R8C/1x, 2x Series

Standard Serial I/O Mode Serial Protocol Specification

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Abstract

This document describes the R8C/1x, 2x Series standard serial I/O mode serial protocol specification. The boot program stored in the boot ROM area prior to MCU shipment can control the flash memory by communicating with a serial programmer. Standard serial I/O mode 2 or standard serial I/O mode 3 can be selected for communication.

Introduction

This specification defines the following:

- Boot program
- Initial settings
- Control commands
- Timings

Applicable products:

- Standard serial I/O mode 2
  R8C/1x, 2x Series
- Standard serial I/O mode 3
  R8C/1x, 2x Series (excluding R8C/10, 11, 12, and 13 Groups)

1. Boot Program

The program in the boot ROM area operates when the MODE pin is set to low and reset is deasserted. This is called a boot program. To enter boot mode, hold the MODE pin low for 30 ms or more before and after reset is deasserted (refer to Figure 2.1).

1.1 Operating Environment

(1) Standard Serial I/O Mode 2 for R8C/10 to R8C/19, R8C/1A, R8C/1B, and R8C/20 to R8C/29 Groups
CPU clock and count source for communication: External oscillator frequency no division

(2) Standard Serial I/O Mode 2 for R8C/2A to R8C/2D Groups (96 KB and 128 KB versions)

(a) Boot program ver. 1.00
CPU clock: Typ. 8 MHz generated by the high-speed on-chip oscillator
Count source for communication: External oscillator frequency no division

(b) Boot program ver. 2.00 or later
CPU clock and count source for communication: Typ. 7.3728 MHz generated by the high-speed on-chip oscillator

(3) Standard serial I/O mode 2 for R8C/2A to R8C/2D Groups (48 KB and 64 KB versions)
CPU clock and count source for communication: Typ. 7.3728 MHz generated by the high-speed on-chip oscillator

(4) Standard serial I/O mode 2 for R8C/2E and R8C/2F Groups
CPU clock: Typ. 8 MHz generated by the high-speed on-chip oscillator
Count source for communication: External oscillator frequency no division

(5) Standard serial I/O mode 2 for R8C/2G to R8C/2L Groups
CPU clock and count source for communication: Typ. 7.3728 MHz generated by the high-speed on-chip oscillator

(6) Standard serial I/O mode 3
CPU clock and count source for communication: Typ. 8 MHz generated by the high-speed on-chip oscillator

Communication may not be available due to frequency fluctuations of the high-speed on-chip oscillator, the board wire layout, or other usage conditions. Refer to the User's Manual: Hardware or Renesas Electronics website for high-speed on-chip oscillator electrical characteristics. Refer to the User's Manual: Hardware for erase and program voltage electrical characteristics.

Careful evaluation on the user system is recommended when communicating or reprogramming.

1.2 Boot Program Content

(1) Initial settings
(2) Initial communication with a serial programmer
(3) Control commands
Flash control commands (program, erase, read)
Various setting commands (such as communication speed setting, status read)

1.3 Communication with a Serial Programmer

Standard serial I/O mode 2 or standard serial I/O mode 3 can be selected for communication with a serial programmer. Standard serial I/O mode 2 is an asynchronous communication format. Standard serial I/O mode 3 is an asynchronous half duplex communication format. Figure 1.1 shows the communication formats.

The transfer data format is as follows:

