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

Operation of Serial I/O (Transmission in Clock-Synchronous Serial I/O Mode)

R01AN0540EC0101
Rev.1.01
Apr. 28, 2011

1. Abstract

In transmitting data in clock-synchronous serial I/O mode, choose functions from those listed in Table 3.1. Operations of the marked items are described below. The examples are explained below using the M16C/65 Group.

2. Introduction

This application note is applied to the following MCUs:

MCU(s): M16C/63, 64A, 64C, 65, 65C, 6C, 5LD, 56D, 5L, 56, 5M, 57 Groups

This application note can be used with other M16C Family MCUs which have the same special function registers (SFRs) as the above groups. Check the manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Chosen functions

Table 3.1 Chosen Functions

Item	Set-up		Item	Set-up	
Clock prior to division select	✓	f1	Transfer format	✓	LSB first
		fOCO-F			MSB first
Peripheral clock	✓	f1SIO	Transmission interrupt factor	✓	Transmission buffer empty
		f2SIO			Transmission complete
Transfer clock source	✓	Internal clock (f1SIO/f2SIO/f8SIO/f32SIO)	Output transfer clock to multiple pins (1)	✓	Not selected
		External clock (CLKi pin)			Selected
$\overline{\text{CTS}}$ function	✓	$\overline{\text{CTS}}$ function enabled	Serial data logic	✓	No reverse
		$\overline{\text{CTS}}$ function disable			Reverse
CLK polarity	✓	Output transmission data at the falling edge of the transfer clock	Separate $\overline{\text{CTS}}$/$\overline{\text{RTS}}$ pins (2)	✓	Shared pin
		Output transmission data at the rising edge of the transfer clock			Separated

Notes:
1. This can be selected only when UART1 is used in combination with the internal clock.
2. This function separates $\overline{\text{CTS0}}$/$\overline{\text{RTS0}}$, outputs $\overline{\text{RTS0}}$ from the P6_0 pin, and inputs $\overline{\text{CTS0}}$ from the P6_4 pin. When this function is selected, UART1 $\overline{\text{CTS}}$/$\overline{\text{RTS}}$ function can not be utilized. Set the UART1 $\overline{\text{CTS}}$/$\overline{\text{RTS}}$ disable bit to “1”.

4. Operation

(1) Setting the transmit enable bit to “1” and writing transmission data to the UARTi transmit buffer register makes data transmissible status ready.

(2) When input to the $\overline{\text{CTSi}}$ pin goes to “L” level, transmission starts (the $\overline{\text{CTSi}}$ pin must be controlled on the reception side).

(3) In synchronization with the first falling edge of the transfer clock, transmission data held in the UARTi transmit buffer register is transmitted to the UARTi transmit register. At this time, the UARTi transmit interrupt request bit goes to “1”. Also, the first bit of the transmission data is transmitted from the TxDi pin. Then the data is transmitted bit by bit from the lower order in synchronization with the falling edges.

(4) When transmission of 1-byte data is completed, the transmit register empty flag goes to “1”, which indicates that transmission is completed. The transfer clock stops at “H” level.

(5) If the next transmission data is set in the UARTi transmit buffer register while transmission is in progress (before the eighth bit has been transmitted), the data is transmitted in succession.

Figure 4.1 shows the operation timing.

