RL78/G23 Group

RL78/G23 Capacitive Touch Low Power Guide (SMS function)

Introduction

This application note explains how to use the SNOOZE Mode Sequencer (SMS) to achieve low power consumption with capacitive touch measurement.

Target Device

RL78/G23

Related Document

RL78/G23 Capacitive Touch Low Power Guide (SNOOZE function) [R01AN5886]

RL78/G23 User's Manual: Hardware [R01UH0896]

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

RL78/G23 Capacitive Touch Evaluation System [R12UZ0095]

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

When applying the contents of this application note to other MCUs, please change them according to the specifications of the MCUs and perform a thorough evaluation.

Contents

1. Outline

This application note shows the reference current when the capacitive touch measurement using the SNOOZE mode sequencer (SMS) function of the RL78/G23 is operated intermittently in 100ms cycles.

It is possible to perform touch on/off judgment processing for capacitive touch measurement in SNOOZE mode by using the SMS function, so current consumption can be further reduced compared to “RL78/G23 Capacitive Touch Low Power Guide (SNOOZE function)”.

2. Operation Environment / Conditions

Table 2.1 shows confirmed operation environment and Table 2.2 shows confirmed operation conditions.

Table 2.1 Operation environment

Item	Contents
MCU	RL78/G23 (R7F100GSN2DFB)
Operating voltage	5.0V
Target board	RL78/G23 capacitive touch evaluation system (RTK0EG0030S01001BJ)
Integrated development environment	e^2 studio (2022-7)
Smart Configurator	V22.7.0
C compiler	CC-RL V1.11.00
QE for Capacitive Touch	V3.1.0
Debugger	E2 emulator Lite

Table 2.2 Operation conditions

Item	Contents
High-speed on-chip oscillator clock (fIH)	12MHz
CPU/peripheral hardware clock (fCLK)	12MHz
Low-speed on-chip oscillator clock (fIL)	32.768 kHz
Low-speed peripheral clock (fSXP)	32.768 kHz
Capacitive Touch measurement cycle	100ms
Sensor drive pulse frequency	2MHz
Capacitance measurement terminal	TS06
CTSU Measurement Mode	Self-capacitance method
CTSU Scan Mode	Multi-scan mode
CTSU Measurement Operation Start Trigger Select	External trigger
CTSU Wait State Power-Saving Enable	Enable power-saving function during wait state
CTSU Power Supply Operating Mode	Normal voltage operating mode
CTSU Current Range Adjustment	40µA
CTSU Sensor Stabilization Wait Time Setting	64µs (Recommended value)
CTSU Multi-Clock	3 frequencies (MCA0, MCA1, MCA2: Available)
CTSU Measurement Count	128µs

3. Capacitive touch settings

Figure 3.1 shows the touch interface configuration. Measuring TS06 terminal by self-capacitance method.

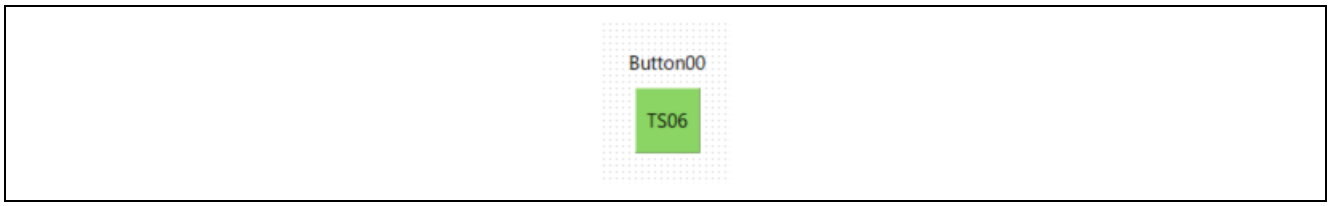
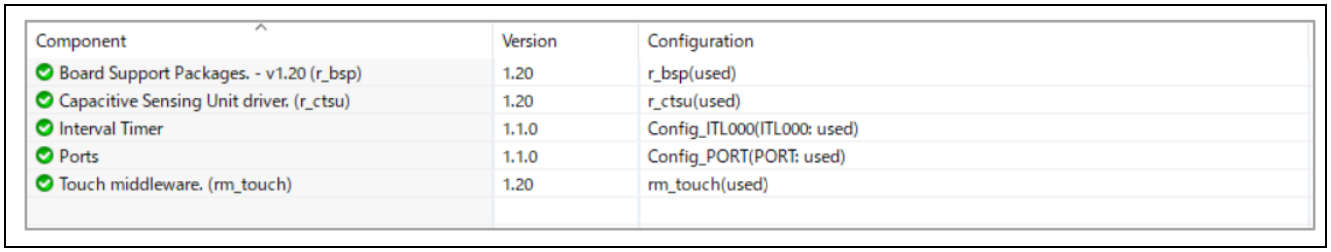


Figure 3.1 Touch interface configuration

4. Used components

Figure 4.1 shows the components used in Smart Configurator.



Component	Version	Configuration
Board Support Packages. - v1.20 (r_bsp)	1.20	r_bsp(used)
Capacitive Sensing Unit driver. (r_ctsu)	1.20	r_ctsu(used)
Interval Timer	1.1.0	Config_ITL000(ITL000: used)
Ports	1.1.0	Config_PORT(PORT: used)
Touch middleware. (rm_touch)	1.20	rm_touch(used)

Figure 4.1 Components of Smart Configurator

5. Current measurement software operation

Below is an overview of the current measurement software.

===== Touch measurement without SMS ==========

1. After reset release by power-on, “RM_TOUCH_Open” function is executed to initialize CTSU.
2. Select the event source for the CTSU in the ELCL.
3. By executing the “RM_TOUCH_ScanStart” function, set the touch measurement setting and SNOOZE function to enable, and then goes to the external trigger wait state.
4. Start the TML32 (measurement cycle: 100ms).
5. Transition to STOP mode by executing the STOP instruction.
6. When the TML32 interrupt source is generated during STOP mode and the falling edge of the external trigger from ELCL is detected, transition to SNOOZE mode and start touch measurement.
7. When the measurement end interrupt occurs, transition to normal mode to perform touch ON/OFF judgement.

===== Touch measurement using SMS ==========

8. After initial offset tuning, set SMS by executing “RM_TOUCH Sms Set” function.
9. By executing the “RM_TOUCH_ScanStart” function, set the touch measurement setting and SNOOZE function to enable, and then goes to the external trigger wait state.
10. Start the TML32 (measurement cycle: 100ms).
11. Transition to STOP mode by executing the STOP instruction.
12. When the TML32 interrupt source is generated during STOP mode and the falling edge of the external trigger from ELCL is detected, transition to SNOOZE mode and start touch measurement.
13. When a measurement end interrupt occurs, touch ON/OFF judgement is performed while in SNOOZE mode.

