User's Manual

RA2L1 Group

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

Renesas RA Family
RA2 Series

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by Renesas Electronics Corp. without notice. Please review the latest information published by Renesas Electronics Corp. through various means, including the Renesas Electronics Corp. website (http://www.renesas.com).

Renesas Electronics
www.renesas.com

Rev.1.00 Jun 2020

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan

www.renesas.com

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

© 2020 Renesas Electronics Corporation. All rights reserved.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

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 RA2L1 Capacitive Touch Evaluation System (RTK0EG0022S01001BJ). 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.

Renesas RTK0EG0022S01001BJ Disclaimer

By using this RTK0EG0022S01001BJ, the User accepts the following terms, which are in addition to, and control in the event of disagreement, with Renesas' General Terms and Conditions available at https://www.renesas.com/en-us/legal/disclaimer.html.

The RTK0EG0022S01001BJ is not guaranteed to be error free, and the entire risk as to the results and performance of the RTK0EG0022S01001BJ is assumed by the User. The RTK0EG0022S01001BJ is provided by Renesas on an "as is" basis without warranty of any kind whether express or implied, including but not limited to the implied warranties of good workmanship, fitness for a particular purpose, title, merchantability, and non-infringement of intellectual property rights. Renesas expressly disclaims any implied warranty.

Renesas does not consider the RTK0EG0022S01001BJ to be a finished product and therefore the RTK0EG0022S01001BJ may not comply with some requirements applicable to finished products, including, but not limited to recycling, restricted substances and electromagnetic compatibility regulations. Refer to Certifications section, for information about certifications and compliance information for the RTK0EG0022S01001BJ. It is the kit User's responsibility to make sure the kit meets any local requirements applicable to their region.

Renesas or its affiliates shall in no event be liable for any loss of profit, loss of data, loss of contract, loss of business, damage to reputation or goodwill, any economic loss, any reprogramming or recall costs (whether the foregoing losses are direct or indirect) nor shall Renesas or its affiliates be liable for any other direct or indirect special, incidental or consequential damages arising out of or in relation to the use of this RTK0EG0022S01001BJ, even if Renesas or its affiliates have been advised of the possibility of such damages.

Renesas has used reasonable care in preparing the information included in this document, but Renesas does not warrant that such information is error free nor does Renesas guarantee an exact match for every application or parameter to part numbers designated by other vendors listed herein. The information provided in this document is intended solely to enable the use of Renesas products. No express or implied license to any intellectual property right is granted by this document or in connection with the sale of Renesas products. Renesas reserves the right to make changes to specifications and product descriptions at any time without notice. Renesas assumes no liability for any damages incurred by you resulting from errors in or omissions from the information included herein. Renesas cannot verify, and assumes no liability for, the accuracy of information available on another company's website.

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

RA2L1 Group Capacitive Touch Evaluation System User's Manual

Contents

1. Overview 3
2. Product Configuration 4
3. Product Ordering Information 5
4. Hardware Details 6
4.1 Jumper Settings 6
4.1.1 Default Board Settings 6
5. Board Layout 6
5.1 Block Diagram 6
5.2 Power Supply 7
5.2.1 Power Supply Options 7
5.2.1.1 USB MicroB connector (default setting) 7
5.2.1.2 DC jack 7
5.2.1.3 Power source ON operations 7
5.2.1.4 Current measurement 8
5.3 Connectivity 8
5.3.1 USB Serial Conversion 8
5.3.2 Debug Interface 8
5.3.3 LEDs 8
5.3.4 Switches 8
5.3.5 Application Board Interface 9
5.4 Added Functions 10
5.4.1 Clock Circuit 10
5.4.2 MCU Operating Mode Settings 10
5.4.3 Internal Voltage Regulator Circuit 11
5.4.4 CTSU Related Circuits 11
5.4.4.1 CTSU correction circuit 11
6. Capacitive Touch Application Board 12
6.1 CPU Board Connection 12
6.2 Signal Assignments 13
7. Certifications 14
7.1 European Union regulatory notices 14
8. Website and Support 15
Revision History 16

Figures

Figure 1. RA2L1 Cap Touch CPU Board Top Side 4
Figure 2. Application Board Top Side 5
Figure 3. RA2L1 Cap Touch CPU Board Block Diagram 6
Figure 4. Power Source System Diagram 7
Figure 5. RA2L1 Operating Mode Setting Circuit 10
Figure 6. Internal Voltage Regulator Circuit 11
Figure 7. RA2L1 Cap Touch CPU Board and Capacitive Touch Application Board Connection Method 12