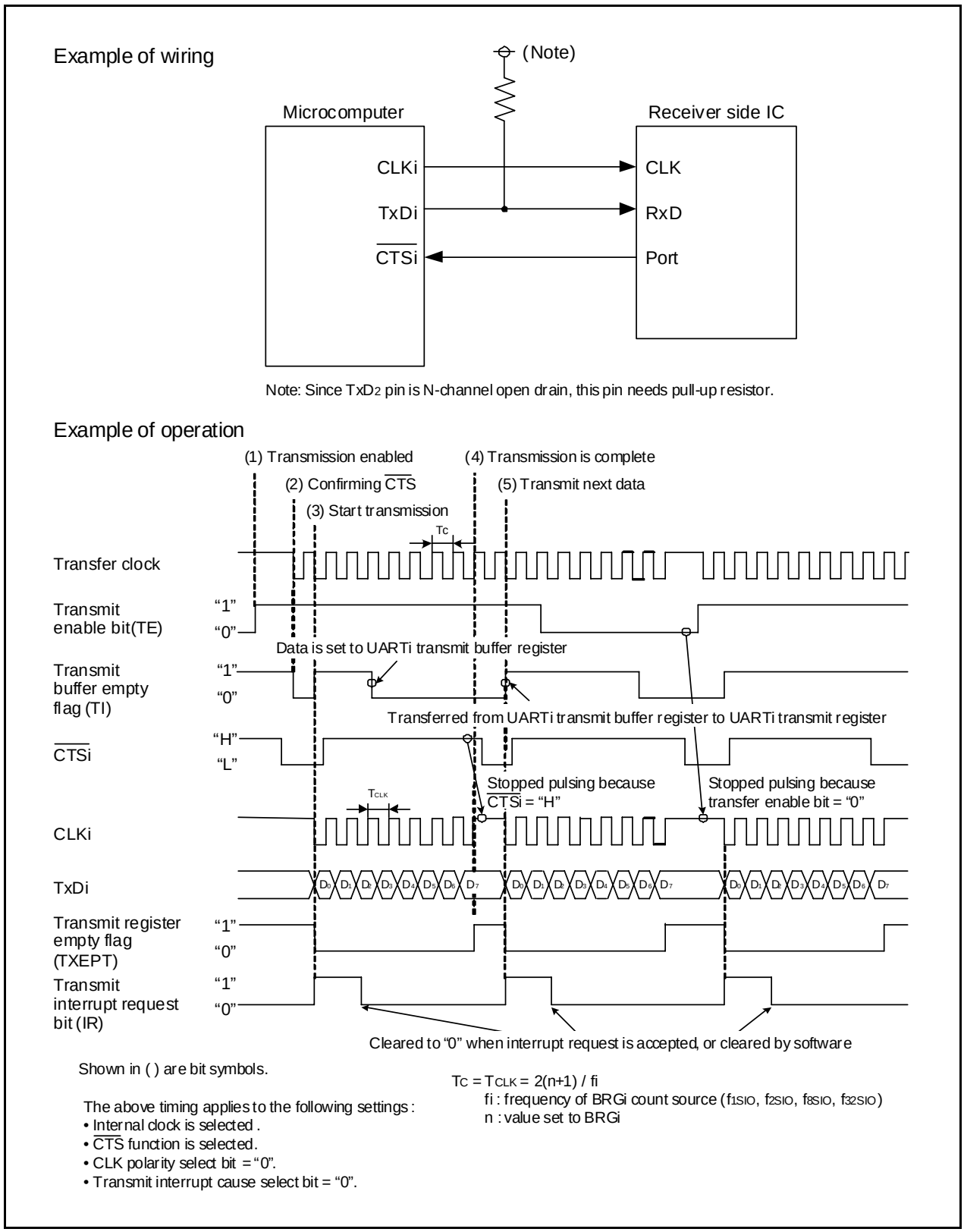
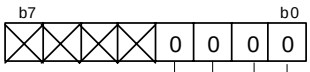


Figure 4.1 Operation Timing of Transmission in Clock-Synchronous Serial I/O Mode

5. Set-up Procedure

Setting UART clock select register

(Set the OCOSEL0 or OCOSEL1 bit before setting other registers associated with UART0 to UART2 and UART5 to UART7. After changing the OCOSEL0 or OCOSEL1 bit, set other registers associated with UART0 to UART2 and UART5 to UART7 again.)



UART clock select register [Address 0252h] UCLKSEL0

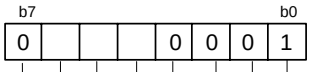
Set to "0"

UART0 to UART2 clock prior to division select bit
0 : f_1

UART5 to UART7 clock prior to division select bit
0 : f_1

Note: Set bits OCOSEL0 and OCOSEL1 while transmission/reception of UART0 to UART2 and UART5 to UART7 stops.

