

RL78/G23

Timer Sample sketch (Arduino™ sketch)

Introduction

This application note explains how to use the timer function of the RL78/G23-64p Fast Prototyping Board (FPB) library for Arduino to control a piezoelectric sounder to play a melody after a certain period.

Target Device

Evaluation Board : RL78/G23-64p Fast Prototyping Board

Trademarks

Arduino is a trademark of Arduino SA.

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1. System overview

This system is composed of the RL78/G23-64p Fast Prototyping Board (RL78/G23-64p FPB), a piezoelectric sounder and an LCD display module with I2C. Arduino™ IDE is used for creating a program and writing a program to RL78/G23. Also, with this system, after pressing the switch (SW1) on the FPB, the remaining time is displayed as a countdown on the LCD display module, and when 0 second remain, a melody is played from the piezoelectric sounder.

The block configuration of the sample code used in this system is shown below.

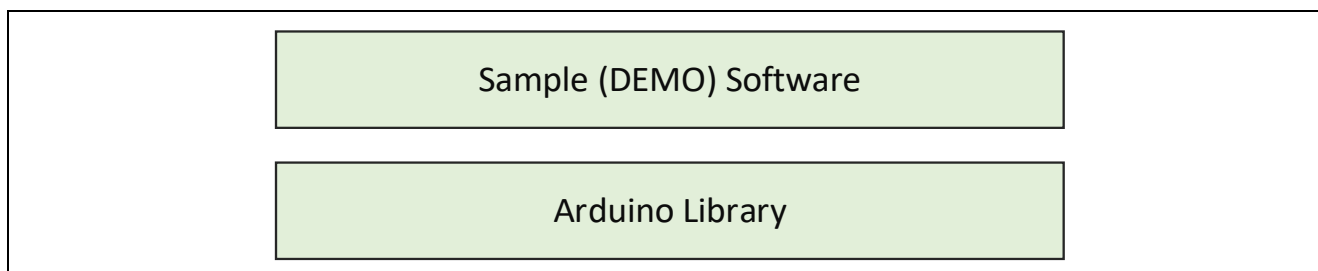


Figure 1-1 Block configuration of software

The simple diagram of this system configuration is shown below.

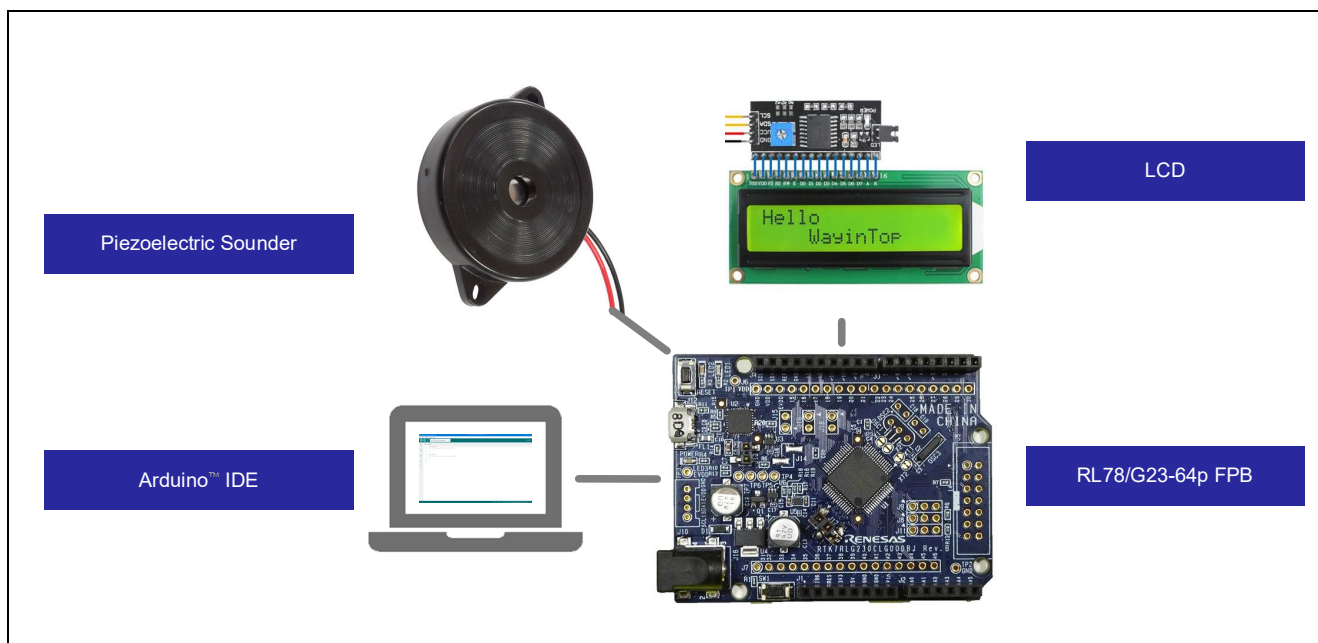


Figure 1-2 System configuration

1.1 Piezoelectric sounder

A piezoelectric sounder is a sounding component that generates sound according to an input signal. In this sample system, generates any sound by supplying a square wave of a specific frequency from the FPB.

The frequency of the square wave that controls the piezoelectric sounder is shown below.

Table 1-1 Frequency of square wave used in piezoelectric sounder

Pitch name	Frequency [Hz]
C	523
D	587
E	659
F	698
G	784
A	880
B	988

1.2 LCD display module with I2C

The LCD display module with I2C can display any character on the LCD by sending commands from the FPB via I2C communication. This system uses the LCD display module used in the Arduino IDE sketch example for RL78/G23-64p Fast Prototyping Board.

The following is the LCD display module used in this system.



Figure 1-3 LCD display module with I2C

This system uses an I2C connection that requires only two pins. Although, Arduino also provides a sketch example that directly control the LCD driver to display characters. In that case, more pins are required for control, but characters can be displayed similarly.

2. Operation confirmation environment

The operation of the sample code provided by this application note has been tested under the following conditions.

Table 2-1 Operation confirmation environments (Hardware)

Item	Description
Evaluation board	RL78/G23-64p Fast Prototyping Board – RTK7RLG230CLG000BJ
Piezoelectric sounder	SPT15
LCD display module with I2C	WayinTop 1602
Operating voltage	5V

Table 2-2 Operation confirmation environments (Software)

Item	Description	Version
OS	Windows 10	-
Integrated development environment (IDE)	Arduino™ IDE	2.3.2
Library	RL78/G23-64p FPB library for Arduino	2.3.1

3. Build development environment

How to connect boards and how to set up the Arduino™ IDE are explained.

The Arduino™ IDE 2.3.2 is used in this system. Installation of the Arduino™ IDE 2.3.2 or later is necessary if it is not installed.

<https://www.arduino.cc/en/software>

3.1 Board connection

The PC and the RL78/G23-64p FPB are connected via USB as shown in Figure 3-1. Also, connect the RL78/G23-64p FPB, piezoelectric sounder, and LCD display module with I2C via jumper wires.

USB is used for power supply to the RL78/G23-64p FPB in this system. For the power supply, check the circuit of the RL78/G23-64p FPB by referring to the manual, and set jumpers if required.

In this system, jumpers of the RL78/G23-64p FPB are set as shown in Table 3-1.

Table 3-1 Jumper pins setting of RL78/G23-64p FPB

Jumper pin	Setting	Function
J8	1-2 short-circuit	COM port debugging
J9		
J11		
J13	Open-circuit	5V power supply to MCU
J17	1-2 short-circuit	

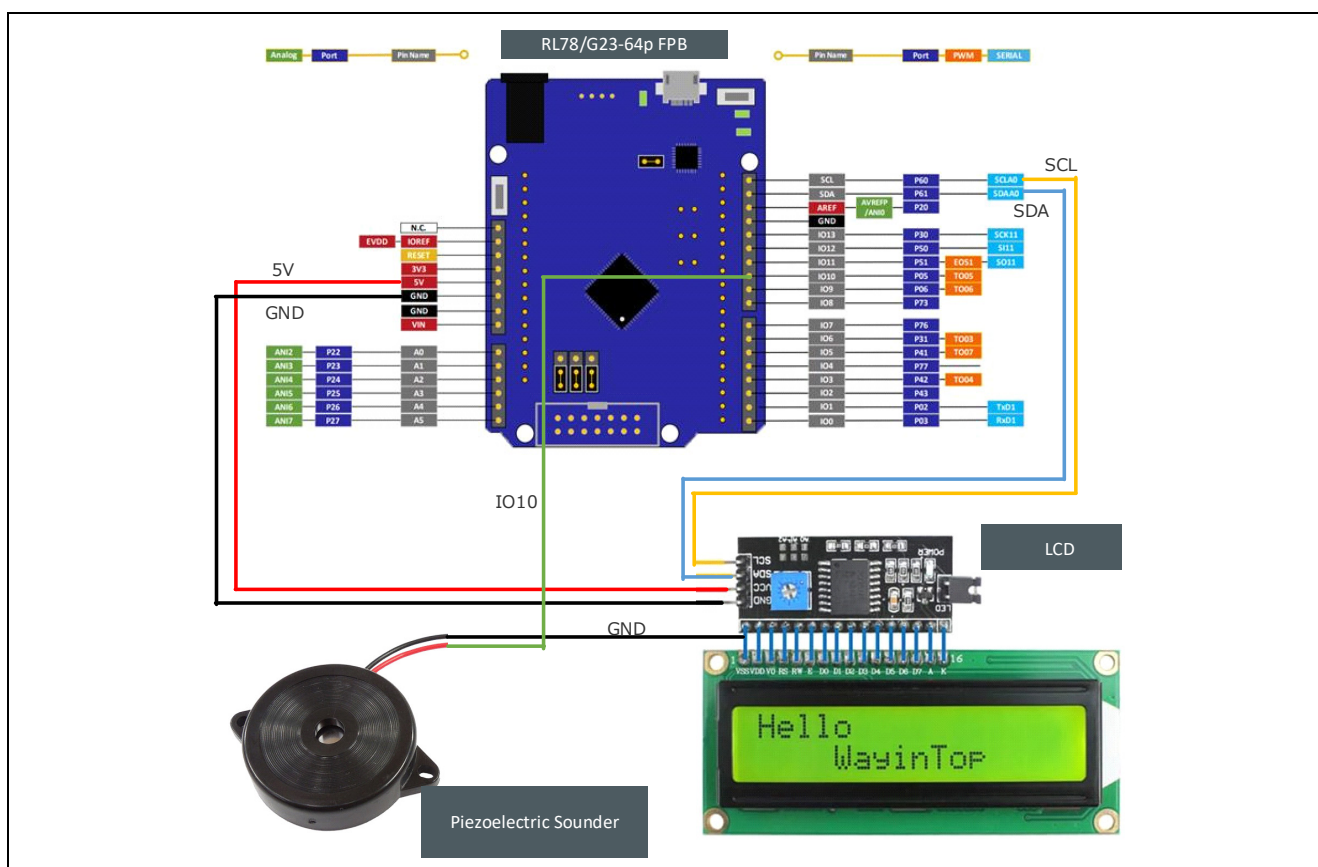


Figure 3-1 Connection of boards

3.2 List of pins used

The pins used in this system are shown below.

