RX130 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 Sensor Unit (CTSU) hardware. CTSU detects human touch by measuring the electrostatic capacitance generated between the touch electrode and the human body.

Target Device

RX130 Group

Related Documents

1. RX Family Development of Capacitive Touch Applications using QE and FIT (R01AN4516)
2. RX Family Firmware Integration Technology User's Manual (R01AN1833)
3. RX Family Board Support Package Module Firmware Integration Technology (R01AN1685)
4. RX Family QE Touch Module Firmware Integration Technology (R01AN4470)
5. RX Family QE CTSU Module Firmware Integration Technology (R01AN4469)
6. Capacitive sensor Microcontrollers Touchless Button Electrode Board (R12AN0115)
7. RX130 Group RX Capacitive Touch Evaluation System CPU Board User's Manual (R12UZ0003)

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 e2studio 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 FIT 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.

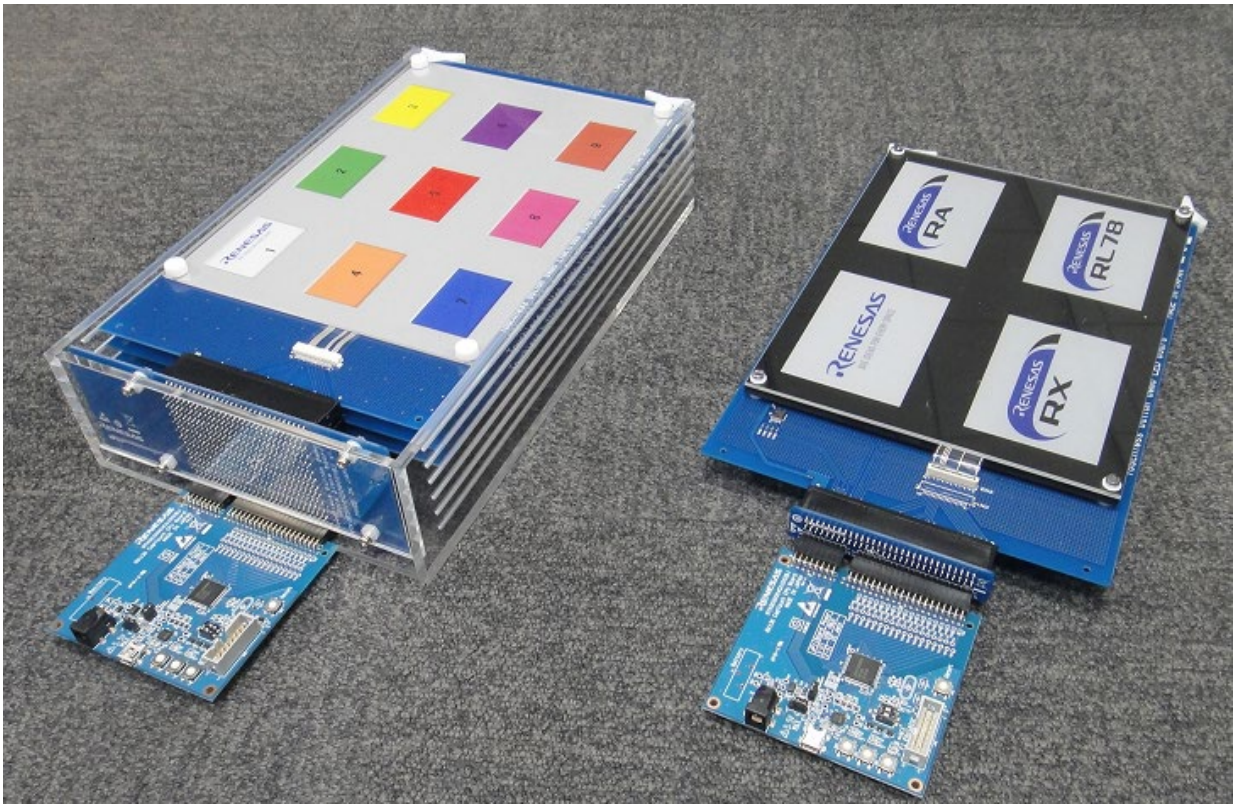

Figure 1.2Touchless Button Electrode Board (Left: with housing, Right: without housing)

As shown in Figure 1.3, 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.

