

# RL78/G23

## Renesas Solution Starter Kit Capacitive Touch Evaluation System User's Manual

### 16-bit Single Chip Microcontrollers

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### 1. Precaution against Electrostatic Discharge (ESD)

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.

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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.

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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.

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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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Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

# How to Use This Manual

## 1. Purpose and Target Readers

This is a manual for users to understand the outline and hardware functions of the RL78/G23 Capacitive Touch Evaluation System (RTK0EG0030S01001BJ). This manual is intended for users who use this CPU board. A basic knowledge of electric circuits, logical circuits, and MCUs is necessary in order to use this manual.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

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The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

- Ensure attached cables do not lie across the equipment.
- Reorient the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Power down the equipment when not in use.
- Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

- The user is advised that mobile phones should not be used within 10 m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Evaluation Kit does not represent an ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

## Safety Items

### Definitions of Symbols

A variety of symbols are used in this document and on the product itself to prevent in advance danger to you the user or any third parties and to prevent in advance damage to any physical property.

This section, Safety Items, presents these symbols and their meanings. It also presents safety notes to assure that this produce is used safely and correctly.

This product should only be used after fully understanding the material presented in this section.



### Warning

Warning items indicate things that, if not avoided, could lead to death or serious injury.



### Caution

Caution items indicate both latent dangers that can lead to minor or moderately severe injury and latent dangers that can lead to property damage if not avoided.

In addition to the above two markings, the following are displayed at the same time if appropriate.

**[Important]** Indicates a point that can lead to equipment failure or malfunction if incorrectly set when setting up this product.

A triangular mark  indicates a warning or caution.

Example:



## Electrical Shock Hazard

The



mark indicates something that is forbidden.

Example: :



## Do Not Disassemble

## Warning



### Warning

#### Handling related warnings:



Do not disassemble or modify this product. Renesas does not guarantee this product if it has been disassembled or modified.

The power supply for this product can be selected to be either the USB bus or a DC jack. A jumper is used to select the power supply.

If, during either use or storage of this product, any abnormality in the product itself (including abnormal odors, heating, color changes, or shape changes to the product itself) are observed, disconnect the USB cable and power supply cable immediately.

#### Installation:



Do not install this equipment in a location that has a high humidity or where water or other fluids could get on it. This equipment may be damaged if water or other fluids could get on it.

#### Ambient temperature:



The upper limit for the ambient temperature under which this product may be used is 35°C.

This maximum rated ambient temperature must not be exceeded.

## Caution



### Handling related cautions:

Use the antistatic band. Failure to do so could cause malfunction or unstable motion or be damaged Internal components.

This product must be handled carefully. Do not drop, knock over, or apply any strong mechanical shocks to this product.



When connecting or disconnecting cables from this product, hold the parts of the cable intended to be grasped (such as the plugs) and avoid putting stress on the cable. Do not pull on this product when it is connected to a communications cable or user system connection cable. Stress on the cable can result in internal disconnections in the cable. When connecting a cable to a connector, be careful not to insert the plug in the reverse orientation. Reverse insertion can result in damage to this product itself or to connected equipment.

The power supply for this product can be selected from two options (the DC jack or the USB cable). The jumper JP1 (on the top side of the circuit board) is used to select the power supply. Always check the jumper position before connecting a power source. An incorrect jumper position can result in damage to this product or the PC connected over the USB cable.

Do not handle this product with wet hands. This can lead to failure of the product.

### Transport methods:



**When transporting this product, use the product's packing box and cushioning materials and ship it with precision equipment handling.** If the products packing is insufficient, it may be damaged during shipping.

If it must be transported by some other method, pack it carefully as precision equipment. When packing this product, always use the antistatic pouch included with this product. If some other pouch is used, damage to the product may be caused by electrostatic discharge.

### Abnormal operation:



If operation of this product becomes abnormal due to interference from, for example, external noise, apply the following procedure.

1. Turn off the power.
2. Wait 10 seconds and then turn the power back on.

### Disposal:



When disposing of this product, handle it as industrial waste according to all applicable laws.



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# Table of Contents

Corporate Headquarters .....	1
Contact information.....	1
Trademarks .....	1
1. Purpose and Target Readers.....	2
1. Overview.....	1
1.1 Purpose.....	1
1.2 Main Characteristics and Functions.....	1
1.3 Board Specifications .....	2
1.4 Regulatory Compliance Notices .....	3
1.4.1 European Union regulatory notices.....	3
2. CPU Board .....	4
2.1 System Block Diagram.....	4
2.2 Product Configuration .....	5
2.3 Hardware Details .....	6
2.3.1 Default Jumper Settings.....	6
2.3.2 Power Supply .....	7
2.3.3 Clock Circuit .....	7
2.3.4 Reset Circuit.....	7
2.3.5 Push Switch.....	8
2.3.6 LEDs.....	8
2.3.7 USB Serial Conversion .....	8
2.3.8 Debug Interface.....	8
2.3.9 Application Header .....	9
2.3.10 CTSU Related Circuits .....	10
2.3.11 Pmod™ Interface (CN3).....	10
3. Application Board (Self-Capacitance Electrode Board) .....	11
3.1 Board Layout.....	11
3.2 Application Headers.....	11
4. Reference Materials.....	13
5. Additional Information .....	14
Appendix: Self-Capacitance Touch Electrode Board Connection.....	15

# 1. Overview

## 1.1 Purpose

The RL78/G23 Capacitive Touch Evaluation System (RTK0EG0030S01001BJ) is a kit created for evaluating the Renesas Electronics RL78/G23 Group of MCUs. This manual describes the RL78/G23 Cap Touch Evaluation System's hardware.

