

RL78/G15

Serial Interface IICA (for Slave Transmission/Reception)

Introduction

This application note describes slave transmission and reception implemented via the serial interface IICA. Using IICA, the single master system described here performs slave operation (address reception, and data transmission and reception).

Target Device

RL78/G15

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

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1. Specifications

This application note describes a method for using a serial interface IICA for master transmission/reception (address transmission data transmission and reception) in a single-master configuration. It is assumed that each slave has a register to specify an address in the slave.

When the slave address 0b1010000 is specified, the slave becomes capable of transmitting and receiving data.

The following is a summary of the slave specifications assumed in this application note.

- Slave address: 0b1010000^{note}
- At the specified address, an arbitrary number of data bytes can be read out or written.
- The slave serial RAM area is register addresses 0x80 to 0xFF (128 bytes). Slave operation is specified using the command register at register address 0x00.
- When 0x01 to 0x7F is specified as the register address, NACK is returned and there is disengagement from communication.
- When the register address exceeds 0xFF, the serial RAM area is selected, and only the lower 7 bits of the specified register address are handled as valid.

Caution: This sample code corresponds to the Application Note for the RL78/G15 serial interface IICA (master transmission/reception) (R01AN7019E).

Peripheral functions used and applications are shown in Table 1.1, and the IIC communication is summarized in Figure 1.1. IIC communication timing charts appear in Figure 1.2 to Figure 1.8.

Table 1.1 Peripheral Function to be Used and Its Use

| Peripheral Function | Use |
|-----------------------|--|
| Serial interface IICA | IIC communication in a single master system (using the SCLA0 and SDAA0 pins) |

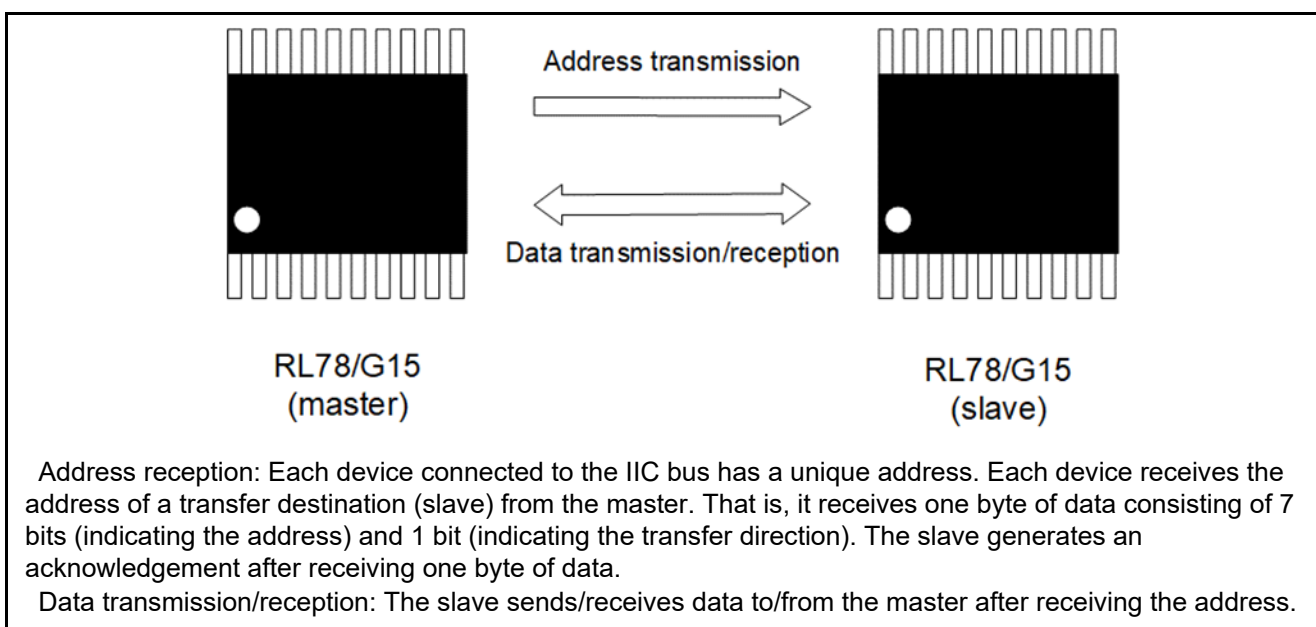


Figure 1.1 Overview of IIC Communication

1.1 IIC Communication Timing Chart

(1) Master-to-slave communication 1 (start condition – address – data)

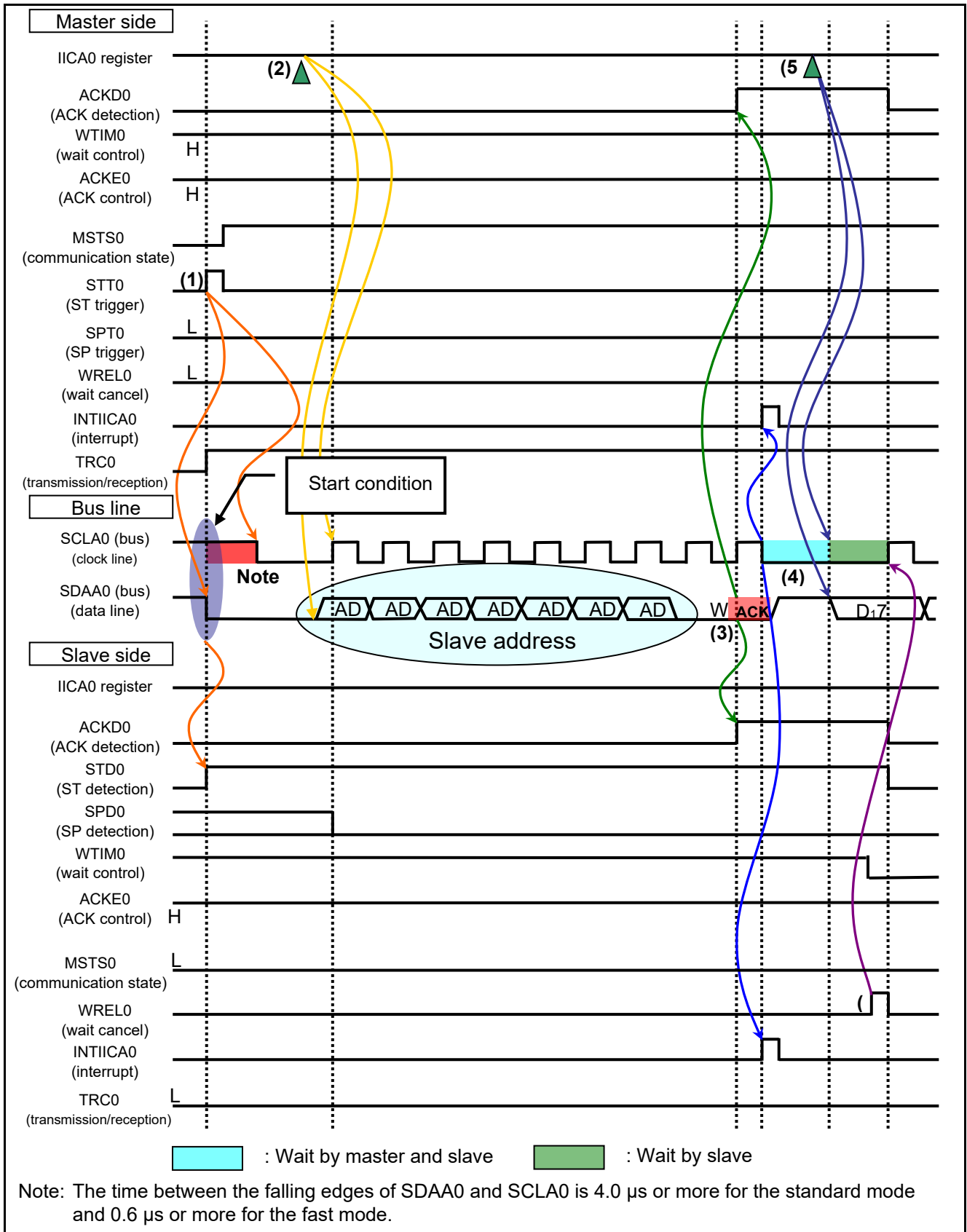


Figure 1.2 IIC Communication Timing Chart (Master-to-Slave Communication Example) (1/4)

- (1) The start condition trigger is set (STT0 = 1) on the master side. Then, the SDAA0 line falls, thereby generating a start condition. Later, when the start condition is detected (STD0 = 1), the master enters a master device communication state (MSTS0 = 1). The SCLA0 line falls at the end of the hold period. This completes preparations for communication.
- (2) The values of the address and data direction bit W (transmission) are written to the IICA0 register on the master side. Then, the slave address is transmitted.
- (3) If the received address and slave address match ^{Note}, the slave hardware sends ACK0 to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (4) When the ninth clock signal falls, an address transmission end interrupt (INTIICA0) occurs on the master side. If the addresses match, an address match interrupt (INTIICA0) occurs on the slave side. Both the master and the slave which has the matching address enter a wait state (SCLA0 line: Low)^{Note}.
- (5) The master writes transmit data to the IICA0 register and cancels the wait.
- (6) The slave selects an 8-clock wait (WTIM0 = 0) because it receives data. When the slave cancels the wait (WRELO = 1), the master starts transferring data to the slave.

Note: When there is a mismatch between a received address and the [station's own/local](#) address, the slave side does not return ACK to the master side (NACK). Moreover, a slave-side INTIICA0 interrupt (address match interrupt) does not occur, and a wait state is not entered on the slave side. However, on the master side an INTIICA0 interrupt (address transmission complete interrupt) occurs, regardless of whether the result is ACK or NACK.

In the RL78 family, the [local](#) address ~~of the station~~ (7 bits) is represented by the upper 7 bits in the SVA0 register. The lowermost bit in the SVA0 register is fixed at 0.

(2) Master-to-slave communication 2 (address – data – data)

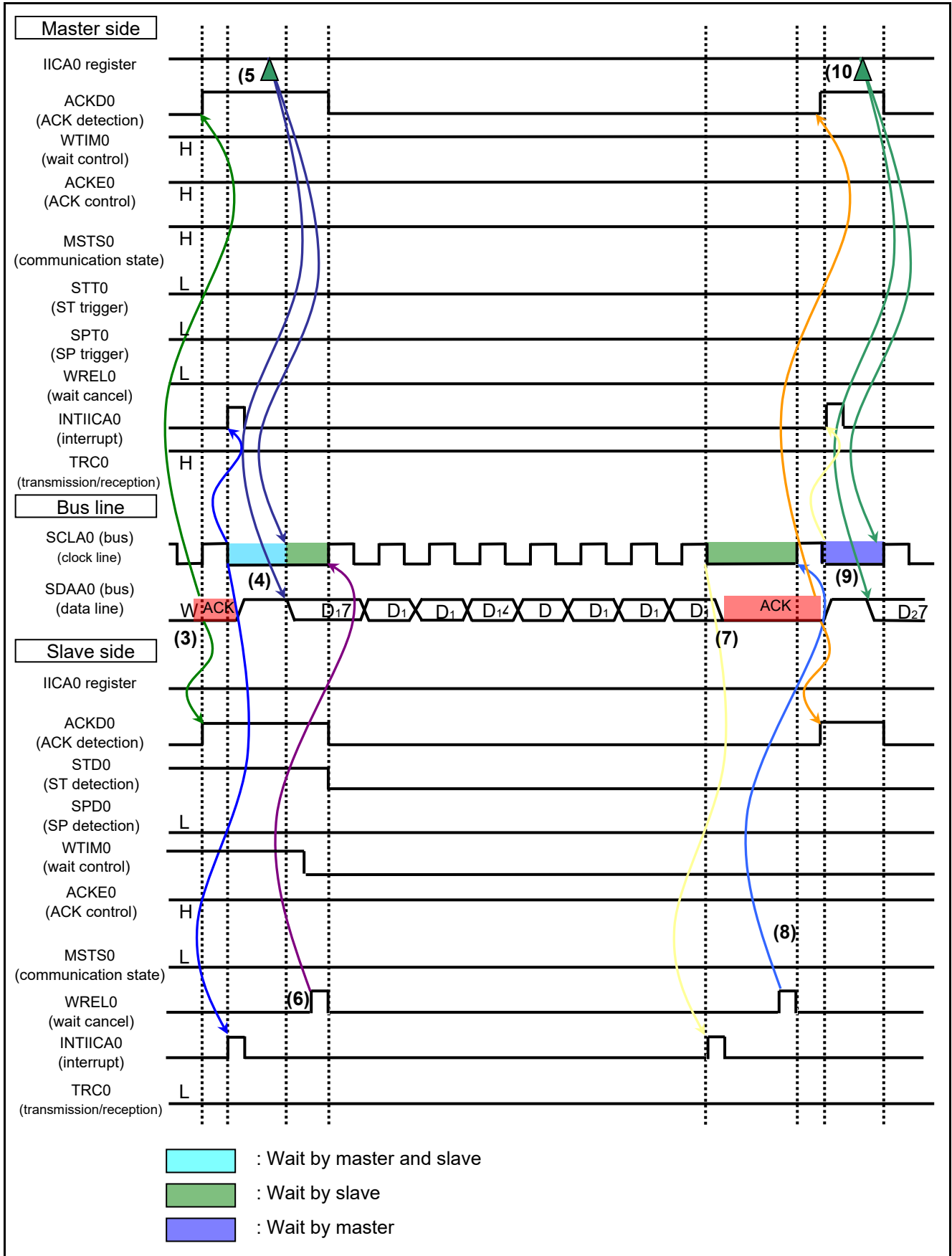


Figure 1.3 IIC Communication Timing Chart (Master-to-Slave Communication Example) (2/4)

- (3) If the received address and slave address match, the slave hardware sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (4) When the ninth clock signal falls, an address transmission end interrupt (INTIICA0) occurs on the master side. If the addresses match, an address match interrupt (INTIICA0) occurs on the slave side. Both the master and the slave which has the matching address enter a wait state (SCLA0 line: Low).
- (5) The master writes transmit data to the IICA0 register and cancels the wait.
- (6) The slave selects an 8-clock wait (WTIM0 = 0) because it receives data. When the slave cancels the wait (WRELO = 1), the master starts transferring data to the slave.
- (7) When the eighth clock signal falls after the data transfer, the slave hardware generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (8) When the slave reads the receive data and cancels the wait (WRELO = 1), the slave sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (9) When the ninth clock signal falls, the master generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master side.
- (10) The master writes transmit data to the IICA0 register and cancels the wait. Then, the master starts transferring data to the slave.

