RX140 Group

CTSU Application Example: 3D Gesture Electrode Board Sample Software

Introduction

RX140 Group is equipped with the hardware called “Capacitive Touch Sensing Unit2 (CTSU2)” that detects human touch by measuring capacitance generated between touch electrodes and the human hand.

This application note describes the software specification of the 3D Gesture Electrode Board (RTK0EG0023B01002BJ) as a sample application of mutual capacitance method used in CTSU2. This product is used in combination with the CPU board of the Capacitive Touch Evaluation System.

Target Device

RX140 Group

Related Documentation

1. RX Family Using QE and FIT to Develop Capacitive Touch Applications (R01AN4516)
2. RX140 Capacitive Touch Evaluation System User's Manual (R12UZ0102)
3. RX130 Group CTSU Application Example: 3D Gesture Demo Set Small version (Hardware) (R01AN4320)
4. RX231 Group CTSU Application Example: 3D Gesture Demo Set (Hardware) (R01AN4219)
5. RX Family CTSU 3D Gesture Demo Set Sample Software (R01AN4101)
6. RX Family CTSU 3D Gesture Demo Set Evaluation Tool ‘3D Monitor’ (R20AN0501)
7. RA2L1 Group 3D Gesture Electrode Board (Hardware) (R01AN6126)

Contents

1. Overview

This application note describes the sample software running on RX140 Cap Touch CPU board (RTK0EG0038C01001BJ) and 3D Gesture Electrode Board (RTK0EG0023B01002BJ). For hardware information, see the related documentation, RA2L1 Group 3D Gesture Electrode Board Hardware (R01AN6126)

1.1 Function

Performs CTSU measurement, detects gestures in a space 5cm away from 3D gesture electrode board, and notifies 3D position calculation result and gesture recognition result.

The 3D position calculation and gesture recognition results can be confirmed with the evaluation tool '3D Monitor'. For detail, please refer to the related document "RX Family CTSU 3D Gesture Demo Set Evaluation Tool '3D Monitor' (R20AN0501)".

2. Operating Environment

Table 2-1 lists the software operating environments.

Table 2-1 Operating environment

Item	Description
Evaluation board	RX140 Cap Touch CPU (RTK0EG0038C01001BJ) (RX140 Capacitive Touch Evaluation System (RTK0EG0039S01001BJ) Accessories)
MCU used	R5FA51406ADFN(Renesas RX140 MCU group)
Operating frequency	48MHz
Operating voltage	5.0V
Integrated Development Environment	Renesas e² studio Version: 2022-07 (22.07.0)
C compiler	Renesas CC-RX V3.04.00
Smart Configurator e² studio plugin	V2.14.0
Capacitance touch IDE	QE for Capacitive Touch V3.1.0
Emulator	Renesas E2 Emulator Lite
Driver package	RX Driver Package V1.36

Figure 2-1 shows the connection diagram for the 3D Gesture Electrode Board.

