RL78/G23 Group

Touchless Button Electrode Board Sample Software

Introduction

This Application Note describes the Touchless Button Electrode Board sample software as an application example of the self-capacitance method used in Capacitive Touch Sensing Unit2L (CTSU2L) hardware. CTSU2L detects human touch by measuring the electrostatic capacitance generated between the touch electrode and the human body.

Target Device

RL78/G23 Group

Related Documents

1. RL78 Family Using QE and SIS to Develop Capacitive Touch Applications (R01AN5512)
2. RL78 Family Board Support Package Module Using Software Integration System (R01AN5522)
3. RL78 Family TOUCH Module Software Integration System (R11AN0485)
4. RL78 Family CTSU Module Software Integration System (R11AN0484)
5. Capacitive Sensor Microcontrollers Touchless Button Electrode Board (R12AN0115)
6. RL78/G23 Capacitive Touch Evaluation System User's Manual (R12UZ0095)
7. RL78/G23 User's Manual: Hardware (R01UH0896)

Contents

1. Overview

This Application Note describes the sample software that runs on the touchless button electrode board based on capacitive touch detection.

This software is provided in e² studio project format including the sample application.

The file structure is the same as that of a general touch button using QE for Capacitive Touch (hereafter QE), which is a development support tool for capacitive touch sensor application, and SIS module.

A general touch button is tuned with QE while a finger is touching the electrode. On the other hand, the touchless button is set with QE tuning while a finger is hovered above the electrode. Appropriate tuning can be made when the used jig is fixed, or otherwise the threshold values can be set by correcting QE output file. This software is set with the latter.

For the specification of the touchless button electrode board, please refer to the related document, ‘Capacitive Sensor Microcontrollers Touchless Button Electrode Board (R12AN0115)’.

There are 2 types of touchless button electrode boards, with housing type and without housing type. Figure 1.1 shows each type of board connected to the CPU board.

The sample software is configured with standard settings with housing for 3 types: 4 buttons, 9 buttons, and 12 buttons.

For standard settings with housing, please refer to ‘2.1 Product Configuration (with housing)’ of ‘Capacitive Sensor Microcontrollers Touchless Button Electrode Board (R12AN0115)’.

For configuration with non-standard settings with housing or configuration without housing, please retune the project for each electrode.

Figure 1.1 Touchless Button Electrode Board (Left: with housing, Right: without housing)

As shown in Figure 1.2, the touchless button electrode board is configured so that the electrodes of the touch detection board can be replaced. The touch electrodes are attached to the back of the acrylic plate and touch is judged based on the detected count value with hand approach.