Start bit: 1 bit
Transfer data: 8 bits
Parity bit: Not used
Stop bit: 1 bit

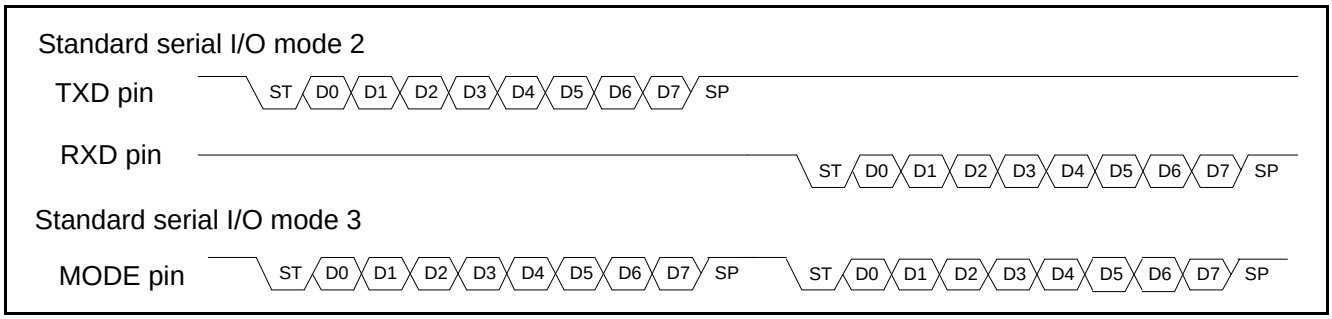
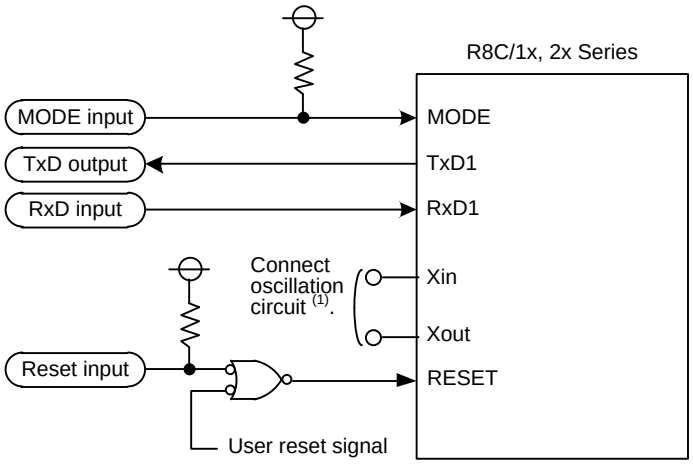


Figure 1.1 Communication Formats

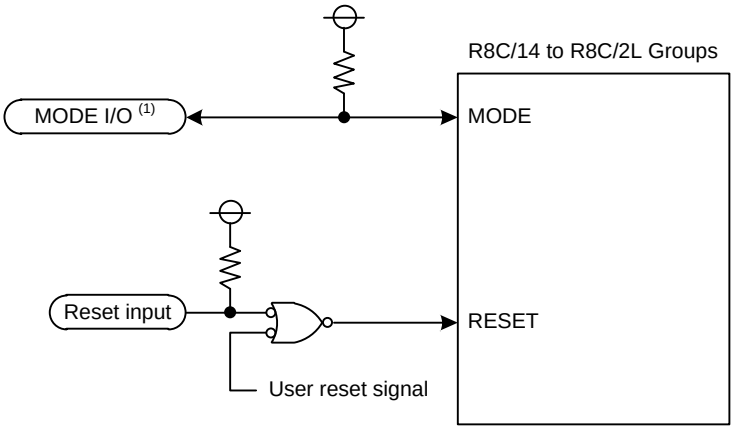
1.4 Assigned Pins

(1) MODE pin
Standard serial I/O mode 2 or standard serial I/O mode 3 is selected according to the MODE pin level after reset is deasserted. This pin also functions as TXD or RXD when standard serial I/O mode 3 is selected. When using standard serial I/O mode 3, pull up the MODE pin with approximately 5 kΩ.
(2) TXD1 and RXD1 pins
These pins are the transmit and receive pins in standard serial I/O mode 2. They are not used in standard serial I/O mode 3.
(3) RESET pin
This pin controls a reset via a serial programmer.
(4) Vcc and Vss pins
When outputting a high or low signal from a serial programmer, use the voltage according to the MCU's high or low input voltage levels.



Note:
1. Refer to 3.1 Operating Environment.