5.1 Operation Image of CPU and CTSU

Figure 5.1 shows an image of the CPU operation mode and CTSU operation status when touch measurement does not use SMS, and Figure 5.2 shows an image of the CPU operation mode and CTSU operation status when touch measurement uses SMS.

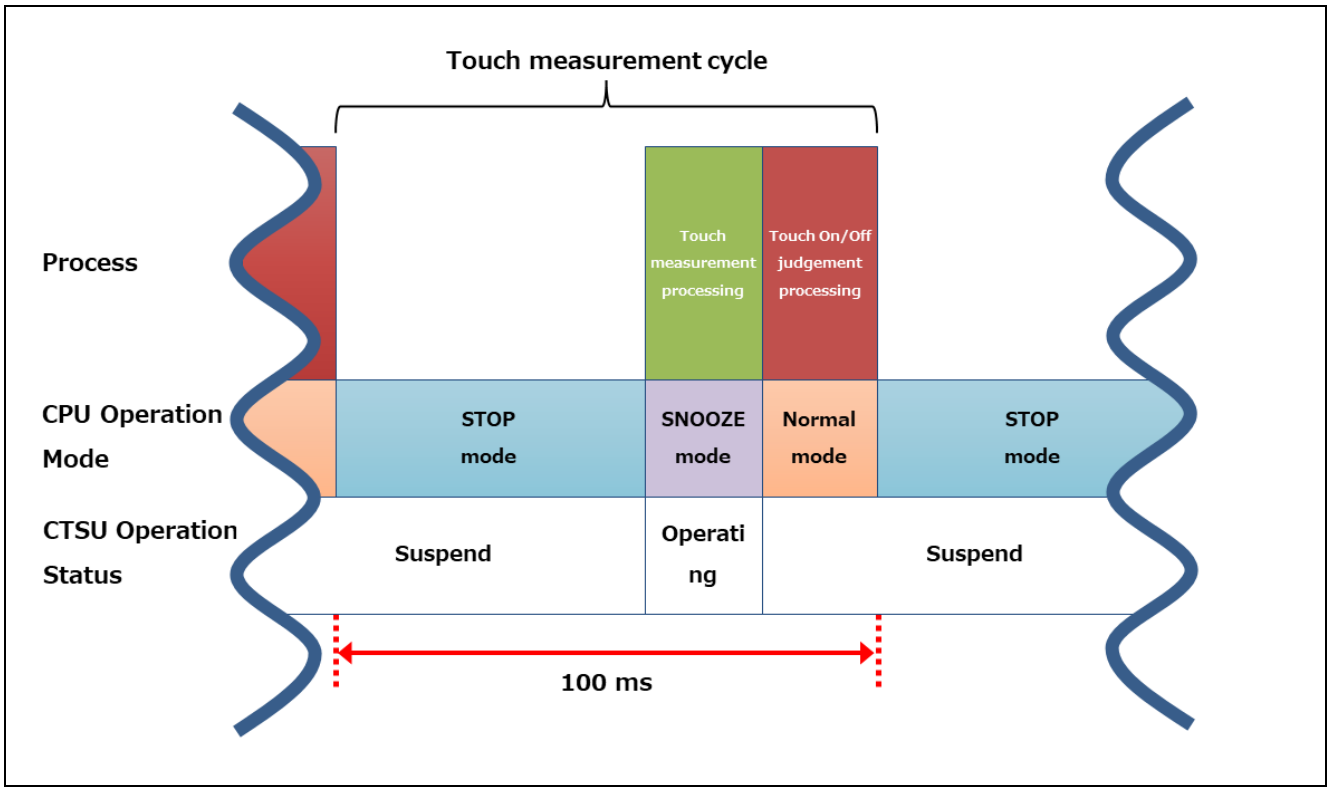


Figure 5.1 Touch measurement without SMS (operation image)

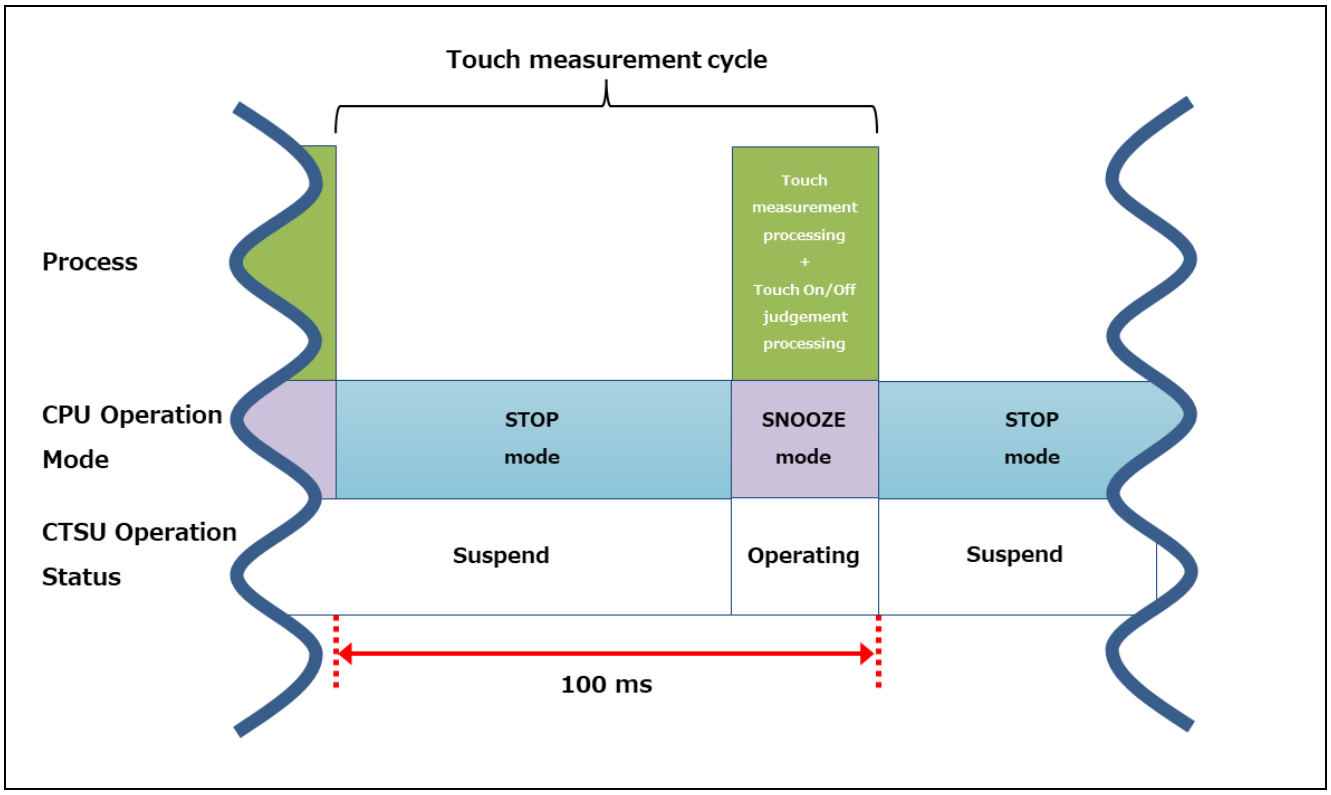


Figure 5.2 Touch measurement using SMS (operation image)

6. Current measurement software flow chart

Explains the flow chart of the current measurement software.