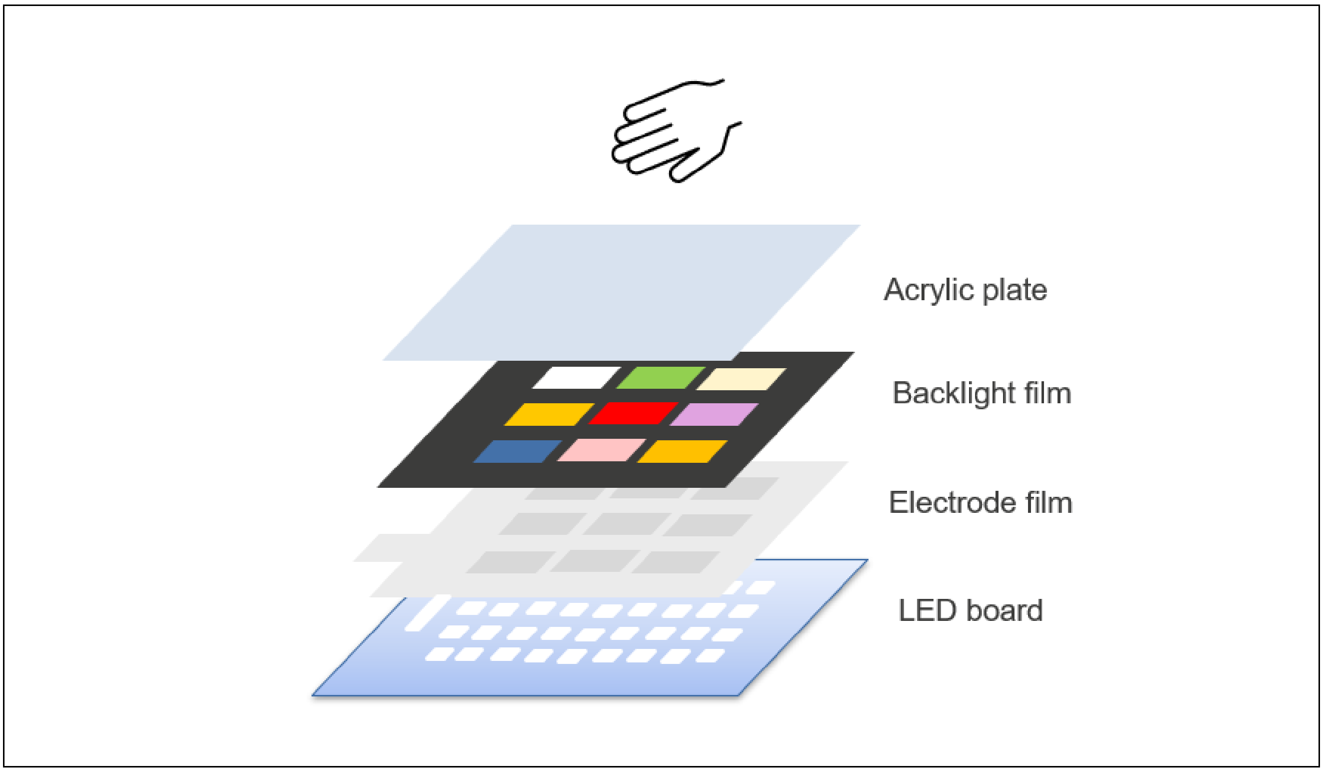

Figure 1.2 Touchless Button Electrode Board Configuration

2. Operating Environment

Table 2.1 and Table 2.2 show the software operating environment with/without housing, respectively。

Table 2.1 Operating Environment 1

Item	Description
CPU Board	RL78/G23 Group Capacitive Touch Evaluation System CPU Board (RTK0EG0030S01001BJ)
Electrode Board	Touchless Button Electrode Board (with housing) (RTK0ES1001D01001BJ)
Microcontroller	RL78/G23
Operating frequency	32 MHz
Operating voltage	5.0 V
Integrated Development Environment	e² studio Version: 2021-10 (21.10.0)
C compiler	CC-RL V1.10.00
Capacitance touch IDE	QE for Capacitive Touch V2.0.0

Table 2.2 Operating Environment 2

Item	Description
CPU Board	RL78/G23 Group Capacitive Touch Evaluation System CPU Board (RTK0EG0030S01001BJ)
Electrode Board	Touchless Button Electrode Board (w/o housing) (RTK0ES1001D02001BJ)
Microcontroller	RL78/G23
Operating frequency	32 MHz
Operating voltage	5.0 V
Integrated Development Environment	e² studio Version: 2021-10 (21.10.0)
C compiler	CC-RL V1.10.00
Capacitance touch IDE	QE for Capacitive Touch V2.0.0

3. Software Structure

Figure 3.1 shows the software structure.

TOUCH module detects touch from the electrostatic capacitance measurement results of CTSU module.

The application informs the touch detection result to the user by LED light of the touchless button electrode board and sound output.

