

RL78/G1D Module (RY7011)

User's Manual: Hardware

Renesas Bluetooth low energy Module

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NOTES FOR CMOS DEVICES

- (1) **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 VIL (MAX) and VIH (MIN) due to noise, etc., 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 VIL (MAX) and VIH (MIN).
- (2) **HANDLING OF UNUSED INPUT PINS:** Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.
- (3) **PRECAUTION AGAINST ESD:** A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that 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 should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.
- (4) **STATUS BEFORE INITIALIZATION:** Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.
- (5) **POWER ON/OFF SEQUENCE:** In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.
- (6) **INPUT OF SIGNAL DURING POWER OFF STATE :** Do not input signals or an I/O pull-up power supply while the device is not powered. 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. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

How to Use This Manual

Readers This manual is intended for user engineers who wish to understand the functions of the RY7011 and design and develop application systems and programs for this module.

Purpose This manual is intended to give users an understanding of the functions described in the **Organization** below.

Organization The manual for the RY7011 is this hardware manual. The RY7011 incorporates the RL78/G1D. The RL78/G1D manual is separated into two parts: the hardware edition and the software edition (common to the RL78 family).
Moreover, there is Bluetooth® Low Energy protocol stack user's manual for using RF transceiver function of the RY7011.

RY7011 User's Manual Hardware	RL78/G1D User's Manual Hardware	RL78 family User's Manual Software	Bluetooth® Low Energy protocol stack user's manual
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- | | | | |
|--|--|---|---|
| <ul style="list-style-type: none">• Pin functions• Internal block functions• Deferences from RL78/G1D• Electrical specifications• Examples of application circuits | <ul style="list-style-type: none">• Pin functions• Internal block functions• Interrupts• Other on-chip peripheral functions• Electrical specifications | <ul style="list-style-type: none">• CPU functions• Instruction set• Explanation of each instruction | <ul style="list-style-type: none">• Install• Construction• How to make execution file• Description of function |
|--|--|---|---|

RL78/G1D Module Firmware User's Manual

- Firmware Specification
- Connection with the Host MCU
- Simplified Bi-directional Communication
- Bluetooth Device Address

How to Read This Manual It is assumed that the readers of this manual have general knowledge of electrical engineering, logic circuits, and microcontrollers.

- To gain a general understanding of functions:
 - Read this manual in the order of the **CONTENTS**. The mark "<R>" shows major revised points. The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.
- To know details of the RL78/G1D Microcontroller instructions:
 - Refer to the separate document **RL78 Family Software User's Manual (R01US0015E)**.

Conventions Active low representations: $\overline{\text{xxx}}$ (overscore over pin and signal name)
Note: Footnote for item marked with **Note** in the text
Caution: Information requiring particular attention

Related Documents The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Documents Related to Devices

Document Name	Document No.
RY7011 User's Manual Hardware	This manual
RL78/G1D User's Manual Hardware	R01UH0515E
RL78 Family Software User's Manual	R01US0015E
RL78/G1D Module Firmware User's Manual	R01UW0160E

Documents Related to Flash Memory Programming

Document Name	Document No.
PG-FP5 Flash Memory Programmer User's Manual	—
RL78, 78K, V850, RX100, RX200, RX600 (Except RX64x), R8C, SH	R20UT2923E
Common	R20UT2922E
Setup Manual	R20UT0930E

Caution The related documents listed above are subject to change without notice. Be sure to use the latest version of each document when designing.

Other Documents

Document Name	Document No.
RENESAS MPUs & MCUs RL78 Family	R01CP0003E
Semiconductor Reliability Handbook	R51ZZ0001E

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Notes on using the RF

The use of wireless receivers and transmitters is restricted by international standards and domestic regulations. Wireless receivers and transmitters must therefore be used in accordance with the applicable laws and regulations of the country in which they are being used.

The following standards typically apply to the use of the 2.4 GHz band:

Japan: ARIB STD-T66

United States: FCC CFR47 Sections 15.247 and 15.249

Europe: EN300 440 and EN 300 328

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CHAPTER 1 OUTLINE

The RY7011 is a Bluetooth low energy module incorporating the RL78/G1D, a 32-MHz crystal resonator for the RF chip, and an antenna.

This module has obtained certificates of compliance with Japan's Radio Law, the FCC's module-related standards, IC regulation, CE mark requirements, and the Bluetooth v4.1 specification, so you can use it now.

1.1 Features

Ultra-low power consumption technology (3.0 V/MCU part: STOP mode)

- RF transmission: 4.3 mA (TYP.)
- RF reception: 3.5 mA (TYP.)
- RF sleep (POWER_DOWN mode): 0.3 μ A (TYP.)

On-chip RF transceiver

- Bluetooth v4.1 specification (low energy, single mode)
- 2.4 GHz ISM band, GFSK modulation, TDMA/TDD frequency hopping (including AES encryption circuit)
- Adaptability (only in slave operation)

Code flash memory

- 256 KB (block size: 1 KB)

Data flash memory

- Data flash memory: 8 KB

RAM

- 20 KB

Operating clock

- High-speed on-chip oscillator (selectable from among 32 MHz, 24 MHz, 16 MHz, 12 MHz, 8 MHz, 6 MHz, 4 MHz, 3 MHz, 2 MHz, and 1 MHz): For MCU operation
- Subsystem clock (32.768 kHz): For MCU operation and the RF slow clock
 - External clock input
 - External crystal resonator connection

Small pattern antenna mounted

Software written to the module as shipped

The module is shipped with software for verifying operation written to it. Verify the operation of the module before using it.

- The RL78/G1D module firmware has been written^{Note}.

Note See the RL78/G1D Module Firmware User's Manual.

Development environment

With regard to various information on settings of device files, parameter files, and so on which are used in software development of the MCU and writing of programs, use ones which support the R5F11AGJDNB^{Note}.

Note RL78/G1D product with 256 Kbytes of code flash memory for industrial applications

Certificates of compliance with radio-related laws

Japan: Type certification (authentication number: 007-AE0104)

North America: FCC (FCC ID: 2AEMXY7011A00000), IC (20194-Y7011A00000)

Europe: CE (R&TTE)

Bluetooth SIG certificate has been obtained.

QDID: 82194

Operating environment

- Voltage: 1.6 to 3.6 V^{Note}
- Temperature: -25 to +75°C

Note When the on-chip DC-DC converter is not in use (1.8 to 3.6 V when the on-chip DC-DC converter is in use)

Pin count

- 42 pins

Field of application (quality grade)

- For electronic equipment for general consumer applications) (standard)

1.2 Part Numbers

Figure 1 – 1 Part Numbers of RY7011

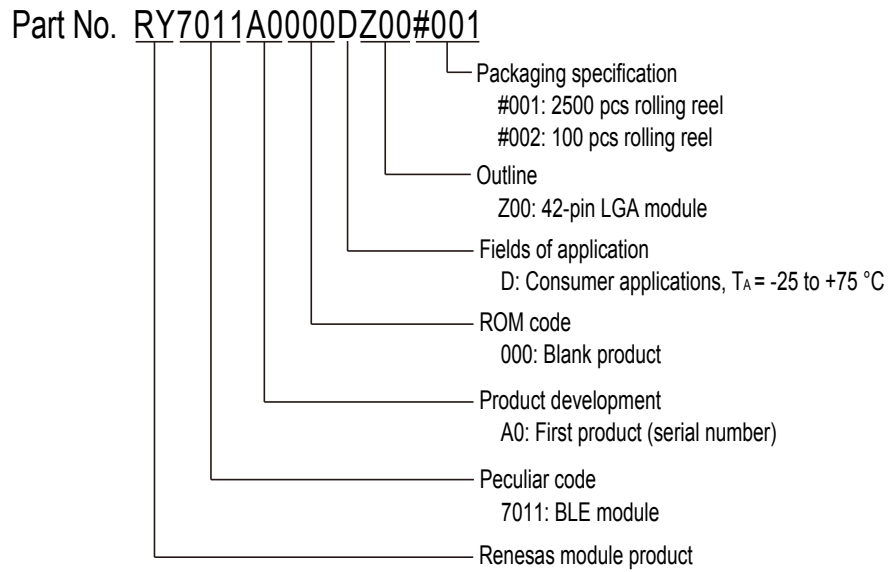


Table 1 – 1 List of Ordering Part Numbers

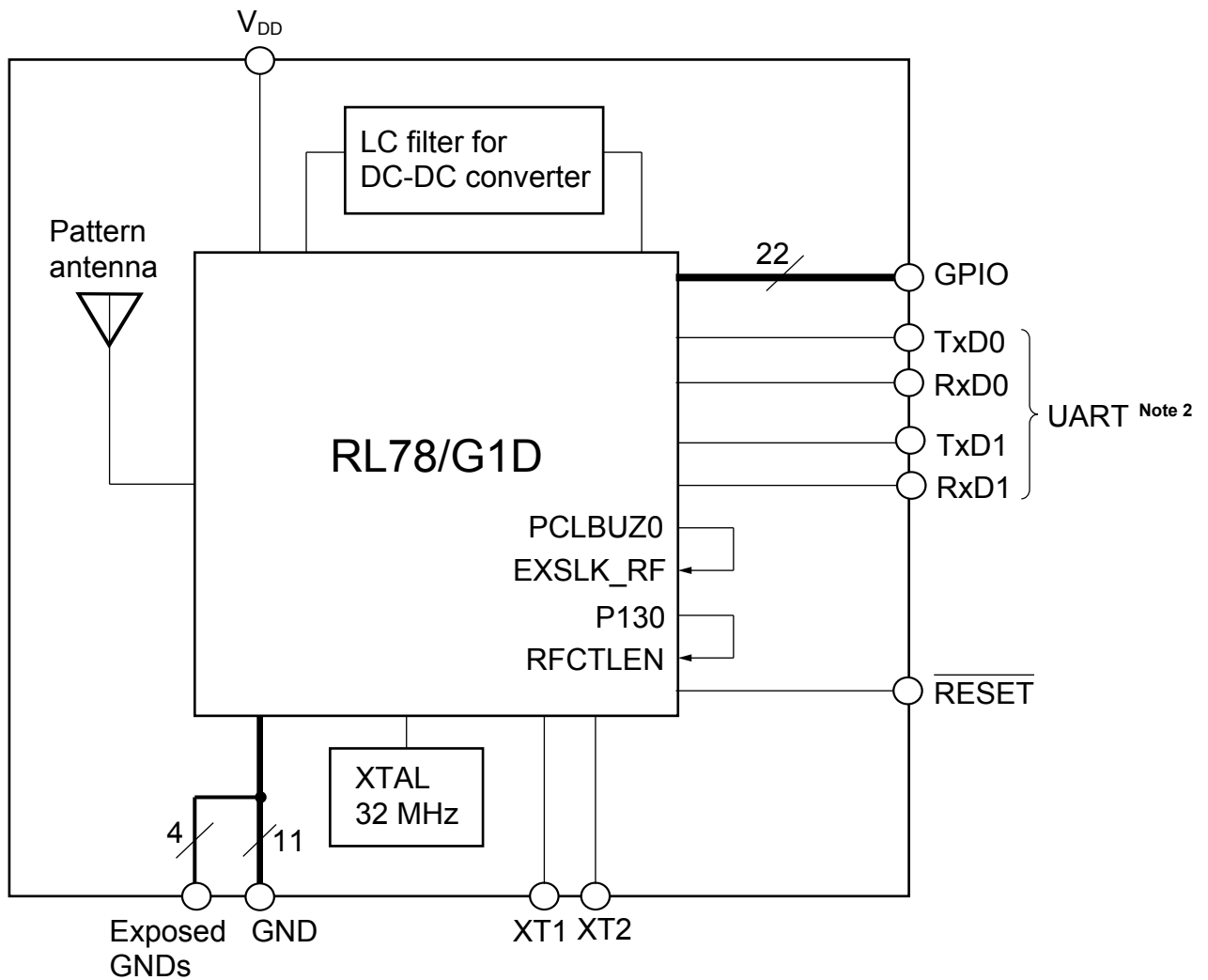
Pin count	Module	Fields of application	Part number	Code flash memory	Data flash memory	Packaging specification
42 pins	Metal cap type	Consumer applications	RY7011A0000DZ00#001	256 Kbytes	8 Kbytes	2500 pcs rolling reel
			RY7011A0000DZ00#002			100 pcs rolling reel

Caution These part numbers are identified at issuing of this manual. Latest part numbers are confirmed on the product page of Renesas Electronics’s web page.

1.4 Pin Identification

ANI0 to ANI3, ANI16 to ANI19:	Analog input
EXCLKS:	External clock input (subsystem clock)
INTP0, INTP3, INTP5:	External interrupt input
P00 to P03:	Port 0
P10 to P16:	Port 1
P20 to P23:	Port 2
P30:	Port 3
P40:	Port 4
P60, P61:	Port 6
P120, P123, P124:	Port 12
P137:	Port 13
P147:	Port 14
$\overline{\text{RESET}}$:	Reset
RTC1HZ:	Real-Time clock correction clock (1 Hz) output
RxD0, RxD1:	Receive data
SCLA0:	Serial clock input/output
SCK00, SCK20, SCL00, SCL20:	Serial clock output
SDAA0, SDA00, SDA20:	Serial data input/output
SI00, SI20:	Serial data input
SO00, SO20:	Serial data output
TI00 to TI07:	Timer input
TO00 to TO07:	Timer output
TOOL0:	Data input/output for tool
TOOLRxD, TOOLTxD:	Data input/output for external device
TxD0, TxD1:	Transmit data
V _{DD} :	Power supply
GND:	Ground
XT1, XT2:	Crystal oscillator (subsystem clock)

1.5 Block Diagram ^{Note 1}



- Notes**
- Software written to the module as shipped realizes simple transmission and reception of data in combination with the host MCU.
This software runs with a 32-kHz on-chip oscillator for the RF slow clock.
 - The UART is assumed to be connected to the host MCU.
The TxD1 and RxD1 (UART1) pins are not used in the software written to the module as shipped.

1.6 Outline of Functions

The following functions can be realized because of development of firmware. For details, see the RL78/G1D User's Manual: Hardware (R01UH0515E).

Code flash memory:	256 KB
Data flash memory:	8 KB
RAM:	20 KB
Address space:	1 MB

Main system clock (high-speed on-chip oscillator)

HS (high-speed main) mode:	1 to 32 MHz ($V_{DD} = 2.7$ to 3.6 V), 1 to 16 MHz ($V_{DD} = 2.4$ to 3.6 V)
LS (low-speed main) mode:	1 to 8 MHz ($V_{DD} = 1.8$ to 3.6 V)
LV (low-voltage main) mode:	1 to 4 MHz ($V_{DD} = 1.6$ to 3.6 V)

Subsystem clock: 32.768 kHz (RF slow clock)

XT1 (crystal) oscillation
External subsystem clock input (EXCLKS)

General-purpose register: (8-bit register × 8) × 4 banks

Number of I/O ports^{Note}

CMOS I/O:	21				
<table> <tr> <td>CMOS output:</td> <td>19</td> </tr> <tr> <td>N-ch open drain output (withstand voltage of 6 V):</td> <td>2</td> </tr> </table>	CMOS output:	19	N-ch open drain output (withstand voltage of 6 V):	2	
CMOS output:	19				
N-ch open drain output (withstand voltage of 6 V):	2				
CMOS input:	3				
Total:	24				

Note When the setting of PIOR0 is 1.

