User's Manual

RX Capacitive Touch Evaluation System

Mutual-Capacitance Matrix Key/Proximity Sensor Board

User's Manual

Renesas Solution Starter Kit
RX Capacitive Touch Evaluation System
Application Board

Renesas Electronics
www.renesas.com

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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 manual is designed to provide the user with a general understanding of the Capacitive Touch Application Board and its electrical characteristics. It is intended for users designing sample code on the RSSK platform, using the many different incorporated peripheral devices.

The manual includes an overview of the Capacitive Touch Application Board functions, but does not serve as a guide for embedded programming or hardware design. 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.

The following documents apply to the Capacitive Touch Application Board included in the Renesas Capacitive Touch Evaluation System. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
User's manual	Description of application board hardware specifications	RX Capacitive Touch Evaluation System: Mutual-Capacitance Button/Proximity Sensor Board User's Manual	This User's Manual

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ACIA	Asynchronous Communications Interface Adapter
bps	bits per second
CRC	Cyclic Redundancy Check
DMA	Direct Memory Access
DMAC	Direct Memory Access Controller
GSM	Global System for Mobile Communications
Hi-Z	High Impedance
IEBus	Inter Equipment Bus
I/O	Input/Output
IrDA	Infrared Data Association
LSB	Least Significant Bit
MSB	Most Significant Bit
NC	Non-Connect
PLL	Phase Locked Loop
PWM	Pulse Width Modulation
SFR	Special Function Register
SIM	Subscriber Identity Module
UART	Universal Asynchronous Receiver/Transmitter
VCO	Voltage Controlled Oscillator

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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:

⚠ Electrical Shock Hazard

The 🛇 mark indicates something that is forbidden.

Example: :

🛇 Do Not Disassemble

Warning

⚠ **Warning**
Handling related warnings: Do not disassemble or modify this product. Renesas does not guarantee this product if it has been disassembled or modified. The power supply for this product can be selected to be either the USB bus or a DC jack. A jumper is used to select the power supply. If, during either use or storage of this product, any abnormality in the product itself (including abnormal odors, heating, color changes, or shape changes to the product itself) are observed, disconnect the USB cable and power supply cable immediately.
Installation: Do not install this equipment in a location that has a high humidity or where water or other fluids could get on it. This equipment may be damaged if water or other fluids could get on it.
Ambient temperature: The upper limit for the ambient temperature under which this product may be used is 35°C. This maximum rated ambient temperature must not be exceeded.

Caution

⚠Caution

Handling related cautions:

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

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

When connecting or disconnecting cables from this product, hold the parts of the cable intended to be grasped (such as the plugs) and avoid putting stress on the cable. Do not pull on this product when it is connected to a communications cable or user system connection cable. Stress on the cable can result in internal disconnections in the cable.
When connecting a cable to a connector, be careful not to insert the plug in the reverse orientation. Reverse insertion can result in damage to this product itself or to connected equipment.
The power supply for this product can be selected from two options (the DC jack or the USB cable). The jumper JP1 (on the top side of the circuit board) is used to select the power supply. Always check the jumper position before connecting a power source. An incorrect jumper position can result in damage to this product or the PC connected over the USB cable.
Do not handle this product with wet hands. This can lead to failure of the product.

Transport methods:

When transporting this product, use the product's packing box and cushioning materials and ship it with precision equipment handling. If the products packing is insufficient, it may be damaged during shipping.
If it must be transported by some other method, pack it carefully as precision equipment.
When packing this product, always use the antistatic pouch included with this product.
If some other pouch is used, damage to the product may be caused by electrostatic discharge.

Abnormal operation:

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

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

Disposal:

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

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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 :2009+A1:2010	Group1 Class A	This product has no intentional external emissions, but internal RF emissions may affect nearby electromagnetically sensitive electronic equipment.
Radiated Emissions			

EMS: Electro Magnetic Susceptibility			
Standard		Level	Guidance for EMC protection
Electrostatic Discharge	EN 61000-4-2:2009	B*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
Radio Frequency Electromagnetic Field	EN 61000-4-3: 2006+A1:2008+A2:2010	A*2	

[*1] Test Condition of Electrostatic Discharge

Discharge Method		Test Voltage	Result
Indirect Discharge	VCP	±4.0kV	Pass
	HCP	±4.0kV	Pass
Direct Discharge	Contact Discharge	±4.0kV	Pass
	Air Discharge	±2.0kV	Pass
		±4.0kV	Pass
		±8.0kV	Pass

[*2] 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

Table of Contents

Mutual-Capacitance Button/Proximity Sensor Board

RX Capacitive Touch Evaluation System Application Board

1. Overview

1.1 Purpose

This product was developed for use with a CPU board as an evaluation tool for the Renesas RX Capacitive Touch Evaluation System.

1.2 Features

This application board offers the following features:

- Connectable to the CPU board included in the Renesas RX Capacitive Touch Evaluation System
- Same interface as the CPU board included in Renesas RX Capacitive Touch Evaluation System
- Evaluation for two methods of touch detection:
  - Mutual-Capacitance method: 20 channels for touch buttons
  - Self-Capacitance method: 1 channel for proximity sensor (film type)
- 3-mm thick acrylic overlay (attached)
- Dimensions (L x W x H) : 145mm x 151mm x 12mm

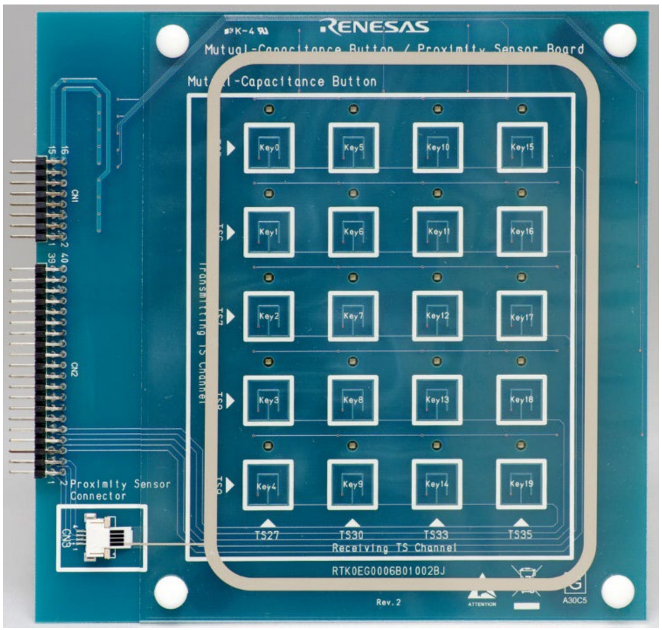

Figure 1.1 Application Board External Dimensions

1.3 Regulatory Compliance Notices

1.3.1 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
  EN IEC 61326-1: 2021 Group1 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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  - 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: RX130 Capacitive Touch Evaluation System
    Type name: RTK0EG0003S02001BJ

Environmental Compliance and Certifications:

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

2. Board Layout

2.1 Component Layout

Figure2.1 shows the component layout of the application board.