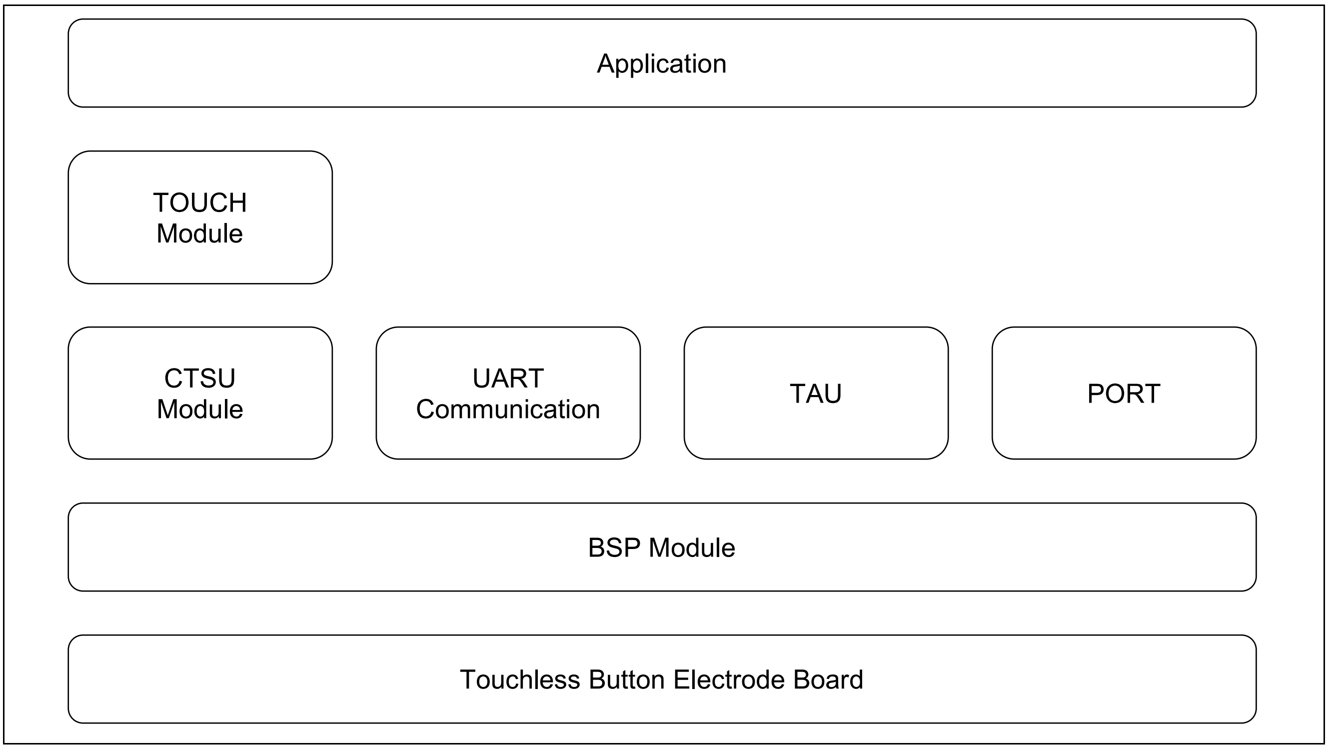

Figure 3.1 Software Structure

Table 3.1 shows the version of SIS modules and code generations which are used in this software.

Table 3.1 Version of SIS and Code Generation

SIS Module	Version
BSP	1.12
CTSU	1.10
TOUCH	1.10
Code generation	**Version**
Port	1.0.0
Interval Timer	1.0.0
UART Communication	1.0.0

4. File Structure

Table 4.1 shows the file structure of this software and the changes from Smart Configurator generation file.

The SIS modules are not changed. For SIS modules, please refer to each Application Note.