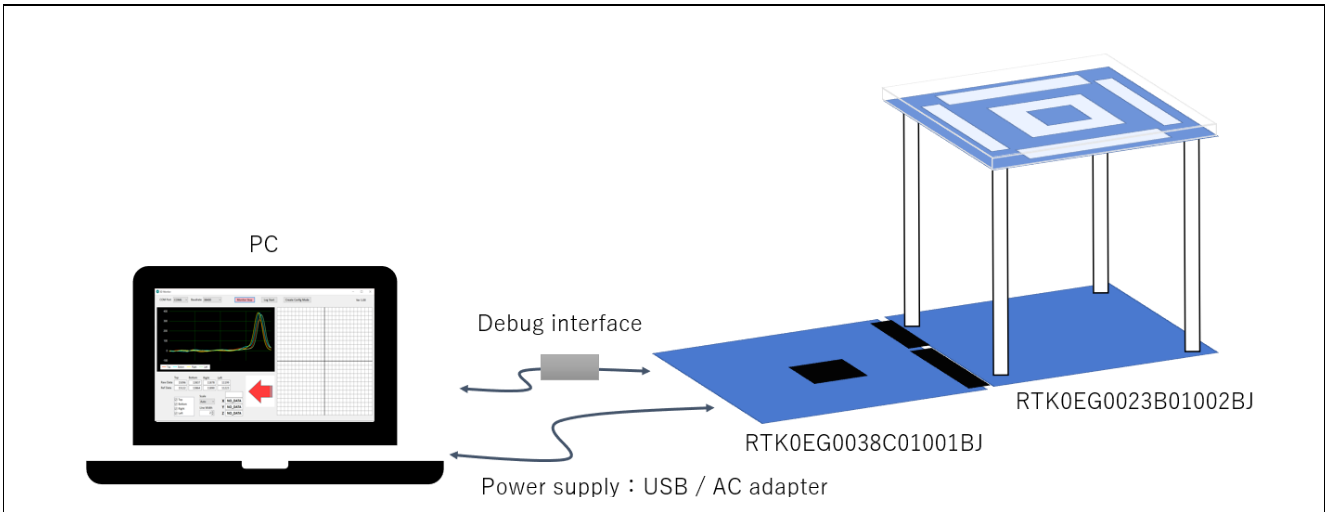

Figure 2-1 3D Gesture Electrode Board Connection Diagram

3. Sample software

This section describes the sample software.

3.1 Outline of Operation

Figure 3-1 shows the overall processing flow of the sample software.

The 3D Gesture sample application has been added based on the QE Touch module application file qe_touch_sample.c.

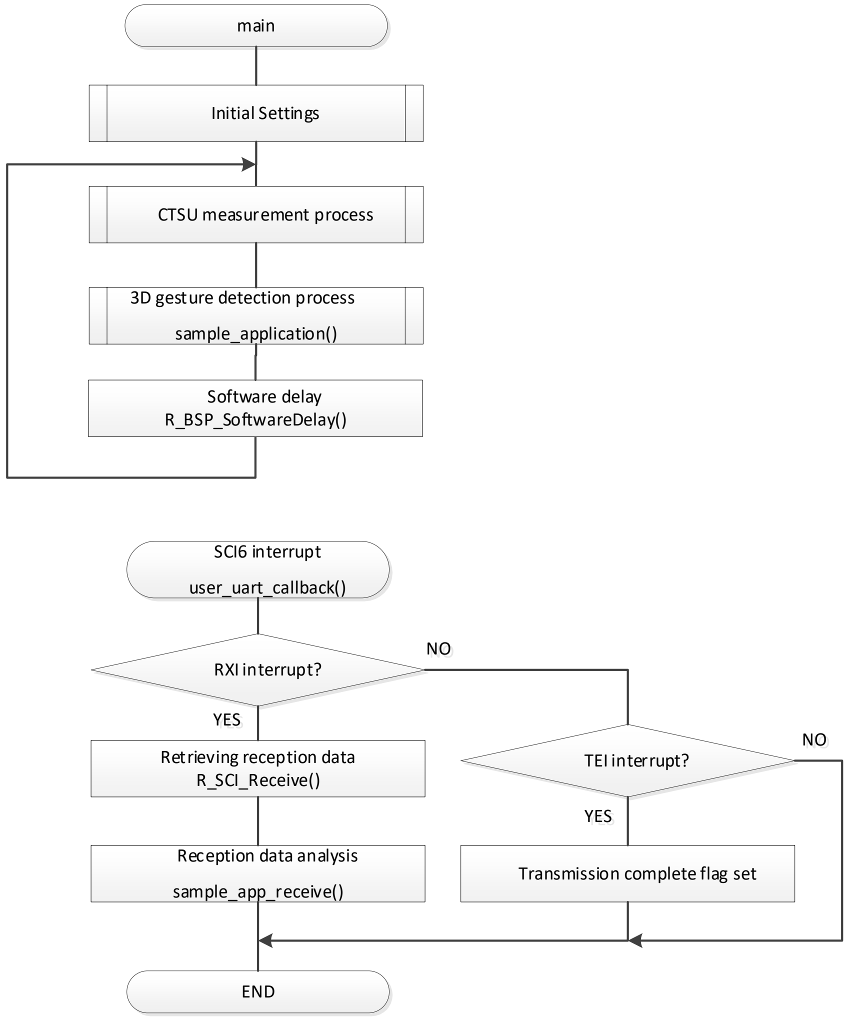

Figure 3-1 Processing flow

1. Initial Settings

The initialization process is as follows.