Setting UARTi transmit/receive mode register (i = 0 to 2, 5 to 7)



UART0 transmit/receive mode register [Address 0248h] U0MR
UART1 transmit/receive mode register [Address 0258h] U1MR
UART2 transmit/receive mode register [Address 0268h] U2MR
UART5 transmit/receive mode register [Address 0288h] U5MR
UART6 transmit/receive mode register [Address 0298h] U6MR
UART7 transmit/receive mode register [Address 02A8h] U7MR

Must be fixed to "001"

Internal/external clock select bit
0 : Internal clock

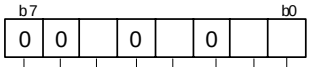
Invalid in clock synchronous I/O mode

Invalid in clock synchronous I/O mode

Invalid in clock synchronous I/O mode

TxD, RxD I/O polarity reverse bit
Usually set to "0"

Setting UARTi transmit/receive control register (i = 0 to 2, 5 to 7)



UART0 transmit/receive control register [Address 024Ch] U0C0
UART1 transmit/receive control register [Address 025Ch] U1C0
UART2 transmit/receive control register [Address 026Ch] U2C0
UART5 transmit/receive control register [Address 028Ch] U5C0
UART6 transmit/receive control register [Address 029Ch] U6C0
UART7 transmit/receive control register [Address 02ACh] U7C0

UiBRG count source select bit

b1 b0
0 0 : f_{1SIO} or f_{2SIO} is selected (Note1)
0 1 : f_{8SIO} is selected
1 0 : f_{32SIO} is selected
1 1 : Do not set to this value

$\overline{CTS}/\overline{RTS}$ function select bit (Valid when bit4 = "0")
0 : $\overline{CTS}$ function is selected (Note2)

Transmit register empty flag
0 : Data present in transmit register (during transmission)
1 : No data present in transmit register (transmission completed)

$\overline{CTS}/\overline{RTS}$ disable bit
0 : $\overline{CTS}/\overline{RTS}$ function enabled

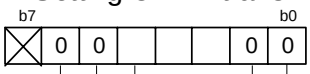
Data output select bit
0 : Pins TxDi/SDAi and SCLi are CMOS output
1 : Pins TxDi/SDAi and SCLi are N-channel open-drain output

CLK polarity select bit
0 : Transmission data is output at falling edge of transfer clock and reception data is input at rising edge

Transfer format select bit
0 : LSB first

Note 1: When the PCLK1 bit in the PCLKR register is "1", the selected clock source is f_{1SIO}. When the PCLK1 bit is "0", the selected clock source is f_{2SIO}.
Note 2: Set the corresponding port direction register to '0" (input mode).

Setting UART transmit/receive control register 2



UART transmit/receive control register 2 [Address 0250h] UCON

UART0 transmit interrupt cause select bit
0 : Transmit buffer empty (TI = 1)

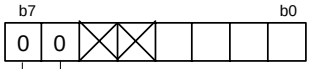
UART1 transmit interrupt cause select bit
0 : Transmit buffer empty (TI = 1)

Valid when bit5 = "1"

UART1 CLK/CLKS select bit 1
0 : CLK output is only from CLK1

Separate UART0 $\overline{CTS}/\overline{RTS}$ bit
0 : $\overline{CTS}/\overline{RTS}$ shared pin

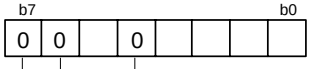
Setting UARTi transmit/receive control register 1 (i = 0 to 2, 5 to 7)



UART0 transmit/receive control register 1 [Address 024Dh] U0C1
UART1 transmit/receive control register 1 [Address 025Dh] U1C1

Data logic select bit
0 : No reverse

Error signal output enable bit
Must always be "0" in clock synchronous I/O mode



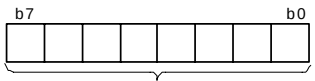
UART2 transmit/receive control register 1 [Address 026Dh] U2C1
UART5 transmit/receive control register 1 [Address 028Dh] U5C1
UART6 transmit/receive control register 1 [Address 029Dh] U6C1
UART7 transmit/receive control register 1 [Address 02ADh] U7C1

UARTi transmit interrupt source select bit
0 : Transmit buffer register empty (TI = 1)

Data logic select bit
0 : No reverse

Error signal output enable bit
Must always be "0" in clock synchronous I/O mode

Setting UARTi bit rate register (i = 0 to 2, 5 to 7)