Table 3-2 Pins used

Item	Arduino™ signal name	Pin number of MCU	Pin
I2C	SDA	18	P61
	SCL	17	P60
Tone	IO10	31	P05
SW1	IO26	9	P137/INTP0
VDD	5V	-	-
GND	GND	14	-

For detailed pin descriptions of each board, refer to the following manuals.

RL78/G23-64p Fast Prototyping Board User's Manual (R20UT4814)

3.3 Setup of Arduino™ IDE

The setup procedure of Arduino™ IDE is explained.

Remark. The setup procedure is almost the same as the procedure explained on the [Quick Start Guide : renesas/Arduino Wiki · GitHub](#). The sample sketch to flash LED is described on the above site. Refer to it if required.

1. Start the Arduino™ IDE.
2. Click the [Tools] - [Board] - [Boards Manager...] menu.

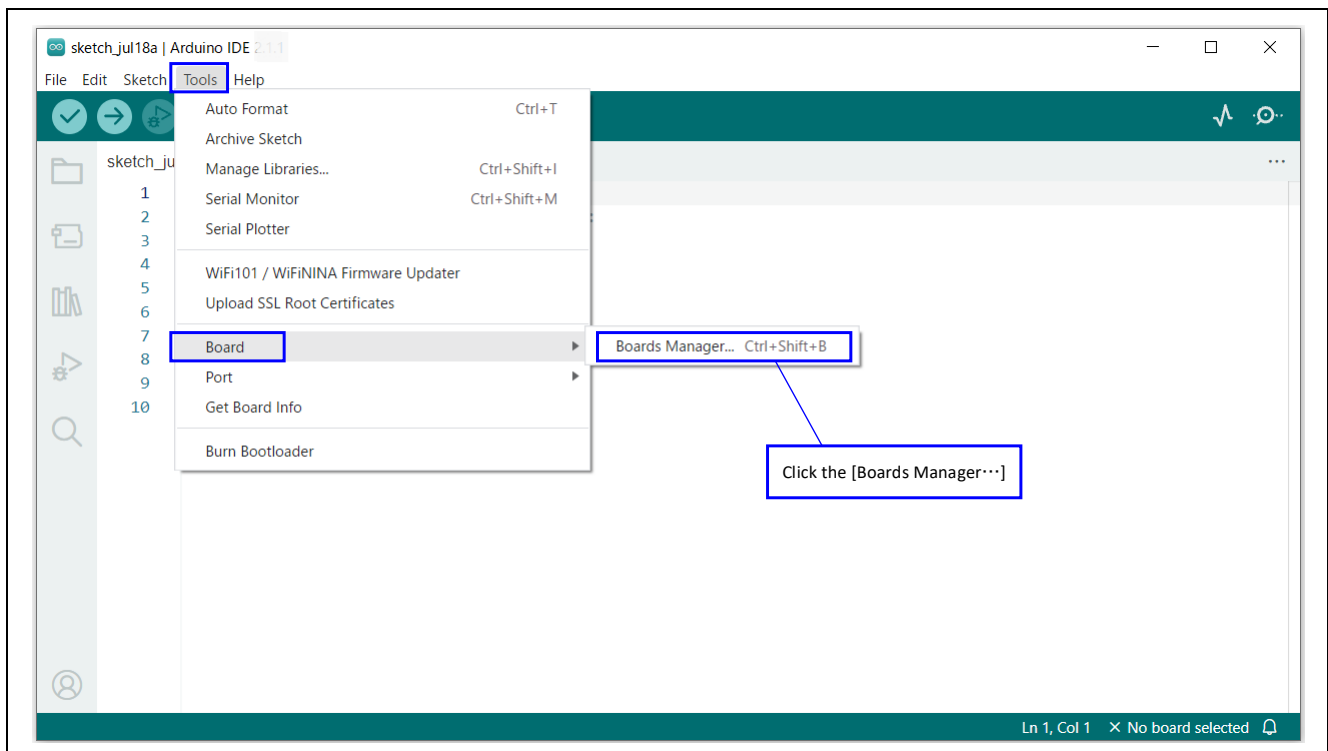


Figure 3-2 Selection of [Boards Manager...]

3. Select “All” at the [Type] and input “RL78/G23” in the textbox. Then, “RL78/G23-64p Fast Prototyping Board” is displayed. Next, click the [INSTALL].

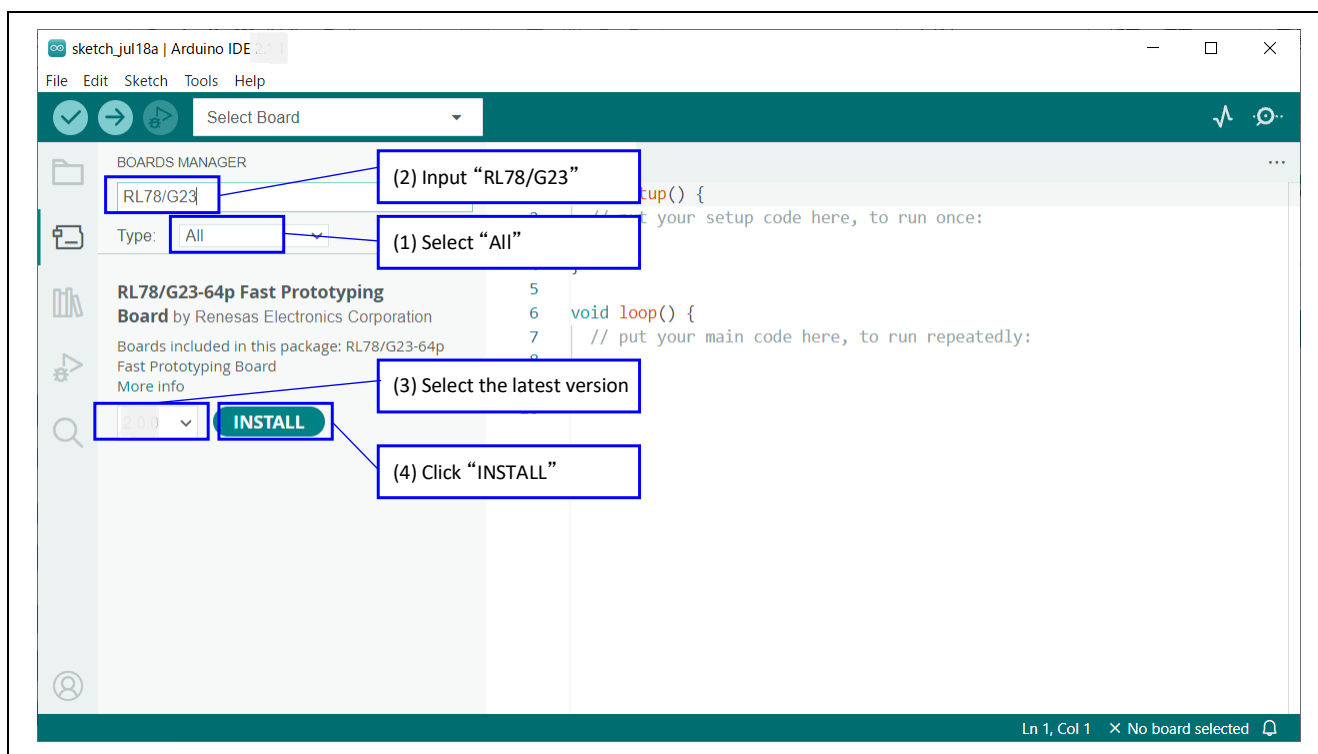


Figure 3-3 Installation of Board Manager

4. Select the serial port assigned to the RL78/G23-64p FPB from the [Tools] - [Port] menu.
COM port number can be checked at the Device Manager of Windows.

