User's Manual

RA6M2 Group

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

Renesas RA Family
RA6 Series

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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 RA6M2 Capacitive Touch Evaluation System (RTK0EG0021S01001BJ). 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 JP2 (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.

European Union regulatory notices:

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".

Renesas RA Family

RA6M2 Group Capacitive Touch Evaluation System User's Manual

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1. Overview

The RA6M2 MCU Group Capacitive Touch Evaluation System (RTK0EG0021S01001BJ) is a kit created for evaluating the RA6M2 MCU Group Capacitive Touch Sensing Unit (CTSU).

RTK0EG0021S01001BJ is composed of two boards: The RA6M2 Cap Touch CPU Board is mounted with an RA6M2 MCU which includes an on-chip CTSU. The Capacitive Touch Application Board is equipped with self-capacitance touch buttons, wheel and slider electrodes, and LEDs touch electrodes.

The main functions of the RA6M2 Cap Touch CPU board are as follows:

- Renesas RA6M2 MCU Group
  - R7FA6M2AF3CFB
  - 144-pin LFQFP package
  - 120MHz Arm® Cortex®-M4 Core with built-in Floating Point Unit (FPU)
  - 384KB SRAM
  - 1MB code flash memory
  - 32KB data flash memory
  - 16-channel capacitive touch sensing unit (CTSU) pins
- Connectivity
  - USB serial conversion interface (FT232RQ manufactured by FTDI)
  - 10-pin JTAG/SWD interface for connecting external debugger or programmer (option)
  - Application board GPIO interface: 2.54mm pitch, 16 pins (8 x 2 DIL)
  - Application board CTSU interface: 2.54mm pitch, 40 pins (20 x 2 DIL)
- Multi-clock source
  - Main clock: 12MHz crystal oscillator
  - Sub clock: 32.768KHz crystal oscillator (option)
  - On-chip oscillator for main MCU
- MCU RESET push button switch
- MCU operating mode setting DIP switch
  - MCU boot mode setting
  - Debug interface switch setting
- Operation voltage
  - An external 5V power supply via USB or power connector is input to the 3.3V onboard power regulator, which powers the onboard logic and interface components.
  - Power source connector (5.5 x 2.1mm center plus DC jack): 5.0V
  - USB bus power: 5V
- Other functions
  - MCU current measurement jumper
  - User push button switches: 2
- User LEDs: 2

Key functions of the Capacitive Touch Application Board are as follows:

- Self-capacitance detection touch electrodes
  - Buttons: 3
  - Wheel (4-electrode configuration): 1
  - Slider (5-electrode configuration): 1
- LEDs: 16
- Renesas MCU Cap Touch CPU Board interfaces:
  - GPIO connector header: 2.54mm pitch, 16 pins (8 x 2 DIL)
  - CTSU connector header: 2.54mm pitch, 40 pins (20 x 2 DIL
- Overlay panel
  - 2mm-thick acrylic panel

2. Product Configuration

This kit includes the following parts:

