RA2E1 Group

Sensor & Touchless key Demo Board

Introduction

This application note explains hardware specification of RTK0EA0005D00001BJ board, which realizes non-contact button (touchless key) operation by Capacitive touch sensor and various sensor control by RA2E1 MCU.

Target Device

RA2E1 Group

Related Document

(1) RA2E1 Group Sensor & Touchless key Demo Sample Software (R11AN0492EJ0100)

Contents

1. Outline

This demo board provides below features and system configuration.

(1) Gas Sensor

Equipped with a gas sensor for detecting a small amount of gas in the indoor environment.

- Total volatile organic compound (TVOC) concentration measurement
- Carbon dioxide equivalent (eCO2) concentration measurement
- Indoor air quality (IAQ) measurement

(2) Temperature / Relative humidity Sensor

(3) Thermopile Sensor

Equipped with a thermopile sensor for measuring radiation temperature.

(4) Touchless key operation by capacitive touch sensor

Equipped with a touchless key with a capacitive touch sensor.

- Detection Distance 15mm
- Simple circuit configuration of MCU, capacitive touch electrode pattern, resistor and capacitor
- Reduced environmental effect by shield electrode pattern

(5) Cooperation with PC demo application

(6) External connector (optional)

- External I2C / SPI / UART device can be connected from the PMOD interface
- Capacitive touch Electrode board for capacitive touch sensor is changeable

(7) Emulator connector

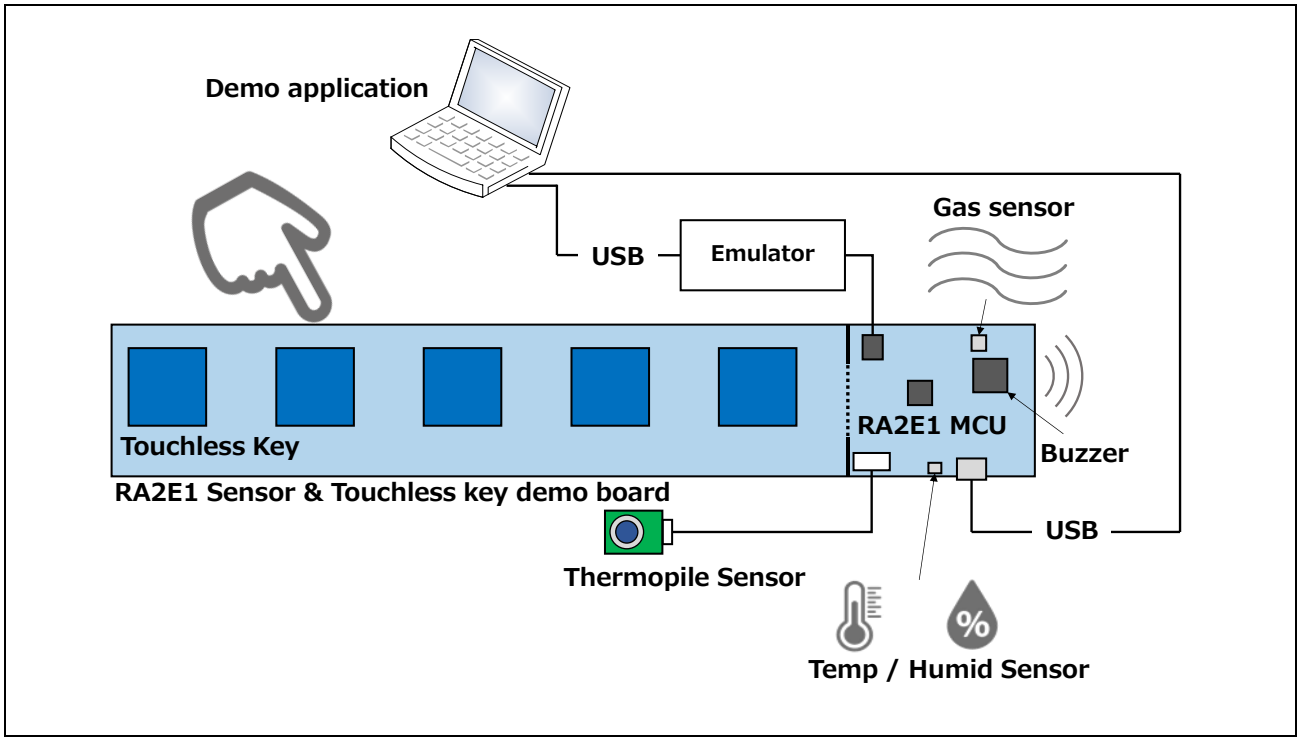

Figure 1-1. System configuration

2. External appearance of demo board

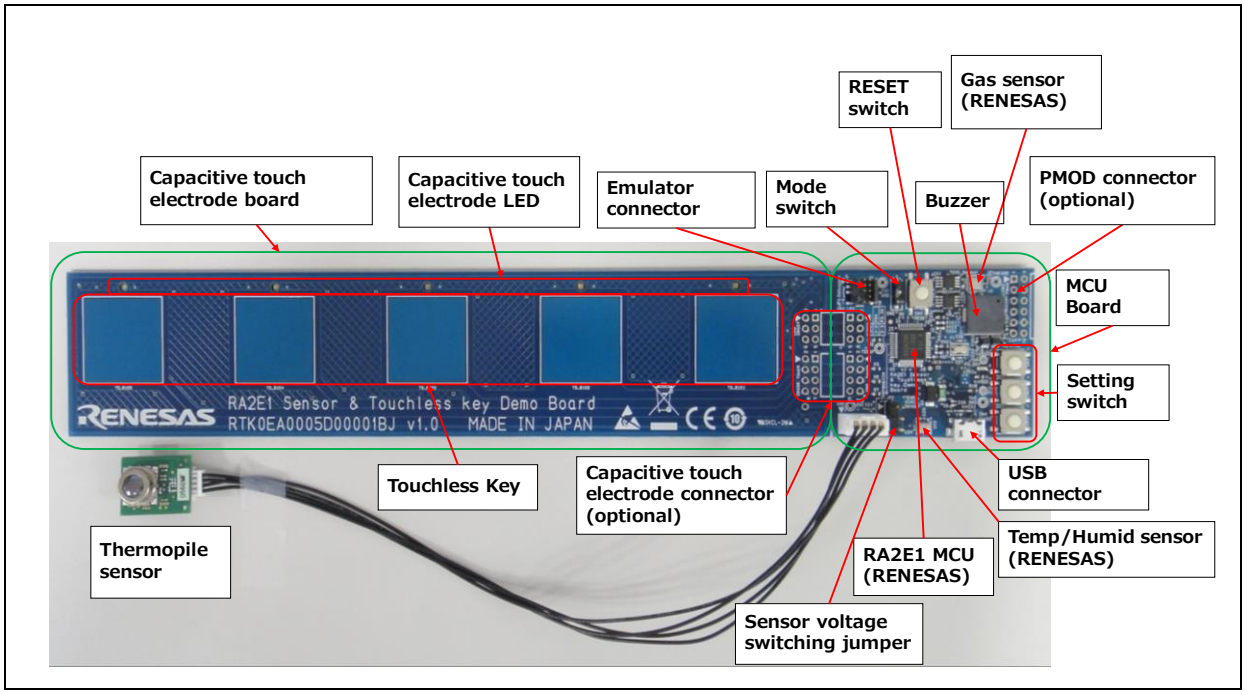

Figure 2-1. Board appearance

3. Hardware specification

Table 1. Hardware specification (1/2)