Figure 1.2 Connection Example in Standard Serial I/O Mode 2



Notes:
1. N-channel open drain output
2. When operating with the on-chip oscillator clock, it is not necessary to connect an oscillation circuit.

Figure 1.3 Connection Example in Standard Serial I/O Mode 3

2. Initial Settings

As an initial operation of boot program, perform the following operations sequentially.

(1) Decide a communication format
(2) Adjust the bit rate

2.1 Deciding Communication Format

Communication format is selected from either standard serial I/O mode 2 or standard serial I/O mode 3. When the MODE pin level is at low 200 ms after reset is deasserted, the MCU enters standard serial I/O mode 2, and enters standard serial I/O mode 3 when it is at high. Fix the MODE pin level within 100 ms after reset is deasserted. The timing diagram is shown in Figure 2.1 Timing to Decide Communication Format. Refer to the User's Manual: Hardware for tw (por1).

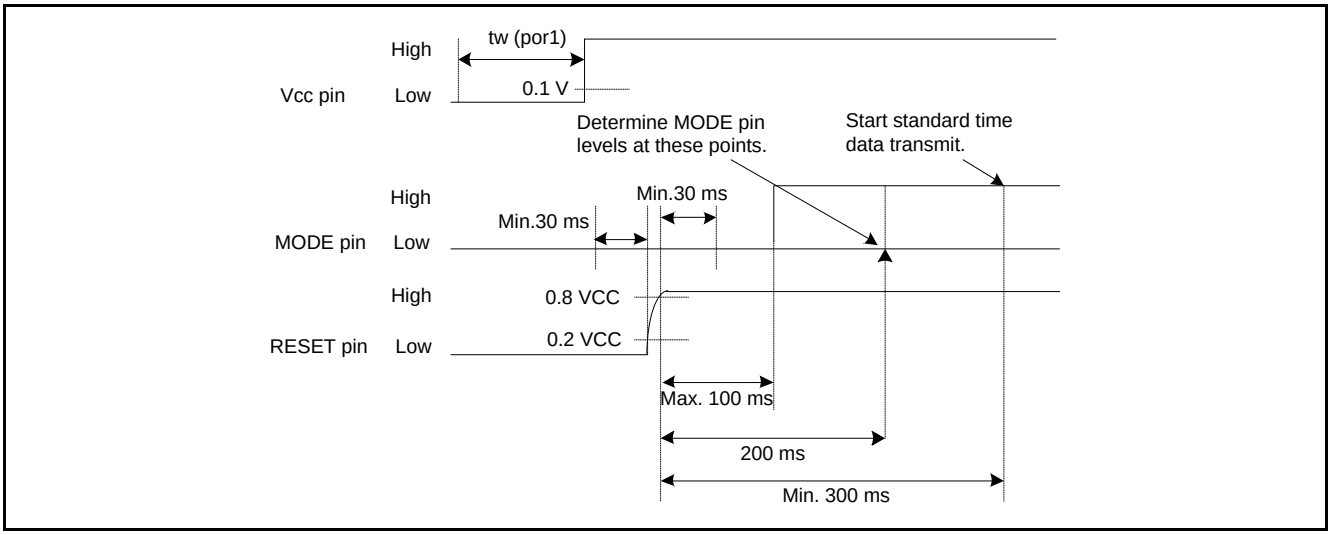


Figure 2.1 Timing to Decide Communication Format

2.2 Adjusting Bit Rate

The bit rate is adjusted to 9600 bps by receiving the standard time data (00h) 16 times at a bit rate of 9600 bps and the bite rate 9600 command (B0h) from the serial programmer. When the bit rate 9600 command (B0h) is received successfully, the MCU returns the command. Figure 2.2 shows the adjustment procedure of bit rate.

Transmit the standard time data at least 300 ms after reset is deasserted.