1. RA6M2 Cap Touch CPU Board (RTK0EG0017C01001BJ): 1
2. Capacitive Touch Application Board (RTK0EG0019B01002BJ): 1

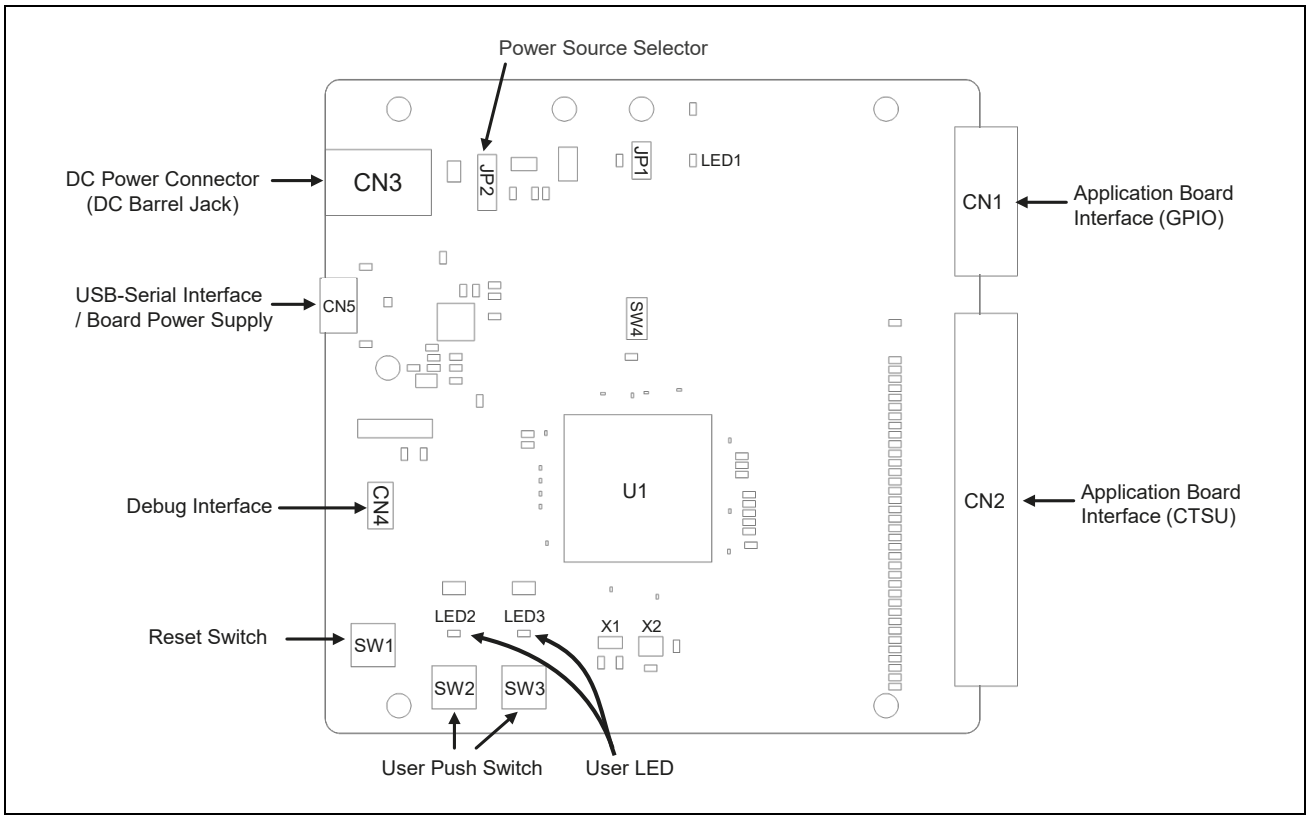

Figure 1. RA6M2 Cap Touch CPU Board

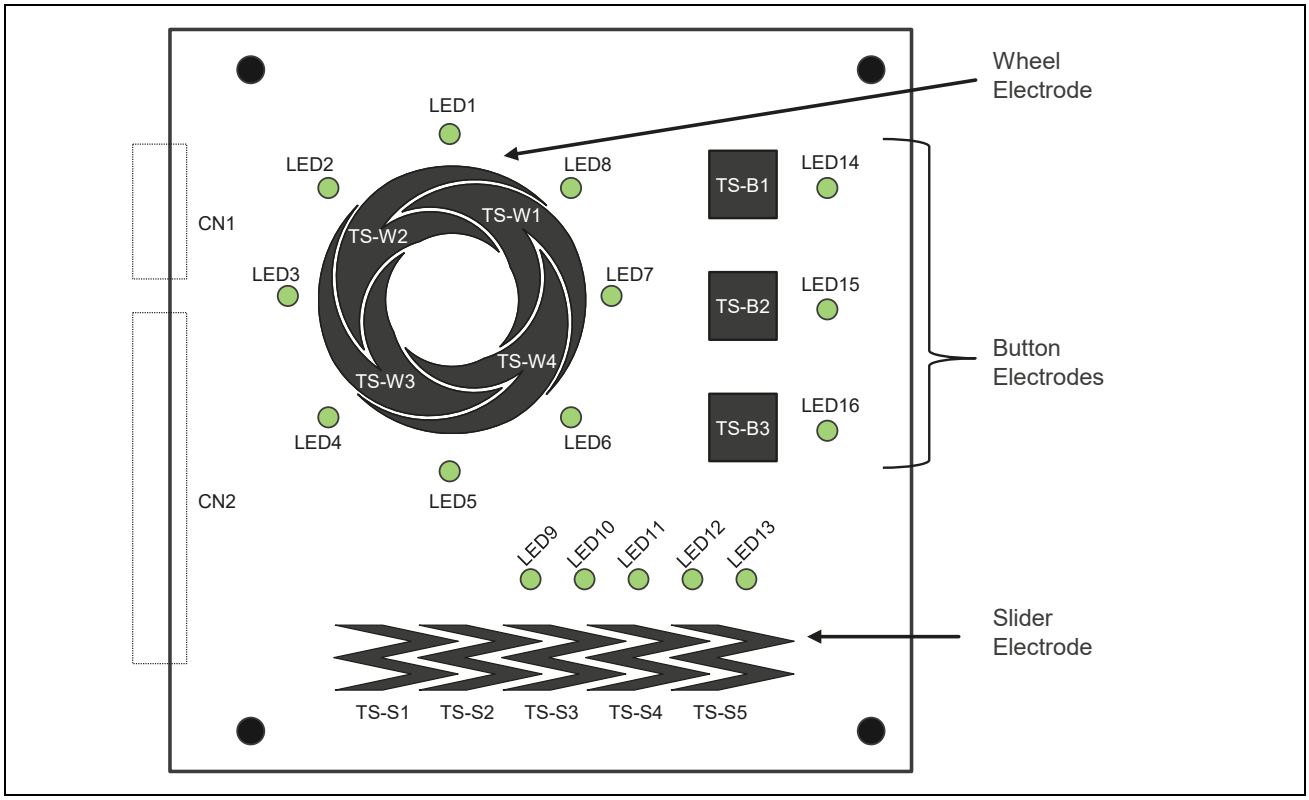

Figure 2. Application Board

3. Product Ordering Information

Part number for ordering the RA6M2 MCU Group Capacitive Touch Evaluation System:
RTK0EG0021S01001BJ
Note: The character underlined in the part number indicates the kit version.

- RA6M2 Cap Touch CPU Board dimensions: 89 mm (W) x 89 mm (L)
- Application Board dimensions: 110 mm (W) x110 mm (L)
-

4. Hardware Details

4.1 Jumper Settings

4.1.1 Default Board Settings

The following table indicates the default settings for each jumper on the RA6M2 Cap Touch CPU Board. The list includes pin jumpers (JPx), resistance jumpers (Rx), and slide switches (SWx).

For a detailed description of most jumper functions, please refer to sections 5.3 Connectivity and 5.4 Added Functions.

Table 1. Default Board Settings

Position	Circuit Group	Default Setting Open / Closed ON / OFF	Function
JP2	Power source	Pins 2-3 closed	Connects USB power source to onboard regulator
JP1		Closed	Connects onboard regulator to MCU VCC
R1		Open	
SW4	MCU mode setting	OFF	Sets MCU mode to boot mode from internal flash
R51		Open	Connects P110 / RXD9 to test pin (RXD)
R52		Open	Connects P109 / TXD9 to test pin (TXD)