2.4 GHz RF transceiver

Supporting Bluetooth v4.1 specification (single mode)
2.4 GHz ISM band, GFSK modulation, TDMA/TDD frequency hopping (including AES encryption circuit)
Adaptability (only in slave operation)

Timer

16-bit timer:	8 channels
Watchdog timer:	1 channel
Real-time clock (RTC):	1 channel
12-bit interval timer:	1 channel
Timer output:	8 channels (PWM output: 7 ^{Note})
Real-time clock (RTC) output:	1 channel, 1 Hz (source: subsystem clock $f_{SUB} = 32.768$ kHz)

Note The number of PWM outputs varies depending on the setting of channels in use (the master channel and the number of slave channels).

8/10-bit resolution A/D converter: 8 channels

Serial interface

CSI/simplified I ² C/UART:	1 channel
CSI/simplified I ² C:	1 channel
UART:	1 channel
I ² C bus:	1 channel

Multiplier and divider/multiply-accumulator

Multiplication:	16 bits × 16 bits = 32 bits (unsigned or signed)
Division:	32 bits ÷ 32 bits = 32 bits (unsigned)
Multiply-accumulate:	16 bits × 16 bits + 32 bits = 32 bits (unsigned or signed)

DMA controller: 4 channels

Vectored interrupt sources

Internal:	29
External:	3

Reset source

- External reset
 - RESE \bar{T} signal input
- Internal reset
 - Watchdog timer
 - Power-on-reset
 - Voltage detector
 - Illegal instruction execution^{Note}
 - RAM parity error
 - Illegal-memory access

Note The illegal instruction is generated when instruction code FFH is executed.

A reset due to the illegal instruction execution is not issued in emulating with the on-chip debug emulator.

Power-on-reset circuit

Power-on-reset: 1.51 V (TYP.)

Power-down-reset: 1.50 V (TYP.)

Voltage detector

Rising edge: 1.67 to 3.13 V (12 stages)

Falling edge: 1.63 to 3.06 V (12 stages)

On-chip debug function: Provided

Power supply voltage: $V_{DD} = 1.6$ to 3.6 V ($V_{DD} = 1.8$ to 3.6 V on usage of the DC-DC converter)

Operating ambient temperature: $T_A = -25$ to $+75^\circ\text{C}$

1.7 Differences from RL78/G1D

The following shows the differences in function between this module and the RL78/G1D.

For functions of RL78/G1D, see RL78/G1D User's Manual Hardware (R01UH0515E).

1.7.1 I/O ports and pin functions

The port and pin functions listed below are not available.

GPIO0/TXSELH_RF

GPIO1/TXSELL_RF

GPIO2/CLKOUT_RF

GPIO3/EXSLK_RF

IC0

IC1

P121/X1

P122/X2/EXCLK

P130

RFCTLEN

P140/PCLBUZ0/INTP6

1.7.2 Clock

(1) Main system clock

Only the high-speed on-chip oscillator clock is available. This module does not support X1 (crystal/ceramic) oscillation and external main system clock input (EXCLK).

(2) Crystal oscillator for the RF chip

This module has a 32-MHz oscillator circuit and crystal resonator for the RF chip.

(3) On-chip local oscillator

The EXSLK_RF and PCLBUZ0 pins of the RL78/G1D are connected with each other. Accordingly a 32.768-kHz crystal resonator should be connected with the XT1 or XT2 pin, or a 32.768-kHz clock signal should be input on the EXCLKS pin.

For this module, the signal equivalent to PCLBUZ0 is input to the on-chip local oscillator (32.768 kHz).

CHAPTER 2 PIN FUNCTIONS

2.1 Pin Functions

The software written to the module as shipped selects the pin functions underlined in the table below.

(1/3)

Pin No.	Pin Name	Function
1	GND	Ground potential
2	P30/INTP3/RTC1HZ	<u>Port P30 input (enabled on-chip pull-up resistor)</u> External interrupt request input 3 Real-time clock correction clock (1 Hz) output
3	P16/TI01/TO01/INTP5	<u>Port P16 input (enabled on-chip pull-up resistor)</u> External count clock/capture trigger input to 16-bit timer 01 Timer output of 16-bit timer 01 External interrupt request input 5
4	P15/SCK20/SCL20(TI02)/(TO02)	<u>Port P15 input (enabled on-chip pull-up resistor)</u> Clock I/O of serial interface CSI20 Clock output of serial interface IIC20 External count clock/capture trigger input to 16-bit timer 02 Timer output of 16-bit timer 02
5	P14/SI20/SDA20/(SCLA0)/(TI03)/(TO03)	<u>Port P14 input (enabled on-chip pull-up resistor)</u> Serial data input of serial interface CSI20 Serial data I/O of serial interface IIC20 Clock I/O of serial interface IICA0 External count clock/capture trigger input to 16-bit timer 03 Timer output of 16-bit timer 03
6	P13/SO20/(SDAA0)/(TI04)/(TO04)	<u>Port P13 input (enabled on-chip pull-up resistor)</u> Serial data output of serial interface CSI20 Serial data I/O of serial interface IICA0 External count clock/capture trigger input to 16-bit timer 04 Timer output of 16-bit timer 04
7	P12/SO00/TxD0/TOOLTxD/(TI05)/(TO05)	Port P12 Serial data output of serial interface CSI00 <u>Serial data output of serial interface UART0</u> UART serial transmission for external device connection used during flash memory programming External count clock/capture trigger input to 16-bit timer 05 Timer output of 16-bit timer 05
8	P11/SI00/RxD0/TOOLRxD/SDA00/(TI06)/(TO06)	Port P11 Serial data input of serial interface CSI00 <u>Serial data input of serial interface UART0</u> UART serial data reception for external device connection used during flash memory programming Serial data I/O of serial interface IIC00 External count clock/capture trigger input to 16-bit timer 06 Timer output of 16-bit timer 06

(2/3)

Pin No.	Pin Name	Function
9	P10/SCK00/SCL00/(TI07)/(TO07)	<p><u>Port P10 input (enabled on-chip pull-up resistor)</u></p> <p>Clock I/O of serial interface CSI00</p> <p>Clock output of serial interface IIC00</p> <p>External count clock/capture trigger input to 16-bit timer 07</p> <p>Timer output of 16-bit timer 07</p>
10	V _{DD}	Positive power supply
11	GND	Ground potential
12	P147/ANI18	<p><u>Port P147 input (enabled on-chip pull-up resistor)</u></p> <p>A/D converter analog input 18</p> <p>Do not pull down this pin while the software written to the module as shipped is in use. Otherwise, the software will not run properly.</p>
13	P23/ANI3	<p><u>Port P23 output</u></p> <p>A/D converter analog input 3</p>
14	P22/ANI2	<p><u>Port P22 output</u></p> <p>A/D converter analog input 2</p>
15	P21/ANI1/AVREFM	<p><u>Port P21 output</u></p> <p>A/D converter analog input 1</p> <p>A/D converter reference potential (- side) input</p>
16	P20/ANI0/AVREFP	<p><u>Port P20 output</u></p> <p>A/D converter analog input 0</p> <p>A/D converter reference potential (+ side) input</p>
17	P03/ANI16/RxD1	<p><u>Port P03 output</u></p> <p>A/D converter analog input 16</p> <p>Serial data input of serial interface UART1</p>
18	P02/ANI17/TxD1	<p><u>Port P02 (enabled on-chip pull-up resistor)</u></p> <p>A/D converter analog input 17</p> <p>Serial data output of serial interface UART1</p>
19	P01/TO00	<p><u>Port P01 input (enabled on-chip pull-up resistor)</u></p> <p>Timer output of 16-bit timer 00</p>
20	GND	Ground potential
21	P00/TI00	<p><u>Port P00 input (enabled on-chip pull-up resistor)</u></p> <p>External count clock/capture trigger input to 16-bit timer 00</p>
22	P120/ANI19	<p><u>Port P120 output</u></p> <p>A/D converter analog input 19</p>
23	P40/TOOL0	<p><u>Port P40 input</u></p> <p>Data I/O for flash memory programmer/debugger</p> <p>In the flash memory programming mode, connect this pin to V_{DD} via a 1-kΩ resistor, and to the dedicated flash memory programmer.</p> <p>For notes when this pin is used as a port pin in normal operation mode, see the RL78/G1D User's Manual: Hardware (R01UH0515E).</p>
24	RESET	<p>This is the active-low system reset input pin.</p> <p>When the external reset pin is not used, connect this pin directly or via a resistor to V_{DD}. For details, see the RL78/G1D User's Manual: Hardware (R01UH0515E).</p>

(3/3)

Pin No.	Pin Name	Function
25	P137/INTP0	<u>Port P137 input</u> External interrupt request input 0
26	P124/XT2/EXCLKS	<u>Port P124 input</u> Resonator connection for subsystem clock External clock input for subsystem clock
27	P123/XT1	<u>Port P123 input</u> Resonator connection for subsystem clock
28	P60/SCLA0	<u>Port P60 input</u> Clock I/O of serial interface IICA0
29	P61/SDAA0	<u>Port P61 input</u> Serial data I/O of serial interface IICA0
30	GND	Ground potential
31	IC	Not used (internal circuit connection): Leave open
32 to 42	GND	Ground potential

2.2 Connection of Unused Pins

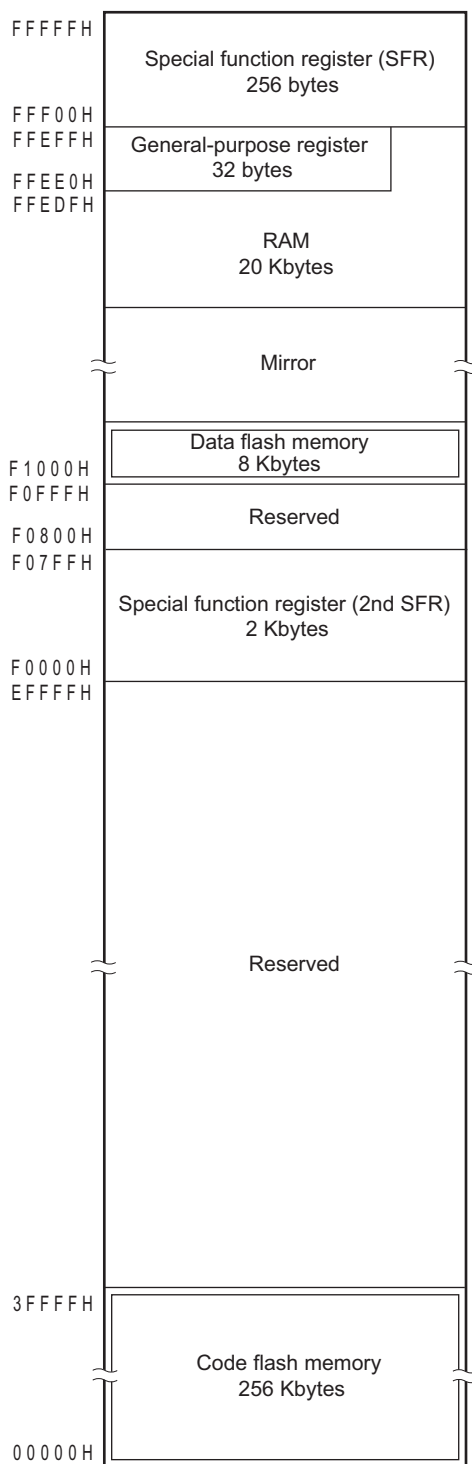
Table 2 – 1 shows the connections of unused pins.

Table 2 – 1 Connection of Unused Pins

Pin Name	I/O	Recommended Connection of Unused Pins
P00/TI00	I/O	Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P01/TO00		
P02/ANI17/TxD1		
P03/ANI16/RxD1		
P10/SCK00/SCL00/(TI07)/(TO07)		Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P11/SI00/RxD0/TOOLRxD/ SDA00/(TI06)/(TO06)		
P12/SO00/TxD0/TOOLTxD/(TI05)/(TO05)		
P13/SO20/(SDAA0)/(TI04)/(TO04)		
P14/SI20/SDA20/(SCLA0)/(TI03)/(TO03)		
P15/SCK20/SCL20/(TI02)/(TO02)		
P16/TI01/INTP5		Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P20/ANI0/AV _{REFP}		Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P21/ANI1/AV _{REFM}		
P22/ANI2		Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P23/ANI3		
P30/INTP3	Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.	
P40/TOOL0	Input: Independently connect to V _{DD} or leave open. Output: Leave open.	
P60/SCLA0	Input: Independently connect to V _{DD} or GND via a resistor. Output: Set the port's output latch to 0 and leave the pins open, or set the port's output latch to 1 and independently connect the pins to V _{DD} or GND via a resistor.	
P61/SDAA0		
P120/ANI19	I/O	Input: Independently connect to V _{DD} or GND via a resistor. Output: Leave open.
P123/XT1	Input	Independently connect to V _{DD} or GND via a resistor.
P124/XT2/EXCLKS		
P137/INTP0	Input	Independently connect to V _{DD} or GND via a resistor.
P147/ANI18	I/O	Input: Independently connect to V _{DD} via a resistor. Output: Leave open.
$\overline{\text{RESET}}$	Input	Connect directly or via a resistor to V _{DD} .
IC	—	Unused (connected internally): Leave open.

CHAPTER 3 FLASH MEMORY

The RL78 microcontroller incorporates the flash memory to which a program can be written, erased, and rewritten. The flash memory includes the “code flash memory”, in which programs can be executed, and the “data flash memory”, an area for storing data.



The following methods for programming the flash memory are available.

The code flash memory can be rewritten to through serial programming using a flash memory programmer or an external device (UART communication), or through self-programming.

- Serial programming using flash memory programmer (see 3.4)

Data can be written to the flash memory on-board or off-board by using a dedicated flash memory programmer.

- Serial programming using external device (UART communication) (see 3.2)

Data can be written to the flash memory on-board through UART communication with an external device (microcontroller or ASIC).

- Self-programming (see 3.6)

The user application can execute self-programming of the code flash memory by using the flash self-programming library.

The data flash memory can be rewritten to by using the data flash library during user program execution (background operation). For access and writing to the data flash memory, see 3.8 **Data Flash**.

3.1 Serial Programming Using Flash Memory Programmer

The following dedicated flash memory programmer can be used to write data to the internal flash memory of the RL78 microcontroller.

- PG-FP5, FL-PR5
- E1 on-chip debugging emulator

Data can be written to the flash memory on-board or off-board, by using a dedicated flash memory programmer.

(1) On-board programming

The contents of the flash memory can be rewritten after the RL78 microcontroller has been mounted on the target system. The connectors that connect the dedicated flash memory programmer must be mounted on the target system.

(2) Off-board programming

Data can be written to the flash memory before the RL78 microcontroller is mounted on the target system.

Remark FL-PR5 is produced by Naito Densai Machida Mfg. Co., Ltd.