Tables

Table 1. Default Board Settings 6
Table 2. Power Source Jumper Settings 7
Table 3. MCU Connections for USB Serial Conversion 8
Table 4. LED Functions 8
Table 5. Push Switch Specifications 8
Table 6. Application Board Connector (CN1) 9
Table 7. Application Board Connector (CN2) 9
Table 8.Clock Specifications 10
Table 9. RA2L1 Operating Mode Settings 10
Table 10. Jumpers for Programming in SCI Boot Mode 10
Table 11. CTSU Correction Circuit Settings 11
Table 12. Application Header (CN1) 13
Table 13. Application Header (CN2) 13

1. Overview

The RA2L1 MCU Group Capacitive Touch Evaluation System (RTK0EG0022S01001BJ) is a kit created for evaluating the RA2L1 MCU Group Capacitive Touch Sensing Unit (CTSU).

RTK0EG0022S01001BJ is composed of two boards: The RA2L1 Cap Touch CPU Board is mounted with an RA2L1 MCU which includes an on-chip CTSU. The Capacitive Touch Application Board Capacitive Touch Application Board is equipped with self-capacitance touch buttons, wheel and slider electrodes, and LEDs touch electrodes.

Note: The function name of the capacitive touch sensor in RA2L1 MCU Group products is “CTSU2,” but is referred to as “CTSU” in this document.

The main functions of the RA2L1 Cap Touch CPU board are as follows:

- Renesas RA2L1 MCU Group
  - R7FA2L1AB2DFP
  - 100-pin LFQFP package
  - 48MHz Arm Cortex®-M23 Core with built-in Arm® MPU (Armv8-M architecture)
  - 32KB SRAM
  - 256KB code flash memory
  - 8KB data flash memory
  - 32-channel capacitive touch sensing unit (CTSU) pins
- Connectivity
  - USB serial conversion interface (FT234XD 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 (option)
  - 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
  - 3.3V to 5.0V
  - Power source connector (5.5 x 2.1mm center plus DC jack): 3.3V to 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. RA2L1 Cap Touch CPU Board (RTK0EG0018C01001BJ): 1 board
2. Capacitive Touch Application Board (RTK0EG0019B01002BJ): 1 board