5. Board Layout

5.1 Block Diagram

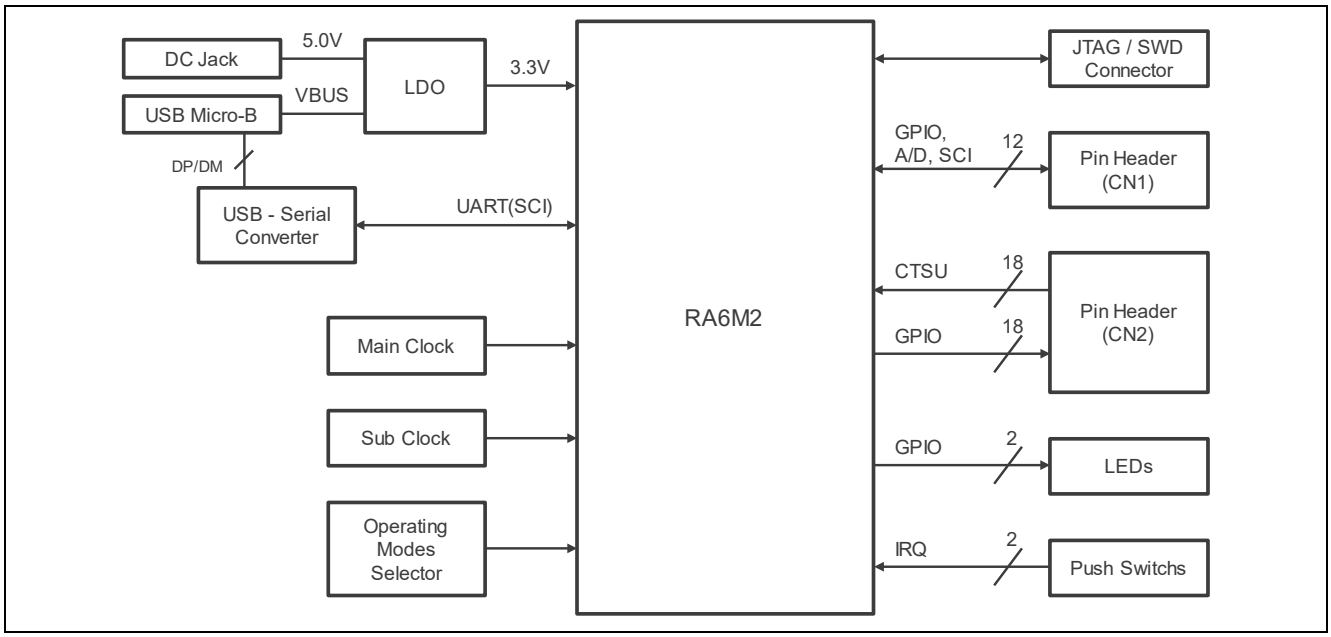

Figure 3. RA6M2 Cap Touch CPU Board Block Diagram

5.2 Power Supply

The RA6M2Cap Touch CPU Board is designed to run on 3.3V. The total current flowing from the low dropout regulator (LDO) to each connected circuit is 600mA, with slight differences based on the 5V power source in use.

5.2.1 Power Supply Options

This section explains several methods for supplying power to the RA6M2 Cap Touch CPU Board.