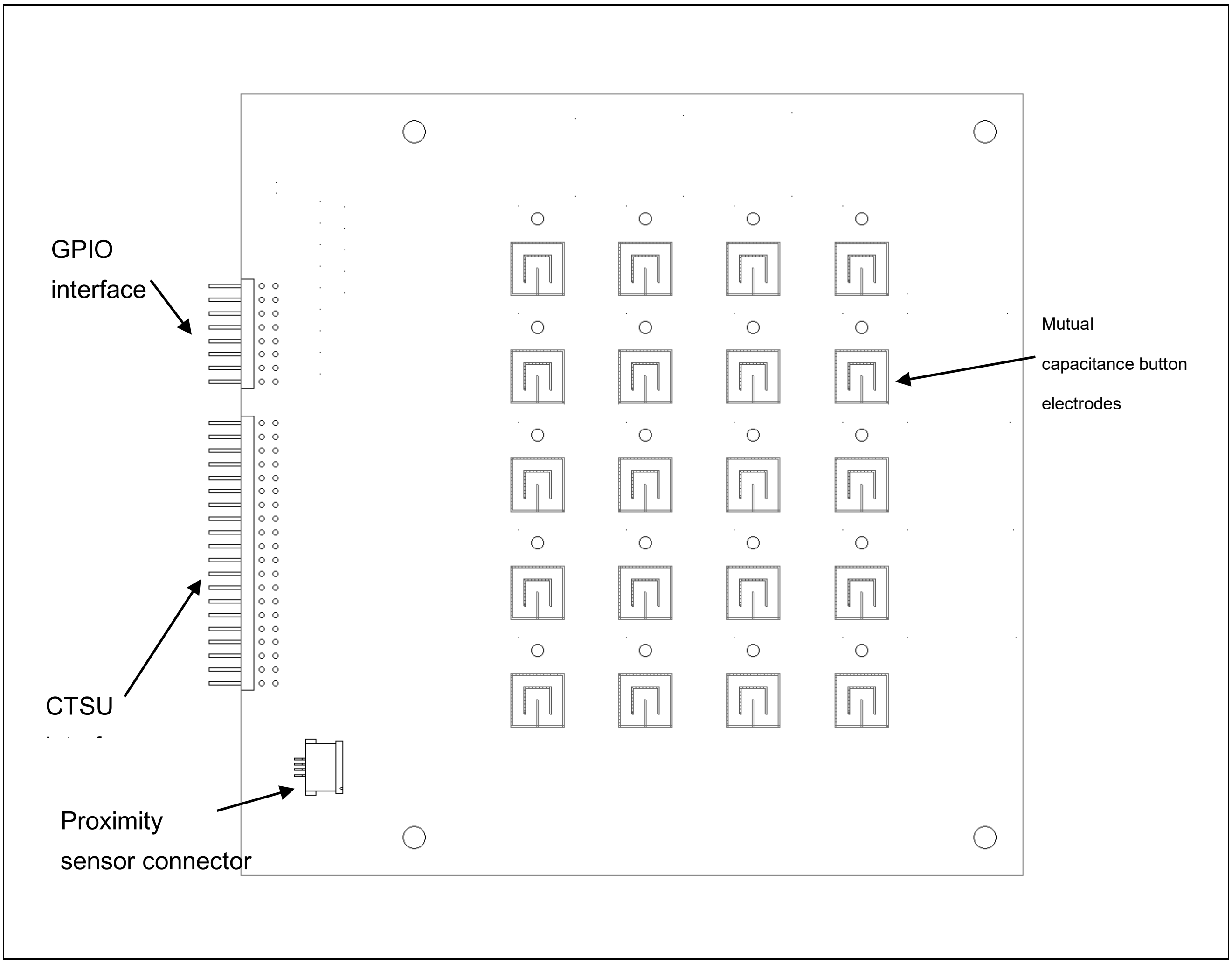

Figure2.1 Component Layout

2.2 Overlay Dimensions

Figure2.2 shows the dimensions of the overlay attached to the application board. Dimensions are shown in millimeters. Overlay thickness is 3.0 mm.

