RA6M2 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

RA6M2 Group

Related Documents

1. RA Family Using QE and FSP to Develop Capacitive Touch Applications (R01AN4934)
2. Capacitive Sensor Microcontrollers Touchless Button Electrode Board (R12AN0115)
3. RA6M2 Group Capacitive Touch Evaluation System User's Manual (R12UZ0085)

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 FSP middleware and driver.

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.

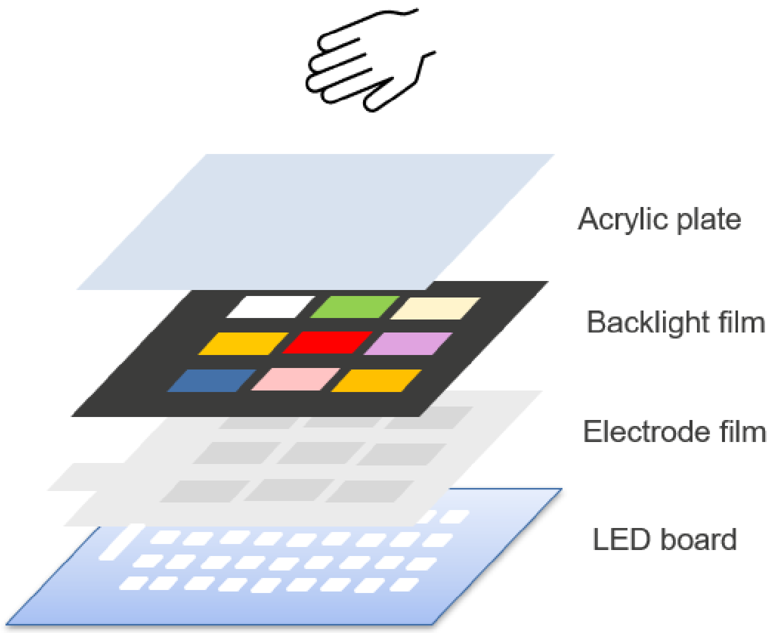

Figure 1.2 Touchless Button Electrode Board Configuration

2. Operating Environment

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

Table 2.1 Operating Environment 1

Item	Description
CPU Board	RA6M2 Group Capacitive Touch Evaluation System CPU Board (RTK0EG0017C01001BJ)
Electrode Board	Touchless Button Electrode Board (with housing) (RTK0ES1001D01001BJ)
Microcontroller	RA6M2
Operating frequency	192 MHz
Operating voltage	5.0 V
Integrated Development Environment	e² studio Version: 2021-10 (21.10.0)
C compiler	GCC ARM Embedded 9.3.1.20200408
Capacitance touch IDE	QE for Capacitive Touch V2.0.0

Table 2.2 Operating Environment 2

Item	Description
CPU Board	RA6M2 Group Capacitive Touch Evaluation System CPU Board (RTK0EG0017C01001BJ)
Electrode Board	Touchless Button Electrode Board (w/o housing) (RTK0ES1001D02001BJ)
Microcontroller	RA6M2
Operating frequency	192 MHz
Operating voltage	5.0 V
Integrated Development Environment	e² studio Version: 2021-10 (21.10.0)
C compiler	GCC ARM Embedded 9.3.1.20200408
Capacitance touch IDE	QE for Capacitive Touch V2.0.0

3. Software Structure

Figure 3.1 shows the software structure.

rm_touch middleware detects touch from the electrostatic capacitance measurement results of r_ctsu driver.