## 1.2 Main Characteristics and Functions

The main functions of the RL78/G23 Capacitive Touch Evaluation System are as follows:

- Renesas Microcontroller programming and debugging
  - E2/E2 Lite debugger connector
- General purpose switches and LEDs
- Capacitive Touch Sensor (CTS02L)
  - 32 channels available
- Pmod interface (Type 2A, Type 3A, and Type 6A)
- Connects to Renesas Capacitive Touch Evaluation System Application Board (option)
  - Includes self-capacitance touch electrode application board

## 1.3 Board Specifications

**Table 1-1 CPU Board Specifications**

Item	Specifications
MCU	Model No.: R7F100GSN2DFB
	Package: 128-pin LFQFP
	On-chip memory: ROM 768KB+8KB, RAM 48KB
	High-speed on-chip oscillator ( $f_{IH}$ ): 32MHz
Input clock	Main clock: 20MHz (option)
	Sub clock: 32.768KHz (option)
Power supply	Operation voltage: 5.0 to 3.3V DC jack 5.0V to 3.3 input USB bus powered (VBUS): 5V Voltage regulator (LDO): 3.3V
Debug interface	Renesas Electronics E2/E2 Lite 14-pin box header
Slide switch	• CTSU temperature compensation circuit selection: 1 pole x 1
Push switches	Reset switch: x 1
	User switches: x 2
LEDs	Power status: red x 1
	User LEDs: green x 1, yellow x 1
USB serial conversion interface	Connector: USB Micro B
	Driver: FT234XD USB serial IC manufactured by FTDI
Application board interface (GPIO)	2.54mm pitch, 16 pins x 1 (CN1)
Application board interface (CTSUs)	2.54mm pitch, 40 pins x 1 (CN2)
Pmod interface	2.54mm pitch, 12 pins x 1 (CN3)
	Type 2A, Type3A, Type 6A (with switch circuit)
Current consumption	500mA or less
Operating Temperature Range	When operating: 10 to 35°C, in storage: -10 to 50°C (no condensation)
Board dimensions (L x W x H)	89mm x 95mm x 18mm (including connectors)

**Table 1-2 Application Board Specifications**

Item	Specifications
Self-capacitance detection touch electrodes	Buttons: 3 Wheel (4-electrode configuration): 1 Sliders (5-electrode configuration): 1
Active shields	1 shield each for button, wheel, and slider areas: 1 shield each
LEDs	16
Renesas MCU Cap Touch CPU board interface	2.54mm pitch, 16 pins x 1 (CN1) 2.54mm pitch, 40 pins x 1 (CN2)
Overlay panel	2mm-thick acrylic panel
Current consumption	500mA or less
Operating Temperature Range	When operating: 10 to 35°C, in storage: -10 to 50°C (no condensation)
Board dimensions (L x W x H)	110mm x 116mm x 11mm (including connectors)

## 1.4 Regulatory Compliance Notices

### 1.4.1 European Union regulatory notices

This product complies with the following EU Directives. (These directives are only valid in the European Union.)

CE Certifications:

- Electromagnetic Compatibility (EMC) Directive 2014/30/EU  
EN61326-1 : 2013 Class A

---

**WARNING:** This is a Class A product. This equipment can cause radio frequency noise when used in the residential area. In such cases, the user/operator of the equipment may be required to take appropriate countermeasures under his responsibility.

---

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Trademark: Renesas  
Product name: RL78/G23 Capacitive Touch Evaluation System  
Type name: RTK0EG0030S01001BJ

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## 2. CPU Board

### 2.1 System Block Diagram

Figure 2-1 shows the system block diagram of the CPU board.

