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/80 Group

Operation of Serial I/O (transmission in UART mode)

1.0 Abstract

In transmitting data in UART mode, choose functions from those listed in Table 1. Operations of the circled items are described below.

Table 1. Choosed functions

Item	Set-up		Item	Set-up	
Transfer clock source (Note 2)	O	Internal clock (f_1 / f_8 / f_{32})	Sleep mode (Note 2)	O	Sleep mode off
		External clock (CLKi pin)			Sleep mode selected
$\overline{\text{CTS}}$ function	O	$\overline{\text{CTS}}$ function enabled	Data logic select function (Note 3)	O	No reverse
		$\overline{\text{CTS}}$ function disabled			Reverse
Transmission interrupt factor		Transmission buffer empty	TxD, RxD I/O polarity reverse bit (Note 3)	O	No reverse
	O	Transmission complete			Reverse
$\overline{\text{CTS}}$ / $\overline{\text{RTS}}$ separation function (Note 1)	O	Pin shared by $\overline{\text{CTS}}$ and $\overline{\text{RTS}}$	Bus collision detection function (Note 3)	O	Not selected
		$\overline{\text{CTS}}$ and $\overline{\text{RTS}}$ separate			Selected

Note 1: UART0 only. (UART1 $\overline{\text{CTS}}$/$\overline{\text{RTS}}$ function cannot be used when this function is selected.)
Note 2: UART0, UART1 only.
Note 3: UART2 to UART4 only.

2.0 Introduction

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

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

(3) Transmission data held in the UARTi transmit buffer register is transmitted to the UARTi transmit register. At this time, the first bit (the start bit) of the transmission data is transmitted from the TxDi pin. Then, data is transmitted, bit by bit, in sequence: LSB, ····, MSB, parity bit, and stop bit(s).

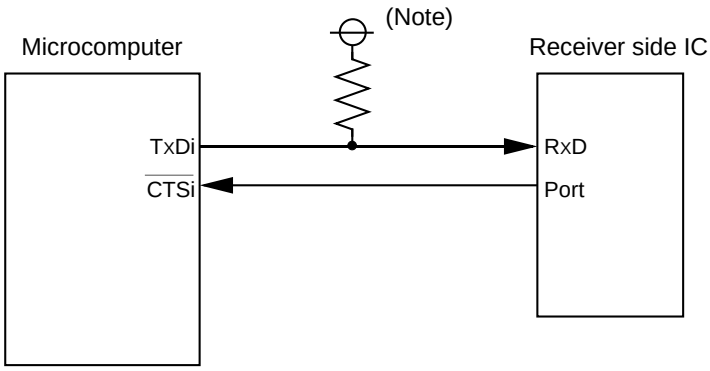
(4) When the stop bit(s) is (are) transmitted, the transmit register empty flag goes to “1”, which indicates that transmission is completed. At this time, the UARTi transmit interrupt request bit goes to “1”. The transfer clock stops at “H” level.

(5) If the transmission condition of the next data is ready when transmission is completed, a start bit is generated following to stop bit(s), and the next data is transmitted.

Note
- Select TxDi output with the function select register A and B.
- Set $\overline{\text{CTSi}}$ pin's function select register A to I/O port and port direction register to “0”.
- When setting the function select registers A, B, and C, sets the function select registers B and/or C first, and then sets the function select register A.