Table 4.1 File Structure

Folder/File Name	Changed
Project	-
qe_gen	-
qe_touch_config.c	Adjustment of the tuning value
qe_touch_config.h	-
qe_touch_define.c	-
qe_touch_sample.c	Sample application
src	-
main.c	Call Sample application
r_touchless_led_board.c	LED/Sound output application
smc_gen	-
Config_PORT (File structure omitted)	-
Config_TAU0_0	-
Config_TAU0_0.c	-
Config_TAU0_0.h	-
Config_TAU0_0_user.c	Call LED application
Config_TAU0_1	-
Config_TAU0_1.c	-
Config_TAU0_1.h	-
Config_TAU0_1_user.c	Call Sound output application
Config_UARTA1 (File structure omitted)	-
general (File structure omitted)	-
r_bsp (File structure omitted)	-
r_config (File structure omitted)	-
r_ctsu (File structure omitted)	-
r_pincfg (File structure omitted)	-
rm_touch (File structure omitted)	-

5. Sample Application

The following describes the sample application.

5.1 Overview of Operation

Figure 5.1 shows the operation overview of this software.

1. After power-on, start initialization.
2. When the offset tuning is completed normally, the LED turns on for 1 sec according to the electrode configuration, then turns off. (When it is completed abnormally, the LED keeps blinking until reset.)
3. After the LED turns off, the touch measurement loop starts to judge touch. Multiple touch detection is not supported.
4. When touch is detected, the LED turns on and sound is output. For LED turn on, refer to '5.4 LED Turn On'. For sound output, refer to '5.5 Sound Output'.