Table 3 – 1 Wiring Between RL78/G1D Module and Dedicated Flash Memory Programmer

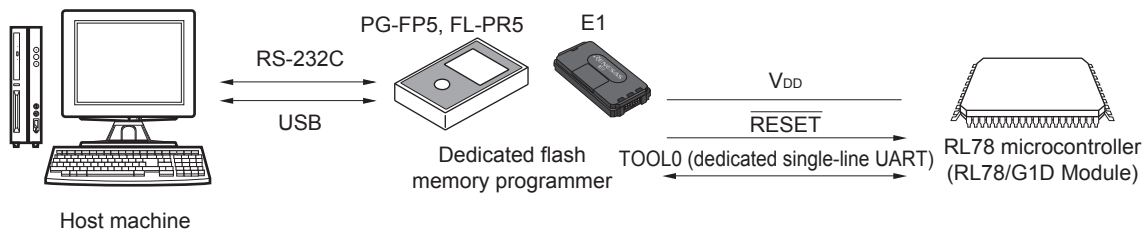
Pin Configuration of Dedicated Flash Memory Programmer				Pin Name	Pin No.
Signal Name		I/O	Pin Function		
PG-FP5, FL-PR5	E1 on-chip debugging emulator				
—	TOOL0	I/O	Transmit/receive signal	TOOL0/ P40	23
SI/RxD	—	I/O	Transmit/receive signal		
—	$\overline{\text{RESET}}$	Output	Reset signal	$\overline{\text{RESET}}$	24
/RESET	—	Output			
V _{DD}		I/O	V _{DD} voltage generation/ power monitoring	V _{DD}	10
GND		—	Ground	GND	11, 20, 30, 32-42
FLMD1	EMV _{DD}	—	Driving power for TOOL0 pin	V _{DD}	10

Remark Pins that are not indicated in the above table can be left open when using the flash memory programmer for flash programming.

3.1.1 Programming environment

The environment required for writing a program to the flash memory of the RL78 microcontroller incorporated in RL78/G1D Module is illustrated below.

Figure 3 – 1 Environment for Writing Program to Flash Memory



A host machine that controls the dedicated flash memory programmer is necessary.

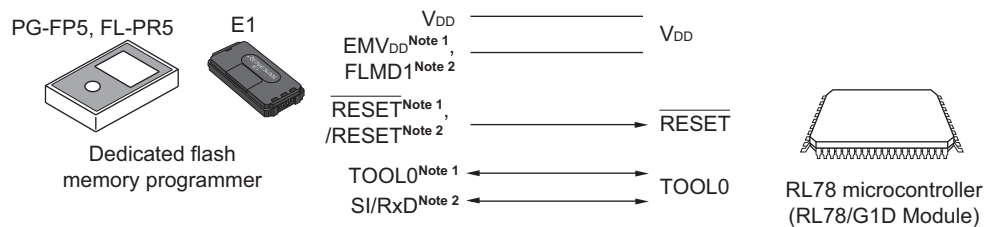
To interface between the dedicated flash memory programmer and the RL78 microcontroller, the TOOL0 pin is used for manipulation such as writing and erasing via a dedicated single-line UART.

3.1.2 Communication mode

Communication between the dedicated flash memory programmer and the RL78 microcontroller is established by serial communication using the TOOL0 pin via a dedicated single-line UART of the RL78 microcontroller.

Transfer rate: 1 M, 500 k, 250 k, 115.2 kbps

Figure 3 – 2 Communication with Dedicated Flash Memory Programmer



- Notes**
1. When using E1 on-chip debugging emulator.
 2. When using PG-FP5 or FL-PR5.

The dedicated flash memory programmer generates the following signals for the RL78 microcontroller. See each manual of PG-FP5, FL-PR5, or E1 on-chip debugging emulator for details.

Table 3 – 2 Pin Connections

Dedicated Flash Memory Programmer			RL78 Microcontroller	
Signal Name		I/O	Pin Function	Pin Name
PG-FP5, FL-PR5	E1 on-chip debugging emulator			
V _{DD}		I/O	V _{DD} voltage generation/power monitoring	V _{DD}
GND		—	Ground	GND
FLMD1	EMV _{DD}	—	Driving power for TOOL0 pin	V _{DD}
/RESET	—	Output	Reset signal	RESET
—	RESET	Output		
—	TOOL0	I/O	Transmit/receive signal	TOOL0
SI/RxD	—	I/O	Transmit/receive signal	

3.2 Serial Programming Using External Device (that Incorporates UART)

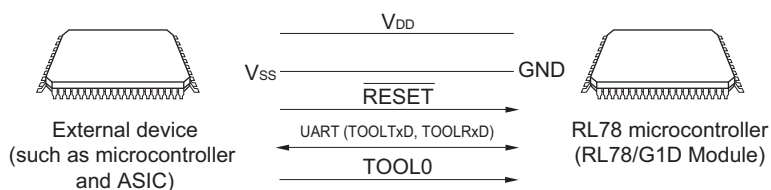
On-board data writing to the internal flash memory is possible by using the RL78 microcontroller and an external device (a microcontroller or ASIC) connected to a UART.

On the development of flash memory programmer by user, refer to the **RL78 Microcontrollers (RL78 Protocol A) Programmer Edition Application Note (R01AN0815)**.

3.2.1 Programming environment

The environment required for writing a program to the flash memory of the RL78 microcontroller is illustrated below.

Figure 3 – 3 Environment for Writing Program to Flash Memory



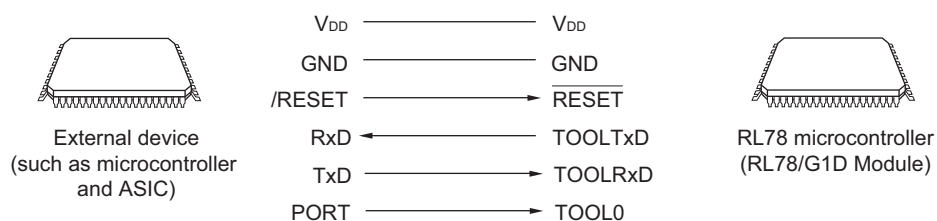
Processing to write data to or erase data from the RL78 microcontroller by using an external device is performed on-board. Off-board writing is not possible.

3.2.2 Communication mode

Communication between the external device and the RL78 microcontroller is established by serial communication using the TOOLTxD and TOOLRxD pins via the dedicated UART of the RL78 microcontroller.

Transfer rate: 1 M, 500 k, 250 k, 115.2 kbps

Figure 3 – 4. Communication with External Device



The external device generates the following signals for the RL78 microcontroller.

Table 3 – 3. Pin Connections

External Device			RL78 Microcontroller
Signal Name	I/O	Pin Function	Pin Name
V _{DD}	I/O	V _{DD} voltage generation/power monitoring	V _{DD}
GND	—	Ground	GND
RESETOUT	Output	Reset signal output	RESET
RxD	Input	Receive signal	TOOLTxD
TxD	Output	Transmit signal	TOOLRxD
PORT	Output	Mode signal	TOOL0

3.3 Connection of Pins on Board

To write the flash memory on-board by using the flash memory programmer, connectors that connect the dedicated flash memory programmer must be provided on the target system. First provide a function that selects the normal operation mode or flash memory programming mode on the board.

When the flash memory programming mode is set, all the pins not used for programming the flash memory are in the same status as immediately after reset. Therefore, if the external device does not recognize the state immediately after reset, the pins must be handled as described below.

Remark For the flash memory programming mode, see 3.4.2 **Flash memory programming mode**.

3.3.1 P40/TOOL0 pin

In the flash memory programming mode, connect this pin to the dedicated flash memory programmer via an external 1 k Ω pull-up resistor.

When this pin is used as the port pin, use that by the following method.

When used as an input pin: Input of low-level is prohibited for t_{HD} period after external pin reset release. However, when this pin is used via pull-down resistors, use the 500 k Ω or more resistors.

When used as an output pin: When this pin is used via pull-down resistors, use the 500 k Ω or more resistors.

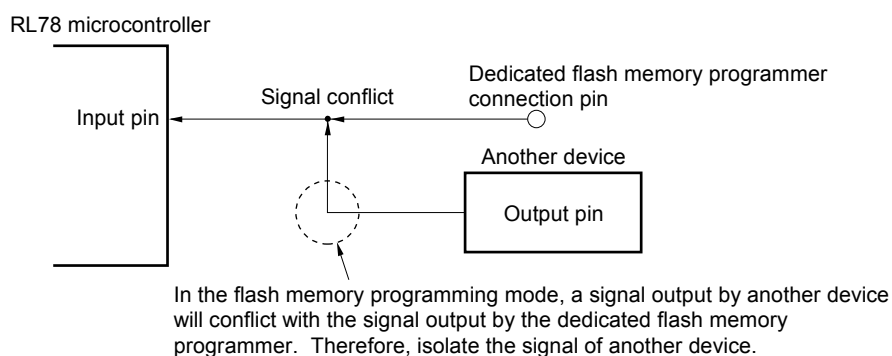
- Remarks**
1. t_{HD} : How long to keep the TOOL0 pin at the low level from when the external and internal resets end for setting of the flash memory programming mode (see 30.13 **Timing of Entry to Flash Memory Programming Modes** of the RL78/G1D User's Manual: Hardware)
 2. The SAU and IICA pins are not used for communication between the RL78 microcontroller and dedicated flash memory programmer, because single-line UART (TOOL0 pin) is used.

3.3.2 $\overline{\text{RESET}}$ pin

Signal conflict will occur if the reset signal of the dedicated flash memory programmer and external device are connected to the $\overline{\text{RESET}}$ pin that is connected to the reset signal generator on the board. To prevent this conflict, isolate the connection with the reset signal generator.

The flash memory will not be correctly programmed if the reset signal is input from the user system while the flash memory programming mode is set. Do not input any signal other than the reset signal of the dedicated flash memory programmer and external device.

Figure 3 – 5 Signal Conflict ($\overline{\text{RESET}}$ Pin)



3.3.3 Port pins

When the flash memory programming mode is set, all the pins not used for flash memory programming enter the same status as that immediately after reset. If external devices connected to the ports do not recognize the port status immediately after reset, the port pin must be connected to V_{DD} or to GND via a resistor.

3.3.4 Power supply

To use the supply voltage output of the flash memory programmer, connect the V_{DD} pin to V_{DD} of the flash memory programmer, and the GND pin to GND of the flash memory programmer.

To use the on-board supply voltage, connect in compliance with the normal operation mode.

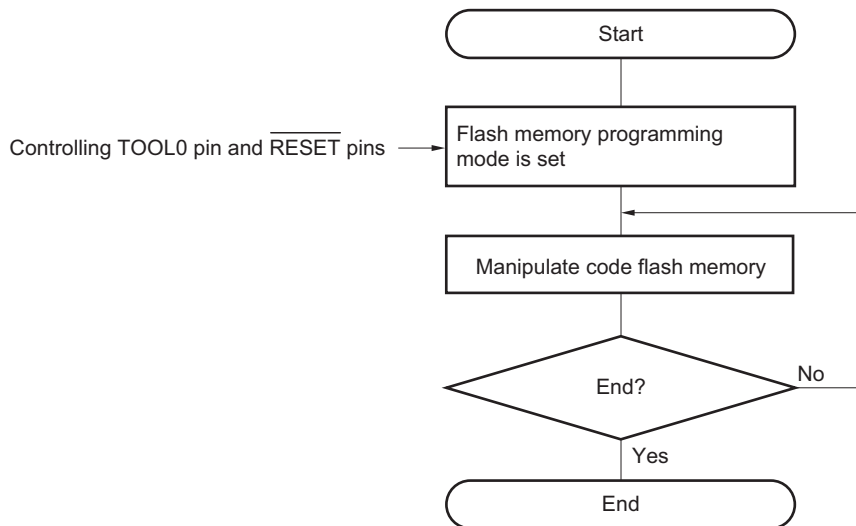
However, when writing to the flash memory by using the flash memory programmer and using the on-board supply voltage, be sure to connect the V_{DD} and GND pins to V_{DD} and GND of the flash memory programmer to use the power monitor function with the flash memory programmer.

3.4 Serial Programming Method

3.4.1 Serial programming procedure

The following figure illustrates a flow for rewriting the code flash memory through serial programming.

Figure 3 – 6 Code Flash Memory Manipulation Procedure



3.4.2 Flash memory programming mode

To rewrite the contents of the code flash memory through serial programming, set the RL78 microcontroller to the flash memory programming mode. To enter the mode, set as follows.

<Serial programming using the dedicated flash memory programmer>

Connect the RL78 microcontroller to a dedicated flash memory programmer. Communication from the dedicated flash memory programmer is performed to automatically switch to the flash memory programming mode.

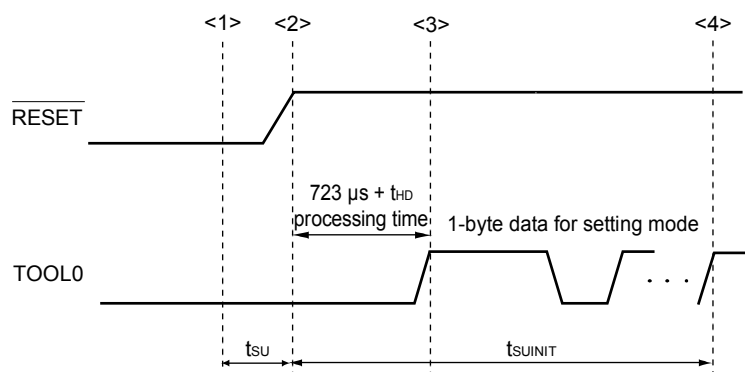
<Serial programming using an external device (UART communication)>

Set the TOOL0 pin to the low level, and then cancel the reset (see **Table 3 – 4**). After that, enter flash memory programming mode according to the procedures <1> to <4> shown in **Figure 3 – 7**. For details, refer to the **RL78 Microcontrollers (RL78 Protocol A) Programmer Edition Application Note (R01AN0815)**.

Table 3 – 4 Relationship between TOOL0 Pin and Operation Mode after Reset Release

TOOL0	Operation Mode
V _{DD}	Normal operation mode
0 V	Flash memory programming mode

Figure 3 – 7 Setting of Flash Memory Programming Mode



- <1> The low level is input to the TOOL0 pin.
- <2> The external reset ends (POR and LVD reset must end before the external reset ends.).
- <3> The TOOL0 pin is set to the high level.
- <4> Baud rate setting by UART reception is completed.

Remark *tsuINIT*: The segment shows that it is necessary to finish specifying the initial communication settings within 100 ms from when the resets end.

tsu: How long from when the TOOL0 pin is placed at the low level until an external reset ends

t_{HD}: How long to keep the TOOL0 pin at the low level from when the external and internal resets end (the flash firmware processing time is excluded)

For details, see **30.13 Timing of Entry to Flash Memory Programming Modes** of the RL78/G1D User's Manual: Hardware.

There are two flash memory programming modes: wide voltage mode and full speed mode. The supply voltage value applied to the microcontroller during write operations and the setting information of the user option byte for setting of the flash memory programming mode determine which mode is selected.

When a dedicated flash memory programmer is used for serial programming, setting the voltage on GUI selects the mode automatically.