(3) Master-to-slave communication 3 (data – data – stop condition)

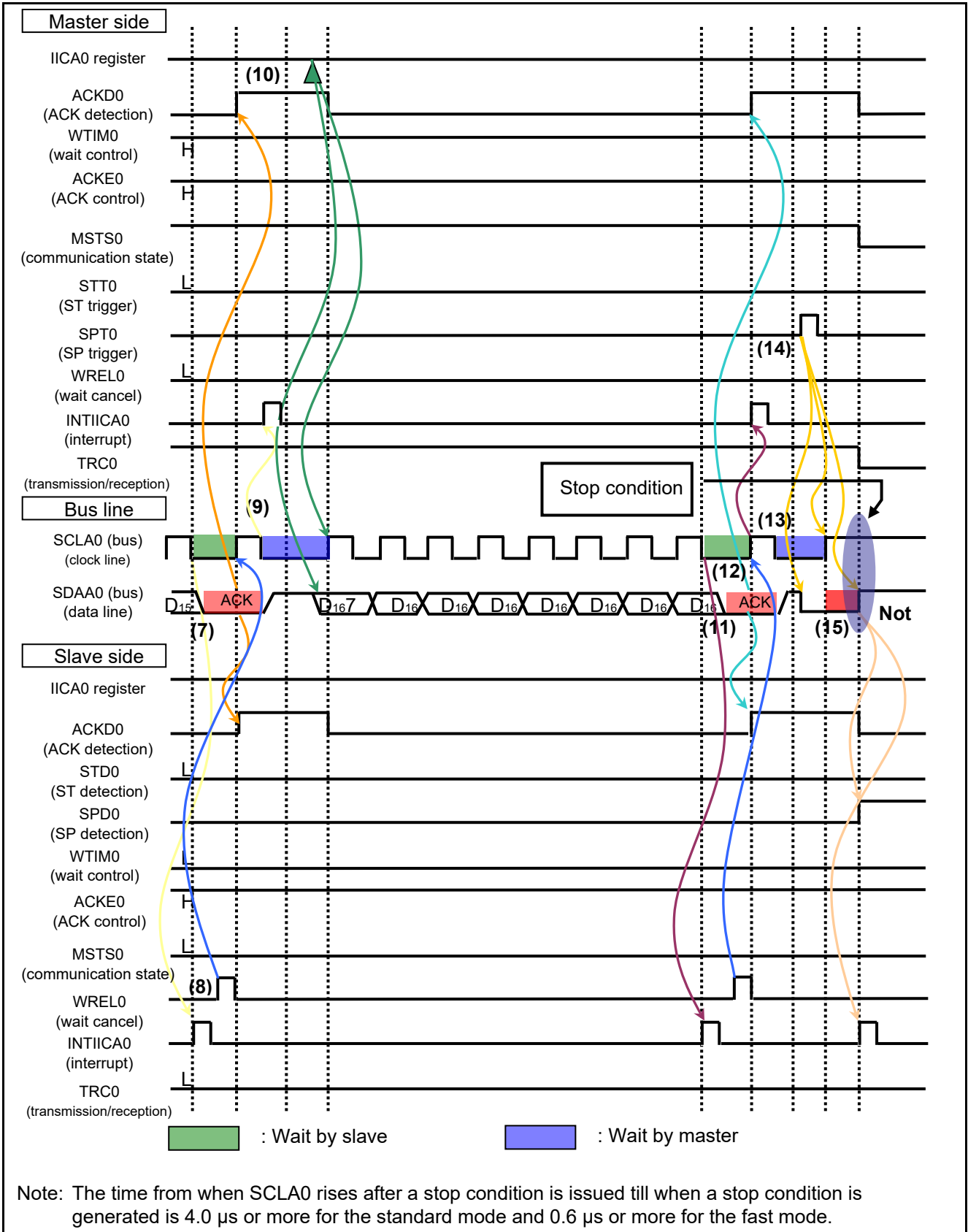


Figure 1.4 IIC Communication Timing Chart (Master-to-Slave Communication Example) (3/4)

- (7) When the eighth clock signal falls after the data transfer, the slave hardware generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (8) When the slave reads the receive data and cancels the wait (WREL0 = 1), the slave sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (9) When the ninth clock signal falls, the master generates a wait (SCLA0 line: Low) and an address transmission end interrupt (INTIICA0) occurs on the master side.
- (10) The master writes transmit data to the IICA0 register and cancels the wait. Then, the master starts transferring the data to the slave.
- (11) When the eighth clock signal falls after the data transfer, the slave hardware generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (12) When the slave reads the receive data and cancels the wait (WREL0 = 1), the slave sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (13) When the ninth clock signal falls, the master generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master side.
- (14) When the stop condition trigger is set (SPT0 = 1), the SDAA0 line falls and the SCLA0 line rises. Upon the elapse of the stop condition setup time, the SDAA0 line rises, thereby generating a stop condition.
- (15) When the stop condition is generated, the slave detects it (SPD0 = 1) and a IICA0 interrupt (stop condition interrupt) occurs on the slave side.

(4) Master-to-slave communication 4 (data – restart condition – address)

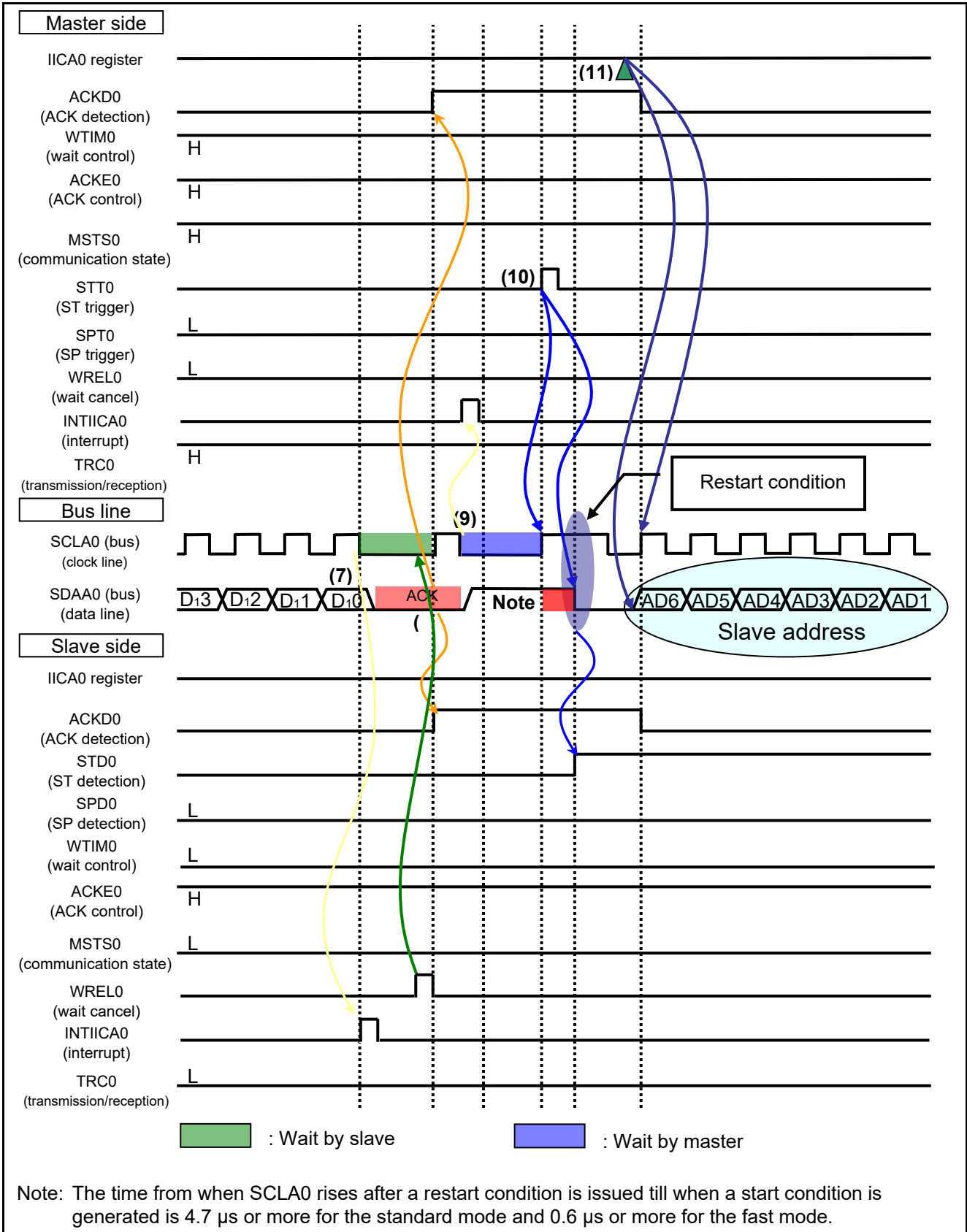


Figure 1.5 IIC Communication Timing Chart (Master-to-Slave Communication Example) (4/4)

- (7) When the eighth clock signal falls after the data transfer, the slave hardware generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (8) The slave reads the receive data and cancels the wait (WREL0 = 1). Then, the slave sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (9) When the ninth clock signal falls, the master generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master side.
- (10) The start condition trigger is set (STT0 = 1) on the master side again. Then, the SCLA0 line rises. Upon the elapse of the restart condition setup time, the SDAA0 line falls, thereby generating a start condition. Later, at the end of the hold period after the start condition is detected (STD0 = 1), the bus clock line falls, thereby completing preparations for communication.
- (11) The master writes the slave address to the IICA0 register and starts transferring the address to the slave.

