User's Manual

16

RL78/L23

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

16-bit Single Chip Microcontrollers

Renesas Electronics
www.renesas.com

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
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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.
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.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   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/L23 Capacitive Touch Evaluation System (RTK0EG0063S01001BJ). 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.

> The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

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Precautions

This Evaluation Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

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:

The ⃠ mark indicates something that is forbidden.

Example: :

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

⚠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 JP4 (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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The WEEE （Waste Electrical and Electronic Equipment） regulations put responsibilities on producers for the collection and recycling or disposal of electrical and electronic waste. Return of WEEE under these regulations is applicable in the European Union only. This equipment （including all accessories） is not intended for household use. After use the equipment cannot be disposed of as household waste, and the WEEE must be treated, recycled and disposed of in an environmentally sound manner. Renesas Electronics Europe GmbH can take back end of life equipment, register for this service at "http://www.renesas.eu/weee".

Electromagnetic Environment

⚠Electromagnetic Environment	
⚠	・This product generates electromagnetic emissions in an industrial environment. Use in a residential environment may affect other equipment. ・This product requires special EMC precautions and should be used in accordance with the EMC information provided below.

EMI: Electro Magnetic Interference			
Standard		Level	Guidance for EMC protection
Test Item	EN 55011 :2016/A1:2017/A2:2021	Group1 Class A	This product has no intentional external emissions, but internal RF emissions may affect nearby electromagnetically sensitive electronic equipment.
Radiated Emissions			
Conducted Emissions			

EMS: Electro Magnetic Susceptibility			
Standard		Level	Guidance for EMC protection
Radio Frequency Electromagnetic Field	EN IEC 61000-4-3:2020	A[*1]	This product is intended for use in electromagnetic environments in industrial settings. The user of the product should pay particular attention to the following electromagnetic immunity. ・Power supply quality ・Protection against static electricity ・Protection against external high-power radio waves ・Protection against external magnetic fields
Electrical Fast Transient / Burst	EN 61000-4-4:2012	B[*2]	
Surge	EN 61000-4-5 :2014/A1:2017	B[*3]	
Conducted Disturbance, Induced by Radio Frequency	EN 61000-4-6:2014	A[*4]	
Power Frequency Magnetic Field	EN 61000-4-8:2010	A[*5]	
Voltage Dips and Interruptions	EN IEC 61000-4-11:2020	B or C[*6]	

*1 Test Condition of Radio Frequency Electromagnetic Field

Test Level	Dwell Time	Modulation	Frequency Step	Antenna Polarization	Result
3V/m (80MHz - 1.0GHz)	1.0sec	1kHz AM 80%	1.0%	Horizontal / Vertical	Pass
3V/m (1.4GHz – 6.0GHz)					Pass

*2 Test Condition of Electrical Fast Transient / Burst

Test Level	Wave Form	Repetition Frequency	Testing Duration	Result
±1.0kV	Rise time: 5.0nsec Pulse Duration: 50nsec	5kHz	60sec	Pass
		100kHz		Pass

*3 Test Condition of Surge

Test Level	Wave form Specification	Phase Angle	Result
±0.5kV	Front time: 1.2 / 8.0 μsec Time to half value: 50 / 20 μsec	0º, 90º,180º, 270º	Pass
			Pass

*4 Test condition of Conducted Disturbance, Induced by Radio Frequency

Test Level	Dwell Time	Modulation	Frequency Step	Result
3V (0.15MHz – 80MHz)	1.0 sec	1kHz AM 80%	1.0%	Pass

*5 Test Condition of Power Frequency Magnetic Field

Test Level	Applied Power Frequency	Test Duration	Result
3A/m (rms)	50Hz	60sec	Pass
	60Hz		Pass

*6 Test Condition of Voltage Dips and Interruptions

Test Item	Test Level	Duration	Phase Angle	Result
Voltage Dips	0%	0.5 cycles	0º, 180º	Pass
		1.0 cycles		Pass
	70%	25 cycles		Pass
Voltage Interruptions	0%	250 cycles		Pass

Table of Contents

1. Overview

1.1 Purpose

The RL78/L23 Capacitive Touch Evaluation System (RTK0EG0063S01001BJ) is a kit created for evaluating the Renesas Electronics RL78/L23 of MCUs. This manual describes the RL78/L23 Cap Touch evaluation System's hardware.

1.2 Main Characteristics and Features

The main functions of the RL78/L23 Capacitive Touch Evaluation System are as follows:

- Renesas Microcontroller programming and debugging
  --- E2 / E2 Lite debugger connector
- General purpose switches and LEDs
- Capacitive Touch Sensors (CTSU2La)
  --- 36 channels available
- Connects to Renesas Capacitive Touch Evaluation System Application Board (option)
  --- Includes self-capacitance touch electrode application board
- Pmod™ interface
  --- PMOD1: Pmod Type 2A/Type 3A/Type 6A
  --- PMOD2: Pmod Type 2A/Type 3A
- LCD interface
  --- 16 segments 8 digits can be connected (LCD not included)

1.3 Board Specifications

Table 2-1 CPU Board Specifications

Item	Specifications
Board part No.	RTK0EG0062C01001BJ
MCU	Model No.: R7F100LPL3CFB
	Package: 100pin LFQFP
	On-chip memory : ROM 512KB, RAM 32KB, DataFlash 8KB
	High-speed on-chip oscillator：32MHz maximum
External resonator connection	Main clock: 1 to 20MHz (option)
	Sub clock: 32.768KHz
Power supply	MCU Supply Voltage：5.0 to 3.3V DC jack (2.1mm Center Positive)：3.3V to 5V(±5%) input USB bus powered (VBUS)：5V
Debug interface	Renesas Electronics E2/E2 Lite 14-pin box header
Slide switch	Board function selection：2 poles 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 Type-C
	Driver: FT234XD USB serial IC manufactured by FTDI
Application board interface (GPIO)	2.54mm pitch, 16 pins x 1 (CN1)
Application board interface (CTSU)	2.54mm pitch, 40 pins x 1 (CN2)
Pmod interface	2.54mm pitch, 12 pins x 2 (PMOD1, PMOD2) PMOD1：Pmod Type6A (default state), Type2A/Type3A (with switch PAD Short/Open) PMOD2：Pmod Type2A/Type3A
LCD interface	2.54mm pitch, 16 pins x 2 (CN7,CN8) (LCD not included)
Current consumption	500mA or less (total with all interfaces in use)
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 18mm (including connectors)

Table 2-2 Application Board Specifications

Item	Specifications
Board part No.	RTK0EG0019B01002BJ
Self-capacitance detection touch electrodes	Buttons: 3 Wheels: (4-electrode configuration): 1 Sliders: (5-electrode configuration): 1
Touch electrode shields	Buttons, wheel, slider: 1 shield each
LED	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 : 2021 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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    Name: Renesas Electronics Corporation
    Address: Toyosu Foresia, 3-2-24, Toyosu, Koto-ku, Tokyo 135-0061, Japan
  - Person responsible for placing on the market
    Name: Renesas Electronics Europe GmbH
    Address: Arcadiastrasse 10, 40472 Dusseldorf, Germany
  - Trademark and Type name
    Trademark: Renesas
    Product name: RL78/L23 Group Capacitive Touch Evaluation System
    Type name: RTK0EG0063S01001BJ

Environmental Compliance and Certifications:

- Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU

2. CPU Board

2.1 System Block Diagram

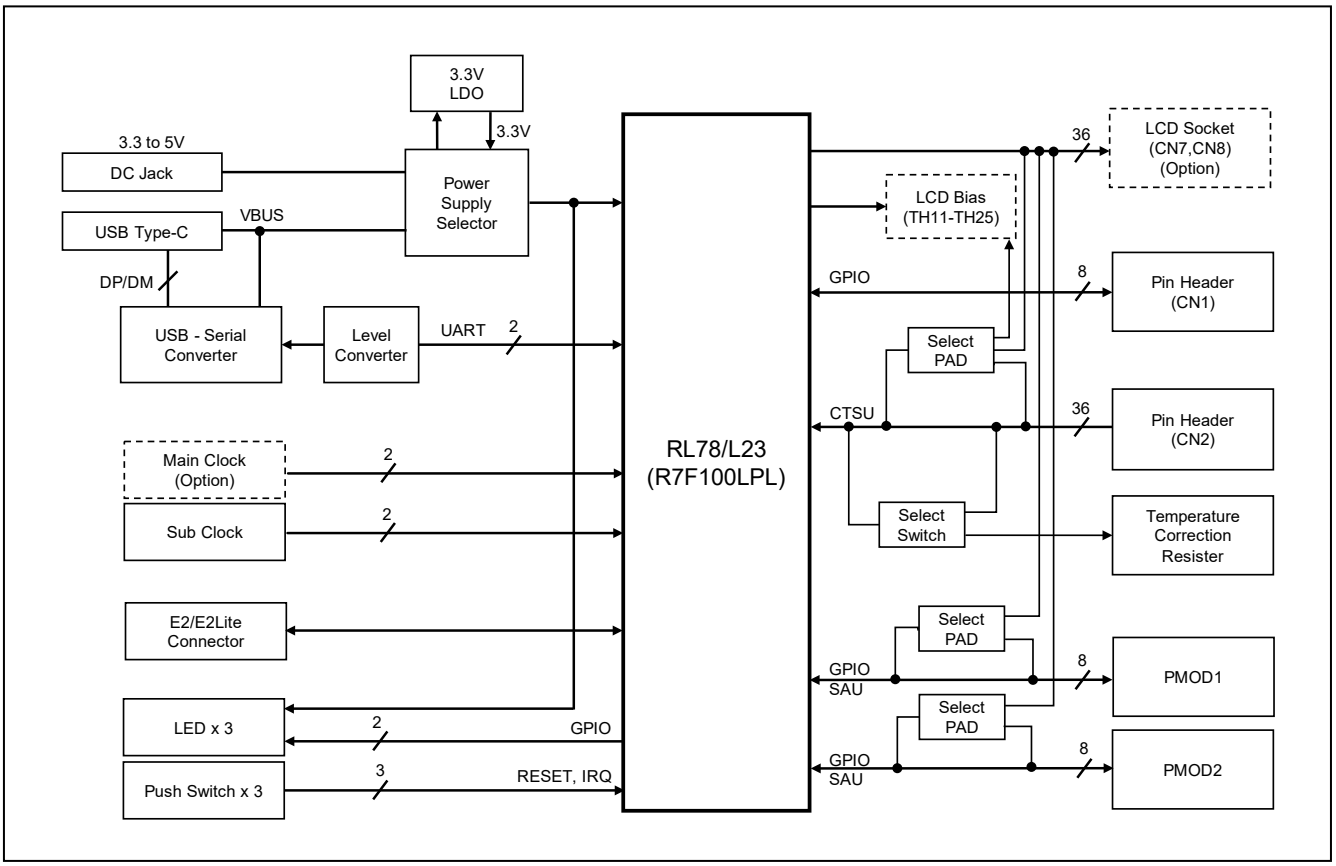


Figure 2-1 System Block Diagram

2.2 Board Layout

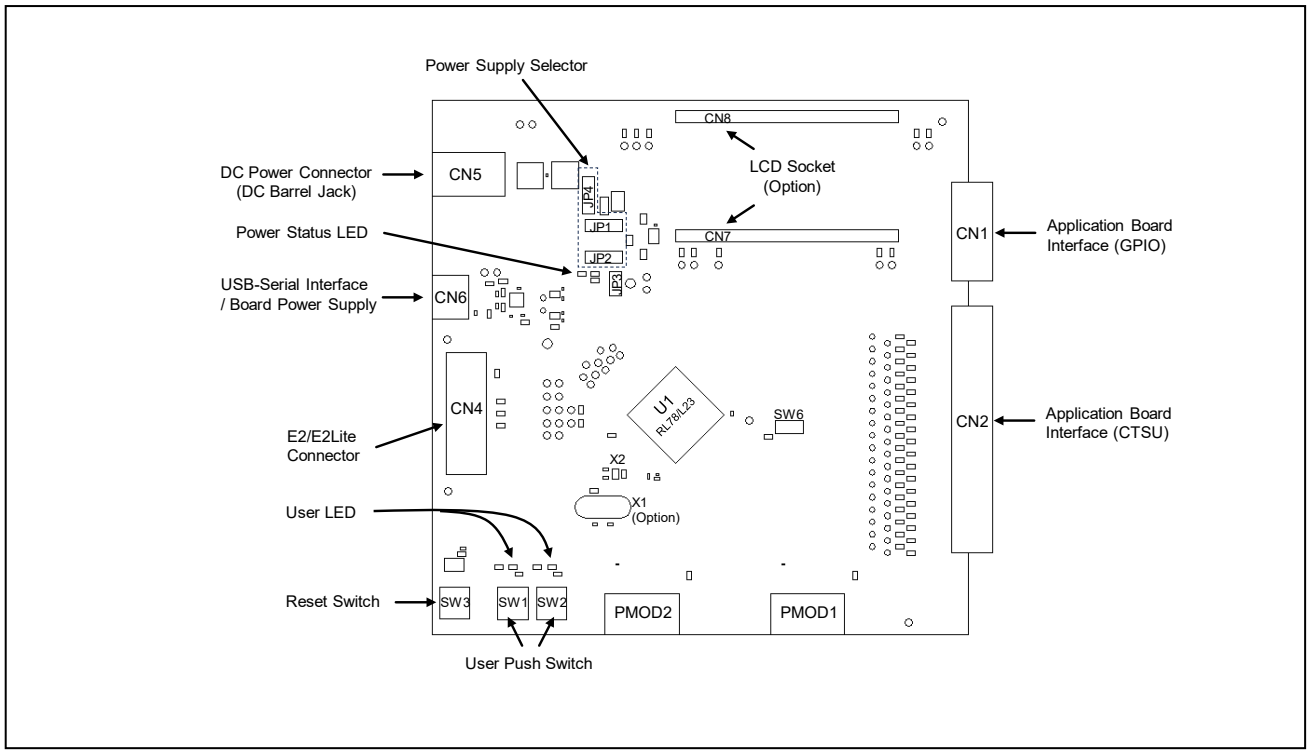


Figure 2-2 Parts Locations

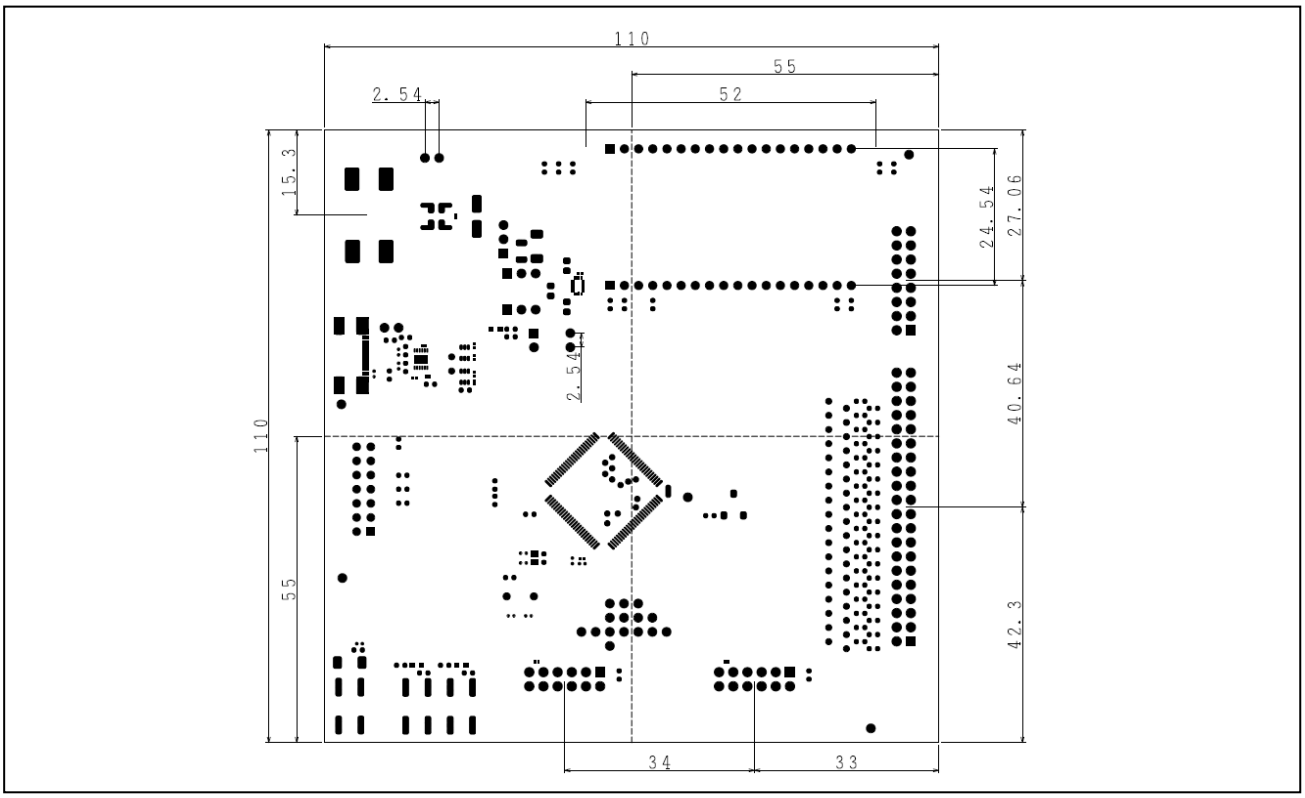


Figure 2-3 Board Dimensions

2.3 Hardware Details

2.3.1 Default Board Settings

This section describes the default state of the jumper switches and slide switches.