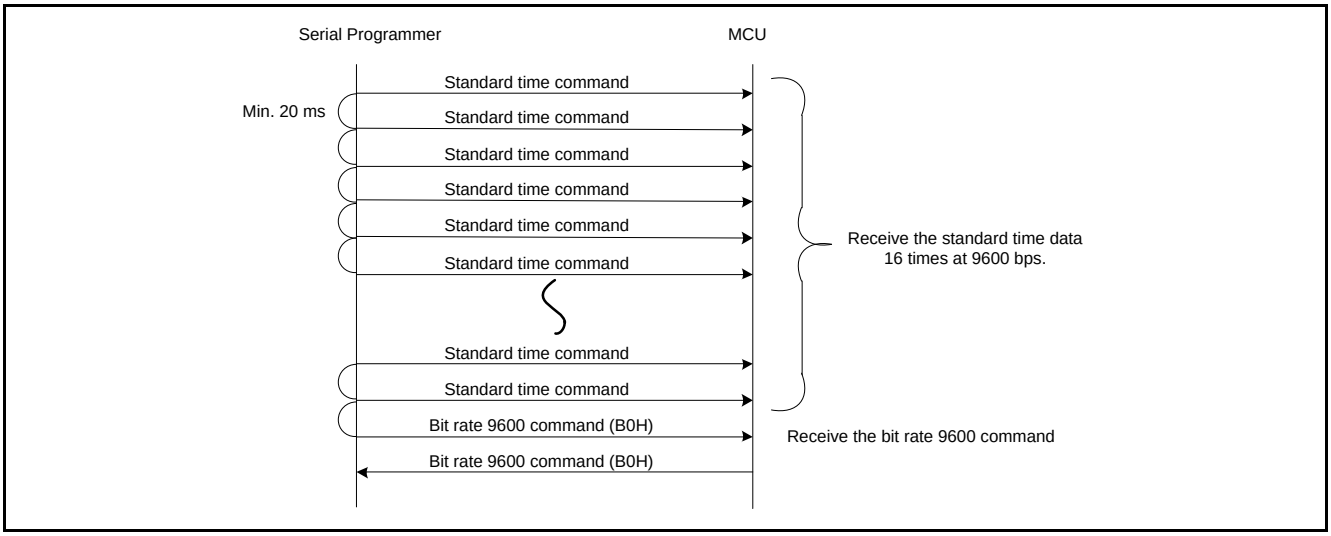


Figure 2.2 Bit Rate Adjustment Procedure

3. Command Specification

3.1 Control Commands

Control commands are listed below.

Control Command	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte or More	ID Unchecked
Page read	FFh	Middle-order address	High-order address	**Data**	**Data**	**Data**	**Up to last data**	Acknowledgment disabled
Page program	41h	Middle-order address	High-order address	Data	Data	Data	Up to last data	Acknowledgment disabled
Unit program	49h	Low-order address	Middle-order address	High-order address	Size	Data	Up to last data	Acknowledgment disabled
Block erase	20h	Middle-order address	High-order address	D0h				Acknowledgment disabled
Erase all unlocked blocks	A7h	D0h						Acknowledgment disabled
Read status register	70h	**SRD**	**SRD1**					Acknowledgment enabled
Clear status register	50h							Acknowledgment disabled
ID data check function	F5h	Low-order address	Middle-order address	High-order address	ID size	ID1	Up to ID7	Acknowledgment enabled
Version information output function	FBh	**Version**	**Version**	**Version**	**Version**	**Version**	**Up to last version**	Acknowledgment enabled
Bit rate 9600	B0h	**B0h**						Acknowledgment enabled
Bit rate 19200	B1h	**B1h**						Acknowledgment enabled
Bit rate 38400	B2h	**B2h**						Acknowledgment enabled
Bit rate 57600	B3h	**B3h**						Acknowledgment enabled
Bit rate 115200	B4h	**B4h**						Acknowledgment enabled
Bit rate setting	B5h	Data	**Data**					Acknowledgment enabled
Standard time data	00h							Acknowledgment enabled

Notes: 1. Shaded areas show transmission from the MCU to the programmer. Non-shaded areas show transmission from the programmer to the MCU.
2. SRD: Status register data. SRD1: Status register data 1.
3. Blank products can acknowledge all commands.
4. Standard time data is transferred 16 times during initial communication.
5. The number of received data is not checked and the timeout error is not processed in the boot program. When transmitting a command, make sure there is no excess or shortage of data.