Item	Description	Remarks
Board size	• MCU board 40.0×50.0[mm] • Capacitive touch electrode board 40.0×199.0[mm]	Exclude slit
Power supply	USB bus power (VBUS) 5V	
Circuit voltage	• MCU voltage 5V • Temp/humid sensor and gas sensor voltage 3.3V • Thermopile sensor voltage 5V / 3.3V selectable	
MCU	RENESAS R7FA2E1A92DFL	• Max. operating frequency：48MHz Arm Cortex-M23 core • Code flash： 128KB • Data flash： 4KB • RAM： 16KB • 48pin LQFP package (0.5mm pitch) • Operating temp. range： -40 to 85°C
Clock	• MCU main system clock High-speed on-chip oscillator • MCU sub system clock 32.768kHz crystal	
Gas sensor	RENESAS(IDT) ZMOD4410AI1V	• I2C IF • Resolution 10 to 16bit • Measurement output − Total volatile organic compounds (TVOC) − Estimated carbon dioxide level (eCO2) − Indoor air quality (IAQ) • Range − Total volatile organic compounds (TVOC) 0 to 1000ppm[1] − Indoor air quality (IAQ) 160 to 30000ppb[1] • Accuracy − TVOC±15% typ (after calibration) − eCO2±25% typ (Comparison with NDIR reference instrument)

Condition [1] Measurement of Ethanol in air

Table 2. Hardware specification (2/2)

Item	Description	Remarks
Relative Humidity and Temperature Sensor	RENESAS(IDT) HS3001	• I2C IF • 14-bit resolution • Range – Temperature: -40 to 125°C – Humidity: 0 to100%RH • Accuracy – Temperature: ±0.2°C typ (-10 to 80°C) – Humidity: ±1.5%RH typ (10 to 90%RH, Ta=25°C)
Thermopile Sensor	OMRON D6T-44L-06	• I2C IF • Number of elements :16 channels (4x4) • Viewing angle X direction=44.2° Y direction=45.7° • NETD[2] 0.06°C • Object temperature detection 5 to 50°C • Output accuracy ±1.5°C (Ta=25°C)
Touchless key (Capacitive touch electrode)	20.0×20.0[mm] 5pcs	
Buzzer	MURATA PKMCS0909E4000-R1	Surface mount piezoelectric sounder
LED	• Power LED orange color x 1pc • Capacitive touch electrode LED orange color x 5pcs	
Switches	• System reset switch • Setting switch • Mode switch	Push switch x 1pc Push switch x 3pcs DIP switch x 1bit
Capacitive touch electrode connector	2.54mm pitch 8pin (4pin×2)	Optional
Capacitive touch electrode LED Connector	2.54mm pitch, 6pin (3pin×2)	Optional
Thermopile sensor Connector	2mm pitch, 4pin	
USB Connector	USB Micro B USB2.0 full speed	
PMOD Connector (Optional)	2.54mm pitch,12pin (6pin×2)	Optional
Emulator Connector	J-Link 9-pin Cortex-M adopter	

[2] NETD (Noise Equivalent Temperature Difference) is temperature resolution.