The current measurement software is created based on the sample software of "RL78 Family RL78/G23 Capacitive Touch Low Power Consumption Guide (SNOOZE Function)", and parts related to SMS are colored.

6.1 Main processing

Figure 6.1 shows the flowchart of main processing.

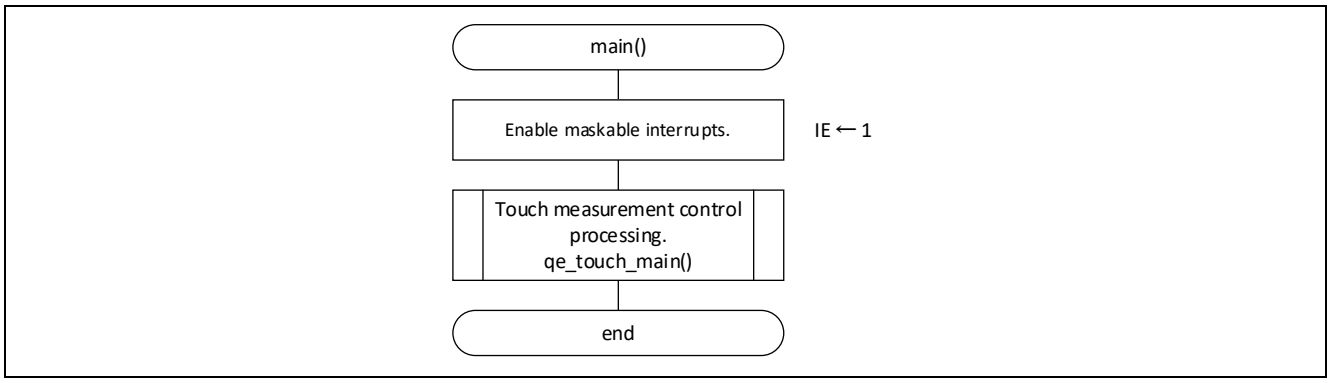


Figure 6.1 Flowchart of main processing

6.2 Touch measurement control processing

Figure 6.2, Figure 6.3, and Figure 6.4 show the touch measurement control processing flowcharts.

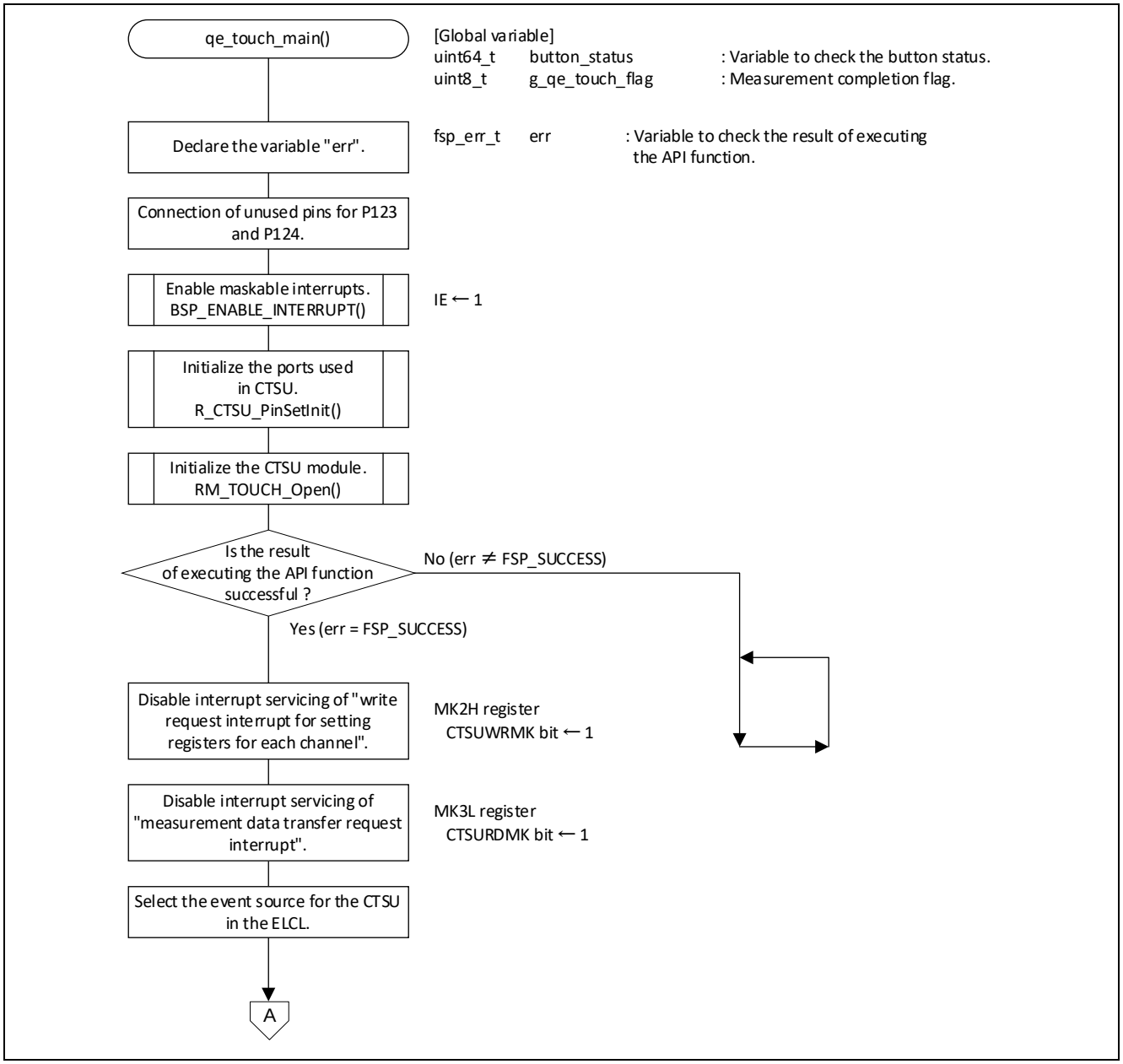


Figure 6.2 Touch measurement control processing (1/3)