(5) Slave-to-master communication 1 (start condition – address – data)

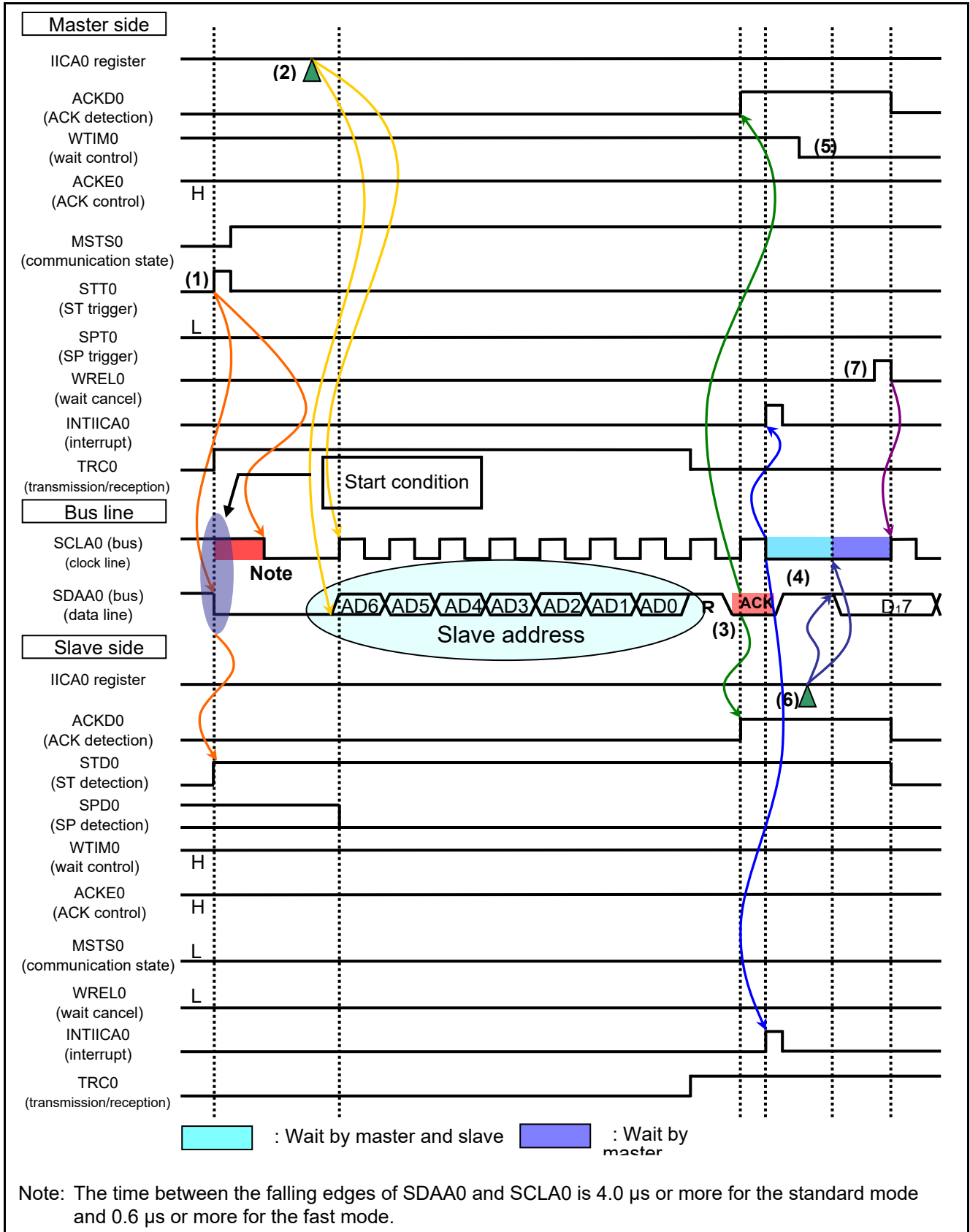


Figure 1.6 IIC Communication Timing Chart (Slave-to-Master Communication Example) (1/3)

- (1) The start condition trigger is set (STT0 = 1) on the master side. Then, the SDAA0 line falls, thereby generating a start condition. Later, when the start condition is detected (STD0 = 1), the master enters a master device communication state (MSTS0 = 1). The SCLA0 line falls at the end of the hold period. This completes preparations for communication.
- (2) The values of the address and data direction bit R (reception) are written to the IICA0 register on the master side. Then, the slave address is transmitted.
- (3) If the received address and slave address match ^{Note}, the slave hardware sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (4) When the ninth clock signal falls, an address transmission end interrupt (INTIICA0) occurs on the master side. If the addresses match, an address match interrupt (INTIICA0) occurs on the slave side. Both the master and the slave which has the matching address enter a wait state (SCLA0 line: Low).
- (5) The master selects an 8-clock wait (WTIM0 = 0) because it receives data.
- (6) The slave writes transmit data to the IICA0 register and cancels the wait.
- (7) When the master cancels the wait (WRELO = 1), the slave starts transferring data to the master.

Note: When there is a mismatch between a received address and the ~~station's own~~local address, the slave side does not return ACK to the master side (NACK). Moreover, a slave-side INTIICA0 interrupt (address match interrupt) does not occur, and a wait state is not entered on the slave side. However, on the master side an INTIICA0 interrupt (address transmission complete interrupt) occurs, regardless of whether the result is ACK or NACK.

In the RL78 family, the ~~local~~ address ~~of the station~~ (7 bits) is represented by the upper 7 bits in the SVA0 register. The lowermost bit in the SVA0 register is fixed at 0.

(6) Slave-to-master communication 2 (address – data – data)

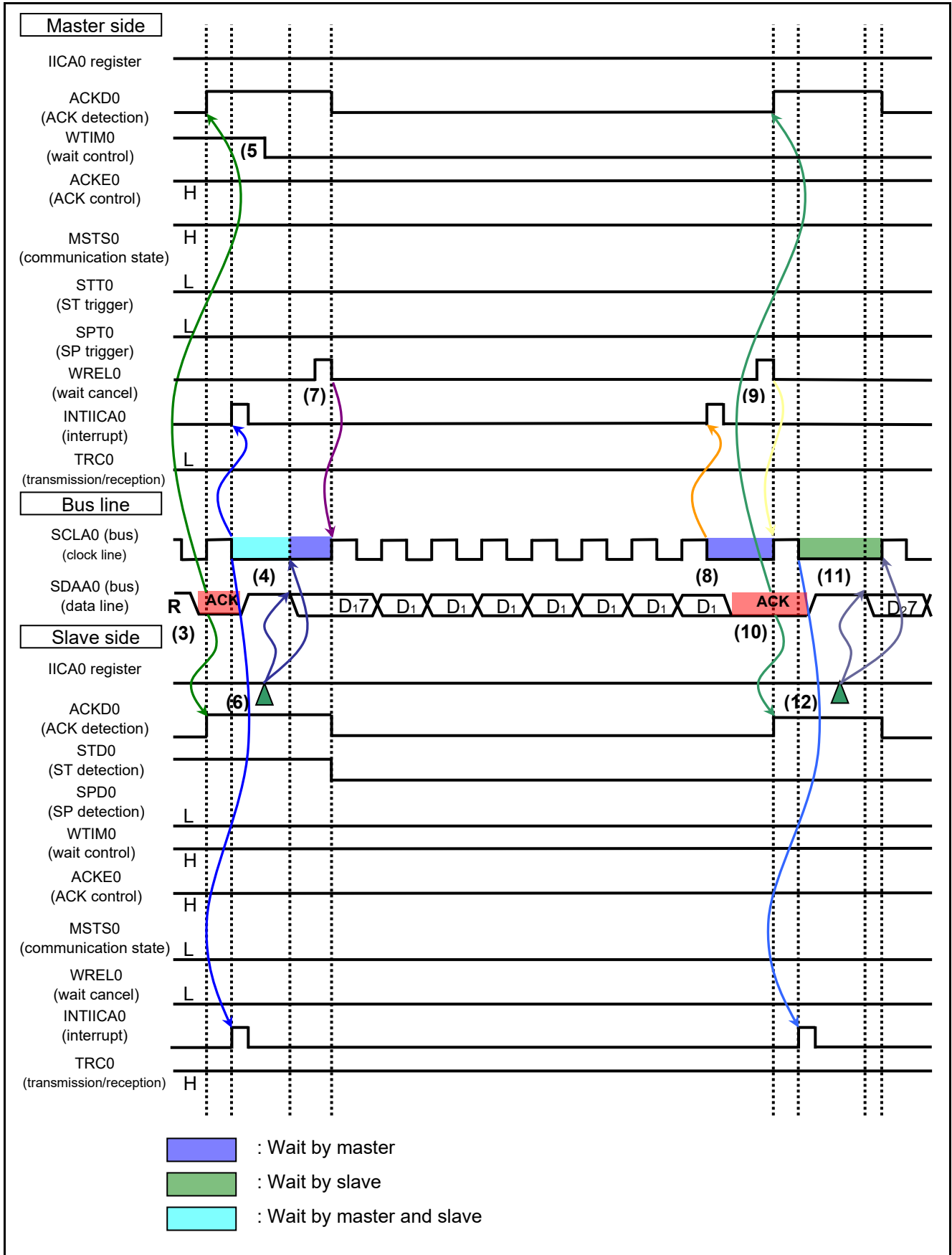


Figure 1.7 IIC Communication Timing Chart (Slave-to-Master Communication Example) (2/3)

- (3) If the received address and slave address match, the slave hardware sends ACK to the master. When the ninth clock signal rises, the master detects ACK (ACKD0 = 1).
- (4) When the ninth clock signal falls, an address transmission end interrupt (INTIICA0) occurs on the master side. If the addresses match, an address match interrupt (INTIICA0) occurs on the slave side. Both the master and the slave which has the matching address enter a wait state (SCLA0 line: Low).
- (5) The master selects an 8-clock wait (WTIM0 = 0) because it receives data.
- (6) The slave writes transmit data to the IICA0 register and cancels the wait.
- (7) When the master cancels the wait (WREL0 = 1), the slave starts transferring data to the master.
- (8) When the eighth clock signal falls, the master generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master side. The master hardware sends ACK to the slave.
- (9) The master reads the receive data and cancels the wait (WREL0 = 1).
- (10) When the ninth clock signal rises, the slave detects ACK (ACKD0 = 1).
- (11) When the ninth clock signal falls, the slave generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (12) The slave writes transmit data to the IICA0 register and cancels the wait. Then, the slave starts transferring data to the master.

(7) Slave-to-master communication 3 (data – data – stop condition)

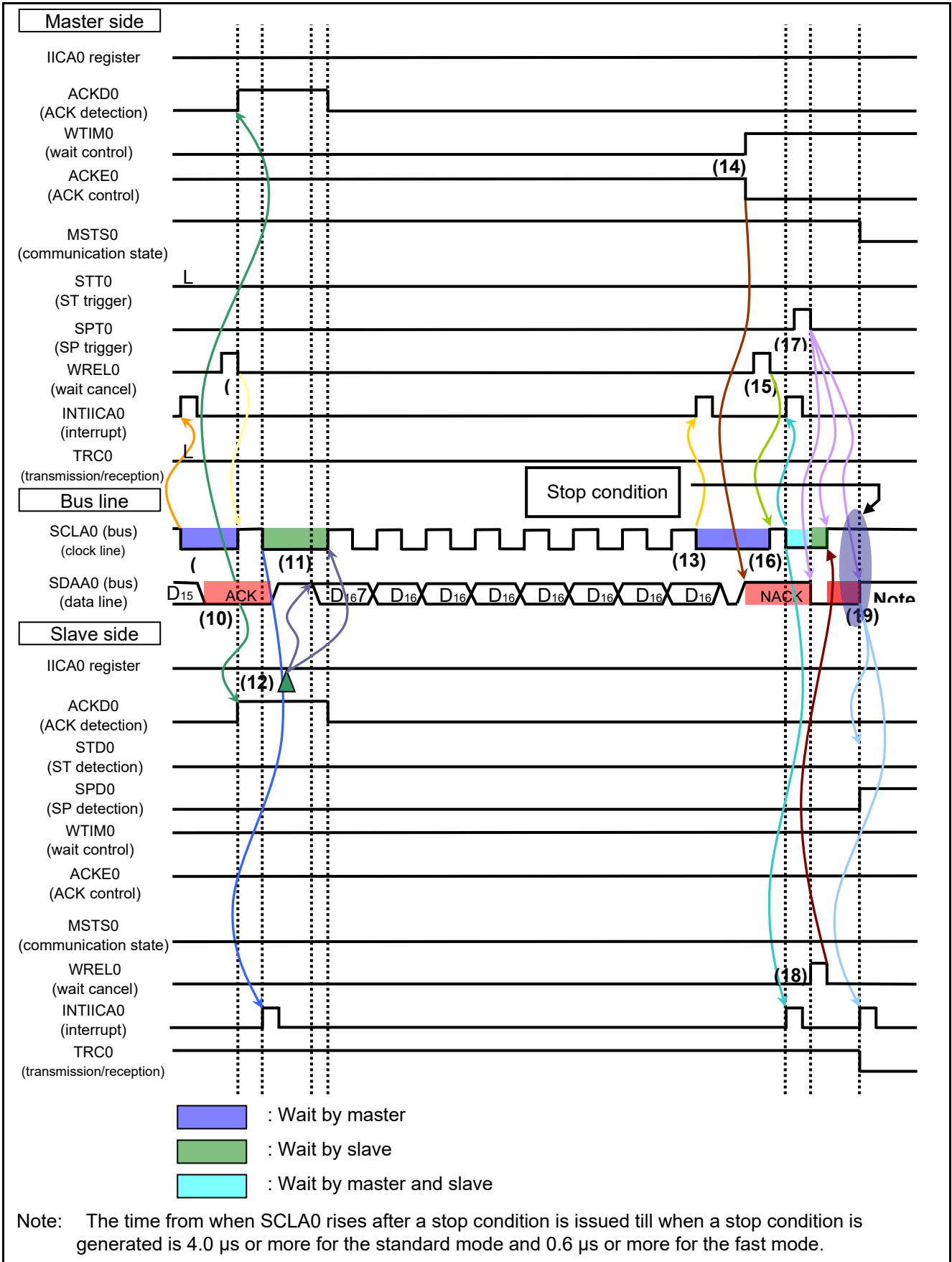


Figure 1.8 IIC Communication Timing Chart (Slave-to-Master Communication Example) (3/3)