Table 3 – 5 Programming Modes and Voltages at Which Data Can Be Written, Erased, or Verified

Power Supply Voltage (V_{DD})	User Option Byte Setting for Switching to Flash Memory Programming Mode		Flash Programming Mode
	Flash Operation Mode	Operating Frequency	
$2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$	Blank state		Full speed mode
	HS (high speed main) mode	1 MHz to 32 MHz	Full speed mode
	LS (low speed main) mode	1 MHz to 8 MHz	Wide voltage mode
	LV (low voltage main) mode	1 MHz to 4 MHz	Wide voltage mode
$2.4\text{ V} \leq V_{DD} < 2.7\text{ V}$	Blank state		Full speed mode
	HS (high speed main) mode	1 MHz to 16 MHz	Full speed mode
	LS (low speed main) mode	1 MHz to 8 MHz	Wide voltage mode
	LV (low voltage main) mode	1 MHz to 4 MHz	Wide voltage mode
$1.8\text{ V} \leq V_{DD} < 2.4\text{ V}$	Blank state		Wide voltage mode
	LS (low speed main) mode	1 MHz to 8 MHz	Wide voltage mode
	LV (low voltage main) mode	1 MHz to 4 MHz	Wide voltage mode

- Remarks 1.** Using both the wide voltage mode and full speed mode imposes no restrictions on writing, erasing, or verification.
- 2.** For details about communication commands, see **3.4.4 Communication commands**.

3.4.3 Selecting communication mode

Communication modes of the RL78 microcontroller are as follows.

Table 3 – 6 Communication Modes

Communication Mode	Standard Setting ^{Note 1}				Pins Used
	Port	Speed ^{Note 2}	Frequency	Multiply Rate	
1-line UART (when flash memory programmer is used, or when external device is used)	UART	115200 bps, 250000 bps, 500000 bps, 1 Mbps	—	—	TOOL0
Dedicated UART (when external device is used)	UART	115200 bps, 250000 bps, 500000 bps, 1 Mbps	—	—	TOOLTxD, TOOLRxD

- Notes**
1. Selection items for Standard settings on GUI of the flash memory programmer.
 2. Because factors other than the baud rate error, such as the signal waveform slew, also affect UART communication, thoroughly evaluate the slew as well as the baud rate error.

3.4.4 Communication commands

The RL78 microcontroller executes serial programming through the commands listed in **Table 3 – 7**.

The signals sent from the dedicated flash memory programmer or external device to the RL78 microcontroller are called commands, and programming functions corresponding to the commands are executed. For details, refer to the **RL78 Microcontrollers (RL78 Protocol A) Programmer Edition Application Note (R01AN0815)**.

Table 3 – 7 Flash Memory Control Commands

Classification	Command Name	Function
Verify	Verify	Compares the contents of a specified area of the flash memory with data transmitted from the programmer.
Erase	Block Erase	Erases a specified area in the flash memory.
Blank check	Block Blank Check	Checks if a specified block in the flash memory has been correctly erased.
Write	Programming	Writes data to a specified area in the flash memory ^{Note} .
Getting information	Silicon Signature	Gets the RL78 microcontroller information (such as the part number, flash memory configuration, and programming firmware version).
	Checksum	Gets the checksum data for a specified area.
	Security Get	Gets security information.
	Security Release	Release setting of prohibition of writing.
Others	Reset	Used to detect synchronization status of communication.
	Baud Rate Set	Sets baud rate when UART communication mode is selected.

Note Confirm that no data has been written to the write area. Because data cannot be erased after block erase is prohibited, do not write data if the data has not been erased.

Product information (such as product name and firmware version) can be obtained by executing the “Silicon Signature” command.

Table 3 – 8 is a list of signature data and **Table 3 – 9** shows an example of signature data.

Table 3 – 8 Signature Data List

Field Name	Description	Number of Transmit Data
Device code	The serial number assigned to the device	3 bytes
Device name	Device name (ASCII code)	10 bytes
Code flash memory area last address	Last address of code flash memory area (Sent from lower address. Example: 00000H to 3FFFFH (256 KB) → FFH, FFH, 03H)	3 bytes
Data flash memory area last address	Last address of data flash memory area (Sent from lower address. Example: F1000H to F2FFFH (8 KB) → FFH, 2FH, 0FH)	3 bytes
Firmware version	Version information of firmware for programming (Sent from upper address. Example: From Ver. 1.23 → 01H, 02H, 03H)	3 bytes

Table 3 – 9 Example of Signature Data

Field Name	Description	Number of Transmit Data	Data (Hexadecimal)
Device code	RL78 protocol A	3 bytes	10 00 06
Device name	R5F11AGJ	10 bytes	52 = “R” 35 = “5” 46 = “F” 31 = “1” 31 = “1” 41 = “A” 47 = “G” 4A = “J” 20 = “ ” 20 = “ ”
Code flash memory area last address	Code flash memory area 00000H to 3FFFFH (256 Kbytes)	3 bytes	FF FF 03
Data flash memory area last address	Data flash memory area F1000H to F2FFFH (8 Kbytes)	3 bytes	FF 2F 0F
Firmware version	Ver.1.23	3 bytes	01 02 03

3.5 Processing Time for Each Command When PG-FP5 Is in Use (Reference Value)

The following shows the processing time for each command (reference value) when PG-FP5 is used as a dedicated flash memory programmer.

Table 3 – 10 Processing Time for Each Command When PG-FP5 Is in Use (Reference Value)

PG-FP5 Command	256 Kbytes Code Flash
Erasing	2.5 s
Writing	6 s
Verification	5.5 s
Writing after erasing	8 s

Remark The command processing times (reference values) shown in the table are typical values under the following conditions.

Port: TOOL0 (single-line UART)

Speed: 1,000,000 bps

Mode: Full speed mode (flash operation mode: HS (high speed main) mode)

3.6 Self-Programming

The RL78 microcontroller supports a self-programming function that can be used to rewrite the code flash memory via a user program. Because this function allows a user application to rewrite the code flash memory by using the flash self-programming library, it can be used to upgrade the program in the field.

- Cautions**
1. The self-programming function cannot be used when the CPU operates with the subsystem clock.
 2. To prohibit an interrupt during self-programming, in the same way as in the normal operation mode, execute the self-programming library in the state where the IE flag is cleared (0) by the DI instruction. To enable an interrupt, clear (0) the interrupt mask flag to accept in the state where the IE flag is set (1) by the EI instruction, and then execute the self-programming library.
 3. The high-speed on-chip oscillator should be kept operating during self-programming. If it is kept stopping, the high-speed on-chip oscillator clock should be operated (HIOSTOP = 0). The self-programming library should be executed after 30 μ s have elapsed.

- Remarks**
1. For details of the self-programming function, refer to **RL78 Microcontroller Flash Self Programming Library Type01 User's Manual (R01AN0350)**.
 2. For details of the time required to execute self-programming, see the notes on use that accompany the flash self-programming library tool.

The self-programming function has two flash memory programming modes; wide voltage mode and full speed mode.

Specify the mode that corresponds to the flash operation mode specified in bits CMODE1 and CMODE0 in option byte 000C2H.

Specify the full speed mode when the HS (high speed main) mode is specified. Specify the wide voltage mode when the LS (low speed main) mode or LV (low voltage main) mode is specified.

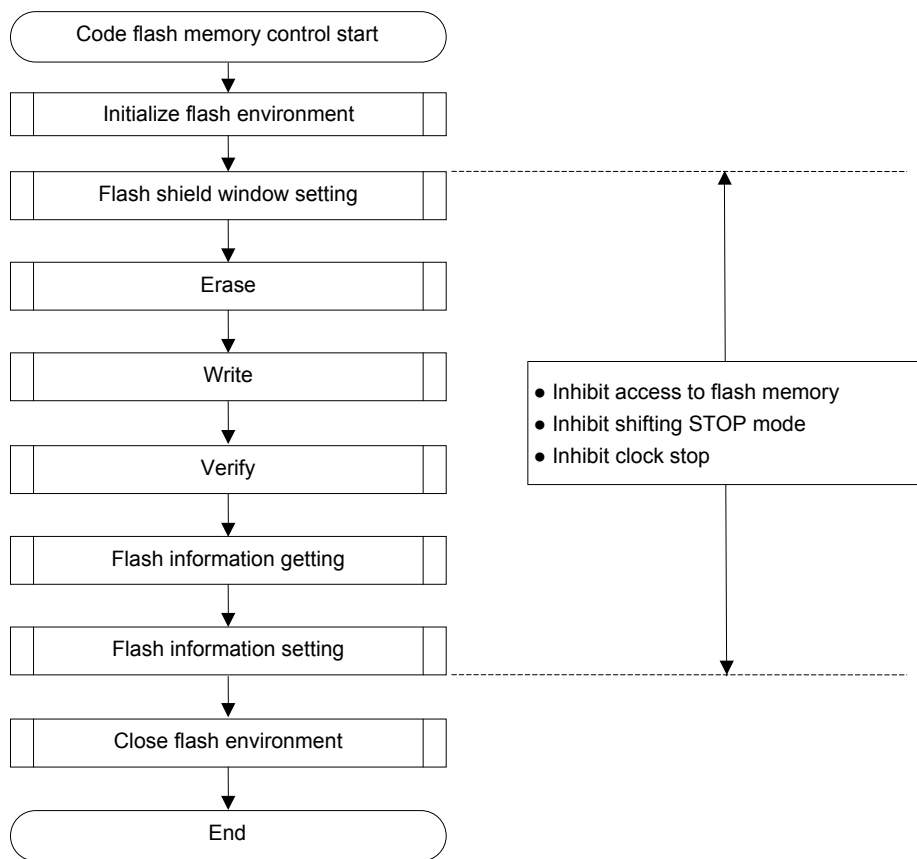
If the argument `fsl_flash_voltage_u08` is 00H when the `FSL_Init` function of the flash self-programming library provided by Renesas Electronics is executed, full speed mode is specified. If the argument is other than 00H, the wide voltage mode is specified.

- Remark** Using both the wide voltage mode and full speed mode imposes no restrictions on writing, erasing, or verification.

3.6.1 Self-programming procedure

The following figure illustrates a flow for rewriting the code flash memory by using a flash self-programming library.

Figure 3 – 8 Flow of Self Programming (Rewriting Flash Memory)



3.6.2 Boot swap function

If rewriting the boot area failed by temporary power failure or other reasons, restarting a program by resetting or overwriting is disabled due to data destruction in the boot area.

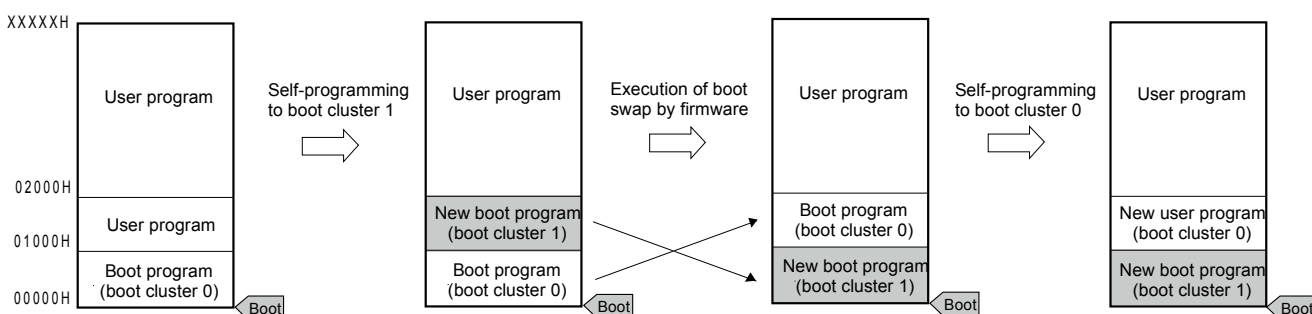
The boot swap function is used to avoid this problem.

Before erasing boot cluster 0^{Note}, which is a boot area, by self-programming, write a new boot program to boot cluster 1 in advance. When the program has been correctly written to boot cluster 1, swap this boot cluster 1 and boot cluster 0 by using the set information function of the firmware of the RL78 microcontroller, so that boot cluster 1 is used as a boot area. After that, erase or write the original area, boot cluster 0.

As a result, even if a power failure occurs while the area is being rewritten, the program is executed correctly because it is booted from boot cluster 1 to be swapped when the program is reset and started next.

Note A boot cluster is a 4 Kbytes area and boot clusters 0 and 1 are swapped by the boot swap function.

Figure 3 – 9 Boot Swap Function

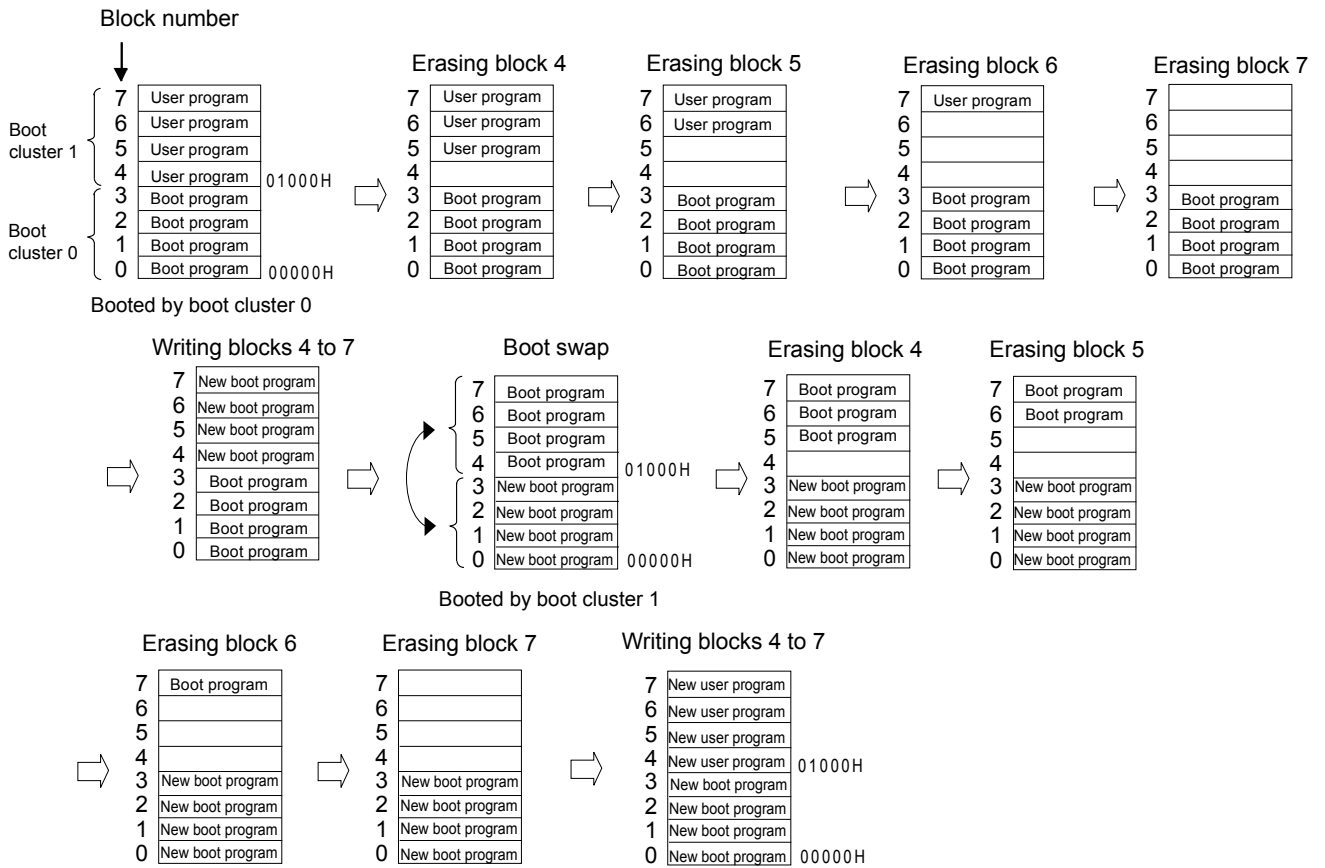


In an example of above figure, it is as follows.