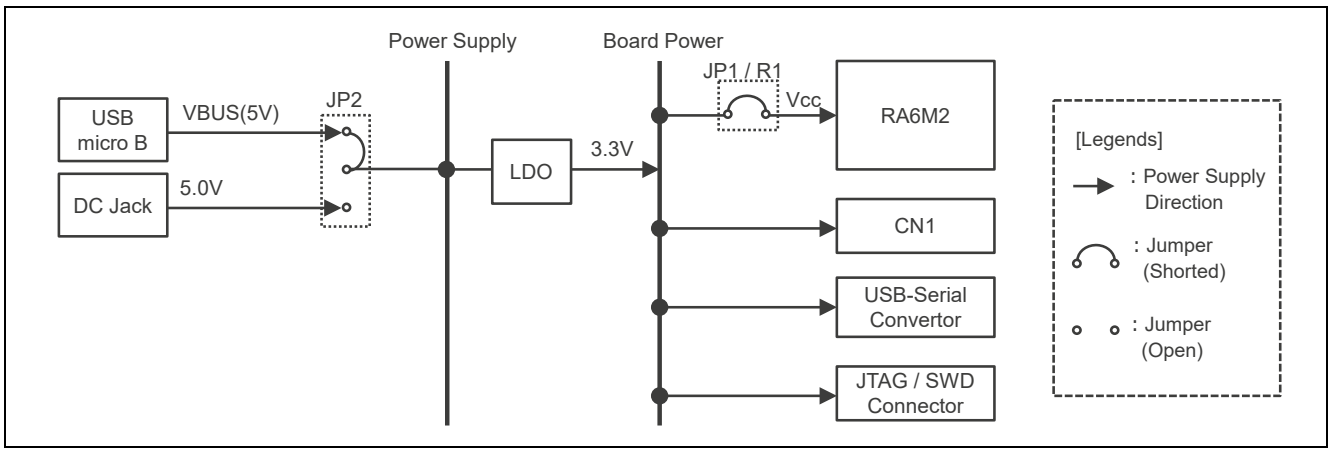

Figure 4. Power Source System Diagram

Table 2. Power Source Jumper Settings

Reference	Jumper Setting	Default Setting (X)	Description
JP2	Shorted Pins 1-2	X	Connects USB power source to LDO
	Shorted Pins 2-3		Connects DC jack (CN3) to LDO
JP1 / R1	Shorted Pins 1-2	X	Connects LDO to MCU VCC
	All open		MCU current consumption measurement setting

5.2.1.1 USB MicroB connector (default setting)

By default, 5V external power is supplied to the LDO via the USB MicroB connector. The LDO converts the voltage from 5V to 3.3V and supplies power to the MCU and all connected devices.

5.2.1.2 DC jack

Board power also can be supplied by connecting a power source to the DC jack. To power the board via the DC jack, shorten pins 2-3 in the JP2 short block.

The onboard low output regulator has a +3.3 V to +5.5V input voltage range and 600 mA current limit. Make sure the external power sources connected to TP3 and TP4 meet these conditions.

5.2.1.3 Power source ON operations

5.2.1.4 LED1 (red) lights up when the power is turned on

5.2.2 Current measurement

The MCU's supply current can be measured using jumper pin JP1. To do so, remove the short block from JP1 and connect an ammeter.

The actual current consumed by the RA6M2 MCU varies based on ambient temperature, internal clock speed, input voltage level, device operating state, and many other factors. Actual MCU current consumption ranges from less than 1mA to nearly 40mA. For detailed electrical characteristics, refer to the RA6M2 *MCU Group User's Manual*.

5.3 Connectivity

5.3.1 USB Serial Conversion

The RA6M2 Cap Touch CPU Board is equipped with USB Serial IC FT232RQ (FTDI Inc.) for USB serial conversion. The FT232RQ is connected to the RA6M2's serial communication interface (SCI) module

Table 3. MCU Connections for USB Serial Conversion

Signal Name	MCU Control Port	Function
TXD	P613 / TXD7_C	SC17 transmit data signal
RXD	P614 / RXD7_C	SC17 receive data signal

5.3.2 Debug Interface

Connector CN4 mounted on the RA6M2 Cap Touch CPU Board is a 10-pin connector for Cortex® debug interface.

The 10-pinCortex® debug connector supports both JTAG and SWD.

For details on the Cortex® debug connector, refer to the Arm® CoreSight™Architecture Specification.

5.3.3 LED

The RA6M2 Cap Touch CPU Board is equipped with 3 LEDs. LED operations are described in the following table.

Table 4. LED Functions

Reference	Color	Function	MCU Control Port
LED1 (Power)	Red	Power status display	LDO (VCC)
LED2	Green	User LED	P006
LED3	Yellow	User LED	P005

5.3.4 Switches

The RA6M2 Cap Touch CPU Board is equipped with 3 push-button type SMT momentary switches, as described in the following table. Pressing the RESET switch will generate a reset signal to restart the main MCU.

Table 5. Push Switch Specifications

Reference	Function	MCU Control Port
SW3（RESET）	Resets the MCU	RES
SW1	User controllable switch	P501 / IRQ11
SW2	User controllable switch	P502 / IRQ12

5.3.5 Application Board Interface

Connectors CN1 and CN2 on the application board are provided as interfaces for connection to the user board.

CN1 is for GPIO pins. For unlisted peripheral functions, refer to the *RA6M2 MCU Group User's Manual*.