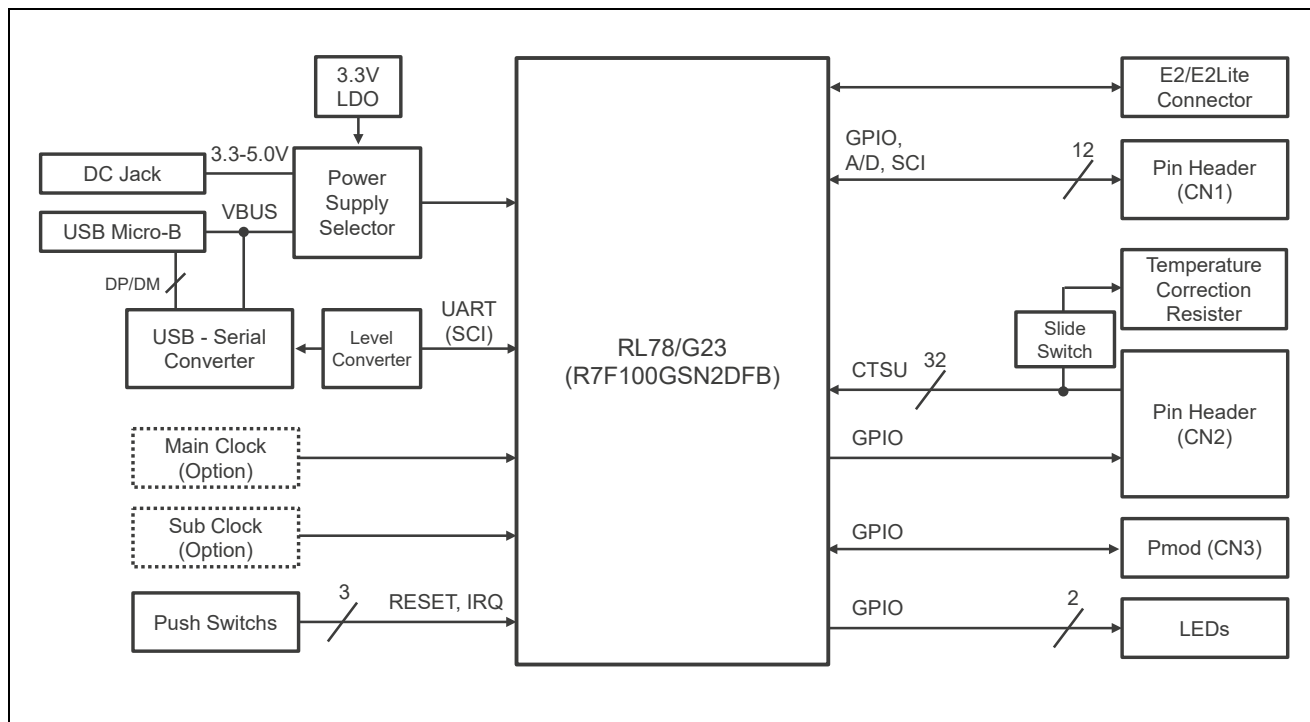
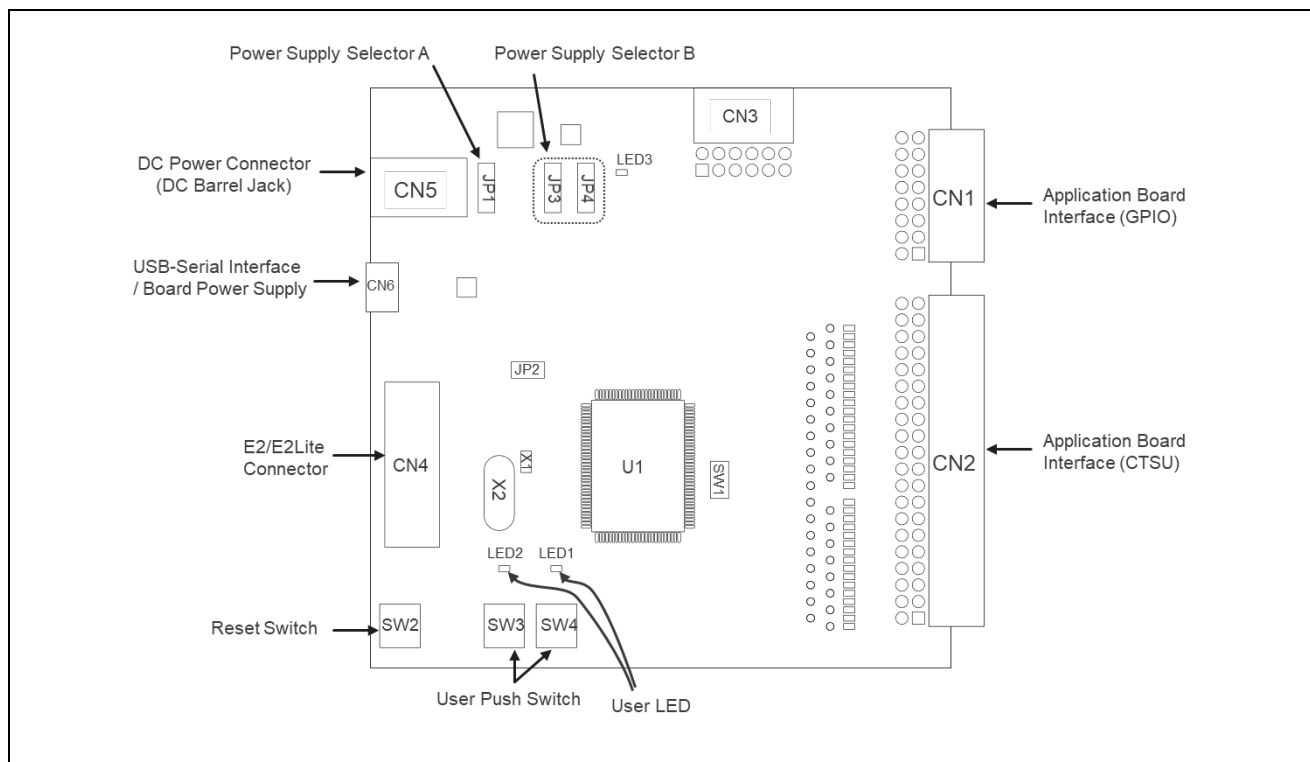