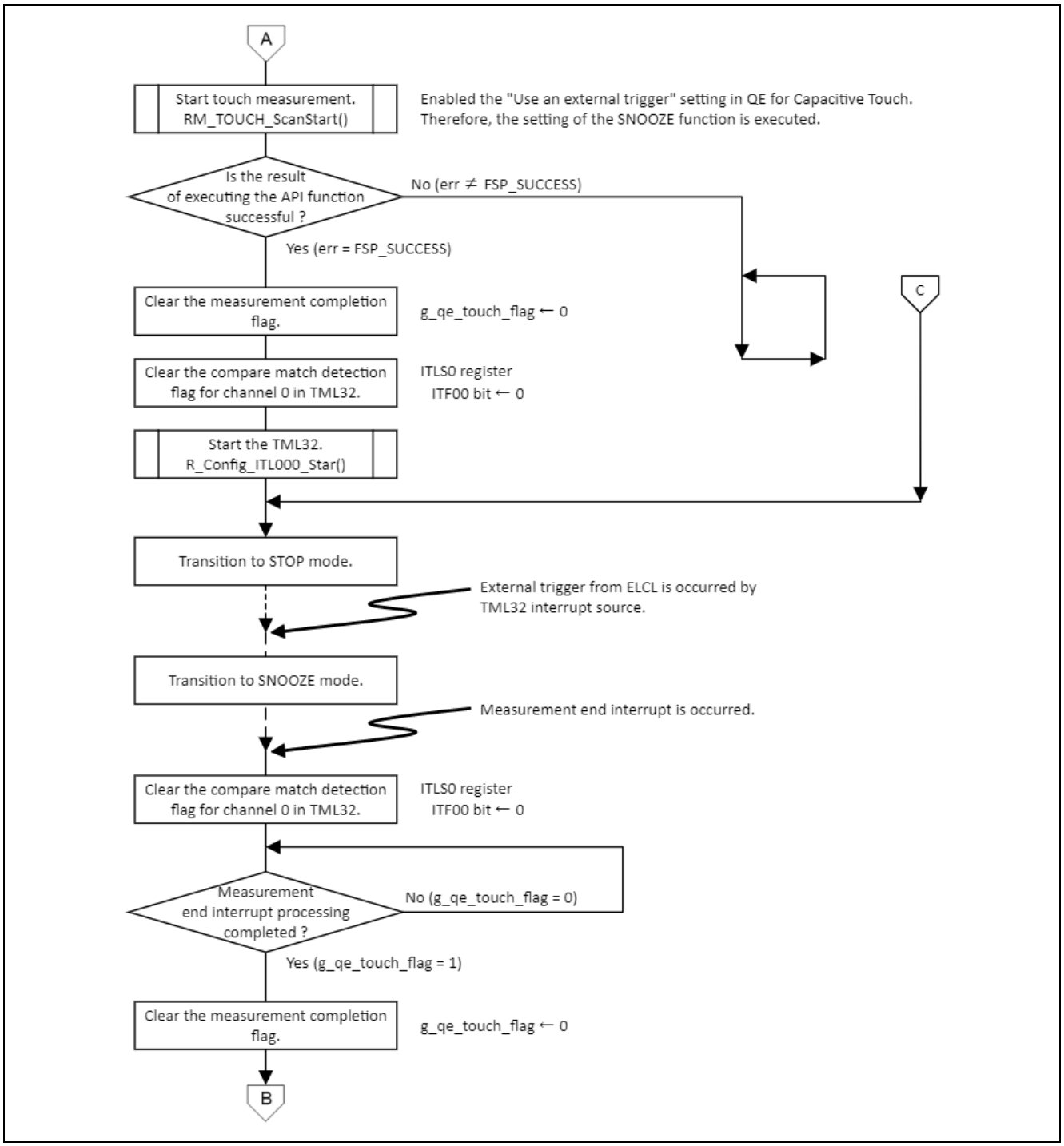


Figure 6.3 Touch measurement control processing (2/3)