- (8) When the eighth clock signal falls, the master generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master side. The master hardware sends ACK to the slave.
- (9) The master reads the receive data and cancels the wait (WREL0 = 1).
- (10) When the ninth clock signal rises, the slave detects ACK (ACKD0 = 1).
- (11) When the ninth clock signal falls, the slave generates a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the slave side.
- (12) The slave writes transmit data to the IICA0 register and cancels the wait. Then, the slave starts transferring data to the master.
- (13) When the eighth clock signal falls, a transfer end interrupt (INTIICA0) occurs on the master side and the master generates a wait (SCLA0 line: Low). The master hardware sends ACK to the slave.
- (14) The master sets a NACK response (ACKE0 = 0) to inform the slave that the master has sent the last data (at the end of communication). Then, the master changes the wait time to 9 clock periods (WTIM0 = 1).
- (15) After the master cancels the wait (WREL0 = 1), the slave detects NACK (ACKD0 = 0) at the rising edge of the ninth clock signal.
- (16) When the ninth clock signal falls, the master and slave generate a wait (SCLA0 line: Low) and a transfer end interrupt (INTIICA0) occurs on the master and slave sides.
- (17) When the master issues a stop condition (SPT0 = 1), the SDAA0 line falls, thereby canceling the wait on the master side. Later, the master waits until the SCLA0 line rises.
- (18) The slave cancels the wait (WREL0 = 1) to terminate communication. Then, the SCLA0 line rises.
- (19) The master confirms that the SCLA0 line has risen. Upon the elapse of the stop condition setup time after this confirmation, the master makes the SDAA0 line rise and issues a stop condition. When the stop condition is generated, the slave detects the stop condition (SPD0 = 1) and a stop condition interrupt (INTIICA0) occurs on the master and slave sides.

1.2 Control of Serial RAM

1.2.1 Command Settings

In this application note, commands are used to specify slave operations. The command setting sequence is shown in **Figure 1.9**, and the command setting timing chart appears in **Figure 1.10**

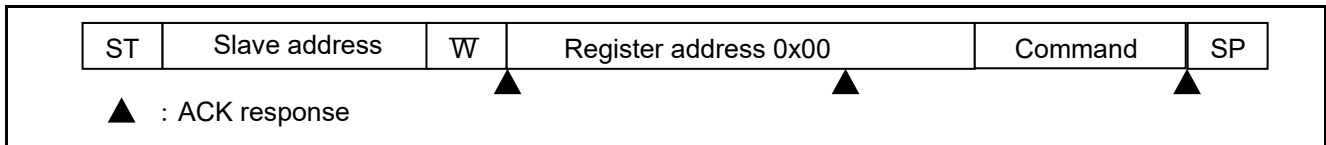


Figure 1.9 Command Setting Sequence

Upon receiving the slave address 0b1010000 following a start condition (ST), the slave returns ACK^{note} after receiving a transfer direction specification bit. When the transfer direction \overline{W} is specified, it is determined that the second-next received data will be written to the address specified by the next received data. Upon receiving the register address 0x00, the slave returns ACK, and determines that the next received data is a command. Upon receiving a stop condition (SP), communication is ended.

Upon receiving an address and data, the slave returns ACK. If the address or data cannot be confirmed, the SDA maintains a high level state (NACK response).

Note: In the RL78 family, if the local address and the slave address match, an ACK response is sent automatically.

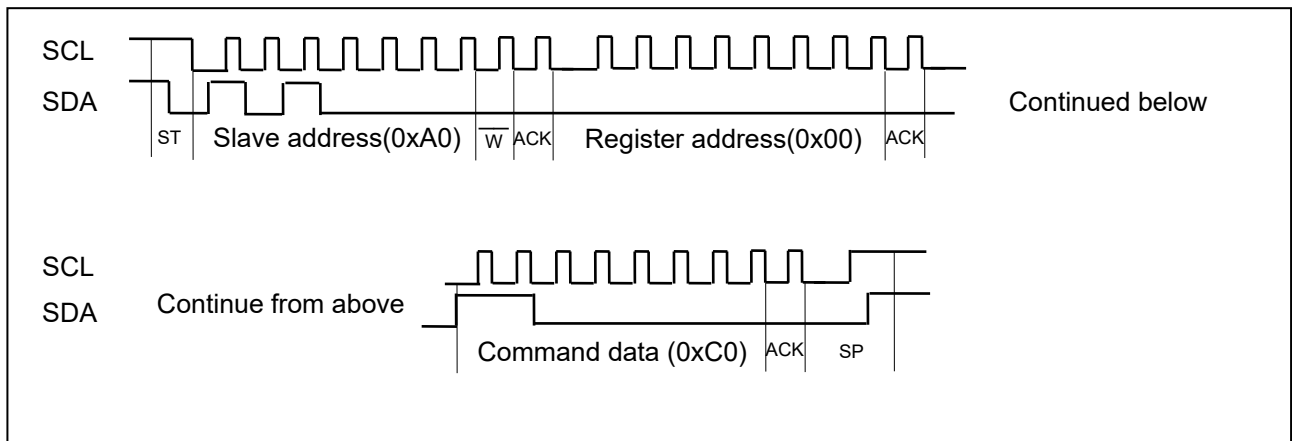


Figure 1.10 Command Setting Timing Chart

A list of command functions appears in **Table 1.2**

Bit 7 (the MSB) of the data written to register address 0x00 (command register) indicates whether the command is valid or invalid. When bit 7 is 1, the slave judges that the command is valid, and when bit 7 is 0, the slave ignores the command as invalid. Bit 6 indicates whether memory functions are used or not. When memory functions are used, bit 6 is set to 1. Bits 5 to 3 are unused, and so are all set to 0. Bit 2 indicates whether writing is forbidden or not. While bit 2 is set to 1 (from when writing is prohibited until writing is again permitted), upon write data reception the slave sends a NACK response and disengages from communication. Bit 1 indicates whether memory is initialized or not. When bit 1 is set to 1, the slave memory is initialized to initialization data specified by bit 0. After the completion of initialization, the slave sets bit 1 of the command register to 0.

Table 1.2 Command functions

| Bit | Meaning | Explanation |
|--------|-------------------------------|---|
| 7 | Command setting | 1: command valid, 0: command invalid |
| 6 | Memory function selection | 1: use memory functions, 0: do not use memory functions |
| 5 to 3 | Unused | Fixed at 0 |
| 2 | Write selection | 1: writing forbidden, 0: writing permitted |
| 1 | Initialization selection | 1: initialize memory (serial RAM area), 0: do nothing |
| 0 | Initialization data selection | 1: value of lowest 7 bits of register address ^{note} , 0: 0x00 |

Note: At each address in the serial RAM area, the value of the lowest 7 bits of the address is written. For example, at register addresses 0x80, 0x81, 0x82, the respective values 0x00, 0x01, 0x02 are written.

1.2.2 Continuous Data Writing

Regarding cases in which a register address is specified and data is written continuously to the serial RAM of a slave, the sequence is shown in Figure 1.11, and the timing chart appears in Figure 1.12.

Upon receiving the slave address 0b1010000 following a start condition (ST), the slave returns ACK^{note} after receiving a transfer direction specification bit. When the transfer direction \bar{W} is specified, it is determined that the second-next received data will be written to the address specified by the next received data. Upon receiving the register address, the slave returns ACK and stores the register address value.

Then, received data is written in sequence from the specified register address (sequential write). Upon receiving a stop condition (SP), communication is ended.

Upon receiving the address and data, the slave returns ACK. If the address or data cannot be confirmed, the SDA maintains a high level state (NACK response).

Note: In the RL78 family, if the local address and the slave address match, an ACK response is sent automatically.

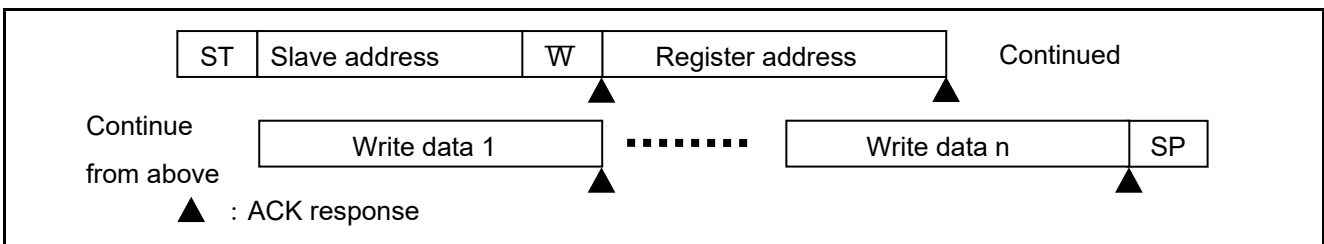


Figure 1.11 Sequence for Continuous Data Writing by Register Address Specification

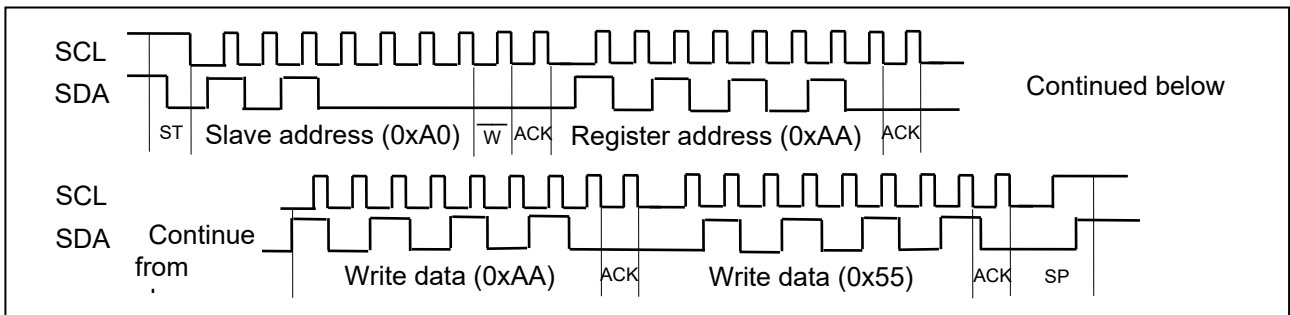


Figure 1.12 Timing Chart for Continuous Data Writing by Register Address Specification

The timing chart for data writing when writing is forbidden is shown in Figure 1.13. The slave returns ACK in response to the slave address and a register address, but returns NACK in response to write data, and disengages from communication. The master confirms the NACK response and generates a stop condition, ending communication.

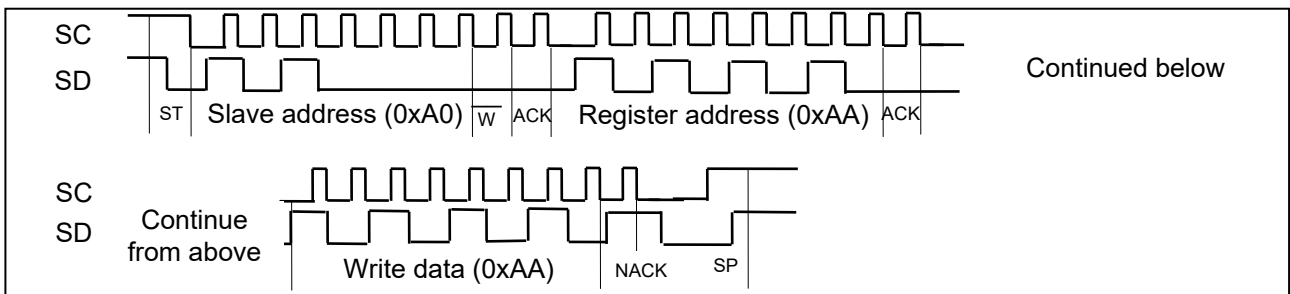


Figure 1.13 Timing Chart for Data Writing When Writing is Forbidden

1.2.3 Continuous Data Reading

Regarding cases in which a register address is specified and data is read continuously from a slave, the sequence is shown in Figure 1.14, and the timing chart appears in Figure 1.15.

Upon receiving the slave address 0b1010000 following a start condition (ST), the slave returns ACK^{note} after receiving a transfer direction specification bit. When the transfer direction \bar{W} is specified, it is determined that the second-next received data will be written to the address specified by the next received data. Upon receiving the register address, the slave returns ACK and stores the register address value.

However, before receiving data scheduled for writing, if after a restart condition (ST) the slave address 0b1010000 and the transfer direction R are received, the slave reads data in sequence from the previously specified register address and transmits the data to the master (sequential read).

Upon detecting a NACK from the master, the slave halts data transmission. With a stop condition (SP) from the master, communication is completed.