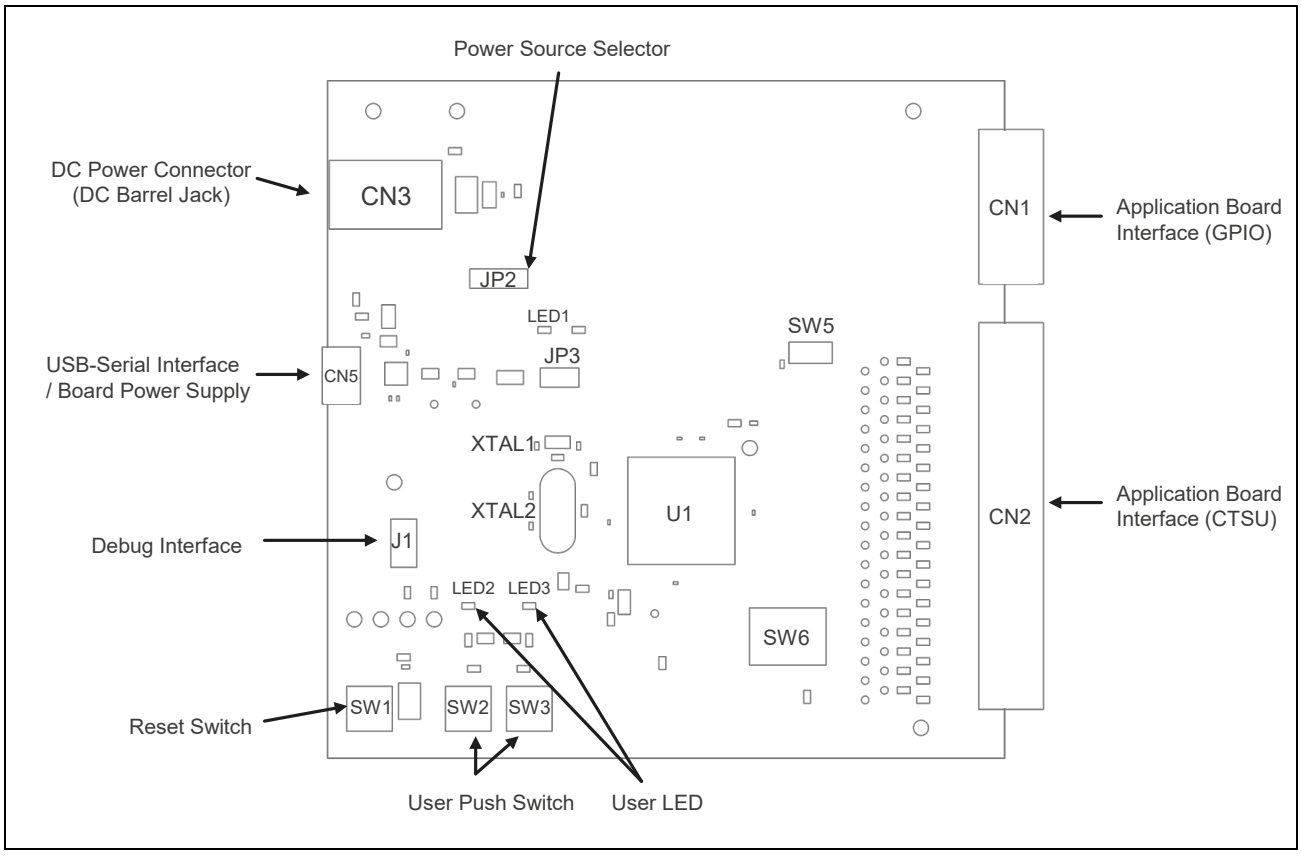

Figure 1. RA2L1 Cap Touch CPU Board Top Side

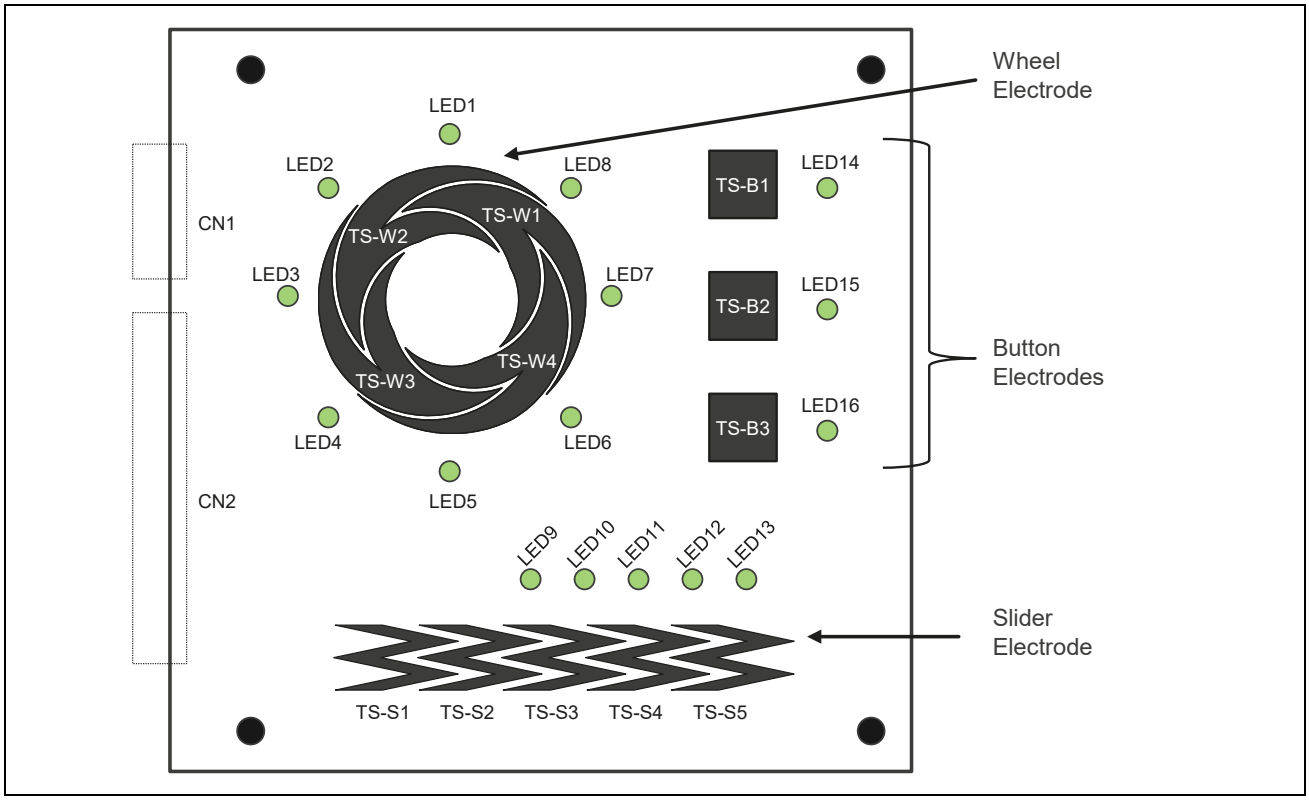

Figure 2. Application Board Top Side

3. Product Ordering Information

Part number for ordering the RA2L1 MCU Group Capacitive Touch Evaluation System:
RTK0EG0022S01001BJ
Note: The character underlined in the part number indicates the kit version.

- RA2L1 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 RA2L1 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 エラー! 参照元が見つかりません。 and 5.4 Added Functions.

Table 1. Default Board Settings

Position	Circuit Group	Default State Open/Closed ON/OFF	Function
JP2	Power source	Pins 2-3 closed	Connects USB power source to board power source