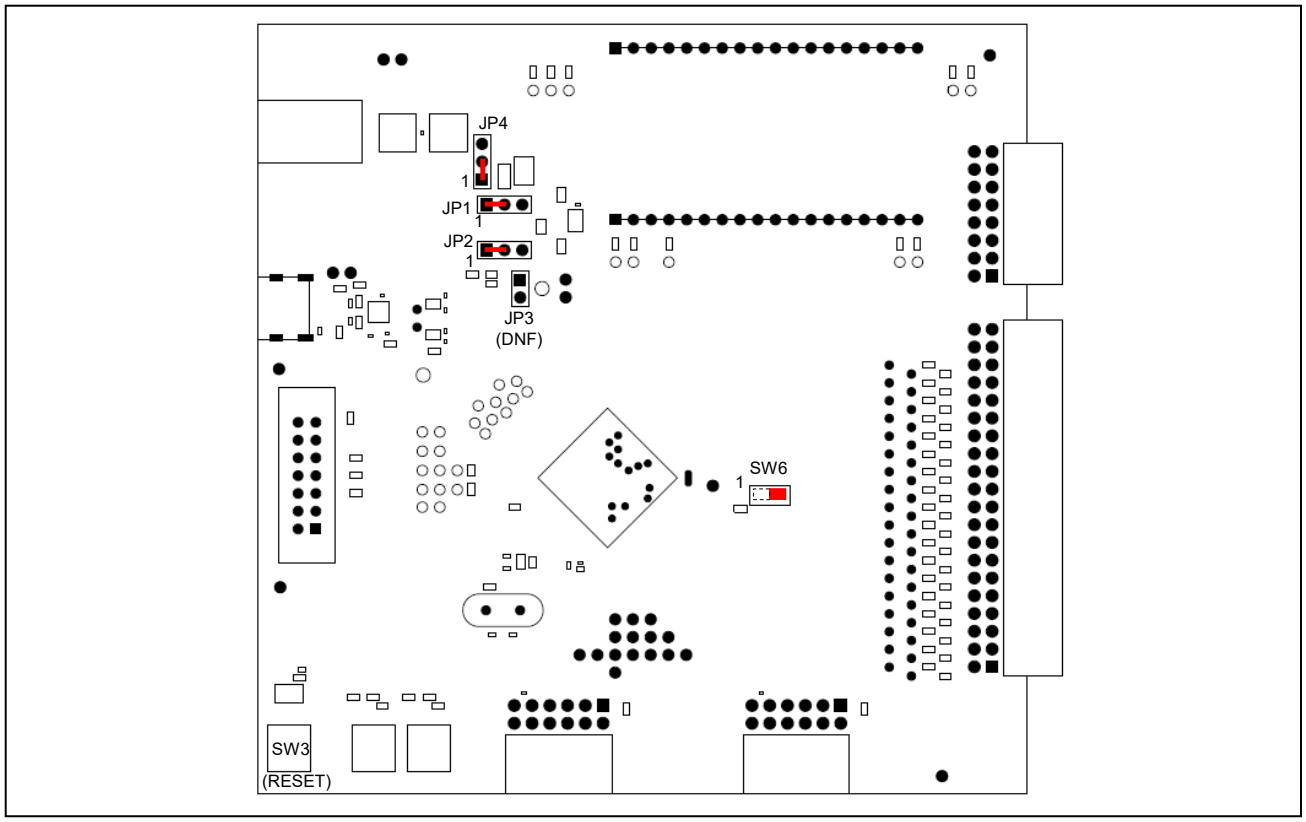


Figure 2-4 Default Positions of Jumper and Slide Switches

Table 2-1 Default Settings for Jumper and Slide Switches

Reference	Functional Overview	Default State	Description
JP4	Power supply setting (USB or DC jack)	Supplied from USB 1-2 Pin closed	2.3.2 Power Supply
JP1,2	3.3V LDO ON/OFF	LDO OFF JP1 1-2 Pin closed JP2 1-2 Pin closed	
SW6	RL78/L23 pin (TS16) connection setting (pull-down or CN2)	Connected to CN2 2-3 Pin closed	2.3.7 CTSU Correction Circuit

2.3.2 Power Supply

This section describes the power supply and selection method. Power can be supplied via USB or DC jack (2.1mm center plus).

Table 2-2 Power Source Jumper Settings

Reference	Jumper Setting	Default Setting (X)	Description
JP4	Shorted Pin 1-2	X	Select USB power supply
	Shorted Pin 2-3		Select DC Jack (CN5)
JP1, JP2	Shorted Pin 1-2	X	Supplies JP4 power source to board power source
	Shorted Pin 2-3		Supplies LDO (3.3V) to board power source
JP3 / PAD3	Shorted	X	Supplies board power source to MCU
	Open		For measuring MCU current consumption

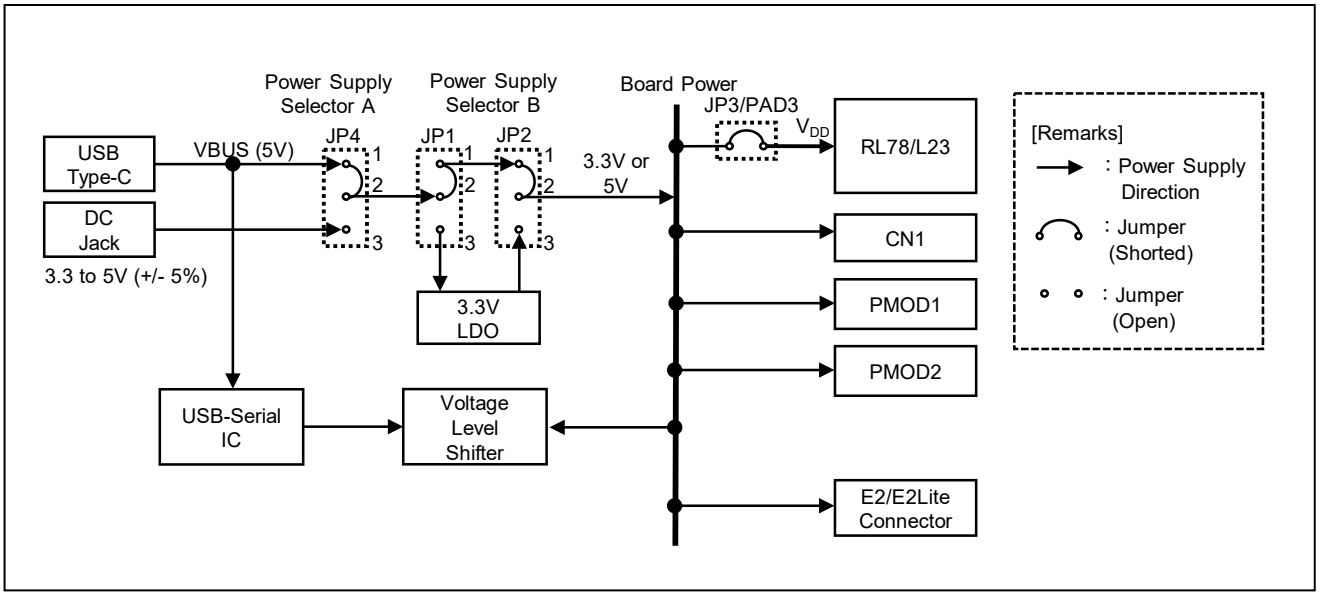


Figure 2-5 Power Source System Diagram

2.3.3 Clock Circuit

The CPU board does not implemented an X1 oscillator for the RL78/L23. Since there is a pattern for mounting, you can mount an oscillator as needed. The resonator for X2 is implemented.

In the default state of this CPU board, the microcontroller software operates using the on-chip oscillator (HOCO) built into the RL78/L23.

