RL78/L23

Capacitive Touch with segment LCD display Sample Code

Introduction

This application note describes the RL78/L23 Capacitive Touch Evaluation System and the contents of the sample code displaying the detected position of the Capacitive Touch on the LCD panel.

Target Device

RL78/L23

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Overview

This sample code is software that display the detected position of the capacitive touch on the LCD panel with the RL78/L23 Capacitive Touch Evaluation System (RSSK-RL78L23) and the LCD module.

The following is added to the project.

- Components generated by the Smart Configurator
- Capacitive touch configuration files and applications tuning with QE for Capacitive Touch (QE)
- LED control application
- LCD control application (Note: Because the LCD is an optional function, you need to configure to use.)

1.1 Function

The functions are shown below.

1. Capacitive touch function operates all electrodes (3 buttons, slider, wheel, shield) of Capacitive Touch Evaluation Application Board.
2. LED control linked to capacitive touch buttons, sliders, and wheels.
3. Enable USB serial interface to control serial communication and supports QE serial monitor and serial tuning. For more information on serial monitoring and serial tuning, refer to ”8. [Additional function] Setting the serial communication monitor using UART” in “Application Note RL78 Family Using QE and SIS to Develop Capacitive Touch Applications (R01AN5512)”. When performing serial monitoring and serial tuning of QE, set the serial communication bit rate to 115200bps.
4. LED control linked to CPU board push buttons. Pressing SW1, LED1 lights up. Pressing SW2, LED2 lights up.

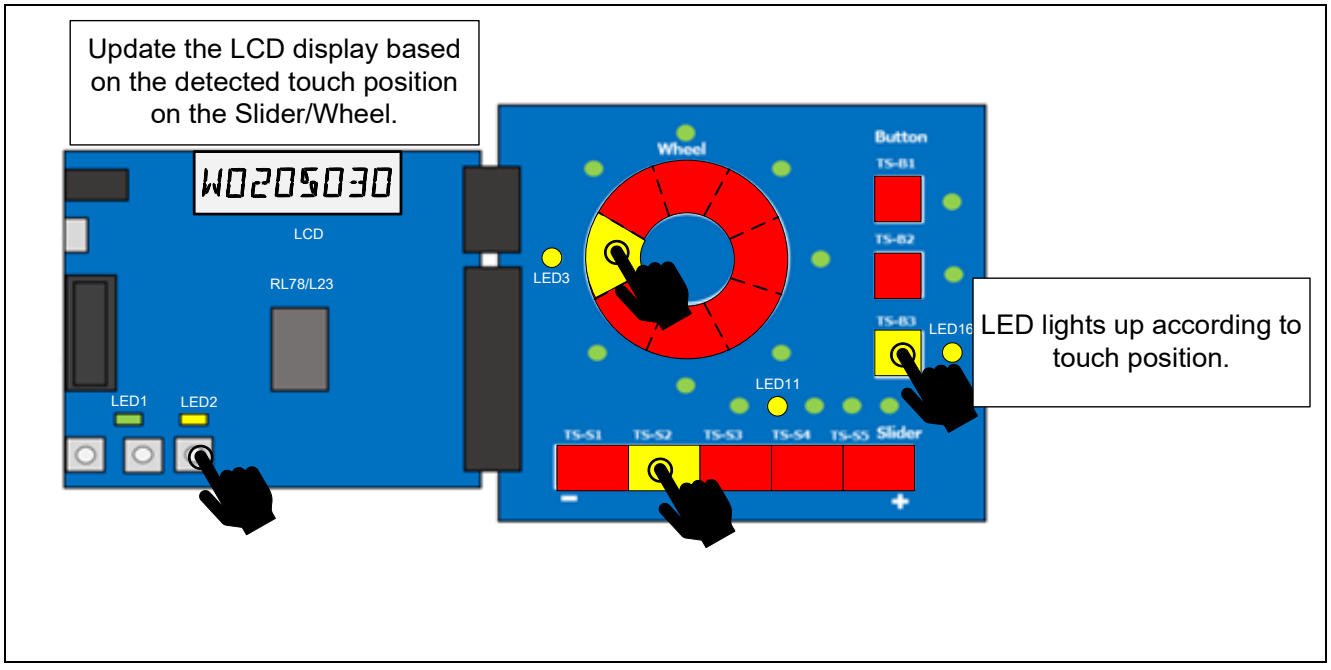


図 1-1 Description of the function

2. Operation Confirmation Conditions

The operation of this sample code has been confirmed the following environment.

Table 2-1 Operation Confirmation Conditions

Item	Contents
MCU	RL78/L23 (R7F100LPL3CFB)
Operating frequency	32MHz (HOCO 32MHz)
Operating voltage	3.3V LVD0 detection voltage : Reset mode At rising edge TYP. 2.97V(TYP) (2.88V to 3.06V) At falling edge TYP. 2.91V(TYP) (2.82V to 3.00V)
Evaluation board	Capacitive Touch Evaluation System for RL78/G23 (Product No: RTK0EG0063S01001B) • RL78/L23 CPU Board (Product No: RT0EG0062C01001BJ) • Capacitive Touch Evaluation Application Board Self-Capacitance Buttons / Wheels / Slider Board (Product No: RTK0EG0019B01002BJ)
LCD(Note)	Varitronix VIM-878-DP-FC-S-LV 16 segments x8 digits Header : 36-pin (18 x 2 rows) x 1 Operating voltage condition : 3V to 4.6V (When using the module with operating voltage other than 3.3V, remove the LCD panel.)
Integrated development environment (e^2 studio)	e^2 studio Version 2025-07 from Renesas Electronics Corporation
C Compiler (e^2 studio)	CC-RL V1.15.01 from Renesas Electronics Corporation
Integrated development environment (CS+)	CS+ for CC V8.14.00 from Renesas Electronics Corporation
C Compiler (CS+)	CC-RL V1.15.01 from Renesas Electronics Corporation
Smart Configurator	RL78 Smart Configurator V1.14.0 from Renesas Electronics Corporation
Development Assistance Tool for Capacitive Touch Sensors	QE for Capacitive Touch V4.2.0
Board support package (BSP)	V1.91 from Renesas Electronics Corporation
Emulator	Renesas E2Emulator Lite (RTE0T0002LKCE00000R)

Note: This board doesn't come with any LCD.

Figure 2-1 shows device connection diagram.

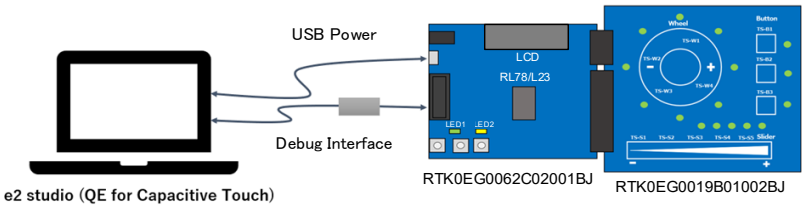


Figure 2-1 Device Connection Diagram

3. Hardware configuration

The LCD is optional in the RL78/L23 Capacitive Touch Evaluation System. You must configure RL78/L23 CPU Board (No: RT0EG0062C02001BJ) properly to enable its use.

3.1 Connect wires to LCD

Since the LCD is not connected in the initial state, switch the wiring using Short-PAD/Open-PAD to use the LCD.

The LCD drive power supply settings need to be changed. This application note uses the capacitance division method.