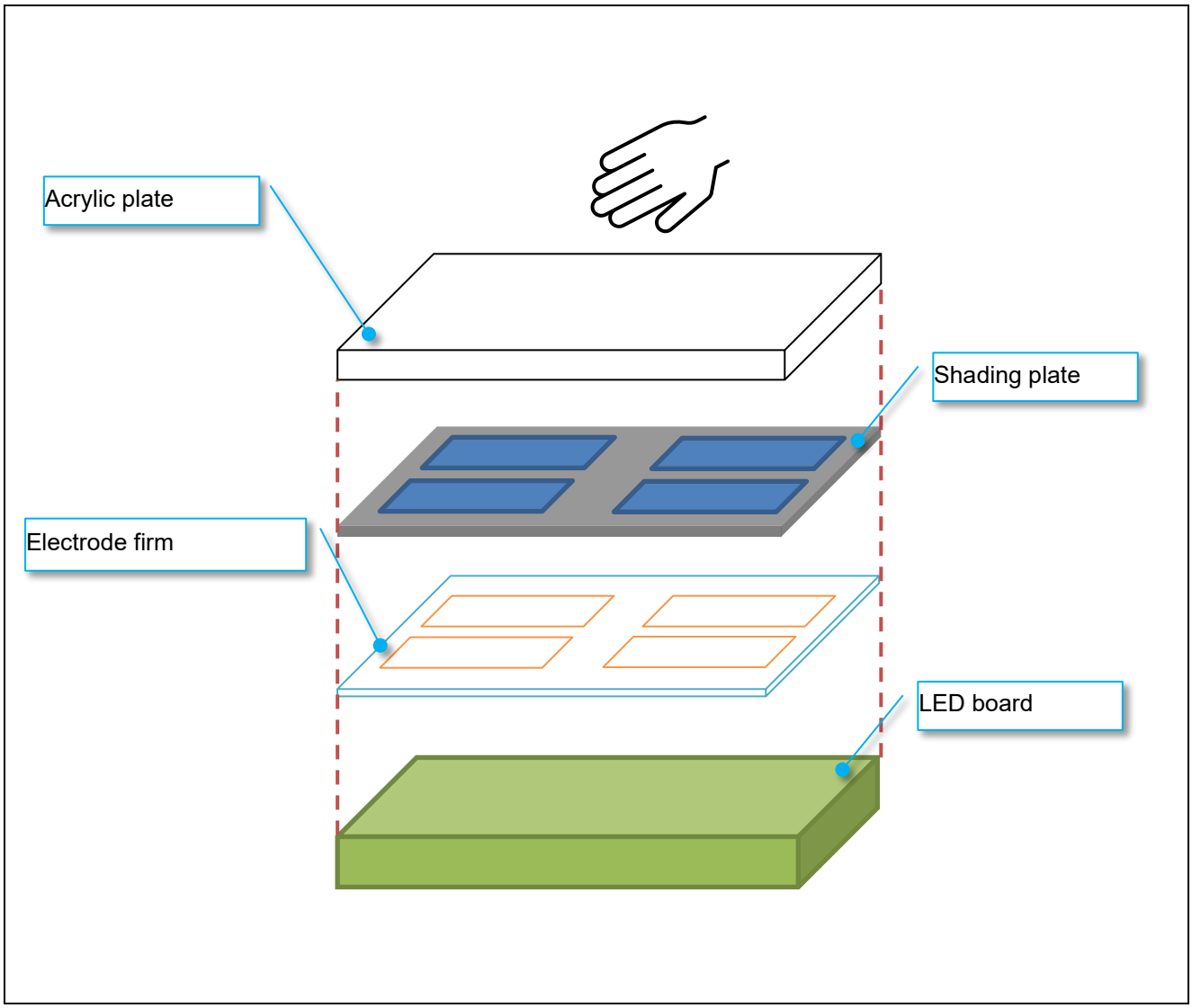

Figure 1.4 Touchless Button Electrode Board Configuration

2. Operating Environment

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

Table 2.3 Operating Environment 1

Item	Description
CPU Board	RX130 Group RX Capacitive Touch Evaluation System CPU Board (RTK0EG0004C01002BJ)
Electrode Board	Touchless Button Electrode Board (with housing) (RTK0ES1001D01001BJ)
Microcontroller	RX130
Operating frequency	32 MHz
Operating voltage	5.0 V
Integrated Development Environment	e^2 studio Version: 2020-07 (20.7.0)
C compiler	CC-RX V3.03.00
Capacitance touch IDE	QE for Capacitive Touch V1.1.0

Table 2.4 Operating Environment 2

Item	Description
CPU Board	RX130 Group RX Capacitive Touch Evaluation System CPU Board (RTK0EG0004C01002BJ)
Electrode Board	Touchless Button Electrode Board (w/o housing) (RTK0ES1001D02001BJ)
Microcontroller	RX130
Operating frequency	32 MHz
Operating voltage	5.0 V
Integrated Development Environment	e^2 studio Version: 2020-07 (20.7.0)
C compiler	CC-RX V3.03.00
Capacitance touch IDE	QE for Capacitive Touch V1.1.0

3. Software Structure

Figure 3.1 shows the software structure.