Table 2-3 Clock Specifications

Clock	Function	Default State	Frequency	Package
X1	Main clock	Not mounted	1 to 20MHz	Through Hole Mount HC-49/U
X2	Sub clock	Mounted	32.768kHz	Surface Mount Device 2.00mm x 1.20mm

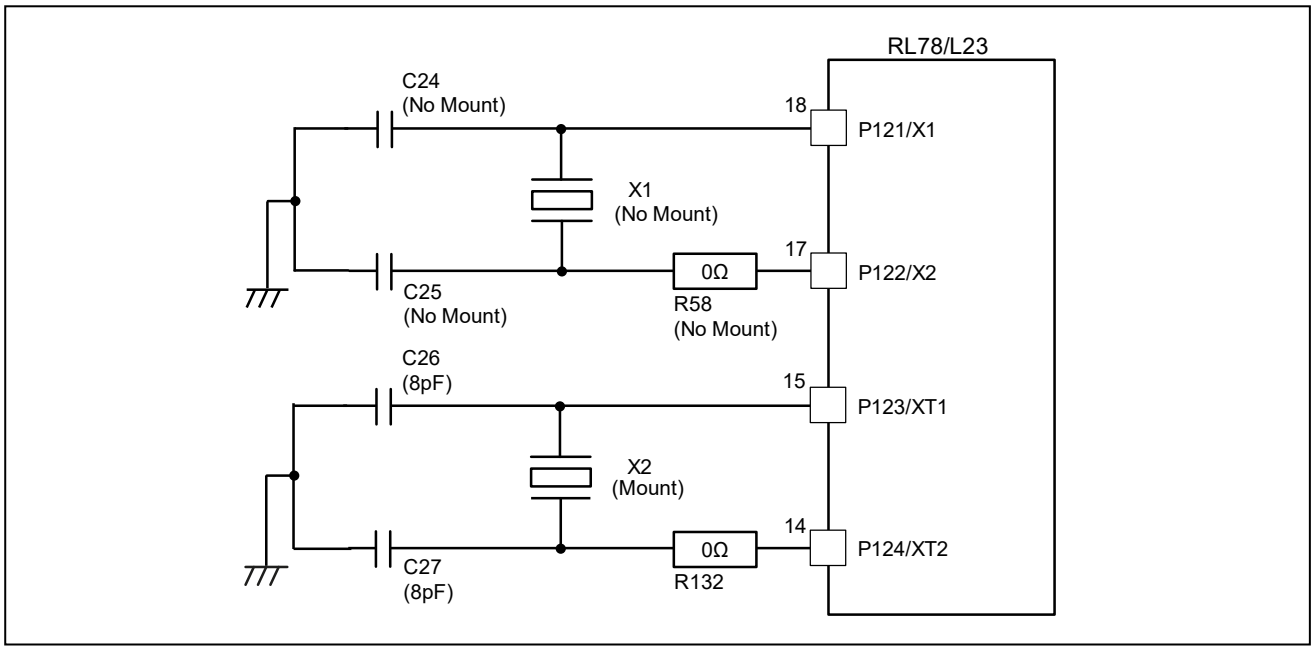


Figure 2-6 Clock Circuit

2.3.4 Reset Circuit / Debug Interface

The CPU board is equipped with a reset switch (SW3) which generates a reset signal to restart the main MCU.

The CPU board is equipped with an E2/E2Lite connector (14-pin box header) for the debug interface.Figure 2-7 shows the connection between the RL78/L23 and the debug interface connector (CN4). For details on the debug interface, refer to [2] of 4 Reference Materials

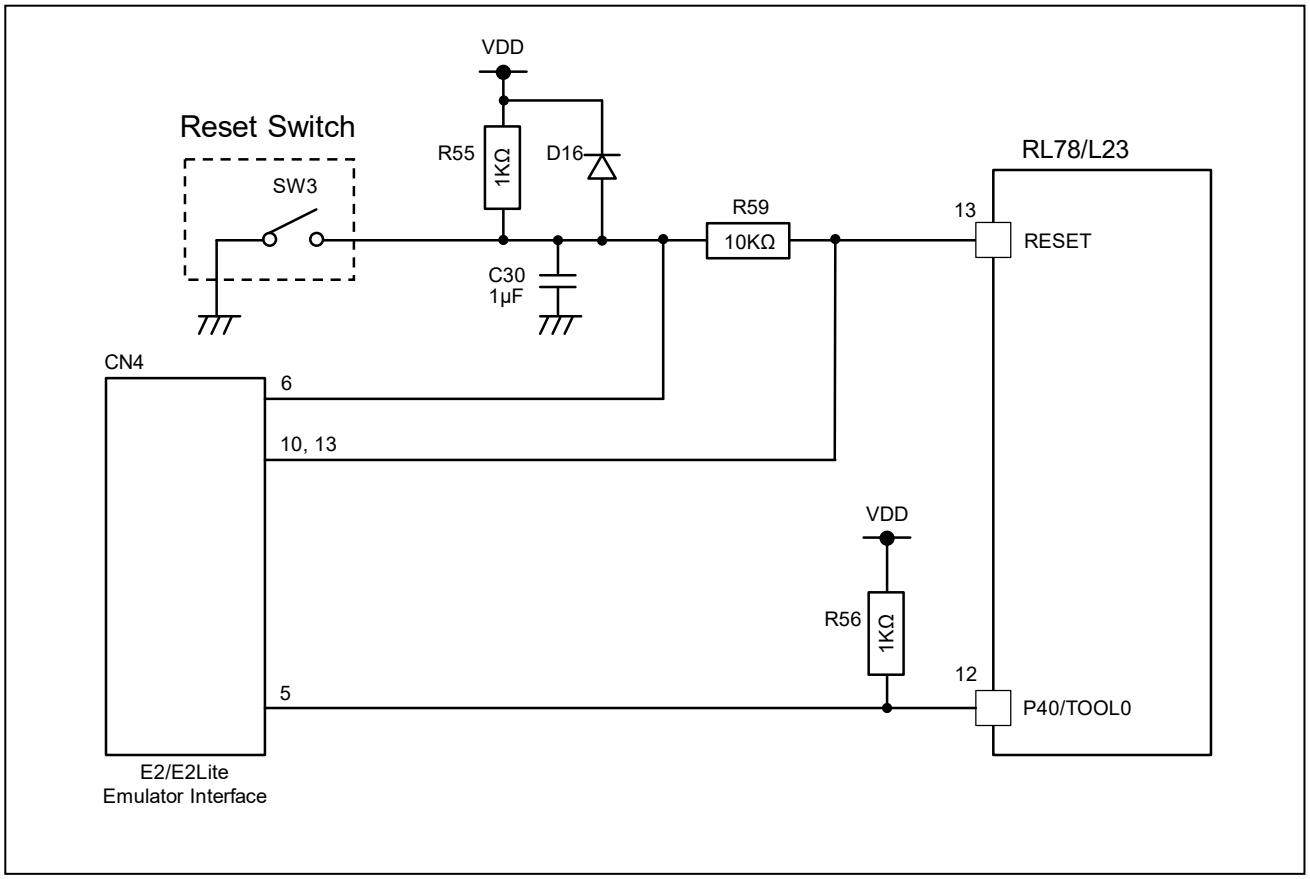


Figure 2-7 Reset Circuit / Debug Interface

2.3.5 Push Switches / LEDs

Table 2-4 Push Switch (SW1, SW2, SW3)

Reference	MCU Control Port	Function
SW1	P60/(INTP3)	User controllable switch
SW2	P61/(INTP4)	User controllable switch
SW3	RESET	Resets the MCU

Table 2-5 LED1, LED2, LED3

LED	MCU Control Port	Function	Color
LED1	P64	User controllable LED	Green
LED2	P65	User controllable LED	Yellow
LED3	VDD	Power status display	Red

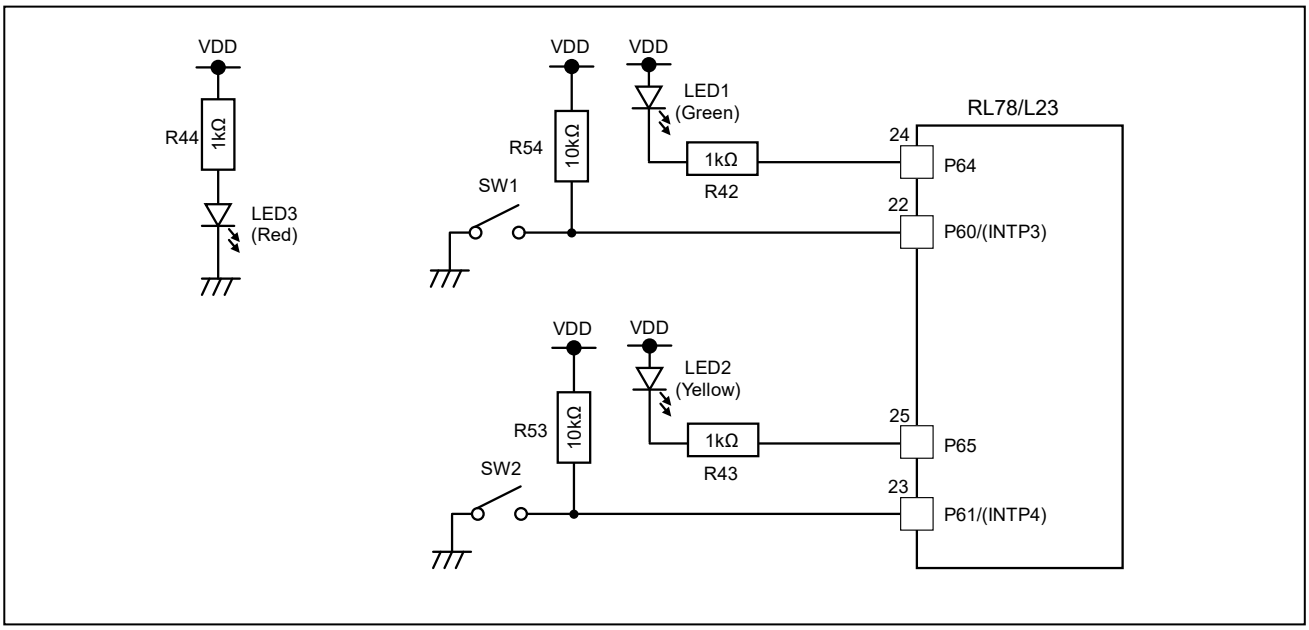


Figure 2-8 Push Switch/LED Circuit

2.3.6 USB Serial Converter

The CPU board is equipped with an FTDI USB serial IC (FT234XD) and is connected to the RL78/L23's serial array unit (SAU) module.