For details on the wiring to be switched and its settings, refer to the “RL78/L23 Renesas Solution Starter Kit Capacitive Touch Evaluation System User's Manual (R12UZ0175).”

3.2 LCD connection

To connect to the LCD, installation of the LCD connection socket on the CPU board is required. After that, you can use the LCD. You can refer to "RL78/L23 LCD display(Clock demo)(R01AN7852)" for more details.

3.3 Jumper wires configuration

The sample code accompanying this application note has been run and confirmed under the conditions of Table 3-1. The LCD used in this note operates at 3.0V to 4.6V, so power must be supplied through LDO.

Table 3-1 Jumper Settings for CPU Board

Jumper	Configuration	Contents
JP4	Short 1-2	Supplied from USB
JP1	Short 2-3	Using 3.3V LDO
JP2	Short 2-3	
SW6	Short 2-3	TS16 is connected to CN2

4. Software Specification

4.1 Software Structure Diagram

Figure 4-1 shows the software structure diagram of this sample code.

This software uses components generated by the Smart Configurator.

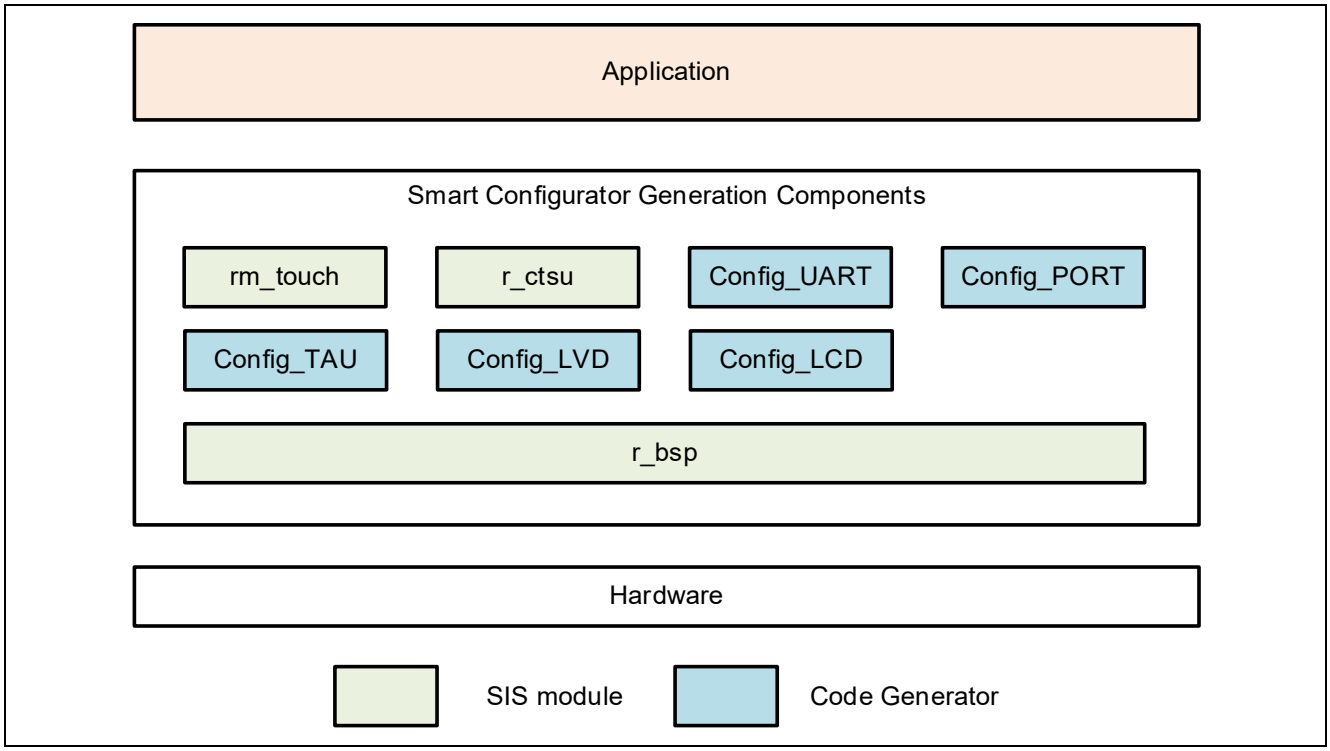


Figure 4-1 Software structure diagram

Figure 4-2 shows a list of components and their versions.

Refer to the smart configurator for component settings.

Component	Version	Configuration
Board Support Packages. - v1.91 (r_bsp)	1.91	r_bsp(used)
Capacitive Sensing Unit driver. (r_ctsu)	2.20	r_ctsu(used)
Interval Timer	1.8.0	Config_TAU0_2(TAU0_2: used), Config_TAU0_1(TAU0_1: used), Config_TAU0_3(TAU0_3: used)
LCD Controller	1.1.0	Config_LCD(LCD: used)
Ports	1.8.0	Config_PORT(PORT: used)
Touch middleware. (rm_touch)	2.20	rm_touch(used)
UART Communication	1.10.0	Config_UART2(UART2: used)
Voltage Detector	1.6.1	Config_LVD0(LVD0: used)

Figure 4-2 Components and their versions list

4.2 File Structure

This is the file structure of this sample code. The project configuration file and smart configurator generation file of the development environment are omitted.

Table 4-1 File structure of this sample code

Folder and file name	Description	Smart Configurator Usage
rl78l23_rssk_lcd <DIR>	Sample code folder	
QE-Touch <DIR>	QE structure folder	
rl78l23_rssk_lcd.tifcfg	Touch interface configuration file	
qe_gen	QE generated folder	
qe_touch_config.c	Touch configuration source	
qe_touch_config.h	Touch configuration header	
qe_touch_define.h	Touch define header	
qe_touch_sample.c	Touch sample application	
src <DIR>	Source Folder	
rl78l23_rssk_lcd.c	Main file	
r_rssk_switch_led.c	Switch % LED function source	
r_rssk_switch_led.h	Switch % LED function header	
r_rssk_touch_led.c	Touch electrode & LDE function source	
r_rssk_touch_led.h	Touch electrode & LDE function header	
r_rssk_touch_lcd.c	Touch electrode & LCD function source	
r_rssk_touch_lcd.h	Touch electrode & LCD function header	
smc_gen <DIR>	Smart Configuration generated folder	✓
Config_LCD <DIR>	LCD driver folder	✓
Config_LVD <DIR>	LVD driver folder	✓
Config_PORT <DIR>	PORT driver folder	✓
Config_TAU0_1 <DIR>	TAU0_1 driver folder	✓
Config_TAU0_2 <DIR>	TAU0_2 driver folder	✓
Config_TAU0_3 <DIR>	TAU0_3 driver folder	✓
r_ctsu <DIR>	CTSU SIS module folder	✓
rm_touch <DIR>	TOUCH SIS module folder	✓

4.3 Setting of Option Byte

Table 4-2 shows the option byte settings.