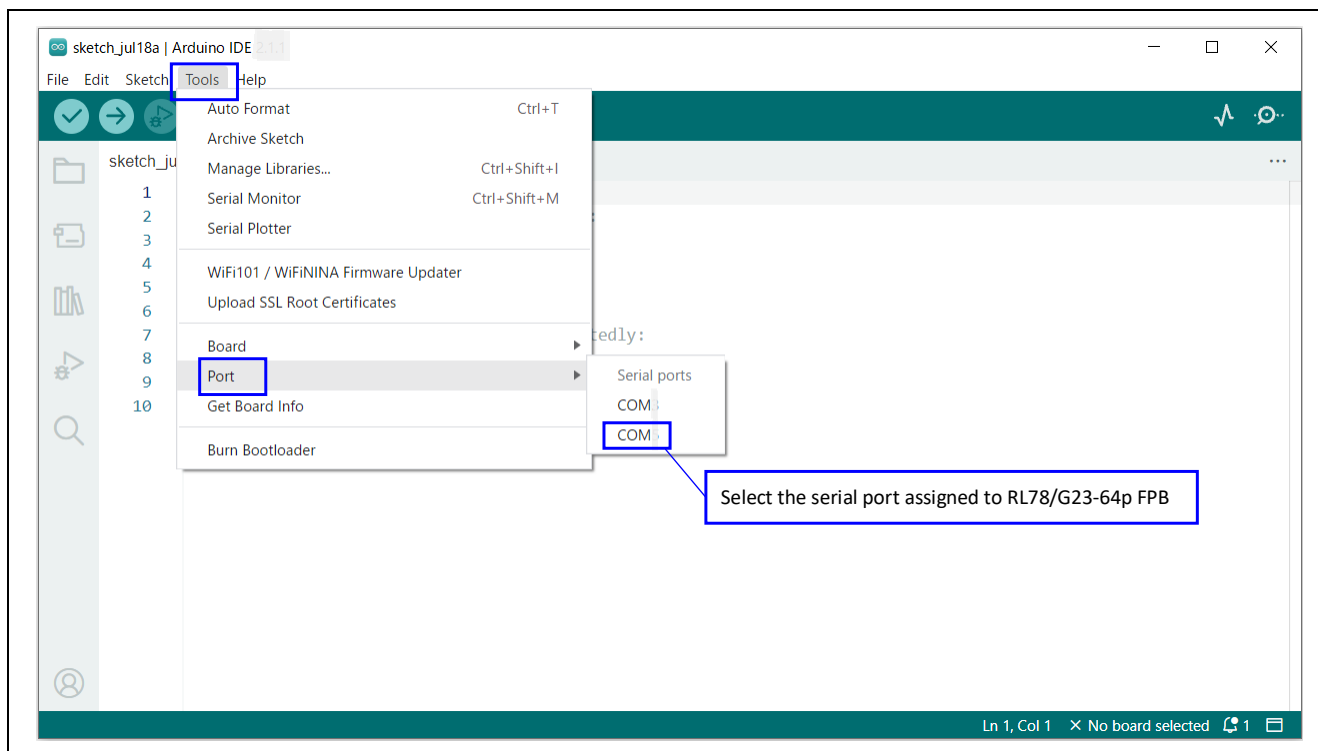


Figure 3-4 Selection of serial port

5. Select the [Tools] - [Board] - [RL78/G23-64p Fast Prototyping Board] - [RL78/G23-64p Fast Prototyping Board] menu.

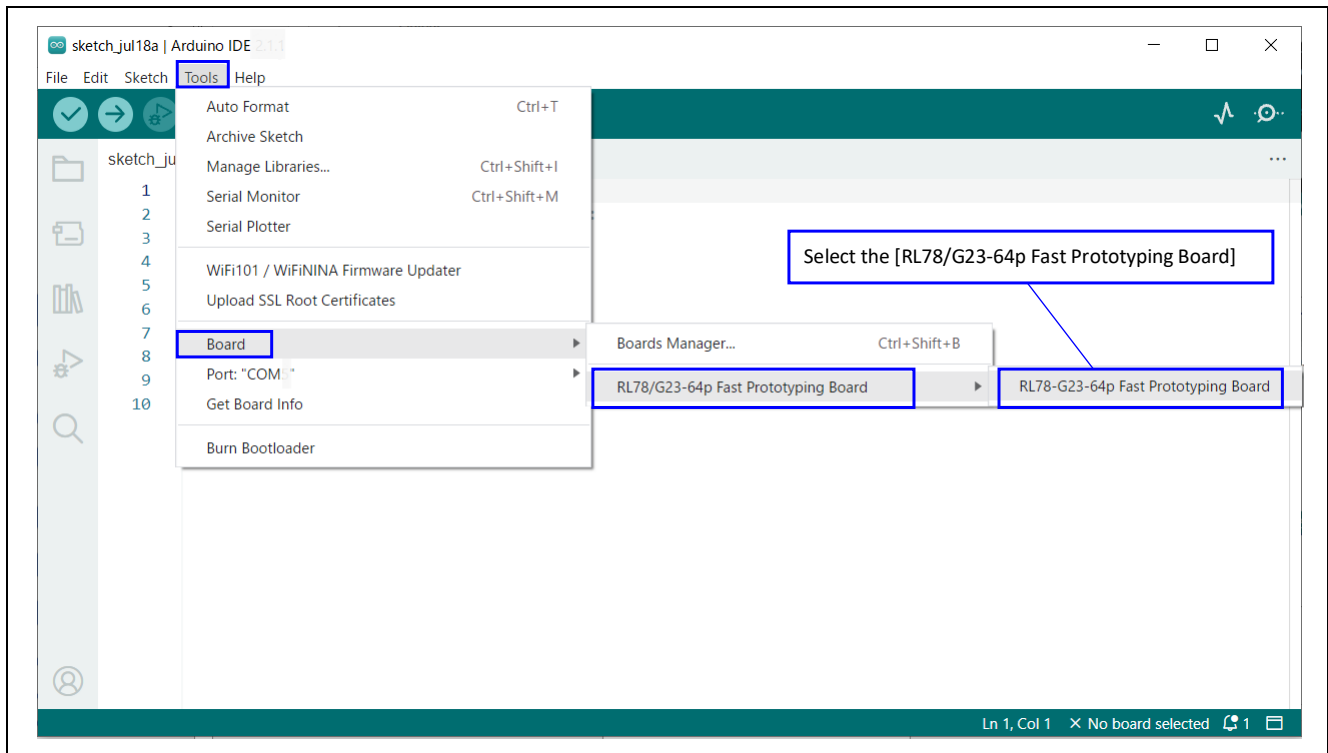


Figure 3-5 Selection of board

4. Software

4.1 Overview of sample code

This sample code is a sample sketch executed on the Arduino™ IDE. This sample uses “MSTimer2” to count down the remaining time until playing the sound, uses “Tone” to play the melody, and uses “Wire” to display the remaining time on the LCD display module with I2C. The file structure is shown below.

For details of API functions, refer to “4.3 API functions”, for details of the sample sketch, “4.4 Operating procedure of sample sketch”.

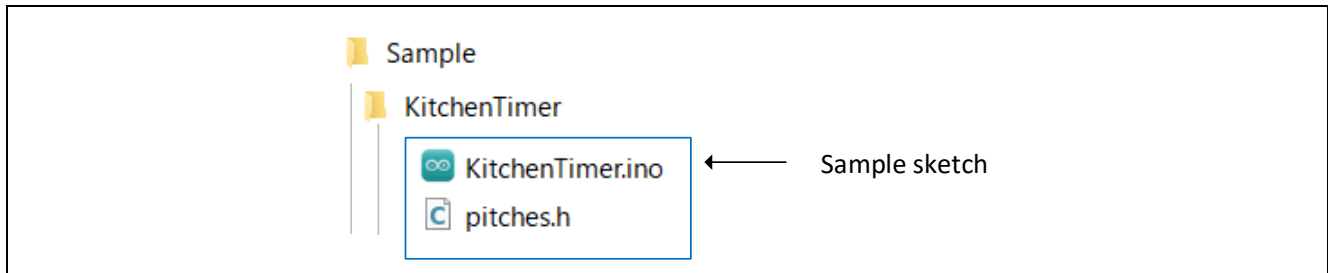


Figure 4-1 File structure of sample code

4.2 Sketch example used in sample code

This sample code uses sketch examples provided by Arduino™ IDE. The following shows how to refer to sketch examples.

4.2.1 MTimer2 / FlashLed

This is a sketch example that uses MTimer2 to blink the LED on the RL78/G23-64p Fast Prototyping Board every 0.5 seconds. How to refer to the sketch example is as follows.

1. Start the Arduino™ IDE.
2. Click the [Files] - [Examples] - [MTimer2] – [FlashLed] menu.

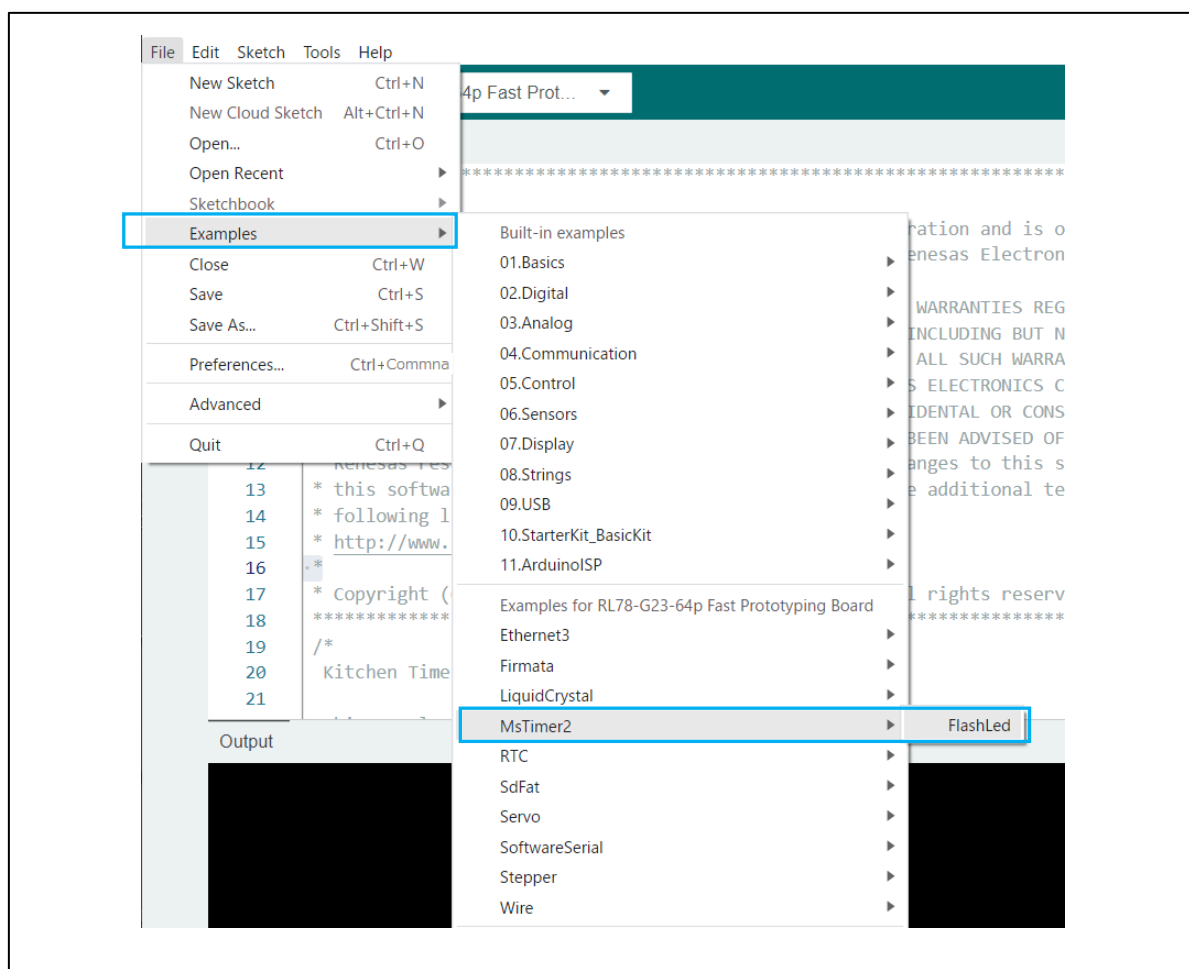


Figure 4-2 Selection of [MTimer2] – [FlashLed]

4.2.2 Wire / i2c-lcd

This is a sketch example that uses Wire to display "Hello RL78!" on the LCD display module with I2C. How to refer to the sketch example is as follows.