4. Block Diagram

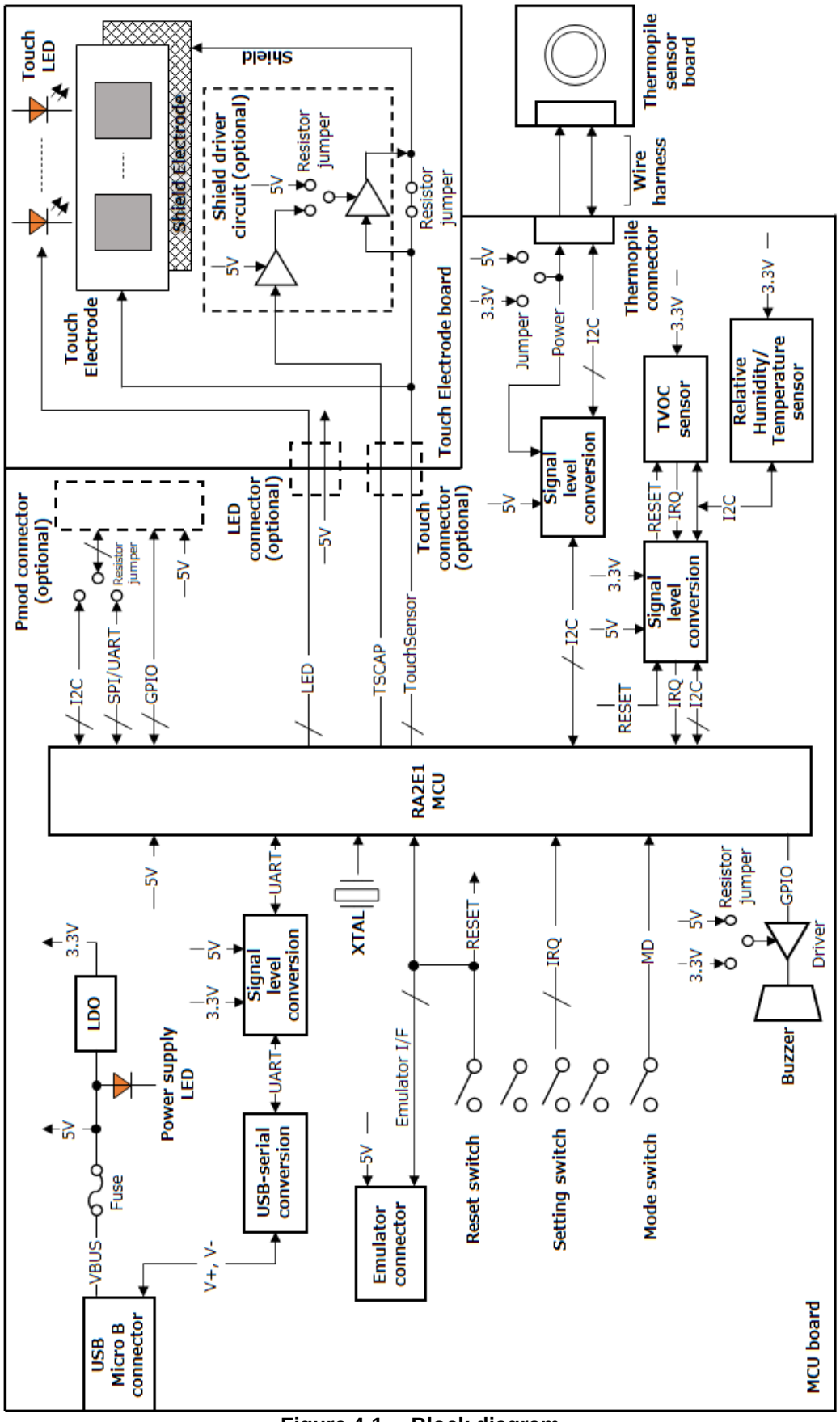

Figure 4-1. Block diagram

5. Sensor

The gas sensor, temperature / humidity sensor, and thermopile sensor are controlled by the I2C interface.

Table 3 shows the I / O port assignments for I2C signals.

For the demo application using each sensor, refer to the RA2E1 Group Sensor & Touchless key Demo Sample Software (R11AN0492EJ0100).

Table 3. I2C for Sensor control

I/O port / I2C signal	Note
P212/SCL1_A	I2C SCL signal
P213/SDA1_A	I2C SDA signal

6. Capacitive touch Sensor

Table 4 shows the I / O port assignments for capacitive touch sensor.

For the demo application using the capacitive touch sensor, refer to the RA2E1 Group Sensor & Touchless key Demo Sample Software (R11AN0492EJ0100).

Table 4. Capacitive touch Sensor

Parts reference	I/O port / Capacitive touch sensor number	Note
C1	P112/TSCAP_C	TSCAP
SE101	P111/TS12-CFC	Shield electrode
TS_B101	P015/TS28-CFC	Capacitive touch electrode
TS_B102	P013/TS33-CFC	Capacitive touch electrode
TS_B103	P012/TS32-CFC	Capacitive touch electrode
TS_B104	P011/TS31-CFC	Capacitive touch electrode
TS_B105	P010/TS30-CFC	Capacitive touch electrode

7. Buzzer

The buzzer installed in this product is an external drive circuit piezoelectric sounder.

Table 5 shows the buzzer I / O port assignments.

Table 5. Buzzer

Parts reference	I/O port / Timer
SP1	P208/AGTOB0_A

8. Sensor voltage switching jumper

This is a jumper that switches the voltage supply to the thermopile sensor.

For this product, short the 1-2 pin of JP2 before use.

9. LED

9.1 Power LED

For this board, power supplied by USB cable and LED1 turns on.

9.2 Capacitive touch electrode LED

Table 6 shows the I/O port assignment for the capacitive touch electrode LEDs.

The capacitive touch electrode LED turns on with L and turns off with H.

Table 6. Capacitive touch electrode LED

Parts reference	I/O port
LED102	P401
LED103	P103
LED104	P102
LED105	P100
LED106	P500

10. Switches

10.1 Reset switch

Input reset by pressing SW4 for RA2E1 MCU and emulator.

10.2 Setting switch

Table 7 shows the I / O port assignments for the configuration switches.

When the setting switch is pressed, it becomes L, and when it is released, it becomes H.

Table 7. Setting switch

Parts reference	I/O port interrupt number
SW1	P000/IRQ6
SW2	P001/IRQ7
SW3	P002/IRQ2

10.3 Mode switch

When the power supplied with SW6 turned on, the RA2E1 MCU operates in SCI boot mode.

11. Connectors

The specification of each connecter are shown in section 11.1 to 11.6.

The input / output directions listed in the table are the directions when the connection destination is viewed from the MCU.

11.1 Capacitive touch electrode connector (optional)

Table 8 shows the signals for capacitive touch electrode connector.

Table 8. Signals for capacitive touch electrode connector

CN2, CN106		
Pin number	**Signal**	**Function**
1	P112/TSCAP_C	IN/OUT
2	GND	POWER
3	P111/TS12-CFC	IN/OUT
4	P015/TS28-CFC	IN/OUT
5	P013/TS33-CFC	IN/OUT
6	P012/TS32-CFC	IN/OUT
7	P011/TS31-CFC	IN/OUT
8	P010/TS30-CFC	IN/OUT

11.2 Capacitive touch electrode LED connector (optional)

Table 9 shows the signals for capacitive touch electrode LED connector.

Table 9. Signals for capacitive touch electrode LED connector

CN1, CN107		
Pin number	**Signal**	**Function**
1	P5V	POWER
2	P401/GTIOC9B_A	IN/OUT
3	P103/GTIOC5A_ A	IN/OUT
4	P102/GTIOC5B_ A	IN/OUT
5	P100/GTIOC8B_ A	IN/OUT
6	P500/GTIOC5A_ B	IN/OUT

11.3 Thermopile sensor connector

Table 10 shows the signal for the thermopile sensor connector, and Figure 11-1 shows the specifications for the thermopile sensor connection harness.

Table 10. Signals for thermopile sensor connector

CN5		
Pin number	**Signal**	**Function**
1	SDA	IN/OUT
2	SCL	IN/OUT
3	P5V/P3.3V	POWER
4	GND	POWER

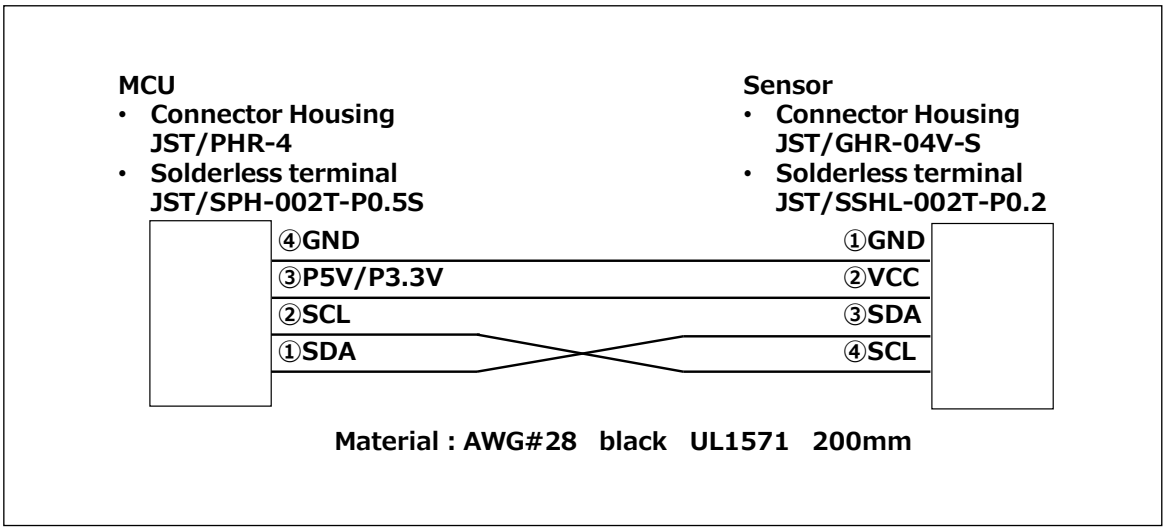

Figure 11-1. Thermopile sensor connecting harness

11.4 USB connecter

Table 11 shows the signals for the USB connector.