CN2 is mostly used for CTSU pins. Although GPIOs can also be connected, CN2 should be fixed to low by software for normal use. Do not connect anything to TSCAP.

Table 6. Application Board Connector (CN1)

CN1	**MCU**		**CN1**	**MCU**	
Pin	Port	Peripheral	Pin	Port	Peripheral
16	VSS（GND）		15	VCC（3.3V）	
14	P007	AN107	13	P008	
12	P009		11	P014	
10	P505	IRQ14	9	P015	
8	P508		7	P506	
6	P504		5	P503	
4	P103	SSLA0_A	3	P100	MISOA_A
2	P102	RSPCKA_A	1	P101	MOSIA_A

Table 7. Application Board Connector (CN2)

CN2	**MCU**		**CN2**	**MCU**	
Pin	Port	CTSU	Pin	Port	CTSU
40	P203	TSCAP	39	－	－
38	－	－	37	－	－
36	P204	TS00	35	P600	－
34	P206	TS01	33	P601	－
32	P602	－	31	P207	TS02
30	P603	－	29	P604	－
28	P407	TS03	27	P605	－
26	P612	－	25	P611	－
24	P610	－	23	P609	－
22	P408	TS04	21	P409	TS05
20	P608	－	19	P410	TS06
18	P115	－	17	P114	－
16	P411	TS07	15	P113	－
14	P112	－	13	P111	－
12	P301	－	11	P302	－
10	P412	TS08	9	P413	TS09
8	P414	TS10	7	P415	TS11
6	P708	TS12	5	P709	TS13
4	P710	TS14	3	P711	TS15
2	P712	TS16	1	P713	TS17

－ : Not Applicable

5.4 Added Functions

5.4.1 Clock Circuit

The RA6M2 Cap Touch CPU Board comes with 2 high-precision crystal clock sources.

Table 8. Clock Specifications

Clock	Function	Frequency	Default Setting	Package
X1	Sub clock	32.768kHz	Not mounted	HC-49
X2	Main clock	12MHz	Mounted	3.2mm x 1.5mm SMD

5.4.2 MCU Operating Mode Settings

DIP switch SW6 is used to set the RA6M2 operating mode.

Table 9. RA6M2 Operating Mode Settings

Reference	Position	Default Setting (X)	Setting
SW4	OFF	X	MCU operates in “Single Chip Mode”
	ON		MCU operates in “SCI Boot Mode”

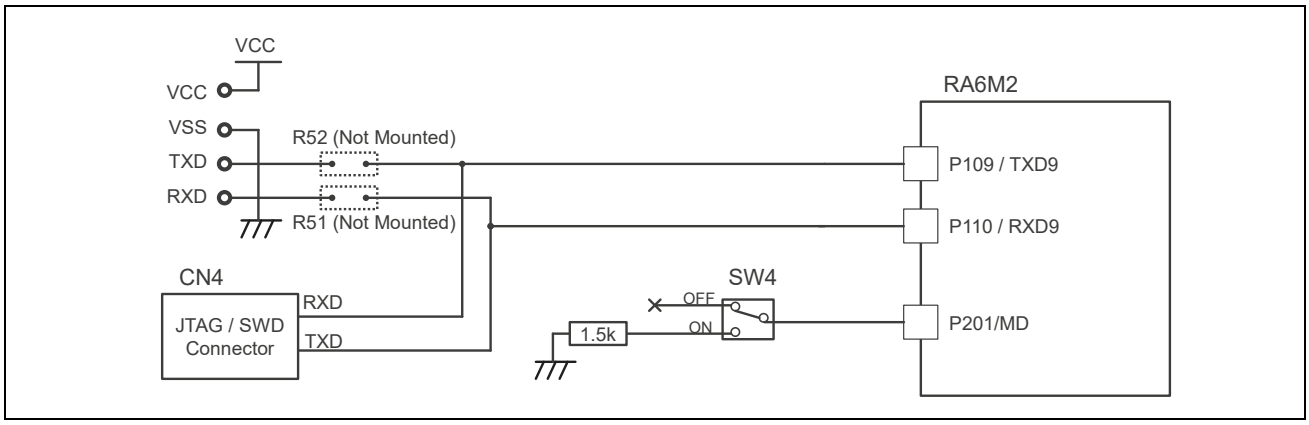

Figure 5. RA6M2 Operating Mode Setting Circuit

When starting up the MCU in SCI Boot Mode for onboard programming, short the SCI Boot Mode programming jumpers listed in the following table. Make sure you do not connect the debugger when programming onboard in the SCI Boot Mode.