Upon receiving the address and data, the slave returns ACK. If the address or data cannot be confirmed, the SDA maintains a high level state (NACK response).

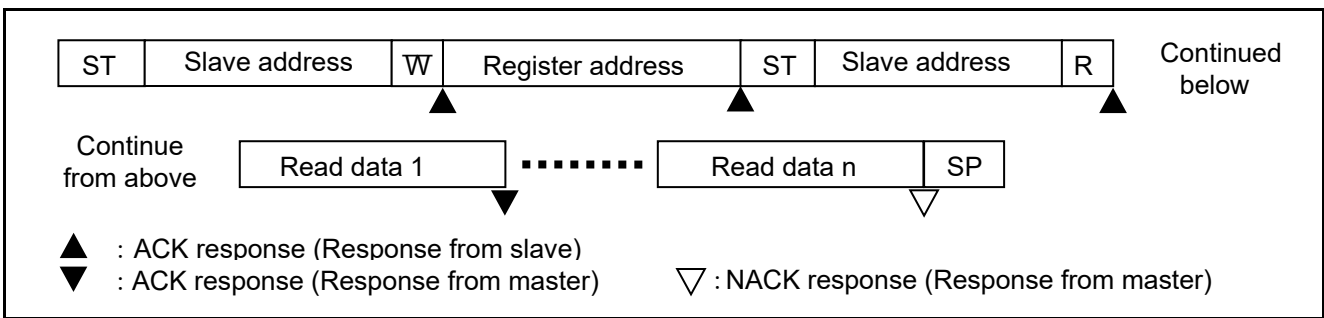


Figure 1.14 Sequence for Continuous Data Reading by Register Address Specification

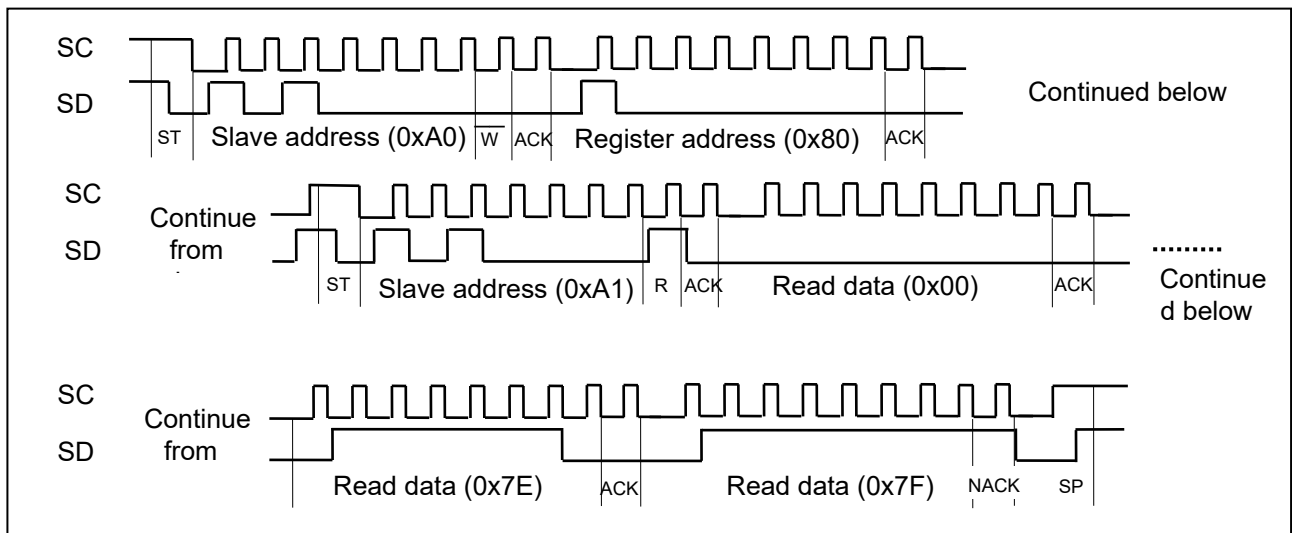


Figure 1.15 Timing Chart for Continuous Data Reading by Register Address Specification

2. Operation Check Conditions

The sample code contained in this application note has been checked under the conditions listed in the Table 2.1 below.

Table 2.1 Operation Check Conditions

| Item | Description |
|--|--|
| Microcontroller used | RL78/G15 (R5F12608ASP) |
| Board used | RL78/G15-20p Fast Prototyping Board (RTK5RLG150C00000BJ) |
| Operating frequency | High-speed on-chip oscillator (HOCO) clock: 16 MHz |
| Operating voltage | 5.0 V (can be operated at 2.4 V to 5.5 V) |
| Integrated development environment (CS+) | Renesas Electronics CS + for CC V8.10.00 |
| C compiler (CS+) | Renesas Electronics CC-RL V1.12.01 |
| Integrated development environment (e ² studio) | Renesas Electronics e ² studio V2023-07 (23.7.0) |
| C compiler (e ² studio) | Renesas Electronics CC-RL V1.12.01 |
| Integrated development environment (IAR) | IAR systems IAR Embedded Workbench for Renesas RL78 V5.10.1 |
| C compiler (IAR) | IAR systems IAR Embedded Workbench for Renesas RL78 V5.10.1 |
| Smart configurator (SC) | V1.70 from Renesas Electronics Corp. |
| Board support package (BSP) | V1.60 from Renesas Electronics Corp. |

3. Related Application Note

The application notes that are related to this application note are listed below for reference.

- RL78/G15 Serial Interface IICA (for Master Transmission/Reception) (R01AN7019E) Application Note

4. Description of the Hardware

4.1 Hardware Configuration Example

Figure 4.1 shows an example of hardware configuration that is used for this application note.

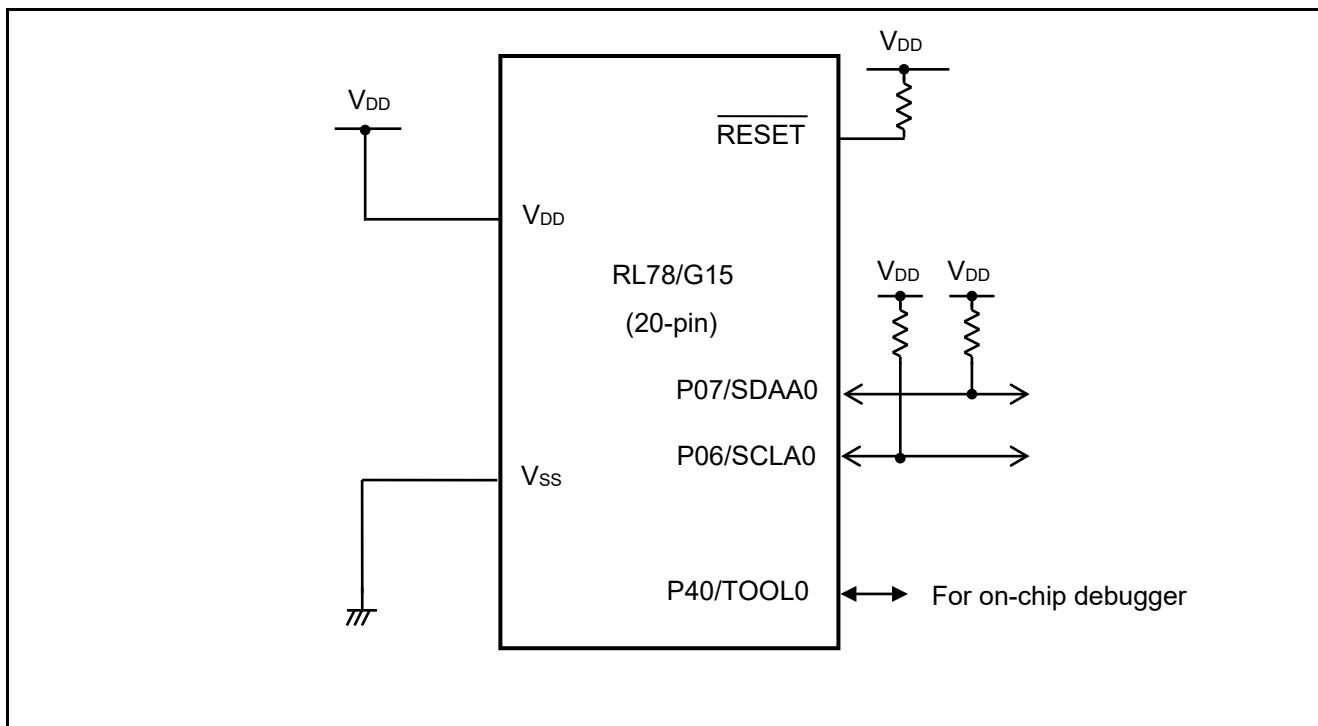


Figure 4.1 Hardware Configuration

- Cautions:
1. The purpose of this circuit is only to provide the connection outline and the circuit is simplified accordingly. When designing and implementing an actual circuit, provide proper pin treatment and make sure that the hardware's electrical specifications are met (connect the input-only ports separately to VDD or VSS via a resistor).
 2. VDD must be held at not lower than the reset release voltage (VSPOR) that is specified as SPOR.

4.2 List of Pins to be Used

Table 4.1 lists the pins to be used and their functions.

Table 4.1 Pins to be Used and their Functions

| Pin Name | I/O | Description |
|-----------|--------------|--|
| P06/SCLA0 | Input/Output | IICA0 serial clock I/O pin |
| P07/SDAA0 | Input/Output | IICA0 serial data transmission/reception pin |

5. Description of the Software

5.1 Operation Outline

The sample program covered in this application note provides IICA slave transmission and reception (address reception, and data transmission and reception) through the serial interface IICA.

(1) Initialize serial interface IICA.

<Conditions for setting>

- Select the fast mode as the operation mode.
- To set the slave address to 0b1010000, set 0xA0 to slave address register 0 (SVA0).
- Turn the digital filter on
- Generate an interrupt in response to the ninth clock signal
- Disable stop condition interrupts.
- Use the P06/SCLA0 pin for transfer clock input and the P07/SDAA0 pin for data transmission/reception.

(2) Get the communication buffer (16 bytes) ready for use.

(3) The IICA wakeup function is used to reduce power consumption. A STOP instruction is executed, and an interrupt (INTIICA0) occurring when the local address or an extension code is received is awaited.

(4) When the local address or an extension code is received, wakeup occurs, and data communication is begun. When an extension code has been received, the slave exits from communication and returns to (3).

(5) Register address reception

1. When the received register address is 0x10 to 0x7F, the slave exits from communication. (NACK response)
2. When the register address is 0x00, ACK is returned. The next data (command) is analyzed, and ACK/NACK is returned. Moreover, processing specified by a command is performed.
3. When the register address is 0x80 to 0xFF, the register address is stored. Thereafter, an instruction from the master is awaited.

(6) Data transmission/reception

1. When the transfer direction is R, data is read in sequence from the specified register address, and data that has been read is transmitted from the slave to the master (sequential read) until a NACK response from the master is detected.
2. When the transfer direction is \overline{W} , received data is written in sequence (sequential write) from the specified register address (serial RAM region).

(7) When a stop condition from the master is detected, the slave exits from communication.

(8) When a start condition from the master is detected, processing is repeated from (4).

(9) The above processing (3) to (7) is repeated.

Caution This sample code is related to the RL78/G15 IICA Master Transmission/Reception (R01AN7019E) Application Note only. This sample code performs actions conforming to instructions from the master rather than actions determined in advance. The conditions for completion of communication are detection of a stop condition, and NACK detection during data transmission. When communication is completed, the next start of communication from the master is awaited. During serial RAM initialization and other communication processing, wait states (SCLA0 pin at low level) are used to synchronize with the master.

Remark Higher-level main processing is performed while checking the value of the variable `g_ica0_slave_status_flag` indicating the processing state of the IICA0 interrupt.

5.2 List of Option Byte Settings

Table 5.1 summarizes the settings of the option bytes.

Table 5.1 Option Byte Settings

| Address | Value | Description |
|---------|-----------|---|
| 000C0H | 11101110B | Disables the watchdog timer. (Stops counting after the release from the reset state.) |
| 000C1H | 11111011B | SPOR detection voltage: At rising edge TYP. 2.57 V (2.44 V to 2.68 V) At falling edge TYP. 2.52 V (2.40 V to 2.62 V) P125 is used as the reset pin |
| 000C2H | 11111001B | High-speed on-chip oscillator clock (fIH): 16 MHz |
| 000C3H | 10000101B | Enables the on-chip debugger. |

5.3 List of Constants

Table 5.2 lists the constants that are used in this sample program.