Table 4-2 Option Byte Settings

Address	Setting Value	Content
000C0H / 040C0H	1110 1111b(0xEF)	Disables the watchdog timer. (Counting stopped after reset)
000C1H / 040C1H	1111 1011b(0xFB)	LVD0 detection voltage : Reset mode At rising edge TYP. 2.67V(TYP) (2.59V to 2.75V) At falling edge TYP. 2.62V(TYP) (2.54V to 2.70V)
000C2H / 040C2H	1110 1000b(0xE8)	HS (high-speed main) mode High-speed on-chip oscillator clock: 32 MHz
000C3H / 040C3H	1000 0100b(0x84)	Enables on-chip debugging

Figure 4-3 shows the screen to check with the build options

The setting value of the option byte can be checked from the project properties after code generation. Open the project properties (ALT+Enter) and select “C/C++ Build” -> “Settings” to open a “Tool Settings” tab, and select “Linker” -> “Device” and the “User option byte value” and “On-chip debug control value” are displayed.

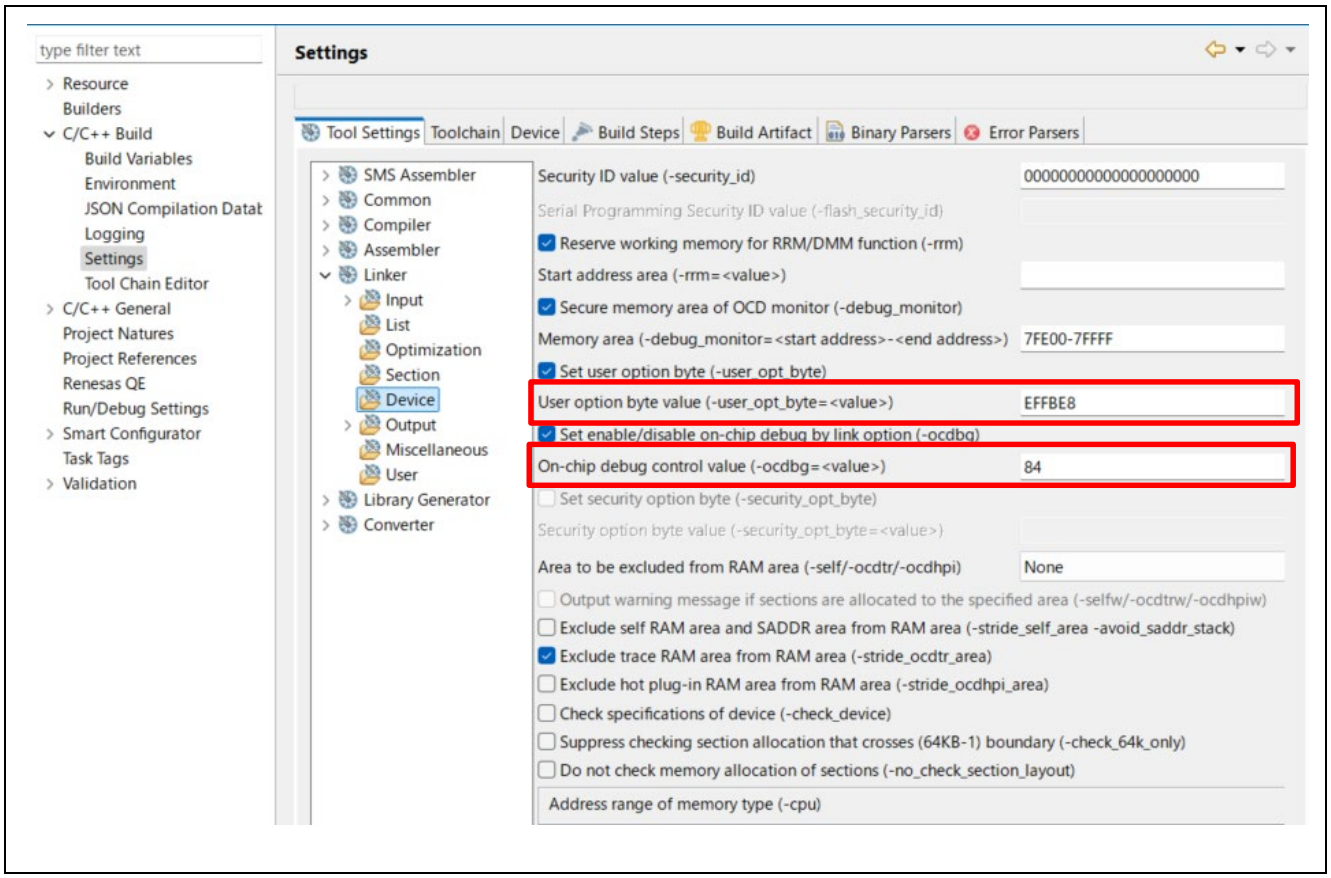


Figure 4-3 User Option Byte Value and On-chip Debug Control Value

4.4 Constants

Table 4-3, Table 4-4 lists the constants.

Table 4-3 List of Constant (1/2)

Constant Name	Setting Value	Description
File name : qe_touch_main.c		
TOUCH_SCAN_INTERVAL_EXAMPLE	(20 * 1000)	Software delay value [unit: µs]
TEST_INTERVAL_EXAMPLE	(1 * 1000)	Initial LED software delay value [unit: µs]
File name : r_rssk_switch_led.c		
RSSK_SW1_PORT	(P6_bit.no0)	Pointer to port control register connected to SW1
RSSK_SW2_PORT	(P6_bit.no1)	Pointer to port control register connected to SW2
RSSK_LED1_PORT	(P6_bit.no4)	Pointer to port control register connected to LED1
RSSK_LED2_PORT	(P6_bit.no5)	Pointer to port control register connected to LED2
RSSK_SW1_PORT_MODE	(PM6_bit.no0)	Pointer to port mode register connected to SW1
RSSK_SW2_PORT_MODE	(PM6_bit.no1)	Pointer to port mode register connected to SW2
RSSK_LED1_PORT_MODE	(PM6_bit.no4)	Pointer to port mode register connected to LED1
RSSK_LED2_PORT_MODE	(PM6_bit.no5)	Pointer to port mode register connected to LED2
RSSK_LED_ON	(0x00U)	Turn on the LED
RSSK_LED_OFF	(0x01U)	Turn off the LED
File name : r_rssk_touch_led.c		
LED_COL0	(P14_bit.no0)	Pointer to port control register connected to COL0
LED_COL1	(P8_bit.no4)	Pointer to port control register connected to COL1
LED_COL2	(P8_bit.no3)	Pointer to port control register connected to COL2
LED_COL3	(P8_bit.no2)	Pointer to port control register connected to COL3
LED_ROW0	(P2_bit.no1)	Pointer to port control register connected to ROW0
LED_ROW1	(P2_bit.no0)	Pointer to port control register connected to ROW1
LED_ROW2	(P8_bit.no1)	Pointer to port control register connected to ROW2
LED_ROW3	(P8_bit.no0)	Pointer to port control register connected to ROW3
LED_COL_MAX	(4U)	Number of COL signals
LED_COL_ON	(1U)	COL signal ON
LED_COL_OFF	(0U)	COL signal OFF
LED_ROW_OFF	(1U)	ROW signal OFF

Table 4-4 List of Constant (2/2)

Constant Name	Setting Value	Description
File name : r_rssk_touch_led.c		
SLIDER_LED_NUM	(5U)	Number of slider LED
SLIDER_RESOLUTION	(100U)	Maximum slider touch result
WHEEL_LED_NUM	(8U)	Wheel LED control bit MSB
WHEEL_LED_MSB	(1U << (WHEEL_LED_NUM - 1U))	Wheel LED control bit MSB
WHEEL_RESOLUTION_DEGREE	(360U)	Maximum wheel touch result [unit: degree]
WHEEL_POSITION_OFFSET_DEGREE	(112U)	Wheel touch position offset [unit; degree]
ALL_LED_NUM	(16U)	Total number of touch electrode board LEDs
LED_TEST_INTERVAL	(100U)	LED lighting interval time
File Name : r_rssk_touch_lcd.c		
TOUCH_BUTTON1_ONLY_ON	(0x02)	Enable only touch button 1
TOUCH_BUTTON2_ONLY_ON	(0x04)	Enable only touch button 2
TOUCH_BUTTON3_ONLY_ON	(0x01)	Enable only touch button 3
LCD_STATE_OFF	(0)	LCD display OFF state
LCD_STATE_ON	(1)	LCD display ON state
LCD_STATE_BLINK_150MS	(2)	LCD display blinking at 150ms intervals
LCD_STATE_BLINK_250MS	(3)	LCD display blinking at 250ms intervals

4.5 Enumerations

Table 4-5 lists the rssk_sw_status_t enum.