Boot cluster 0: Boot area before boot swap

Boot cluster 1: Boot area after boot swap

Figure 3 – 10 Example of Executing Boot Swapping



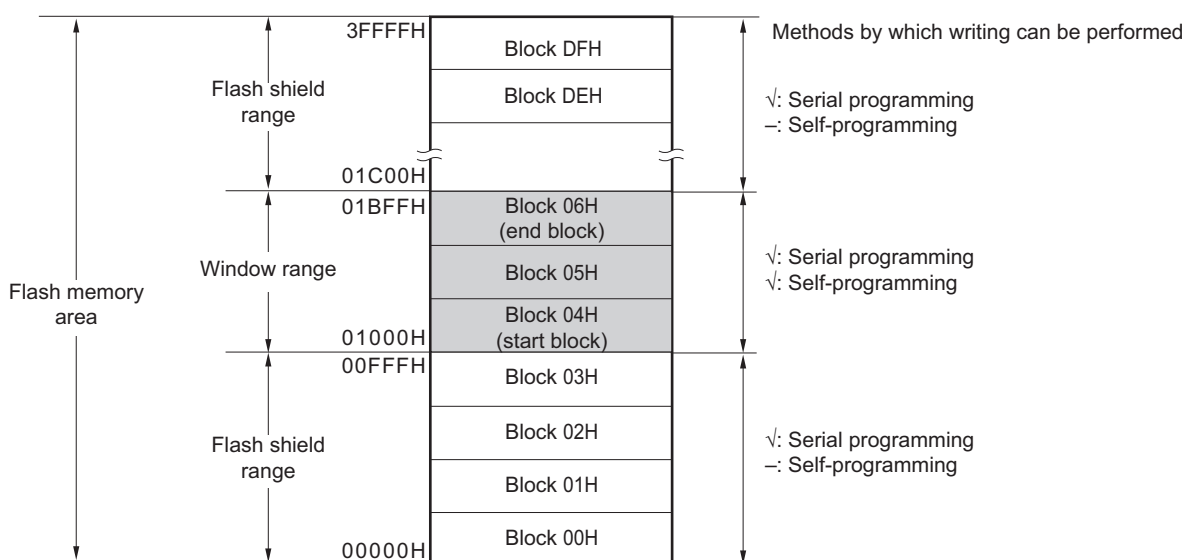
3.6.3 Flash shield window function

The flash shield window function is provided as one of the security functions for self-programming. It disables writing to and erasing areas outside the range specified as a window only during self-programming.

The window range can be set by specifying the start and end blocks. The window range can be set or changed during both serial programming and self-programming.

Writing to and erasing areas outside the window range are disabled during self-programming. During serial programming, however, areas outside the range specified as a window can be written and erased.

**Figure 3 – 11 Flash Shield Window Setting Example
(Start Block: 04H, End Block: 06H)**



- Cautions** 1. If the rewrite-prohibited area of the boot cluster 0 overlaps with the flash shield window range, prohibition to rewrite the boot cluster 0 takes priority.
- 2. The flash shield window can only be used for the code flash memory (and is not supported for the data flash memory).

Table 3 – 11 Relationship Between Flash Shield Window Function Setting/Change Methods and Commands

Programming Conditions	Window Range Setting/Change Methods	Execution Commands	
		Block Erase	Write
Self-programming	Specify the starting and ending blocks by the flash self-programming library.	Block erasing is enabled only within the window range.	Writing is enabled only within the range of window range.
Serial programming	Specify the starting and ending blocks on GUI of dedicated flash memory programmer, etc.	Block erasing is enabled also outside the window range.	Writing is enabled also outside the window range.

Remark See 3.7 Security Settings to prohibit writing/erasing during serial programming.

3.7 Security Settings

The RL78 microcontroller supports a security function that prohibits rewriting the user program written to the internal flash memory, so that the program cannot be changed by an unauthorized person.

The operations shown below can be performed using the Security Set command.

- Disabling block erase

Execution of the block erase command for a specific block in the flash memory is prohibited during serial programming. However, blocks can be erased by means of self-programming.

- Disabling write

Execution of the write command for entire blocks in the code flash memory is prohibited during serial programming. However, blocks can be written by means of self-programming.

After the setting of prohibition of writing is specified, releasing the setting by the Security Release command is enabled by a reset.

- Disabling rewriting boot cluster 0

Execution of the block erase command and write command on boot cluster 0 (00000H to 00FFFH) in the code flash memory is prohibited by this setting.

The block erase, write commands and rewriting boot cluster 0 are enabled by the default setting when the flash memory is shipped. Security can be set by serial programming and self-programming. Each security setting can be used in combination.

Table 26-12 shows the relationship between the erase and write commands when the RL78 microcontroller security function is enabled.

Caution The security function of the dedicated flash programmer does not support self-programming.

Remark To prohibit writing and erasing during self-programming, use the flash shield window function (see 3.6.3 for detail).

Table 3 – 12 Relationship Between Enabling Security Function and Command

(1) During serial programming

Valid Security	Executed Command	
	Block Erase	Write
Prohibition of block erase	Blocks cannot be erased.	Can be performed. ^{Note}
Prohibition of writing	Blocks can be erased.	Cannot be performed.
Prohibition of rewriting boot cluster 0	Boot cluster 0 cannot be erased.	Boot cluster 0 cannot be written.

Note Confirm that no data has been written to the write area. Because data cannot be erased after block erase is prohibited, do not write data if the data has not been erased.

(2) During self-programming

Valid Security	Executed Command	
	Block Erase	Write
Prohibition of block erase	Blocks can be erased.	Can be performed.
Prohibition of writing		
Prohibition of rewriting boot cluster 0	Boot cluster 0 cannot be erased.	Boot cluster 0 cannot be written.

Remark To prohibit writing and erasing during self-programming, use the flash shield window function (see 3.6.3 for detail).

Table 3 – 13 Setting Security in Each Programming Mode

(1) During serial programming

Security	Security Setting	How to Disable Security Setting
Prohibition of block erase	Set via GUI of dedicated flash memory programmer, etc.	Cannot be disabled after set.
Prohibition of writing		Set via GUI of dedicated flash memory programmer, etc.
Prohibition of rewriting boot cluster 0		Cannot be disabled after set.

Caution Releasing the setting of prohibition of writing is enabled only when the security is not set as the block erase prohibition and the boot cluster 0 rewrite prohibition with code flash memory area and data flash memory area being blanks.

(2) During self-programming

Security	Security Setting	How to Disable Security Setting
Prohibition of block erase	Set by using flash self-programming library.	Cannot be disabled after set.
Prohibition of writing		Cannot be disabled during self-programming (set via GUI of dedicated flash memory programmer, etc. during serial programming).
Prohibition of rewriting boot cluster 0		Cannot be disabled after set.

3.8 Data Flash

3.8.1 Data flash overview

An overview of the data flash memory is provided below.

- The user program can rewrite the data flash memory by using the data flash library. For details, refer to **RL78 Family Data Flash Library User's Manual**.
- The data flash memory can also be rewritten through serial programming using the dedicated flash memory programmer or an external device.
- The data flash can be erased in 1-block (1-Kbyte) units.
- The data flash can be accessed only in 8-bit units.
- The data flash can be directly read by CPU instructions.
- Instructions can be executed from the code flash memory while rewriting the data flash memory (that is, background operation (BGO) is supported).
- Because the data flash memory is an area exclusively used for data, it cannot be used to execute instructions.
- Accessing the data flash memory is not possible while rewriting the code flash memory (during self-programming).
- Manipulating the DFLCTL register is not possible while rewriting the data flash memory.
- Transition to the STOP mode is not possible while rewriting the data flash memory.

- Cautions**
1. **The data flash memory is stopped after a reset is canceled. The data flash control register (DFLCTL) must be set up in order to use the data flash memory.**
 2. **The high-speed on-chip oscillator should be kept operating during data flash rewrite. If it is kept stopping, the high-speed on-chip oscillator clock should be operated (HIOSTOP = 0). The data flash library should be executed after 30 μ s have elapsed.**

Remark For rewriting the code flash memory via a user program, see 3.6 **Self-Programming**.

3.8.2 Register controlling data flash memory

(1) Data flash control register (DFLCTL)

This register is used to enable or disable accessing to the data flash.

The DFLCTL register is set by a 1-bit or 8-bit memory manipulation instruction.

Reset input sets this register to 00H.

Address: F0090H After reset: 00H R/W

Symbol	7	6	5	4	3	2	1	<0>
DFLCTL	0	0	0	0	0	0	0	DFLEN

DFLEN	Data flash access control
0	Disables data flash access
1	Enables data flash access

Caution Manipulating the DFLCTL register is not possible while rewriting the data flash memory.

3.8.3 Procedure for accessing data flash memory

The data flash memory is stopped after a reset ends. To access the data flash, make initial settings according to the following procedure.

- <1> Set bit 0 (DFLEN) of the data flash control register (DFLCTL) to 1.
- <2> Wait for the setup to finish for software timer, etc.
The time setup takes differs for each flash operation mode for the main clock.
<Setup time for each flash operation mode>
 - HS (High speed main): 5 μ s
 - LS (Low speed main): 720 ns
 - LV (Low voltage main): 10 μ s
- <3> After the wait, the data flash memory can be accessed.

- Cautions**
1. Accessing the data flash memory is not possible during the setup time.
 2. Transition to the STOP mode is not possible during the setup time. To enter the STOP mode during the setup time, clear DFLEN to 0 and then execute the STOP instruction.
 3. The high-speed on-chip oscillator should be kept operating during data flash rewrite. If it is kept stopping, the high-speed on-chip oscillator clock should be operated (HIOSTOP = 0). The flash data library should be executed after 30 μ s have elapsed.

After initialized, the data flash memory can be read by using a CPU instruction or can be read/written by using a data flash library.

If the DMA controller operates when the data flash memory is accessed, however, follow one of these procedures:

- (A) Suspending/forcibly terminating DMA transfer
Before reading the data flash memory, suspend DMA transfer of all the channels used.
After setting the DWAITn bit to 1, however, wait at least for the duration of three clocks (f_{CLK}) before reading the data flash memory. After reading the data flash memory, lift the suspension of transfer by clearing the DWAITn bit to 0.
Or, forcibly terminate DMA transfer in accordance with the procedure in **17.5.5 Forced termination by software** of the RL78/G1D User's Manual: Hardware before reading the data flash memory. Resume DMA transfer after the data flash memory has been read.
- (B) Access the data flash memory
Access the data flash memory by using the newest data flash library.
- (C) Insertion of NOP
Insert an NOP instruction immediately before the instruction that reads the data flash memory.

<Example>

```
MOVW    HL,!addr16    ; Reads RAM.
NOP                                ; Insert NOP instruction before reading data flash memory.
MOV     A,[DE]        ; Read data flash memory.
```

If a high-level language such as C is used, however, the compiler may generate two instructions for one code. In this case, the NOP instruction is not inserted immediately before the data flash memory read instruction. Therefore, read the data flash memory by (A) or (B) above.

- Remarks**
1. n: DMA channel number (n = 0, 1)
 2. f_{CLK} : CPU/peripheral hardware clock frequency

CHAPTER 4 ELECTRICAL SPECIFICATIONS

This chapter describes the differences in specifications from the RL78/G1D.

For details on the specifications, the description of which is omitted from this user's manual, see the RL78/G1D User's Manual: Hardware (R01UH0515E).

4.1 Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Operating ambient temperature	T_A		-25 to +75	°C
Storage temperature	T_{stg}		-40 to +85	°C

4.2 Operating Voltage

Clock generator		Flash operation mode	Operation voltage	CPU operation frequency (f_{CLK}) ^{Note 1}
Main system clock (f_{MAIN})	High speed on-chip oscillator clock (f_{IH})	HS (high-speed main) mode	$2.7 V \leq V_{DD} \leq 3.6 V$	1 to 32 MHz
			$2.4 V \leq V_{DD} \leq 2.7 V$	1 to 16 MHz
		LS (low-speed main) mode	$1.8 V \leq V_{DD} \leq 3.6 V$	1 to 8 MHz
		LV (low-voltage main) mode ^{Note 2}	$1.6 V \leq V_{DD} \leq 3.6 V$	1 to 4 MHz
Subsystem clock (f_{SUB})	XT1 clock (f_{XT})	-	$1.6 V \leq V_{DD} \leq 3.6 V$	32.768 kHz
	External subsystem clock (f_{EXT}) ^{Note 1}	-	$1.6 V \leq V_{DD} \leq 3.6 V$	32.768 kHz

Notes 1. Indicates only permissible oscillator frequency ranges. Refer to AC characteristics for instruction execution times. Request evaluation by the manufacturer of the oscillator circuit mounted on a board to check the oscillator characteristics.

2. Use of this mode is prohibited in the case of using the DC-DC converter.

4.3 Oscillator Characteristics

This module does not support X1 oscillation. Use the high-speed on-chip oscillator clock.