・CTSU initialization process

Pinning and initialization are performed using CTSU drivers.

・Peripheral function initialization process

Use init_peripheral_function() to initialize SCI6 using SCI drivers.

Table 3-1 shows SCI6 settings.

Table 3-1 SCI6 setting

Setting	Set value
Baud rate	38400bps
Data length	8bit
Parity	None
Stop bit	1bit
Flow control	None

・3D Gesture Electrode Board Initialization Process

Initialization is performed by sample_initialize() using 3D position calculation software.

2. CTSU measurement process

Perform CTSU measurement with RM_TOUCH_ScanStart(), use RM_TOUCH_DataGet() to check if the measurement was successful, and then use R_CTSU_DataGet() to obtain the touch count.

3. 3D gesture-detection process

Using the count value obtained by CTSU measurement, 3D position calculation is acquired to 3D Monitor using SCI drivers by using R_CAPPOS_Read(), and the gesture recognition result is acquired by R_GESTURE_Detect().

4. Software delay

Adjusts the period of CTSU measurement. The default setting is 5msec.

You can change the rate at which 3D gestures are detected by adjusting CTSU measurement period.

Increase software delay → supports detection of slow gestures

Shorten software delay → support fast gesture detection

5. SCI6 interrupt handling

In SCI6 interrupt handling, when a reception completion interrupt (RXI) occurs, the received data from 3D Monitor is analyzed.

When the "Monitor Start" command is received, 3D position calculation result and the gesture recognition result are sent to the tool. Transmission is stopped when the "Monitor Stop" command is received. For the communication format with 3D Monitor, refer to "7 Sample Application" in "RX Family CTSU 3D Gesture Demo Set Sample Software" (R01AN4101).

When a transmit end interrupt (TEI) occurs, the transmit end flag is set.

3.2 Software structure

Figure 3-2 shows the software structure diagram.

Capacitance measurement with CTSU2 uses the Development Assistance Tool for Capacitive Touch Sensors QE for Capacitive Touch and software generated by the Smart Configurator (QE Touch Module, QE CTSU Module).

The gesture recognition library analyzes changes in this 3D position to recognize gestures.

The application communicates USB with PC to notify the user of 3D position calculation and gesture recognition results.

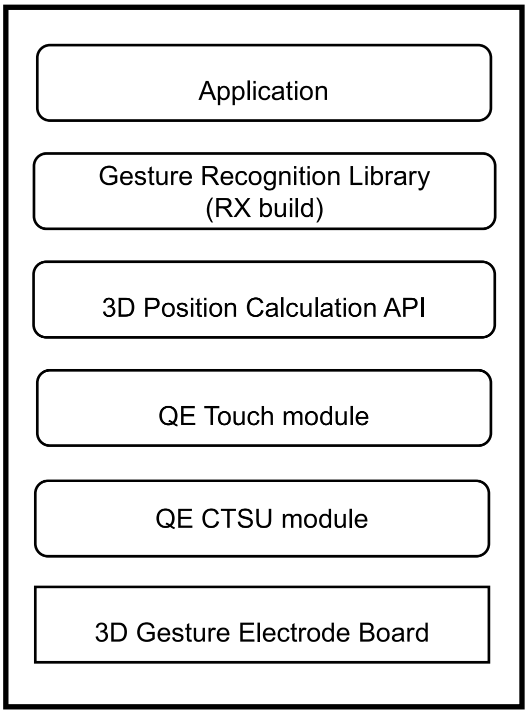

Figure 3-2 Software Structure

3.3 File Configuration

Table3-2 shows the file configuration. The source file/header file generated by the Smart Configurator, such as QE Touch module, is omitted.