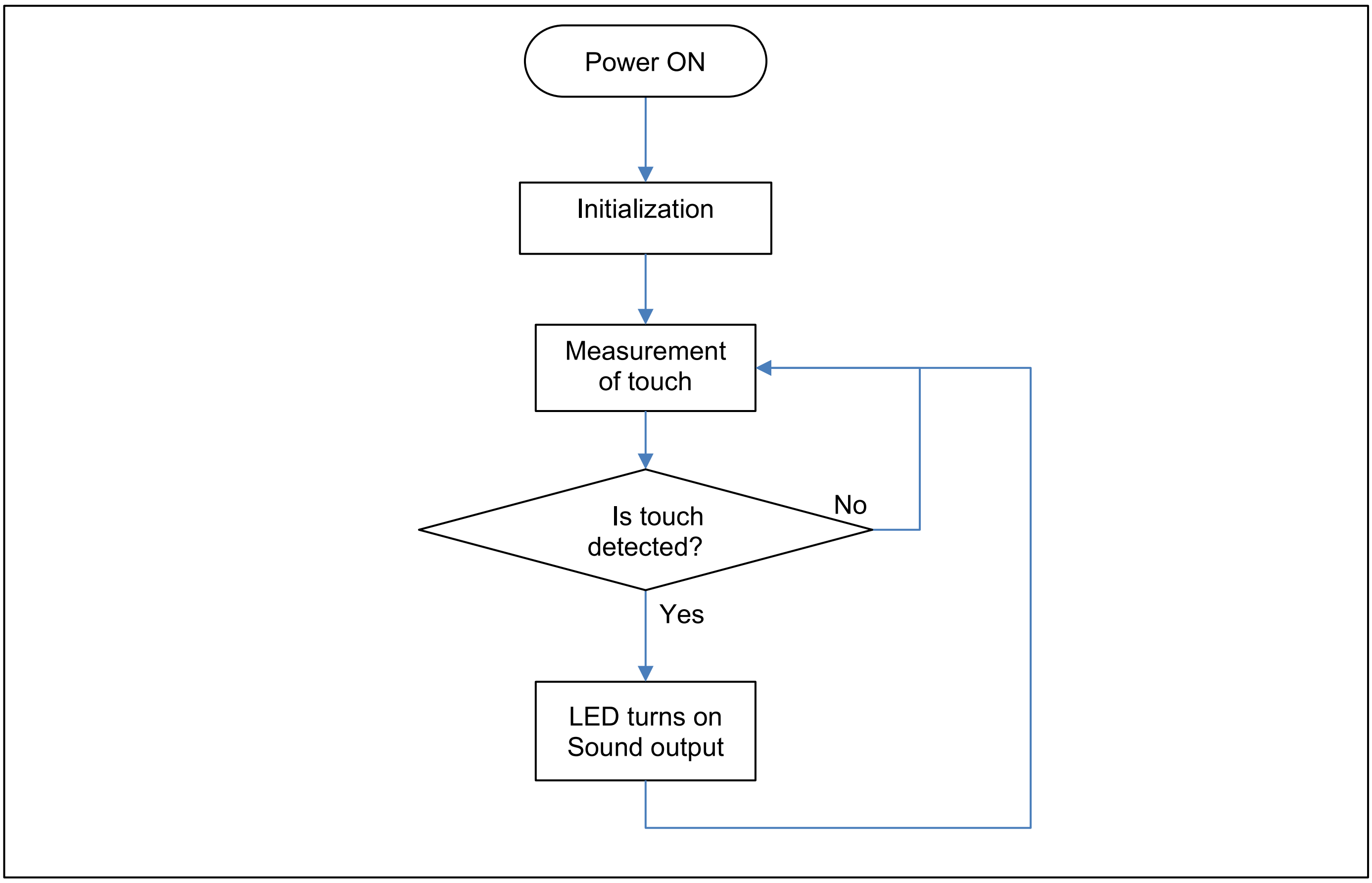

Figure 5.1 Overview of Operation

5.2 Touch Interface Configuration

Figure 5.2 shows the settings of TS pins of this software.

This software provides two types of touch interface configurations depending on the settings of the shield board. There are two types of shield pins: “touchless_electrode_sample_project_rl78g23_xxe.tifcfg”, where TSXX, which is assigned to the shield pin, is configured as an active shield, which is a function of CTSU2L, and “touchless_electrode_sample_project_ rl78g23_xxe_Low.tifcfg”, where TSXX is configured as a GPIO fixed low, and the former is the default setting. If you are evaluating the version without housing, set it to the latter, and from the CapTouch Main (QE) screen, select "Output Parameter Files" under "2.Tuning”.