4.4 RF Transceiver Characteristics

4.4.1 RF transmission characteristics

($T_A = +25^\circ\text{C}$, $V_{DD} = 3.0\text{ V}$, $f = 2402$ to 2480 MHz , $\text{GND} = 0\text{ V}$)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
RF frequency range	RF_{CF}		2402		2480	MHz
Maximum transmitted output power	RF_{POWER}	RF low power mode		-15		dBm
		RF normal mode		0		dBm
		RF high performance mode		0		dBm
Frequency tolerance	RF_{TXFERR}	-25 to $+75^\circ\text{C}$	-50		+50	ppm

4.4.2 RF reception characteristics

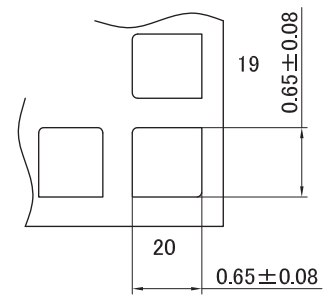
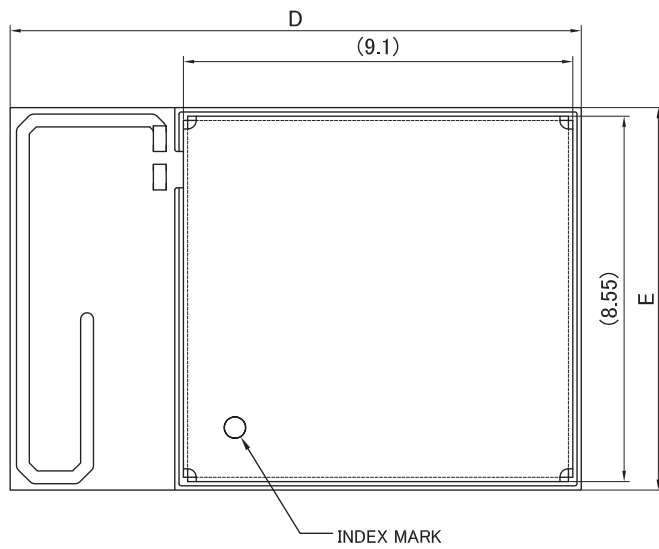
($T_A = +25^\circ\text{C}$, $V_{DD} = 3.0\text{ V}$, $f = 2402$ to 2480 MHz , $\text{GND} = 0\text{ V}$)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	
RF frequency range	RF_{CF}		2402		2480	MHz	
Maximum input level	RF_{LEVEL}	$\text{PER} \leq 30.8\%$		0		dBm	
Receiver sensitivity	RF_{STY}	$\text{PER} \leq 30.8\%$ ideal	RF low power mode		-60		dBm
			RF normal mode		-90		dBm
			RF high performance mode		-92		dBm
		$\text{PER} \leq 30.8\%$ dirty	RF normal mode			-70	dBm

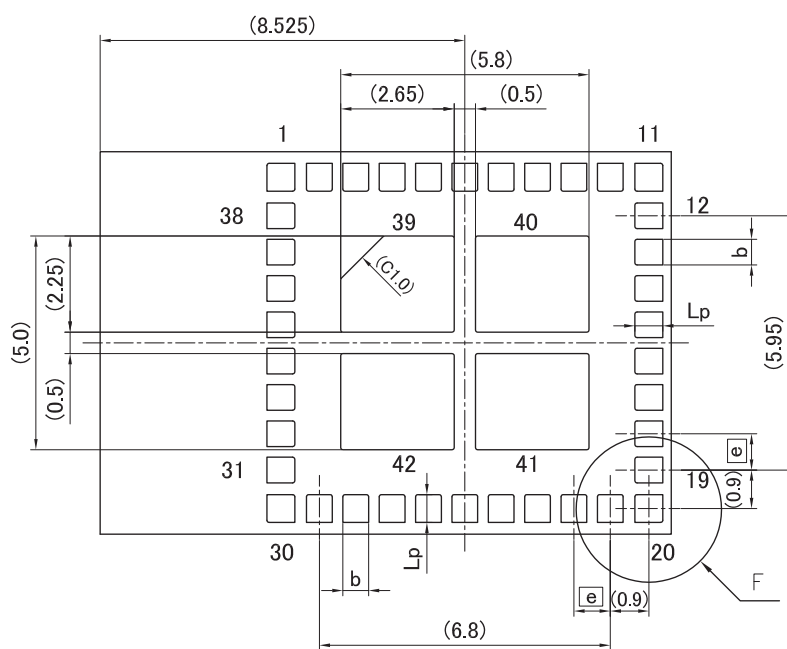
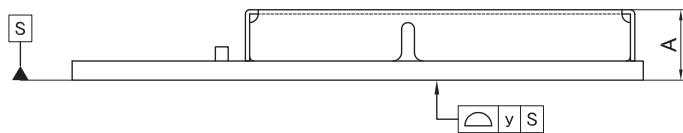
CHAPTER 5 PACKAGE RELATED INFORMATION

5.1 Module Drawings

JEITA Package Code	RENESAS Code	Previous Code	MASS [Typ.]
-	MLZZ0042ZA-A	—	0.357 g

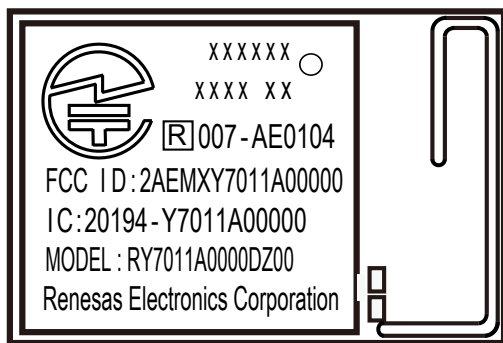


Detail F

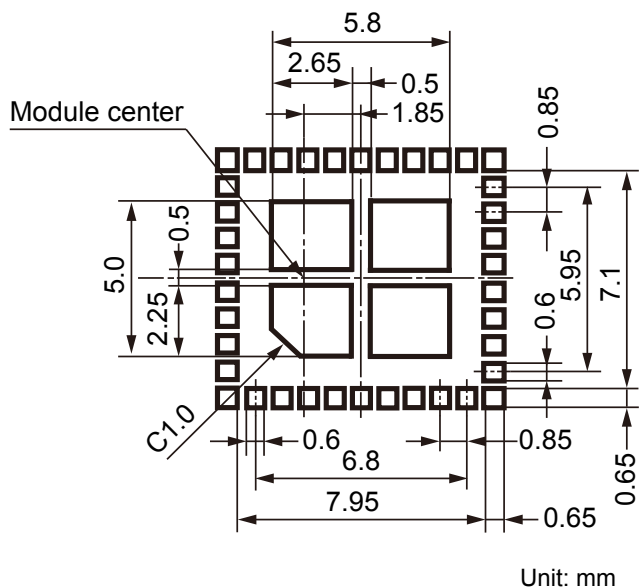


Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	13.20	13.35	13.50
E	8.80	8.95	9.10
A	—	—	1.7
e	—	0.85	—
Lp	0.57	0.65	0.73
b	0.52	0.6	0.68
y	—	—	0.1

5.2 Marking



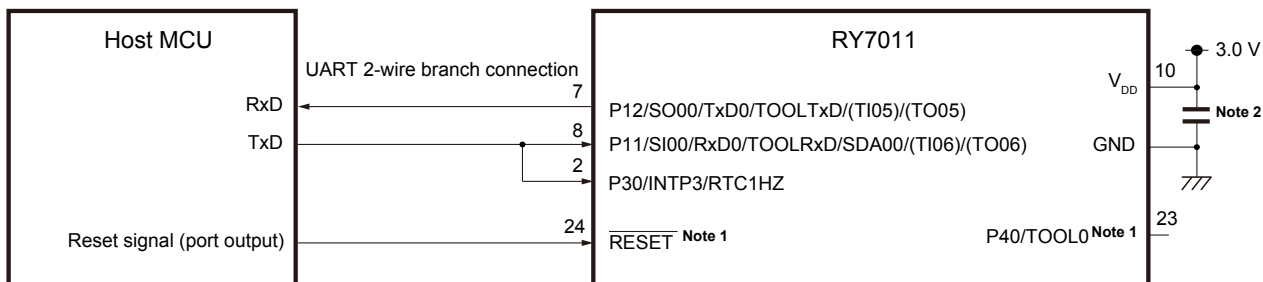
5.3 Foot Pattern (Top View: For Reference)



CHAPTER 6 EXAMPLES OF APPLICATION CIRCUITS

Figure 6 – 1 shows example of connecting to a host MCU, when the module is operated by software for verifying operation written to ship.

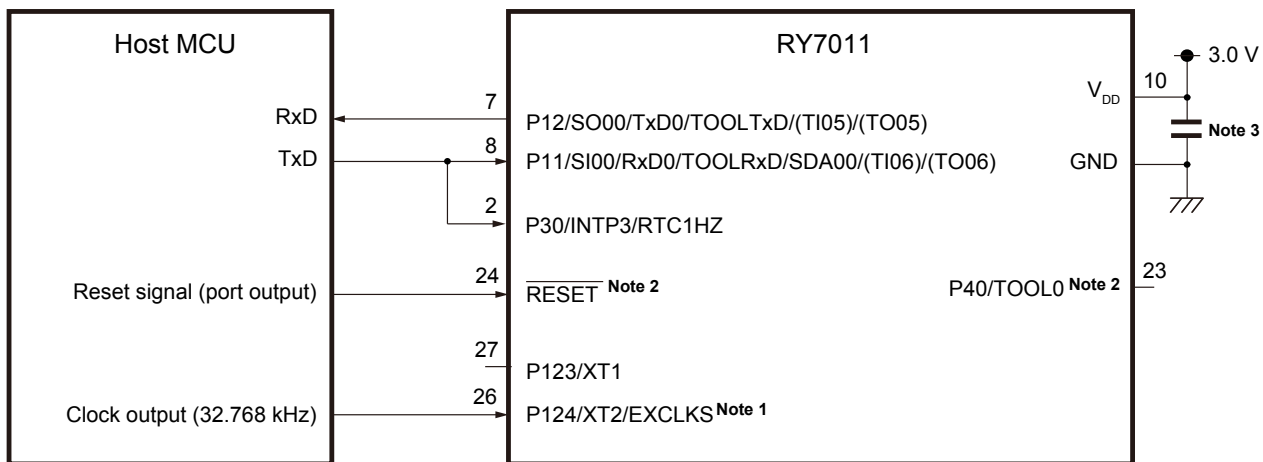
Figure 6 – 1 Operation by Software for Verifying Operation Written to Ship



- Note 1.** $\overline{\text{RESET}}$ and P40/TOOL0 pins are pulled-up/puledl-down with a resistor in accordance with the system requirement (see RL78/G1D User’s Manual: Hardware).
- 2.** Insert bypass capacitor of several μF between the V_{DD} and GND pins to suit the characteristics the power supply and wiring patterns.

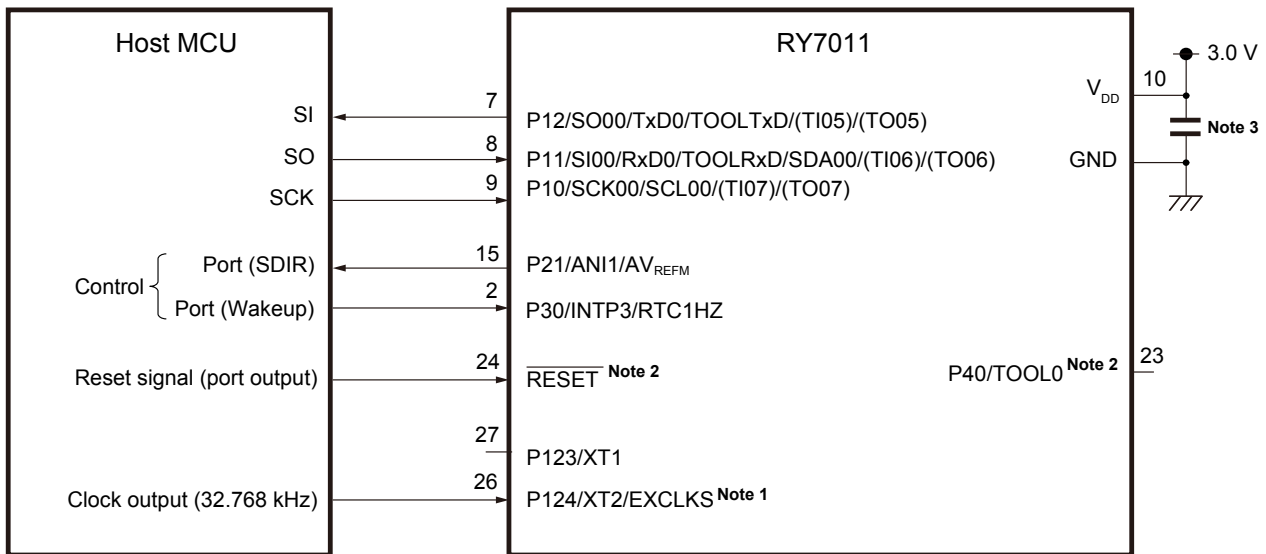
Figure 6 – 2 to figure 6 – 6 show examples of application circuits.

Figure 6 – 2 UART Operation (2-wire Branch Connection: default) : Supply of the RF Slow Clock Signal from the Host MCU to This Module^{Notes 1, 2, 3}



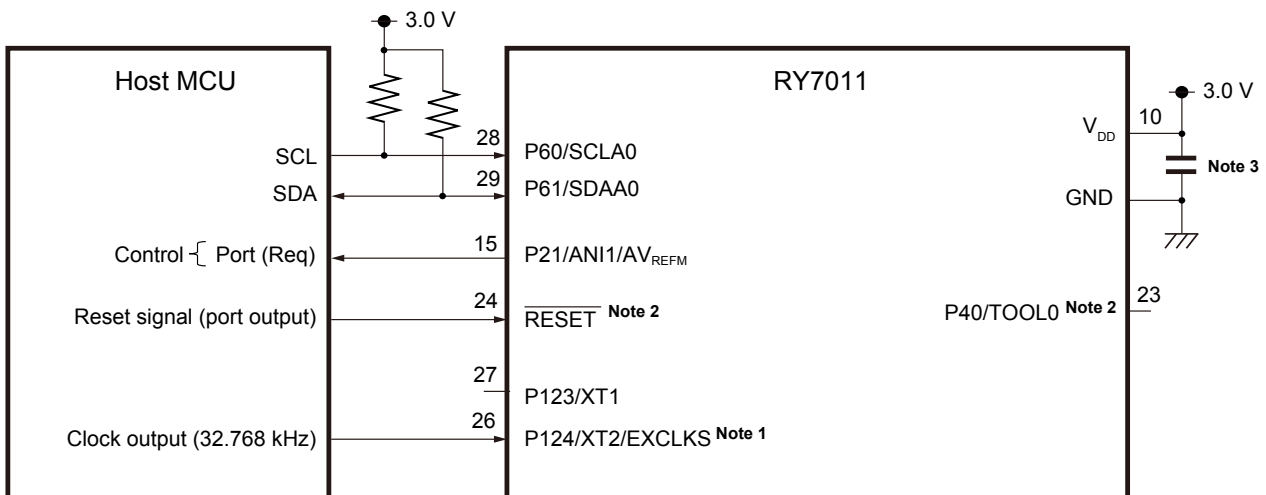
- Notes 1.** Accuracy of the frequency should be no greater than ± 250 ppm.
- 2.** Add an appropriate resistor (pull-up or pull-down) to be connected to the $\overline{\text{RESET}}$ and P40/TOOL0 pins as required (see the RL78/G1D User’s Manual: Hardware).
- 3.** Insert a bypass capacitor of several μF between the V_{DD} and GND pins to suit the characteristics of the power supply and wiring patterns.

Figure 6 – 3 CSI Operation (5-wire Connection) : Supply of the RF Slow Clock Signal from the Host MCU to This Module ^{Notes 1, 2, 3}



- Notes**
1. Accuracy of the frequency should be no greater than ± 250 ppm.
 2. Add an appropriate resistor (pull-up or pull-down) to be connected to the $\overline{\text{RESET}}$ and P40/TOOL0 pins as required (see the RL78/G1D User's Manual: Hardware).
 3. Insert a bypass capacitor of several μF between the V_{DD} and GND pins to suit the characteristics of the power supply and wiring patterns.

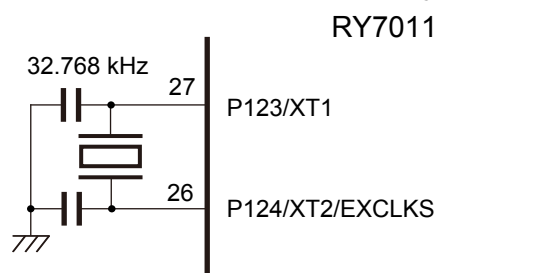
Figure 6 – 4 I²C Operation (3-wire Connection: default) : Supply of the RF Slow Clock Signal from the Host MCU to This Module ^{Notes 1, 2, 3}



- Notes**
1. Accuracy of the frequency should be no greater than ± 250 ppm.
 2. Add an appropriate resistor (pull-up or pull-down) to be connected to the $\overline{\text{RESET}}$ and P40/TOOL0 pins as required (see the RL78/G1D User's Manual: Hardware).
 3. Insert a bypass capacitor of several μF between the V_{DD} and GND pins to suit the characteristics of the power supply and wiring patterns.