Table 4-5 rssk_sw_status_t

Member	Value	Description
File Name : r_rssk_switch_led.h		
RSSK_SW_OFF	0x00	Switch OFF state
RSSK_SW_ON	0x01	Switch ON state

4.6 Global Variables

Table 4-6 lists the global variables.

Table 4-6 List of Global Variable

Variable Name	Types	Description
File Name : qe_touch_sample.c		
button_status	uint64_t	Button Status
slider_position[1]	uint16_t	Slider touch position information
wheel_position[1]	uint16_t	Wheel touch position information
File Name : r_rssk_touch_led.c		
s_led_drive_colmun	uint8_t	Touch electrode board LED drive information
s_button_idx[3]	uint8_t	Button index array
File Name : r_rssk_touch_lcd.c		
s_lcd_state	uint8_t	LCD display state
s_lcd_blink_150ms_on	uint8_t	LCD blinking at 150ms intervals
s_lcd_blink_250ms_on	uint8_t	LCD blinking at 250ms intervals
s_lcd_display_array[8]	uint8_t	Array to store characters displayed on the LCD
File Name : r_rssk_lcd_segdata.c		
g_show_segdata[41][4]	const uint8_t	Segment values for displaying characters on the LCD
g_digit_segdata[8][4]	const uint8_t	Number of digits on the LCD for displaying

4.7 Functions

Table 4-7 lists the functions.

Table 4-7 List of Function

Function Name	Description
File Name : qe_touch_main.c	
qe_touch_main	Main Function
qe_touch_delay	Software delay
r_rssk_initialize	Initialization processing of Capacitive Touch Evaluation System
r_rssk_led_test	LED test processing for Capacitive Touch Evaluation System
r_rssk_timer_callback	TAU0 interrupt callback
File Name : r_rssk_switch_led.c	
r_rssk_switch_led_init	CPU board LED initialization processing
r_rssk_switch_led_control	CPU board LED control processing
rssk_get_sw1_status	SW1 state response processing
rssk_get_sw2_status	SW2 state response processing
r_rssk_led1_on	CPU board LED1 turn on
r_rssk_led1_off	CPU board LED1 turn off
r_rssk_led2_on	CPU board LED2 turn on
r_rssk_led2_off	CPU board LED2 turn off
File Name : r_rssk_touch_led.c	
r_rssk_touch_led_test	Touch electrode board LED test pattern processing
r_rssk_touch_led_control	Touch electrode board LED control processing
File Name : r_rssk_touch_lcd.c	
r_rssk_lcd_init	Display on the LCD at the beginning
r_rssk_touch_lcd_control	Touch board LCD control processing
r_rssk_blink_150ms_callback	Callback for LCD display blinking at 150ms intervals
r_rssk_blink_250ms_callback	Callback for LCD display blinking at 250ms intervals
lcd_update_display	Update LCD display
lcd_clear_display	Clear LCD display
lcd_show_array	Display character array on the LCD
lcd_show	Displays a character on the LCD
touch_button1_lcd	Touch detection processing for touch button 1
touch_button2_blink_150ms	Touch detection processing for touch button 2
touch_button3_blink_250ms	Touch detection processing for touch button 3
timer_stop_blink	Stop LCD display blinking timers
timer_start_blink_150ms	Start LCD display blinking timer at 150ms intervals
timer_start_blink_250ms	Start LCD display blinking timer at 250ms intervals
update_lcd_wheel_value	Update the value of wheel on the LCD
update_lcd_slider_value	Update the value of slider on the LCD

4.8 List of Peripheral Functions Used and Pins Used

Table 4-8 and Table 4-9 show a list of used pins, and Table 4-10 shows a list of handling of unused pins in this sample software.

Table 4-8 List of used pins (1/2)

Pin No.	Pin Name	I/O	Usage
34	TS03	I/O	CTSU measurement
35	TS04	I/O	
36	TS05	I/O	
37	TS06	I/O	
39	TS07	I/O	
40	TS08	I/O	
75	TS09	I/O	
74	TS10	I/O	
43	TS11	I/O	
44	TS12	I/O	
56	TS21	I/O	
69	TS32	I/O	
70	TS33	I/O	
71	TS34	I/O	
72	TS35	I/O	
51	TSCAP	-	
42	RxD2	I	QE serial communication
41	TxD2	O	
22	P60/SW1	I	Switch input
23	P61/SW2	I	
24	P64/LED1	O	LED Control
25	P65/LED2	O	
99	P21/LED_ROW0	O	
100	P20/LED_ROW1	O	
68	P81/LED_ROW2	O	
73	P80/LED_ROW3	O	
1	P140/LED_COL0	O	
49	P84/LED_COL1	O	
50	P83/LED_COL2	O	
67	P82/LED_COL3	O	

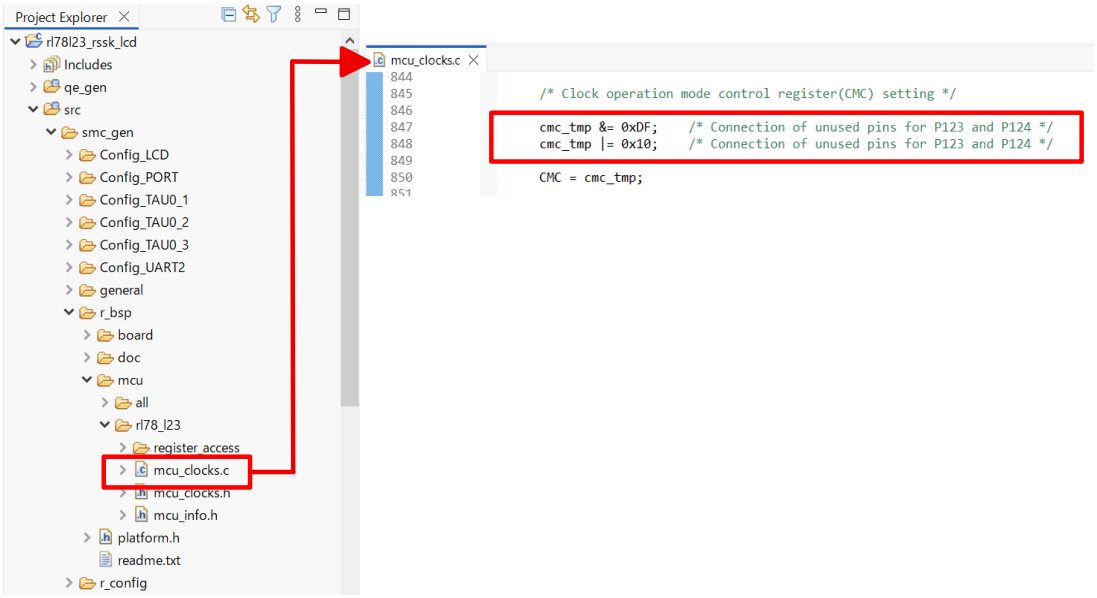
Table 4-9 List of used pins(2/2)