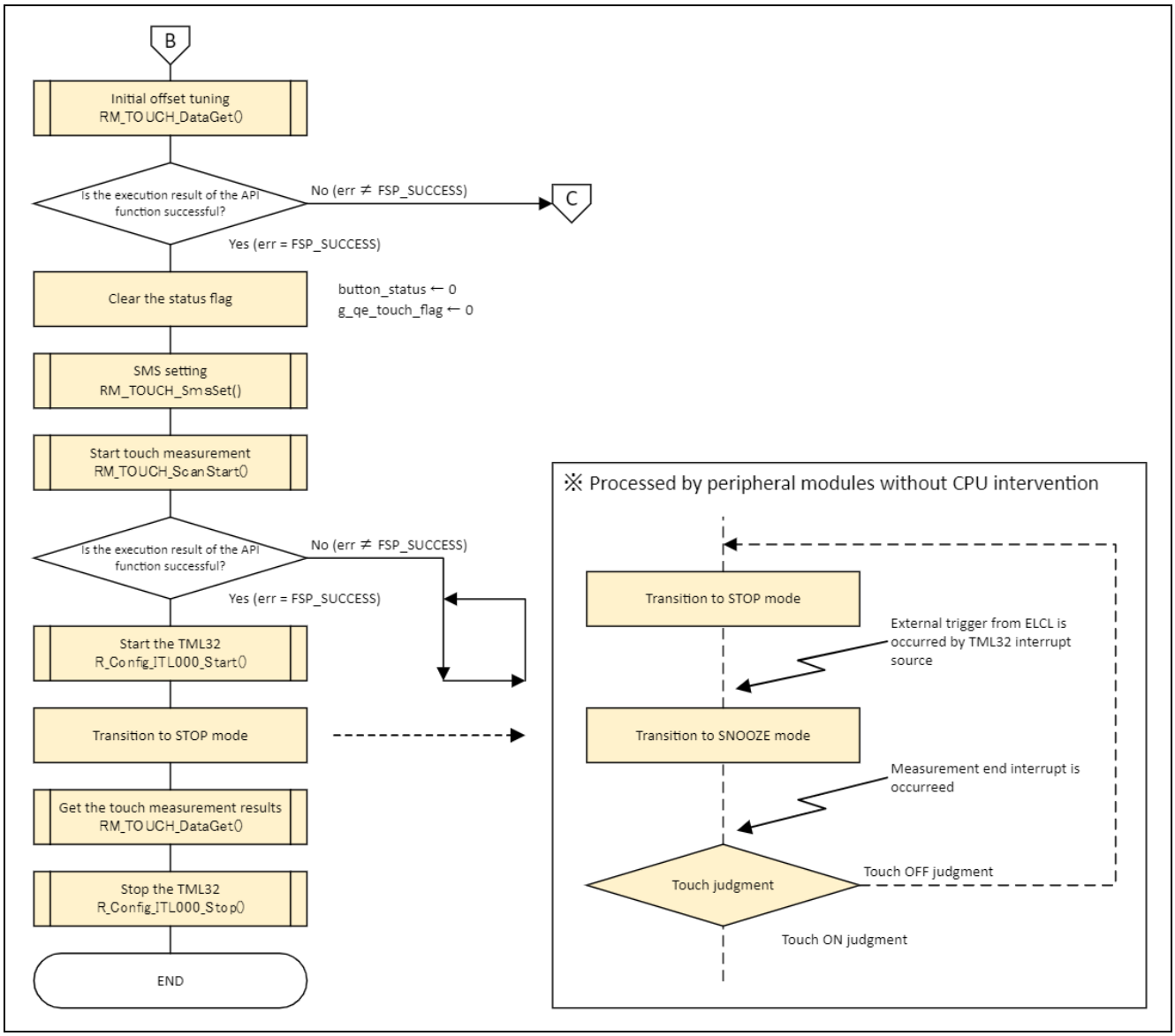


Figure 6.4 Touch measurement control processing (3/3)

7. How to measure current consumption

7.1 Environment to Measure Current Consumption

Figure 7.1 shows environment to measure current consumption.

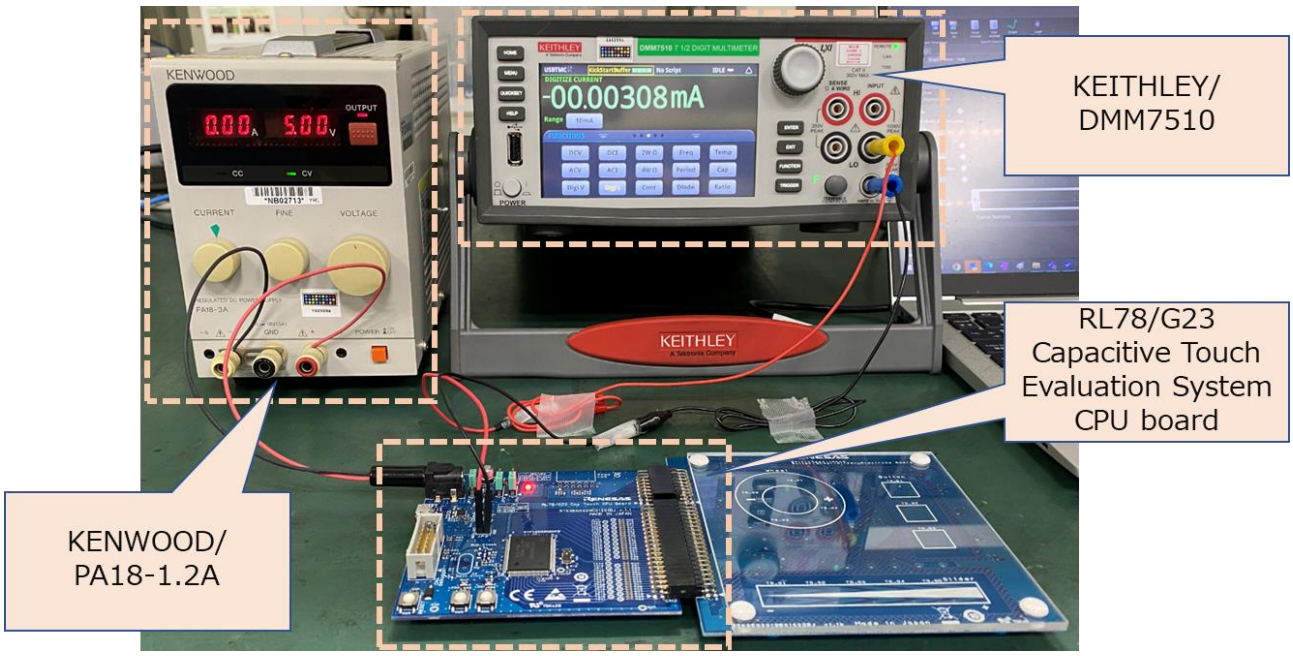


Figure 7.1 Environment to measure current consumption

7.2 Equipment and Software

Table 7.1 shows equipment and software used in current consumption measurement.

Table 7.1 Current measuring equipment and Software

Type	Name	Use
Digital multi meter	KEITHLEY/DMM7510	Measure current consumption.
Stable power suppl	KENWOOD/PA18-1.2A	Supply power to RL78/G23 Capacitive Touch Evaluation System CPU board.
Software	KEITHLEY/KickStart Software	Get result of current consumption measurement from Keithley DMM7510 and output the result to log-file.

7.3 How to connect the target board and each equipment

Figure 7.2 shows how to connect the RL78/G23 capacitive touch evaluation system CPU board and each equipment, and Figure 7.3 shows the power supply system diagram for the RL78/G23 capacitive touch evaluation system CPU board.

