To our customers,

# Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

# 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.

# M16C/64 Group

## Operation of serial I/O (transmission in clock-synchronous serial I/O mode)

### 1. Abstract

In transmitting data in clock-synchronous serial I/O mode, choose functions from those listed in Table 1. Operations of the circled items are described below.

### 2. Introduction

This application note is applied to the M16C/64 group microcomputers.

This program can be operated under the condition of M16C family products with the same SFR (Special Function Register) as M16C/64 Group products. Because some functions may be modified of the M16C family products, see the user's manual. When using the functions shown in this application note, evaluate them carefully for an operation.

## 3. Chosen functions

**Table 1. Chosen functions**

| Item | Set-up | | Item | Set-up | |
|---|---|---|---|---|---|
| Transfer clock source | O | Internal clock ($f_{1SIO}$/$f_{2SIO}$/$f_{8SIO}$/$f_{32SIO}$) | Transmission interrupt factor | O | Transmission buffer empty |
| | | External clock (CLKi pin) | | | Transmission complete |
| $\overline{CTS}$ function | O | $\overline{CTS}$ function enabled | Output transfer clock to multiple pins (Note 1) | O | Not selected |
| | | $\overline{CTS}$ function disable | | | Selected |
| CLK polarity | O | Output transmission data at the falling edge of the transfer clock | Data logic select function | O | No reverse |
| | | Output transmission data at the rising edge of the transfer clock | | | Reverse |
| Transfer format | O | LSB first | TxD, RxD I/O polarity reverse bit | O | No reverse |
| | | MSB first | | | Reverse |

Note 1: This can be selected only when UART1 is used in combination with the internal clock. When this function is selected, UART1 $\overline{CTS}$ / $\overline{RTS}$ function can not be utilized. Set the UART1 $\overline{CTS}$ / $\overline{RTS}$ 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 $\overline{CTSi}$ pin goes to "L" level, transmission starts (the $\overline{CTSi}$ pin must be controlled on the reception side).

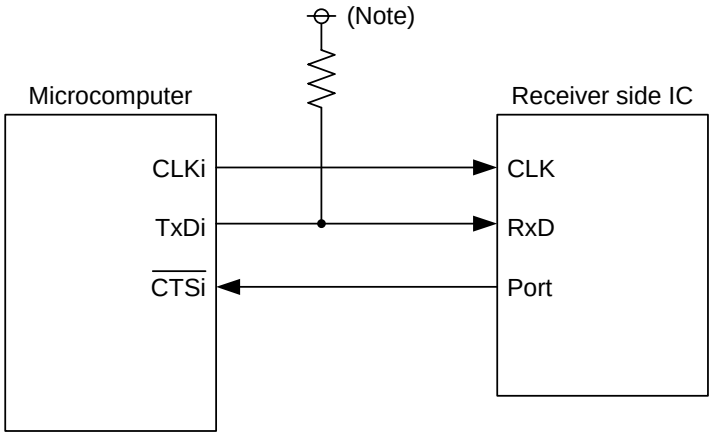
(3) In synchronization with the first falling edge of the transfer clock, transmission data held in the UARTi transmit buffer register is transmitted to the UARTi transmit register. At this time, the UARTi transmit interrupt request bit goes to "1". Also, the first bit of the transmission data is transmitted 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.