Pin No.	Pin Name	I/O	Usage
62	SEG00	O	LCD Control
61	SEG01	O	
60	SEG02	O	
59	SEG03	O	
46	SEG14	O	
45	SEG15	O	
4	SEG26	O	
3	SEG27	O	
2	SEG28	O	
98	SEG29	O	
97	SEG30	O	
93	SEG31	O	
92	SEG32	O	
91	SEG33	O	
90	SEG34	O	
87	SEG35	O	
86	SEG36	O	
85	SEG37	O	
84	SEG38	O	
83	SEG39	O	
82	SEG40	O	
81	SEG41	O	
80	SEG42	O	
79	SEG43	O	
78	SEG44	O	
77	SEG45	O	
76	SEG46	O	
96	SEG51	O	
95	SEG52	O	
94	SEG53	O	
89	SEG54	O	
88	SEG55	O	
66	COM0	O	
65	COM1	O	
64	COM2	O	
63	COM3	O	

Table 4-10 List of Handling of Unused Pins

Pin No.	Pin Name	I/O	Handling
19	REGC	I	Connect the pin to GND via a capacitor (1uF)
21	VDD	I	Connect the pin to GND via a capacitor (0.1uF)
20	VSS	I	Connect the pin to GND
38	EVSS	I	
16	P137	I	Connect the pin to V_{DD} via a register (10kohm)
15	P124/XT2Note	I	Set the EXCLKS bit to 0 and the OSCSELS bit to 1 in the clock operation mode control register (CMC), set the XTSTOP bit in the clock operation status control register (CSC) to 1, and leave the pins open.
14	P123/XT1Note	I	
pins than the above		-	Low output

Note: The CMC register is set by the mcu_clock_setup function in mcu_clocks.c as shown in Figure 4-4.



Caution If you change the version of the "r_bsp" component in the Smart Configurator, mcu_clocks.c will be overwritten and any code added by the user will be erased.
Therefore, whenever you change the version of the "r_bsp" component, you will need to add the code for the above settings.

Figure 4-4 Edit mcu_clocks.c

Table 4-11 shows a list of peripheral functions used.

Table 4-11 List of Peripheral Functions Used

Peripheral Function	Usage
LVD	Low Voltage Detection
CTSU	CTSU measurement
UART2	QE serial monitoring and serial tuning
TAU0_1	LED control trigger
TAU0_2	Trigger for LCD display blinking control at 150ms intervals
TAU0_3	Trigger for LCD display blinking control at 250ms intervals
LCD	LCD control
PORT	LED control

The peripheral function settings using Smart Configurator are shown below.

- Voltage Detector

The reset generation voltage settings are shown in Table 4-12.

Table 4-12 Voltage Detector

Item	Setting
Operation mode	Reset mode
Detection level Reset generation voltage (VLVD0)	2.91V

- UART communication

Use UARTA1 for serial monitoring of QE for Capacitive Touch. Table 4-13 shows the UART2 settings.

Table 4-13 UART2 setting

Item	Setting
Operation clock	CK10
Clock Source	f_{CLK}/2^2
Transfer mode setting	Single transfer mode
Data length setting	8 bits
Transfer direction segging	LSB
Parity setting	None
Stop bit length setting	1 bit
Transfer rate setting	Non-reverse
Transfer rate setting	115200
Interrupt setting	level 3
Callback function setting	Transmission end

- Interval Timer

Use TAU0_1 for LED control. Table 4-14 shows the TAU0_1 settings.

Table 4-14 TAU0_1 Setting

Item	Setting
Operation clock	CK03
Clock source	f_{CLK}/2^10
Interval value (higher 8bit)	5ms
Interrupt setting	End of timer channel1 count, generate an interrupt (INTTM01H) : Enable (level 3)

Use interval timer "TAU0_2" to control the LCD display blinking at 150 ms intervals. Table 4-15 shows the TAU0_2 settings.

Table 4-15 TAU0_2 Settings

Item	Setting
Operation clock	CK00
Clock source	f_{CLK}/2^10
Interval value (16 bit)	150ms
Count start interrupt	Generates INTTM02 when counting is started: Enable
Interrupt setting	End of timer channel 2 count, generate an interrupt (INTTM02) : Enable (Level 3)

Use interval timer "TAU0_3" to control the LCD display blinking at 250 ms intervals. Table 4-16 shows the TAU0_3 settings.

Table 4-16 TAU0_3 Settings

Item	Setting
Operation clock	CK00
Clock source	f_{CLK}/2^10
Interval value (16 bit)	250ms
Count start interrupt	Generates INTTM03 when counting is started: Enable
Interrupt setting	End of timer channel 3 count, generate an interrupt (INTTM03) : Enable (Level 3)

- LCD

Use LCD. Table 4-17 shows LCD setting.

Table 4-17 LCD Setting

Item	Setting
Display waveform setting	Type A waveform
Drive voltage generator setting	Capacitor split ethod for the V_{DD} reference
Display mode setting	Number of time slices: 4(1/3 bias mode)
Display data area setting	A-pattern area data
Clock source	f_{IL}
Frequency divider	f_{IL}/2^7
Frame frequency	64Hz

- Ctsu middleware (r_ctsu)

Use r_ctsu for touch control. Table 4-18 shows r_ctsu setting.

Table 4-18 r_ctsu Setting

Item	Setting
Data Transfer of INTCTSUWR and INTCTSURD	Interrupt handler
DTC setting	Setting in r_ctsu
Auto-judgment function in Snooze mode using SMS	Disable
Interrupt level for INTCTSUWR	Level 2
Interrupt level for INTCTSURD	Level 2
Interrupt level for INTCTSUFN	Level 2

- Touch middleware (rm_touch)

Use rm_touch for touch control. Table 4-19 shows rm_touch setting. This setting

Enables QE serial monitoring and serial tuning.

Table 4-19 rm_touch Setting

Item	Setting
Support QE monitor using UART	Enable
Support QE tuning using UART	Enable
UART channel	UART2

4.9 Processing Flowchart

Figure 4-5 shows processing flowchart of this sample code.