Table 11. Signals for USB connector

CN1		
Pin number	**signal**	**Function**
1	VBUS	POWER
2	D-	IN/OUT
3	D+	IN/OUT
4	NC	-
5	GND	POWER

11.5 PMOD Connector (optional)

11.5.1 SPI / UART Connection

Table 12 shows the signal for SPI or UART communication with PMOD connector, and Figure 11-2 shows the resistance jumper settings.

Table 12. Signals for PMOD Connector (SPI / UART)

CN3		
Pin number	**Signal**	**Function**
1	P409/IRQ6_B	IN/OUT
2	P101/TXD0_A/MOSI0_A	IN/OUT
3	P206/RxD0_D/MISO0_D	IN/OUT
4	P400/SCK0_B	IN/OUT
5	GND	POWER
6	P5V	POWER
7	P915	IN/OUT
8	P914	IN/OUT
9	P913	IN/OUT
10	P207	IN/OUT
11	GND	POWER
12	P5V	POWER

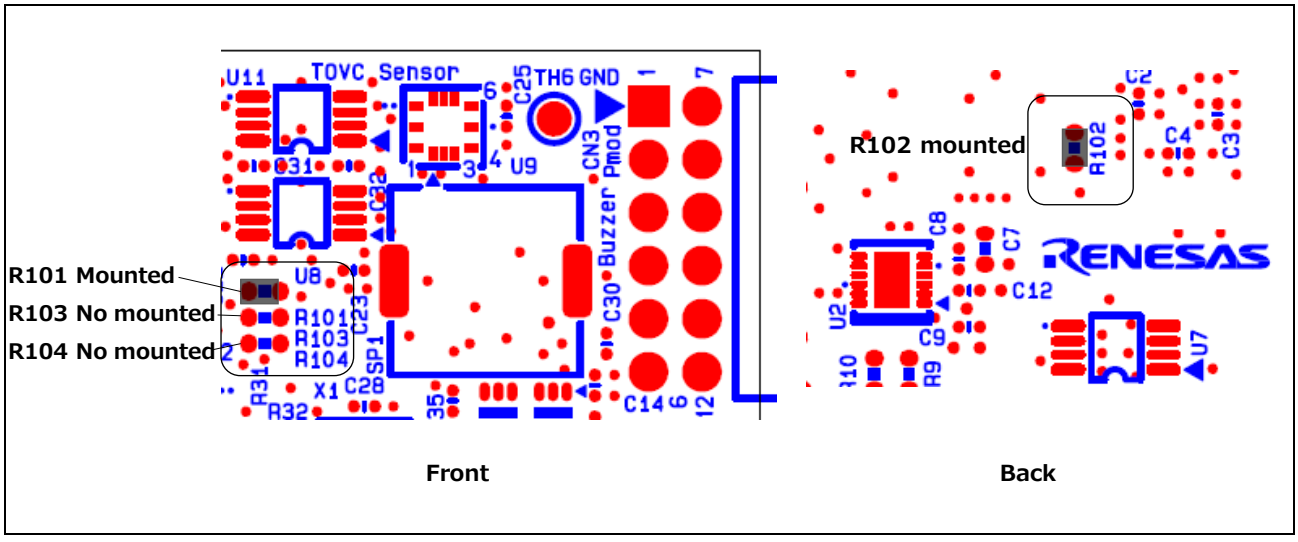

Figure 11-2. Resistance Jumper settings (SPI/UART)

11.5.2 SPI / UART Connection

Table 13 shows the signal for I2C communication using PMOD connector, and Figure 11-3 shows resistance jumper settings.

Table 13. Signals for PMOD Connector (I2C)

CN3		
Pin number	**Signal**	**Function**
1	P409/IRQ6_B	IN/OUT
2	P101/TXD0_A/MOSI0_A	IN/OUT
3	P408/SCL0_C	IN/OUT
4	P407/SDA0_B	IN/OUT
5	GND	POWER
6	P5V	POWER
7	P915	IN/OUT
8	P914	IN/OUT
9	P913	IN/OUT
10	P207	IN/OUT
11	GND	POWER
12	P5V	POWER

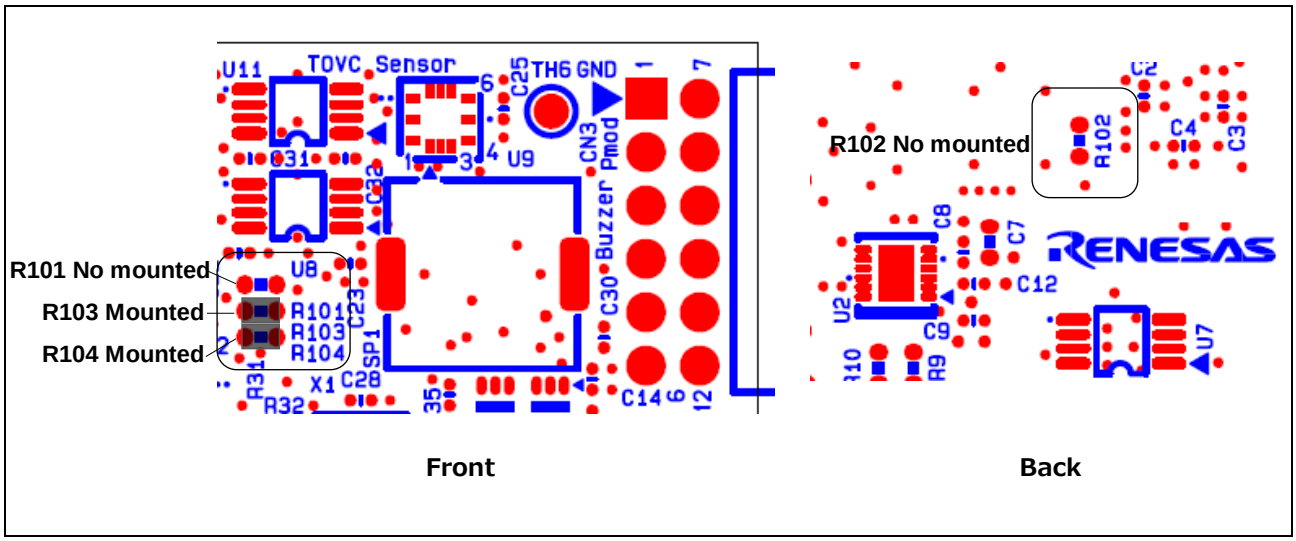

Figure 11-3. Resistance Jumper setting(I2C)

11.6 Emulator Connector

Table 14 shows signals for emulator connector.