Table3-2 File Configuration

Folder/file name			Overview
3d_gesture_electrode_sample_project_rx140			Project folder
	.cproject		C project file
	.project		Project file
	3d_gesture_electrode_sample_project_rx140 .launch		Debug configuration file
	3d_gesture_electrode_sample_project_rx140.scfg		Smart Configurator configuration file
	Gesture_Recognition_RXv2.lib		Gesture recognition library
	qe_gen		Source/header file storage folder
		qe_touch_config.c	QE Touch configuration definition source file
		qe_touch_config.h	QE Touch configuration definition header file
		qe_touch_define.h	QE Touch configuration definition header file
		qe_touch_sample.c	Application file
	src		
		r_cap_position.c	3D position calculation API source file
		r_cap_position_config.h	3D position calculation API config file
		r_cap_position_measure.h	3D position calculation API pre-measurement file
		r_cap_position_if.h	3D position calculation API interface file
		r_cap_position.h	3D position calculation API header file
		r_cap_gesture_if.h	Gesture recognition interface file
		3d_gesture_electrode_sample_project_rx140.c	Main source file
	QE-Touch		QE for Capacitive Touch generated folder
		3d_gesture_electrode_sample_project_rx140.tifcfg	Touch I/F configuration file

3.4 List of Peripheral Functions and Pins Used

Table 3-3 lists the peripheral functions used by this sample software, Table 3-4 lists the pins used, and Table 3-5 lists the unused pins and remedies.

Table 3-3 List of peripheral functions to be used

Peripheral functions	Use
CTSU、DTC	CTSU measurement
SCI6	Communicating with 3D Monitor

Table 3-4 List of Pins Used

Pin number	Terminal name	I/O	Use
17	TS01	I	CTSU measurement
25	TS05	I	
29	TS07	I	
31	TS09	I	
61	TS35	I	
38	TSCAP	I	
65	PD1/RXD6	I	Communicating with 3D Monitor
66	PD0/TXD6	O	

Table 3-5 List of unused pins and remedies

Pin number	Terminal name	I/O	Unused measures
1	P06	O	Low output
2	P03	O	Low output
4	VCL	I	Connected to GND via a capacitor (4.7uF)
6	MD	I	Input
9	RES#	I	Connected to the reset circuit
14	NMI	I	Input
15	IRQ4	I	Input
77	AVCC0	I	Connected to GND via a capacitor (0.1uF)
19	AVSS0	I	Connect to GND
Pins other than the above		-	Open, Low output

The peripheral function settings using the smart configurator are shown below.

- CTSU、DTC（CTSU measurement)）

Use CTSU to perform touch measurement. DTC is used to set the register of CTSU and to acquire the measurement result.

Table 3-6 and Table 3-7 show the settings of each peripheral function.

Table 3-6 CTSU setting

Item	Setting
Data transfer by interrupt	DTC
Automatic judgment function	Disabled

Table 3-7 DTC setting

Item	Setting
DTCER control	All DTCER registers are cleared by the open-function.
Address mode	Full address mode
DTC transfer read skip	Enabled
Sequence transfer	Not used

- SCI6

SCI6 is used to communicate with 3D Monitor. SCI6 settings are shown in Table 3-8.

Table 3-8 SCI6 setting

Item	Setting
Mode to use	ASYNC Mode
Channels to be used	Channel 6
Transfer complete interrupt	Enabled

3.5 Software configuration

3.5.1 File Configuration

Table 3-9 shows the source files.

Table 3-9 Source file

File name	Description	Notes
qe_touch_sample.c	Application file	-

3.5.2 Constants

Table 3-10 shows the constants of the qe_touch_sample.c.