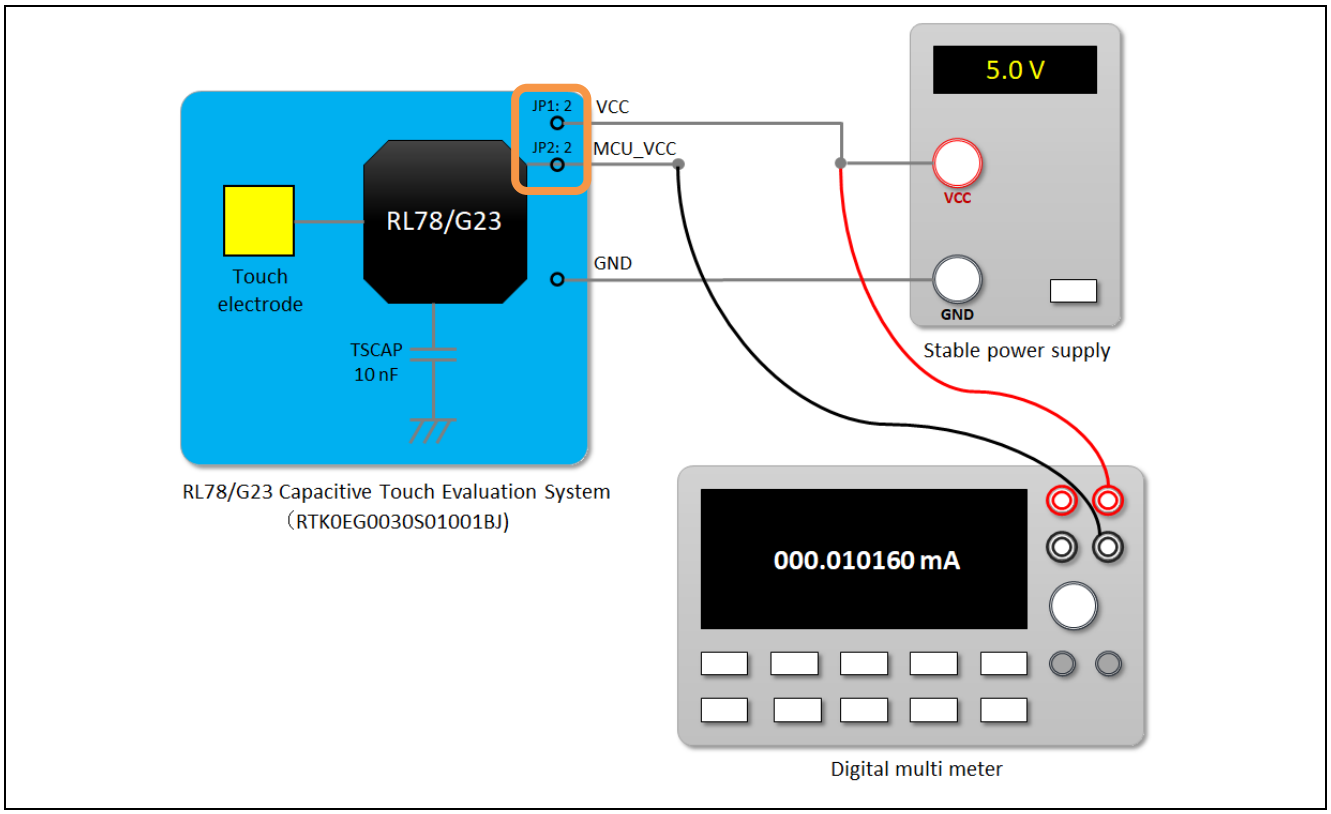


Figure 7.2 Connect the RL78/G23 capacitive touch evaluation system CPU board and each equipment

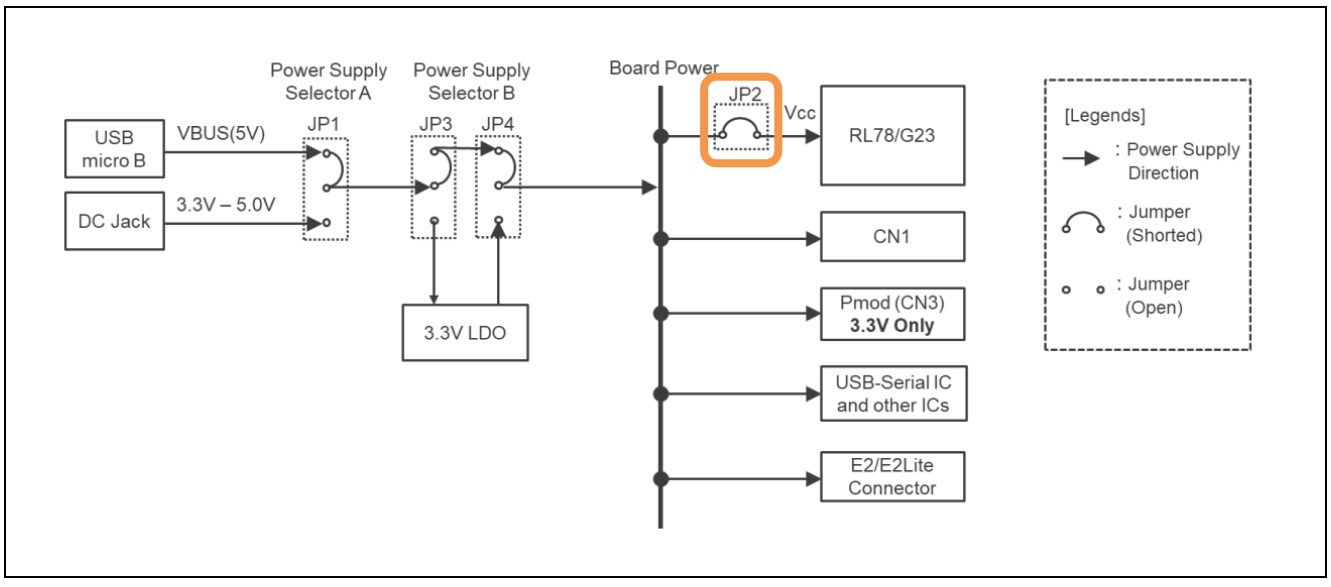


Figure 7.3 Power supply system diagram for the RL78/G23 capacitive touch evaluation system CPU board

7.4 RL78/G23 Capacitive Touch Evaluation System CPU Board

Figure 7.4 shows the pins of the RL78/G23 capacitive touch evaluation system CPU board connected to the digital multimeter, and Table 7.2 shows the jumper settings of the RL78G23 capacitive touch evaluation system CPU board.

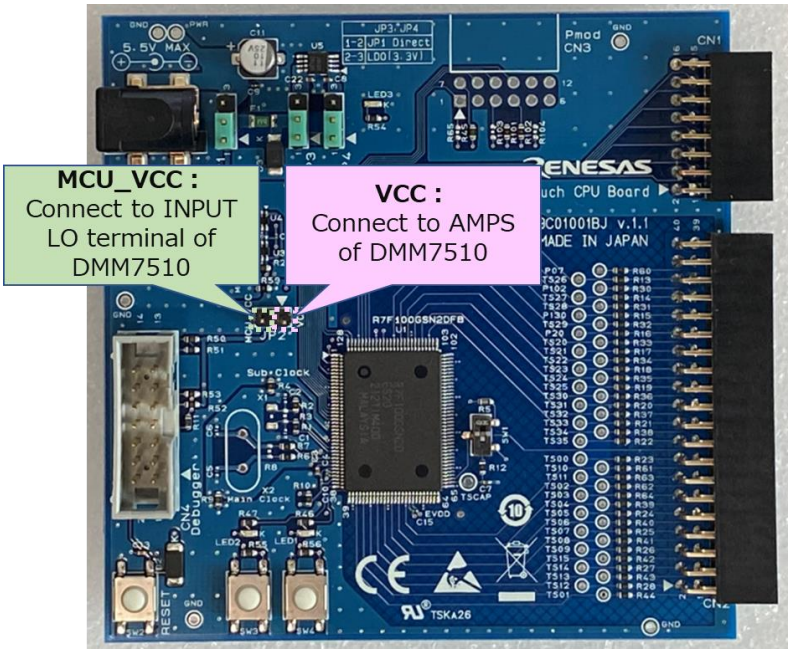


Figure 7.4 Pins of CPU board connected to the digital multimeter

Table 7.2 CPU board jumper settings

Position	Circuit group	Jumper setting	Use
JP1	VCC power	Open	Power supply from JP1: 2
JP2	MCU_VCC power	Open	Measure current consumption
JP3	Power supply jumper	Shorted pin 1-2	-
JP4	Power supply jumper	Shorted pin 1-2	-

7.5 Settings of current measuring software

Figure 7.5 shows settings of KEITHLEY/KickStart software to measure current consumption.