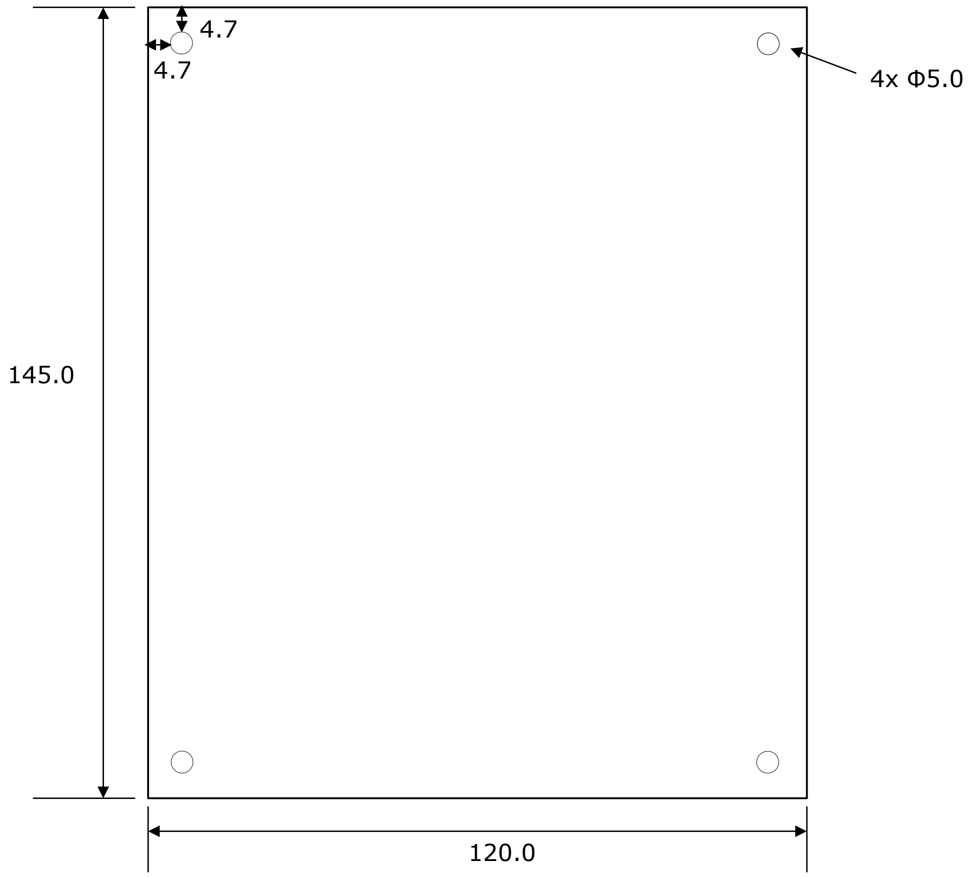

Figure2.2 Overlay Dimensions

2.3 Proximity Sensor Dimensions

Figure2.3 shows the film base dimensions of the proximity sensor and Figure2.4 shows the dimensions of the proximity sensor electrode area. Dimensions are shown in millimeters.

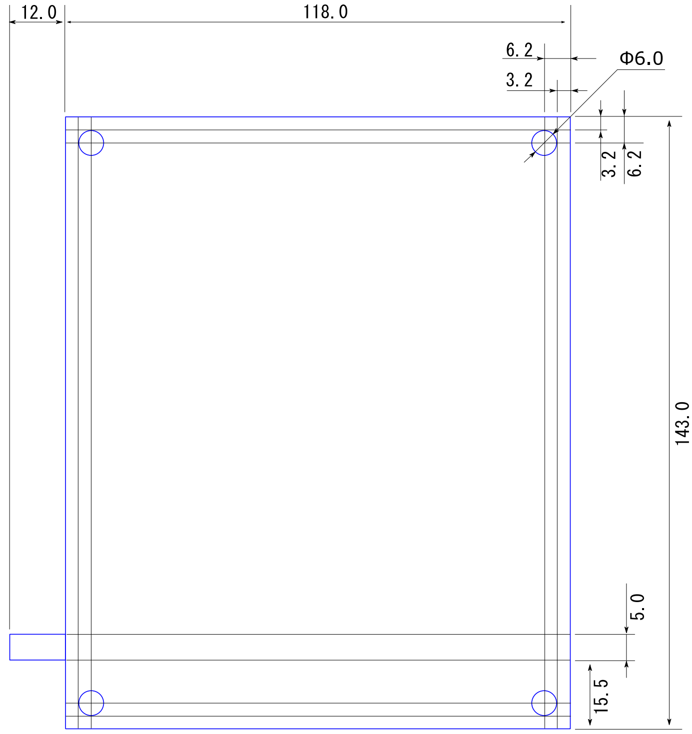

Figure2.3 Film Base Dimensions

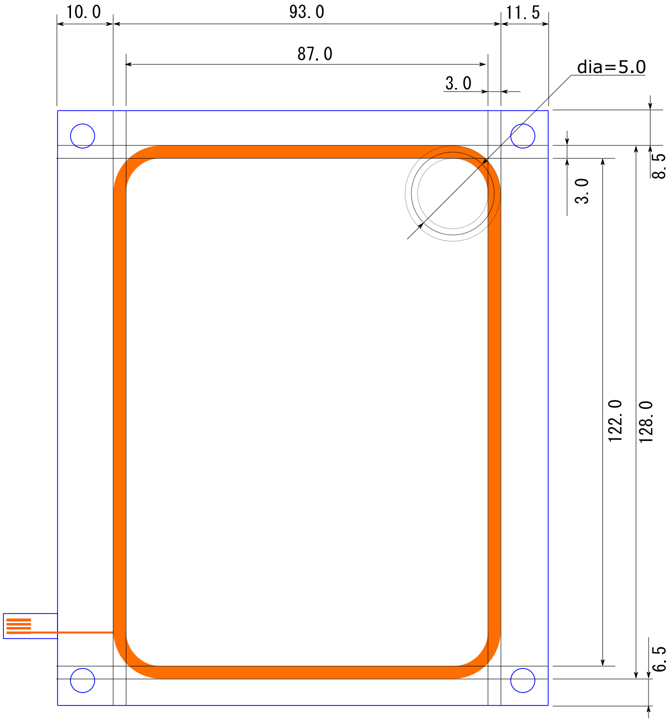

Figure2.4 Proximity Sensor Electrode Area Dimensions

2.4 Component Placement

Figure2.5 and Figure2.6 show the placement of individual components on the application board.