Figure 6 – 5 Connection of the XT1 and XT2/EXCLKS Pins When an On-Chip Oscillator Is in Use^{Note}

Note For pins P123 and P124, see 2.2 Connection of Unused Pins.

Figure 6 – 6 Connection of the XT1 and XT2/EXCLKS Pins When a Crystal Resonator Is Externally Connected^{Note}

Note Request evaluation by the manufacturer of the oscillator circuit to check the crystal resonator characteristics.
Recommendation: FC-12M (manufactured by Seiko Epson Corporation, specification No.: Q15-013-6A)

CHAPTER 7 SOLDERING CONDITION

7.1 Soldering Method

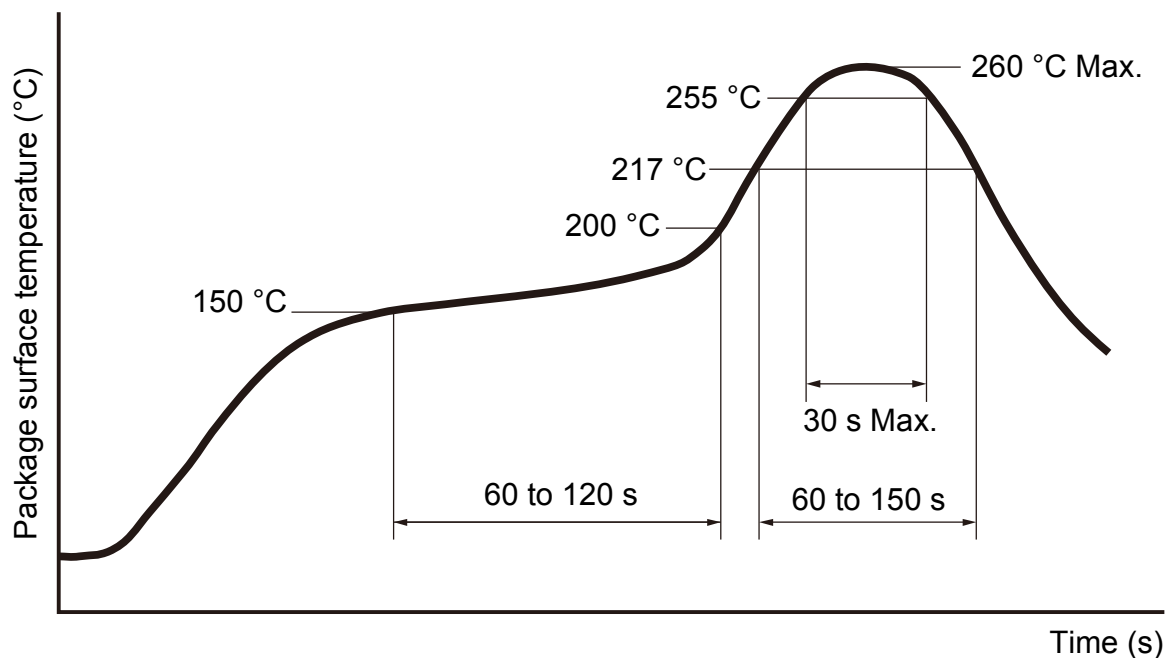
Reflow

7.2 Maximum Reflow Times

Twice

7.3 Recommended Temperature Profile

Item	Condition
Maximum reflow temperature (package surface)	$\leq 260\text{ }^{\circ}\text{C}$
Period over which the temperature is no lower than $255\text{ }^{\circ}\text{C}$	$\leq 30\text{ s}$
Period over which the temperature is no lower than $217\text{ }^{\circ}\text{C}$	60 to 150 s
Period over which the temperature remains at the preheat temperature (150 to $200\text{ }^{\circ}\text{C}$)	60 to 120 s

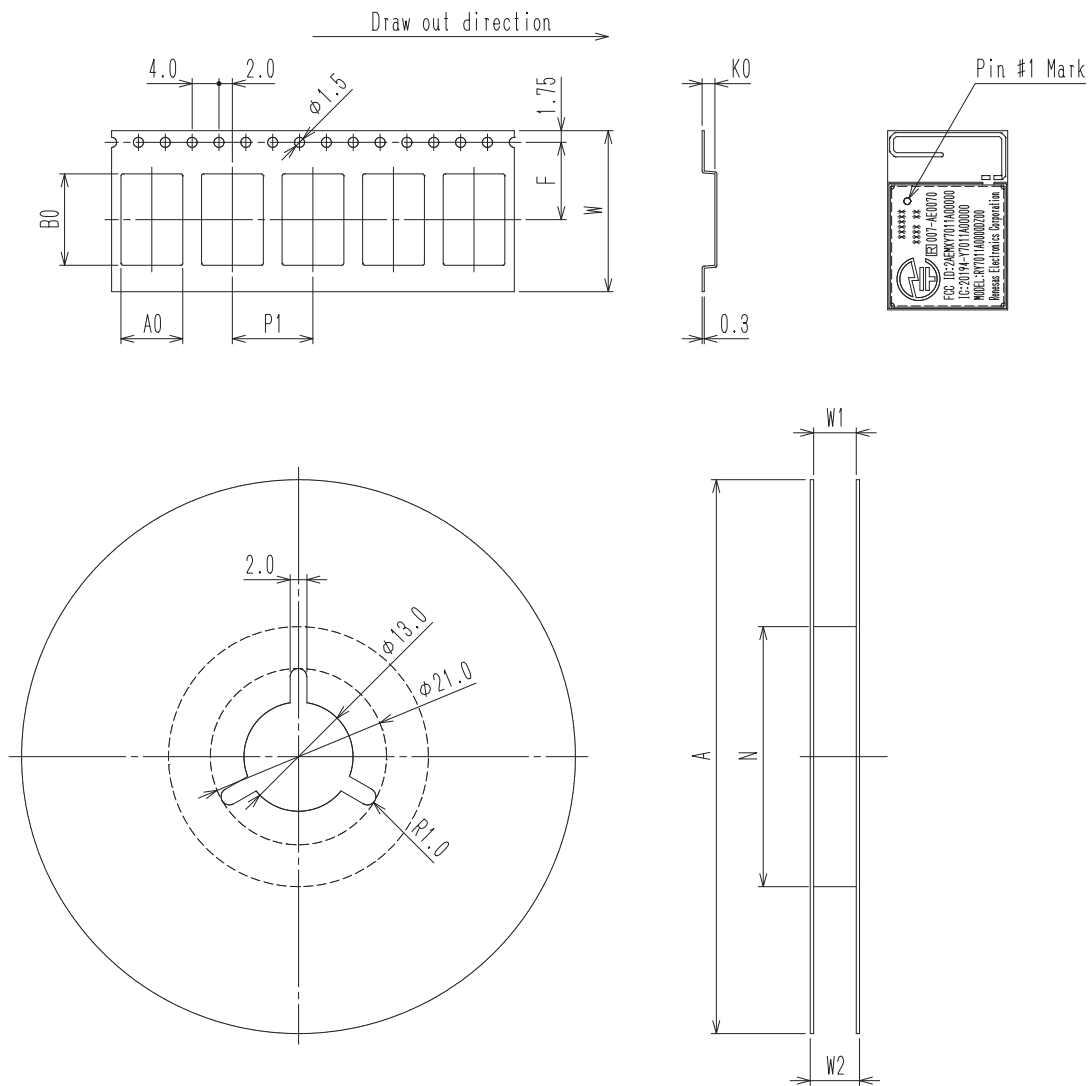


CHAPTER 8 PACKAGING**8.1 Quantity of Components to Be Packaged**

RY7011A0000DZ00#001: 2500 pcs (per reel)

RY7011A0000DZ00#002: 100 pcs (per reel)

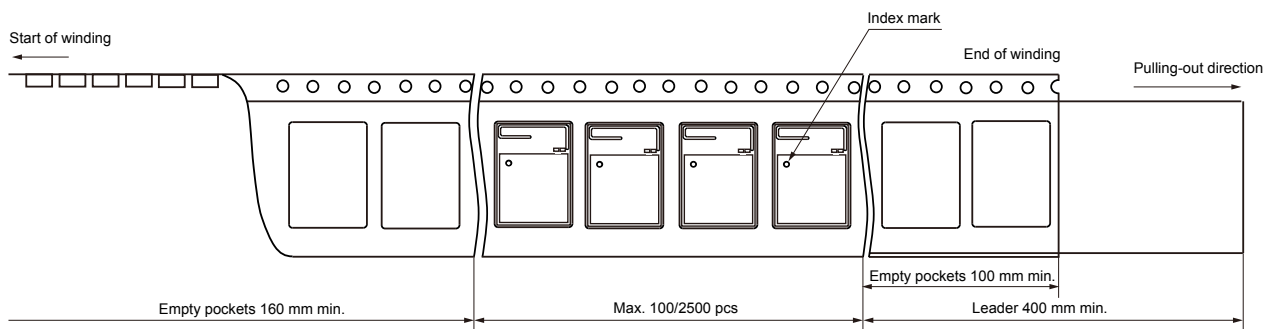
8.2 Carrier Tape and Reel Dimensions



Tape Code		
Tape Dimensions (mm)	W	24.0
	P1	12.0
	A0	9.2
	B0	13.6
	K0	1.9
	F	11.5
Reel Dimensions (mm)	A	330.0
	N	80.0
	W1	25.4
	W2	29.4
Maximum storage pcs. Module/Reel		2500
Material	Tape	Carbon PS
	Reel	Carbon PS
Surface resistance	Tape	$1.0 \times 10^5 \sim 1.0 \times 10^{11} \Omega/\square$
	Reel	$1.0 \times 10^5 \sim 1.0 \times 10^{11} \Omega/\square$

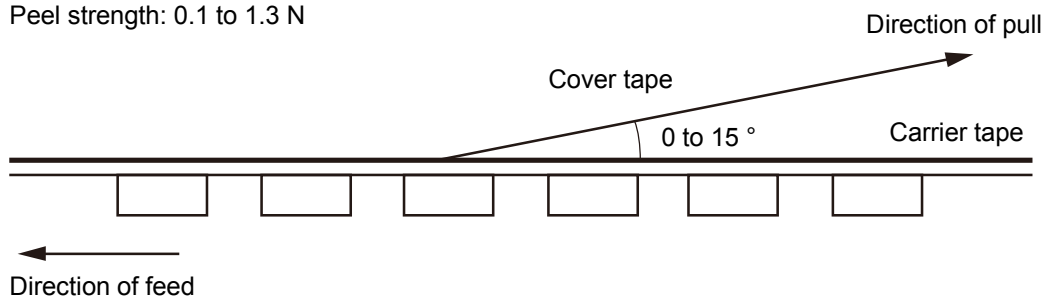
【Unit:mm】

8.3 Taping Direction and Quantity of Components to Be Packaged

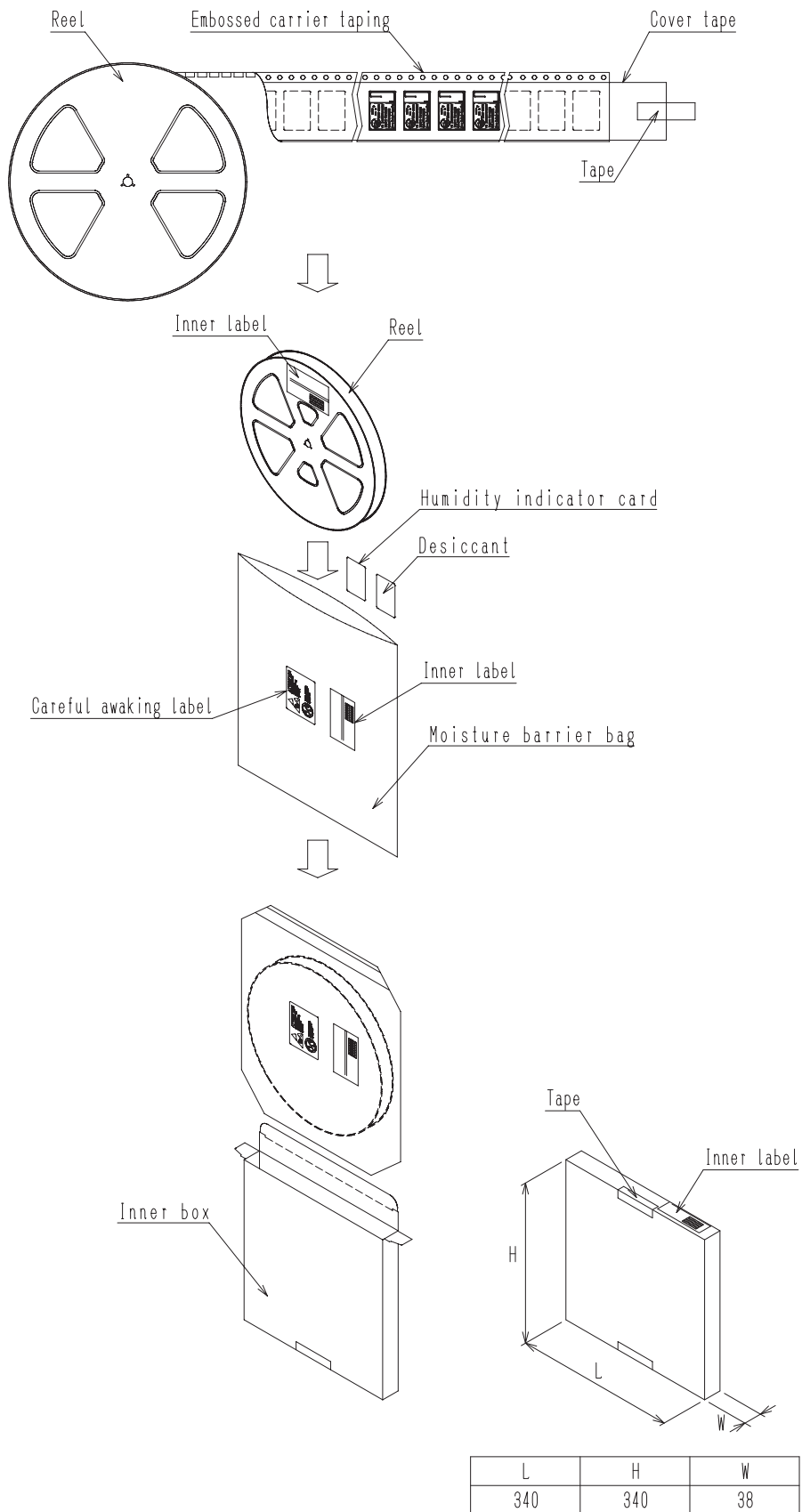


8.4 Peel Strength of Cover Tape

Peel strength: 0.1 to 1.3 N



8.5 Packaging Specifications



【Unit:mm】

8.6 Storage Conditions

Unopened state: We recommend storing packages at 5 to 35 °C and under humidity of up to 60 %, and using components within two years after the delivery.

After opening: Mount the components at 30 °C and under humidity of up to 60 % within 7 days after opening.

Once 7 days elapsed after opening, put a product through the baking process at 125 °C for 24 hours before mounting it.