JP3		Closed	Connects board power source to MCU VCC
R9	MCU internal voltage regulator	Closed	Connects VCL pin to L3
R11		Open	Connects VSS_DCDC pin to VSS pin
SW5	Capacitance touch	OFF (on the white line side)	Enables/disables CTSU correction function
SW6	MCU mode setting	1: OFF 2: OFF 3: OFF	1: Selects MCU boot mode 2: Use P109 as TS10 pin 3: Use P110 as TS11 pin
R20		Open	Connects P109 / TXD9 to test pin (TXD)
R21		Open	Connects P110 / RXD9 to test pin (RXD)

5. Board Layout

5.1 Block Diagram

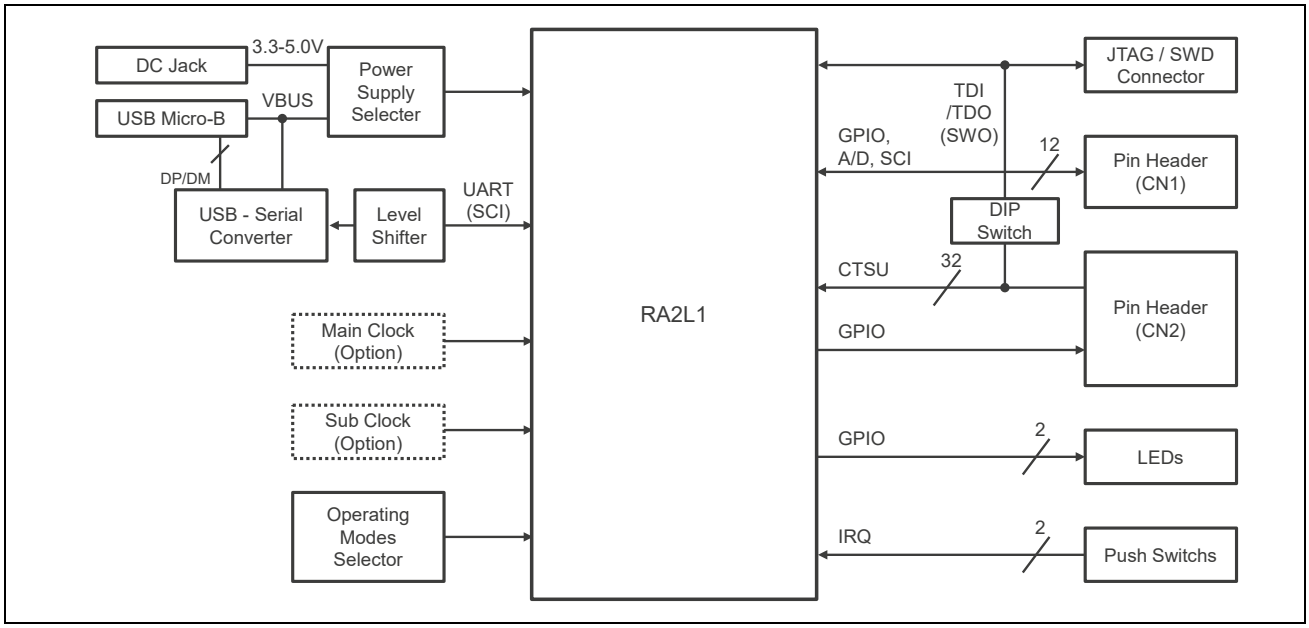

Figure 3. RA2L1 Cap Touch CPU Board Block Diagram

5.2 Power Supply

The RA2L1 Cap Touch CPU Board is designed to run on 3.3 to 5.0V.