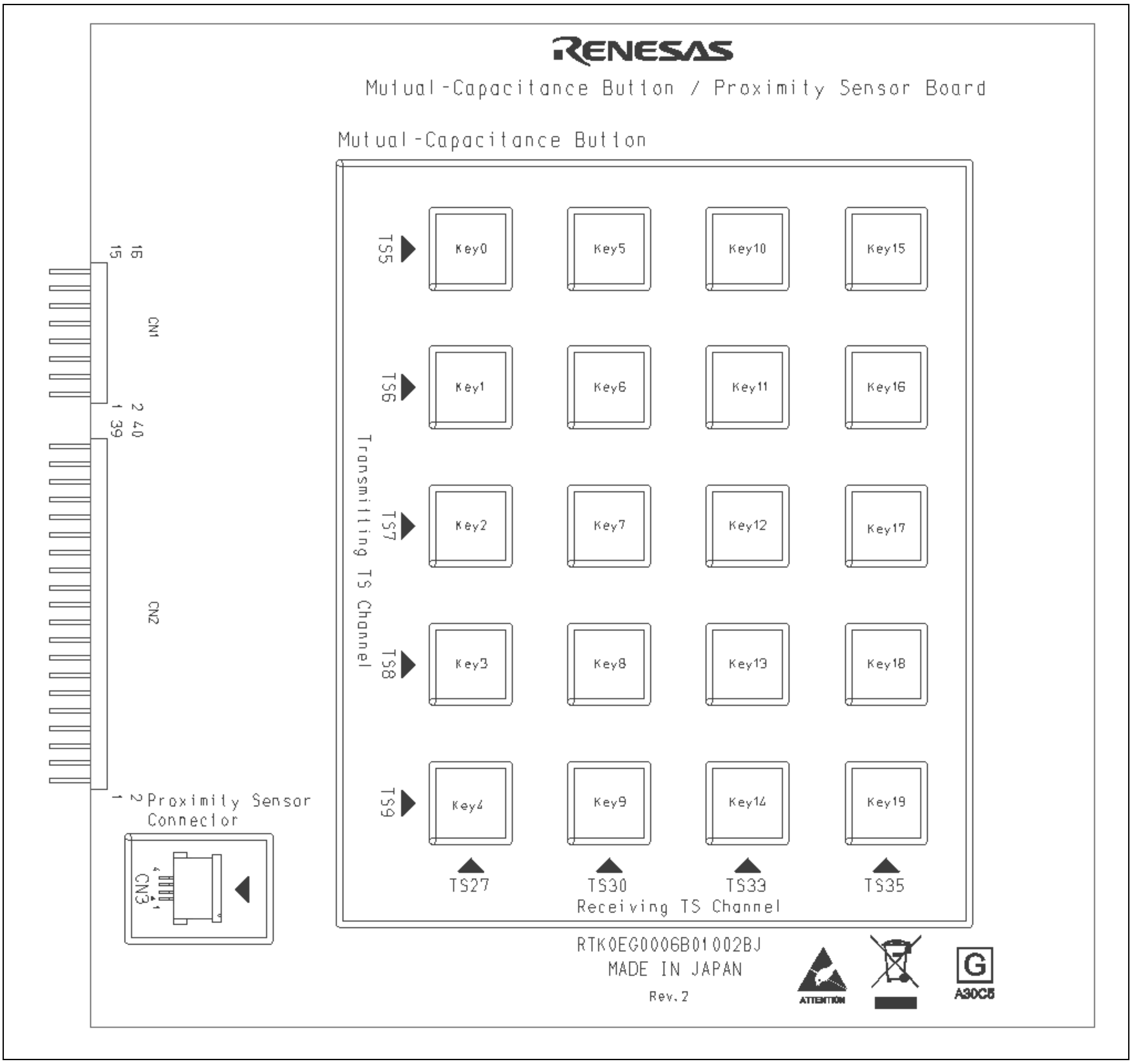

Figure2.5 Application Board Component Placement (top/component side)