Table 14. Signals for PMOD Connector (I2C)

JP1		
Pin number	**Signal**	**Function**
1	VCC	POWER
2	SWDIO	IN/OUT
3	GND	POWER
4	SWCLK	IN
5	GND	POWER
6	RXD	OUT
7	NC	-
8	TXD	IN
9	GND	POWER
10	nRES	IN/OUT

12. Circuit configuration

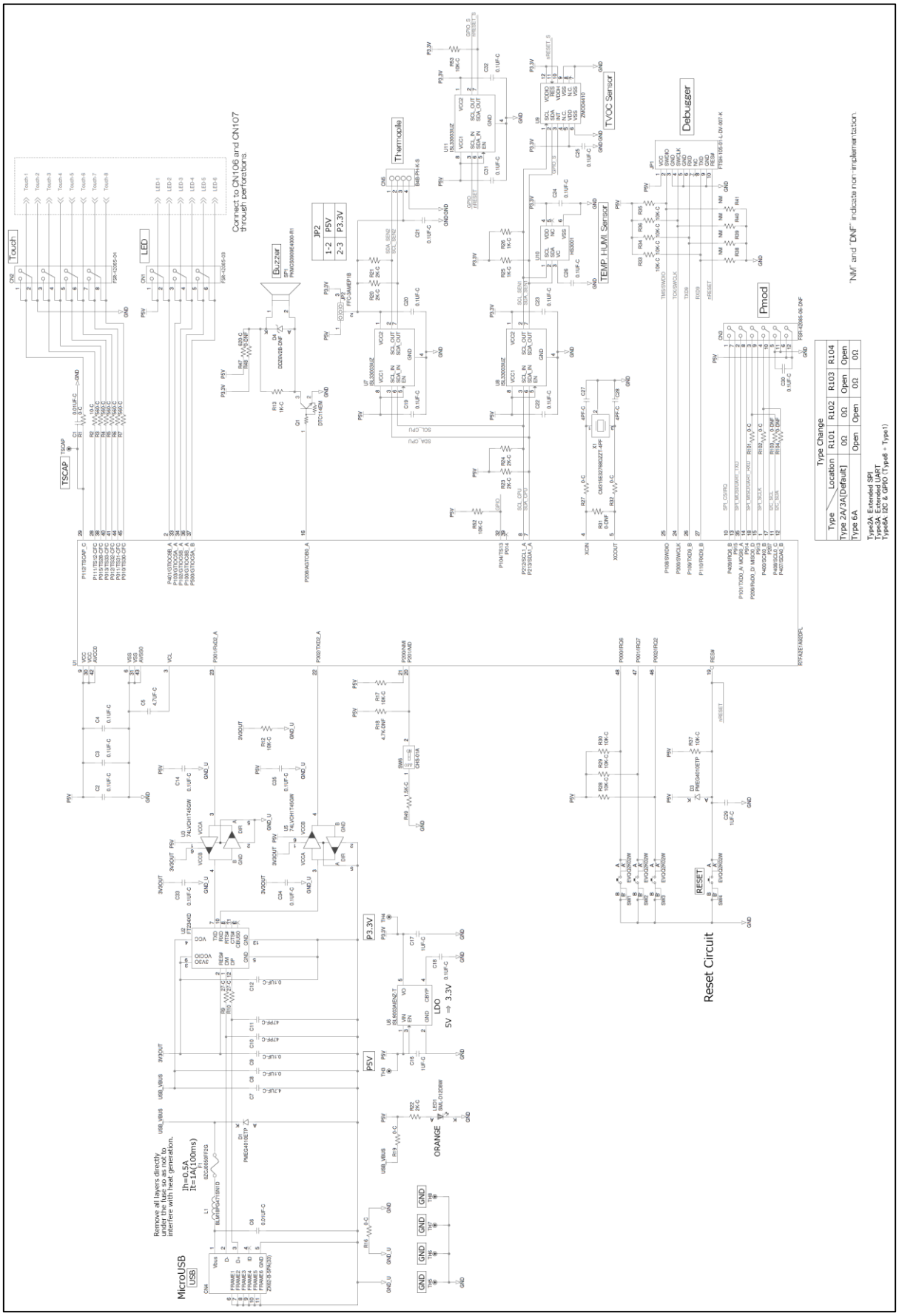

Figure 12-1. MCU board circuit configuration