4. Commands

4.1 Page Read

4.1.1 Operation

This command is used to read the specified user ROM area in the flash memory in 256-byte units. The read area is specified by the high-order address (A16 to A23) and middle-order address (A8 to A15). The targets are 256 bytes from addresses xxxx00h to xxxxFFh.

4.1.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command	**Address**		**Data**	**Up to last data**
Programmer to MCU	FFh	Middle-order address	High-order address		
MCU to Programmer				Data 0	Up to Data 255

Note: 1. Data 0 is the data which is stored in address xxxx00h. Data 255 is the data which is stored in address xxxxFFh.

4.1.3 Procedure

(1) Transmit the page read command FFh to the first byte.
(2) Transmit the middle-order address to the second byte and the high-order address to the third byte.
(3) After the fourth byte, receive the data sequentially from the data which is stored in address xxxx00h.

4.2 Page Program

4.2.1 Operation

This command is used to program the data to the specified user ROM area in the flash memory in 256-byte units. The program area is specified by the high-order address (A16 to A23) and middle-order address (A8 to A15). The targets are 256 bytes from xxxx00h to xxxxFFh.

This command programs blocks even if they are protected by the lock bits.

4.2.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command	Address		Data	Up to last data
Programmer to MCU	41h	Middle-order address	High-order address	Data 0	Up to Data 255
MCU to Programmer					

Note: 1. Data 0 is the data whose destination address is xxxx00h. Data 255 is the data whose destination data address is xxxxFFh.

4.2.3 Procedure

(1) Transmit the page program command 41h to the first byte.
(2) Transmit the middle-order address to the second byte and the high-order address to the third byte.
(3)After the fourth byte, transmit the program data sequentially from the data whose destination address is xxxx00h.

When the program data is less than 256 bytes, transmit FFh for the shortage. When the program data is 257 bytes or more, any data after the 257th byte is considered a command. If an error occurs during programming, the SR4 bit becomes 1 (Error).

After executing this command, use the read status register command to confirm that program error does not occur.

4.3 Unit Program

4.3.1 Operation

This command is used to program the data to the specified user ROM area in the flash memory by the specified size. The starting address of the program area is specified by the high-order address (A16 to A23), middle-order address (A8 to A15), and low-order address (A0 to A7). The specified amount of program data is programmed from the start address.

4.3.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	Up to N Byte
	Command	**Address**			**No. of Pcs**	**Data**	**Up to last data**
Programmer to MCU	49h	Low-order address	Middle-order address	High-order address	Size	Data (1)	Up to Data (N)
MCU to Programmer							

Notes: 1. Data (1) is data to be written to the start address and Data (N) is data to be written to (start address + N-1)
2. Make sure the “Size” does not change the value in the high-order address (e.g. When the start address is 1FFF0h, the maximum “Size” is 0Fh).

4.3.3 Procedure

(1) Transmit the unit program command 49h to the first byte.
(2) Transmit the low-order address to the second byte, the middle-order address to the third byte, and the high-order address to the fourth byte.
(3) Transmit the program size (01h to FFh) to the fifth byte.
(4) Transmit the specified amount of program data sequentially to the sixth byte or later.

If an error occurs during programming, the SR4 bit becomes 1 (Error).

After executing this command, use the read status register command to confirm that program error does not occur.

4.4 Block Erase

4.4.1 Operation

This command is used to erase the specified block in the flash memory. The block area is specified by the eight high-order bits (A16 to A23) and eight middle-order bits (A8 to A15) at any address of the block to be erased.