5.2.1 Power Supply Options

This section explains several methods for supplying power to the RA2L1 Cap Touch CPU Board.

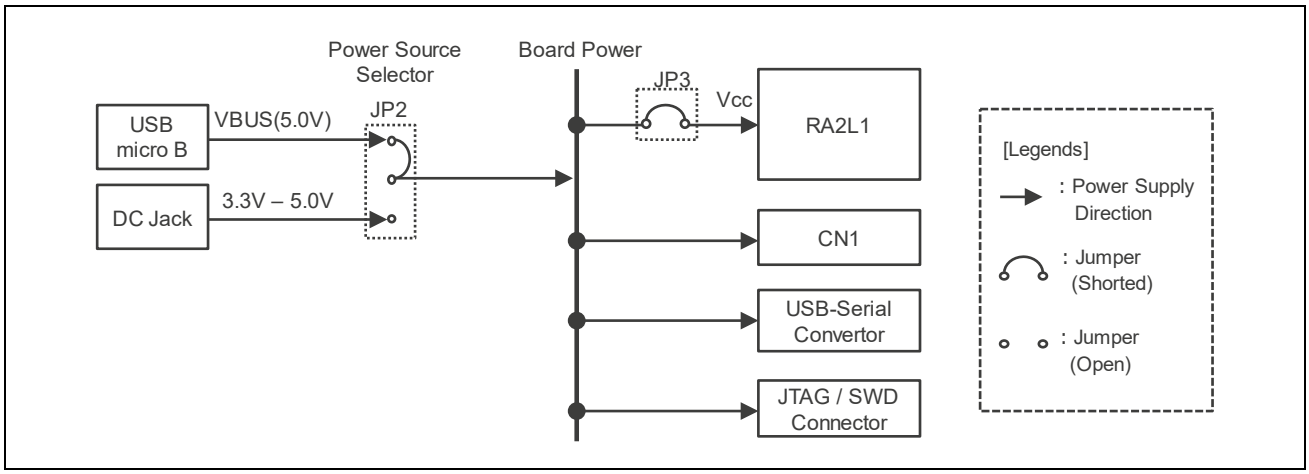

Figure 4. Power Source System Diagram

Table 2. Power Source Jumper Settings

Reference	Jumper Setting	Default Setting (X)	Description
JP2	Shorted Pins 1-2		Connects DC jack (CN3) to board power source
	Shorted Pins 2-3	X	Connects USB power source to board power source
JP3	Shorted Pins 1-2	X	Connects board power source to the MCU's 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 MCU and connected devices via the USB MicroB connector.

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.

5.2.1.3 Power source ON operations

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

5.2.1.4 Current measurement

The MCU's supply current can be measured using jumper pin JP3. To do so, remove the short block from JP3 and connect an ammeter.

The actual current consumed by the RA2L1 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 *RA2L1 MCU Group User's Manual*.

5.3 Connectivity

5.3.1 USB Serial Conversion

The RA2L1 Cap Touch CPU Board is equipped with USB serial IC FT234XD (FTDI Ltd.) for USB serial conversion. The FT234XD is connected to the RA2L1's serial communication interface (SCI) module. When using this function, use the shortest possible USB cable.

Table 3. MCU Connections for USB Serial Conversion

Signal Name	MCU Control Port	Function
TXD	P203 / TXD9_A	SCI9 transmit data signal
RXD	P202 / RXD9_A	SCI9 receive data signal

5.3.2 Debug Interface

Connector J1 mounted on the RA2L1 Cap Touch CPU Board is a 10-pin Cortex® debug connector interface.

Note: The RA2L1 MCU does not support JTAG; it only supports SWD.