1. Start the Arduino™ IDE.
2. Click the [Files] - [Examples] - [Wire] – [i2c-lcd] menu.

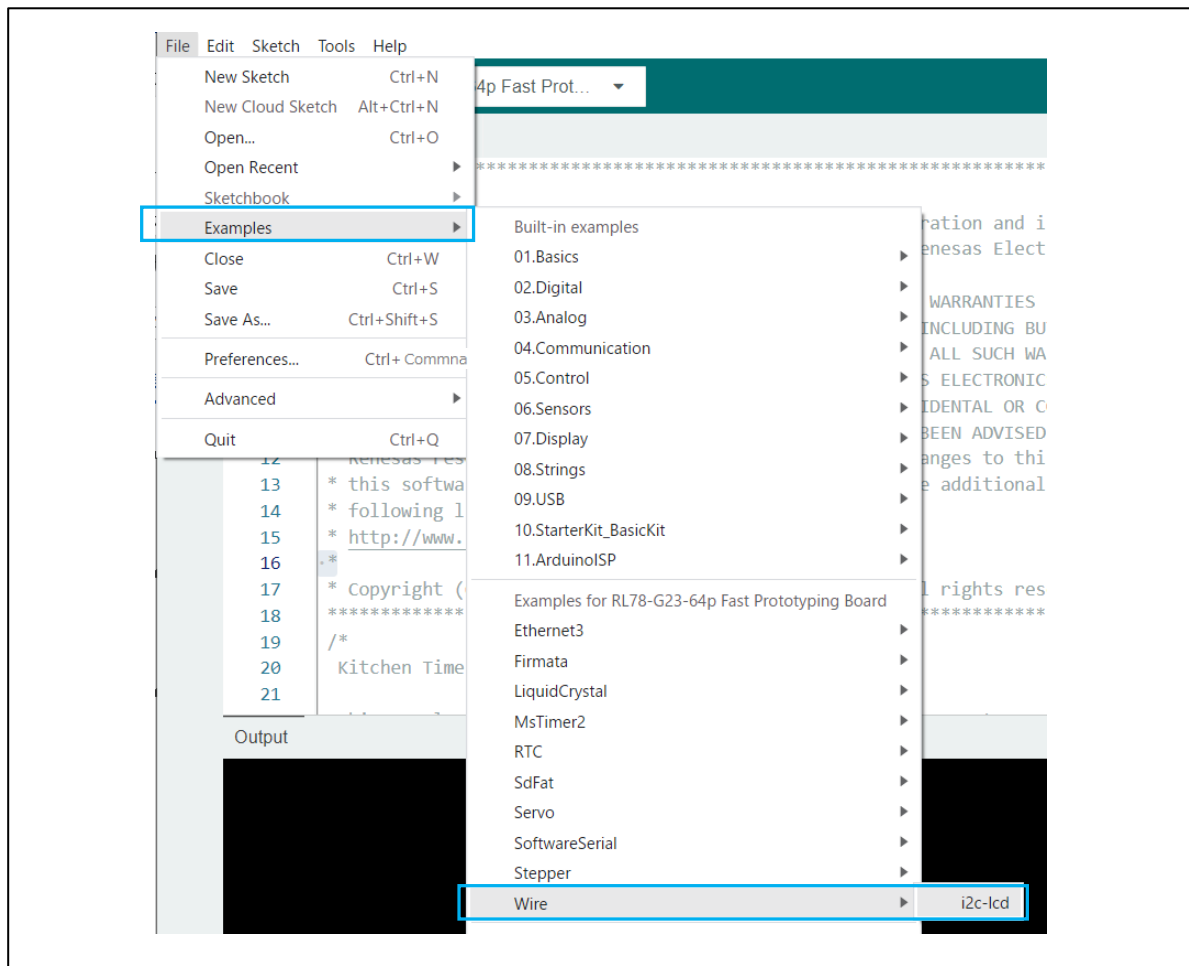


Figure 4-3 Selection of [Wire] – [i2c-lcd]

4.3 API functions

This sample code uses “digitalWrite” function, “Tone” related functions, “attachInterrupt” function, “MsTimer2” library and “Wire” library. The API functions of each library are shown below.

Table 4-1 List of APIs

API function	Function
<code>digitalWrite(pin,value)</code>	Output HIGH/LOW from the digital pin.
<code>tone(pin, frequency, duration)</code>	Output a square wave of the specified frequency to the digital pin.
<code>noTone()</code>	Stop generating square waves.
<code>Wire.begin(address)</code>	Initialize Wire library. In this sample, connect to the I2C bus as a master.
<code>Wire.setClock(clockFrequency);</code>	Change the clock frequency of I2C communication.
<code>Wire.beginTransmission(address)</code>	Begin a transmission to the I2C slave device with the given address.
<code>Wire.write(value)</code>	Add a character string or data to the end of the transmit buffer.
<code>Wire.endTransmission()</code>	Transmit the bytes that were queued by write() and end a transmission to a slave device.
<code>MsTimer2::set(ms, function)</code>	Specify a periodic operation executed in the specified interval (ms).
<code>MsTimer2::start()</code>	Start the periodic operation specified by set function.
<code>MsTimer2::stop()</code>	Stop the periodic operation.
<code>attachInterrupt(digitalPinToInterrupt(pin), ISR, mode)</code>	Specify a mode of an external interrupt and a function to call when an external interrupt occurs.

For API function specifications of each library, refer to the website of Arduino™ and the other.

[API List · renesas/Arduino Wiki · GitHub](#)

[digitalWrite\(\) - Arduino Reference](#)

[tone\(\) - Arduino Reference](#)

[noTone\(\) - Arduino Reference](#)

[Wire - Arduino Reference](#)

[MsTimer2 - Arduino Reference](#)

[attachInterrupt\(\) - Arduino Reference](#)

4.3.1 API functions for LCD display module with I2C

The functions that control the LCD display module with I2C are shown below.

(1) LCD module initialization

Outline	Initialize LCD module.	
API function	lcd_init ()	
Usage example	lcd_init ()	Initialize LCD module.

(2) LCD module control command transmission

Outline	Send the command to control the LCD module.	
API function	lcd_send_cmd(cmd)	
cmd	Control command	
Usage example	lcd_send_cmd (0x01)	Send the command to clear LCD display.

(3) LCD module display data transmission

Outline	Send characters to display on the LCD module.	
API function	lcd_send_data(data)	
data	Character	
Usage example	lcd_send_data (0x30)	Send the data to display "0" on the LCD.

(4) Clearing LCD display module

Outline	Clear the LCD display module.	
API function	lcd_clear()	
Usage example	lcd_clear ()	Clear the LCD display.

(5) Specifying LCD display position

Outline	Specify the character display position.	
API function	lcd_put_cur(row, col)	
row	Display position of the vertical axis	
col	Display position of the horizontal axis	
Usage example	lcd_put_cur(0, 3)	Specify the 4th character of the 1st line.

(6) LCD module display string transmission

Outline	Send the string data to display on the LCD.	
API function	lcd_send_string(str)	
str	String data	
Usage example	lcd_send_str ("Hello")	Display "Hello" on the LCD.

4.4 Operating procedure of sample sketch

The operation procedure of this sample sketch is shown below. Before the steps below, setup the Arduino™ IDE in the “3.3 Setup of Arduino™ IDE”.