4.4.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command	Block Address			
Programmer to MCU	20h	Middle-order address	High-order address	D0h	
MCU to Programmer					

4.4.3 Procedure

(1) Transmit the block erase command 20h to the first byte.
(2) Transmit the middle-order address to the second byte and the high-order address to the third byte.
(3) Transmit the confirmation command D0h to the fourth byte.

After the confirmation command D0h is received, erasing starts on the specified block. Erasing sets the flash content to FFh. If an error occurs during erasing, the SR5 bit becomes 1 (Error).

After executing this command, use the read status register command to confirm that erase error does not occur.

4.5 Erase All Unlocked Blocks

4.5.1 Operation

This command is used to erase the entire user ROM area (data flash area and program ROM) in the flash memory.

4.5.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command				
Programmer to MCU	A7h	D0h			
MCU to Programmer					

4.5.3 Procedure

(1) Transmit the erase all unlocked block command A7h to the first byte.
(2) Transmit the confirmation command D0h to the second byte.

After receiving the confirmation command D0h, erasing starts on all blocks. Erasing sets the flash content to FFh. If an error occurs during erasing, the SR5 bit becomes 1 (Error).

After executing this command, use the read status register command to confirm that erase error does not occur.

4.6 Read Status Register

4.6.1 Operation

This command is used to confirm the operating status of the flash memory.

4.6.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command	SRD			
Programmer to MCU	70h				
MCU to Programmer		SRD output	SRD1 output		

4.6.3 Procedure

(1) Transmit the read status register command 70h to the first byte.
(2) Receive SRD to the second byte.
(3) Receive SRD1 to the third byte.

4.6.4 SRD Register

Bit in SRD	Status Name	Definition	
		1	0
SR7 (bit 7)	Sequencer status	Ready	Busy
SR6 (bit 6)	Reserved		
SR5 (bit 5)	Erase status	Error	Completed normally
SR4 (bit 4)	Program status	Error	Completed normally
SR3 (bit 3)	Reserved		
SR2 (bit 2)	Reserved		
SR1 (bit 1)	Reserved		
SR0 (bit 0)	Reserved		

(1) Sequencer status

The sequencer status shows the operating status of the flash memory. This bit becomes 0 during auto-programming or auto-erase. It becomes 1 when auto-programming or auto-erase is completed.

(2) Erase status

The erase status shows the erase operating status. If an error occurs, this bit becomes 1. It becomes 0 when the clear status register command is executed.

(3) Program status

The program status shows the programming status. If an error occurs, this bit becomes 1. It becomes 0 when the clear status register command is executed.

Bits SR5 and SR4 become 1 under the following conditions:

- When a defined command is not input successfully
- When data other than D0h or FFh is input in the input cycle for the block erase confirmation command. If FFh is input, the command is cancelled the MCU enters read array mode.

(4) Reserved

The read value is undefined.

4.6.5 SRD1 Register

Bit in SRD1	Status Name	Definition	
		1	0
SR15 (bit 7)	Reserved		
SR14 (bit 6)	Reserved		
SR13 (bit 5)	Reserved		
SR12 (bit 4)	Reserved		
SR11 (bit 3)	ID check bits	00: Unchecked 01: Mismatched 10: Reserved 11: Matched	
SR10 (bit 2)			
SR9 (bit 1)	Reserved		
SR8 (bit 0)	Reserved		

(1) ID check bits

These bits show the ID check result.

(2) Reserved

The read value is undefined.

4.7 Clear Status Register

4.7.1 Operation

This command is used to initialize the status register. Initialize the status register before erasing the flash memory or performing the page program.

4.7.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 256th Byte
	Command				
Programmer to MCU	50h				
MCU to Programmer					

4.7.3 Procedure

(1) Transmit the clear status register command 50h to the first byte.

After executing this command, use the read status register command to confirm that clear status error does not occur.