QE Touch FIT module detects touch from the electrostatic capacitance measurement results of QE CTSU FIT module.

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

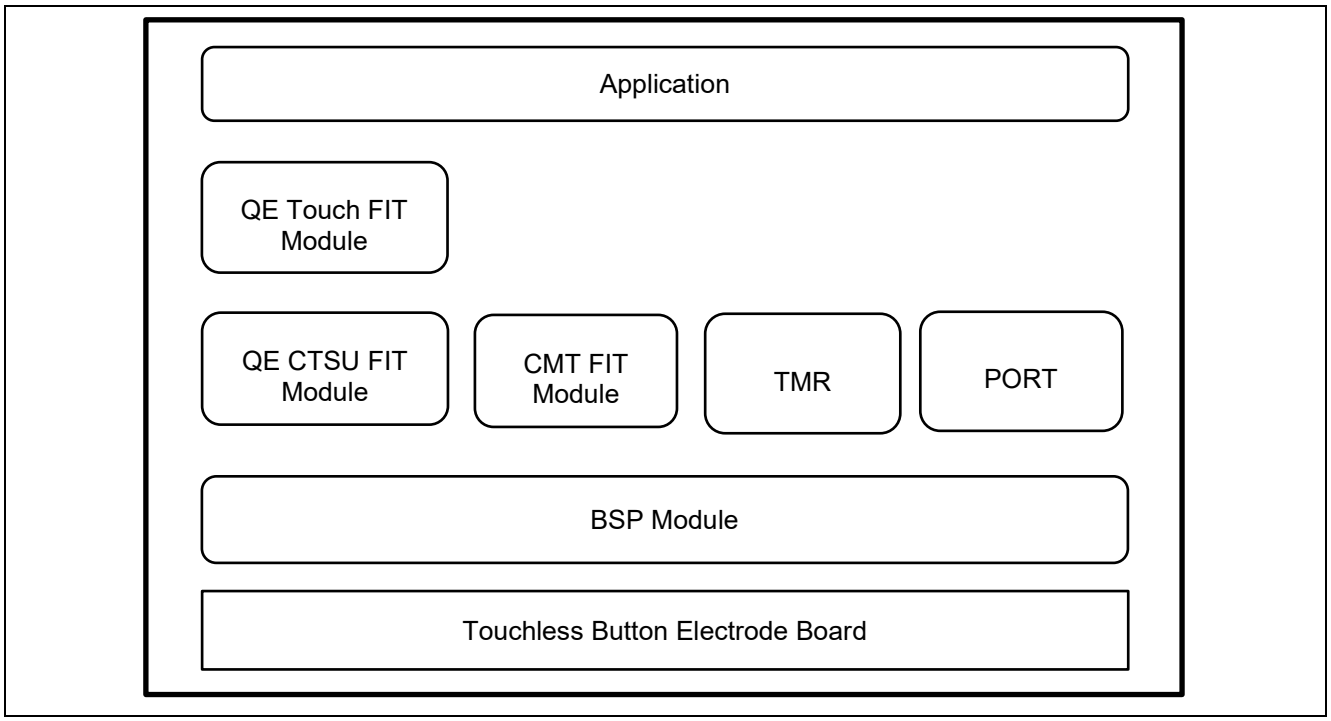

Figure 3.2 Software Structure

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

Table 3.2 Version of FIT and Code Generation

FIT Module	Version
BSP	5.61
CTSU	1.11
Touch	1.11
CMT	4.70
Code generation	Version
Port	2.0.2
8bit timer	1.7.0

4. File Structure

Table 4.1 shows the file structure of this software and the changes from Smart Configurator generation file.
The FIT modules are not changed. For FIT modules, please refer to each Application Note.