1. Select the [File] - [Open...] menu to open the sample sketch “KitchenTimer.ino”.

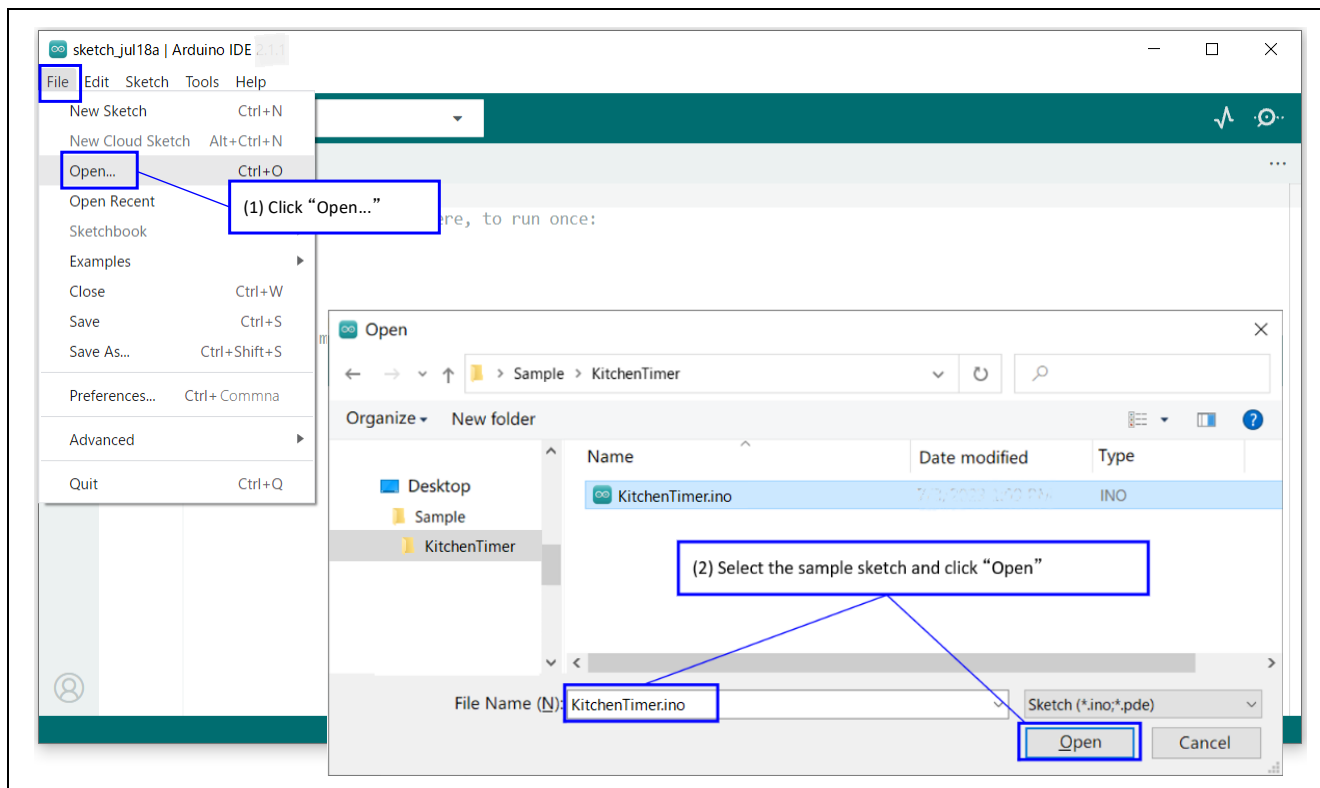


Figure 4-4 Select sample sketch

- Click the [Verify] icon to start compiling the sketch.

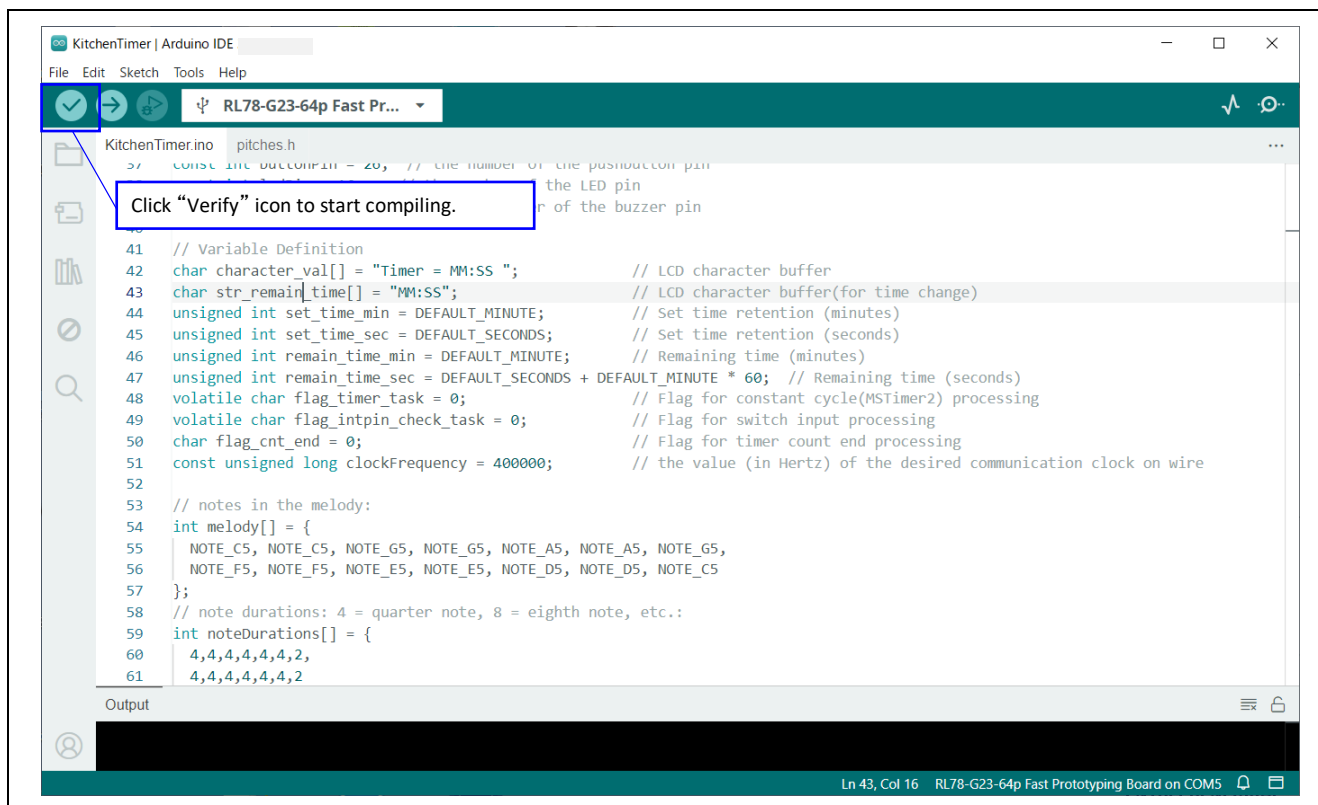


Figure 4-5 Compile sketch

- After compiling is finished, click the [Upload] icon to write the program to the device.

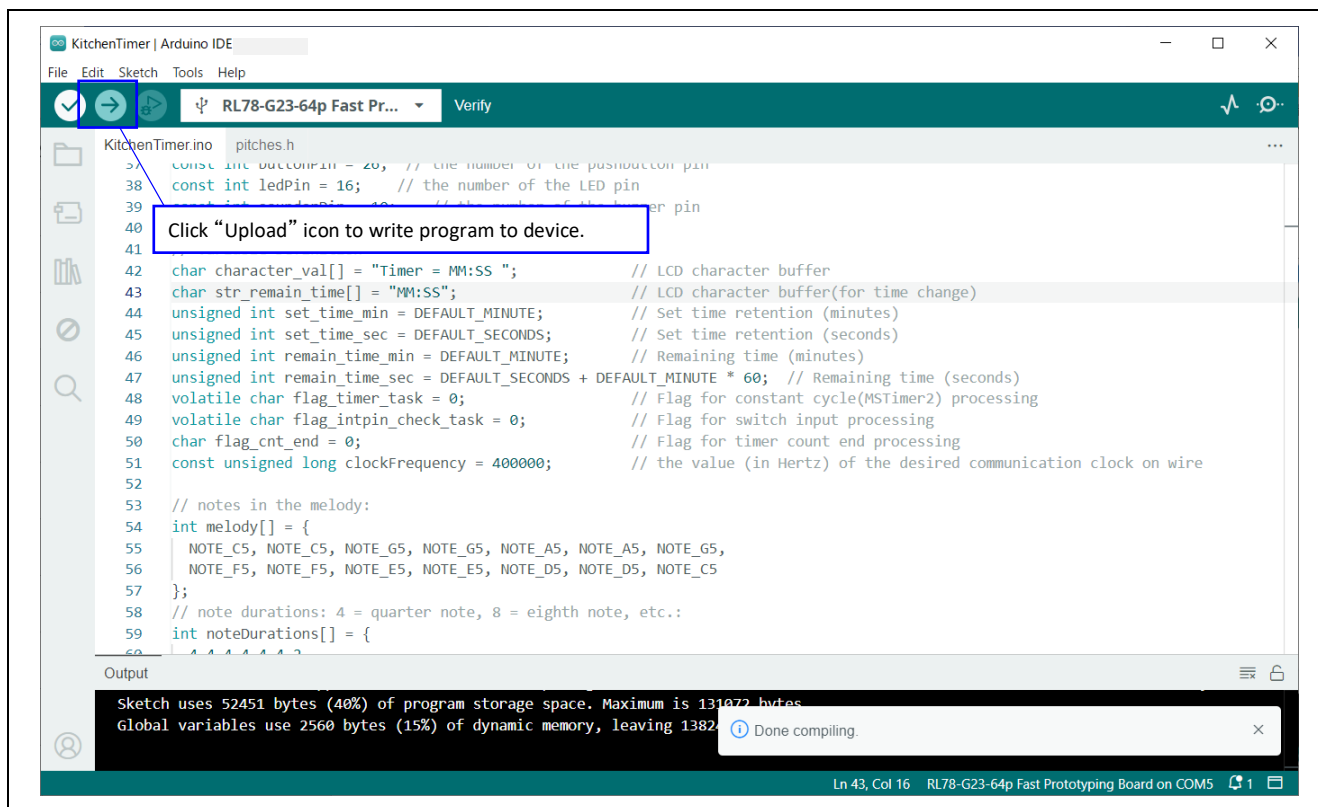


Figure 4-6 Write sketch to board

4. After writing is finished, RL78/G23 starts operation and “Timer = 3:00” is displayed on the LCD.



Figure 4-7 Initial display of LCD module

5. Press the switch SW1 on the FPB to start the countdown.



Figure 4-8 LCD module display during countdown

4.5 Flowchart

4.5.1 main processing

The flow of the sample sketch is shown below.