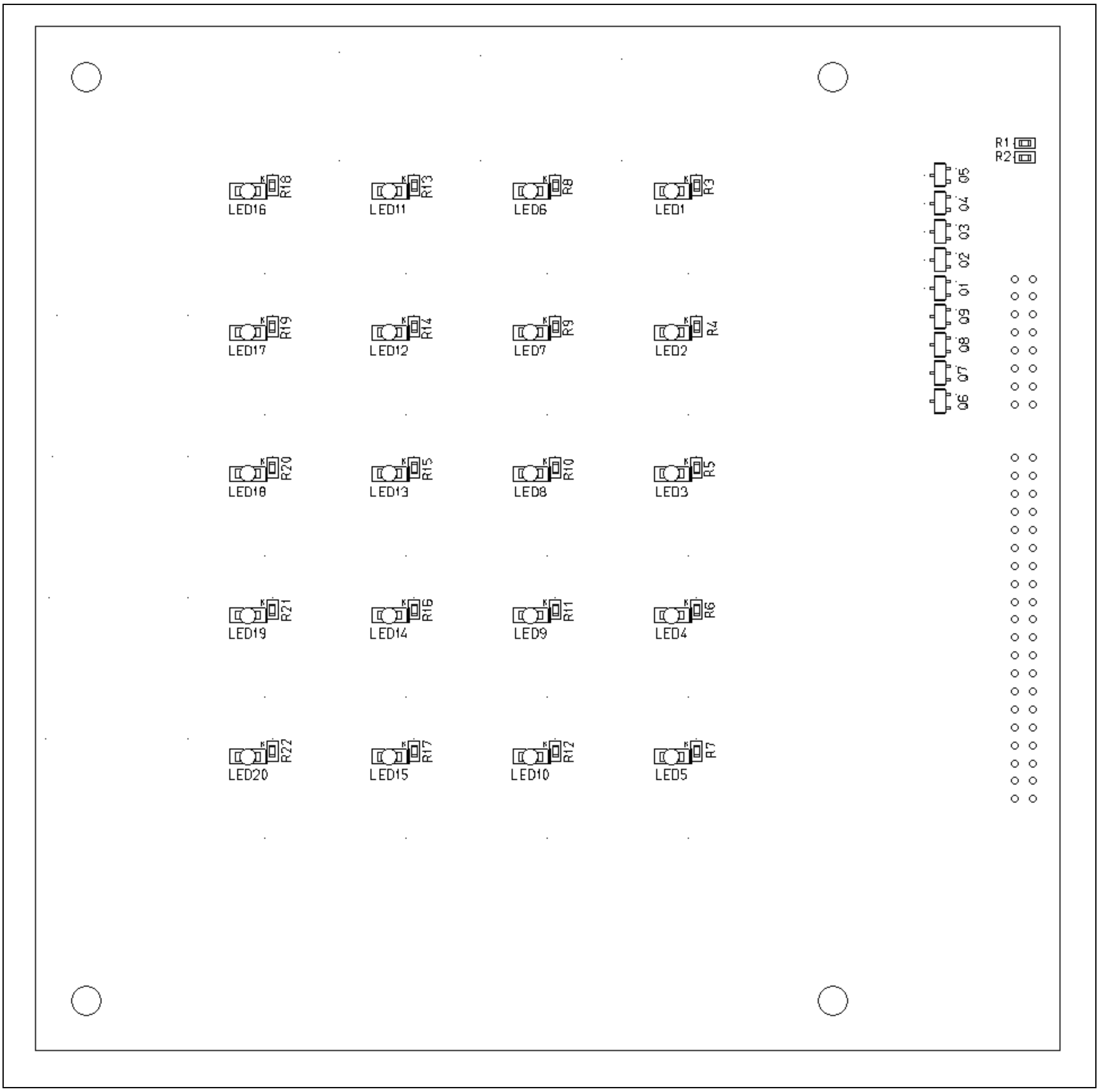

Figure2.6 Application Board Component Placement (bottom/soldered side)

3. Board Attachment & Specifications

3.1 Board Connection Configuration

Insert headers CN1 and CN2 on the application board into the corresponding CN1 and CN2 sockets on the CPU board. Make sure both headers are inserted to match the direction and number of pins on the corresponding connectors and that the pins are fully inserted into the sockets.