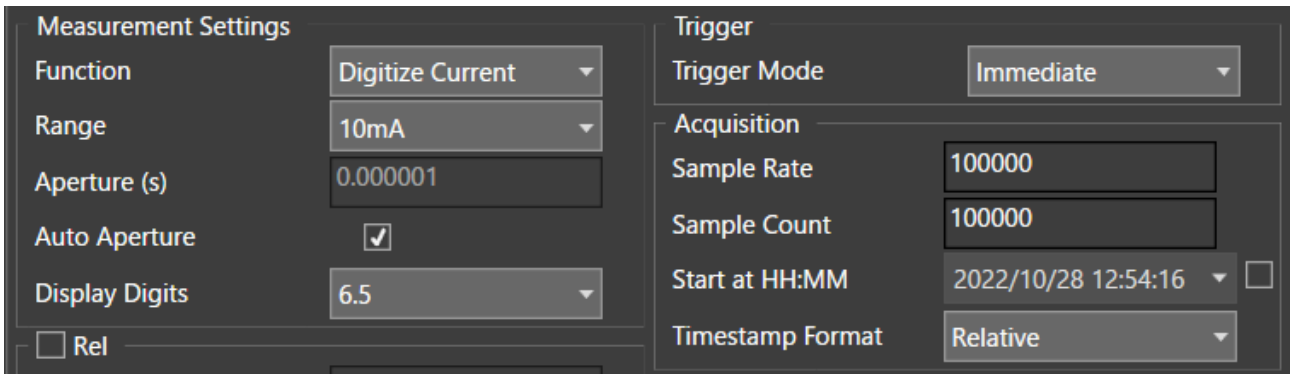


Figure 7.5 Settings of KEITHLEY/KickStart software

8. Current consumption measurement result

8.1 Current consumption waveform in intermittent operation

Figure 8.1 shows the Current consumption waveform in intermittent operation with touch measurement every 100ms.

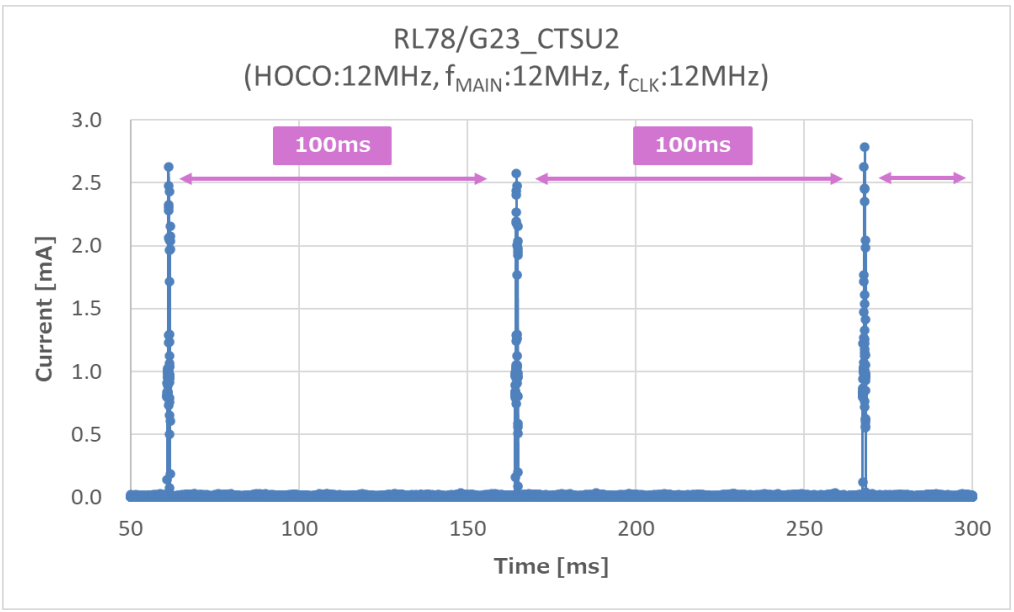


Figure 8.1 Current waveform in intermittent operation with touch measurement every 100ms

8.2 Current consumption waveform in CPU transition (Touch measurement using SMS)

Figure 8.2 shows the current consumption waveform when the CPU operation mode transitions to STOP mode and SNOOZE mode (touch measurement processing + touch on/off determination processing).

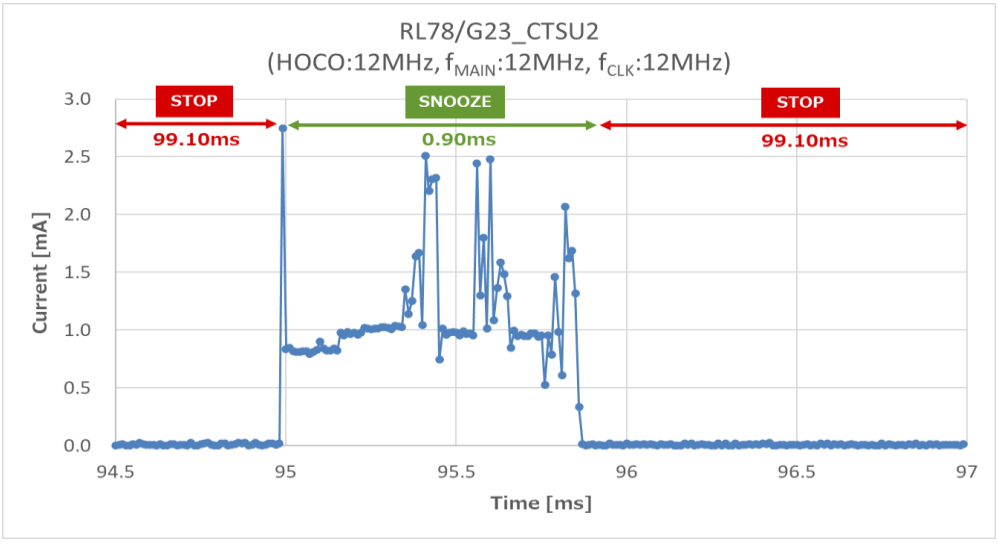


Figure 8.2 Current consumption waveform 1ch measurement (Touch measurement using SMS)

8.3 Calculation result of current consumption (Touch measurement using SMS)

Figure 8.3 shows the average current consumption of 100ms cycle by the KEITHLEY/KickStart software.