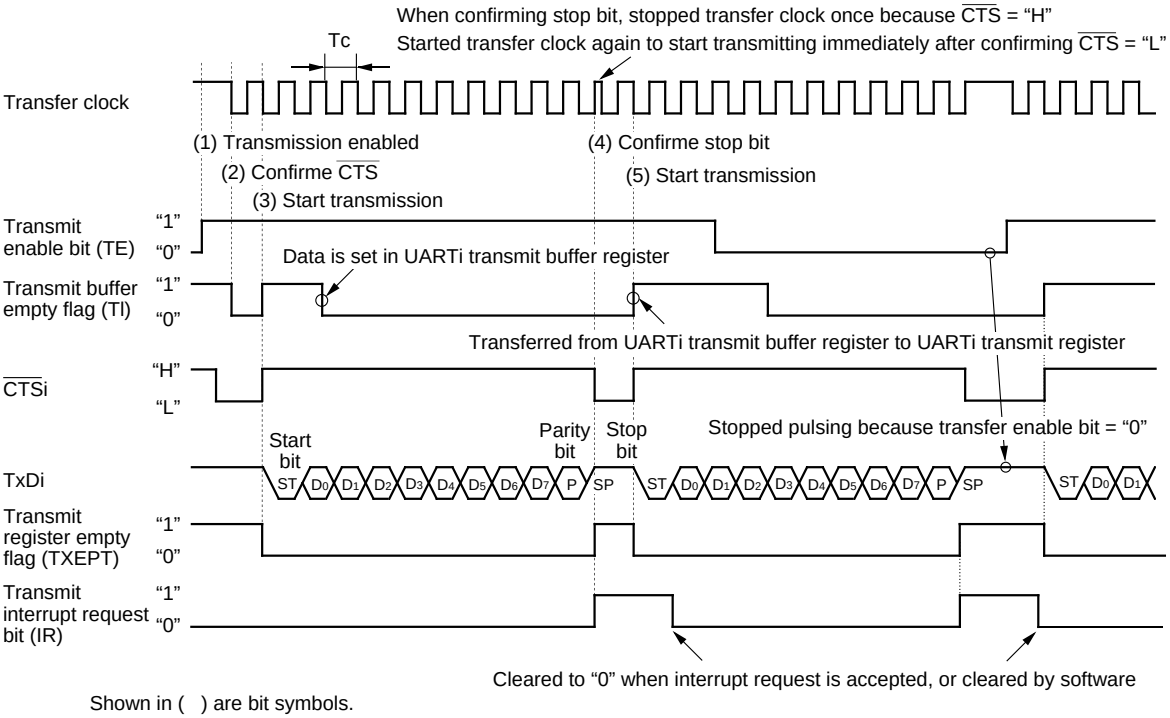
Figure 1 shows the operation timing

Example of wiring



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

Example of operation



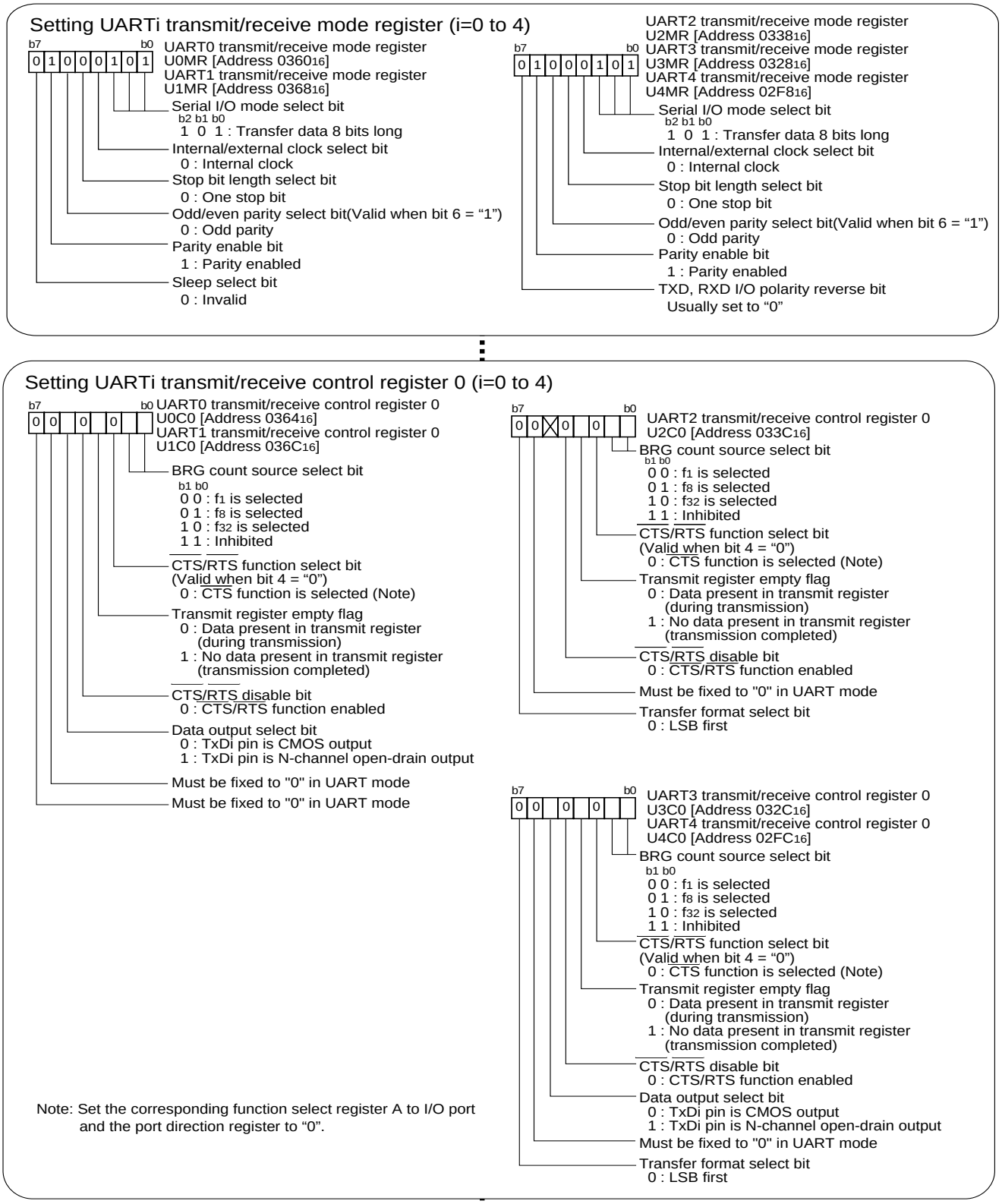
Shown in ( ) are bit symbols.

The above timing applies to the following settings :
- Parity is enabled.
- One stop bit.
- CTS function is selected.
- Transmit interrupt cause select bit = "1".

Tc = 16 (n + 1) / fi or 16 (n + 1) / fEXT
fi : frequency of BRGi count source (f1, f8, f32)
fEXT : frequency of BRGi count source (external clock)
n : value set to BRGi