Table 4.2 File Structure

Folder/File Name	Changes
Project	-
src	-
qe_common.c	-
qe_common.h	-
qe_config01.c	Adjustment of the tuning value
qe_config01.h	Adjustment of the tuning value
main.c	Sample application
smc_gen	-
Config_PORT (File structure omitted)	-
Config_TMR0	-
Config_TMR0.c	-
Config_TMR0.h	LED application
Config_TMR0_user.c	LED application
Config_TMR1	-
Config_TMR1.c	-
Config_TMR1.h	-
Config_TMR1_user.c	Sound output application
general (File structure omitted)	
r_bsp (File structure omitted)	
r_cmt_rx (File structure omitted)	
File structure omitted	
r_ctsu_qe (File structure omitted)	
r_pincfg (File structure omitted)	
r_touch_qe (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.
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'.

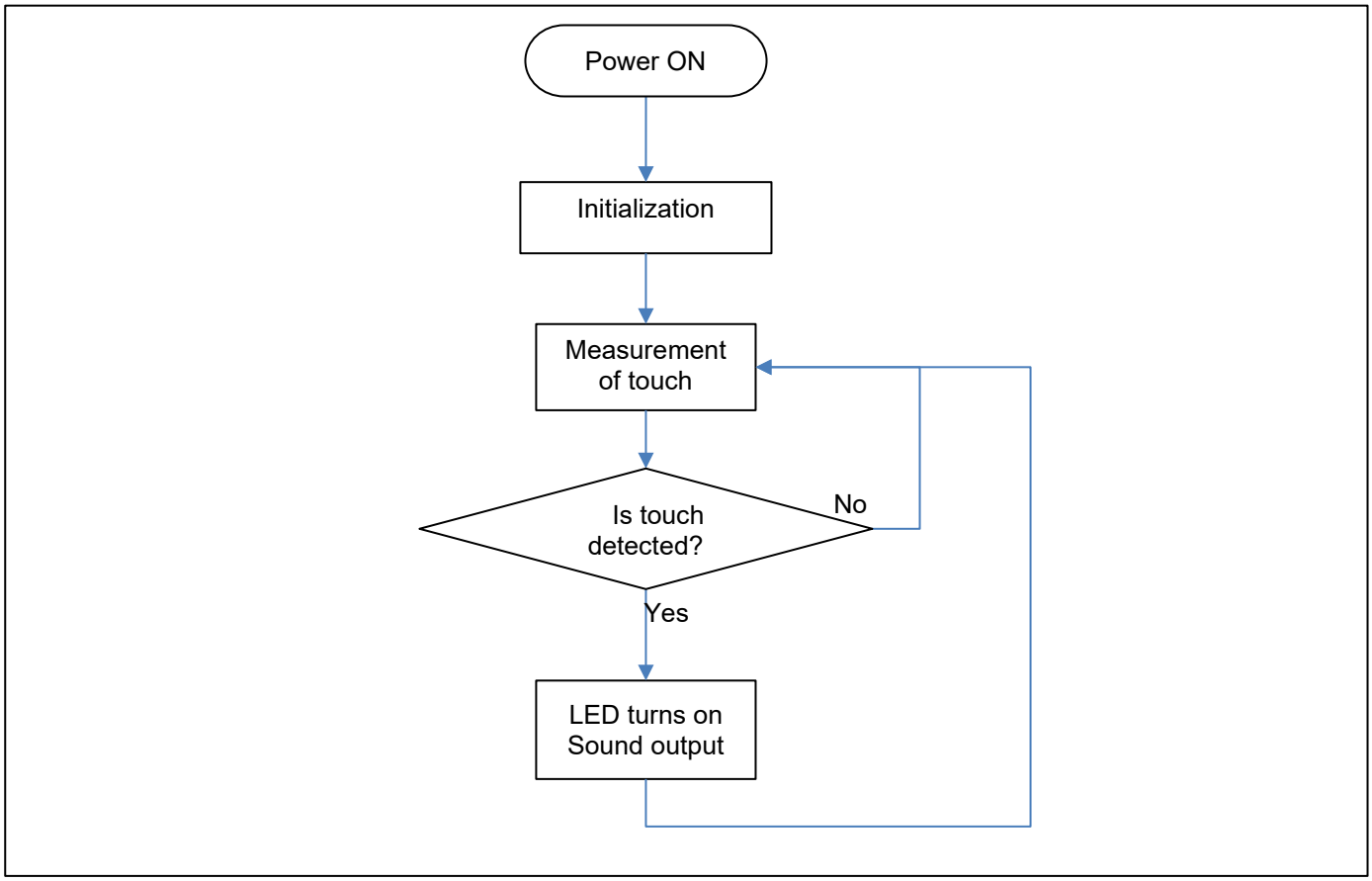

Figure 5.2 Overview of Operation

5.2. Touch Interface Configuration

Figure 5.3 shows the settings of TS pins of this software.