Table 2-6 USB Serial Conversion Ports

Signal Name	MCU Control Port	Function
MCU_TXD	P146/(TxD2)	SAU transmit data signal
MCU_RXD	P147/(RxD2)	SAU receive data signal

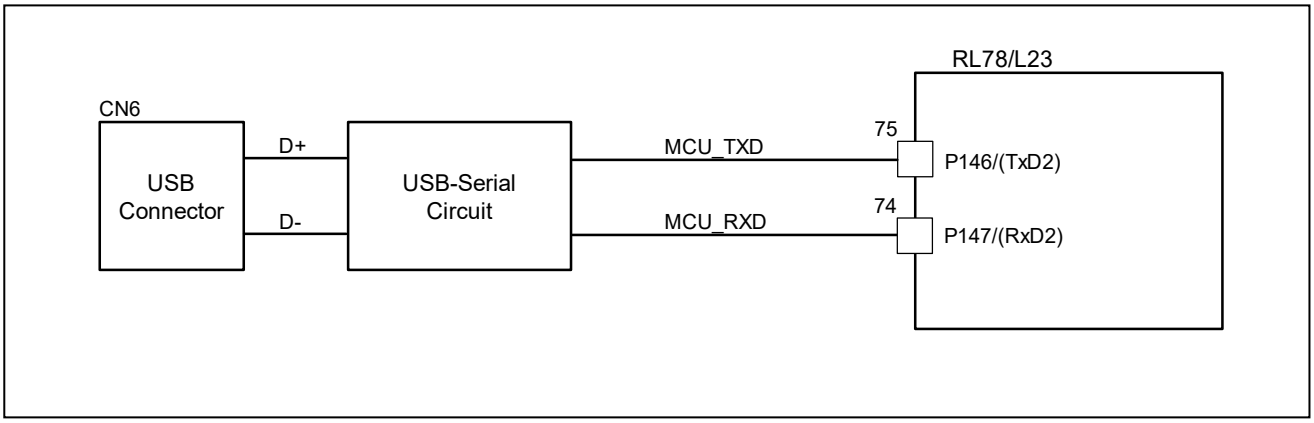


Figure 2-9 Interface for MCU and USB Serial Conversion Circuit

2.3.7 CTSU Correction Circuit

This circuit improves the accuracy of the CTSU's capacitive measurement. The control software for the CTSU correction function is required separately. When using TS16 as a normal CTSU pin, set the position of SW6 to 2-3 short.

Table 2-7 Selection Switch for CTSU Correction Function (TS16 Connection Destination Selection Switch) (SW6)

Reference	Position	Default State (X)	Function
SW6	(2-3 pin)	X	Connect to CN2 (select touch function)
	(1-2 pin)		10kΩ pull-down (select CTSU correction function)

2.3.8 Pmod Interface

This CPU board is equipped with 2 Pmod interface connectors (PMOD1, PMOD2).

PMOD1 can be selected for Pmod Type 2A, Type 3A, and Type 6A. The default setting is Type 6A.

PMOD2 can be used for Pmod Type 2A or Type 3A.

The Pmod interface and the LCD interface have signals that are used in common, and you can select the connection destination. To select the connection destination, switch between Short-PAD and Open-PAD.

For the Type change of PMOD1, refer to Table 2-8 and Figure 2-10.

For switching between Pmod wiring and LCD wiring, refer to section 2.3.9 and Figure 2-10

When connecting the Pmod module, check the pin positions and be careful not to misalign the positions or insert the pins backwards. Incorrect pin insertion can cause the product to malfunction.

Table 2-8 PMOD1 Pin Assignments (Default Type 6A)

Pin	Function (Type)			MCU Port
	2A	3A	6A	
1	CS	CTS	NC	**[2A,3A]** P62/(INTP5) **[6A]** (Unrelated)
2	MOSI	TXD	NC	**[2A,3A]** P42/(TxD1)/(SO10)/(SCLA0) **[6A]** (Unrelated)
3	MISO	RXD	SCL	**[2A,3A]** P41/(SI10)/(RxD1)/(SDAA0) **[6A]** P42/(TxD1)/(SO10)/(SCLA0)
4	SCK	RTS	SDA	**[2A,3A]** P66/(SCK10) **[6A]** P41/(SI10)/(RxD1)/(SDAA0)
5	GND			—
6	VCC			—
7	GPIO			P67/(INTP2)
8	GPIO			P46/SEG26
9	GPIO			P47/SEG27
10	GPIO			P23/SEG30
11	GND			—
12	VCC			—

Table 2-9 PMOD2 Pin Assignments

Pin	Function (Type)			MCU Port
	2A	3A	6A	
1	CS	CTS	Not supported	**[2A,3A]** P63
2	MOSI	TXD		**[2A,3A]** P43/SO30/TxD3
3	MISO	RXD		**[2A,3A]** P44/SI30/RxD3
4	SCK	RTS		**[2A,3A]** P45/SCK30
5	GND			—
6	VCC			—
7	GPIO			P22/SEG29/(INTP7)
8	GPIO			P141/SEG51
9	GPIO			P142/SEG52
10	GPIO			P143/SEG53
11	GND			—
12	VCC			—