Figure 1. Operation timing of transmission in UART mode

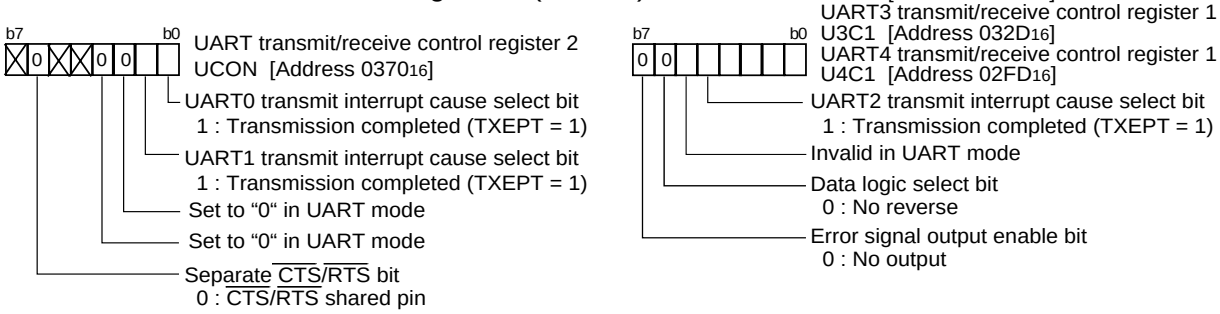
3.0 Set-up procedure



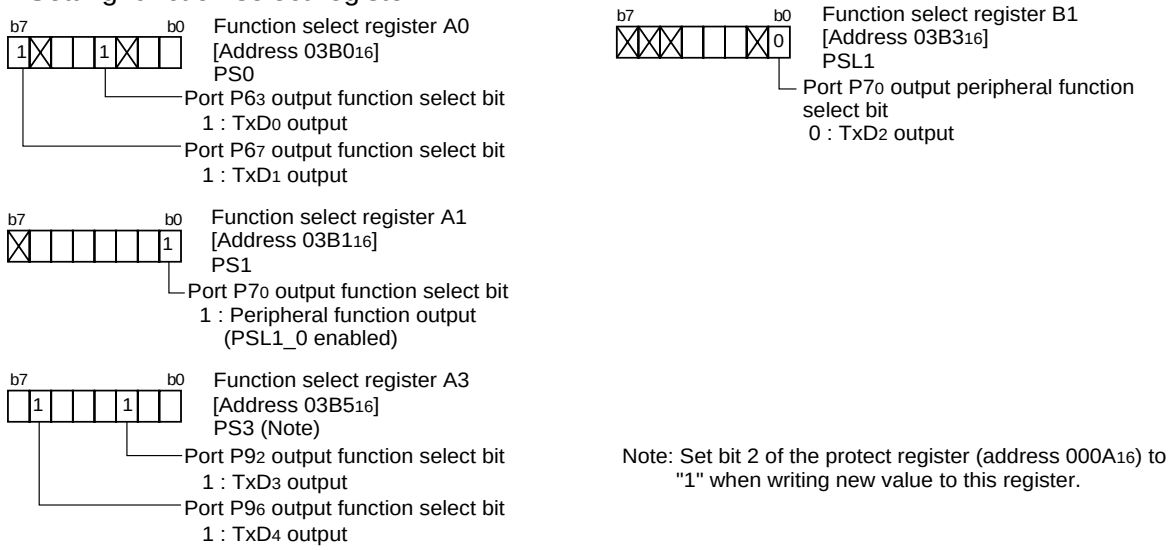
Continued to the next page

Continued from the previous page

Setting UART transmit/receive control register 2 and UARTi transmit/receive control register 1 (i=2 to 4)

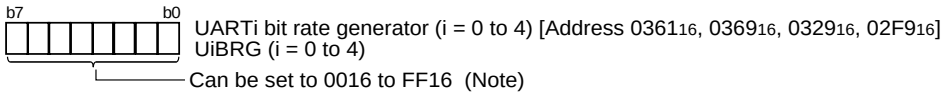


Setting function select register



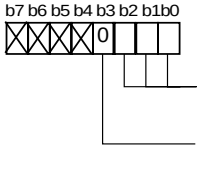
Note: Set bit 2 of the protect register (address 000A16) to "1" when writing new value to this register.

Setting UARTi bit rate generator (i = 0 to 4)



Note: Write to UARTi bit rate generator when transmission/reception is halted.

Clearing UARTi transmit interrupt request bit (i=0 to 4)