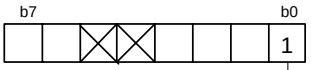


UART0 bit rate register [Address 0249h] U0BRG
UART1 bit rate register [Address 0259h] U1BRG
UART2 bit rate register [Address 0269h] U2BRG
UART5 bit rate register [Address 0289h] U5BRG
UART6 bit rate register [Address 0299h] U6BRG
UART7 bit rate register [Address 02A9h] U7BRG

Can be set to 00h to FFh (Note)

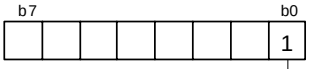
Note : Write to the UiBRG register while serial interface is neither transmitting nor receiving. Use MOV instruction to write to the UiBRG register. Write to the UiBRG register after setting bits CLK1 to CLK0 in the UiC0 register.

Transmission enabled



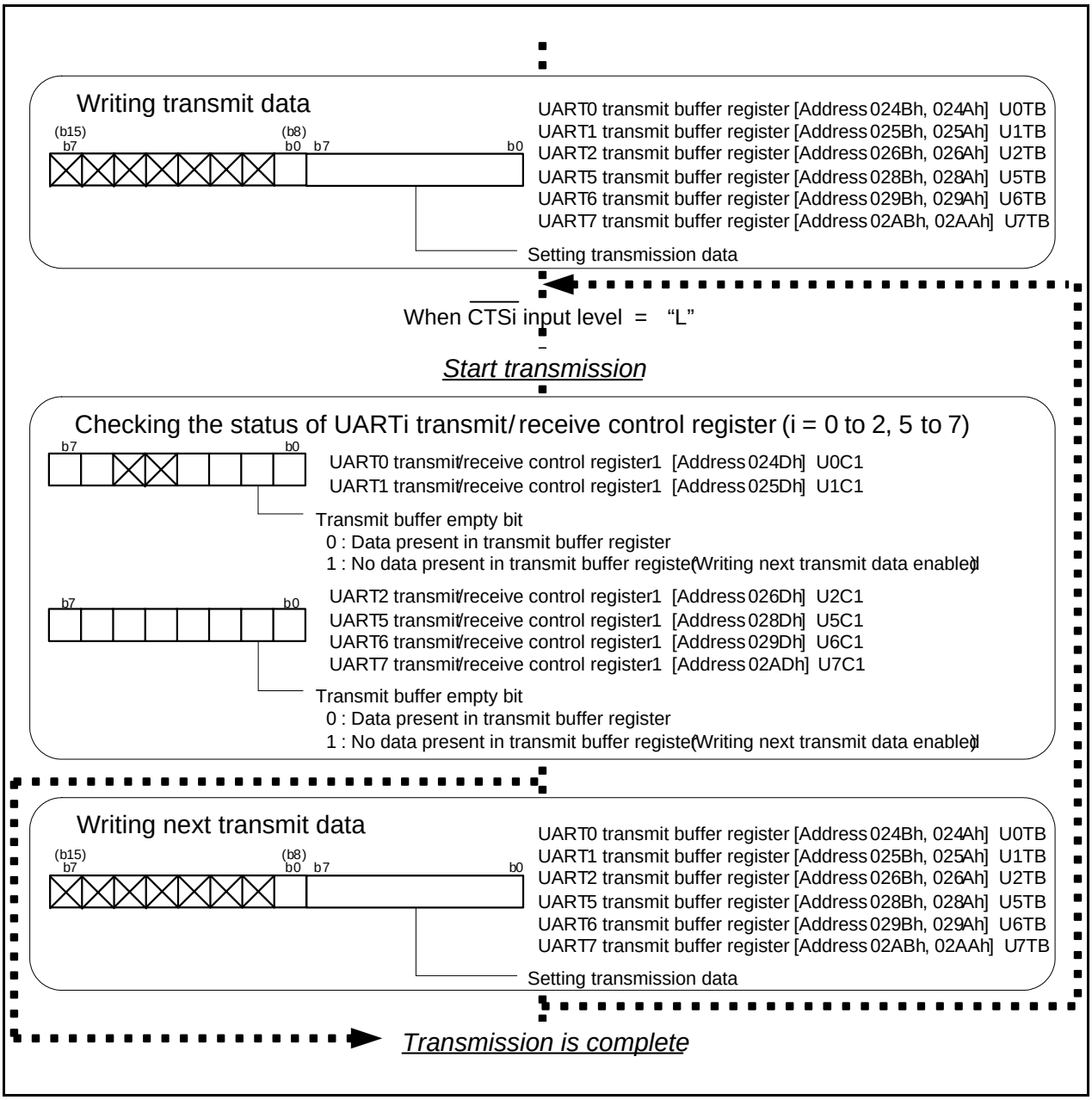
UART0 transmit/receive control register 1 [Address 024Dh] U0C1
UART1 transmit/receive control register 1 [Address 025Dh] U1C1