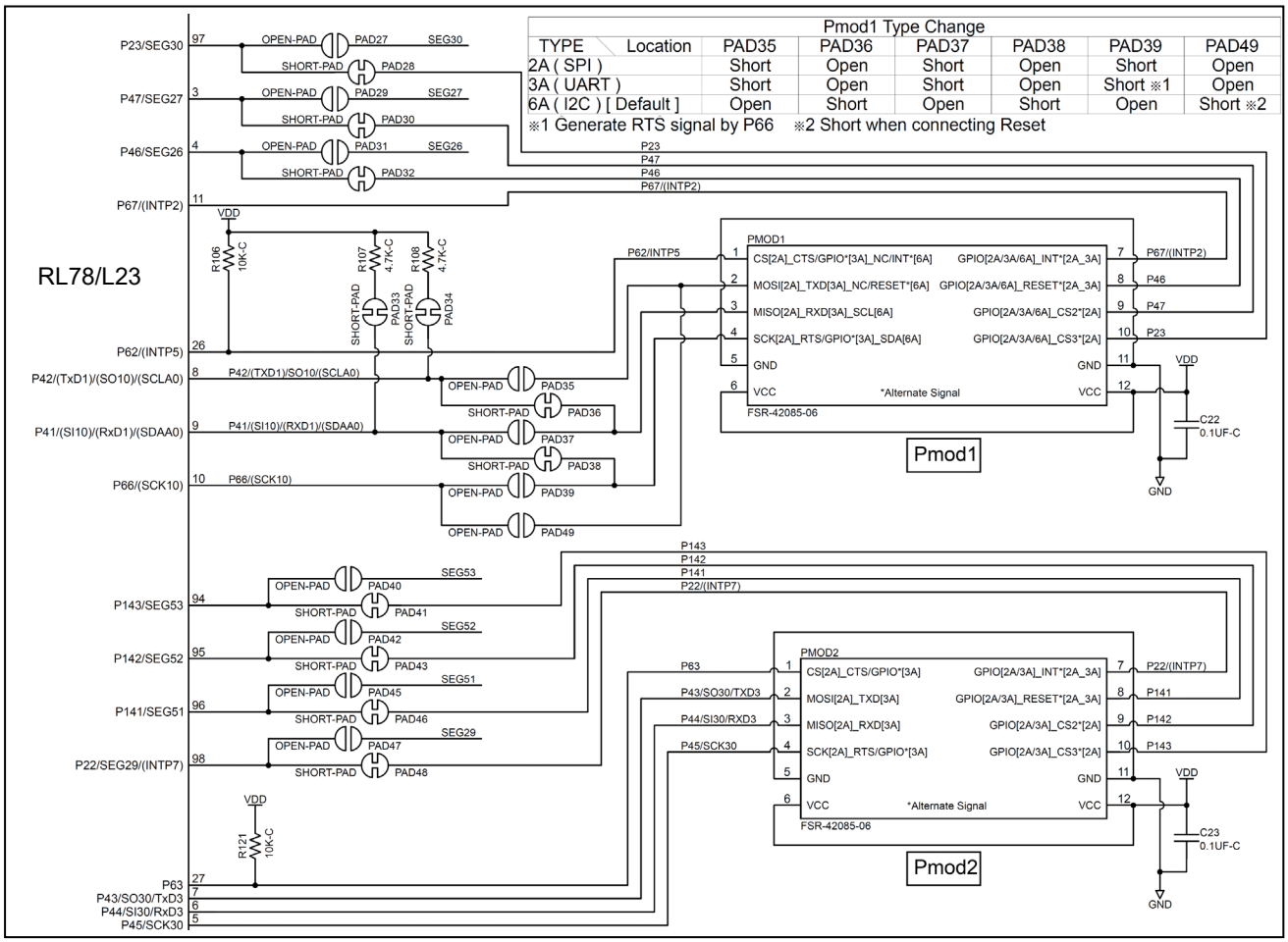


Figure 2-10 PAD for Pmod Connector Wiring Switching

2.3.9 Pmod wiring/LCD wiring switching

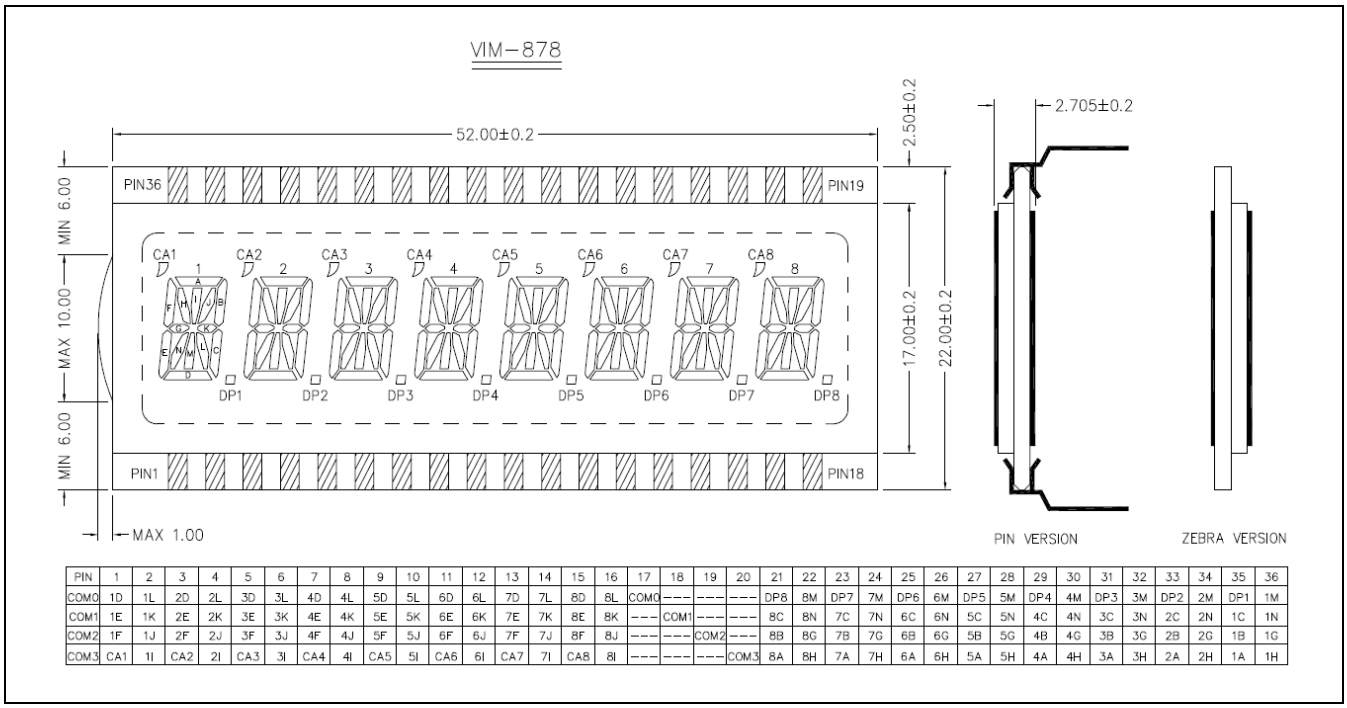
The CPU board has wiring that is shared by Pmod and LCD (optional function). These wirings are switched by Short-PAD/Open-PAD (Table 2-10). The default state is set to use Pmod.

Table 2-10 How to switch between Pmod wiring and LCD wiring

Reference	Short-PAD/Open-PAD	Using Pmod (default state)	Using LCD
PMOD1	PAD27,29,31	Open	Short
	PAD28,30,32	Short	Open
PMOD2	PAD40,42,45,47	Open	Short
	PAD41,43,46,48	Short	Open

2.3.10 LCD Circuit

The CPU board is equipped with an LCD circuit as an optional function. The application headers CN7 and CN8 can be connected to the Varitronix VIM-878-DP-FC-S-LV LCD panel (14 segments, 8 digits). The operating voltage requirements of this LCD panel are 3.0V to 4.6V. When using with an operating voltage other than 3.3V, remove the LCD panel. Note that the LCD is not included.



PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
COM0	1D	1L	2D	2L	3D	3L	4D	4L	5D	5L	6D	6L	7D	7L	8D	8L	COM0	---	---	---	DP8	8M	DP7	7M	DP6	6M	DP5	5M	DP4	4M	DP3	3M	DP2	2M	DP1	1M
COM1	1E	1K	2E	2K	3E	3K	4E	4K	5E	5K	6E	6K	7E	7K	8E	8K	---	COM1	---	---	8C	8N	7C	7N	6C	6N	5C	5N	4C	4N	3C	3N	2C	2N	1C	1N
COM2	1F	1J	2F	2J	3F	3J	4F	4J	5F	5J	6F	6J	7F	7J	8F	8J	---	---	COM2	---	8B	8G	7B	7G	6B	6G	5B	5G	4B	4G	3B	3G	2B	2G	1B	1G
COM3	CA1	1I	CA2	2I	CA3	3I	CA4	4I	CA5	5I	CA6	6I	CA7	7I	CA8	8I	---	---	---	COM3	8A	8H	7A	7H	6A	6H	5A	5H	4A	4H	3A	3H	2A	2H	1A	1H

Figure 2-11 LCD Panel

Excerpt from：Datasheet for VIM-878-DP-FC-S-LV Varitronix Optoelectronics | Octopart

Table 2-11 and Table 2-12 show the LCD pin assignments for CN7 and 8.

The LCD interface and the CN2 and Pmod interfaces of the application board for CTSU have signals that are commonly used, and the connection destination can be selected. To select these, switch between Short-PAD and Open-PAD. The LCD circuit has unconnected wires in the initial state, so please check the following and switch the wiring before use.

For switching between CTSU wiring and LCD wiring, refer to section 2.3.11.

For switching between Pmod wiring and LCD wiring, refer to section 2.3.9.

For switching the LCD drive power setting, refer to section 2.3.12.

Table 2-11 LCD Pin Assignments / Application Header (CN7)

CN7 Pin No.	LCD Panel Pin No.	MCU Signal	Port Name	MCU Pin No.	Default State
1	LCD_1	SEG15/TS13	P73	45	Not Connected *Note
2	LCD_2	SEG3/TS24	P97	59	Not Connected *Note
3	LCD_3	SEG26	P46	4	Not Connected *Note
4	LCD_4	SEG1/TS26	P95	61	Not Connected *Note
5	LCD_5	SEG28	P130	2	SEG28
6	LCD_6	SEG30	P23	97	Not Connected *Note
7	LCD_7	SEG52	P142	95	Not Connected *Note
8	LCD_8	SEG31	P24	93	SEG31
9	LCD_9	SEG33	P26	91	SEG33
10	LCD_10	SEG54	P144	89	SEG54
11	LCD_11	SEG35	P10	87	SEG35
12	LCD_12	SEG37	P12	85	SEG37
13	LCD_13	SEG39	P14	83	SEG39
14	LCD_14	SEG41	P16	81	SEG41
15	LCD_15	SEG43	P00	79	SEG43
16	LCD_16	SEG45	P02	77	SEG45
17	LCD_17	COM0/TS31	P90	66	Not Connected *Note
18	LCD_18	COM1/TS30	P91	65	Not Connected *Note

Table 2-12 LCD Pin Assignments / Application Header (CN8)

CN8 Pin No.	LCD Panel Pin No.	MCU Signal	Port Name	MCU Pin No.	Default State
1	LCD_36	SEG14/TS14	P72	46	Not Connected *Note
2	LCD_35	SEG2/TS25	P96	60	Not Connected *Note
3	LCD_34	SEG27	P47	3	Not Connected *Note
4	LCD_33	SEG0/TS27	P94	62	Not Connected *Note
5	LCD_32	SEG29/(INTP7)	P22	98	Not Connected *Note
6	LCD_31	SEG51	P141	96	Not Connected *Note
7	LCD_30	SEG53	P143	94	Not Connected *Note
8	LCD_29	SEG32	P25	92	SEG32
9	LCD_28	SEG34	P27	90	SEG34
10	LCD_27	SEG55	P145	88	SEG55
11	LCD_26	SEG36	P11	86	SEG36
12	LCD_25	SEG38	P13	84	SEG38
13	LCD_24	SEG40	P15	82	SEG40
14	LCD_23	SEG42	P17	80	SEG42
15	LCD_22	SEG44	P01	78	SEG44
16	LCD_21	SEG46	P03	76	SEG46
17	LCD_20	COM3/TS28	P93	63	Not Connected *Note
18	LCD_19	COM2/TS29	P92	64	Not Connected *Note

Note : By default, the MCU signal is not connected because it is connected to CN2 which is the application board interface for CTSU, or to the Pmod interface.