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

5.3.3 LEDs

The RA2L1 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	VCC
LED2	Green	User LED	P305
LED3	Yellow	User LED	P304

5.3.4 Switches

The RA2L1 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
SW1 (RESET)	Resets the MCU.	RES
SW2	User controllable switch	P206 / IRQ0
SW3	User controllable switch	P205 / IRQ1

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 *RA2L1 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）	VSS	15	VCC	VCC
14	P006	AN012	13	P414	－
12	P415	－	11	P708	－
10	P401	IRQ5	9	P404	－
8	P405	－	7	P406	－
6	P714	－	5	P400	－
4	P504	SS1_C	3	P502	MISO1_C
2	P503	SCK1_C	1	P501	MOSI1_C

－ : Not Applicable

Table 7. Application Board Connector (CN2)

CN2	**MCU**		**CN2**	**MCU**	
Pin	Port	CTSU	Pin	Port	CTSU
40	P112	TSCAP	39	－	－
38	－	－	37	－	－
36	P402	TS18	35	P403	TS17
34	P000	TS21	33	P001	TS22
32	P003	TS24	31	P002	TS23
30	P010	TS30-CFC	29	P004	TS25
28	P012	TS32-CFC	27	P011	TS31-CFC
26	P015	TS28-CFC	25	P013	TS33-CFC
24	P101	TS16-CFC	23	P100	TS26-CFC
22	P103	TS14-CFC	21	P102	TS15-CFC
20	P105	TS34-CFC	19	P104	TS13-CFC
18	P107	－	17	P107	－
16	P107	－	15	P107	－
14	P114	TS29-CFC	13	P115	TS35-CFC
12	P111	TS12-CFC	11	P113	TS27-CFC
10	P109	TS10-CFC	9	P110	TS11-CFC
8	P301	TS09-CFC	7	P204	TS00
6	P302	TS08-CFC	5	P408	TS04
4	P303	TS02-CFC	3	P409	TS05
2	P411	TS07	1	P410	TS06

－ : Not Applicable

5.4 Added Functions

5.4.1 Clock Circuit

The RA2L1 Cap Touch CPU Board comes with 2 high-precision crystal clock sources.

Table 8.Clock Specifications

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

5.4.2 MCU Operating Mode Settings

DIP switch SW6 is used to set the RA2S1 operating mode.

Table 9. RA2L1 Operating Mode Settings

Reference	Channel	Position	Default Setting (X)	Setting
SW6	1	OFF	X	MCU operates in “Single Chip Mode”
		ON		MCU operates in “SCI Boot Mode”
	2	OFF	X	Use P109 as TS10 pin
		ON		Use P109 as TDO/SWO pin
	3	OFF	X	Use P110 as TS11 pin
		ON		Use P110 as TDI pin

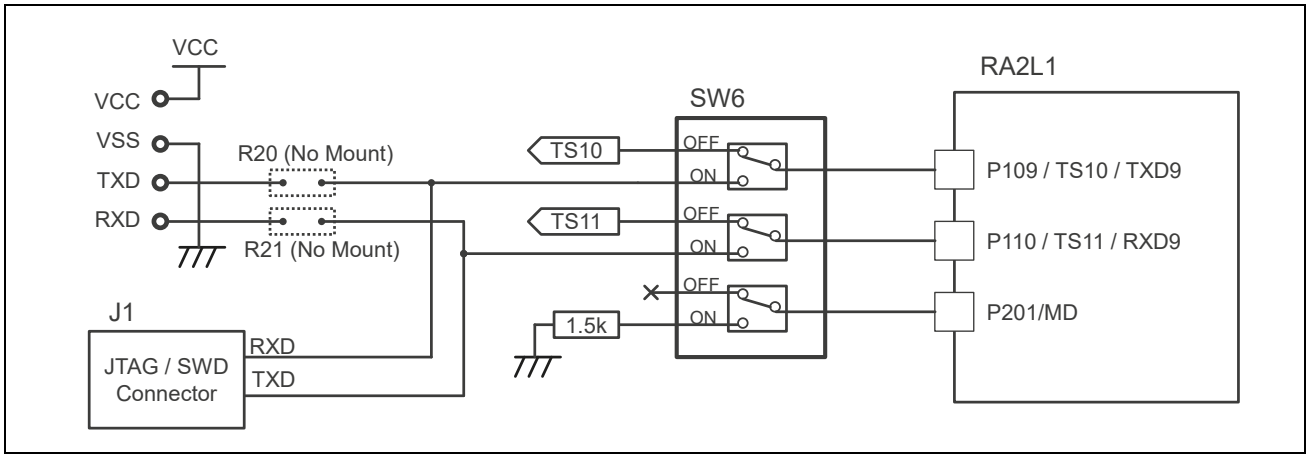

Figure 5. RA2L1 Operating Mode Setting Circuit

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
R20	Connects P109 / TXD9 to test pin (TXD)	Not mounted	0 Ohm	1.6mm x 0.8mm SMD
R21	Connects P110 / RXD9 to test pin (RXD)	Not mounted	0 Ohm	1.6mm x 0.8mm SMD

5.4.3 Internal Voltage Regulator Circuit

The RA2L1's internal voltage regulator can be set by software to be used in the LDO mode (default) or DCDC mode. To use the regulator in the DCDC mode, short the R11 pin.