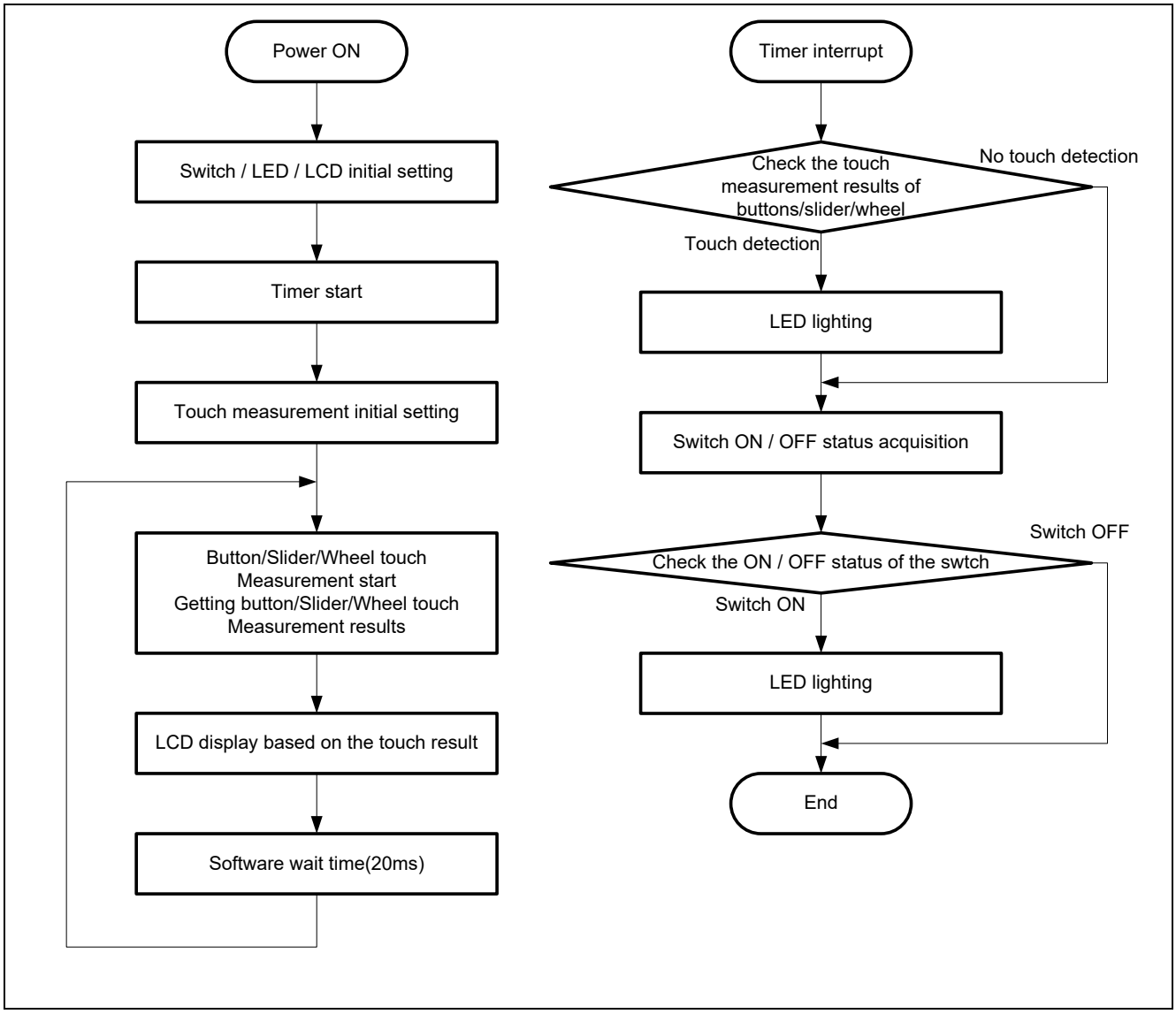


Figure 4-5 Processing Flowchart (Self-Capacitance Buttons / Wheel / Slider Board)

4.10 LCD Display Details

Figure 4-6 shows the detail of how LCD display works in this sample code.

Upon power-on, display "WHEE" on the leftmost 4 LCD digits and "SLID" on the rightmost 4 digits.

- Wheel
  When a touch event is detected, display W and the detected position (1 to 360) on the leftmost 4 LCD digits. When missing any touch subsequently, display "W---" on the same digits.
- Slider
  When a touch event is detected, display S and the detected position (1 to 100) on the rightmost 4 LCD digits. When missing any touch subsequently, display "S---" on the same digits.

The changing display by Wheel and Slider is executed independently.

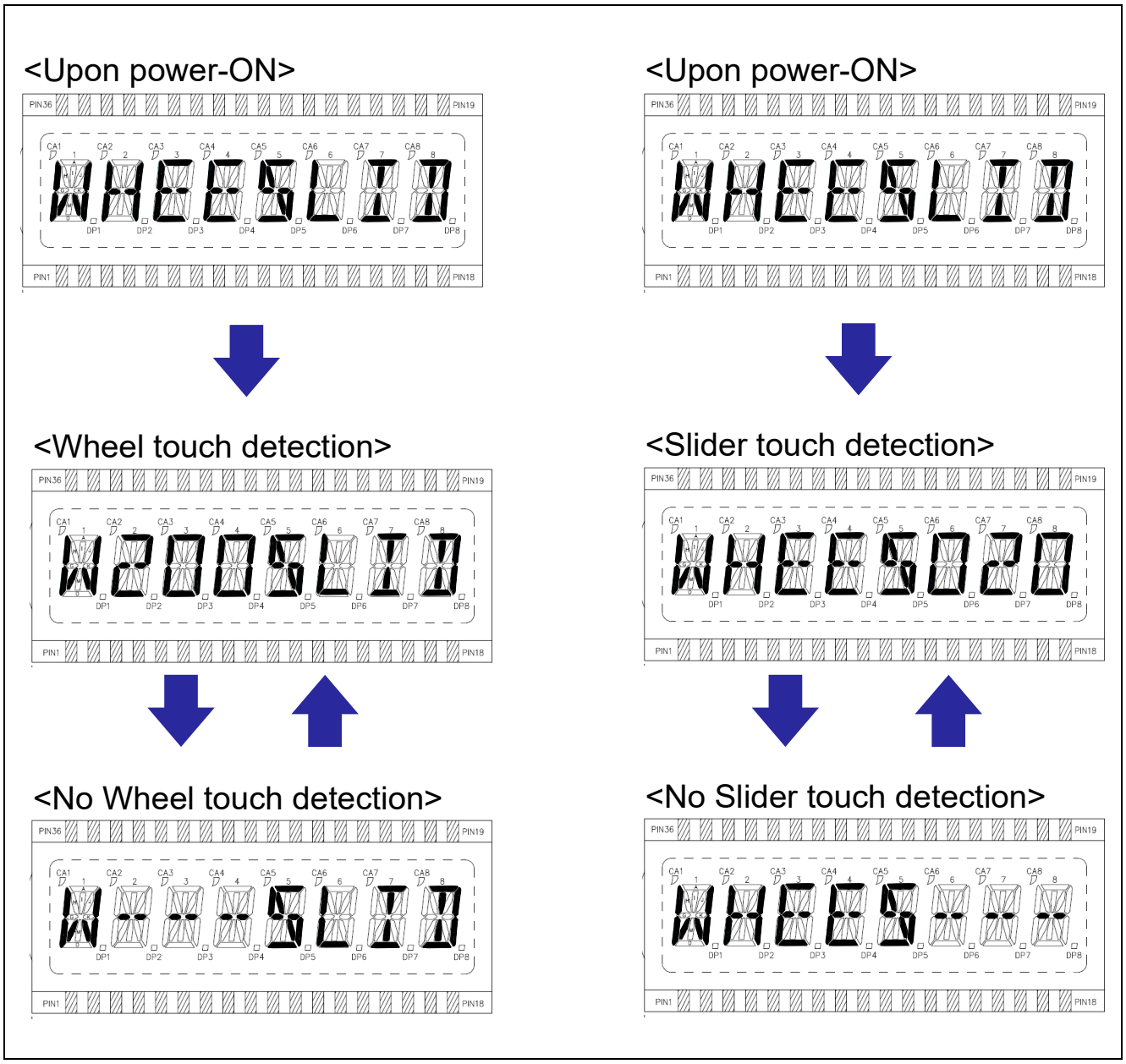


Figure 4-6 LCD Display Details

When a touch event is detected on a touch button, control the LCD display according to the specific button pressed. Figure 4-7 shows examples of touch button.