Table 5.2 Constants for the Sample Program

| Constant | Setting | Description |
|-------------|---------|---|
| DATA_LENGTH | 0x10 | IIC transmit/receive data length |
| REGADDR | 1 | Number of bytes of register address |
| ON_COMM | 0x00 | In communication |
| DET_STOP | 0x01 | Stop condition detected |
| TX_END | 0x02 | NACK detected (data transmission ends) |
| TD_REQ | 0x04 | Data transmission request |
| RX_END | 0x08 | Reception of specified number of data items completed |
| DR_REQ | 0x10 | Received data read request |
| AR_END | 0x20 | Register address (reception) completed |
| NOT_SEL | 0x80 | After restart, address mismatch/extension code received |

5.4 List of Variables

Table 5.3 lists the global variables that are used in this sample program.

Table 5.3 Global Variables for the Sample Program

| Type | Variable Name | Contents | Function Used |
|----------------|---------------------------|---|---|
| uint8_t | g_iica0_slave_status_flag | IICA0 slave flag | R_Config_IICA0_Slave_Receive(), r_IICA0_slave_handler(),main() |
| uint8_t* | gp_iica0_rx_address | IICA0 receive buffer address | R_Config_IICA0_Slave_Receive(), r_IICA0_slave_handler() |
| uint16_t | g_iica0_rx_len | IICA0 receive data length | R_Config_IICA0_Slave_Receive(), r_IICA0_slave_handler() |
| uint16_t | g_iica0_rx_cnt | IICA0 receive data count | R_Config_IICA0_Slave_Receive(), r_IICA0_slave_handler() |
| uint8_t* | g_iica0_tx_address | IICA0 transmit buffer address | R_IICA0_Slave_Send(), r_IICA0_slave_handler() |
| uint16_t | g_iica0_tx_cnt | IICA0 transmit data count | R_IICA0_Slave_Send(), r_IICA0_slave_handler() |
| static uint8_t | g_rx_data[DATA_LENGTH] | Data receive buffer | R_Config_IICA0_Slave_Receive() |
| static uint8_t | g_serial_RAM[128] | Serial RAM area | main(), R_Command() |
| static uint8_t | g_com_stat | Command status | main(), R_Command() |
| uint16_t | g_reg_addr | Internal address (Address of serial ram area) | main(),R_Increment_Address (), r_IICA0_slave_handler () |

5.5 Variable Specifications

Table 5.4 lists the Variable Specifications that are used in this sample program.

Table 5.4 Variable Specifications

[Variable name] g_iica0_slave_status_flag

| | |
|-------------|-------------------------------------|
| Summary | IICA0 slave flag |
| Explanation | Indicates the slave operation state |

| Bit | Meaning |
|-----|--|
| 7 | 1: Received other than slave address 0b1010000 (address mismatch after restart) 0: Received slave address 0b1010000 |
| 6 | Fixed to 0 |
| 5 | 1: Register address set (includes update of same value) 0: Register address not set |
| 4 | 1: Received data exceeding specified number of times 0: Did not receive data exceeding specified number of times |
| 3 | 1: Received data the specified number of times (also used for register address setting) 0: Did not receive data the specified number of times |
| 2 | 1: Data transmission request from master 0: No data transmission request from master |
| 1 | 1: NACK detected (master has completed reception of last data) 0: NACK not detected |
| 0 | 1: Stop condition detected 0: Stop condition not detected |

5.6 List of Functions

Table 5.5 summarizes the functions that are used in this sample program.

Table 5.5 Functions

| Function Name | Outline |
|------------------------------|--|
| R_Increment_Address | Internal address update processing |
| R_Command | Command execution processing |
| R_Config_IICA0_Slave_Receive | Slave reception setting |
| r_Config_IICA0_interrupt | IICA0 interrupt processing |
| r_IICA0_slave_handler | Slave processing within IICA 0 interrupt |

5.7 Function Specifications

This section describes the specifications for the functions that are used in this sample program.

[Function Name] R_Increment_Address

| | |
|--------------|---|
| Synopsis | Internal address update processing |
| Header | - |
| Declaration | void R_Increment_Address(void) |
| Explanation | Updates the serial RAM address. After 0xFF returns to 0x80. |
| Arguments | None |
| Return value | None |
| Remarks | None |

[Function Name] R_Command

| | |
|--------------|---|
| Synopsis | Command execution processing |
| Header | - |
| Declaration | void R_Command(void) |
| Explanation | Performs processing corresponding to the command written to the command register. |
| Arguments | None |
| Return value | None |
| Remarks | None |

[Function Name] R_Config_IICA0_Slave_Receive

| | |
|--------------|---|
| Synopsis | Slave reception setting |
| Header | Config.IICA0.h |
| Declaration | void R_Config_IICA0_Slave_Receive(uint8_t * const rx_buf and uint16_t rx_num) |
| Explanation | Specifies the slave reception mode. |
| Arguments | rx_buf Receive data buffer address rx_num Receive data length |
| Return value | None |
| Remarks | None |

[Function Name] r_Config_IICA0_interrupt

| | |
|--------------|--|
| Synopsis | IICA0 interrupt processing |
| Header | - |
| Declaration | static void __near r_Config_IICA0_interrupt(void) |
| Explanation | Interrupt handler for IICA0 interrupt. |
| Arguments | None |
| Return value | None |
| Remarks | In this sample code, in order to meet the specifications, processing to stop the wakeup function operation is added to the beginning of this function, which is generated by the code generator. Even when code is generated, a setting for code generation is used so as to output only an initialization function so as not to exert an influence; interrupt processing is provided in the "r_serial_user.c" file. |

[Function Name] r_IICA0_slave_handler

| | |
|--------------|--|
| Synopsis | Slave processing within IICA0 interrupt |
| Header | r_cg_serial.h |
| Declaration | static void r_IICA0_slave_handler(void) |
| Explanation | Performs slave transmission and reception during IICA0 interrupt handling. |
| Arguments | None |
| Return value | None |
| Remarks | In this sample code, code generated by the code generator is not used. |

5.7.1 Main Processing

Figure 5.1 through Figure 5.2 shows the flowchart for the main processing.

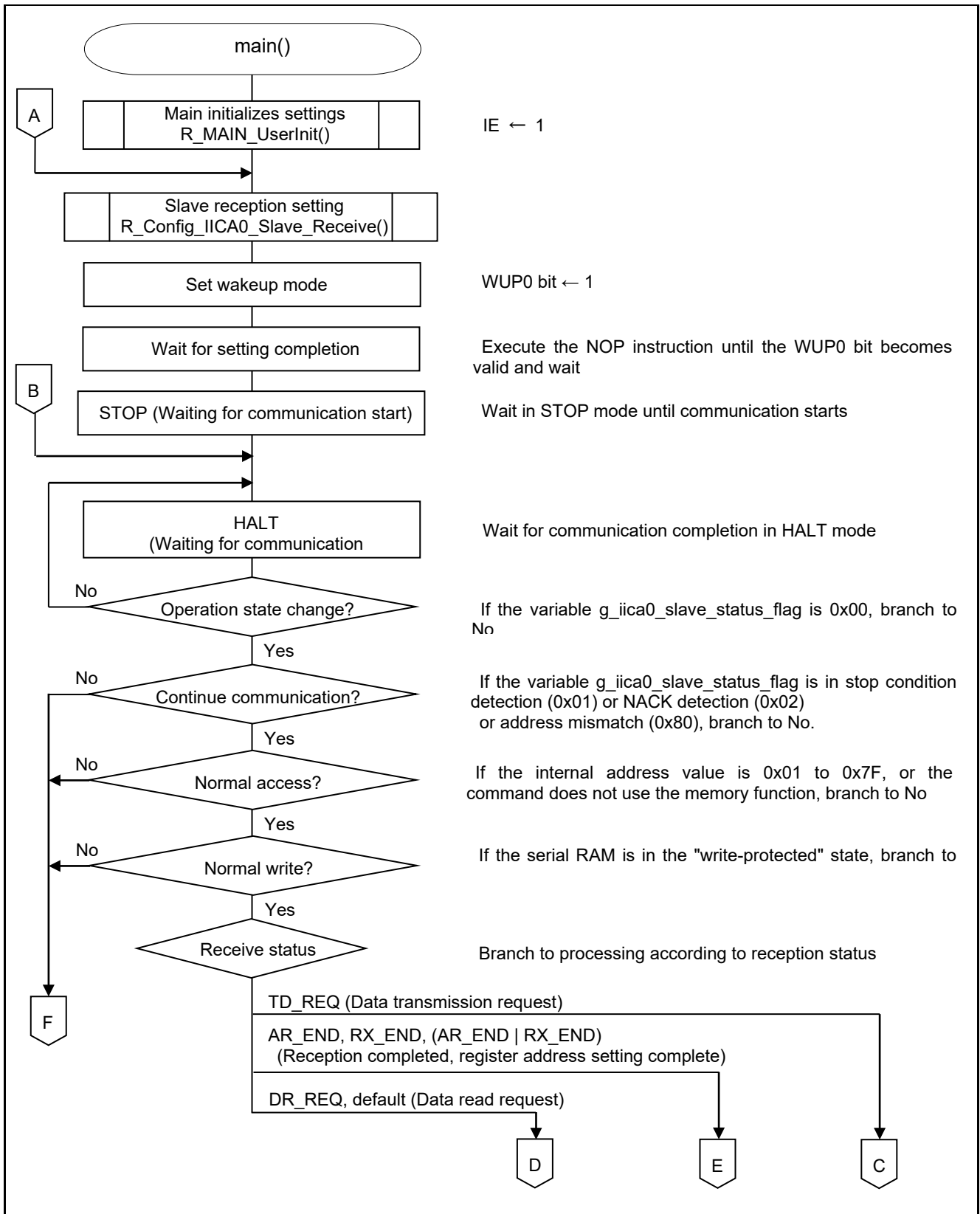


Figure 5.1 Main Processing (1/2)

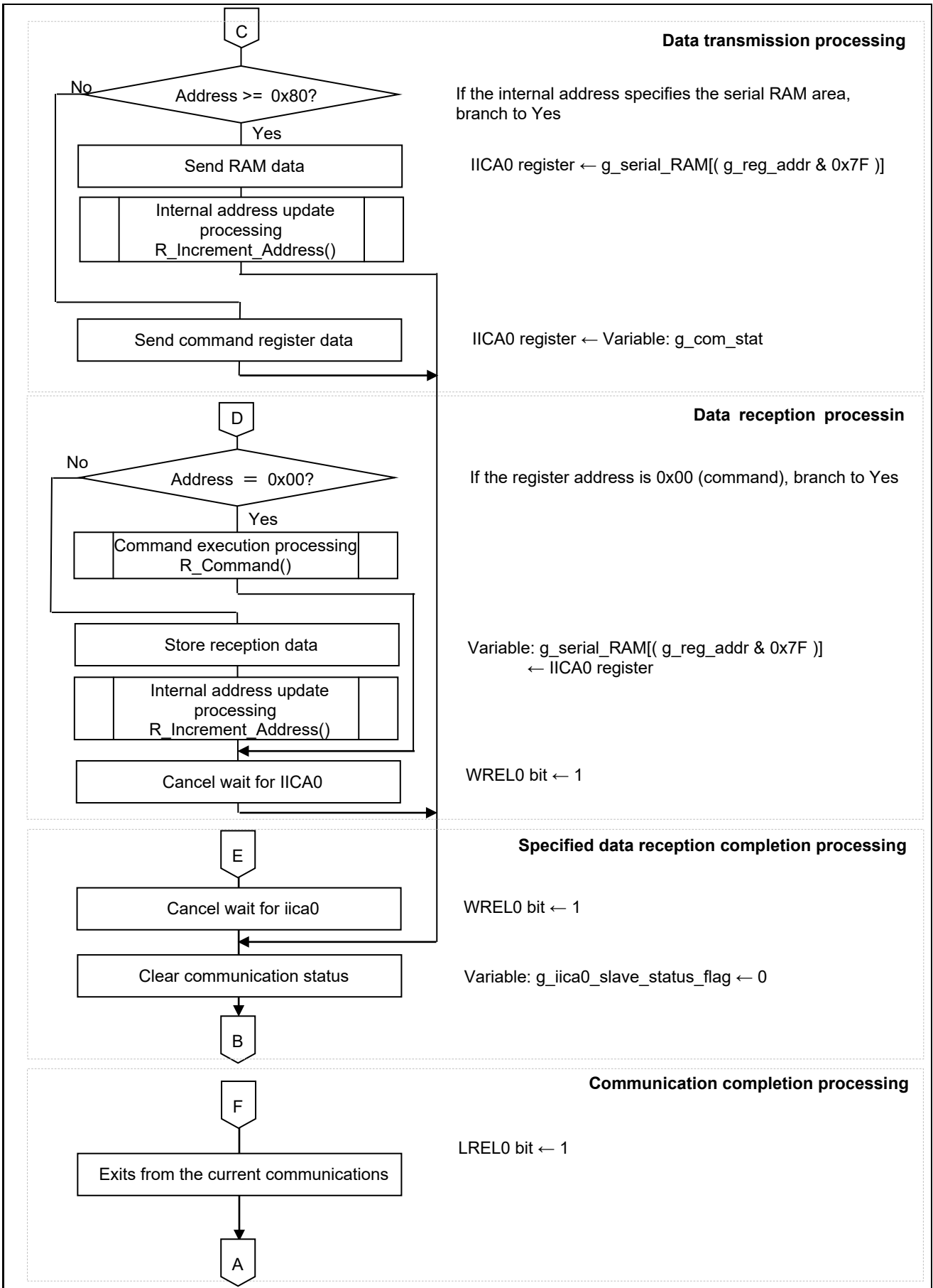


Figure 5.2 Main Processing (2/2)

5.7.2 Internal Address Update Processing

Figure 5.3 shows the flowchart for the internal address update processing.