CHAPTER 9 CERTIFICATION OF COMPLIANCE

9.1 Radio-Related Laws

Japan: Type certification (authentication number: 007-AE0104)

North America: FCC (FCC ID: 2AEMXY7011A00000), IC (20194-Y7011A00000)

Europe: CE (R&TTE)^{Note}

Note Certificates of compliance with radio-related tests based on R&TTE order.

User system is required the final certification tests and CE marking.

9.2 Bluetooth SIG

QDID : 82194

Name : Renesas Bluetooth low energy Module

Model Number : RY7011A0000DZ00

Product Type : End Product

9.3 Labeling and Requirement for User Information

Following descriptions are precautions for implementation of this module to an end system.

Since this module is not sold to general end users directly, there is no user manual. For the details about this module, please refer to the specification sheet. This module should be installed in the host product according the installation manual.

The following statements must be described on the user manual of host device of this module;

Note to users in the United States of America

Caution:

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Declaration of Conformity

This device complies with part 15 of FCC Rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Note to users in the United States of America and Canada

Note to users

It is strictly forbidden to use antenna except designated.

This equipment must not be co-located or operated in conjunction with any other antenna or transmitter.

[For mobile equipment]

This equipment complies with FCC/IC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment has very low levels of RF energy that is deemed to comply without maximum permissive exposure evaluation (MPE).

Note to users in Canada

Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles des radioélectriques (RF) de la FCC lignes directrices d'exposition et d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'IC. Cet équipement émet une énergie RF très faible qui est considérée comme conforme sans évaluation de l'exposition maximale autorisée (MPE).

[For portable equipment]

This equipment complies with FCC/IC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment has very low levels of RF energy that is deemed to comply without testing of specific absorption rate(SAR).

Note to users in Canada

Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles des radioélectriques (RF) de la FCC lignes directrices d'exposition et d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'IC. Cet équipement émet une énergie RF très faible qui est considérée comme conforme sans évaluation du débit d'absorption spécifique (DAS).

Note to users in Canada

This device complies with Industry Canada's licence-exempt RSSs.

Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Remarque concernant les utilisateurs au Canada

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

The following information must be indicated on the host device of this module;**[for FCC]**

Contains Transmitter Module FCC ID: 2AEMXY7011A00000

or

Contains FCC ID: 2AEMXY7011A00000

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

[for IC]

Contains IC: 20194-Y7011A00000

European Community Compliance Statement**Note:**

Hereby, Renesas Electronics Corporation, declares that this RY7011A0000DZ00 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.



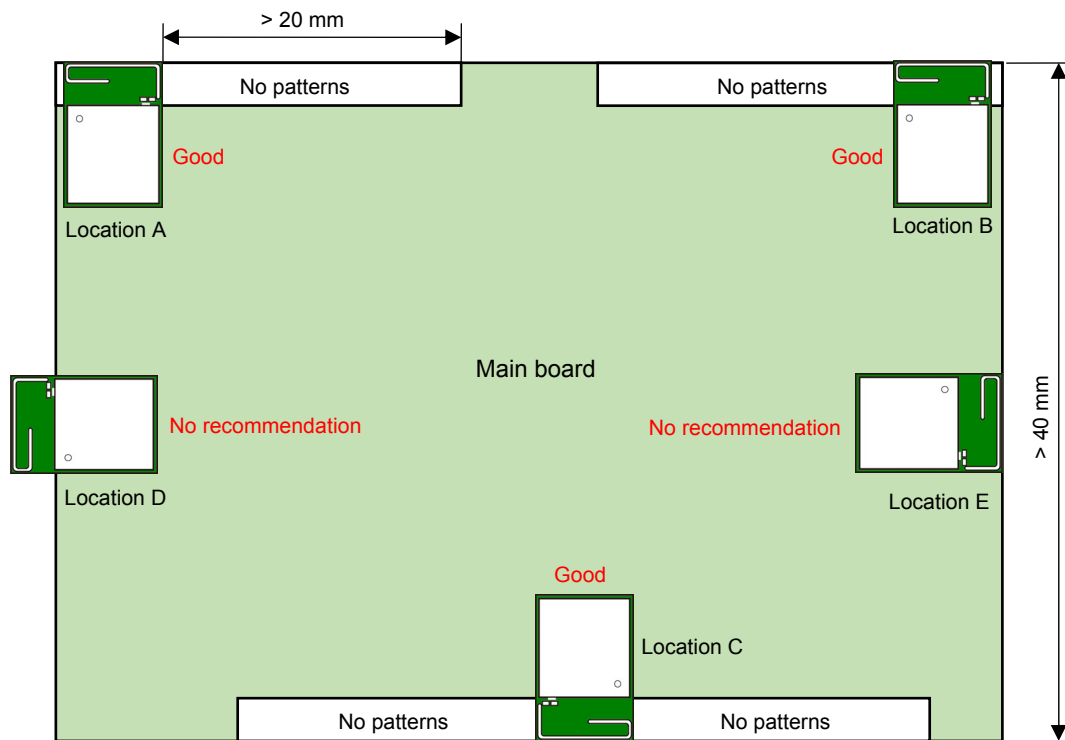
CHAPTER 10 NOTES ON LAYOUT

10.1 Main Board Design

To secure the antenna characteristics, take into account the following points to note in mounting this module on the main board.

<R>

Figure 10 – 1 Layout of the Main Board



- Use a board which satisfies the conditions described below as the main board.

Material: FR4

Thickness: 1.0 to 1.6 mm

- Do not place patterns and a solid ground or power supply under the area where the module antenna is formed such as location E on the main board.
- Do not place patterns and conductors near the module antenna on the main board.

<R>

As a guideline, we recommend that any conductors have a separation of approximately at least 20 mm from the antenna, such as at locations A, B, and C in the figure.

Good antenna characteristics cannot be obtained if they are placed within 20 mm of the antenna.

- Place the main board under the area where the module antenna is formed.

<R>

The antenna has been adjusted on the assumption that the main board is under the area of the antenna. Good antenna characteristics cannot be obtained if the main board is not under the antenna.

We recommend not placing the module antenna beyond the edge of the board, as it is at location D in the figure.

- Make a solid ground to be included in the layer configuration of the main board as large as possible.

<R>

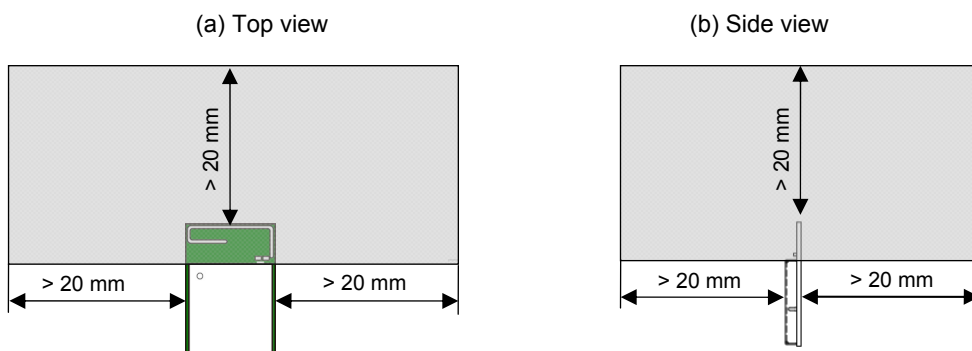
As a guideline, we recommend that the solid ground should extend for be approximately 40 mm, at least, in both directions.

If the ground area is smaller than 40-mm square, good antenna characteristics cannot be obtained.

10.2 Housing Design

To secure the antenna characteristics, take into account the following points to note in putting this module in a housing.

Figure 10 – 2 Distance from the Housing



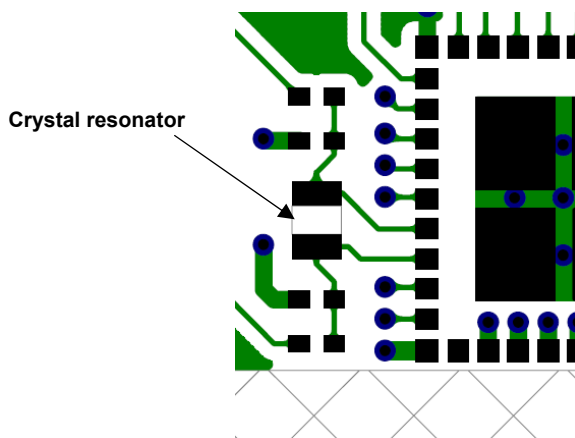
- Do not place metal conductors or components put in housings made of materials with high permittivity (ϵ) and high dielectric loss tangent ($\tan\Delta$) near the module antenna.

Separate them by approximately 20 mm as a guide from the antenna.

- If the module antenna and housing are close to each other, use a material with a low permittivity (ϵ) and low dielectric loss tangent ($\tan\Delta$) for the housing.

10.3 Layout of the Crystal Resonator for the External Subsystem Clock

Figure 10 – 3 External Crystal Resonator

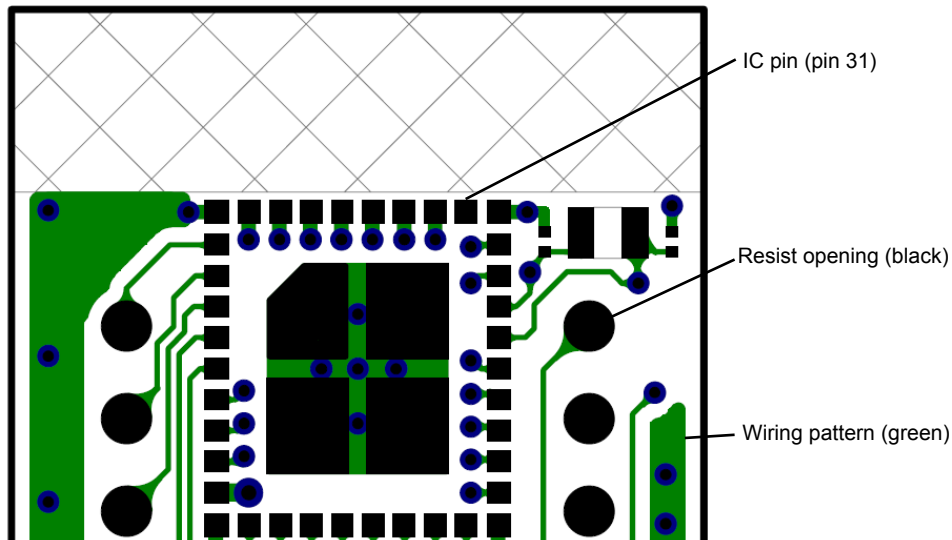


- If the crystal resonator is to be used for the external subsystem clock, connect the crystal resonator with the P123/XT1 and P124/XT2/EXCLKS pins such that the wiring between the resonator and these pins is as short as possible.

10.4 Handling of IC Pin

IC (Internally Connected) pin must be open without connection to any signal, V_{DD} or GND as **Figure 10 – 4**. However, it is acceptable to solder to a pad.

Figure 10 – 4 Example of PCB Wiring



10.5 Designing the Power Supply System

Supply the power to the power supply pin (V_{DD}) directly from a power supply which has little noise, such as a battery or low drop-out (LDO) regulator. When the power is supplied from a switching power supply, such as an external DC/DC converter, input the power externally or use the 32.768 kHz crystal oscillator. Do not use the on-chip oscillator for the RF slow clock.

Design the circuit such that the highest noise levels do not exceed 100 mV.

When a switching power supply such as an external DC/DC converter is in use with the RF slow clock (on-chip oscillator), apply one of the measures below.

1. Keep the switching frequency of the switching power supply to no more than 10 Hz or at 200 kHz or above.
2. Insert an LDO regulator between the switching power supply and the power supply pin (V_{DD}) of the RF chip, making sure that this is in compliance with the recommended conditions of usage for the regulator.

Caution Switching power supplies produce periodic noise, so the device or system may require measures against noise if you are using one as the power supply. If this is the case, thoroughly confirm the operation of the device or system.

APPENDIX A REVISION HISTORY

A.1 Major Revisions in This Edition

Page	Description	Classification
CHAPTER 10 NOTES ON LAYOUT		
p.55	Change of Figure 10 – 1 Layout of the Main Board	(c)
p.55, 56	Change of description in 10.1 Main Board Design	(c)
p.57	Addition of 10.5 About Noise of Power Supply Pin	(c)

Remark "Classification" in the above table classifies revisions as follows.

(a): Error correction, (b): Addition/change of specifications, (c): Addition/change of description or note,

(d): Addition/change of package, part number, or management division, (e): Addition/change of related documents

A.2 Revision History of Preceding Edition

Rev.	Description	Chapter
1.01	Changed 1.3 Pin Configuration	CHAPTER 1 OUTLINE
	Changed 1.4 Pin Identification	
	Changed 1.5 Block Diagram	
	Changed 2.1 Pin Functions	CHAPTER 2 PIN FUNCTIONS
	Changed 2.2 Connection of Unused Pins	
	Changed 5.1 Module Drawings	CHAPTER 5 PACKAGE RELATED INFORMATION
	Changed 5.2 Marking	
	Figure 6 – 1 Operation by Software for Verifying Operation Written to Ship to Figure 6 – 4 I2C Operation	CHAPTER 6 EXAMPLES OF APPLICATION CIRCUITS
	Changed 9.1 Radio-Related Laws, and 9.2 Bluetooth SIG	CHAPTER 9 CERTIFICATION OF COMPLIANCE
Changed 10.2 Housing Design	CHAPTER 10 NOTES ON LAYOUT	
1.00	Changed 1.1 Features	CHAPTER 1 OUTLINE
	Changed Table 3 – 8 Signature Data List, and Table 3 – 9 Example of Signature Data	CHAPTER 3 FLASH MEMORY
	Changed 5.1 Module Drawings	CHAPTER 5 PACKAGE RELATED INFORMATION
	Changed 5.2 Marking	
	Changed 8.2 Carrier Tape and Reel Dimensions	CHAPTER 8 PACKAGING
	Changed 8.5 Packaging Specifications	CHAPTER 9 CERTIFICATION OF COMPLIANCE
Changed 9.1 Radio-Related Laws, and 9.2 Bluetooth SIG		
0.90	Changed the opening description	CHAPTER 1 OUTLINE
	Changed 1.1 Features	
	Added 1.2 Part Numbers	
	Changed 1.3 Pin Configuration (Top View)	
	Changed 1.6 Outline of Functions	
	Added description to 1.7 Differences from RL78/G1D	
	Changed 2.1 Pin Functions	CHAPTER 2 PIN FUNCTIONS
	Added 2.2 Connection of Unused Pins	
	Added the chapter	CHAPTER 3 FLASH MEMORY
	Changed 4.4 RF Transceiver Characteristics	CHAPTER 4 ELECTRICAL SPECIFICATIONS
	Changed the descriptions	CHAPTER 5 PACKAGE RELATED INFORMATION
	Changed the descriptions	CHAPTER 5 PACKAGE RELATED INFORMATION
	Added and changed the descriptions	CHAPTER 6 EXAMPLES OF APPLICATION CIRCUITS
	Changed 8.1 Minimum Quantity of Components to Be Packaged	CHAPTER 8 PACKAGING
	Changed 8.6 Packaging Specifications	
	Changed 9.1 Radio-Related Laws	CHAPTER 9 CERTIFICATION OF COMPLIANCE
	Added 10.4 Handling of IC Pin	CHAPTER 10 NOTES ON LAYOUT
0.50	First edition issued.	Throughout

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