L, 56, 5M, 57 Groups

ROM Verification Using Checksum During Self-Test on MCU Start-Up

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>July 31, 2011</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>

All trademarks and registered trademarks are the property of their respective owners.
General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   - The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   - The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   - The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   - When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products
   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.
   - The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.
1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our websites.

2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.

4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application example. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.

5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacturer, user, or sale is prohibited under any applicable domestic or foreign laws or regulations.

6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.

7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depend on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics.

8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.

9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as cutting design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of noncomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

Notice

Renesas Electronics Corporation

SALES OFFICES
Renesas Electronics Corporation

Refer to "http://www.renesas.com" for the latest and detailed information.

Renesas Electronics America Inc.,
2890 South Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel. +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited,
1731 Northpoint Road, Newmarket, Ontario L3Y 9C3, Canada
Tel. +1-905-938-3441, Fax: +1-905-938-3200

Renesas Electronics Europe Limited,
Dukes Meadow, Millboard Road, Bozone End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH,
Academiastrasse 10, 40472 Dusseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7F, Floor, Quanyan Plaza, No.27 Zh Chaoyuan District, Beijing 100083, P.R.China
Tel: +86-10-8255-1153, Fax: +86-10-8255-9670

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lupu Ji Road Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6897-7885 / 7898

Renesas Electronics Hong Kong Limited
15/F, 1018, The Centre, No. 9-13 Chater Road, Sheung Wan, Hong Kong
Tel: +852-2585-2000, Fax: +852-2585-2044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8755-9600, Fax: +886-2-8755-9670

Renesas Electronics Singapore Pte. Ltd.
1 Harbourfront Avenue, #05-10, Fullerton Bay Tower, Singapore 098932
Tel: +65-6213-6200, Fax: +65-6278-9001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Inticom, Acom Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-6090, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F, Jamsil 4-dong, Jamsil-dong, Songpa-gu, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

© 2011 Renesas Electronics Corporation. All rights reserved.