1. Abstract

This document describes the synchronous serial interface mode for intelligent I/O group 2.

2. Introduction

The application example described in this document applies to the following microcomputers (MCUs):

MCUs: R32C/116 Group, R32C/117 Group, and R32C/118 Group

This application note can be used with other R32C/100 Series MCUs which have the same special function registers (SFRs) as the above groups. Check the manuals for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.
3. Application Example

This application example describes how to perform synchronous serial communication with an 8-bit character length using variable synchronous serial interface mode.

Transmit data is output from the ISTXD2 pin, and the transmit/receive clock is output from the ISCLK2 pin. Receive data is input from the ISRXD2 pin.

Table 3.1 and Table 3.2 list the Clock Frequency Settings and Selectable Functions in Variable Synchronous Serial Interface Mode, respectively.

### Table 3.1 Clock Frequency Settings

<table>
<thead>
<tr>
<th>Clock</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main clock</td>
<td>16 MHz</td>
</tr>
<tr>
<td>PLL clock</td>
<td>100 MHz</td>
</tr>
<tr>
<td>Base clock</td>
<td>50 MHz</td>
</tr>
<tr>
<td>CPU clock</td>
<td>50 MHz</td>
</tr>
<tr>
<td>Peripheral bus clock</td>
<td>25 MHz</td>
</tr>
<tr>
<td>Peripheral function clock</td>
<td>25 MHz</td>
</tr>
</tbody>
</table>

### Table 3.2 Selectable Functions in Variable Synchronous Serial Interface Mode

<table>
<thead>
<tr>
<th>Item</th>
<th>Functions</th>
<th>Function Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit/receive clock</td>
<td>Internal clock</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>External clock</td>
<td></td>
</tr>
<tr>
<td>Bit order selection</td>
<td>LSB first</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MSB first</td>
<td></td>
</tr>
<tr>
<td>Transmit interrupt source</td>
<td>Transmit buffer is empty</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Transmission is completed</td>
<td>✓</td>
</tr>
<tr>
<td>Intelligent I/O group 2 input pin</td>
<td>Port P6/port P7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Port P6/port P9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Port P13</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Port P6/port P4</td>
<td></td>
</tr>
</tbody>
</table>
3.1 Settings for Bit Rate and Transmit/Receive Clock

(1) Setting the bit rate using channel 0.
Use channel 0 with waveform generation selected. Set bits MOD2 to MOD0 in the G2POCR0 register to 111b (use an output for the serial interface). The base timer is reset by matching with the G2PO0 register. When fBT2 is the count source of the base timer and n is the setting value of the G2PO0 register, the bit rate (transmit/receive clock cycle) can be calculated by the following equation.

\[
\text{Bit rate: } \frac{f_{BT2}}{2(n + 2)}
\]

Set one or above to the G2PO0 register.

(2) Generating the transmit/receive clock using channel 2.
Use channel 2 with waveform generation selected. Set bits MOD2 to MOD0 in the G2POCR2 register to 010b (inverted waveform output mode). Set a value in the G2PO2 register smaller than the G2PO0 register value.
### 3.2 Timing

Figure 3.2 shows the Timing Diagram for Variable Synchronous Serial Interface Mode.

![Timing Diagram](image)

**Figure 3.1 Timing Diagram for Variable Synchronous Serial Interface Mode**

### 3.3 Notes on Intelligent I/O Interrupts

If an interrupt is accepted, the IR bit in the IIOiIC register is set to 0 automatically \((i = 0 \text{ to } 11)\). However, even if an interrupt is accepted, each bit in the IIOiIR register is not automatically set to 0. They should be set to 0 by either the AND or BCLR instruction. Note that every generated interrupt request is ignored until these bits are set to 0.
3.4 Flowcharts

Figure 3.2 shows the Main Function, Figure 3.3 and Figure 3.4 show the Intelligent I/O Initial Setting Function, Figure 3.5 shows Intelligent I/O Interrupt 5, and Figure 3.6 shows Intelligent I/O Interrupt 6.