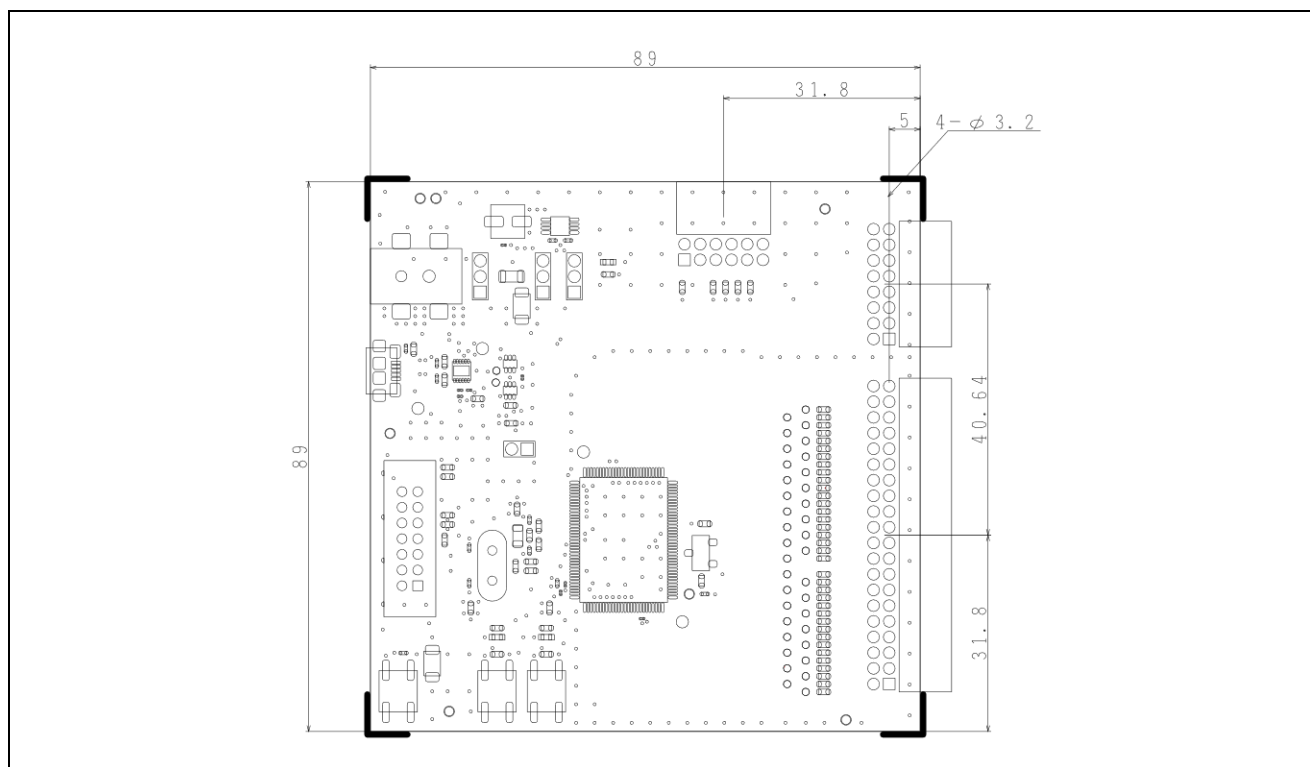
Figure 2-1. System Block Diagram

## 2.2 Product Configuration

Figure 2-2 shows the product configuration of the RL78/G23 system.



**Figure 2-2. RL78/G23 cap Touch CPU System Board Top Side**



**Figure 2-3. RL78/G23 Cap Touch CPU System Board Dimensions**

## 2.3 Hardware Details

### 2.3.1 Default Jumper Settings

Figure 2-4. shows the default positions of the jumpers. Table 2-1 lists the default jumper settings.