Table 3-10 Constants（qe_touch_sample.c）

Constant name	Setting value	Description
TOUCH_SCAN_INTERVAL_EXAMPLE	(5)	Software delay value [msec units]
LOG_SEND_DATA_SIZE	(0x1C)	Data size to be sent from a single CTSU measurement
LOG_RECV_DATA_SIZE	(0x04)	Receive data size from 3D Monitor
LOG_HEADER	(0x55)	Value indicating the header of the log communication data format
LOG_DELIMITER	(0x0A)	Value indicating the delimiter of the log communication data format
LOG_COMMAND_START	(0x01)	Indicates START of the command.
LOG_COMMAND_STOP	(0x02)	Indicates STOP of the command.
LOG_COMMAND_DATA	(0x03)	Indicates DATA of the command.
LOG_ON	(0x01)	Value indicating that log transmission is valid
LOG_OFF	(0x00)	Value indicating that log transmission is disabled
LOG_ID_MAX	(0xFF)	ID Maximum value
LOG_INDEX_HEADER	(0)	Value indicating the index of the header of the log communication data format
LOG_INDEX_ID	(1)	Indicates the indexes of ID in the log communication data format.
LOG_INDEX_COMMAND	(2)	Value indicating the index of the command in the log communication data format
LOG_SEND_COUNT	(2)	CTSU count required for logging transmission
BUF_SIZE_SND	(LOG_SEND_DATA_SIZE * LOG_SEND_COUNT)	Transmit data buffer size
BUF_SIZE_DATA	(8)	CTSU measured value storage buffer size
SCI_BAUDRATE	(38400)	SCI6 baud rate setting
SCI_INT_PRIORITY	(1)	SCI6 interrupt priority setting
SCI_RECV_DATA_SIZE	(1)	SCI6 Received data size

3.5.3 Functions

Table 3-11 shows the functions.

Table 3-11 Functions

Function Name	Processing overview
qe_touch_sample.c	
qe_touch_main	Main function
init_peripheral_function	Peripheral function initialization processing
sample_initialize	3D Gesture Electrode Board Initialization Process
sample_application	3D gesture-detection process
sample_app_receive	Receive-data analysis process from 3D Monitor
user_uart_callback	SCI6 interrupt callback

For further API specifics, please refer to the application notes of the individual modules.

3.6 3D Position Computation Software Specifications

3.6.1 File Configuration

Table 3-12 shows the source file used in this sample software.

Table 3-12 Source file

File name	Description	Notes
r_cap_position.c	3D position calculation API source file	-

Table 3-13 shows the header files.

Table 3-13 Header files

File name	Description	Notes
r_cap_position_config.h	3D position calculation API config file	-
r_cap_position_measure.h	3D position calculation API pre-measurement file	-
r_cap_position_if.h	3D position calculation API interface file	-
r_cap_position.h	3D position calculation API header file	For use in 3D position calculation API

3.6.2 Constants

Table 3-14 shows the r_cap_positon_if.h constants.

Table 3-14 Constants (r_cap_position_if.h)

Constant name	Setting value	Description
CAPPOS_NODETECT	(0x3FFF)	Value displayed when no 3D position calculation results are detected
CAPPOS_SUCCESS	(0x00)	3D position calculation API completed normally
CAPPOS_ERROR	(0x01)	3D position calculation API error occurred
CAPPOS_NORMAL	(0x00)	Value displayed when result of noise environment is normal
CAPPOS_NOISY	(0x01)	Value displayed when result of noise environment is noise detection

Table 3-15 shows the r_cap_position_config.h constants.

The default setting value is the value for the 3D Gesture Electrode Board; change as necessary to fit the usage environment.