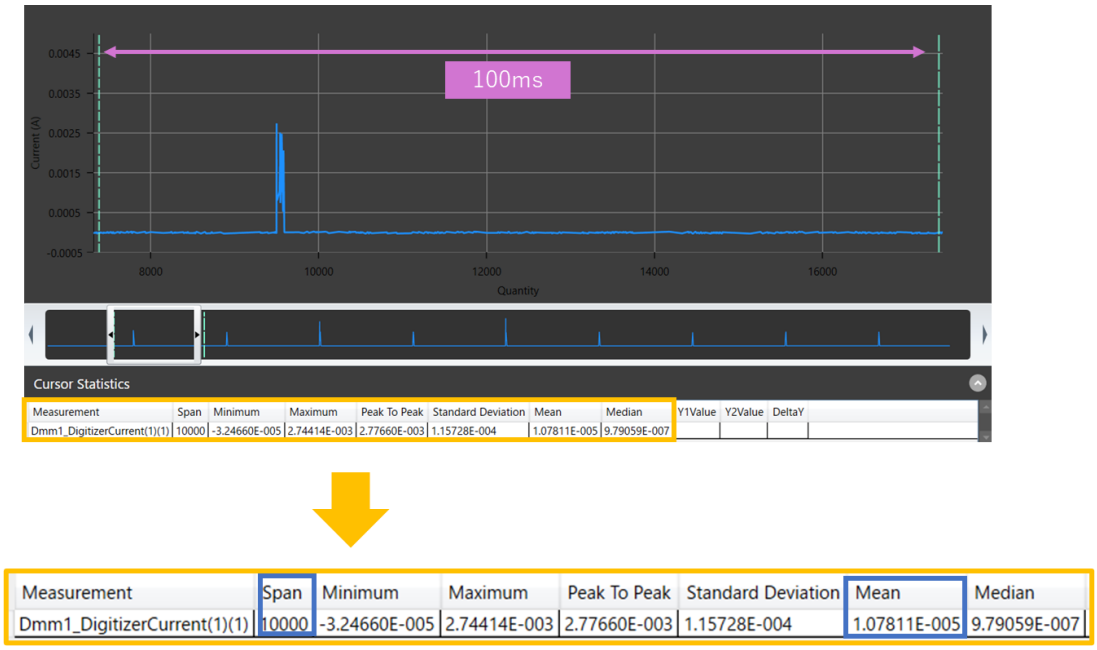


Figure 8.3 Current consumption result by the KEITHLEY/KickStart (touch measurement using SMS)

Current consumption (touch measurement cycle of 100ms) = **10.7811 µA**

8.4 Current consumption waveform in CPU transition (Touch measurement without SMS)

For reference, the current measurement results for touch measurement without using SMS under the same conditions are shown below.

Figure 8.4 shows the current consumption waveform when the CPU operation mode transitions to STOP mode, SNOOZE mode (touch measurement processing) and Normal mode (touch on/off determination processing).

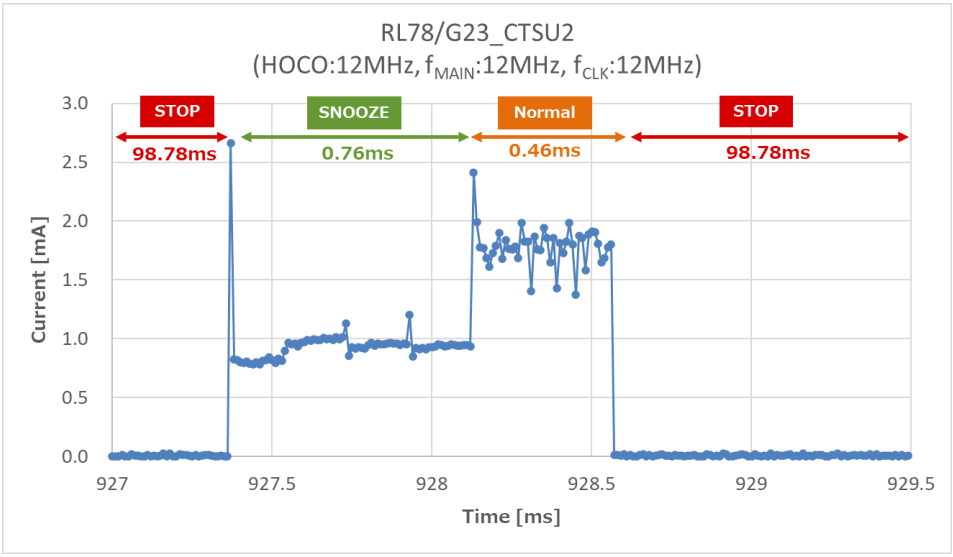


Figure 8.4 Current consumption waveform 1ch measurement (Touch measurement w/o SMS)

8.5 Calculation result of current consumption (Touch measurement without SMS)

Figure 8.35 shows the average current consumption of 100ms cycle by the KEITHLEY/KickStart software.

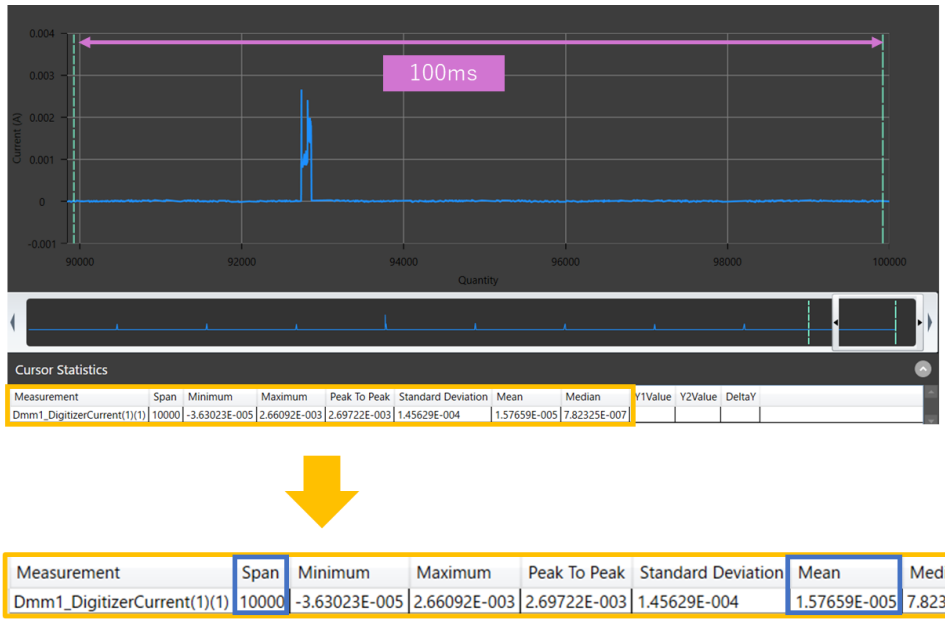


Figure 8.5 Current consumption result by the KEITHLEY/KickStart (Touch measurement w/o SMS)

Current consumption (touch measurement cycle of 100ms) = **15.7659 µA**

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Oct.31.22	-	First edition issued

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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.
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   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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