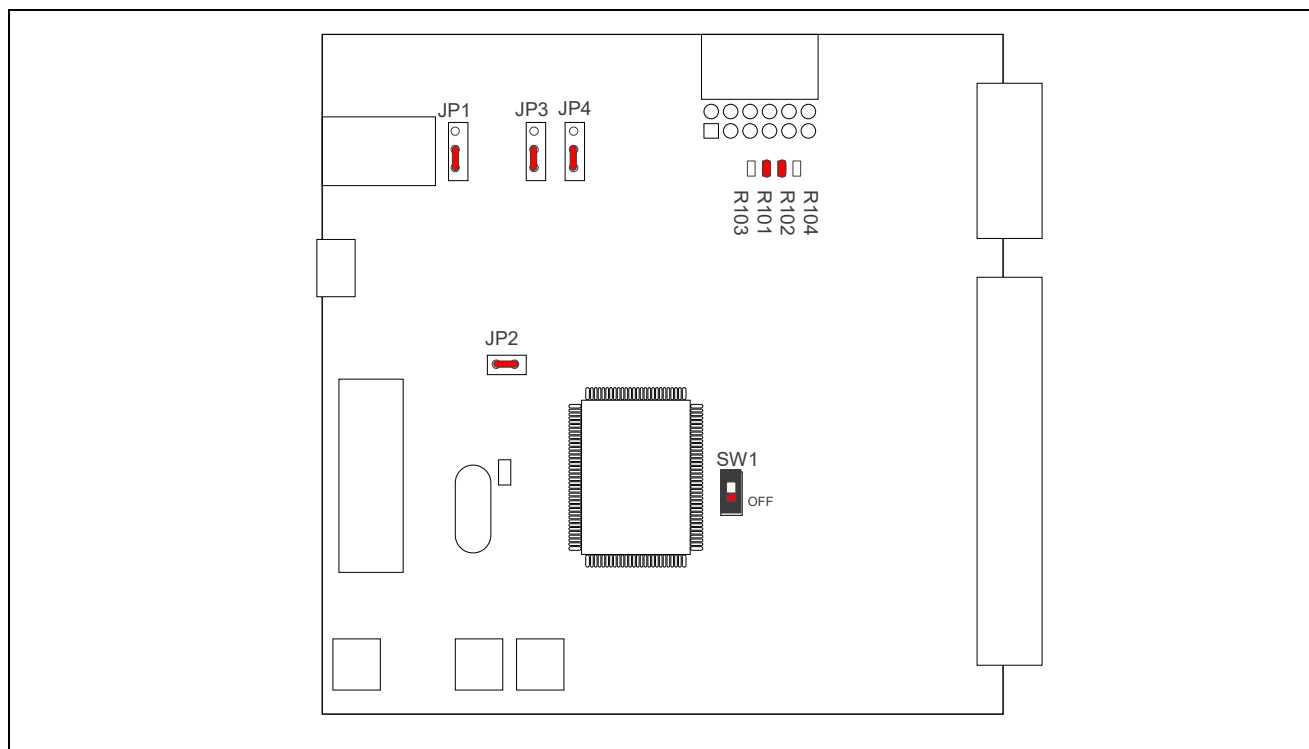


Figure 2-4. Default Jumper Positions

Table 2-1. Default Jumper Settings

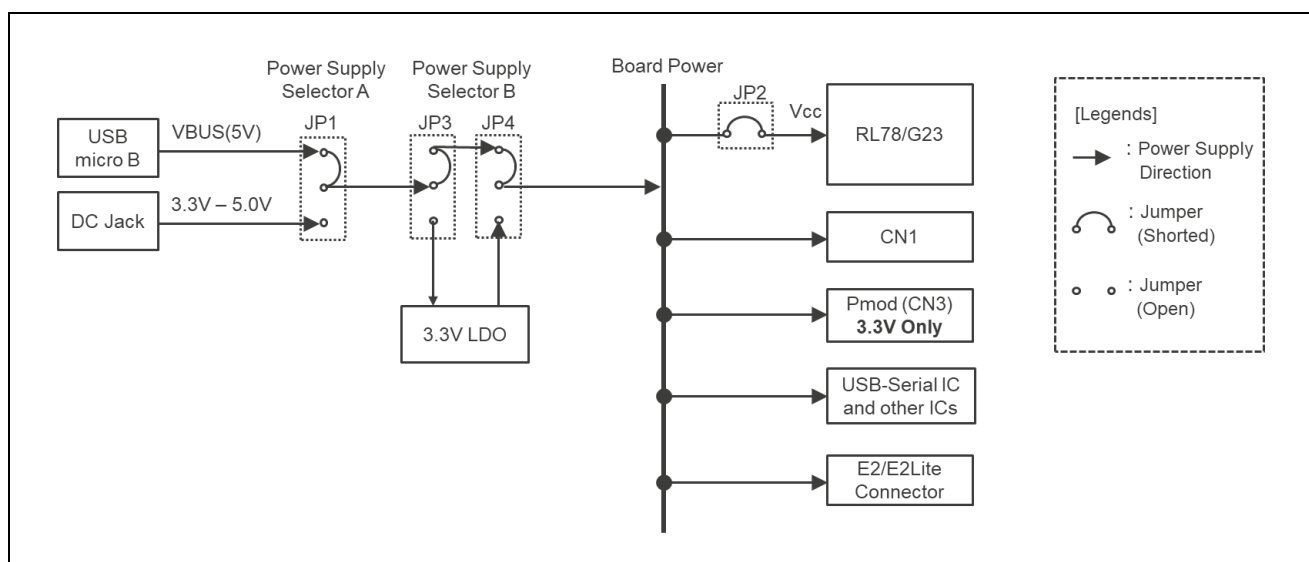
Reference	Circuit Group	Default State	Description
JP1	Power supply	Pins 1-2 closed	Supplies USB power to board USB
JP3		Pins 1-2 closed	Supplies JP1 power to board devices
JP4		Pins 1-2 closed	
JP2		Closed	Supplies board device power to MCU
SW1	Capacitive touch	OFF	Sets TS00 as normal CTSU pin
R101	Pmod interface (CN3)	Short	Uses CN3 as Pmod Type 2A or Type 3A
R102		Short	
R103		Open	
R104		Open	

### 2.3.2 Power Supply

Table 2-2 provides the power supply jumper settings. Figure 2-5 the power source system diagram. This CPU board can be supplied with power by USB or a 2.1mm DC barrel jack connector (center + pin).

**Table 2-2. Power Source Jumper Settings**

Reference	Jumper Setting	Default Setting (X)	Description
JP1	Shorted Pins 1-2	X	Supplies USB power source to power source selector B (JP1)
	Shorted Pins 2-3		Supplies DC jack (CN5) to power source selector B (JP1)
JP3, JP4	Shorted Pins 1-2	X	Supplies JP1 power source to board power source
	Shorted Pins 2-3		Supplies LDO (3.3V) to board power source
JP2	Shorted Pins 1-2	X	Supplies board power source to MCU
	Open		MCU current consumption measurement setting



**Figure 2-5. Power Source System Diagram**

### 2.3.3 Clock Circuit

**Table 2-3. Clock Specifications**

Clock	Function	Default State	Frequency	Package
X2	Main clock (crystal resonator)	Not mounted	20MHz	HC-49/S
X1	Sub clock	Not mounted	32.768kHz	3.2mm x 2.5mm SMD

### 2.3.4 Reset Circuit

The RL78/G23 CPU Board is equipped with a reset switch (SW2) which generates a reset signal to restart the main MCU.



### 2.3.5 Push Switch

Table 2-4. lists the push switch specifications.

**Table 2-4. Push Switch Specifications**

Reference	MCU Control Port	Function
SW2 (Reset)	RESET	Resets the MCU.
SW3	P57 / INTP3	User controllable switch.
SW4	P16 / INTP5	User controllable switch.

### 2.3.6 LEDs

Table 2-5 provides the connection port and function of each LED.

**Table 2-5. LED Functions and Connections**

LED	MCU Control Port	Function	Color
LED3 (Power)	VCC	Power status display	Red
LED1	P60	User LED	Green
LED2	P61	User LED	Yellow

### 2.3.7 USB Serial Conversion

Table 2-6 lists connections for USB serial IC and MCU controller. The RL78/G23 Cap Touch Evaluation System Board is equipped with USB serial IC FT234XD (FTDI Ltd.) for USB serial conversion. The FT234XD is connected to the RL78/G23's serial communication interface (SCI) module.

**Table 2-6 USB Serial Conversion**

Signal Name	MCU Control Port	Function
TXD	P34 / TXDA1	UARTA1 transmit data signal
RXD	P33 / RXDA1	UARTA1 receive data signal

### 2.3.8 Debug Interface

The CPU board is equipped with an E2/E2 Lite connector (14-pin box connector) for use as debugging interface. For details, refer to Reference Materials [2].

### 2.3.9 Application Header

The two application headers, CN1 and CN2, can be used as interface for the user's own board.

CN1 is used for GPIO pins. For more details regarding peripheral functions not listed here, refer to the User's Manual Hardware Version.

CN2 is mainly used for CTSU pins. Fix the GPIO pins to low by software. Do not connect anything to TSCAP.