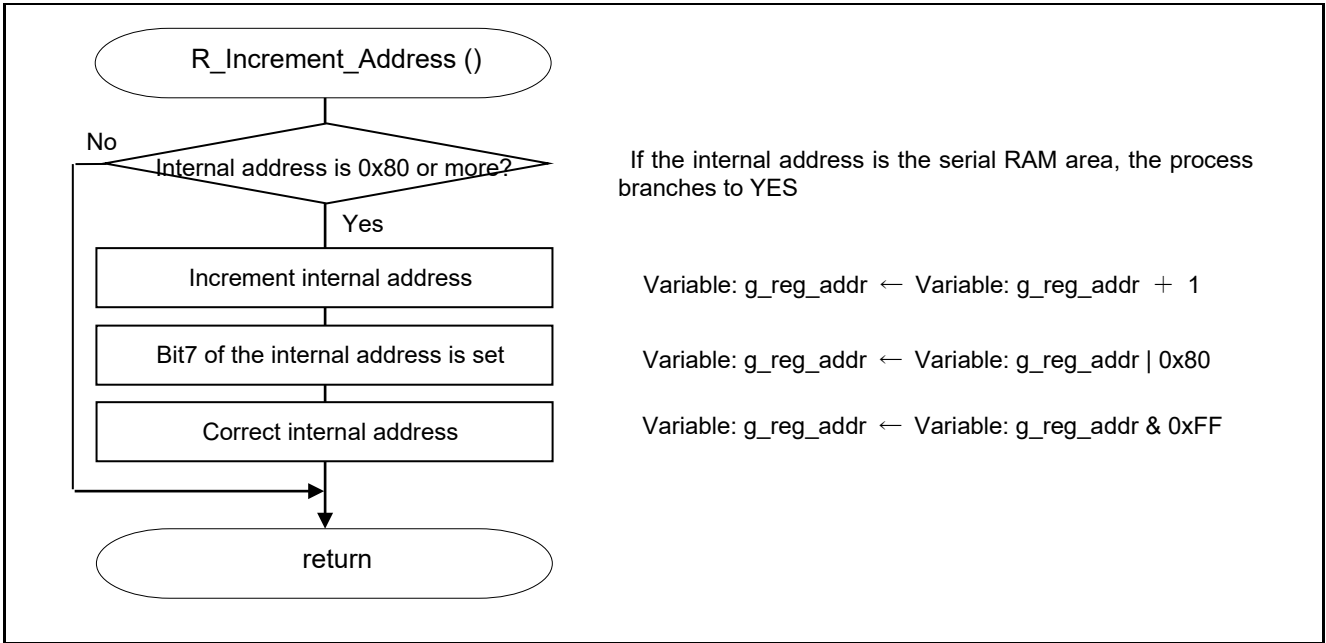


Figure 5.3 Internal Address Update Processing

5.7.3 Command Execution Processing

Figure 5.4 shows the flowchart for the command execution processing.

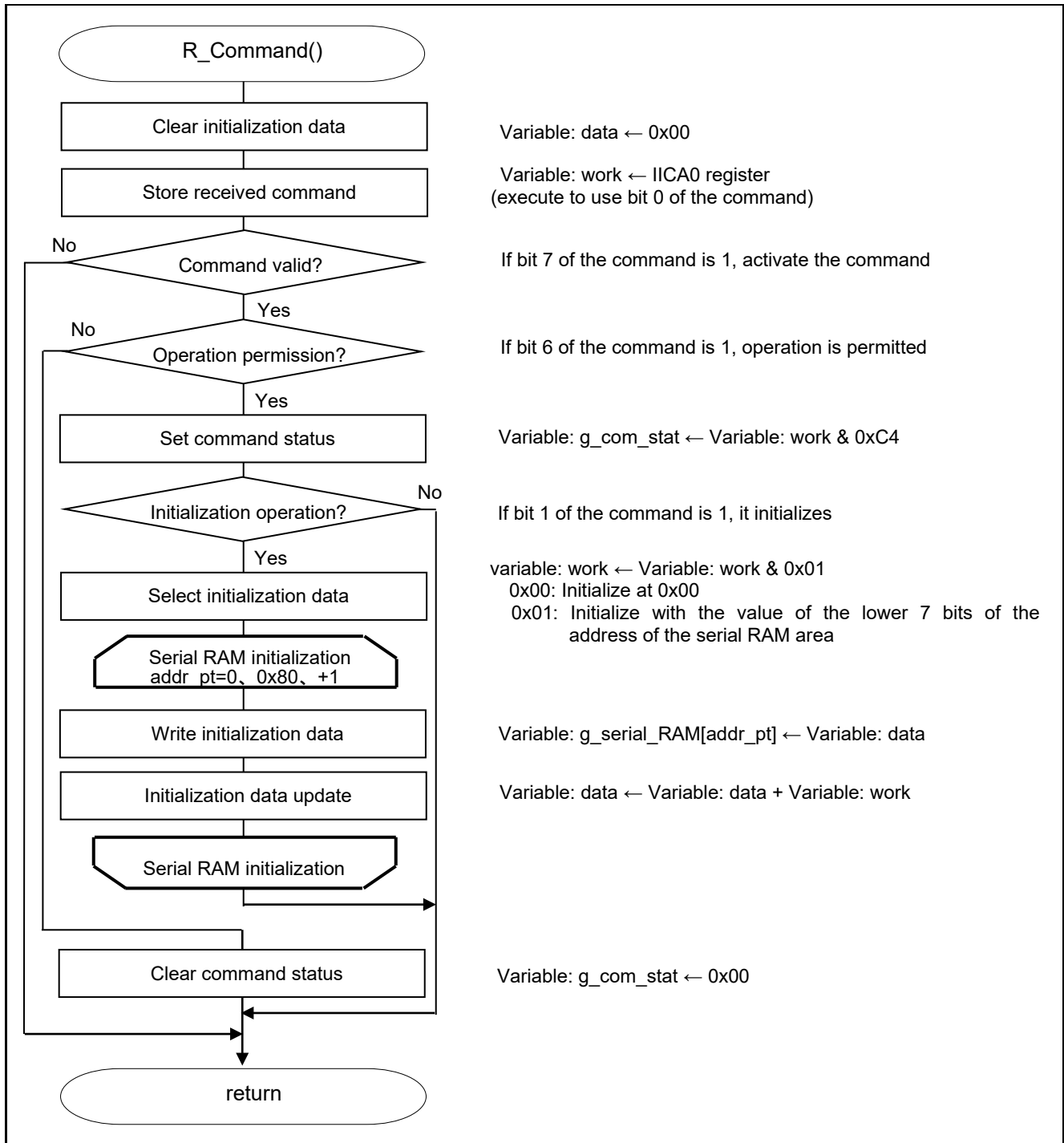


Figure 5.4 Command Execution Processing

5.7.4 Slave Reception Setting

Figure 5.5 shows the flowchart for the slave reception setting.

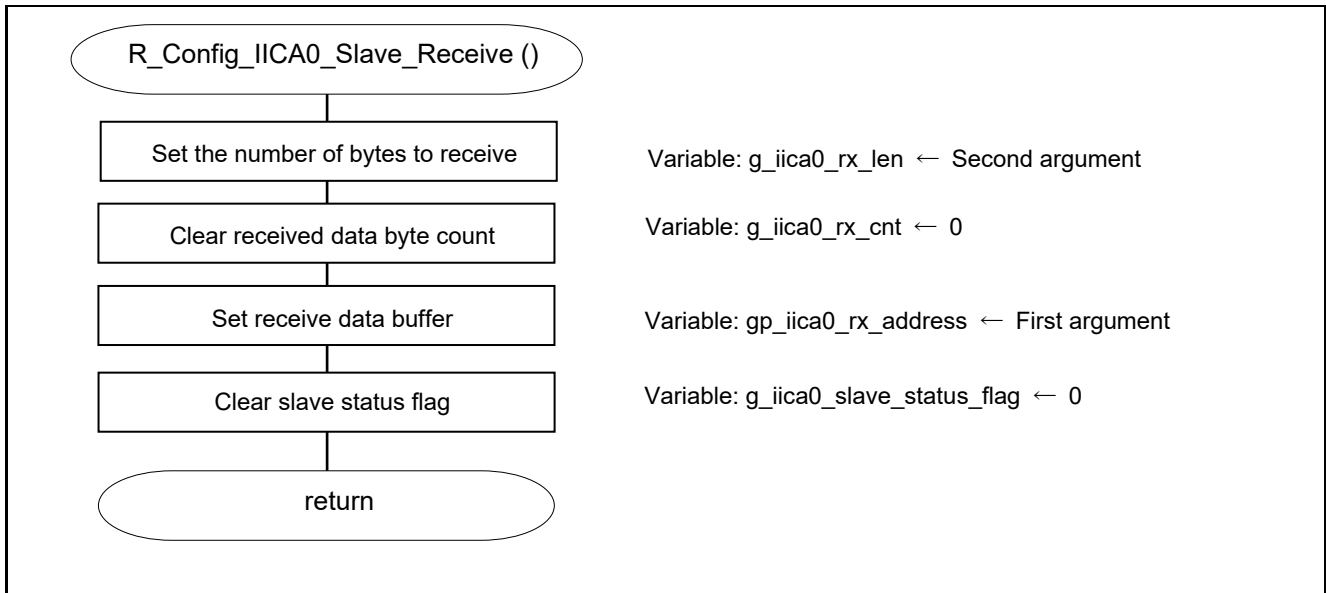


Figure 5.5 Slave Reception Setting

5.7.5 IICA0 Interrupt Processing

Figure 5.6 shows the flowchart for IICA0 interrupt processing.

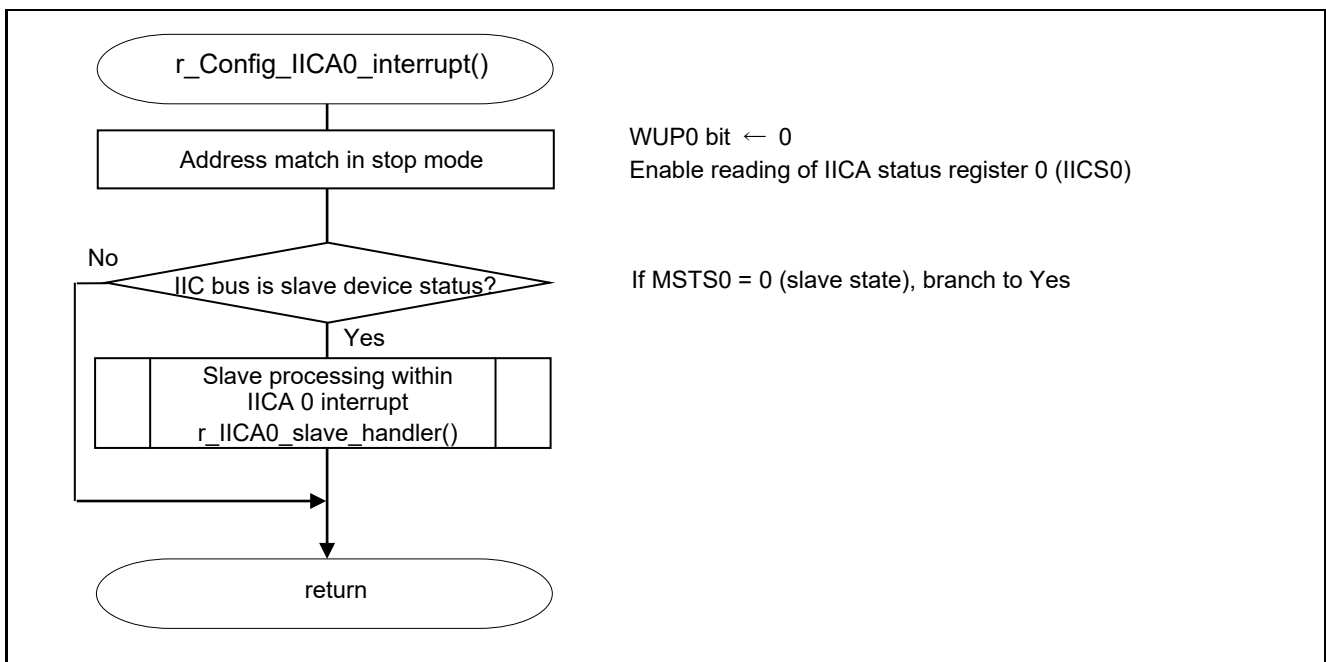


Figure 5.6 IICA0 Interrupt Processing

5.7.6 IICA0 Slave Handler

Figure 5.7 through Figure 5.9 show the flowcharts for the IICA0 slave handler.