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

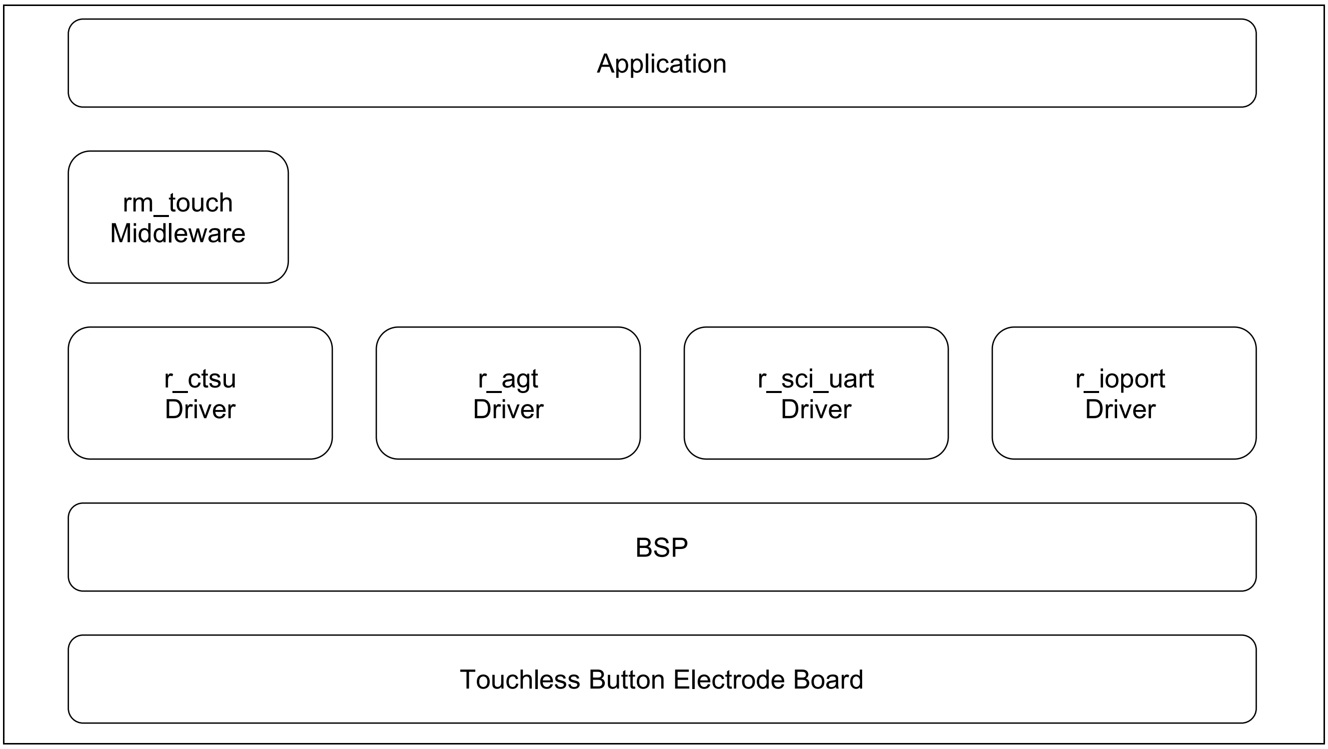

Figure 3.1 Software Structure

Table 3.1 shows the version of FSP middleware and drivers which are used in this software.

Table 3.1 Version of FSP Middleware and Driver

FSP Middleware, Driver	Version
BSP	3.4.0
r_ctsu	3.4.0
rm_touch	3.4.0
r_ioport	3.4.0
r_agt	3.4.0
r_sci_uart	3.4.0

4. File Structure

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

The FSP middleware and driver are not changed. For FSP middleware and driver, please refer to each documents.

Table 4.1 File Structure

Folder/File Name	Changes
Project	-
qe_gen	-
qe_touch_config.c	Adjustment of the tuning value
qe_touch_config.h	-
qe_touch_define.h	-
qe_touch_sample.c	Sample application
ra (File structure omitted)	-
ra_cfg (File structure omitted)	-
ra_gen (File structure omitted)	-
src	-
hal_entry.c	Call sample application
r_touchless_led_board.c	LED/Sound output application

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. This software does not support multiple touch detections.
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'.