Table 10. Jumpers for Programming in SCI Boot Mode

Reference	Function	Default State	Spec.	Package
R52	Connects P109 / TXD9 to CN5	Not mounted	0 Ohm	1.6mm x 0.8mm SMD
R51	Connects P110 / RXD9 to CN5	Not mounted	0 Ohm	1.6mm x 0.8mm SMD

5.4.3 CTSU Related Circuits

5.4.3.1 TSCAP Pins

The RA6M1 board is equipped with two TSCAP pins. At the time of shipping, P203 is connected to TSCAP.

Table 11. TSCAP Pin Settings

Reference	Connection Position	Default State	Spec.	Package
C23	P203 / TSCAP	Mounted	0.01uF	1.0mm x 0.5mm SMD
C24	P205 / TSCAP	Not mounted		

5.4.3.2 CTSU correction circuit (option)

This circuit improves the absolute accuracy of the CTSU's capacitive measurement. The resistor and control software required for the correction function are sold separately. When not using the correction control software, no resistor is necessary.

Table 12. CTSU Correction Circuit Settings

Reference	Connection Position	Default State	Spec.	Package
R10	P003	Not mounted	100K Ohm	1.6mm x 0.8mm SMD
R11	P002	Not mounted	68K Ohm	
R12	P001	Not mounted	51K Ohm	
R13	P000 / AN000	Not mounted	0 Ohm	

6. Capacitive Touch Application Board

The Capacitive Touch Application Board is equipped with self-capacitance touch buttons, wheel and slider touch electrodes, and multiple LEDs.

6.1 CPU Board Connection

The two boards can be connected using the application header (CN1 and CN2) connectors on the Capacitive Touch Application Board and the application board connectors (CN1 and CN2) on the RA6M2 Cap Touch CPU Board.

Ensure that all CN1 and CN2 pins of both boards are connected correctly by inserting as indicated by the arrows in the following figure.