**Table 2-7. Application Header (CN1)**

CN1			MCU		
Pin	Port	Peripheral	Pin	Port	Peripheral
16	V <sub>SS</sub> (GND)		15	V <sub>DD</sub>	
14	P120	ANI19	13	P104	
12	P105		11	P106	
10	P47		9	P32	
8	P35		7	P36	
6	P37		5	P140	
4	P141		3	P143	RxD3
2	P142	SCL30	1	P144	TxD3

**Table 2-8. Application Header (CN12)**

CN2			MCU		
Pin	Port	CTS	Pin	Port	CTS
40	PC4	TSCAP	39	—	—
38	—	—	37	—	—
36	—	TS26	35	P07	—
34	—	TS27	33	P102	—
32	P130	—	31	P03	TS28
30	P20	—	29	P02	TS29
28	P23	TS21	27	P22	TS20
26	P25	TS23	25	P24	TS22
24	P27	TS25	23	P26	TS24
22	P151	TS31	21	P150	TS30
20	P153	TS33	19	P152	TS32
18	P155	TS35	17	P154	TS34
16	P50	TS00	15	P05	TS10
14	P06	TS11	13	P70	TS02
12	P71	TS03	11	P72	TS04
10	P73	TS05	9	P74	TS06
8	P75	TS07	7	P76	TS08
6	P77	TS09	5	P67	TS15
4	P66	TS14	3	P65	TS13
2	P64	TS12	1	P31	TS01

— : Not Applicable

## 2.3.10 CTSU Related Circuits

### 2.3.10.1 CTSU correction circuit

This circuit improves the absolute accuracy of the CTSU's capacitive measurement. This function requires the use of additional control software (sold separately). When using the CTSU pin in normal conditions make sure you it set to the OFF position.

**Table 2-9. CTSU Correction Circuit Switch**

Reference	Position	Default Setting (X)	MCU Operating Mode
SW1	OFF	X	Uses TS00 as the normal CTSU pin.
	ON		Uses TS00 as the CTSU correction pin.

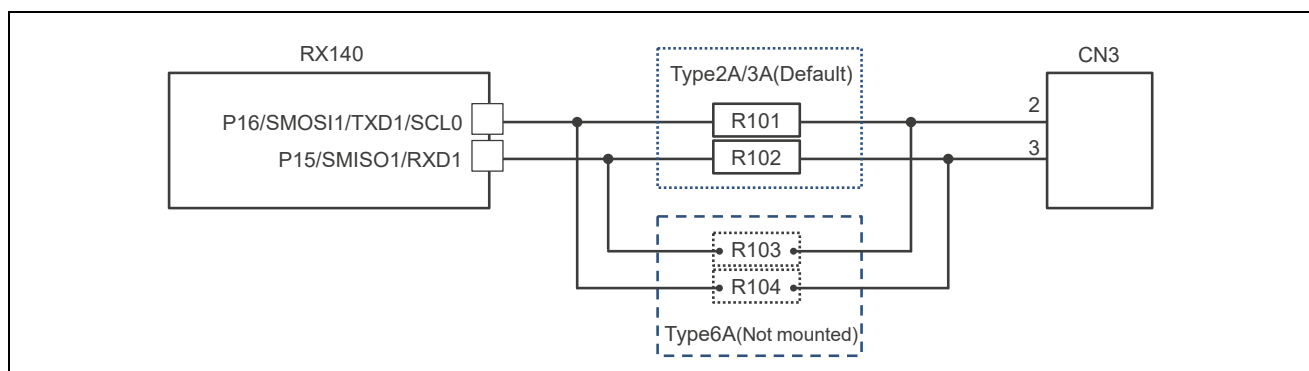
### 2.3.11 Pmod™ Interface (CN3)

Header CN3 is the interface for Pmod™ Type 2A and Type 3A. CN3 can also be used for Pmod™ Type 6A by using the Pmod™ interface switch circuit. When using this connector, set the power supply voltage to 3.3V. The functions of pins 1 to 4 on CN3 are shared with CN1 pins 1 to 4. When using these pin functions, only connect a device to one of the two interfaces.

**Table 1-1. CN3 Pin Assignments**

Pin	Type 2A/3A Function	MCU Port	Pin	Type 6A Function	MCU Port
1	CS/CTS	P14/SS1/CTS1#	1	NC	P14/IRQ4
2	MOSI/TXD	P16/SMOSI1/TXD1 (Note)	2	NC	P15 (Note)
3	MISO/RXD	P15/SMISO1/RXD1 (Note)	3	SCL	P16/SCL0 (Note)
4	SCK/RTS	P17/SCK1	4	SDA	P17/SDA0
5	GND	GND	5	GND	GND
6	VCC	VCC	6	VCC	VCC
7	GPIO	P03	7	GPIO	P03
8	GPIO	P05	8	GPIO	P05
9	GPIO	PJ6	9	GPIO	PJ6
10	GPIO	PJ7	10	GPIO	PJ7
11	GND	GND	11	GND	GND
12	VCC	VCC	12	VCC	VCC

Note: Replace resistors of R101, R102, R103, and R104.



**Figure 1-1. Pmod™ Interface Switch Circuit**

## 3. Application Board (Self-Capacitance Electrode Board)

### 3.1 Board Layout

Figure 3-1 shows the layout of the RL78/G23 application board.