Table 3-15 Constants (r_cap_position_config.h)

Constant name	Setting value	Description
CAPPOS_CNF_MOVAVG_NUM	(15)	Moving average setting value
CAPPOS_CNF_DRIFT_NUM	(150)	Drift measurement number
CAPPOS_CNF_DRIFT_THR	(25)	Drift threshold
CAPPOS_CNF_RESUME_NUM	(25)	Resume measurement number
CAPPOS_CNF_RESUME_THR	(20)	Resume threshold
CAPPOS_CNF_NOISE_THR_A	(150)	Noise threshold A (difference with reference value)
CAPPOS_CNF_NOISE_THR_B	(50)	Noise threshold B (difference with past value)
CAPPOS_CNF_MAX_X	(100)	X direction calculation range [mm]
CAPPOS_CNF_MAX_Y	(100)	Y direction calculation range [mm]

Table 3-16 shows the r_cap_position_measure.h constants.

The default setting value is the value for the 3D Gesture Electrode Board; change as necessary to fit the usage environment.

Table 3-16 Constants (r_cap_position_measure.h)

Constant name	Setting value	Description
CAPPOS_MEAS_Z0	(10)	Measured Z direction position [mm] Set to 1 or higher.
CAPPOS_MEAS_Z1	(20)	Measured Z direction position [mm] Set to a value higher than CAPPOS_MEAS_Z0
CAPPOS_MEAS_Z2	(30)	Measured Z direction position [mm] Set to a value higher than CAPPOS_MEAS_Z1
CAPPOS_MEAS_Z3	(40)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z2. If positions were measured in 3 locations, set to 0 for this constant and all "CAPPOS_MEAS_*_3" constants.
CAPPOS_MEAS_Z4	(50)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z3. If positions were measured in 4 locations, set to 0 for this constant and all "CAPPOS_MEAS_*_4" constants.
CAPPOS_MEAS_Z5	(60)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z4. If positions were measured in 5 locations, set to 0 for this constant and all "CAPPOS_MEAS_*_5" constants.
CAPPOS_MEAS_Z6	(70)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z5. If positions were measured in 6 locations, set to 0 for this constant and all "CAPPOS_MEAS_*_6" constants.
CAPPOS_MEAS_Z7	(80)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z6. If positions were measured in 7 locations, set to 0 for this constant and all "CAPPOS_MEAS_*_7" constants.

CAPPOS_MEAS_Z8	(90)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z7. If positions were measured in 8 locations, set to 0 for this constant and all “CAPPOS_MEAS_*_8” constants.
CAPPOS_MEAS_Z9	(100)	Measured Z direction position [mm]. Set to a value higher than CAPPOS_MEAS_Z8. If positions were measured in 9 locations, set to 0 for this constant and all “CAPPOS_MEAS_*_9” constants.
CAPPOS_MEAS_X	(60)	Measured X direction position [mm] If the X direction is not measured, set to 0 for this constant.
CAPPOS_MEAS_Y	(0)	Measured Y direction position [mm] If the Y direction is not measured, set to 0 for this constant.
CAPPOS_MEAS_TOP	(15284)	Top electrode count value when nothing is in vicinity of board
CAPPOS_MEAS_BTM	(14017)	Bottom electrode count value when nothing is in vicinity of board
CAPPOS_MEAS_RGT	(11991)	Right electrode count value when nothing is in vicinity of board
CAPPOS_MEAS_LFT	(11348)	Left electrode count value when nothing is in vicinity of board
CAPPOS_MEAS_TOP0	(13615)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_TOP1	(14451)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_TOP2	(14791)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_TOP3	(14967)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_TOP4	(15060)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_TOP5	(15117)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_TOP6	(15165)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_TOP7	(15206)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_TOP8	(15215)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_TOP9	(15239)	Top electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_BTM0	(12637)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_BTM1	(13297)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_BTM2	(13565)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_BTM3	(13717)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_BTM4	(13801)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_BTM5	(13852)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_BTM6	(13894)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_BTM7	(13926)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_BTM8	(13950)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_BTM9	(13976)	Bottom electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_RGT0	(10725)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_RGT1	(11347)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_RGT2	(11597)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_RGT3	(11729)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_RGT4	(11805)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_RGT5	(11852)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_RGT6	(11890)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_RGT7	(11918)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_RGT8	(11930)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_RGT9	(11950)	Right electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_LFT0	(10229)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_LFT1	(10785)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_LFT2	(11009)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_LFT3	(11124)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_LFT4	(11192)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_LFT5	(11230)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z5)