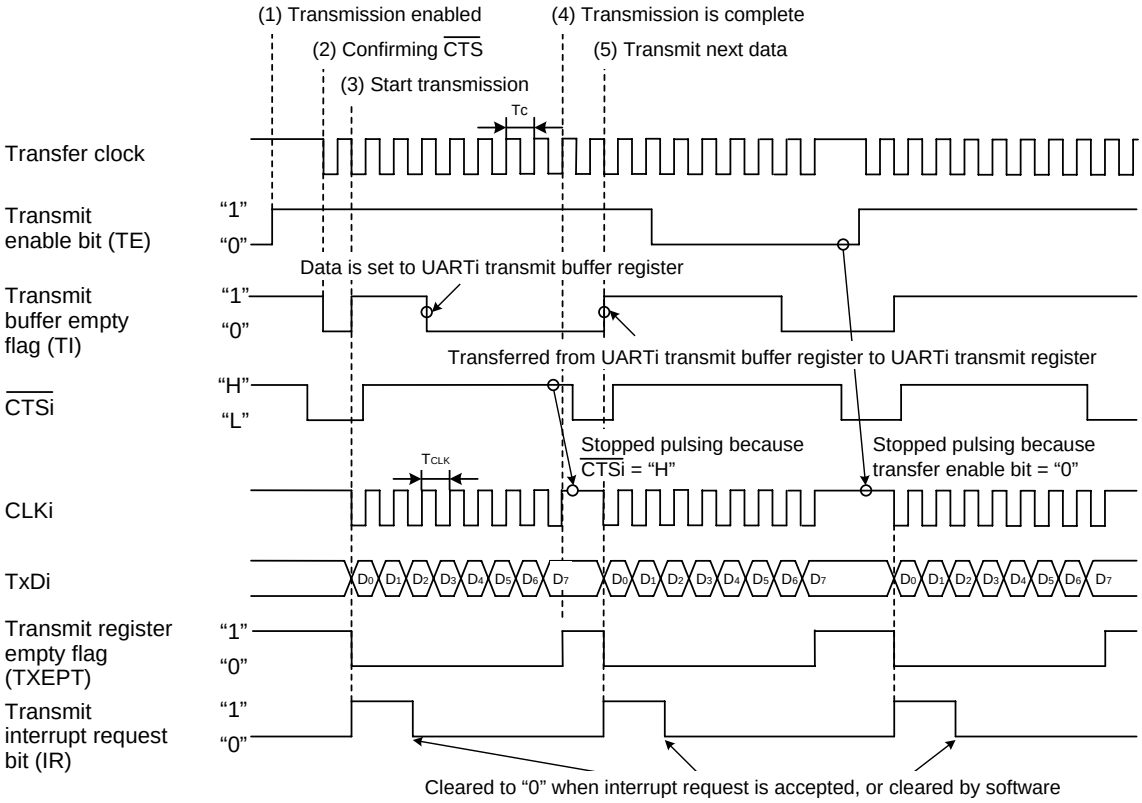
Figure 1 shows the operation timing.

Example of wiring




Note: Since TxD2 pin is N-channel open drain, this pin needs pull-up resistor.

Example of operation




Shown in ( ) are bit symbols.

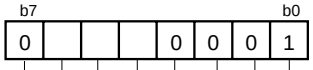
The above timing applies to the following settings:
- Internal clock is selected.
- CTS function is selected.
- CLK polarity select bit = "0".
- Transmit interrupt cause select bit = "0".

$T_C = T_{CLK} = 2(n+1) / fi$
fi : frequency of BRGi count source ($f_{1SIO}$, $f_{2SIO}$, $f_{8SIO}$, $f_{32SIO}$)
n : value set to BRGi

**Figure 1. Operation timing of transmission in clock-synchronous serial I/O mode**

## 5. Set-up procedure

### 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

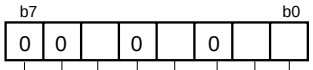
Invalid in clock synchronous I/O mode

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 : f1SIO or f2SIO is selected
0 1 : f8SIO is selected
1 0 : f32SIO 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 (Note)

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

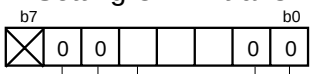
CLK polarity select bit
0 : Transmission data is output at falling edge of transfer clock and reception data is input at rising edge

Transfer format select bit
0 : LSB first

Note : Set the corresponding port direction register to “0”.

▪
▪

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)

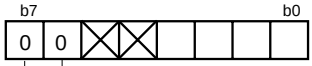
Valid when bit5 = "1"

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

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

▪

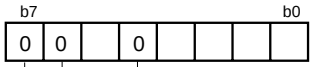
Setting UARTi transmit/receive control register 1 (i = 0 to 2, 5 to 7)




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

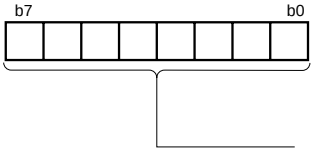
UARTi transmit interrupt source select bit
0 : Transmit buffer register empty (TI = 1)

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 UARTi bit rate register when transmission/reception is halted.

▪
▪

Transmission enabled

b7 b0

1

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

Transmit enable bit
1 : Transmission enabled

b7 b0

1

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) (b8)
b7 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 $\overline{\text{CTS}}$i 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 register 1 [Address 024Dh] U0C1
UART1 transmit/receive control register 1 [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)

b7 b0

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 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) (b8)
b7 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. Reference

Hardware manual

M16C/64 Group Hardware Manual

(Use the most recent version of the document on the Renesas Technology Web site.)

Technical news/Technical update

(Use the most recent version of the document on the Renesas Technology Web site.)

## Web-site and contact for support

Renesas Technology Web site

http://www.renesas.com/

Inquiries

http://www.renesas.com/inquiry

csc@renesas.com

## Revision

| Rev. | Issue date | Revised | |
|---|---|---|---|
| | | Page | Point |
| 1.00 | 2008.06 | - | First edition issued |
| | | | |

## Notes regarding these materials

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, 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 products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)
5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.
8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
   (1) artificial life support devices or systems
   (2) surgical implantations
   (3) healthcare intervention (e.g., excision, administration of medication, etc.)
   (4) any other purposes that pose a direct threat to human life

   Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.
9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas 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 applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.