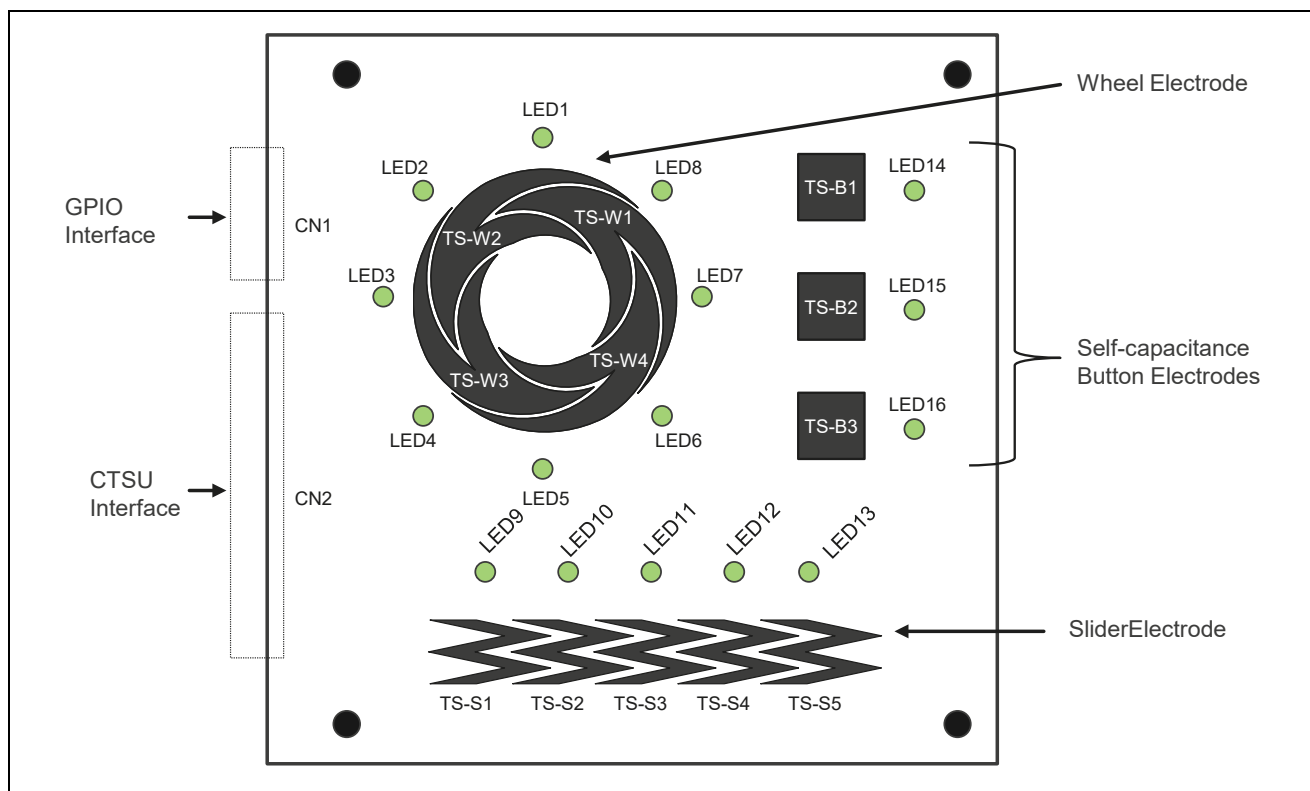


Figure 3-1. Board Layout and TS Pin Assignments

### 3.2 Application Headers

Application headers CN1 and CN2 are the interface for connection to the Renesas Capacitive Touch Evaluation System CPU board. Table 2-7 lists the pin assignments for CN1. Table 2-8 lists the pin assignments for CN2.

Table 3-1. Application Header (CN1)

Pin	Function	MCU Connection	Pin	Function	MCU Connection
15	LED_VCC	V <sub>DD</sub>	16	LED_VSS (GND)	V <sub>SS</sub> (GND)
13	LED_ROW0	P104	14	LED_ROW1	P120
11	LED_ROW2	P106	12	LED_ROW3	P105
9	—	P32	10	—	P46
7	LED_COL3	P36	8	—	P35
5	LED_COL1	P140	6	LED_COL2	P37
3	—	P143	4	LED_COL0	P141
1	—	P144	2	—	P142

— : Not Applicable

**Table 3-2. Application Header (CN12)**

Pin	Touch Electrode	CTSU (RL78/G23) (Note1)	Pin	Touch Electrode	CTSU (RL78/G23) (Note1)
39	—	—	40	—	TSCAP
37	—	—	38	—	—
35	—	P07 (Note3)	36	TS-W1	TS26
33	—	P102 (Note3)	34	TS-W2	TS27
31	TS-W3	TS28	32	—	P130 (Note3)
29	—	TS29	30	—	P20 (Note3)
27	—	TS20	28	TS-W4	TS21
25	—	TS22	26	—	TS23
23	—	TS24	24	—	TS25
21	—	TS30	22	SHIELD-W1	TS31 (Note2)
19	—	TS32	20	—	TS33
17	—	TS34	18	—	TS35
15	—	TS10	16	—	TS00
13	—	TS02	14	—	TS11
11	—	TS04	12	—	TS03
9	TS-B1	TS06	10	TS-B2	TS05
7	SHIELD-B1	TS08 (Note2)	8	TS-B3	TS07
5	TS-S1	TS15	6	SHIELD-S1	TS09 (Note2)
3	TS-S3	TS13	4	TS-S2	TS14
1	TS-S5	TS01	2	TS-S4	TS12

— : Not Applicable

Note 1: Set output of all unassigned pins to low by software.

Note 2: SHIELD-S1, SHIELD-W1 and SHIELD-B1 are shield electrodes. To enable the function, set the pin to shield signal output mode by software.

Note 3: Set output to low by software.

## 4. Reference Materials

- [1]. Renesas RL78/G23 Group User's Manual: Hardware (01UH0896)
- [2]. E1/E20/E2 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78 Devices) (R20UT1994)

## 5. Additional Information

### Support

Refer to the Integrated Development Environment help menu for more information on how to use the IDE.

Refer to the RL78/G23 Group User's Manual Hardware Version for more information on RL78/G23 Group MCUs.