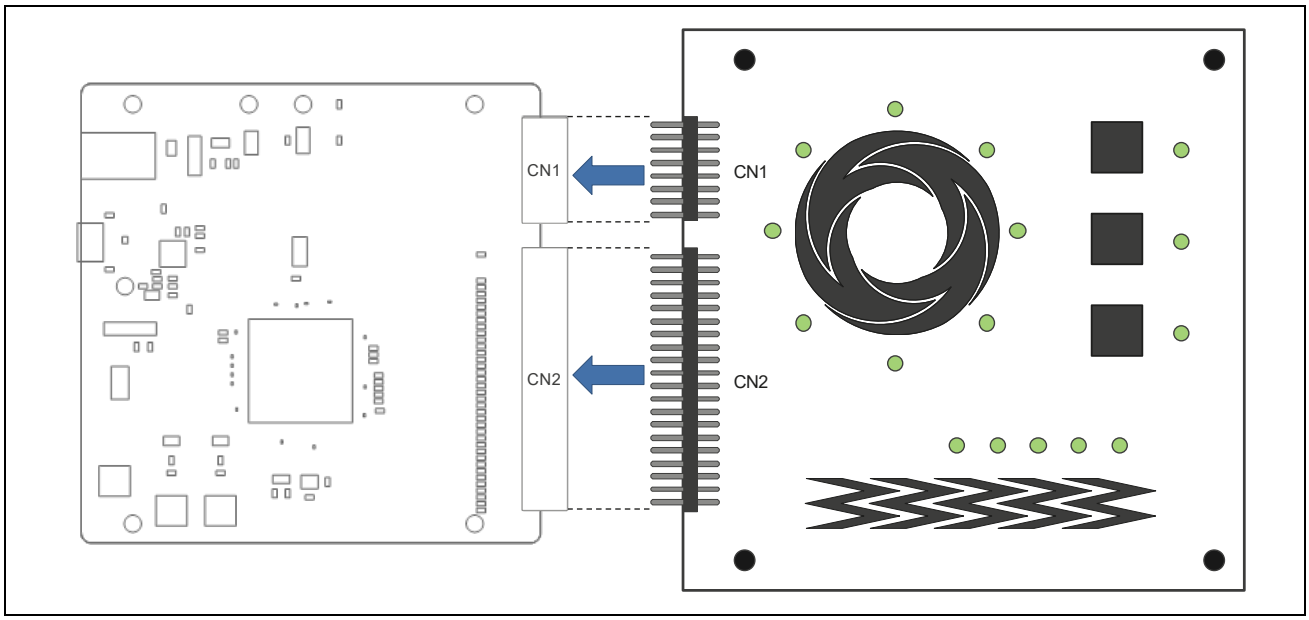

Figure 6. RA6M2 Cap Touch CPU Board and Capacitive Touch Application Board Connection Method

6.2 Signal Assignments

Application headers CN1 and CN2 on the Capacitive Touch Application Board are interfaces for connections to the Renesas Capacitive Touch Evaluation System's CPU board and to the GPIO and CTSU ports. The following table lists the signal assignments between the Capacitive Touch Application Board and RA6M2 Cap Touch CPU Board.

Table 13. Application Header (CN1)

CN1 Pin	Function	MCU Connection	CN1 Pin	Function	MCU Connection
15	VCC (3.3V)	VCC	16	VSS (GND)	VSS
13	LED_ROW0	P008	14	LED_ROW1	P007
11	LED_ROW2	P014	12	LED_ROW3	P009
9	—	P015	10	—	P505
7	LED_COL3	P506	8	—	P508
5	LED_COL1	P503	6	LED_COL2	P504
3	—	P100	4	LED_COL0	P103
1	—	P101	2	—	P102

— : Not Applicable

Table 14. Application Header (CN2)

CN2 Pin	Touch Electrode	CTSU (RA6M2)	CN2 Pin	Touch Electrode	CTSU (RA6M2)
39	—	—	40	—	TSCAP
37	—	—	38	—	—
35	—	—	36	TS-W1	TS00
33	—	—	34	TS-W2	TS01
31	TS-W3	TS02	32	—	—
29	—	—	30	—	—
27	—	—	28	TS-W4	TS03
25	—	—	26	—	—
23	—	—	24	—	—
21	—	TS05	22	SHIELD-W1	P415
19	—	TS06	20	—	—
17	—	—	18	—	—
15	—	—	16	—	TS07
13	—	—	14	—	—
11	—	—	12	—	—
9	TS-B1	TS09	10	TS-B2	TS08
7	SHIELD-B1	P415	8	TS-B3	TS10
5	TS-S1	TS13	6	SHIELD-S1	P415
3	TS-S3	TS15	4	TS-S2	TS14
1	TS-S5	TS17	2	TS-S4	TS16

— : Not Applicable

Note : SHIELD-S1、SHIELD-W1 and SHIELD-B1 are shield electrodes. To enable the function, set the pin to low level output by software.

7. Certifications

7.1 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.

- ・Information for traceability
  - Authorised representative
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  - Trademark and Type name
    Trademark: Renesas
    Product name: RA6M2Capacitive Touch Evaluation System
    Type name: RTK0EG0021S01001BJ

Environmental Compliance and Certifications:

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

8. Website and Support

Visit the following URLs to learn about the kit and the RA family of microcontrollers, download tools and documentation, and get support.

- RTK0EG0021S01001BJ Resources renesas.com/rssk-touch-ra6m2
- Renesas Capacitive Touch Sensor Solutions renesas.com/solutions/touch-key
- RA Product Information renesas.com/ra
- RA Product Support Forum renesas.com/ra/forum
- Renesas Support renesas.com/support

Revision History

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		Page	Summary
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