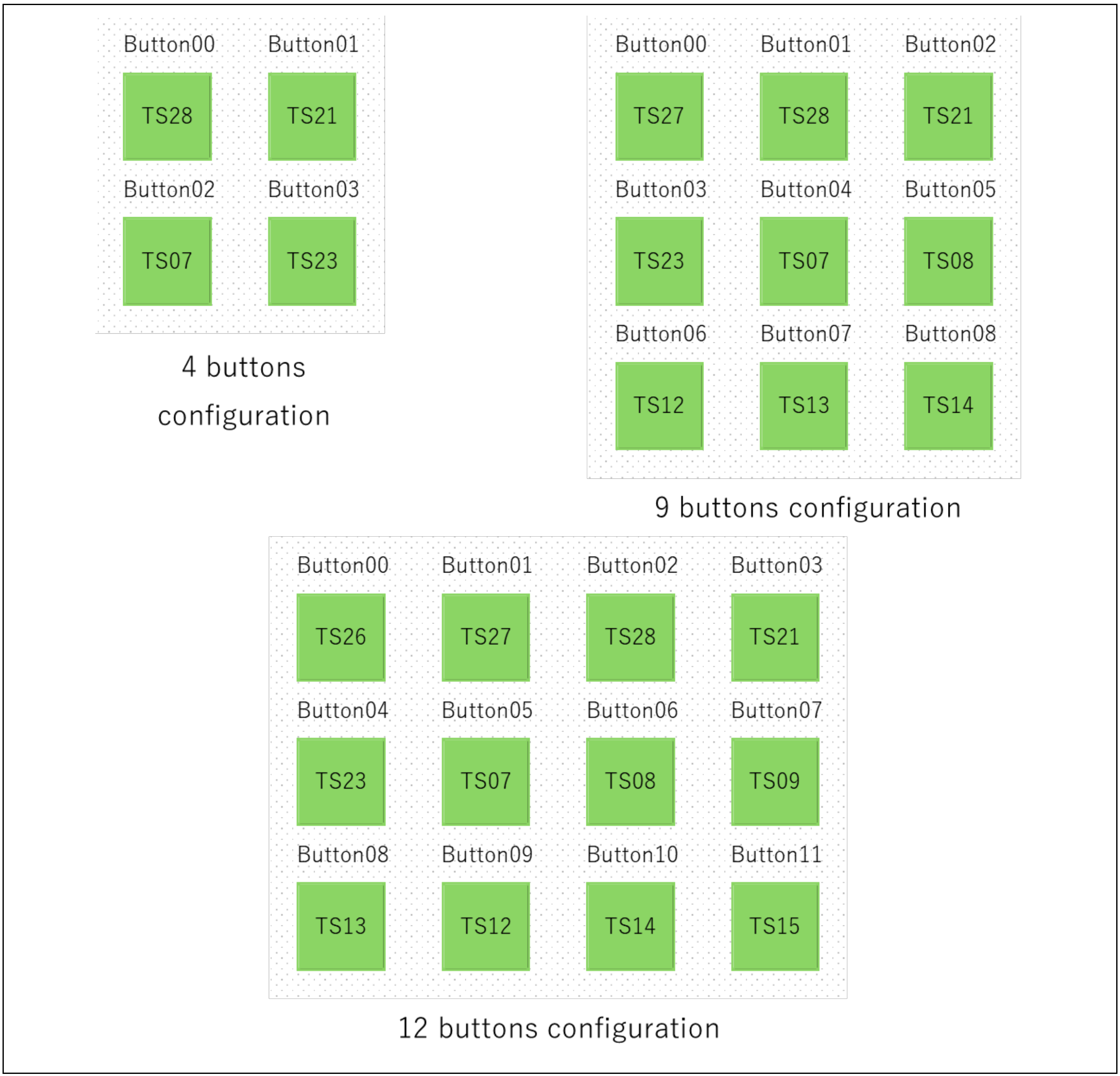

Figure 5.2 Touch Interface Configuration

5.3 Change of Tuning Value

5.3.1 Change of Current mode

This software uses the "Advanced Tuning" of QE to change the current mode. The measurement current ratio flowing through the oscillator can be changed by setting the current mode. For more information about the current mode, please refer to the explanation about ATUNE1 and ATUNE2 bits in "RL78/G23 User's Manual: Hardware" (R01UH0896). In the self-capacitance method, the default setting is 40uA, but in this software, it is changed to 20uA.

5.3.2 Change of Threshold Value

The threshold values and hysteresis of QE output file qe_touch_config.c are changed in this sample software.

As the threshold values are fixed, the touch detection distance differs for each electrode.

Table 5.1, Table 5.2 and Table 5.3 list the variable name and setting value changed for each electrode configuration, and the touch detection distance of the electrode.

Each value is the value of the interface configuration in "touchless_electrode_sample_project_rl78g23_xxe.tifcfg" for the version with housing. Re-tuning is required when evaluating without housing version or the "touchless_electrode_sample_project_rl78g23_xxe_Low.tifcfg" interface configuration.

Table 5.1 Changed Variable and Touch Detection Distance (4 buttons)

Variable name	Setting value	Touch detection distance	
		One finger (mm)	Palm (mm)
g_qe_touch_button_cfg_config01[0].threshold	600	30	40
g_qe_touch_button_cfg_config01[0].hysteresis	30		
g_qe_touch_button_cfg_config01[1].threshold	470		
g_qe_touch_button_cfg_config01[1].hysteresis	23		
g_qe_touch_button_cfg_config01[2].threshold	490		
g_qe_touch_button_cfg_config01[2].hysteresis	24		
g_qe_touch_button_cfg_config01[3].threshold	450		
g_qe_touch_button_cfg_config01[3].hysteresis	22		

Table 5.2 Changed Variable and Touch Detection Distance (9 buttons)