Figure 5.4 Touch Interface Configuration

5.3. Change of Tuning Value

5.3.1. Change of Drive Pulse Frequency

The parasitic capacitance of the touchless button electrode board differs for each electrode. Therefore, the drive pulse frequency is set differently for each electrode by auto-adjustment of QE tuning.

As the different drive pulse frequency makes a difference in sensitivity, the drive pulse frequency is fixed at 2MHz in this sample software.

To fix the drive pulse frequency, use ‘Advanced Configuration’ of QE. Specifically, check ‘Enable Advanced Configuration’ before QE tuning, then select ‘Start Tuning’ of the ‘Setup CTSU Sensor Drive Pulse Frequency’ to go to the screen where you can set the drive pulse frequency. Change the drive pulse frequency of each TS pin to 2MHz there and start tuning.

5.3.2. Change of Threshold Value

The threshold values and hysteresis of QE output file qe_config01.h. are changed in this sample software.

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

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

Table 5.4 Changed Variable and Touch Detection Distance (4 buttons)

Constant name	Setting value	Touch detection distance	
		One finger (mm)	Palm (mm)
CONFIG01_BUTTON00_THR_OFFSET	600	20	40
CONFIG01_BUTTON00_HYS_OFFSET	30		
CONFIG01_BUTTON01_THR_OFFSET	600		
CONFIG01_BUTTON01_HYS_OFFSET	30		
CONFIG01_BUTTON02_THR_OFFSET	600		
CONFIG01_BUTTON02_HYS_OFFSET	30		
CONFIG01_BUTTON03_THR_OFFSET	600		
CONFIG01_BUTTON03_HYS_OFFSET	30		

Table 5.5 Changed Variable and Touch Detection Distance (9 buttons)

Constant name	Setting value	Touch detection distance	
		One finger(mm)	Palm(mm)
CONFIG01_BUTTON00_THR_OFFSET	600	10	15
CONFIG01_BUTTON00_HYS_OFFSET	30		
CONFIG01_BUTTON01_THR_OFFSET	600		
CONFIG01_BUTTON01_HYS_OFFSET	30		
CONFIG01_BUTTON02_THR_OFFSET	600		
CONFIG01_BUTTON02_HYS_OFFSET	30		
CONFIG01_BUTTON03_THR_OFFSET	600		
CONFIG01_BUTTON03_HYS_OFFSET	30		
CONFIG01_BUTTON04_THR_OFFSET	600		
CONFIG01_BUTTON04_HYS_OFFSET	30		
CONFIG01_BUTTON05_THR_OFFSET	600		
CONFIG01_BUTTON05_HYS_OFFSET	30		
CONFIG01_BUTTON06_THR_OFFSET	600		
CONFIG01_BUTTON06_HYS_OFFSET	30		
CONFIG01_BUTTON07_THR_OFFSET	600		
CONFIG01_BUTTON07_HYS_OFFSET	30		
CONFIG01_BUTTON08_THR_OFFSET	600		
CONFIG01_BUTTON08_HYS_OFFSET	30		

Table 5.6 Changed Variable and Touch Detection Distance (12 buttons)

Constant name	Setting value	Touch detection distance	
		One finger(mm)	Palm(mm)
CONFIG01_BUTTON00_THR_OFFSET	600	10	12
CONFIG01_BUTTON00_HYS_OFFSET	30		
CONFIG01_BUTTON01_THR_OFFSET	600		
CONFIG01_BUTTON01_HYS_OFFSET	30		
CONFIG01_BUTTON02_THR_OFFSET	600		
CONFIG01_BUTTON02_HYS_OFFSET	30		
CONFIG01_BUTTON03_THR_OFFSET	600		
CONFIG01_BUTTON03_HYS_OFFSET	30		
CONFIG01_BUTTON04_THR_OFFSET	600		
CONFIG01_BUTTON04_HYS_OFFSET	30		
CONFIG01_BUTTON05_THR_OFFSET	600		
CONFIG01_BUTTON05_HYS_OFFSET	30		
CONFIG01_BUTTON06_THR_OFFSET	600		
CONFIG01_BUTTON06_HYS_OFFSET	30		
CONFIG01_BUTTON07_THR_OFFSET	600		
CONFIG01_BUTTON07_HYS_OFFSET	30		
CONFIG01_BUTTON08_THR_OFFSET	600		
CONFIG01_BUTTON08_HYS_OFFSET	30		
CONFIG01_BUTTON09_THR_OFFSET	600		
CONFIG01_BUTTON09_HYS_OFFSET	30		
CONFIG01_BUTTON10_THR_OFFSET	600		
CONFIG01_BUTTON10_HYS_OFFSET	30		
CONFIG01_BUTTON11_THR_OFFSET	600		
CONFIG01_BUTTON11_HYS_OFFSET	30		