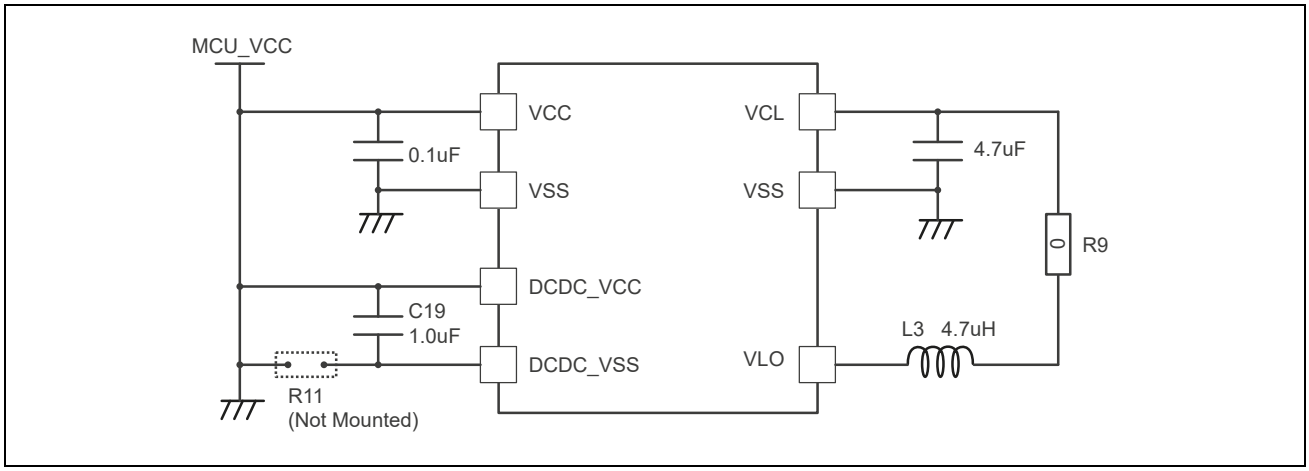

Figure 6. Internal Voltage Regulator Circuit

5.4.4 CTSU Related Circuits

5.4.4.1 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 11. CTSU Correction Circuit Settings

Reference	Position	Default Setting (X)	Setting
SW5	OFF	X	Use TS21 as the normal CTSU pin
	ON		Use TS21 as the CTSU correction pin

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 RA2L1 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.