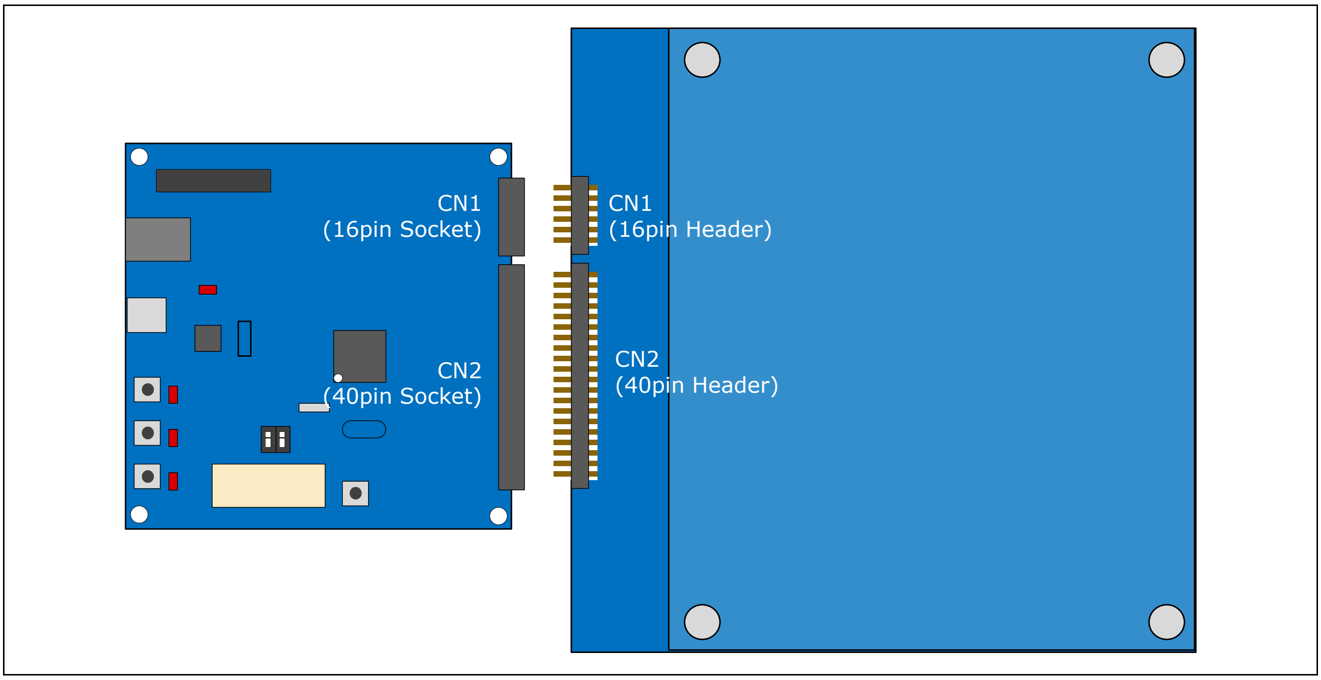

Figure3.1 Board Connection Direction

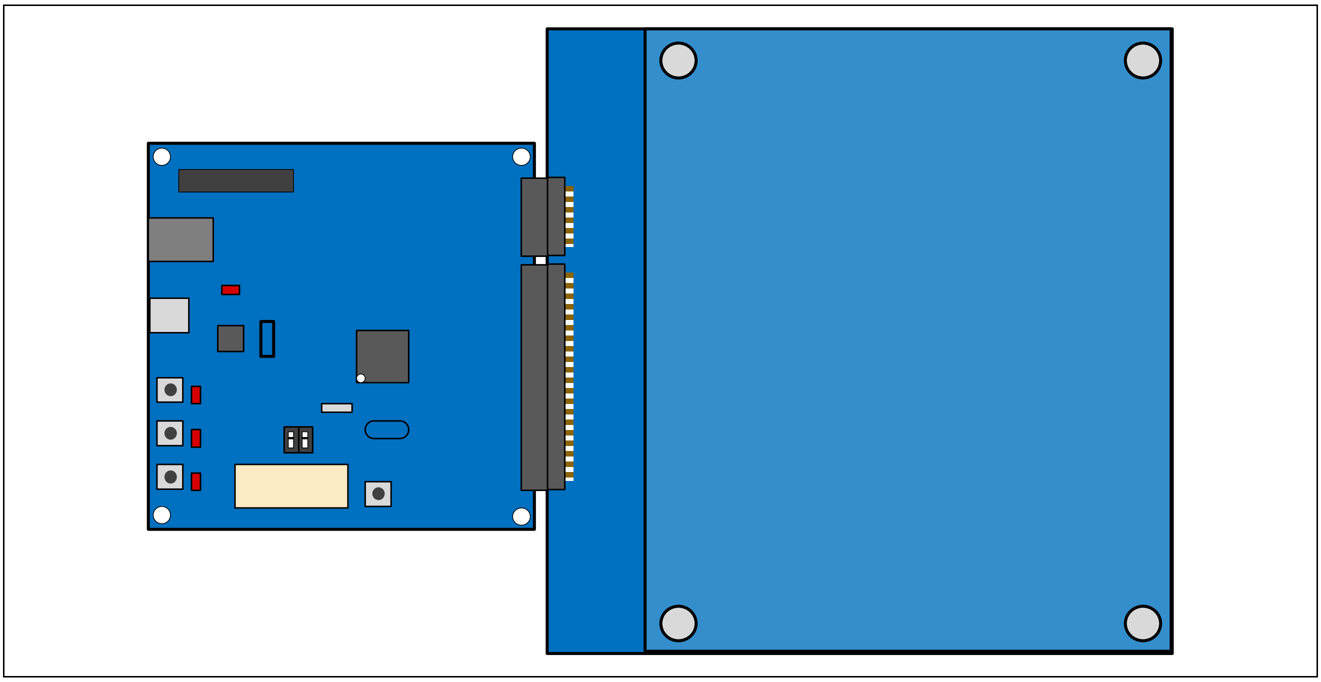

Figure3.2 Connected Boards

3.2 Mutual-Capacitance Button Specification

The user can configure up to 20 channels for mutual-capacitance buttons on the application board. To use the mutual-capacitance buttons, first set the capacitive touch sensor pins connected to electrodes to mutual-capacitance mode, and then set the transmit/receive pins. The mutual-capacitance electrodes are pre-determined for transmit or receive. Confirm the names of the application board circuit nets and the names of the MCU's connection pins, and set the appropriate pin functions by software. For details concerning how to set pins, please refer to the corresponding MCU user's manual. Table3.1 shows the application board circuit net names and transmit/receive pin assignments.

Table3.1 Application Board Circuit Net Names and Transmit/Receive Pin Assignments

Application Board Circuit Net Name	Capacitive Touch Sensor Pin Function	Application Board Circuit Net Name	Capacitive Touch Sensor Pin Function
TS5	Transmission	TS27	Reception
TS6		TS30	
TS7		TS33	
TS8		TS35	
TS9			

3.3 Proximity Sensor Connector

Table3.2 shows the specifications for the proximity sensor connection pins (CN3). To use the proximity sensor, set the capacitive touch sensor pins connected to electrodes to self-capacitance mode. Confirm the names of the application board circuit nets and the names of the MCU's connection pins, and set the appropriate pin functions by software.

Table3.2 Proximity Sensor Connection Pin (CN3）Specifications

CN3 Pin	Circuit Net Name	Proximity Sensor Pin Function
1	TS0	Connect to electrode
2	TS1	Not connected
3	TS2	Not connected
4	TS3	Not connected

3.4 LEDs

There are 20 LEDs on the application board, connected in a 4 x 5 matrix.

4. Headers

Header names (circuit net names) differ for the application board and the CPU board. This section provides details on all headers; the following information can serve as verification tables when using the extension board function.

4.1 GPIO Interface

Table4.1 Application Headers (CN1)

Pin	Header Name	Pin	Header Name
1	LED0	2	LED1
3	LED2	4	LED3
5	-	6	-
7	LED6	8	LED7
9	LED8	10	LED9
11	LED10	12	-
13	-	14	ADC
15	VCC_LED	16	VSS_GND

- : Non Connection

4.2 CTSU Interface

Table4.2 Application Headers (CN2)

Pin	Header Name	Pin	Header Name
1	TS0	2	TS1
3	TS2	4	TS3
5	-	6	TS5
7	TS6	8	TS7
9	TS8	10	TS9
11	-	12	-
13	-	14	-
15	-	16	-
17	-	18	-
19	-	20	-
21	-	22	-
23	-	24	-
25	-	26	-
27	-	28	TS27
29	-	30	-
31	TS30	32	-
33	-	34	TS33
35	-	36	TS35
37	-	38	-
39	-	40	-

- : Non Connection

5. Circuit Diagram

The circuit diagram is shown on the Appendix 1.

6. PCB Layout Diagram

The PCB layout diagram is shown on the Appendix 2.

7. Parts List

The parts list is shown on the Appendix 3.

8. Additional Information

Technical Support

For more information about how to use the application board, refer to the Renesas website.

For information about the target microcontroller, refer to the corresponding User’s Hardware Manual.