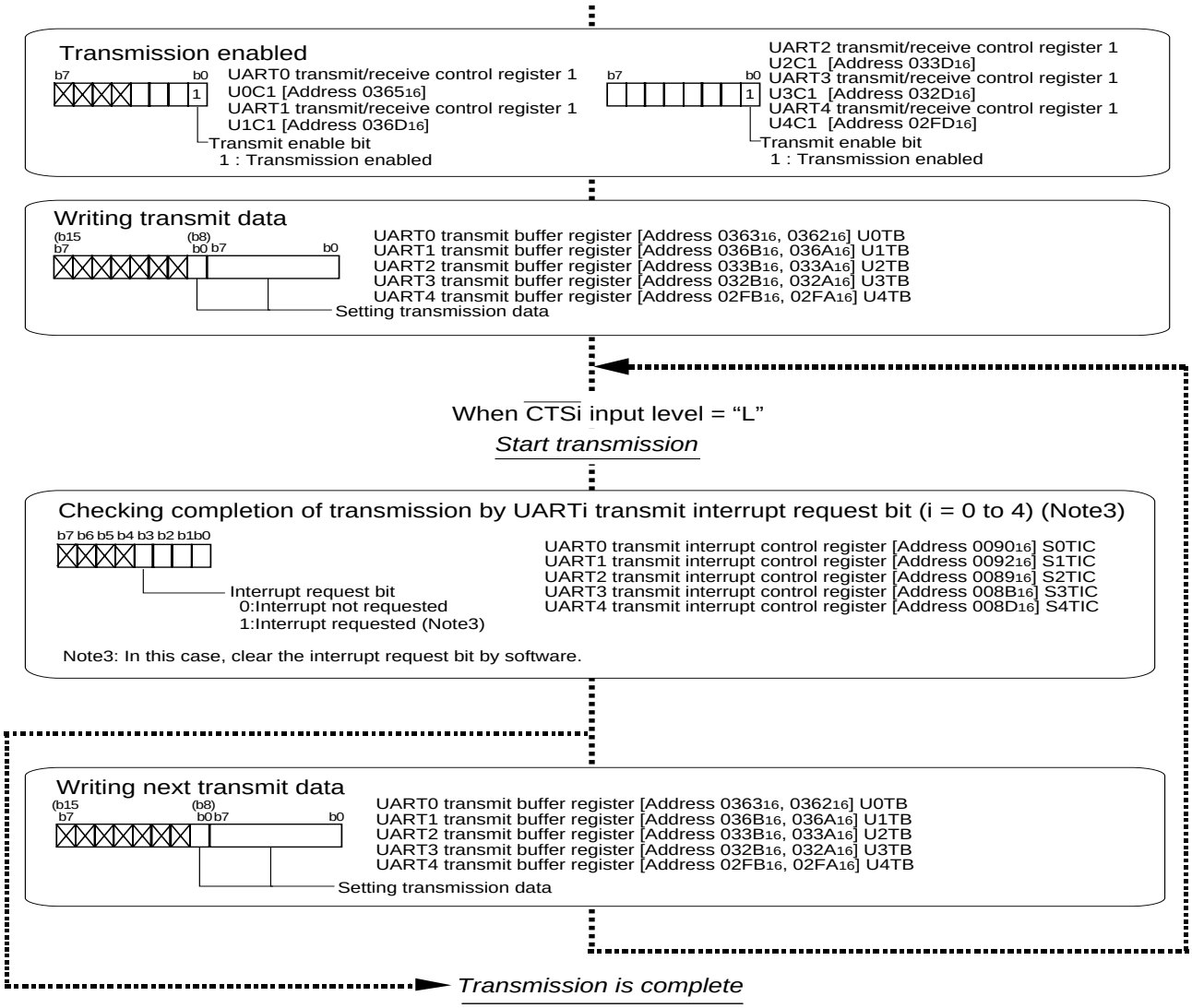


UART0 transmit interrupt control register [Address 009016] S0TIC
UART1 transmit interrupt control register [Address 009216] S1TIC
UART2 transmit interrupt control register [Address 008916] S2TIC
UART3 transmit interrupt control register [Address 008B16] S3TIC
UART4 transmit interrupt control register [Address 008D16] S4TIC

Note2:This bit can only be accessed for reset (=0), but cannot be accessed for set (=1).