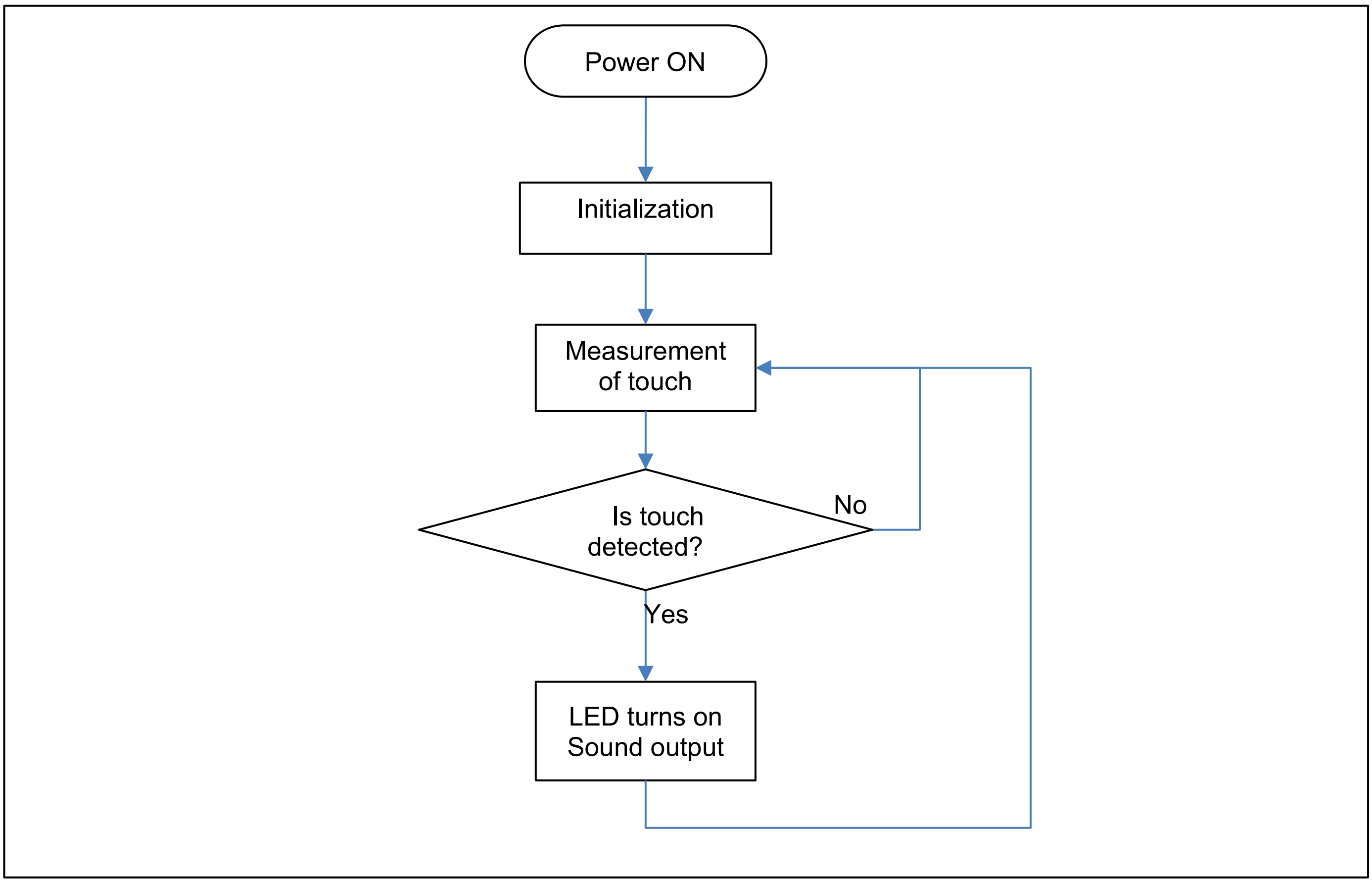

Figure 5.1 Overview of Operation

5.2. Touch Interface Configuration

Figure 5.2 shows the settings of TS pins of this software. TS pins is not set to Button03 in the 4 buttons configuration and 9 buttons configuration, and to Button04 in the 12 buttons configuration.

Figure 5.2 Touch Interface Configuration

5.3. Change of Tuning Value

5.3.1. 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. These value are settings for touchless button electrode board with housing. Retune when evaluating touchless button electrode board without housing.

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	170	20	40
g_qe_touch_button_cfg_config01[0].hysteresis	8		
g_qe_touch_button_cfg_config01[1].threshold	180		
g_qe_touch_button_cfg_config01[1].hysteresis	9		
g_qe_touch_button_cfg_config01[2].threshold	180		
g_qe_touch_button_cfg_config01[2].hysteresis	9		

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	120	15	20
g_qe_touch_button_cfg_config01[0].hysteresis	6		
g_qe_touch_button_cfg_config01[1].threshold	160		
g_qe_touch_button_cfg_config01[1].hysteresis	8		
g_qe_touch_button_cfg_config01[2].threshold	180		
g_qe_touch_button_cfg_config01[2].hysteresis	9		
g_qe_touch_button_cfg_config01[3].threshold	160		
g_qe_touch_button_cfg_config01[3].hysteresis	8		
g_qe_touch_button_cfg_config01[4].threshold	190		
g_qe_touch_button_cfg_config01[4].hysteresis	9		
g_qe_touch_button_cfg_config01[5].threshold	170		
g_qe_touch_button_cfg_config01[5].hysteresis	8		
g_qe_touch_button_cfg_config01[6].threshold	150		
g_qe_touch_button_cfg_config01[6].hysteresis	7		
g_qe_touch_button_cfg_config01[7].threshold	110		
g_qe_touch_button_cfg_config01[7].hysteresis	5		