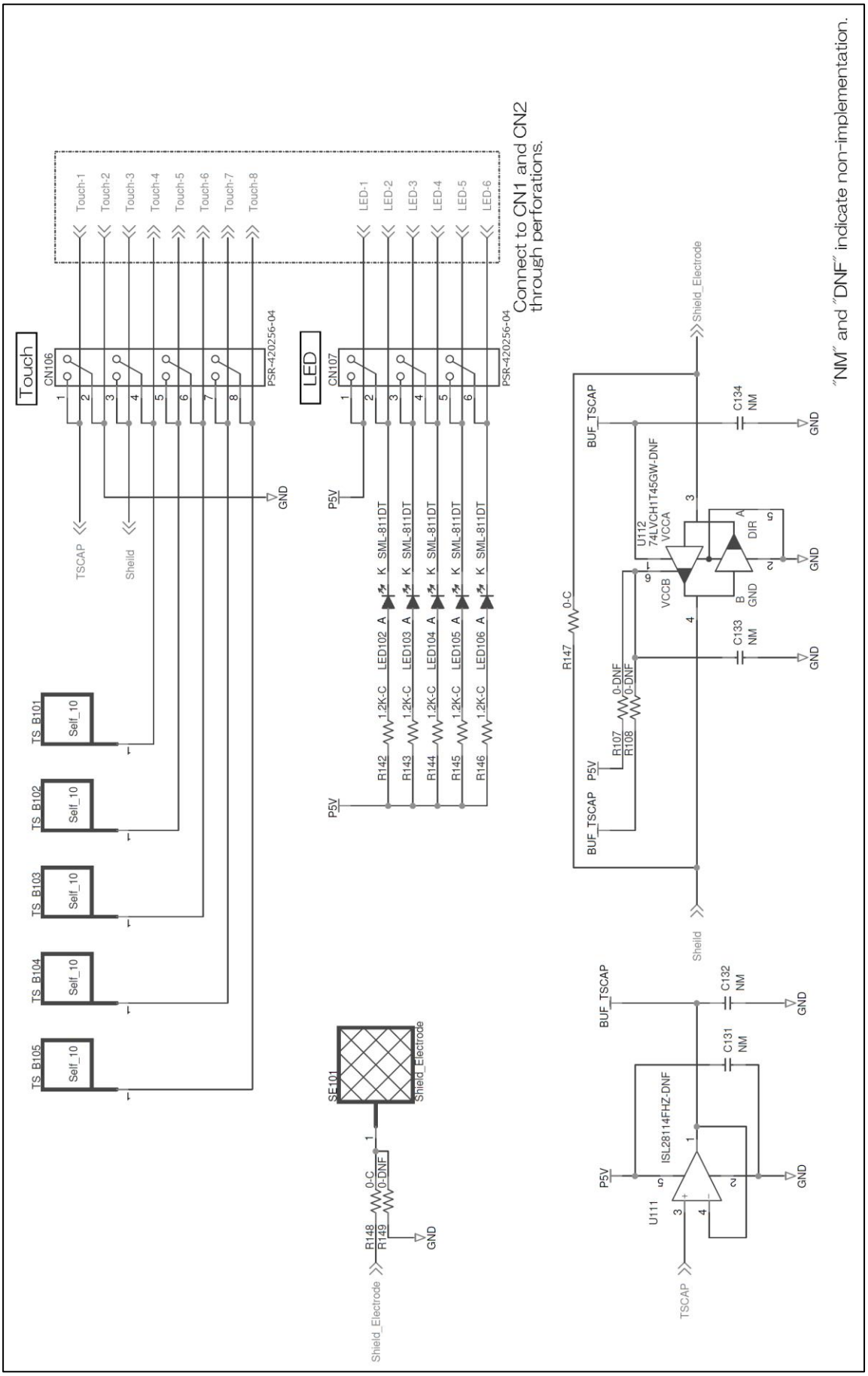

Figure 12-2. Electrode board circuit configuration

13. Board Layout

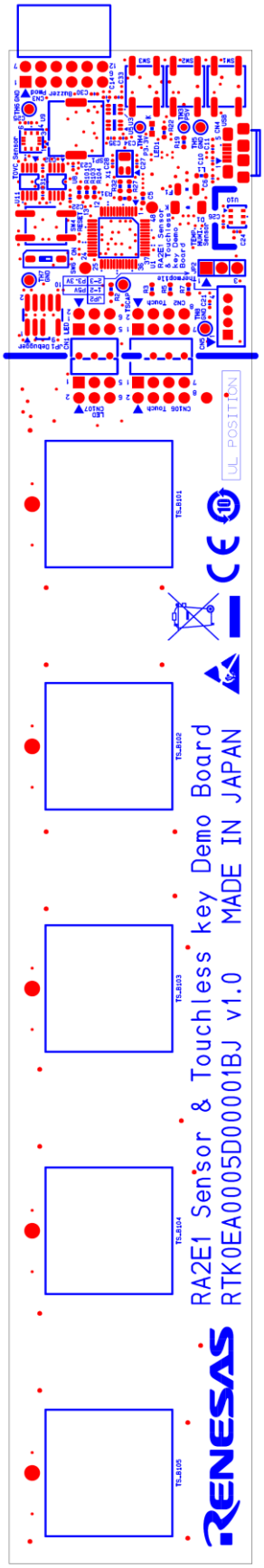

Figure13 -1. Part SILK (Top view)

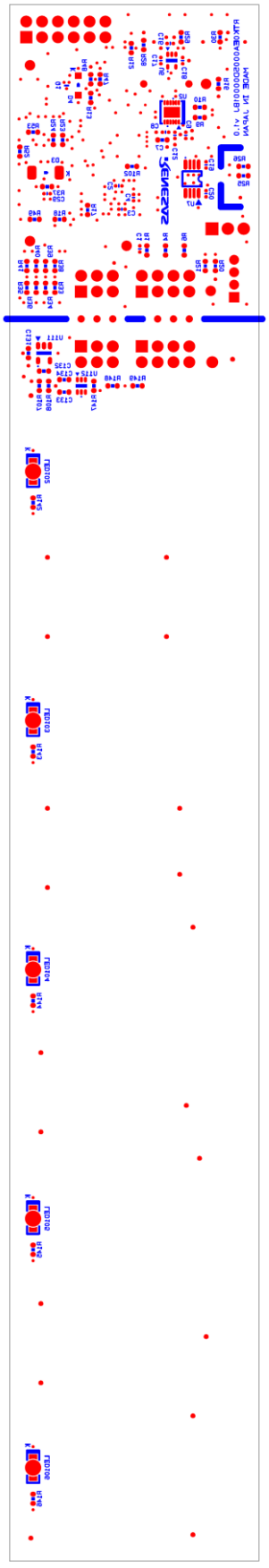

Figure 13-2. Solder SILK (Top view)

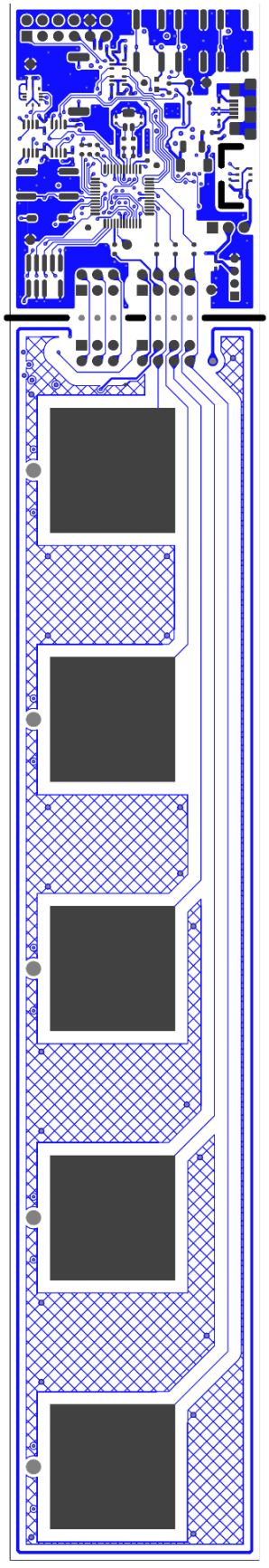

Figure 13-3. First layer pattern (Top view)