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

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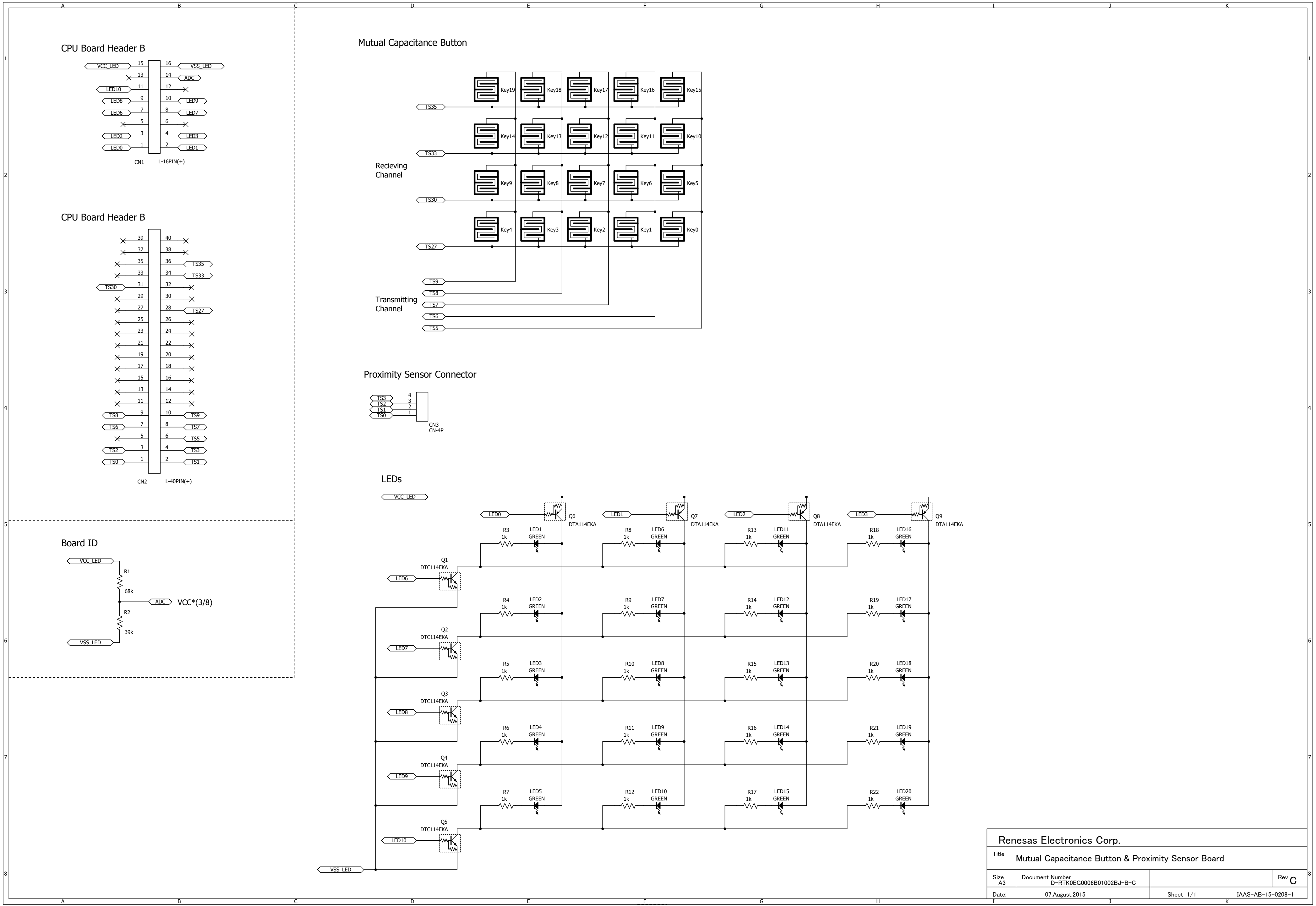
Appendix 1.



Renesas Electronics Corp.

Title Mutual Capacitance Button & Proximity Sensor Board

Size A3
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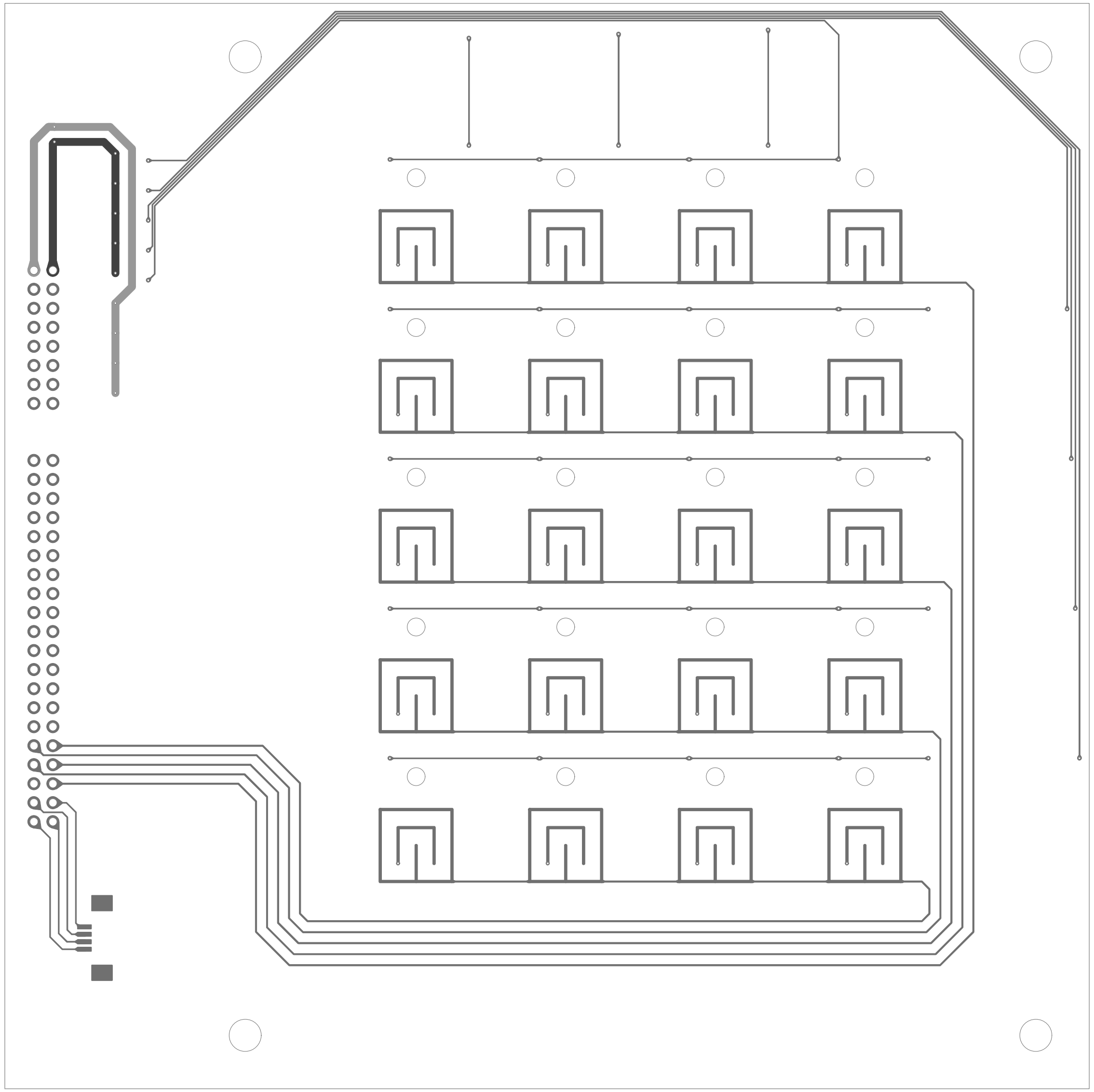
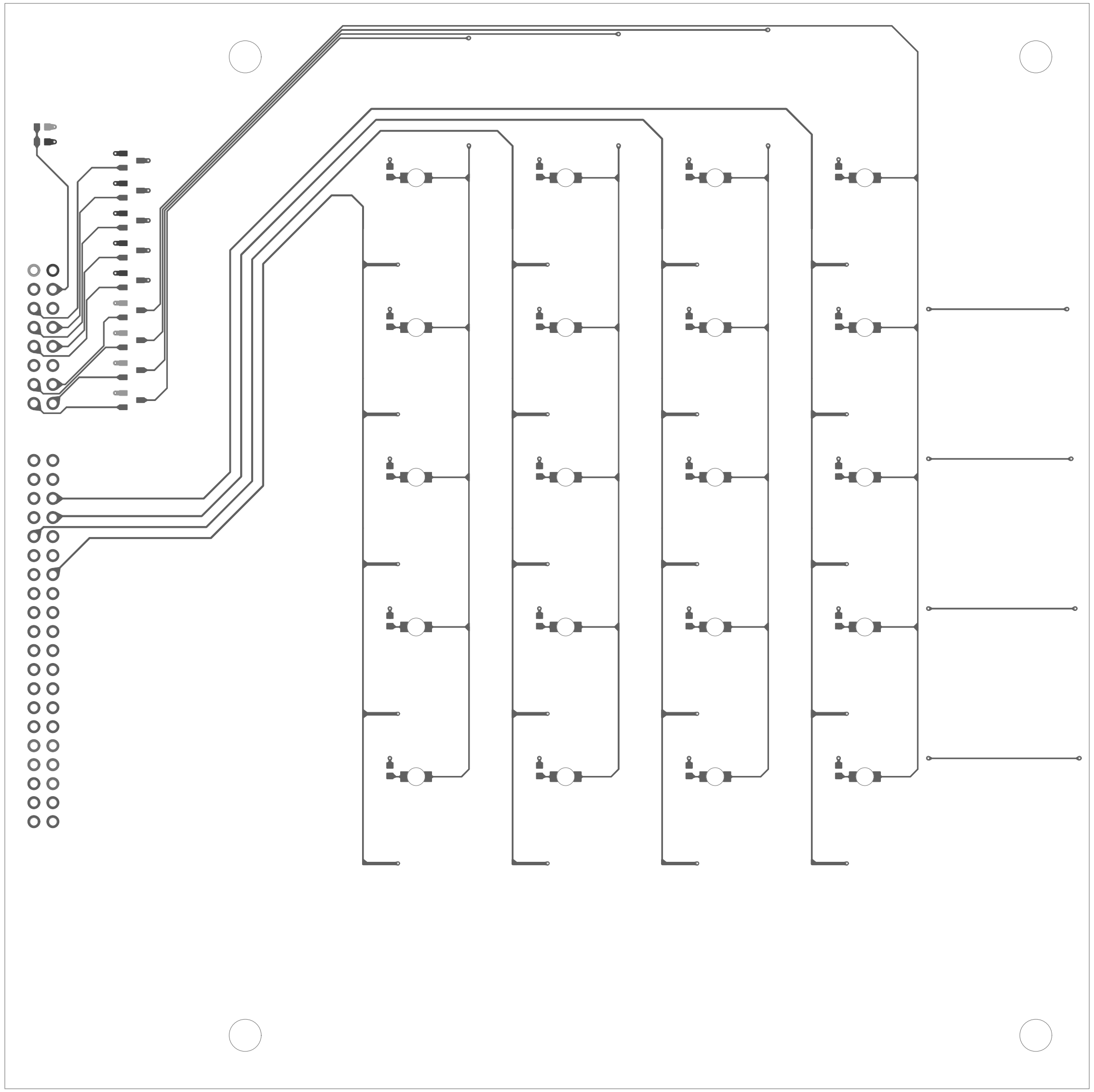
Rev C