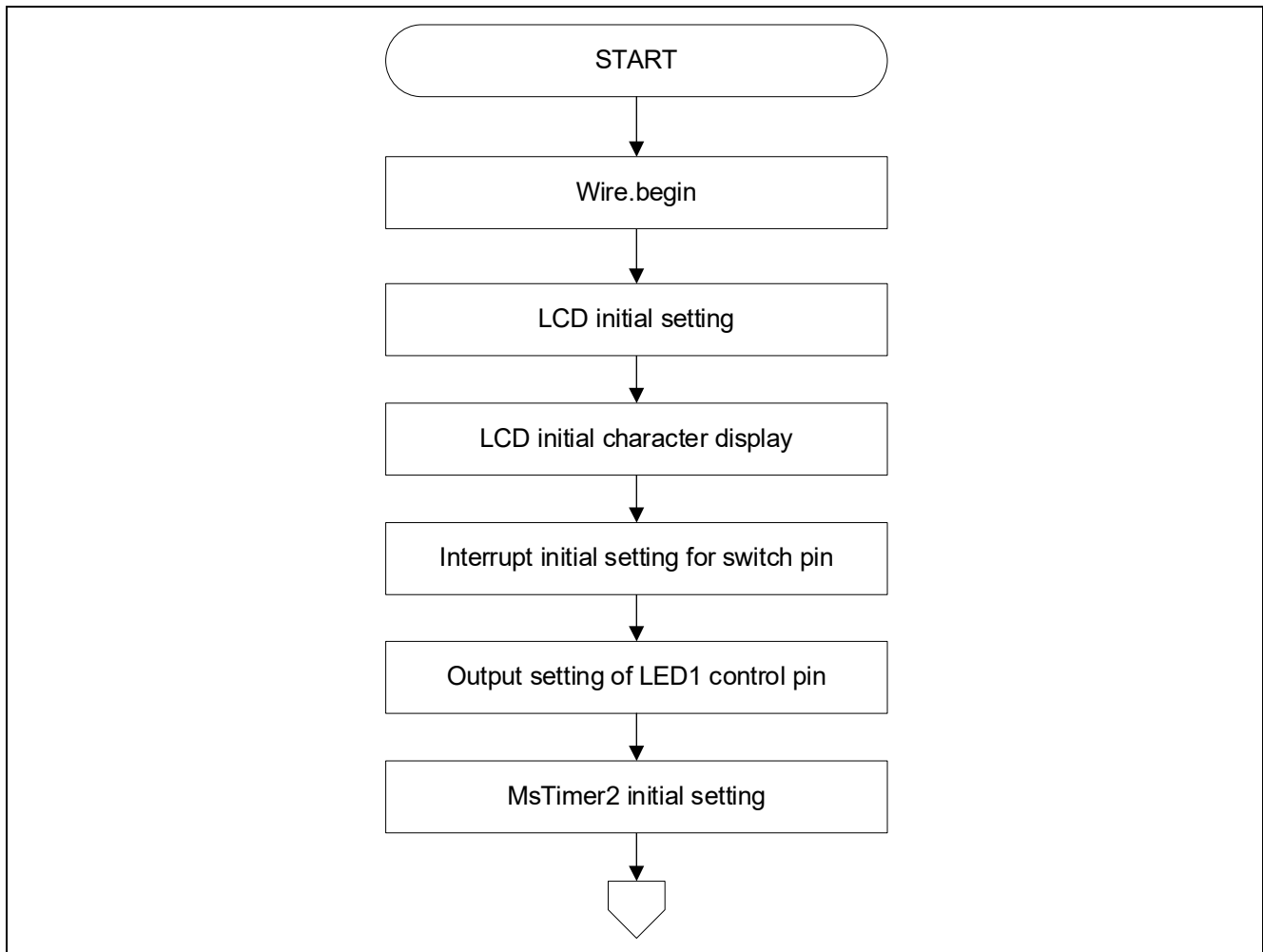


Figure 4-9 Flowchart of main processing (1/2)

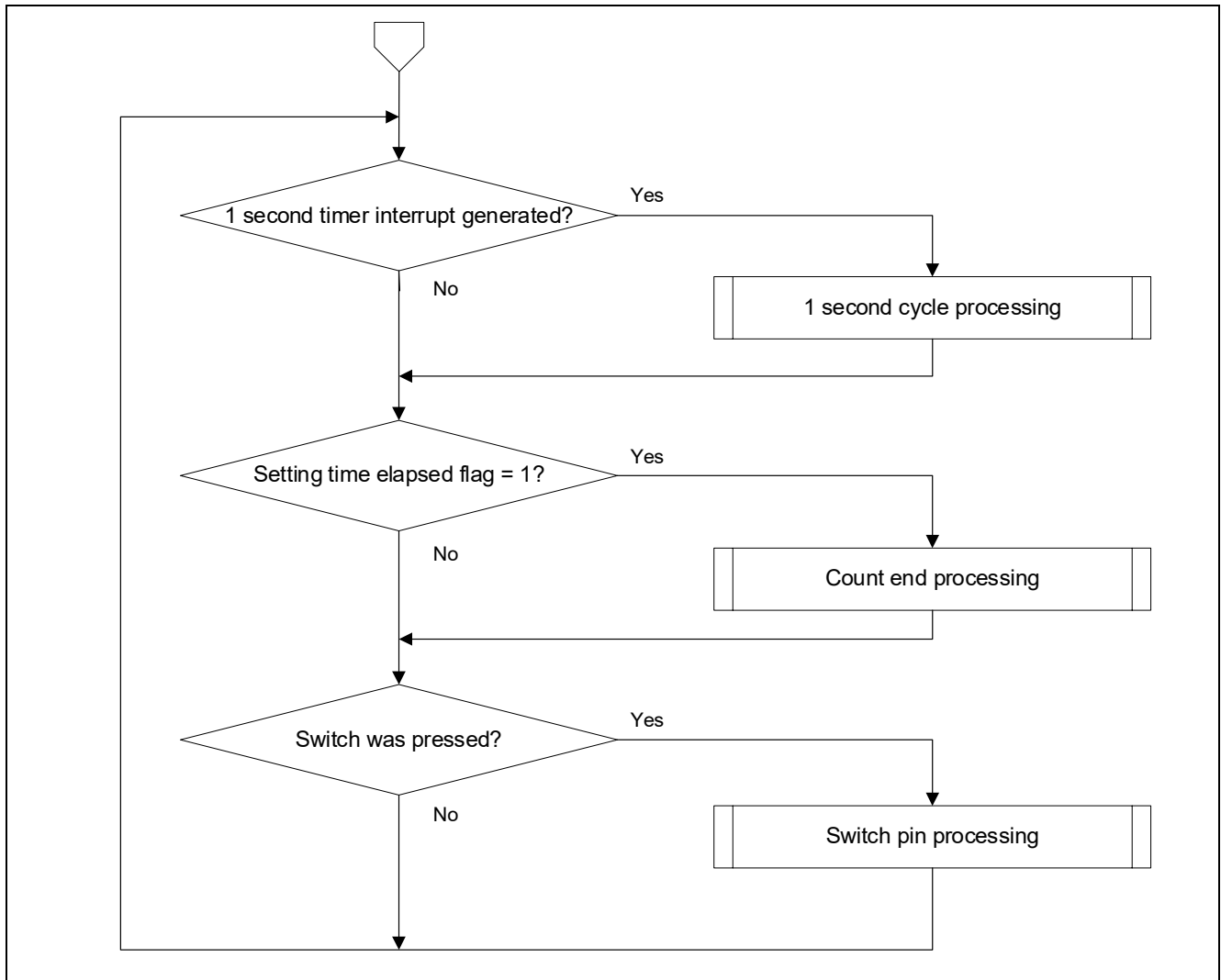


Figure 4-10 Flowchart of main processing (2/2)

4.5.2 Sub routine

The flow of processing of functions called from the loop function is shown below.

(1) timerTask:

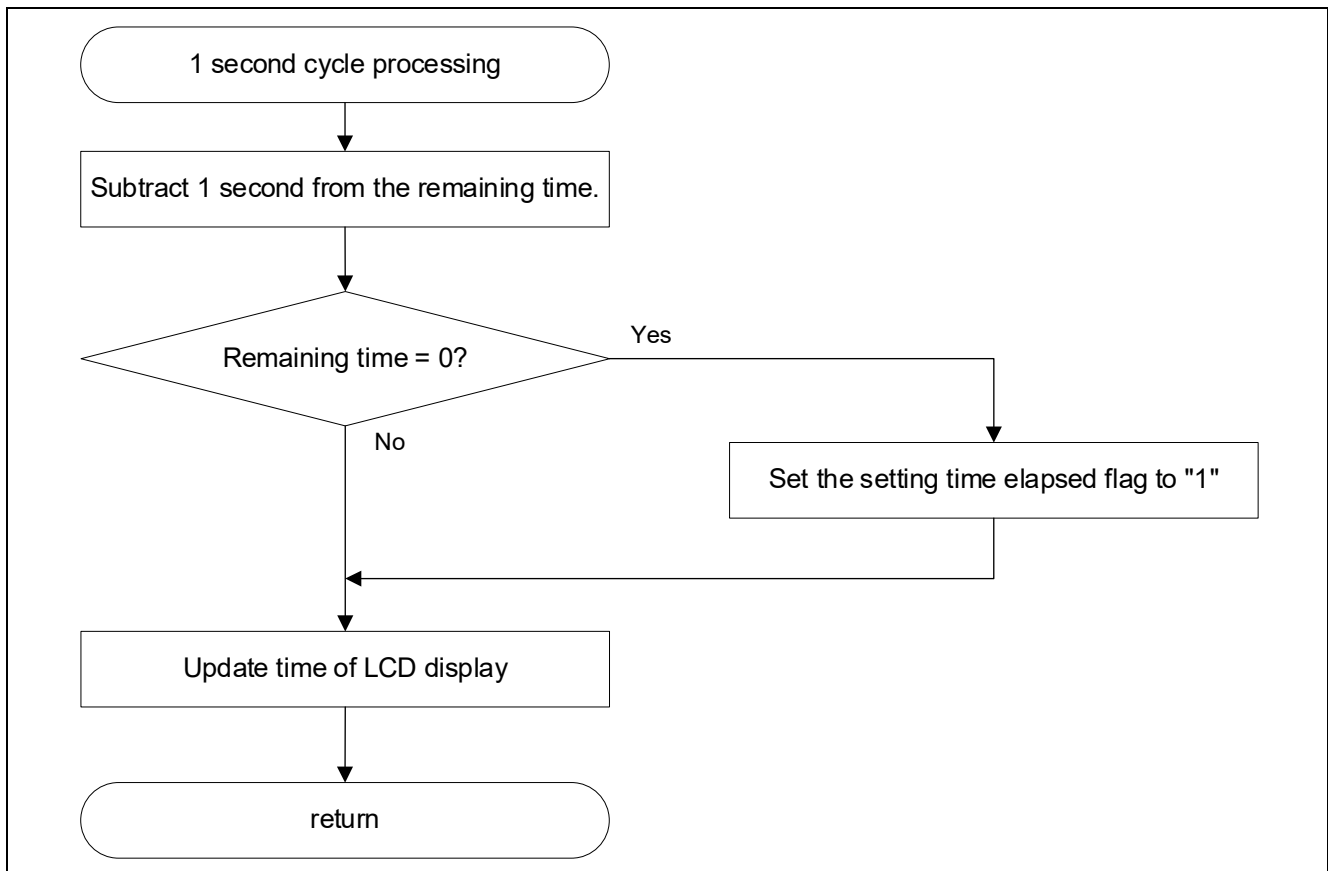


Figure 4-11 Flowchart of timerTask

(2) timeEnd:

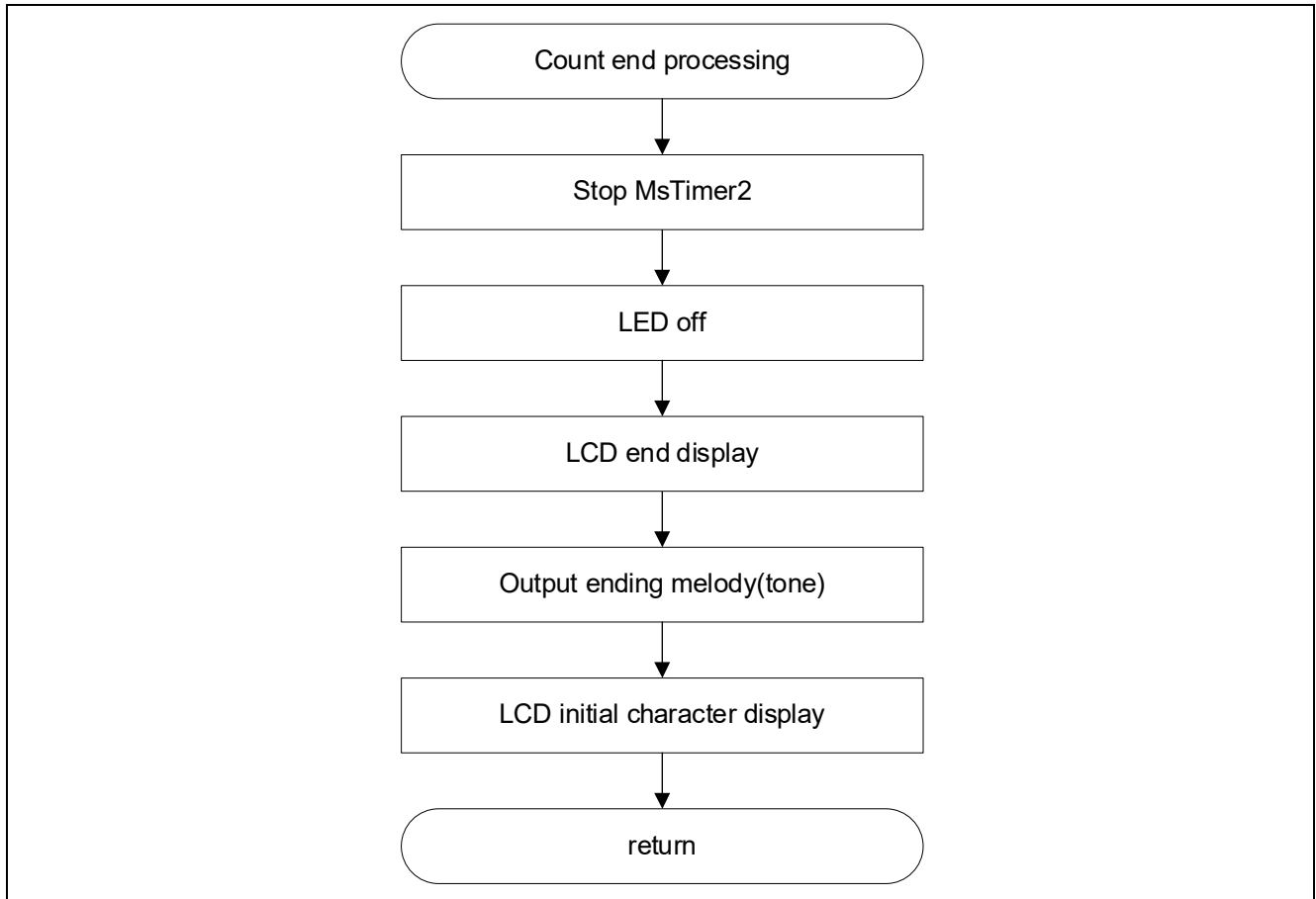


Figure 4-12 Flowchart of timeEnd

(3) intpinCheck :

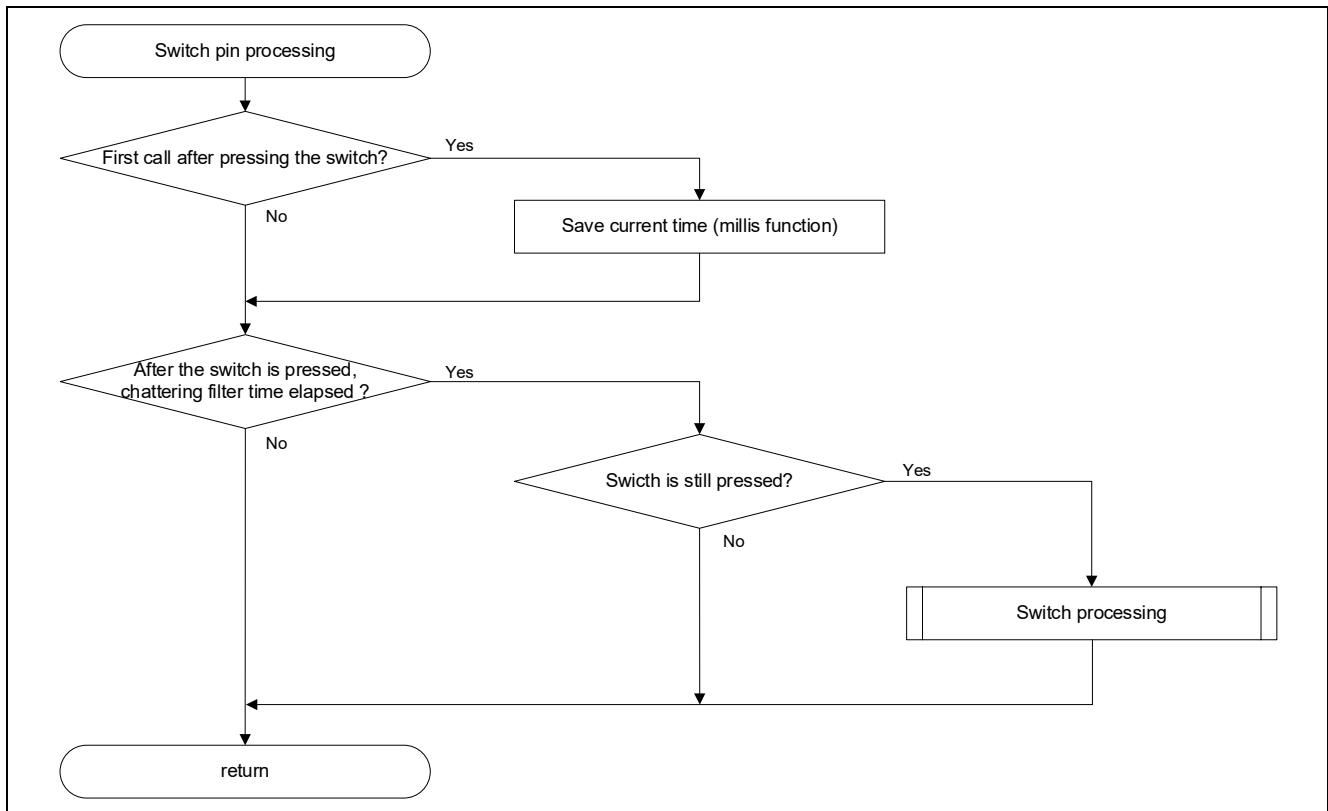


Figure 4-13 Flowchart of intpinCheck (1/2)

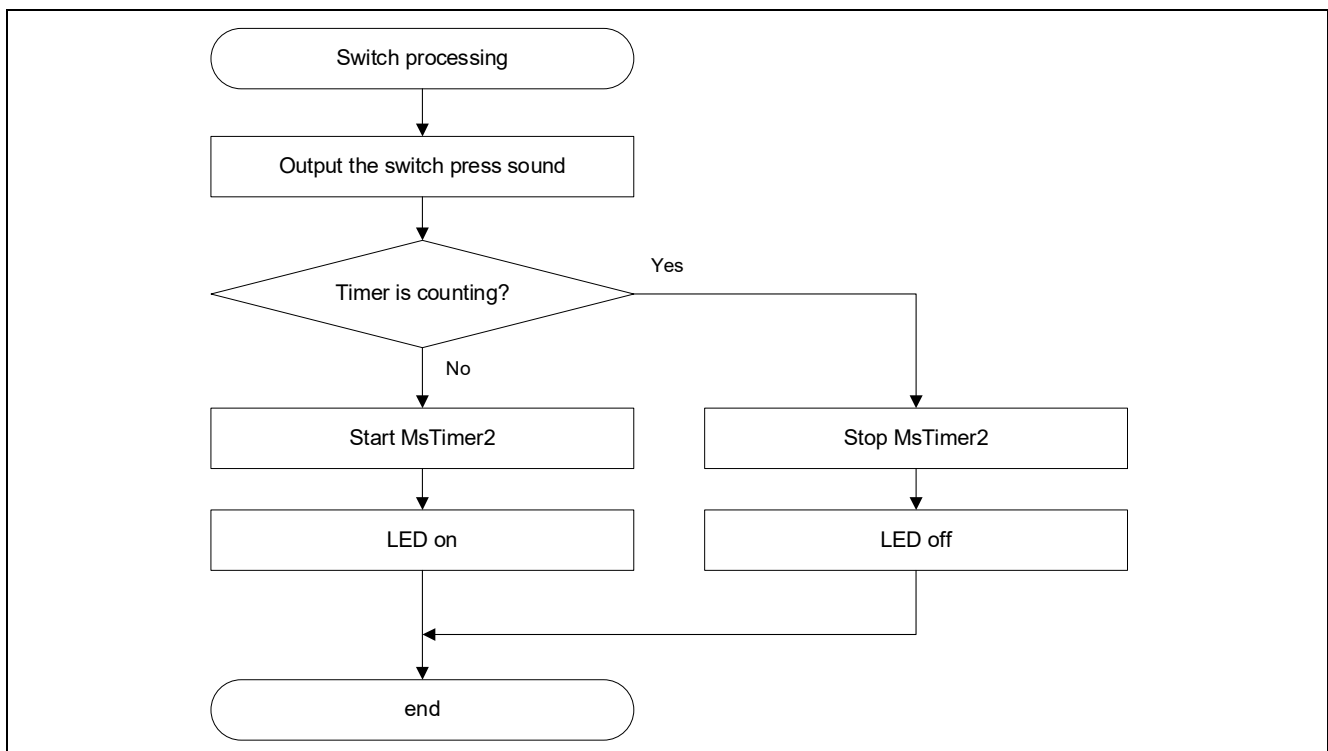


Figure 4-14 Flowchart of intpinCheck (2/2)