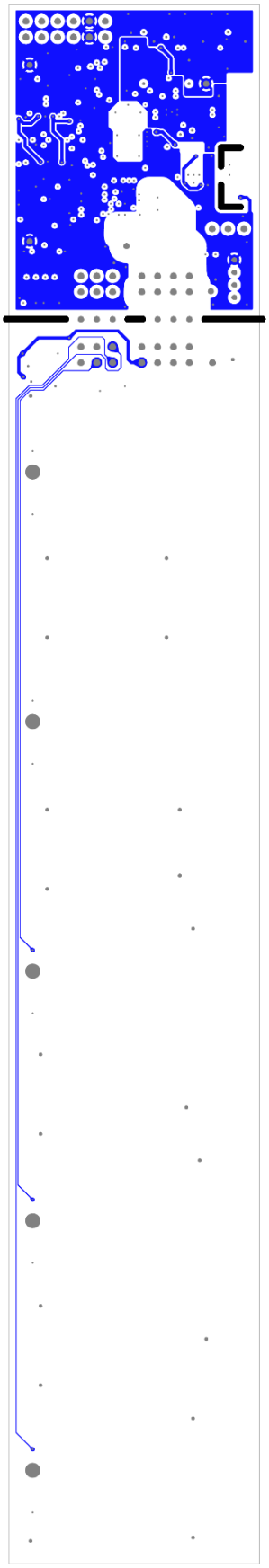

Figure 13-4. Second layer pattern (Top view)

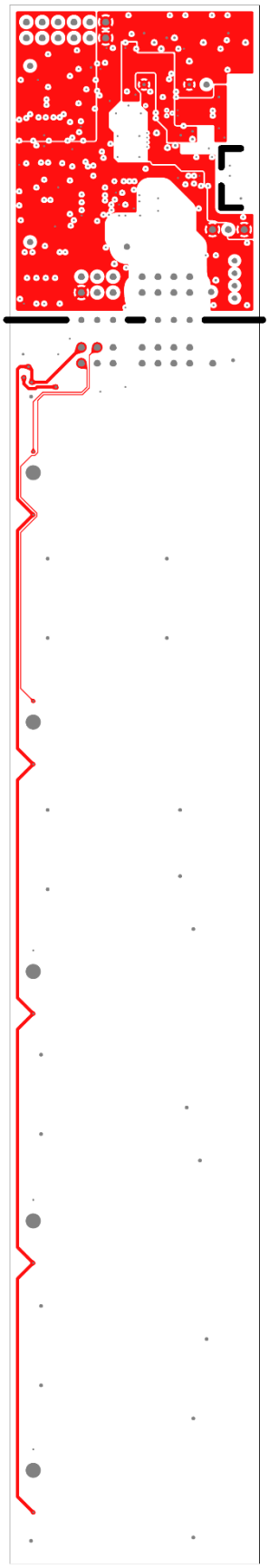

Figure 13-5. Third layer pattern (Top view)

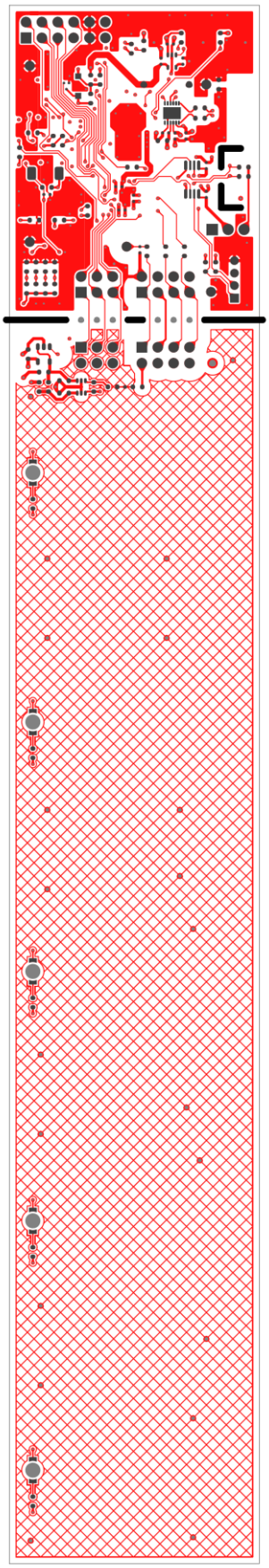

Figure 13-6 Fourth layer pattern (Top view)

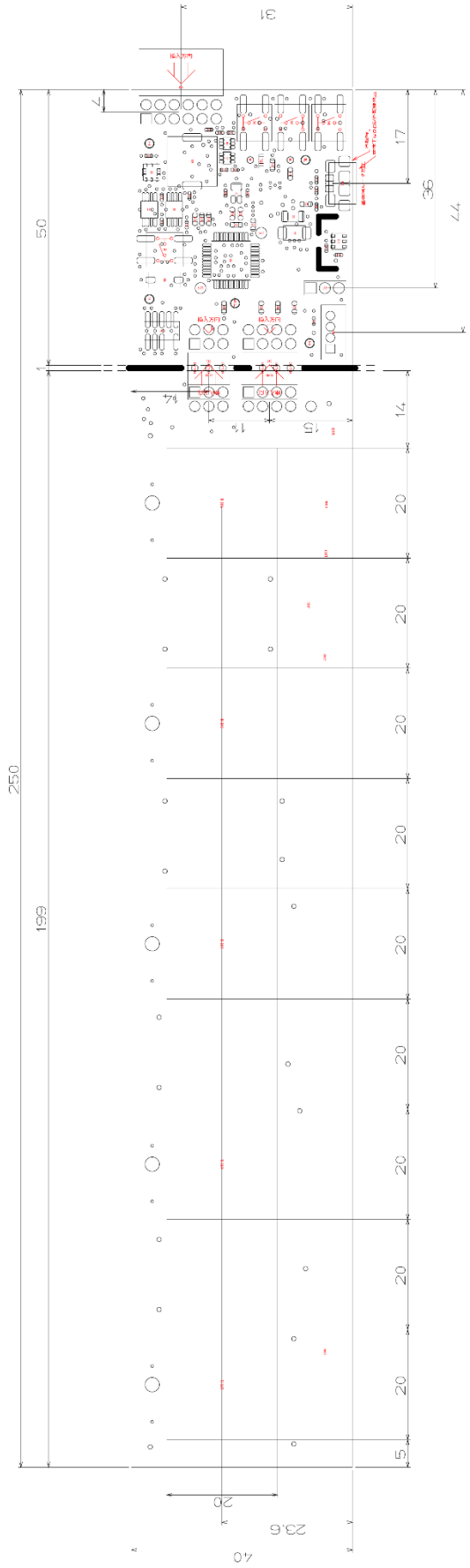

Figure 13-7. Package dimension (unit : mm)