Transmit enable bit
1 : Transmission enabled



UART2 transmit/receive control register 1 [Address 026Dh] U2C1
UART5 transmit/receive control register 1 [Address 028Dh] U5C1
UART6 transmit/receive control register 1 [Address 029Dh] U6C1
UART7 transmit/receive control register 1 [Address 02ADh] U7C1

Transmit enable bit
1 : Transmission enabled


Writing transmit data
(b15)
b7
(b8)
b0
b7
b0
UART0 transmit buffer register [Address 024Bh, 024Ah] U0TB
UART1 transmit buffer register [Address 025Bh, 025Ah] U1TB
UART2 transmit buffer register [Address 026Bh, 026Ah] U2TB
UART5 transmit buffer register [Address 028Bh, 028Ah] U5TB
UART6 transmit buffer register [Address 029Bh, 029Ah] U6TB
UART7 transmit buffer register [Address 02ABh, 02AAh] U7TB
Setting transmission data
When CTSi input level = "L"
Start transmission
Checking the status of UARTi transmit/receive control register (i = 0 to 2, 5 to 7)
b7
b0
UART0 transmit/receive control register1 [Address 024Dh] U0C1
UART1 transmit/receive control register1 [Address 025Dh] U1C1
Transmit buffer empty bit
0 : Data present in transmit buffer register
1 : No data present in transmit buffer register (Writing next transmit data enabled)
UART2 transmit/receive control register1 [Address 026Dh] U2C1
UART5 transmit/receive control register1 [Address 028Dh] U5C1
UART6 transmit/receive control register1 [Address 029Dh] U6C1
UART7 transmit/receive control register1 [Address 02ADh] U7C1
Transmit buffer empty bit
0 : Data present in transmit buffer register
1 : No data present in transmit buffer register (Writing next transmit data enabled)
Writing next transmit data
(b15)
b7
(b8)
b0
b7
b0
UART0 transmit buffer register [Address 024Bh, 024Ah] U0TB
UART1 transmit buffer register [Address 025Bh, 025Ah] U1TB
UART2 transmit buffer register [Address 026Bh, 026Ah] U2TB
UART5 transmit buffer register [Address 028Bh, 028Ah] U5TB
UART6 transmit buffer register [Address 029Bh, 029Ah] U6TB
UART7 transmit buffer register [Address 02ABh, 02AAh] U7TB
Setting transmission data
Transmission is complete

6. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

7. 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 Group, M16C/56D Group User's Manual: Hardware Rev.1.10
M16C/5L Group, M16C/56 Group User's Manual: Hardware Rev.1.00
M16C/5M Group, M16C/57 Group User's Manual: Hardware Rev.1.01
The latest version 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.

8. 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 Operation of Serial I/O (Transmission in Clock-Synchronous Serial I/O Mode)

Rev.	Date	Description	
		Page	Summary
1.00	Sep. 27, 2009	—	First edition issued
1.01	Apr. 28, 2011	—	Add: M16C/63, M16C/64A, M16C/64C, M16C/65C, M16C/6C, M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, and M16C/57

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.

Notice

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 website.
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 examples. 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 manufacture, use, 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 depends 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. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.
   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
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 safety 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 microcomputer 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.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

RENESAS

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

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

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

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

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
7F, No. 363 Fu Shing North Road Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 1.0