For general information on Renesas microcontrollers, visit : <https://www.renesas.com/>

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## Appendix: Self-Capacitance Touch Electrode Board Connection

The following describes how to use the Renesas Self-Capacitance Touch Electrode Board (RTK0EG0019B01002BJ).

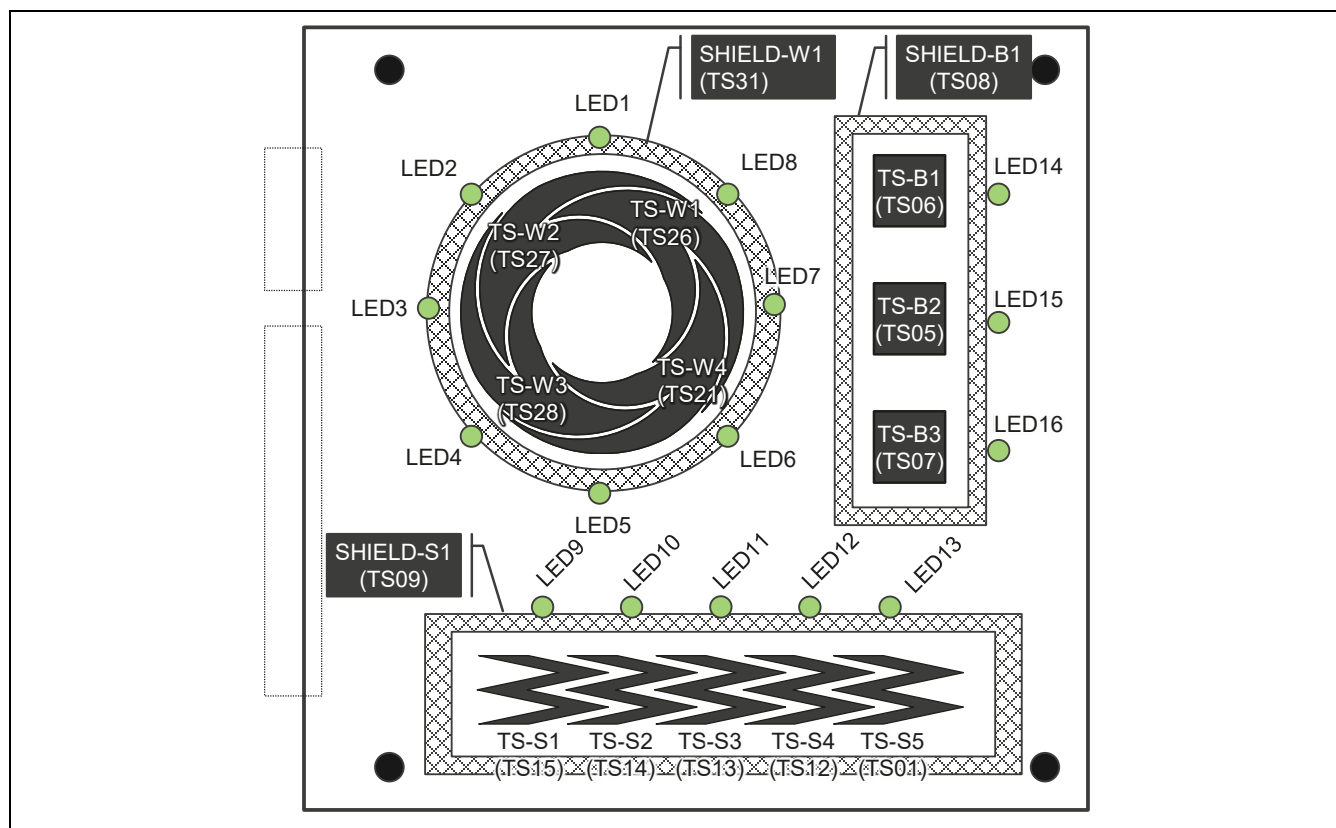


Figure 2. Board Layout and TS Pin Assignments

Table 1. TS Pin (CN2) Assignments

Touch Electrode	CTSU (RL78/G23)	Description
TS-W1	TS26	Wheel Electrode
TS-W2	TS27	
TS-W3	TS28	
TS-W4	TS21	
SHIELD-W1	TS31 (Note)	Wheel Shield Electrode
TS-B1	TS06	Button Electrode
TS-B2	TS05	
TS-B3	TS07	
SHIELD-B1	TS08 (Note)	Button Shield Electrode
TS-S1	TS15	Slider Electrode
TS-S2	TS14	
TS-S3	TS13	
TS-S4	TS12	
TS-S5	TS01	
SHIELD-S1	TS09 (Note)	Slider Shield Electrode

Note: Set the pin to shield signal output mode by software.



**Table 2. TS Pin (CN2) Assignments**

Signal	RL78/G23 Port	Description
LED_ROW0	P104	LED Matrix, High Side Transistor Drive
LED_ROW1	P120	
LED_ROW2	P106	
LED_ROW3	P105	
LED_COL0	P141	LED Matrix, Low Side Transistor Drive
LED_COL1	P140	
LED_COL2	P37	
LED_COL3	P36	
LED_VCC	V <sub>DD</sub>	VCC
LED_GND	GND	GND

**Table 3. LED Matrix Table**

	LED_COL0	LED_COL1	LED_COL2	LED_COL3
LED_ROW0	LED1	LED5	LED13	LED9
LED_ROW1	LED2	LED6	LED14	LED10
LED_ROW2	LED3	LED7	LED15	LED11
LED_ROW3	LED4	LED8	LED16	LED12

**Table 4. LED Status and Pin Output Settings**

LED	LED_ROWn Connection Pin	LED_COLn Connection Pin
On	Low	High
Off	High	Low

Note: n=0~3

Revision History	RL78/G23 Capacitive Touch Evaluation System User's Manual
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Rev.	Date	Description	
		Page	Summary
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