CAPPOS_MEAS_LFT6	(11261)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_LFT7	(11279)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_LFT8	(11297)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_LFT9	(11317)	Left electrode count value measured when coordinates are (0, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_X_RGT0	(10956)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_X_RGT1	(11417)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_X_RGT2	(11640)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_X_RGT3	(11760)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_X_RGT4	(11828)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_X_RGT5	(11869)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_X_RGT6	(11905)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_X_RGT7	(11924)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_X_RGT8	(11948)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_X_RGT9	(11956)	Right electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_X_LFT0	(11123)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_X_LFT1	(11198)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_X_LFT2	(11232)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_X_LFT3	(11257)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_X_LFT4	(11278)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_X_LFT5	(11290)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_X_LFT6	(11307)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_X_LFT7	(11308)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_X_LFT8	(11327)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_X_LFT9	(11332)	Left electrode count value measured when coordinates are (CAPPOS_MEAS_X, 0, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_Y_TOP0	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_Y_TOP1	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_Y_TOP2	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_Y_TOP3	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_Y_TOP4	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z4)

CAPPOS_MEAS_Y_TOP5	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_Y_TOP6	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_Y_TOP7	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_Y_TOP8	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_Y_TOP9	(0)	Top electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z9)
CAPPOS_MEAS_Y_BTM0	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z0)
CAPPOS_MEAS_Y_BTM1	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z1)
CAPPOS_MEAS_Y_BTM2	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z2)
CAPPOS_MEAS_Y_BTM3	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z3)
CAPPOS_MEAS_Y_BTM4	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z4)
CAPPOS_MEAS_Y_BTM5	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z5)
CAPPOS_MEAS_Y_BTM6	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z6)
CAPPOS_MEAS_Y_BTM7	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z7)
CAPPOS_MEAS_Y_BTM8	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z8)
CAPPOS_MEAS_Y_BTM9	(0)	Bottom electrode count value measured when coordinates are (0, CAPPOS_MEAS_Y, CAPPOS_MEAS_Z9)

3.6.3 Structures

Table 3-17 shows the st_position_result_t structures.

Table 3-17 st_cappos_result_t Structures

Type	Member	Description
int16_t	coord_x	x position calculation result [mm]
int16_t	coord_y	y position calculation result [mm]
int16_t	coord_z	z position calculation result [mm]
uint8_t	noise	Result of noise environment detection

Table 3-18 shows the st_captouch_data_t structures.

Table 3-18 st_captouch_data_t Structures

Type	Member	Description
uint16_t	top	Top electrode count value
uint16_t	btm	Bottom electrode count value
uint16_t	rgt	Right electrode count value
uint16_t	lft	Left electrode count value

3.7 API Function Specification

For API function specification, refer to "5.4 API function specification" in "RX Family CTSU 3D Gesture Demo Set Sample Software" (R01AN4101).

3.8 Gesture Recognition Library Specifications

3.8.1 File Configuration

Table 3-19 shows the library files.

Table 3-19 Library file

File name	Description
Gesture_Recognition_RXv2.lib	Gesture recognition library file (RX build)

Table 3-20 shows the header file.

Table 3-20 Header file

File name	Description
r_cap_gesture_if.h	Gesture recognition API interface file

3.8.2 Constants

Table 3-21 shows the constants. These are defined by enumerated type e_gesture_result_t.