4.8 ID Data Check Function

4.8.1 Operation

This command is used to check if each ID stored in the flash memory matches an ID transmitted from the serial programmer. Some commands cannot be acknowledged if the ID check function finds a mismatch.

4.8.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	Up to 12th Byte
	Command	**Address**			**ID Size**	**ID**	**ID**
Programmer to MCU	F5h	DFh	FFh	00h	07h	ID1	UP to ID7
MCU to Programmer							

Notes: 1. Address means the address where ID1 is stored.

4.8.3 Procedure

(1) Transmit the ID data check function command F5h to the first byte.
(2) Transmit the low-order address where ID1 is stored to the second byte, the middle-order address to the third byte, and the high-order address to the fourth byte.
(3) Transmit the number of IDs (07h) to the fifth byte.
(4) Transmit the IDs sequentially to the sixth byte or later.

After transmission, the results are reflected in SR10 and SR11. If the transmitted address is not the ID address, or the ID size is not 7, it is determined as a mismatch even if the IDs are matched.

After executing this command, use the read status register command to confirm that the status is 11 (Matched).

4.9 Version Information Output Function

4.9.1 Operation

This command is used to confirm the boot program version.

4.9.2 Packet

	1st Byte	2nd Byte	3rd Byte	4th Byte	Up to 9th Byte
	Command				
Programmer to MCU	FBh				
MCU to Programmer		V	E	R	X

Note: 1. Version information consists of an eight-character ASCII code written as “VER. X. XX” (X’s are Roman numerals). Version information is received starting with “V”

4.9.3 Procedure

(1) Transmit the version information output function command FBh to the first byte.
(2) Receive the version information from the second byte to the ninth byte in ASCII characters.

4.10 Bit Rate 9600

4.10.1 Operation

This command is used to change the bit rate to typ. 9600 bps. When an external oscillator is necessary in standard serial I/O mode 2, a bit rate error due to frequency error may occur. Change the bit rate to typ. 9615 bps in standard serial I/O mode 3.

4.10.2 Packet

	1st Byte	2nd Byte
	Command	
Programmer to MCU	B0h	
MCU to Programmer		B0h

4.10.3 Procedure

(1) Transmit the bit rate 9600 command B0h to the first byte.
(2) Receive the confirmation command B0h to the second byte.
(3) The boot program sets the bit rate to typ. 9600 bps after transmitting the confirmation command.

4.11 Bit Rate 19200

4.11.1 Operation

This command is used to change the bit rate to typ. 19200 bps. When an external oscillator is necessary in standard serial I/O mode 2, a bit rate error due to frequency error may occur. Change the bit rate to typ. 19230 bps in standard serial I/O mode 3.

4.11.2 Packet

	1st Byte	2nd Byte
	Command	
Programmer to MCU	B1h	
MCU to Programmer		B1h

4.11.3 Procedure

(1) Transmit the bit rate 19200 command B1h to the first byte.
(2) Receive the confirmation command B1h to the second byte.
(3) The boot program sets the bit rate to typ. 19200 bps after transmitting the confirmation command.

4.12 Bit Rate 38400

4.12.1 Operation

This command is used to change the bit rate to typ. 38400 bps. When an external oscillator is necessary in standard serial I/O mode 3, a bit rate error due to frequency error may occur. Change the bit rate to typ. 38461 bps in standard serial I/O mode 3.

4.12.2 Packet

	1st Byte	2nd Byte
	Command	
Programmer to MCU	B2h	
MCU to Programmer		B2h

4.12.3 Procedure

(1) Transmit the bit rate 38400 command B2h to the first byte.
(2) Receive the confirmation command B2h to the second byte.
(3) The boot program sets the bit rate to typ. 38400 bps after transmitting the confirmation command.

4.13 Bit Rate 57600

4.13.1 Operation

This command is used to change the bit rate to typ. 57600 bps. When an external oscillator is necessary in standard serial I/O mode 2, a bit rate error due to frequency error may occur. Change the bit rate to typ. 55555 bps in standard serial I/O mode 3.