![Flowchart of Main Function](image)

**Figure 3.2 Main Function**

Note:
1. Refer to the hardware user's manual for initializing the clock.
Intelligent I/O initial setting. (1)
Set group 2 base timer control register 0.
Set the base timer start register.
Set group 2 base timer control register 0.

(2) Set group 2 waveform generation control register 0.
Operating mode select bit: Use an output for the serial interface (use the ISTXD2 pin as an output).
G2PO0 register value reload timing select bit: Reload the value into the GiPOj register on a write access.

(3) Set group 2 waveform generation control register 1.
Operating mode select bit: Use an output for the serial interface (use the ISCLK2 pin as an output).

(4) Set group 2 waveform generation control register 2.
Operating mode select bit: Inverted waveform output mode (the transmit/receive clock is generated)
G2PO2 register value reload timing select bit: Reload the value into the GiPOj register on a write access.

(5) Set the bit rate. (2)

(6) Set the group 2 function enable register.
Enable the function for channels 0 to 2 in group 2.

(7) Group 2 serial interface control register
Transmit enable bit: Transmission disabled
Receive enable bit: Reception disabled
ISTxD output polarity switching bit: Not inverted
ISRxD input polarity switching bit: Not inverted

(8) Set the group 2 serial interface mode register.
Serial interface mode select bit: Variable synchronous serial interface mode
Internal/external clock select bit: Internal clock
Bit order select bit: LSB first
Transmit interrupt source select bit: Transmission is completed

(9) Insert wait time
Wait two or more fBT2 clocks.

Notes:
1. The initial settings of bits and registers for the intelligent I/O are required as follows:
   (1) Set the G2BCR0 register to provide the clock to the group 2 base timer.
   (2) Set bits BT0S to BT2S all to 0 (base timer is reset).
   (3) Set other registers associated with the intelligent I/O.
   The BTiS bit allows the base timers of two or all groups to start counting simultaneously (i = 0 to 2). To start counting individually, the BTiS bit should be set to 0 and the BTS bit in the GiBCR1 register should be set.
2. Set to a value in the G2PO2 register smaller than that in the G2PO0 register.

Figure 3.3 Intelligent I/O Initial Setting Function (1/2)
Figure 3.4 Intelligent I/O Initial Setting Function (2/2)
Figure 3.5  Intelligent I/O Interrupt 5

- intelligent_io_int5
  
  (1) SIO2RR_IIO5IR = 1 ?
  
  Yes
  
  No
  
  (2) SIO2RR_IIO5IR ← 0
  
  Read receive data

- REIT

Read the receive interrupt request bit.
Clear the receive interrupt request bit.

Figure 3.6  Intelligent I/O Interrupt 6

- intelligent_io_int6
  
  (1) SIO2TR_IIO6IR = 1 ?
  
  Yes
  
  No
  
  (2) SIO2TR_IIO6IR ← 0
  
  Increment transmit data

- Set the transmit data to the G2TB register

- REIT

Read the transmit interrupt request bit.
Clear the transmit interrupt request bit.
4. **Sample Program**

A sample program can be downloaded from the Renesas Electronics website.

5. **Reference Documents**

User’s Manuals
R32C/116 Group User’s Manual: HardwareRev.1.00
R32C/117 Group User’s Manual: HardwareRev.1.00
R32C/118 Group User’s Manual: HardwareRev.1.00
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
R32C/100 Series C Compiler Package V.1.02 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

R32C/100 Series  
Synchronous Serial Interface Mode for Intelligent I/O Group 2

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Nov. 16, 2010</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 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 damages 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 manufacturers, 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 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.

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.

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 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 REACH 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. 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 assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

13. Notice

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

Renesas Electronics Corporation

© 2010 Renesas Electronics Corporation. All rights reserved.

Colophon 1.0