14. BOM list

Table 15. BOM List (1/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
1	PCB	-	RTK0EA0005D00001BJ	Sanyo kogyo	-	1	
2	MCU	U1	R7FA2E1A92CFL	Renesas	Mount	1	
3	CRYSTAL OSCILLATOR	X1	CM315E32768DZZT-4PF	Citizen Finedevice	Mount	1	32.768kHz, 4pF
4	Temp and RH sensor	U10	HS3001	Renesas	Mount	1	
5	TVOC sensor	U9	ZMOD4410AI1V	Renesas	Mount	1	
6	Level converter	U3,U5	74LVCH1T45GW	Nexperia	Mount	2	
7	Level converter	U112	74LVCH1T45GW	Nexperia	UnMount	1	
8	I2C level converter	U7,U8,U11	ISL33003IUZ	Renesas	Mount	3	TSSOP
9	USB to Serial converter	U2	FT234XD	FTDI	Mount	1	
10	Operational amplifier	U111	ISL28114FHZ	Renesas	UnMount	1	
11	Digital transistor	Q1	DTC114EMT2L	Rohm	Mount	1	NPN
12	Schottky diode	D1,D3	PMEG4010ETP	Nexperia	Mount	2	
13	Zener diode	D4	DDZ6V2B	Diodes	UnMount	1	6.2V
14	LDO Regulator	U6	ISL9003AIENZ-T	Renesas	Mount	1	3.3V
15	Chip LED	LED1	SML-D12D8W	Rohm	Mount	1	Orange
16	Chip LED	LED102,LED103,LED104,LED105,LED106	SML-811DT	Rohm	Mount	5	Reverse-mount, Orange
17	Ferrite beads	L1	BLM18PG471SN1D	Murata	Mount	1	
18	Piezoelectric sounder	SP1	PKMCS0909E4000-R1	Murata	Mount	1	Externally Driven
19	Chip Resistor	R1,R16,R19,R27,R32,R101,R102,R147,R148	MCR03EZPJ000	Rohm	Mount	9	0Ω
20	Chip Resistor	R31,R48,R103,R104,R107,R108,R149	MCR03EZPJ000	Rohm	UnMount	7	0Ω
21	Chip Resistor	R9,R10	MCR03EZPJ270	Rohm	Mount	2	27Ω 5%
22	Chip Resistor	R3,R4,R5,R6,R7	MCR03EZPJ561	Rohm	Mount	5	560Ω,5%
23	Chip Resistor	R47	MCR03EZPJ621	Rohm	Mount	1	620Ω,5%
24	Chip Resistor	R13,R25,R26	MCR03EZPJ102	Rohm	Mount	3	1kΩ 5%
25	Chip Resistor	R142,R143,R144,R145,R146	MCR03EZPJ122	Rohm	Mount	5	1.2kΩ 5%
26	Chip Resistor	R49	MCR03EZPJ152	Rohm	Mount	1	1.5kΩ,5%

Table 16. BOM List (2/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
27	Chip Resistor	R20,R21,R22,R23, R24	MCR03EZPJ202	Rohm	Mount	5	2KΩ 5%
28	Chip Resistor	R18	MCR03EZPJ472	Rohm	UnMount	1	4.7KΩ 5%
29	Chip Resistor	R12,R17,R28,R29, R30,R33,R34,R35, R36,R37,R52,R53	MCR03EZPJ103	Rohm	Mount	12	10kΩ 5%
30	Chip Resistor	R38,R39,R40,R41	MCR03EZPJ103	Rohm	UnMount	4	10kΩ 5%
31	Chip Resistor	R2	MCR03EZPJ100	Rohm	Mount	1	10Ω 5%
32	Ceramic Capacitor	C27,C28	GJM1555C1H4R0WB01D	Murata	Mount	2	4pF/50V
33	Ceramic Capacitor	C10,C11	GJM1555C1H470JB01D	Murata	Mount	2	47pF/50V
34	Ceramic Capacitor	C1,C6	GRM155R71H103KA88D	Murata	Mount	2	0.01uF/50V
35	Ceramic Capacitor	C2,C3,C4,C8,C9,C 12,C14,C18,C19,C 20,C21,C22,C23,C 24,C25,C26,C30,C 31,C32,C33,C34,C 35	GRM155R71E104KE14J	Murata	Mount	22	0.1uF/25V
36	Ceramic Capacitor	C131,C132,C133,C 134	GCJ188R71E104KA12D	Murata	UnMount	4	0.1uF/25V
37	Ceramic Capacitor	C16,C17,C29	GRM155C81C105KE11D	Murata	Mount	3	1uF/16V
38	Ceramic Capacitor	C5,C7	GRM188C71C475KE21D	Murata	Mount	2	4.7uF/16V
39	DIPSW	SW6	CHS-01A	Nidec Copal Electronics	Mount	1	1bit
40	Tactile switch	SW1,SW2,SW3,S W4	EVQQ2K02W	Panasonic	Mount	4	
41	USB Connector	CN4	ZX62-B-5PA(33)	Hirose	Mount	1	micro B, Receptacle
42	Socket connector	CN1	FSR-42085-03	Hirosugi-Keiki	UnMount	1	6P, right angle, 2.54mm pitch
43	Socket connector	CN2	FSR-42085-04	Hirosugi-Keiki	UnMount	1	8P, right angle, 2.54mm pitch
44	Header connector	CN107	PSR-420256-03	Hirosugi-Keiki	UnMount	1	6P, right angle, 2.54mm pitch
45	Header connector	CN106	PSR-420256-04	Hirosugi-Keiki	UnMount	1	8P, right angle, 2.54mm pitch
46	Socket connector	CN3	FSR-42085-06	Hirosugi-Keiki	UnMount	1	12P, right angle, 2.54mm pitch
47	Header connector	CN5	B4B-PH-K-S(LF)(SN)	JST	Mount	1	4P, 2mm pitch
48	Header connector	JP1	FTSH-105-01-L-DV-007-K	Samtec	Mount	1	10P, 1.27mm pitch, Keying Shroud
49	Header connector	JP2	FFC-3AMEP1B	HTK (HONDA TSUSHIN KOGYO)	Mount	1	3P, 2.54mm pitch
50	Resettable fuse	F1	0ZCJ0050FF2G	Bel Fuse	Mount	1	

Table 17. BOM List (3/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
51	Crimping connector	-	PHR-4	JST	-	1	Wire harness assembly
52	Crimping terminal	-	SPH-002T-P0.5S	JST	-	4	Wire harness assembly
53	Crimping connector	-	GHR-04V-S	JST	-	1	Wire harness assembly
54	Crimping terminal	-	SSHL-002T-P0.2	JST	-	4	Wire harness assembly
55	Insulated wire	-	UL1571 Black	Miyama densen	-	4	200mm, Wire harness assembly
56	Thermopile sensor module	-	D6T-44L-06	Omron	-	1	
57	Rubber foot	-	173-5955	RS PRO	-	4	Width 16.5 mm, Height 10.2 mm

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Feb.11.21	-	First release

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.

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 be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. 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.
6. 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.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION (“Vulnerability Issues”). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. 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.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

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

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/.