4.5.3 Specification of functions

The details of the sub routine are as follows.

void timerTask(void)

Outline	Subtract the remaining time of the timer count operation and displays the remaining time on the LCD.
Argument	None
Return value	None

void timerEnd (void)

Outline	Timer count end operation. Output a melody to notify the end of the count and display a message indicating the end of the count on the LCD.
Argument	None
Return value	None

void intpinCheck (void)

Outline	Processing when the switch is pressed. Removes chattering when the switch is pressed, output the sound when the switch is pressed and control the stop/start of timer counting operation
Argument	None
Return value	None

4.6 Application example

4.6.1 Change the set time

By implementing the function of inputting and operating data from the outside, it is possible to add the function "changing the set time". For example, by long-pressing a switch, the system enters the "setting time change mode", and in that mode, you can change the setting time by short-pressing the switch to increment the "setting time".

In this sample sketch, the default setting time is defined like below. It is possible to change the setting time by changing the defined values in the source code.

Definition of the default setting time (minutes) : `#define DEFAULT_MINUTE 3` Note1

Definition of the default setting time (seconds) : `#define DEFAULT_SECONDS 0` Note2

Variable that holds the set time (minutes) : `unsigned int set_time_min`

Variable that holds the set time (seconds) : `unsigned int set_time_sec`

Note1. Set as an integer value greater than or equal to 0.

Note2. Set as an integer value in the range of 0 to 59.

4.6.2 Change the count end melody

In this sample sketch, the count end melody is defined in the following array. By changing the contents of the array, it is possible to change to a different melody. Please refer to the URL below for details.

[Play a Melody using the tone\(\) function](#)

Array that makes up the melody : `int melody[ ]` Note1

Array that specifies the length of each pitch of the melody : `int noteDurations[ ]` Note2

Note1. Set the frequency of each pitch to the array.

Note2. Set the length of each pitch to the array.

5. Notes

5.1 COM port is not displayed on the Windows Device Manager

When connecting the PC and the evaluation board (RL78/G23-64p FPB) for the first time, the PC may not recognize the port and the COM port may not be displayed in Windows Device Manager.

If the COM port is not displayed, install the driver of the USB-to-serial convertor (FT232RQ) from FTDI on the RL78/G23-64p FPB by the following procedure.

1. Download the latest driver installer for the target OS from FTDI's website and install it.
<https://ftdichip.com/drivers/vcp-drivers/>
2. After installation, "USB Serial Port (COMx)" is displayed under the "Ports (COM & LPT)" on the Device Manager. In the following figure, COM5 is the target COM port.

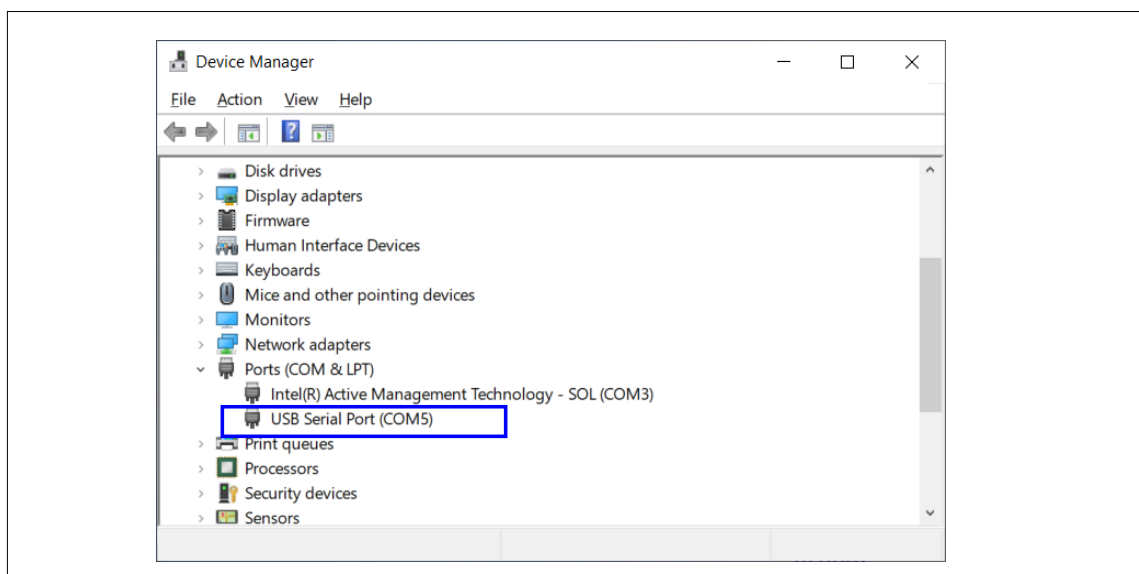


Figure 5-1 Windows Device Manager after installation of device driver

For details of USB-to-serial convertor and COM port, refer to "5.11 USB-to-Serial Converter" and "5.12 USB-to-Serial Converter Reset Header" in RL78/G23-64p Fast Prototyping Board User's manual.

5.2 Program is not written correctly to RL78/G23-64p Fast Prototyping Board

It may not be connected correctly the PC and the RL78/G23-64p FPB even if “USB Serial Port (COMx)” is displayed. Because the RL78/G23-64p FPB is not recognized correctly.

If the program is not written correctly, double-click the target COM port on Windows Device Manager and clear the checkbox of [Serial Emulator].

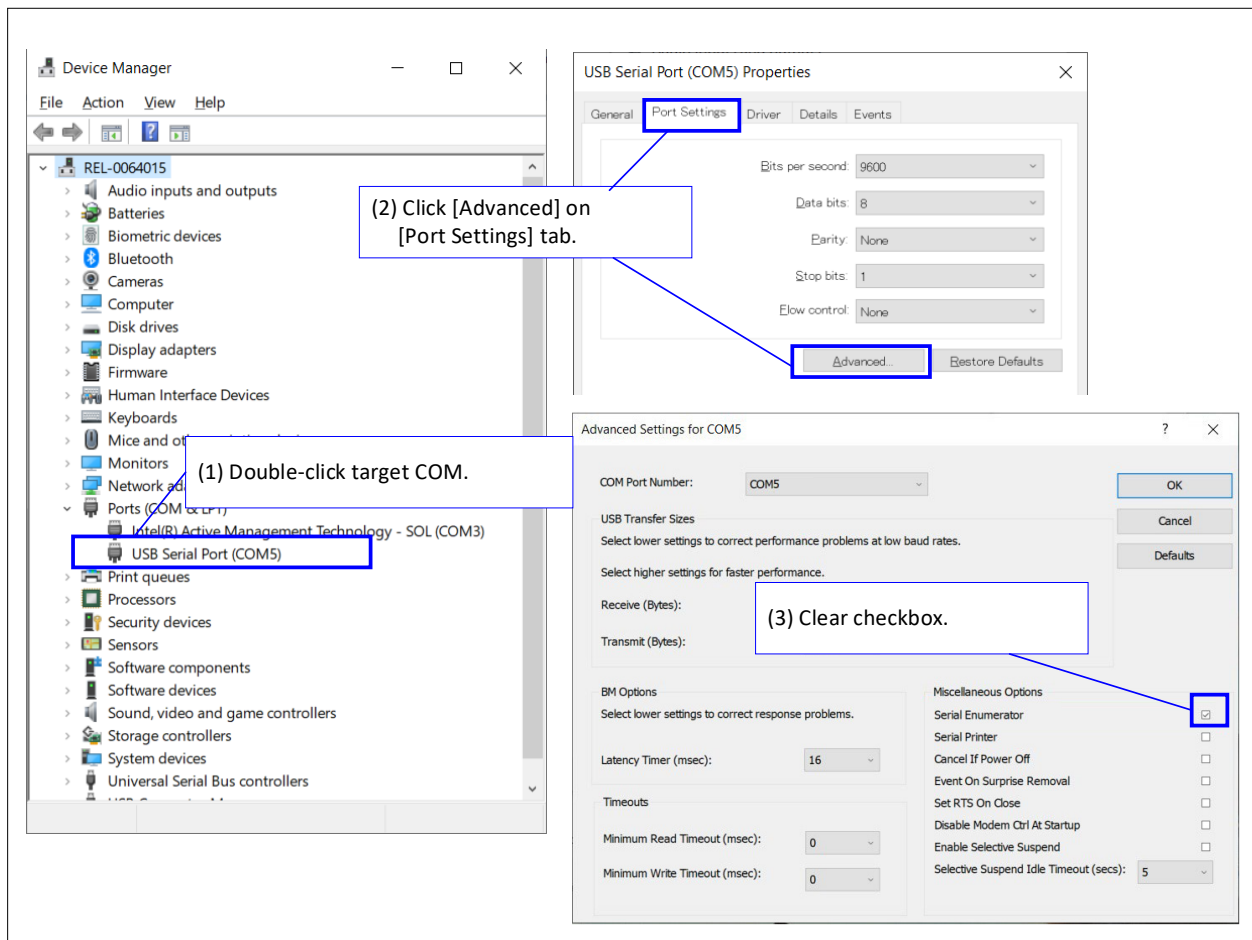


Figure 5-2 Setting example of target COM

6. Sample Code

There is the sample code for this application note.

Sample code can be downloaded from the Renesas Electronics website.

7. Reference Documents

RL78/G23 User's Manual: Hardware (R01UH0896)

RL78/G23-64p Fast Prototyping Board User's Manual (R20UT4814)

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

Technical update

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

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Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Apr.23.24	-	First edition

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.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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