4.13.2 Packet

	1st Byte	2nd Byte
	Command	
Programmer to MCU	B3h	
MCU to Programmer		B3h

4.13.3 Procedure

(1) Transmit the bit rate 57600 command B3h to the first byte.
(2) Receive the confirmation command B3h to the second byte.
(3) The boot program sets the bit rate to typ. 57600 bps after transmitting the confirmation command.

4.14 Bit Rate 115200

4.14.1 Operation

This command is used to change the bit rate to typ. 115200 bps. When an external oscillator is necessary in standard serial I/O mode 2, a bit rate error due to frequency error may occur. **This command does not apply in standard serial I/O mode 3.**

4.14.2 Packet

	1st Byte	2nd Byte
	Command	
Programmer to MCU	B4h	
MCU to Programmer		B4h

4.14.3 Procedure

(1) Transmit the bit rate 115200 command B4h to the first byte.
(2) Receive the confirmation command B4h to the second byte.
(3) The boot program sets the bit rate to typ. 115200 bps after transmitting the confirmation command.

4.15 Bit Rate Setting

4.15.1 Operation

This command is used to transmit the parameter data to set the bit rate in the boot program.

4.15.2 Packet

	1st Byte	2nd Byte	3rd Byte
	Command	Setting value	
Programmer to MCU	B5h	Data	
MCU to Programmer			Data

4.15.3 Procedure

(1) Transmit the bit rate setting command B5h to the first byte.
(2) Transmit the data set to the bit rate register to the second byte.
(3) Receive the confirmation command (data transmitted to the second byte) to the third byte.
(4) The boot program sets the received data to the bit rate register after transmitting the confirmation command.

4.15.4 Communication Bit Rate

The high-speed on-chip oscillator (typ. 8 MHz) is used for the BRG count source in the boot program in standard serial I/O mode 3. Bit rates set in the boot program in standard serial I/O mode 3 are shown below.

Data (BRG setting value)	Bit Rate (bps)
33h	9615
19h	19230
0Ch	38461
08h	55555
03h	125000
01h	250000
00h	500000

5. Timing

5.1 Data Transmit Interval (Between Bytes)

When transmitting a standard time data, set the transmit interval to min. 20 ms, and set it to min. 5 µs when transmitting a control command. This transmit interval is required in the boot program for a receive process time. The process time is for reference when the CPU clock is typ. 8 MHz. Adjust values depending on the oscillation frequency shown below when the CPU clock is selected as external oscillator frequency no division.

	2 MHz	8 MHz	16 MHz
Standard time data	Min. 80 ms	Min. 20 ms	Min. 10 ms
Control command	Min. 20 µs	Min. 5 µs	Min. 2.5 µs

5.2 Switching from Transmit to Receive in Standard Serial I/O Mode 3

Switch from transmit to receive after 2 ms elapses, and from transmit to receive within 500 µs.

5.2.1 Read Status Register Command in Programming and Erasing

By executing the read status register command after transmitting page program, unit program, block erase and erase all unlocked blocks commands, the MCU transmits the values in the SRD after programming or erasing data. For details on electrical characteristics of program time and erase time, refer to the User's Manual: Hardware.

6. Usage Note

6.1 Read Status Register

Even if an error occurs during writing, the SR4 bit may not become 1 (program status ends in error). After programming, always read data and confirm that expected value is programmed.

Website and Support

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

Inquiries
http://www.renesas.com/contact/

REVISION HISTORY	R8C/1x, 2x Series Standard Serial I/O Mode Serial Protocol Specification

Rev.	Date	Description	
		Page	Summary
1.00	Dec. 01, 2010	—	First edition issued
1.01	Oct. 13, 2011	24	An error in 8.1 Read status register revised
1.10	Feb. 15, 2013	9	4.3.2, Packet, note (2) added
		—	Fixed typos

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 type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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