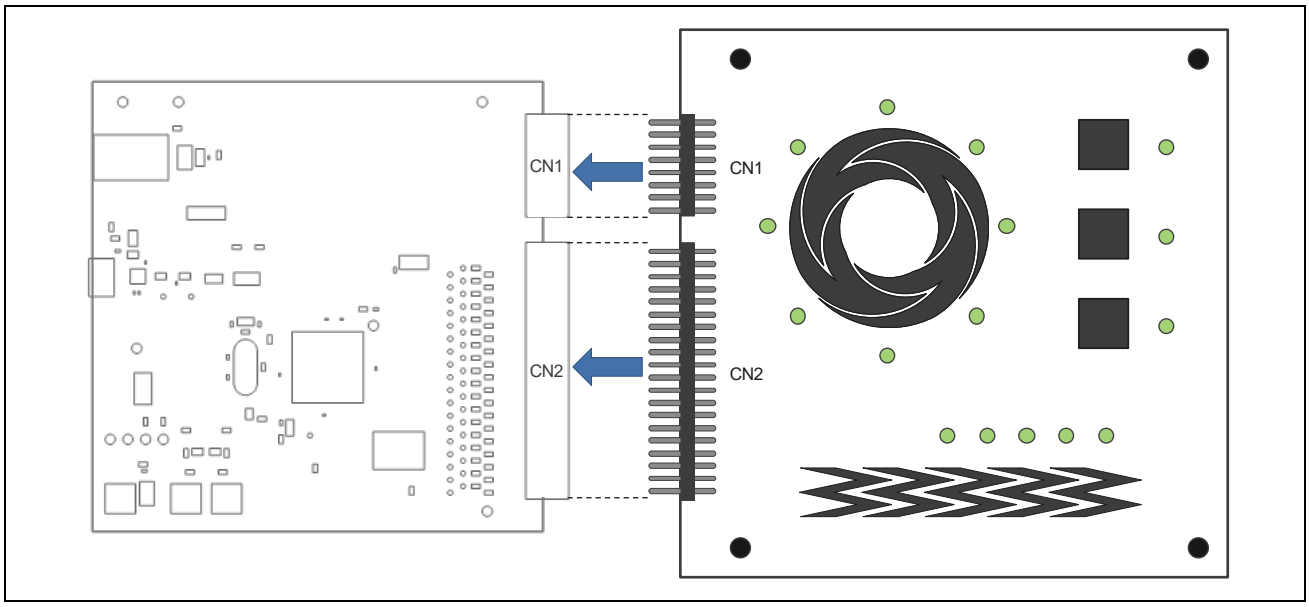

Figure 7. RA2L1 Cap Touch CPU Board and Capacitive Touch Application Board Connection Method

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 RA2L1 Cap Touch CPU Board.

Table 12. Application Header (CN1)

CN1 Pin	Function	MCU Connection	CN1 Pin	Function	MCU Connection
15	VCC	VCC	16	VSS (GND)	VSS
13	LED_ROW0	P414	14	LED_ROW1	P006
11	LED_ROW2	P708	12	LED_ROW3	P415
9	–	P404	10	–	P401
7	LED_COL3	P406	8	–	P405
5	LED_COL1	P400	6	LED_COL2	P714
3	–	P502	4	LED_COL0	P504
1	–	P501	2	–	P503

– : Not Applicable

Table 13. Application Header (CN2)

CN2 Pin	Touch Electrode	CTSU (RA2L1)	CN2 Pin	Touch Electrode	CTSU (RA2L1)
39	–	–	40	–	TSCAP
37	–	–	38	–	–
35	–	TS17	36	TS-W1	TS18
33	–	TS22	34	TS-W2	TS21
31	TS-W3	TS23	32	–	TS24
29	–	TS25	30	–	TS30-CFC
27	–	TS31-CFC	28	TS-W4	TS32-CFC
25	–	TS33-CFC	26	–	TS28-CFC
23	–	TS26-CFC	24	–	TS16-CFC
21	–	TS15-CFC	22	SHIELD-W1	TS14-CFC
19	–	TS13-CFC	20	–	TS34-CFC
17	–	–	18	–	–
15	–	–	16	–	–
13	–	TS35-CFC	14	–	TS29-CFC
11	–	TS27-CFC	12	–	TS12-CFC
9	TS-B1	TS11-CFC	10	TS-B2	TS10-CFC
7	SHIELD-B1	TS00	8	TS-B3	TS09-CFC
5	TS-S1	TS04	6	SHIELD-S1	TS08-CFC
3	TS-S3	TS05	4	TS-S2	TS02-CFC
1	TS-S5	TS06	2	TS-S4	TS07

– : Not Applicable

Note : SHIELD-S1、SHIELD-W1 and SHIELD-B1 are shield electrodes. To enable the function, set the pin to shield signal output mode 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
    Name: Renesas Electronics Corporation
    Address: Toyosu Foresia, 3-2-24, Toyosu, Koto-ku, Tokyo 135-0061, Japan
  - Manufacturer
    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: RA2L1 Capacitive Touch Evaluation System
    Type name: RTK0EG0022S01001BJ

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.

- RTK0EG0022S01001BJ Resources renesas.com/rssk-touch-ra2l1
- 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

Trademarks
All trade names and product names used in this document are trademarks or registered trademarks of their respective companies or organizations.

Copyright
All or part of this manual may be changed without notice.
Renesas Electronics Corporation holds the copyright for this document.
Reproduction, in whole or in part, without the written consent of Renesas Electronics Corporation is prohibited.

© 2020 Renesas Electronics Corporation.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.03.20	-	First edition issued

RA2L1 Group Renesas Solution Starter Kit
Capacitive Touch Evaluation System User's Manual

Publication Date: Rev.1.00 Jun.03.20

Published by: Renesas Electronics Corporation

Renesas RA2L1 Group

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

Renesas Electronics Corporation

R12UZ0084EJ0100