- Touch button 1
  Transition to LCD display ON state.
  When it's already LCD display ON state, transitions to LCD display OFF state.
- Touch button 2
  Transition to LCD display blinking at 150ms intervals state.
  When it's already LCD display blinking at 150ms intervals state, transitions to LCD display ON state.
- Touch button 3
  Transition to LCD display blinking at 250ms intervals state.
  When it's already LCD display blinking at 250ms intervals state, transitions to LCD display ON state.

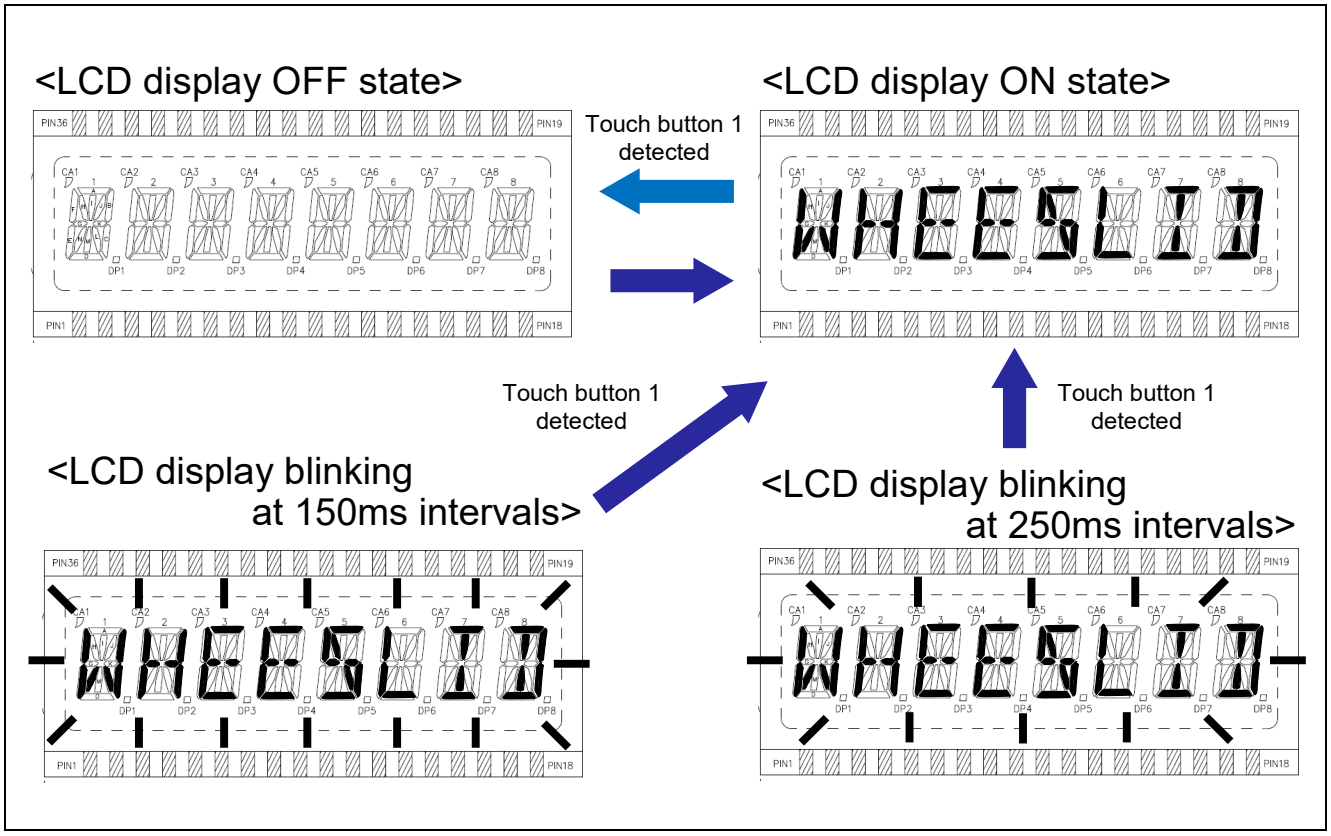


Figure 4-7 Example of LCD display controlled by touch button 1 detection

5. Capacitive Touch Setting

These are the touch interface configuration, configuration (method) settings and tuning results of this sample code. These use the tuning function of QE.

5.1 Touch Interface Configuration

Figure 5-1 shows the setting of the touch interface configuration in this sample code.

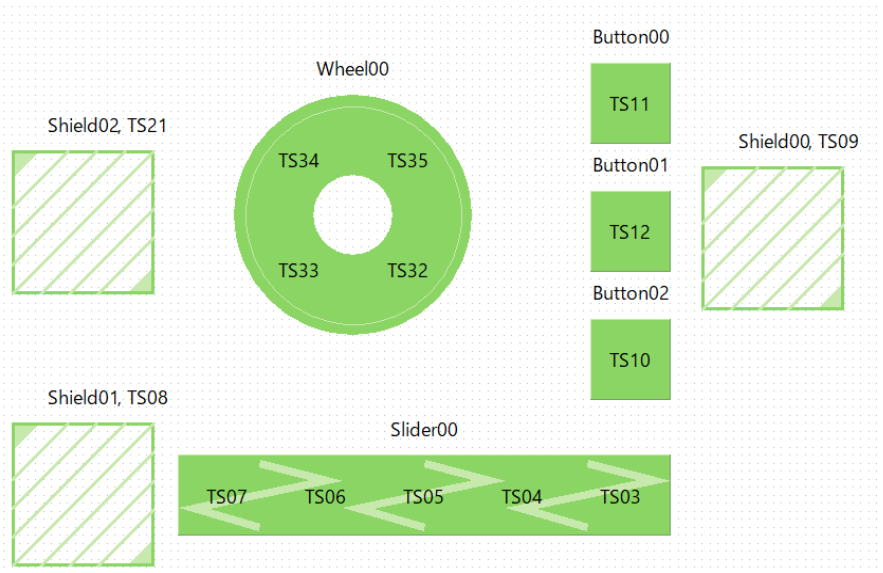


Figure 5-1 Touch interface configuration (Self-Capacitance Buttons / Wheel / Slider Board)

5.2 Configuration (methods) Settings

Figure 5-2 shows configuration (methods) of this sample code. 3 buttons and a shield00 are set enabled in config01. Slider and a shield01 are set enabled in config02. Wheel and a shield02 are set enabled in config03.