Table 3-21 Constants

Constant name	Setting value	Description
GESTURE_RESULT_NONE	(0)	No recognition
GESTURE_RESULT_RIGHT_SWIPE	(1)	Right swipe
GESTURE_RESULT_LEFT_SWIPE	(2)	Left swipe
GESTURE_RESULT_FRONT_SWIPE	(3)	Front swipe
GESTURE_RESULT_BACK_SWIPE	(4)	Back swipe
GESTURE_RESULT_DOWN_SWIPE	(5)	Push
GESTURE_RESULT_CW_SLOW	(6)	Draw circle (Clockwise, Slow)
GESTURE_RESULT_CW_FAST	(7)	Draw circle (Clockwise, Fast)
GESTURE_RESULT_RESERVE	(8)	Reserved
GESTURE_RESULT_CCW_SLOW	(9)	Draw circle (Counter clockwise, Slow)
GESTURE_RESULT_CCW_FAST	(10)	Draw circle (Counter clockwise, Fast)
GESTURE_RESULT_RESERVE2	(11)	Reserved2

3.8.3 Structures

Table 3-22 shows the st_cappos_input_t structure.

Table 3-22 st_cappos_input_t Structures

Type	Member	Description
int16_t	coord_x	x position calculation result [mm]
int16_t	coord_y	y position calculation result [mm]
int16_t	coord_z	z position calculation result [mm]
uint8_t	noise	Result of noise environment detection

3.9 API Function Specification

For API function specification, refer to "6.4 API function specification" in "RX Family CTSU 3D Gesture Demo Set Sample Software" (R01AN4101).

4. Capacitance Touch Settings

This section describes the sample application. The 3D Gesture sample application has been added based on the QE Touch module application file qe_touch_sample.c.

4.1 Touch Interface Configuration

In this software, TS pins are configured as shown in Figure 4-1.

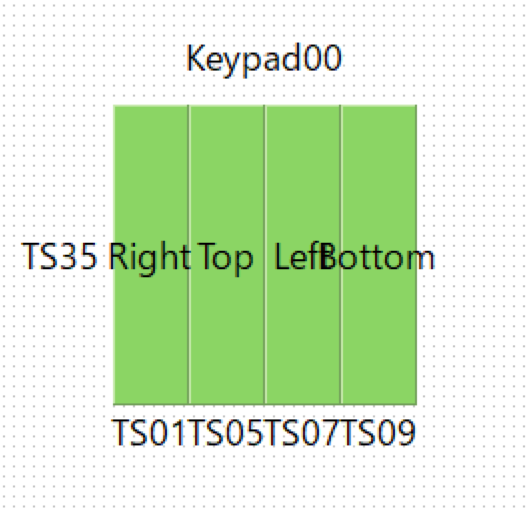

Figure 4-1 Touch Interface Configuration

4.2 Configuration (method) settings

Config01 is set to the keypad.

4.3 Tuning result

The following shows the tuning results in QE tuning. This program operates with the setting values shown in the results list.

Since the values in the result list depend on the operating environment at the time of QE tuning, these values may change when QE tuning is performed again.

Table 4-1 QE Tuning Results

Method	Name	Touch sensor	Parasitic capacitance [pF]	Drive pulse frequency [MHz]	Threshold	Measuring time [ms]	so	snum	sdpa
config01	right	TS01	26.924	1	86	0.576	0x000	0x07	0x0F
config01	top	TS03	26.924	1	80	0.576	0x000	0x07	0x0F
config01	left	TS05	26.924	1	97	0.576	0x000	0x07	0x0F
config01	bottom	TS09	26.924	1	110	0.576	0x000	0x07	0x0F

so：Sensor Offset Setting Variables
snum：Variables for the measurement period setting
sdpa：Clock division setting variable

4.4 Sensitivity adjustment method

Use QE for Capacitive Touch to adjust the sensitivity. There are the following methods for adjusting the sensitivity.

- How to use the tune function of QE for Capacitive Touch

Follow the tutorial from the main window (Cap Touch main) of QE for Capacitive Touch.

5. Calculating 3D position

Refer to Section 4 of RX Family CTSU 3D Gesture Demonstration Set Sample Software (R01AN4101) for information on calculating 3D position.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Nov.11.22	-	First edition release

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.

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   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.).
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(Rev.5.0-1 October 2020)

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