Variable name	Setting value	Touch detection distance	
		One finger (mm)	Palm (mm)
g_qe_touch_button_cfg_config01[0].threshold	480	20	30
g_qe_touch_button_cfg_config01[0].hysteresis	24		
g_qe_touch_button_cfg_config01[1].threshold	455		
g_qe_touch_button_cfg_config01[1].hysteresis	27		
g_qe_touch_button_cfg_config01[2].threshold	400		
g_qe_touch_button_cfg_config01[2].hysteresis	20		
g_qe_touch_button_cfg_config01[3].threshold	440		
g_qe_touch_button_cfg_config01[3].hysteresis	22		
g_qe_touch_button_cfg_config01[4].threshold	420		
g_qe_touch_button_cfg_config01[4].hysteresis	21		
g_qe_touch_button_cfg_config01[5].threshold	450		
g_qe_touch_button_cfg_config01[5].hysteresis	22		
g_qe_touch_button_cfg_config01[6].threshold	380		
g_qe_touch_button_cfg_config01[6].hysteresis	19		
g_qe_touch_button_cfg_config01[7].threshold	380		
g_qe_touch_button_cfg_config01[7].hysteresis	19		
g_qe_touch_button_cfg_config01[8].threshold	400		
g_qe_touch_button_cfg_config01[8].hysteresis	20		

Table 5.3 Changed Variable and Touch Detection Distance (12 buttons)

Variable name	Setting value	Touch detection distance	
		One finger (mm)	Palm (mm)
g_qe_touch_button_cfg_config01[0].threshold	510	10	20
g_qe_touch_button_cfg_config01[0].hysteresis	25		
g_qe_touch_button_cfg_config01[1].threshold	540		
g_qe_touch_button_cfg_config01[1].hysteresis	27		
g_qe_touch_button_cfg_config01[2].threshold	530		
g_qe_touch_button_cfg_config01[2].hysteresis	26		
g_qe_touch_button_cfg_config01[3].threshold	470		
g_qe_touch_button_cfg_config01[3].hysteresis	23		
g_qe_touch_button_cfg_config01[4].threshold	450		
g_qe_touch_button_cfg_config01[4].hysteresis	22		
g_qe_touch_button_cfg_config01[5].threshold	450		
g_qe_touch_button_cfg_config01[5].hysteresis	22		
g_qe_touch_button_cfg_config01[6].threshold	520		
g_qe_touch_button_cfg_config01[6].hysteresis	26		
g_qe_touch_button_cfg_config01[7].threshold	450		
g_qe_touch_button_cfg_config01[7].hysteresis	22		
g_qe_touch_button_cfg_config01[8].threshold	410		
g_qe_touch_button_cfg_config01[8].hysteresis	20		
g_qe_touch_button_cfg_config01[9].threshold	420		
g_qe_touch_button_cfg_config01[9].hysteresis	21		
g_qe_touch_button_cfg_config01[10].threshold	450		
g_qe_touch_button_cfg_config01[10].hysteresis	22		
g_qe_touch_button_cfg_config01[11].threshold	470		
g_qe_touch_button_cfg_config01[11].hysteresis	23		

5.4 LED Turn On

The LED is mounted on the LED board and lights up the location of the touched electrode according to the button configuration of 4 buttons/9 buttons/12 buttons.

Figure 5.3 shows the correspondence of the LED control ports and each electrode.