Continued to the next page

Continued from the previous page



4.0 Programming Code

```
;***********************************************************************************
;
;   M16C/80 Program Collection
;
;   FILE NAME : rjj05b0141_src.a30
;   CPU       : M16C/80 Group
;   FUNCTION  : Operation of Serial I/O
;               (transmission in UART mode)
;   HISTORY   : 2004.02.16  Ver 1.00
;
;   Copyright(C)2003, Renesas Technology Corp.
;   Copyright(C)2003, Renesas Solutions Corp.
;   All rights reserved.
;
;***********************************************************************************
;***********************************************************************************
;       Include
;***********************************************************************************
        .LIST       OFF             ;Stops outputting lines to the assembler list file
        .INCLUDE    sfr80100.inc    ;Reads the file that defined SFR
        .LIST       ON              ;Starts outputting lines to the assembler list file
;
;***********************************************************************************
;       Symbol definition
;***********************************************************************************
RAM_TOP          .EQU    000400H    ;Start address of RAM
RAM_END          .EQU    002BFFH    ;End address of RAM
ROM_TOP          .EQU    0FFC000H   ;Start address of ROM
FIXED_VECT_TOP   .EQU    0FFFFDCH   ;Start address of fixed vector
;
;***********************************************************************************
;       Allocation of work RAM area
;***********************************************************************************
        .SECTION    WORKRAM, DATA
        .ORG        RAM_TOP
WORKRAM_TOP:
C_POWER          .EQU    3
C_DATA_SIZE      .EQU    (1<< C_POWER)  ;Data size
v_Trans_data:    .BLKB   C_DATA_SIZE    ;Area of send data for sample
WORKRAM_END:
;
;***********************************************************************************
;       Program area
;***********************************************************************************
;=================================================================================
;       Start up
;=================================================================================
        .SECTION    PROGRAM, CODE  ;Declares section name and section type
        .ORG        ROM_TOP        ;Declares start address
RESET:
        ; Sets Processor mode, System clock and Main clock division
        MOV.B    #03H, prcr        ;Removes protect
        MOV.B    #10000000B, pm0   ; Single-chip mode
        MOV.B    #11000000B, pm1   ; Flash memory version
        MOV.B    #00001000B, cm0   ; Xcin-Xcout High
        MOV.B    #00100000B, cm1   ; Xin-Xout High
        MOV.B    #00010010B, mcd   ; No division mode
        MOV.B    #00H, prcr        ;Protects all registers
;
```

```
        ; Clears WORKRAM area
        MOV.W    #0, R0
        MOV.W    #(RAM_END-RAM_TOP)/2, R3
        MOV.W    #WORKRAM_TOP, A1
        SSTR.W
        ; Makes transmit data for sample ( 1 to C_DATA_SIZE )
        MOV.B    #1, R0L               ;1st data
        MOV.W    #0, A0                ;Initialize offset address
MAKE_DATA:                             ;
        MOV.B    R0L, v_Trans_data[A0] ;
        ADD.B    #1, R0L               ;
        ADD.W    #1, A0                ;
        CMP.W    #C_DATA_SIZE, A0      ;
        JLTU     MAKE_DATA             ;
;
;=============================================================================
;       Serial I/O (transmission in UART mode)
;=============================================================================
        ; Setting UART0 transmit/receive mode register
        MOV.B    #01000101B, u0mr
;                |||||+++---------;Serial I/O mode select bit (101:Transfer data 8 bits long)
;                ||||+------------;Internal/external clock select bit (0:Internal clock)
;                |||+-------------;Stop bit length select bit (0:One stop bit)
;                ||+--------------;Odd/even parity select bit (0:Odd parity)
;                |+---------------;Parity enable bit (1:Parity enabled)
;                +----------------;Sleep select bit (0:Invalid)
        ; Setting UART0 transmit/ receive control register 0
        MOV.B    #00001000B, u0c0
;                ||||||++---------;BRG count source select bit (00:f1 is selected)
;                |||||+-----------;CTS function is selected (Valid when bit 4="0") (Note)
;                ||||+------------;Transmit register empty flag (Written value is invalid)
;                |||+-------------;CTS/RTS disable bit (0:CTS/RTS function enabled)
;                ||+--------------;Data output select bit (0:TxDi pin is CMOS output)