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 5.5 shows the correspondence of the LED control ports and each electrode.

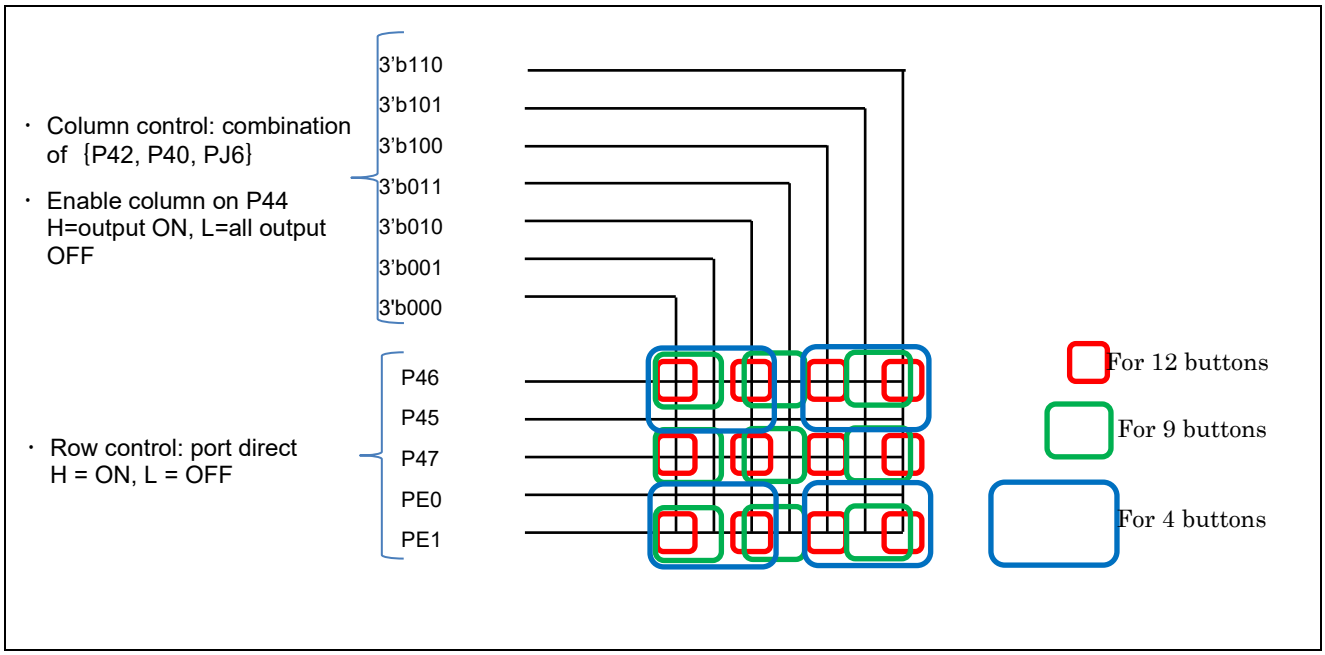

Figure 5.6 Correspondence of LED Control Ports and Each Electrode

The LED control port consists of a 5 x 7 matrix as Figure 5.7, 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 R_TOUCH_GetAllBtnStates() 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_TMR0_user.c.

Table 5.7 shows the settings of the LED lightning timer.

Table 5.8 Settings of LED Lightning Timer

Timer	Timer cycle	Board switching count	Total cycle
8bit 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 PD2 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_TMR1_user.c.

Table 5.9 shows the settings of the sound output timer.

Table 5.10 Settings of Sound Output Timer

Timer	Timer cycle	H/L cycle
8bit timer	956us	1912us

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2021.5.6	-	First edition issued

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
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