2.3.11 Switching between CTSU wiring and LCD wiring

This CPU board has wiring shared by the CTSU and LCD (optional function). These wirings are switched between Short-PAD/Open-PAD (Table 2-13). The default setting is to use CTSU.

Table 2-13 How to switch between CTSU wiring and LCD wiring

	Short-PAD/Open-PAD	Using CTSU (default state)	Using LCD
CN7	PAD4,5,6,7,8 *Note	Open	Short
	PAD9,10,11,12,13	Short	Open
CN8	PAD14,15,16,17,18 *Note	Open	Short
	PAD19,20,21,22,23	Short	Open
LCD-driving Power Circuit (LCD bias)	PAD24,25,26 *Note	Open	Short

Note：PAD4-8, 14-18, and 24-26 are located on the back of this CPU board as shown in Figure 2-12.

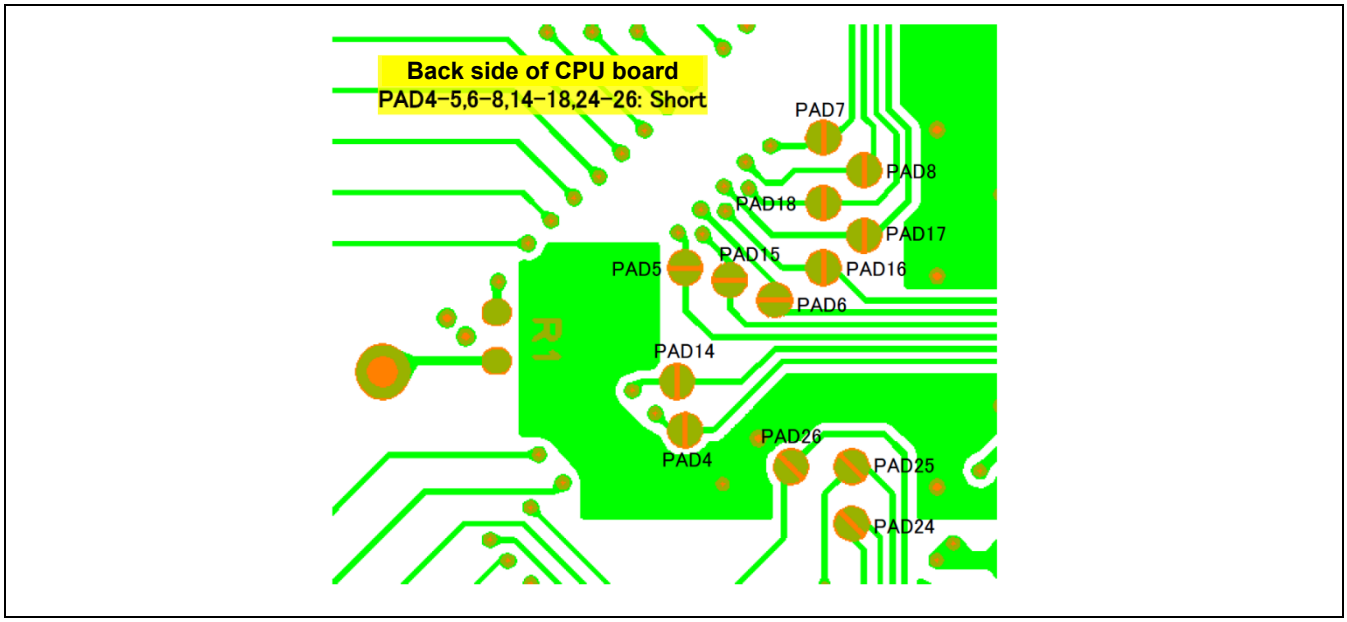


Figure 2-12 PAD for Switching LCD Wiring (Back Side of CPU Board)

2.3.12 Setting the LCD driving Power Supplies

The LCD driving power supply of the RL78/L23 supports three types: external resistance division method, internal voltage boosting method and capacitor split method.

When using the LCD panel (VIM-878-DP-FC-S-LV), the external resistance division method supports the 1/3 bias method and up to four-time-slice mode. The voltage boosting method supports 1/3 bias of the V_{L1} and VL2 references, up to four-time-slice mode. The capacitor split method supports the 1/3 bias method of the VDD and V_{L4} references, up to four-time-slice mode.

The CPU board have through holes which are provided to evaluate the settings of the LCD driving power supplies with the use of parts having leads.

When evaluating using lead components, short-circuit the Open-PAD on the back of the CPU board as shown in Figure 2-12 and mount resistors or capacitors having leads as shown in Figure 2-13.

By default, the P127/CAPH/TS00 (28pin), P126/CAPL/TS01 (29pin) and P125/VL3/TS02 (33pin) are set to TS00, TS01, and TS02, and the P87 (30pin), P86 (31pin), and P85 (32pin) are set to V_{L1}, V_{L2}, and V_{L4}.

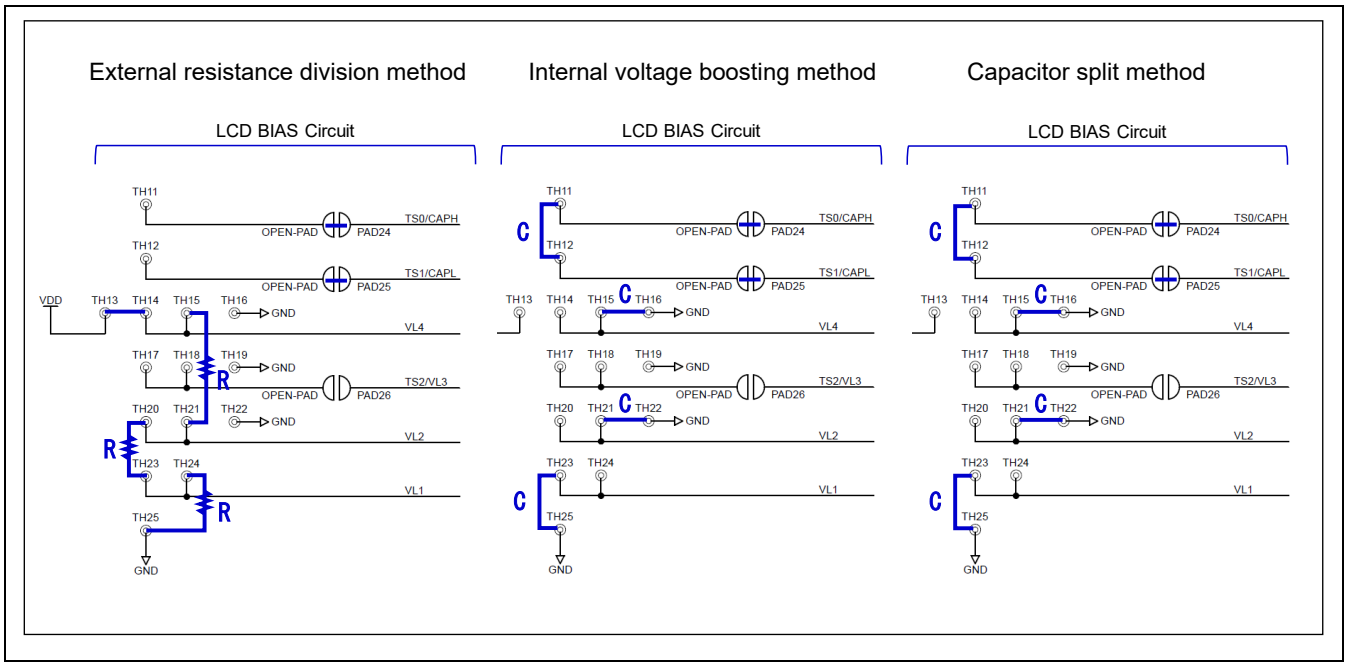


Figure 2-13 Settings for the LCD-driving Power Supplies *Note

Note : The reference resistance “R” value for external resistance division is 10 kΩ to 1 MΩ. In addition, to stabilize the potential of the V_{L1} to V_{L4} pins, connect a capacitor between each of pins V_{L1} to V_{L4} and the GND pin as needed. When using the internal voltage boosting method or the capacitor split method, make the capacitor between CAPH to CAPL a nonpolar capacitor. The reference capacitance “C” is about 0.47 µF but it depends on the LCD panel used, the number of segment pins, the number of common pins, the frame frequency, and the operating environment. Thoroughly evaluate these values in accordance with your system and adjust and determine the capacitance.