Date: 07.August.2015
Sheet 1/1
IAAS-AB-15-0208-1

Appendix 2.



PCB Top-side Layout



PCB Bottom-side Layout

Appendix 3.

Renesas Electronics Corp.

PartNo	RTK0EG0006B01002BJ	Title	Mutual-Capacitance Matrix Button/Proxmity Sensor Board BOM

No	Component Name		Component Specification			Qty/Set	Remarks
	Type	Reference	Product Number (Specfication)	Manufacture	Mount/Unmount		
1	Right Angle Pin Header	CN1	PSR-420256-08	Hirosugi-Keiki	Mount	1	16-pin(2x8), 2.54mm-pitch
2	Right Angle Pin Header	CN2	PSR-420256-20	Hirosugi-Keiki	Mount	1	40-pin(2x20), 2.54mm-pitch
3	FFC Connector	CN3	052207-0460	Molex	Mount	1	4-pole,1.00mm-pitch Top Contact Type
4	Chip Resistor	R1	MCR03ERTJ683	ROHM	Mount	1	68k
5	Chip Resistor	R2	MCR03ERTJ393	ROHM	Mount	1	39k
6	Chip Resistor	R3-22	MCR03ERTJ102	ROHM	Mount	20	1k
7	LED	LED1-LED20	SML-812MT	ROHM	Mount	20	Green, Reverse-mount available type
8	Transistor	Q1-Q5	DTC114EKA	ROHM	Mount	5	
9	Transistor	Q6-Q9	DTA114EKA	ROHM	Mount	4	
10	Touch Electrode	Key1-20	—	—	Mount	20	
11	PCB		RTK0EG0006B01002BJ REV.A		Mount	1	

Revision History	Mutual-Capacitance Button/Proximity Sensor Board User's Manual

Rev.	Date	Description	
		Page	**Summary**
1.00	Feb 17, 2016	—	First Edition issued
1.01	Apr 26, 2024	—	Update Notice and How to Use This Manual
		1	Added board dimensions
		2	Added regulatory compliance notices
		14	Update Additional Information

Mutual-Capacitance Button/Proximity Sensor Board User’s Manual

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RX Capacitive Touch Evaluation System

Mutual-Capacitance Matrix Key/Proximity Sensor Board User's Manual

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