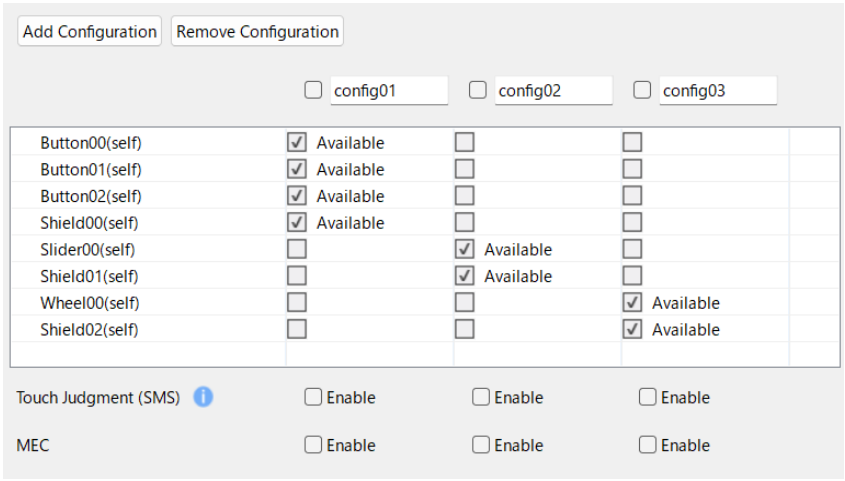


Figure 5-2 Configuration (methods) setting

5.3 Tuning Results

Table 5-1 shows tuning results in QE tuning. Sample code operates with the setting values shown in the QE tuning result list.

Since the values in QE tuning result list depend on the operating environment at QE tuning, these values may change at QE tuning again.

Table 5-1 QE tuning result list (Self-Capacitance Buttons / Wheel / Slider Board)

method	Button name	Touch senser	Parasitic capacitance [pF]	Drive pulse frequency [MHz]	Threshold	Scan time [ms]	so	snum	sdpa
Config01	Button00	TS11	12.688	0.988	709	0.576	0x03B	0x07	0x0D
Config01	Button01	TS12	12.458	0.988	727	0.576	0x041	0x07	0x0D
Config01	Button02	TS10	12.201	0.988	711	0.576	0x03F	0x07	0x0D
Config01	Shield00	TS09	49.701	-	-	-	-	-	-
Config02	Slider00	TS07	11.396	0.99	382	0.576	0x038	0x07	0x0D
Config02	Slider00	TS06	10.604	0.99	382	0.576	0x030	0x07	0x0D
Config02	Slider00	TS05	10.806	0.99	382	0.576	0x030	0x07	0x0D
Config02	Slider00	TS04	10.799	0.99	382	0.576	0x02F	0x07	0x0D
Config02	Slider00	TS03	11.84	0.99	382	0.576	0x036	0x07	0x0D
Config02	Shield01	TS08	49.611	-	-	-	-	-	-
Config03	Wheel00	TS34	12.549	1.067	955	0.576	0x04D	0x07	0x0C
Config03	Wheel00	TS35	12.417	1.067	955	0.576	0x046	0x07	0x0C
Config03	Wheel00	TS32	13.417	1.067	955	0.576	0x046	0x07	0x0C
Config03	Wheel00	TS33	12.812	1.067	955	0.576	0x043	0x07	0x0C
Config03	Shield02	TS21	45.896	-	-	-	-	-	-

so : Variables for sensor offset settings
snum : Variables for setting the measurement period
sdpa : Clock division setting variable

5.4 Sensitivity Adjustment

Button sensitivity adjustment uses QE for Capacitive Touch. The sensitivity adjustment method is as follows.

- The method using monitoring function of QE for Capacitive Touch
  Follow the tutorial from the "CapTouch Workflow (QE)" of QE for Capacitive Touch.

- Real-time change method using monitoring function of QE for Capacitive Touch
  Display the Cap Touch parameter list of QE for Capacitive Touch and adjust it by the following steps.
  1. Select the touch I/F corresponding to the button you want to adjust.
  2. Click [Enable Monitoring] icon to start monitoring.
  3. When the item is displayed, change the value of [Touch Threshold].
  4. Click [Enable Auto Writing] to change the touch threshold.
  5. Repeat steps 3 to 4 to adjust the sensitivity.

The settings for steps 1 to 4 above are performed in steps ① to ④ in Figure 5-3

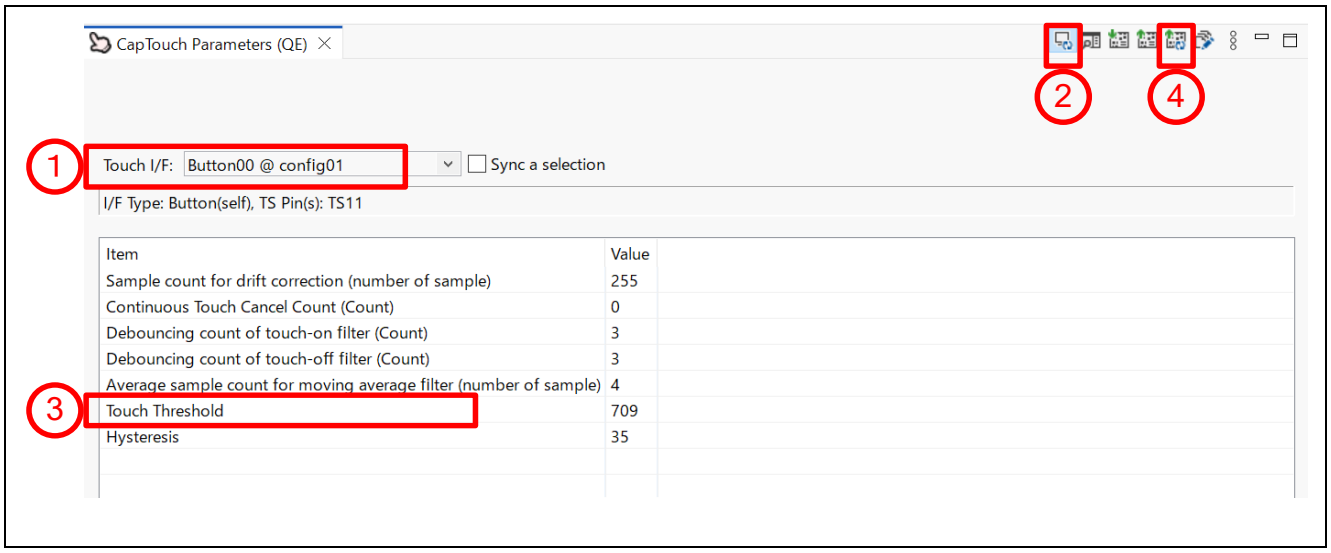


Figure 5-3 Sensitivity adjustment window using the monitoring function

- How to change the code manually
  It can be adjusted by changing member variables of structure variable g_qe_touch_button_cfg_config01 to 03.

  The variables to change are:
  ・threshold : Touch detection threshold

6. Documents for Reference

RL78/L23 User's Manual: Hardware (R01UH1082)

RL78/L23 Renesas Solution Starter Kit Capacitive Touch Evaluation System User's Manual (R12UZ0175)

RL78 Family Using QE and SIS to Develop Capacitive Touch Applications (R01AN5512)

RL78/L23 LCD display (Clock demo) (R01AN7852)

(The latest versions of the documents are available on the Renesas Electronics Web site.)

Technical Updates and Technical News

(The latest information is available on the Renesas Electronics Web site.)

Web site and Support

Renesas Electronics Web site

http://www.renesas.com/

Capacitive Sensing Unit related pages

https://www.renesas.com/solutions/touch-key

https://www.renesas.com/qe-capacitive-touch

Inquiries

http://www.renesas.com/contact/

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug.27.25	-	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit 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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