2.3.13 Application Headers

Application headers CN1 and CN2 are the interface connections for connecting the user's board to the Renesas Capacitive Touch Evaluation System CPU board.

CN1 is equipped with the GPIO interface. For peripheral functions not mentioned in the table below, refer to the target MCU's user's manual (hardware version).

Table 2-14 Application Headers (CN1)

Pin	MCU Signal	Remarks	Pin	MCU Signal	Remarks
16	V_{SS} (GND)		15	V_{DD}	
14	P20		13	P21	
12	P80		11	P81	
10	—	Not Connected	9	—	Not Connected
8	—	Not Connected	7	P82	
6	P83		5	P84	
4	P140		3	—	Not Connected
2	—	Not Connected	1	—	Not Connected

CN2 is mainly used for CTSU pins. Fix the GPIO pins to low by software. Fix the GPIO pins to low by software.

Table 2-15 Application Header (CN2)

Pin	MCU Signal	Remarks	Pin	MCU Signal	Remarks
40	—	Not Connected	39	—	Not Connected
38	—	Not Connected	37	—	Not Connected
36	P04/TS35	TS35	35	P90/COM0/TS31	TS31
34	P05/TS34	TS34	33	P91/COM1/TS30	TS30
32	P92/COM2/TS29	TS29	31	P06/TS33	TS33
30	P93/COM3/TS28	TS28	29	P94/SEG0/COM4/TS27	TS27
28	P07/TS32	TS32	27	P95/SEG1/COM5/TS26	TS26
26	P96/SEG2/COM6/TS25	TS24	25	P97/SEG3/COM7/TS24	TS24
24	P50/TS23	TS23	23	P51/TS22	TS22
22	P52/TS21	TS21	21	P53/TS20	TS20
20	P54/TS19	TS19	19	P55/TS18	TS18
18	P56/TS17	TS17	17	P70/TS16	TS16 *Note1
16	P71/TS15	TS15	15	P72/SEG14/TS14	TS14
14	P73/SEG15/TS13	TS13	13	P125/VL3/TS02	TS2
12	P126/CAPL/TS01	TS1	11	P127/CAPH/TS00	TS0
10	P74/TS12	TS12	9	P75/TS11	TS11
8	P76/TS10	TS10	7	P77/TS09	TS9
6	P30/TS08	TS8	5	P31/TS07	TS7
4	P32/TS06	TS6	3	P33/TS05	TS5
2	P34/TS04	TS4	1	P35/TS03	TS3

Note1: The connection status changes depending on the SW6. Refer to "2.3.7 CTSU Correction Circuit".

3. Application Board (Self-Capacitance Electrode Board)

3.1 Board Layout

Figure 3-1 shows the layout of the application board.

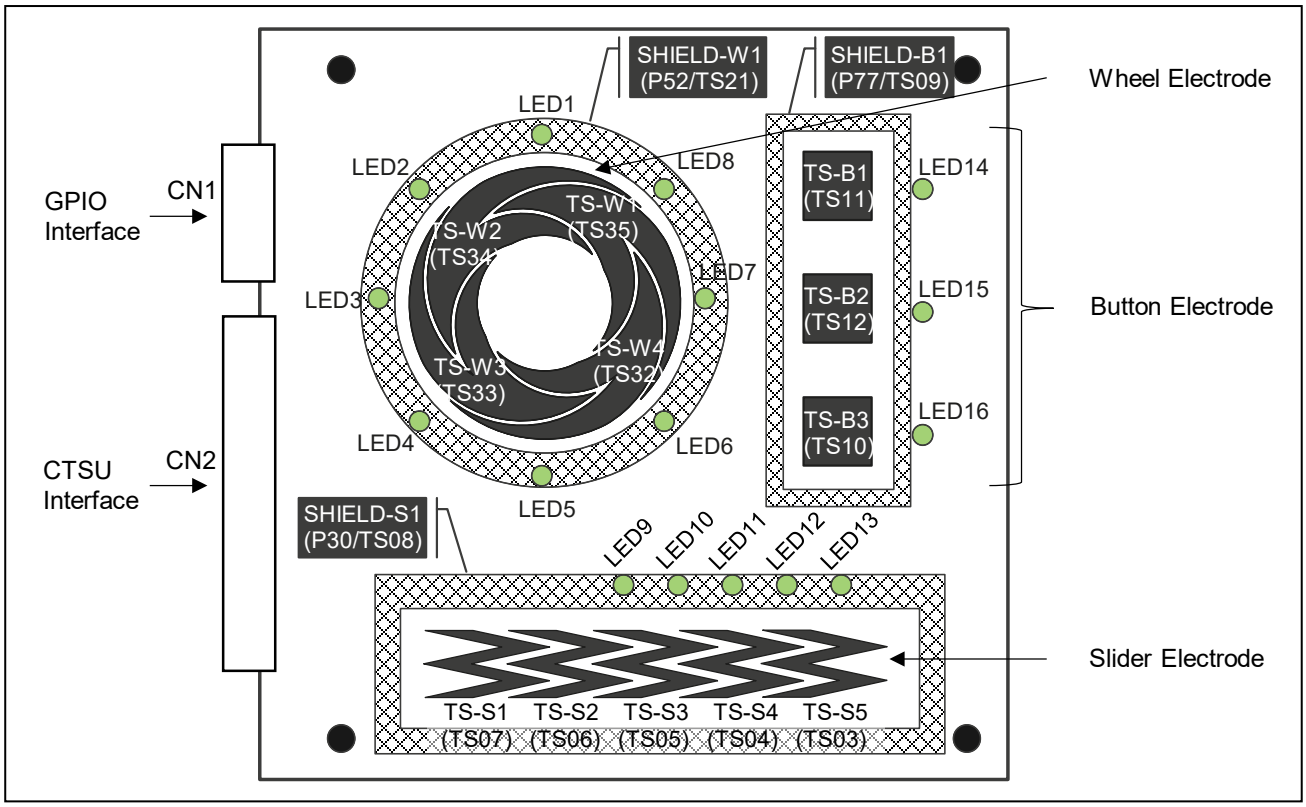


Figure 3-1 Application Board Layout

3.2 Application Headers

Application headers CN1 and CN2 are the interface for connection to the Renesas Capacitive Touch Evaluation System CPU board. Table 3-1 lists the pin assignments for CN1.。 Table 3-2 lists the pin assignments for CN2.

Table 3-1 Application Header (CN1)

Pin	Function	MCU Connection	Pin	Function	MCU Connection
15	LED_VCC	V_{DD}	16	LED_VSS (GND)	V_{SS} (GND)
13	LED_ROW0	P21	14	LED_ROW1	P20
11	LED_ROW2	P81	12	LED_ROW3	P80
9	—	—	10	—	—
7	LED_COL3	P82	8	—	—
5	LED_COL1	P84	6	LED_COL2	P83
3	—	—	4	LED_COL0	P140
1	—	—	2	—	—

— : Not Applicable

Table 3-2 Application Header (CN2)

Pin	Touch Electrode	CTSU (RL78/L23) *Note1	Pin	Touch Electrode	CTSU (RL78/L23) *Note1
39	−	−	40	−	−
37	−	−	38	−	−
35	−	−	36	TS-W1	TS35
33	−	−	34	TS-W2	TS34
31	TS-W3	TS33	32	−	−
29	−	−	30	−	−
27	−	−	28	TS-W4	TS32
25	−	−	26	−	−
23	−	−	24	−	−
21	−	−	22	SHIELD-W1	TS21 *Note2
19	−	−	20	−	−
17	−	−	18	−	−
15	−	−	16	−	−
13	−	−	14	−	−
11	−	−	12	−	−
9	TS-B1	TS11	10	TS-B2	TS12
7	SHIELD-B1	TS09 *Note2	8	TS-B3	TS10
5	TS-S1	TS07	6	SHIELD-S1	TS08 *Note2
3	TS-S3	TS05	4	TS-S2	TS06
1	TS-S5	TS03	2	TS-S4	TS04

− : Not Applicable

Note1 : This shows the TS pin when the RL78/L23 Cap Touch CPU board is connected. "-" may not be a free pin. See CPU board-side connector Table 2-15.

Note2 : SHIELD-S1, SHIELD-W1 and SHIELD-B1 are shield electrodes. To enable these functions, set the pins to low by software.

Table 3-3 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 3-4 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

4. Reference Materials

[1]. Renesas RL78/L23 User's Manual: Hardware (R01UH1082)

[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/L23 User’s Manual Hardware Version for more information on RL78/L23 MCUs.

For online technical support and information, visit: https://www.renesas.com/support/contact.html

For general information on Renesas micrcontrollers, visit: https://www.renesas.com/

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

Renesas Electronics Corporation

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