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	130	10	15
g_qe_touch_button_cfg_config01[0].hysteresis	6		
g_qe_touch_button_cfg_config01[1].threshold	170		
g_qe_touch_button_cfg_config01[1].hysteresis	8		
g_qe_touch_button_cfg_config01[2].threshold	180		
g_qe_touch_button_cfg_config01[2].hysteresis	9		
g_qe_touch_button_cfg_config01[3].threshold	180		
g_qe_touch_button_cfg_config01[3].hysteresis	9		
g_qe_touch_button_cfg_config01[4].threshold	160		
g_qe_touch_button_cfg_config01[4].hysteresis	8		
g_qe_touch_button_cfg_config01[5].threshold	170		
g_qe_touch_button_cfg_config01[5].hysteresis	8		
g_qe_touch_button_cfg_config01[6].threshold	180		
g_qe_touch_button_cfg_config01[6].hysteresis	9		
g_qe_touch_button_cfg_config01[7].threshold	160		
g_qe_touch_button_cfg_config01[7].hysteresis	8		
g_qe_touch_button_cfg_config01[8].threshold	150		
g_qe_touch_button_cfg_config01[8].hysteresis	7		
g_qe_touch_button_cfg_config01[9].threshold	120		
g_qe_touch_button_cfg_config01[9].hysteresis	6		
g_qe_touch_button_cfg_config01[10].threshold	120		
g_qe_touch_button_cfg_config01[10].hysteresis	6		

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.

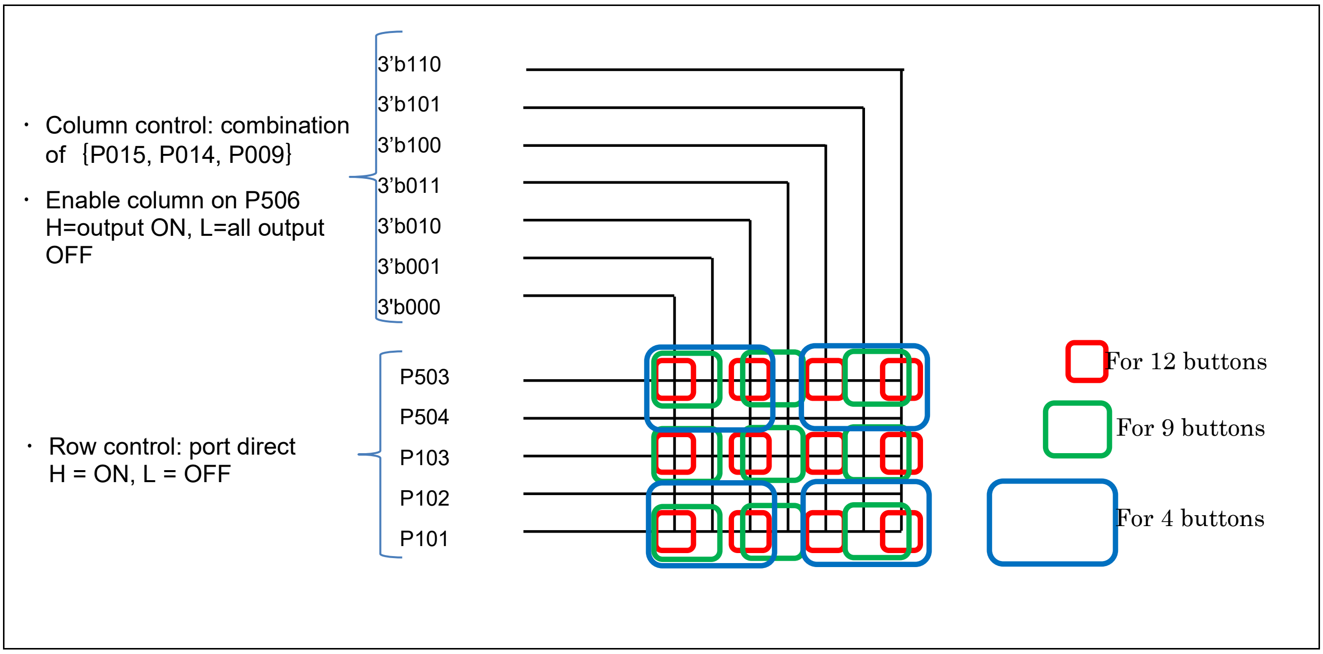

Figure 5.3 Correspondence of LED Control Ports and Each Electrode

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.

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
AGT	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 P100 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.

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
AGT	956us	1912us

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2021.12.2	-	First edition issued

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