;                ++---------------;Must be fixed to "0" in UART mode
        ; Setting UART transmit/receive control register 2
        MOV.B    #00000001B, ucon
;                |||||||+---------;UART0 transmit interrupt cause select
;                |||||||           (1:Transmission completed)
;                ||||||+----------;UART1 transmit interrupt cause select
;                ||||++-----------;Set to "0" in UART mode
;                ||++-------------;Nothing is assigned (When write, set "0")
;                |+---------------;Separate CTS/RTS bit (0:CTS/RTS shared pin)
;                +----------------;Nothing is assigned (When write, set "0")
        ; (Note) Set the corresponding function select register A to I/O port
        ; and port direction register to "0"
        BCLR     pd6_0             ;Port P60 is input direction
        BCLR     ps0_0             ;CTS0[P60] is I/O port
        ; Setting function select register
        BSET     ps0_3             ;Port P63 output function select bit (1:TxD0 output)
        ; Setting UART0 bit rate generator
        MOV.B    #129, u0brg       ;(Approx. 9600bps : fi/16(129+1) @20MHz,f1)
                                   ;(Note) Write to UARTi bit rate generator when
                                   ;       transmission/reception is halted
        ; Clear UART0 transmit interrupt request bit
        MOV.B    #00000000B, s0tic
;                    |+++---------;Interrupt priority level select bit
;                    |             (000:Level 0, interrupt disabled)
;                    +------------;Interrupt request bit (0:Interrupt not requested)
        ; Transmission enabled
        MOV.B    #00000001B, u0c1
;                       +---------;Transmission enabled
;
```

```
;=======================================================================
;       Main program
;=======================================================================
        MOV.W    #0, A0                ;Initialize offset
WRITE_DATA:
        ; Writing transmit data
        MOV.B    v_Trans_data[A0], u0tb
        ; When CTS0 input level = "L", Start transmission
;
WAIT_TRANS:
        ; Checking completion of transmission by UART0 transmit interrupt request bit
        BTST     ir_s0tic
        JNC      WAIT_TRANS
        MOV.B    #00H, s0tic       ; Clear UART0 transmit interrupt request bit
;
PREPARE_NEXT_DATA:
        ADD.W    #1, A0
        AND.W    #(C_DATA_SIZE-1), A0
        JNZ      WRITE_DATA
;
COMPLETE_TRANS:
        ; Transmission is complete
        JMP      COMPLETE_TRANS
;
;=======================================================================
;       Dummy interrupt processing program
;=======================================================================
dummy:
        REIT
;
;***********************************************************************************
;       Setting of fixed vector
;***********************************************************************************
        .SECTION    F_VECT, ROMDATA
        .ORG        FIXED_VECT_TOP
;
        .LWORD    dummy    ;Undefined instruction
        .LWORD    dummy    ;Overflow
        .LWORD    dummy    ;BRK instruction execution
        .LWORD    dummy    ;Address match
        .LWORD    dummy    ;
        .LWORD    dummy    ;Watchdog timer
        .LWORD    dummy    ;
        .LWORD    dummy    ;NMI
        .LWORD    RESET    ;Reset
;
        .END
```

5.0 Reference

Renesas Technology Corporation Semiconductor Home page

http://www.renesas.com/

Technical Support

E-mail: support_apl@renesas.com

Data Sheet

M16C/80 group Rev. E3
(Use the latest version on the Home page: http://www.renesas.com/)

User's Manual

M16C/80 group Rev. B
(Use the latest version on the Home page: http://www.renesas.com/)

Keep safety first in your circuit designs!

- **Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.**

Notes regarding these materials

- **These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.**
- **Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.**
- **All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein.**
  The information described here may contain technical inaccuracies or typographical errors.
  Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
  Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).
- **When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.**
- **Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.**
- **The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.**
- **If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.**
  Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
- **Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.**