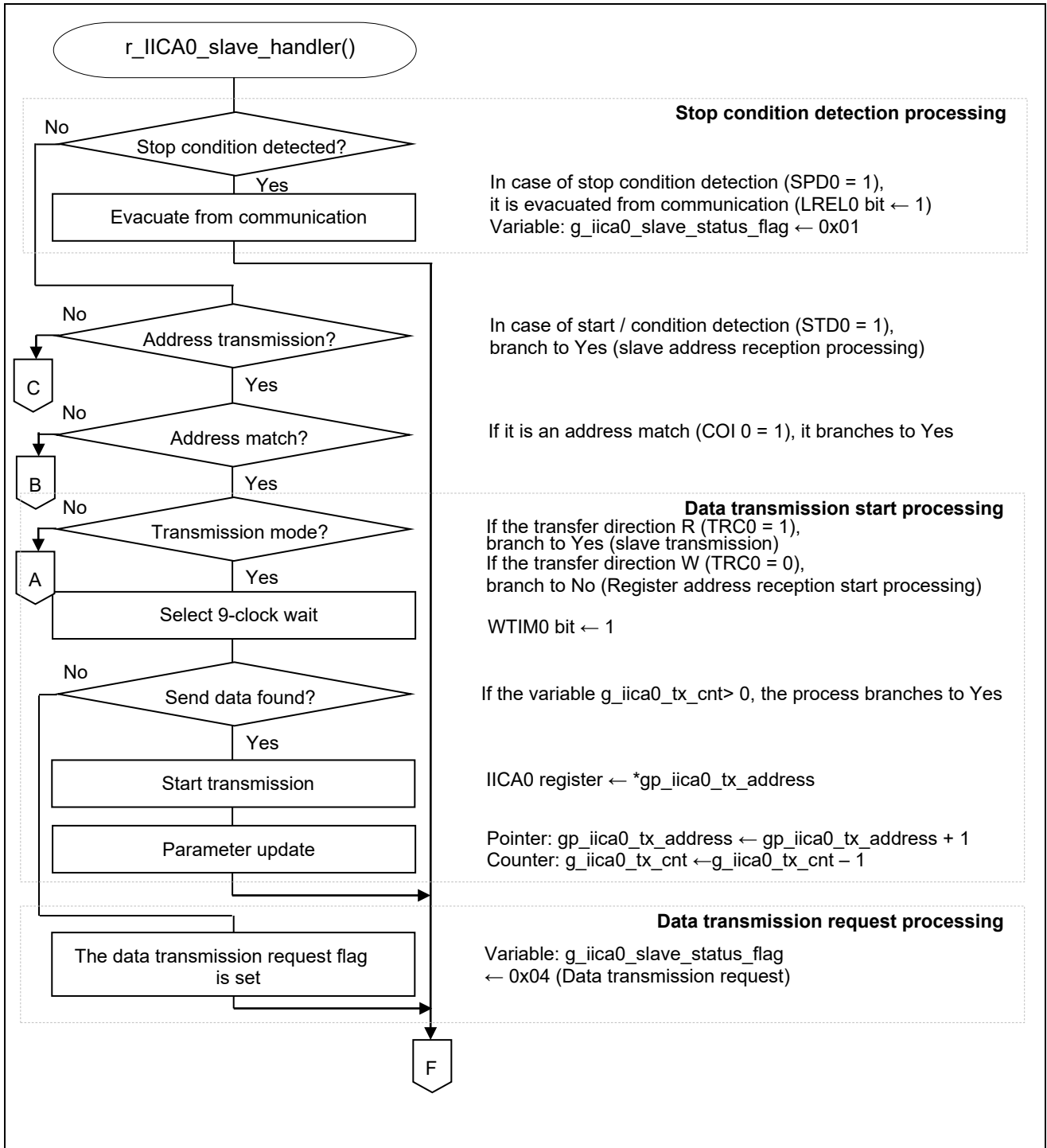


Figure 5.7 IICA0 Slave Handler (1/3)

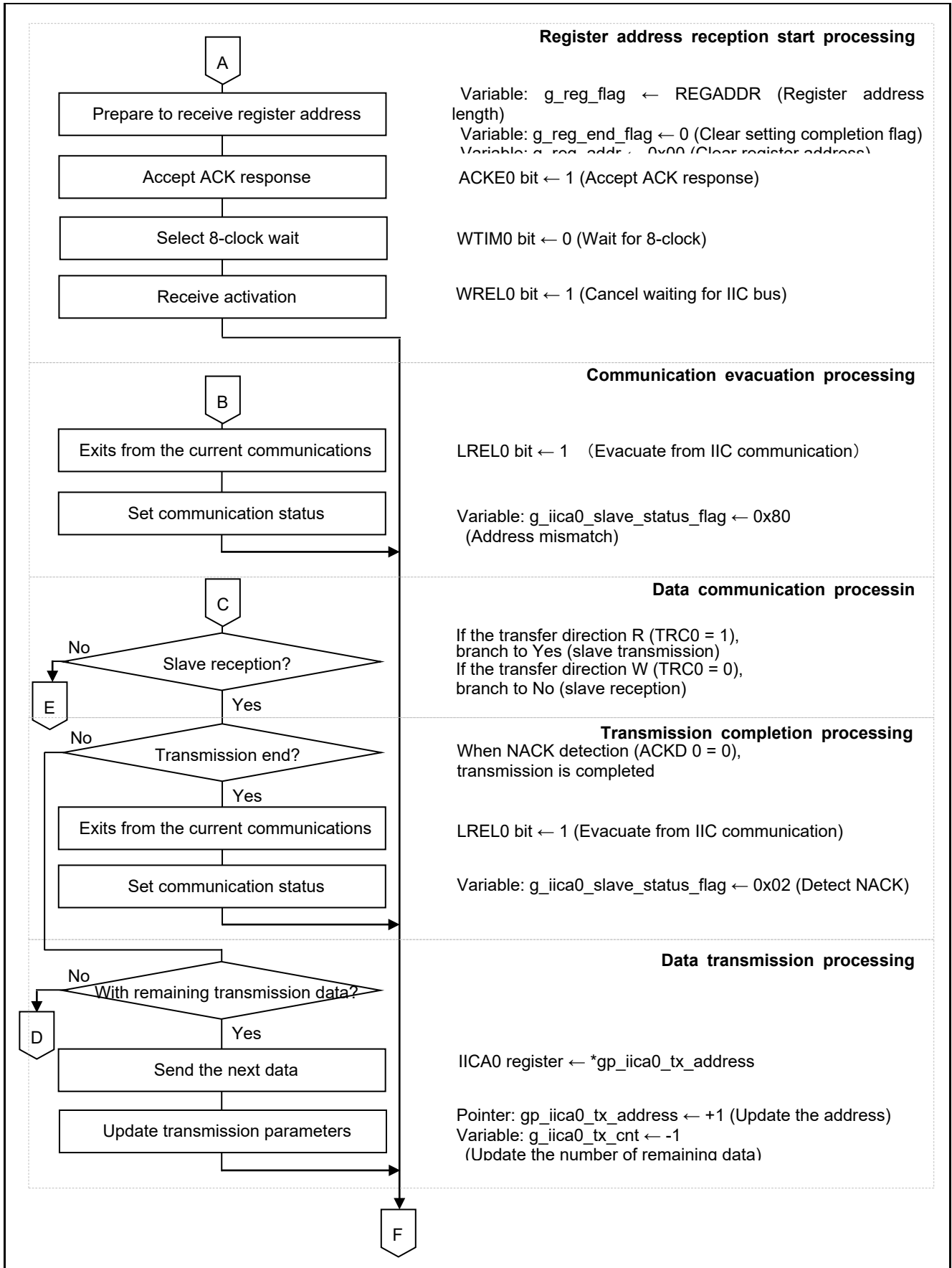


Figure 5.8 IICA0 Slave Handler (2/3)

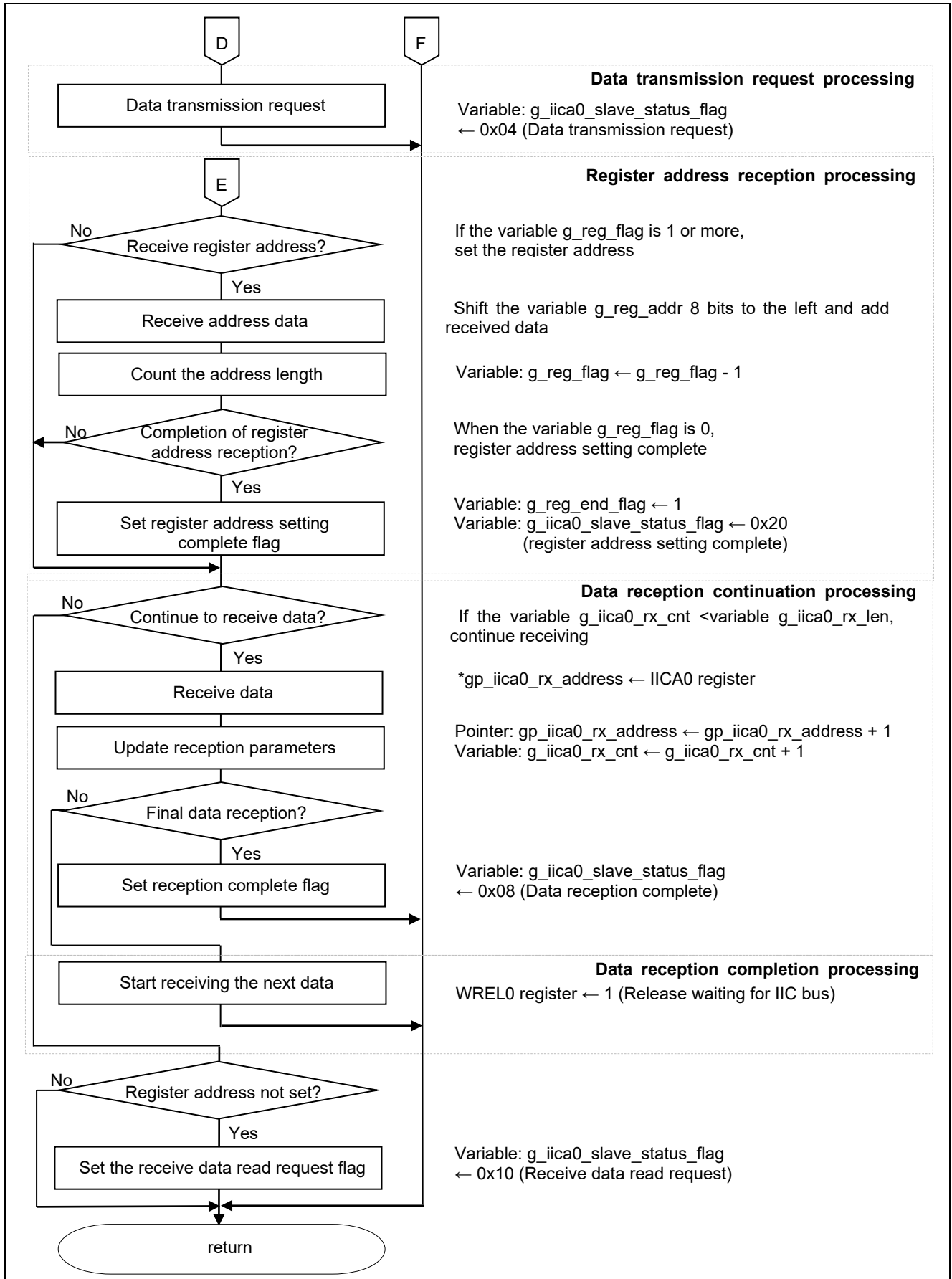


Figure 5.9 IICA0 Slave Handler (3/3)

6. Sample Code

The sample code is available on the Renesas Electronics Website.

7. Documents for Reference

User's Manual:

RL78/G16 User's Manual: Hardware (R01UH0959E)

RL78 Family User's Manual: Software (R01US0015E)

The latest version can be downloaded from the Renesas Electronics website.

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Revision History

| Rev. | Date | Description | |
|------|---------------|-------------|----------------------|
| | | Page | Summary |
| 1.00 | Oct. 20, 2023 | — | First edition issued |

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance 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 the 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.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

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