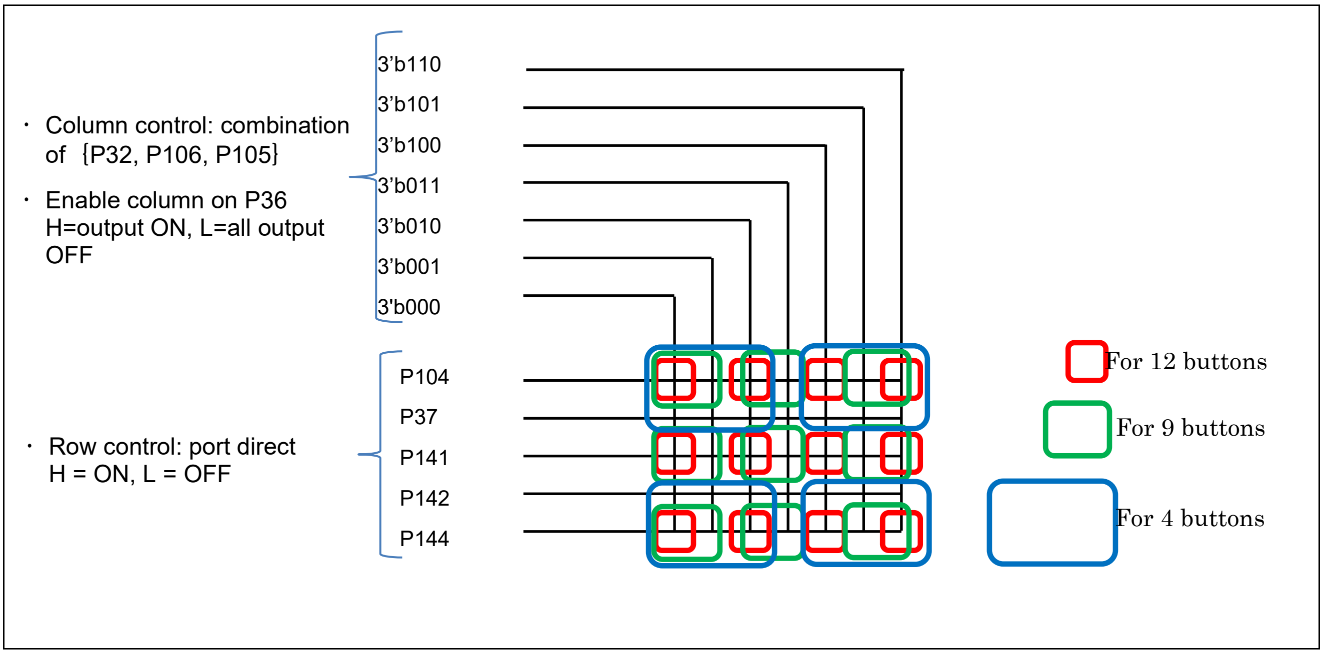

Figure 5.3 Correspondence of LED Control Ports and Each Electrode

The LED control port consists of a 5 x 7 matrix as Figure 5.3, and it is realized by dynamic lighting using the timer.

Touch judgement is executed at a touch measurement cycle of 20ms interval, and the touch status is stored with RM_TOUCH_DataGet() in the global variable.

The above global variable is checked with interrupt of the timer for LED dynamic lightning, and only the LED of the button with touch judgement turns on.

Code is added to the user code area of Config_TAU0_0_user.c.

Table 5.4 shows the settings of the LED lightning timer.

Table 5.4 Settings of LED Lightning Timer

Timer	Timer cycle	Board switching count	Total cycle
Interval Timer	250us	7	1750us

5.5 Sound Output

The buzzer is mounted on the LED board and outputs sound according to touch.

There are 2 ports for sound output, and P143 is used in this sample software.

The sound is output from the buzzer by repeating H/L from the port at the specific frequency (523Hz, at which a music scale C is output) for a certain period of time. The timer is used for H/L output.

Same as LED turn on, the global variable is checked with the timer interrupt and the sound is output. The sound is the same at all buttons.

Code is added to the user code area of Config_TAU0_1_user.c.

Table 5.5 shows the settings of the sound output timer.

Table 5.5 Settings of Sound Output Timer

Timer	Timer cycle	H/L cycle
Interval Timer	956us	1912us

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2021.11.25	-	First edition issued

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   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.
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TOYOSU FORESIA, 3-2-24 Toyosu,
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