# RX130 Group

## CTSU Application Example: 3D Gesture Demo Set Small version (Hardware)

R01AN4320EJ0100
Rev.1.00
Apr 12, 2018

## Introduction

The RX130 Group is equipped with hardware (Capacitive Touch Sensor Unit; CTSU) that senses contact of the human body by measuring the capacitance generated between the touch electrode and the human body (hand, etc.).

This application note explains the hardware specifications of the 3D Gesture Demo Set (RTK0EG0014D00001BJ) which is a sample application of the CTSU mutual capacitance method.

## Target Device

RX130 Group

## Related Documents

1. RX Family CTSU API Reference Guide (R30AN0215EJ)
2. RX Family CTSU Mutual-capacitance Touch Measurement (R30AN0217EJ)
3. RX113 Group CTSU Basis of Cap Touch Detection (R30AN0218EJ)
4. RX Family CTSU 3D Gesture Demo Set Sample Software（R01AN4101EJ）
5. RX231 Group CTSU Application Example: 3D Gesture Demo Set (Hardware)（R01AN4219EJ）

# Contents

## 1. Overview

The RTK0EG0014D00001BJ is a demonstration kit that detects 3D gesture motion by CTSU of RX130. This demo kit has the following features.

- Simple parts configuration: gesture detection only requires an MCU, electrodes on a substrate pattern, a resistor and a capacitor.
- Quick and easy setup and operation: compact and light, powered via USB, uses just three switches
- Detection distance from about 100 mm (board size: 80 mm x 80 mm)
- Easy-to-use demo (runs with PC demo application)
- Includes all tools and necessary interfaces (USB, BLE, E1 emulator)

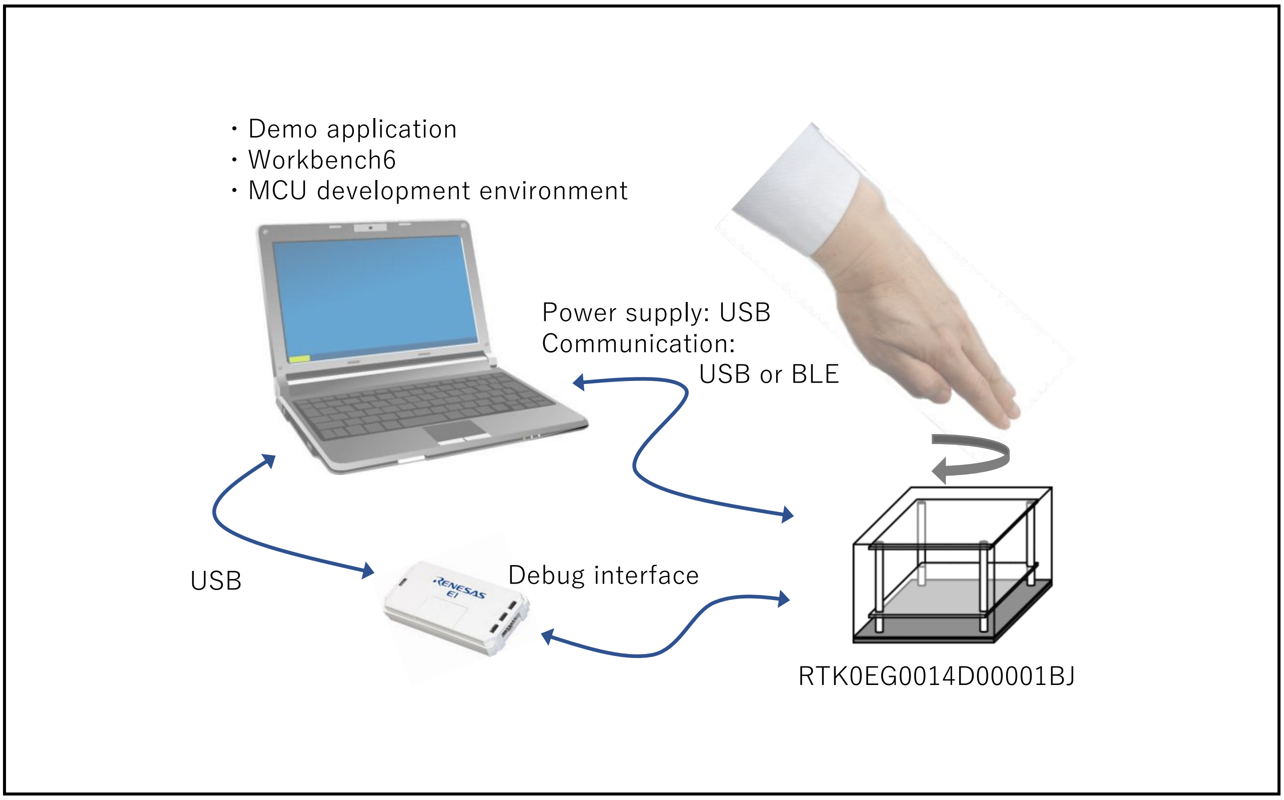


**Figure 1-1 3D Gesture Demo System**

## 2. External Appearance

Figure 2-1 toFigure 2-3 show the external appearance and part names related to the 3D Gesture Demo Set.

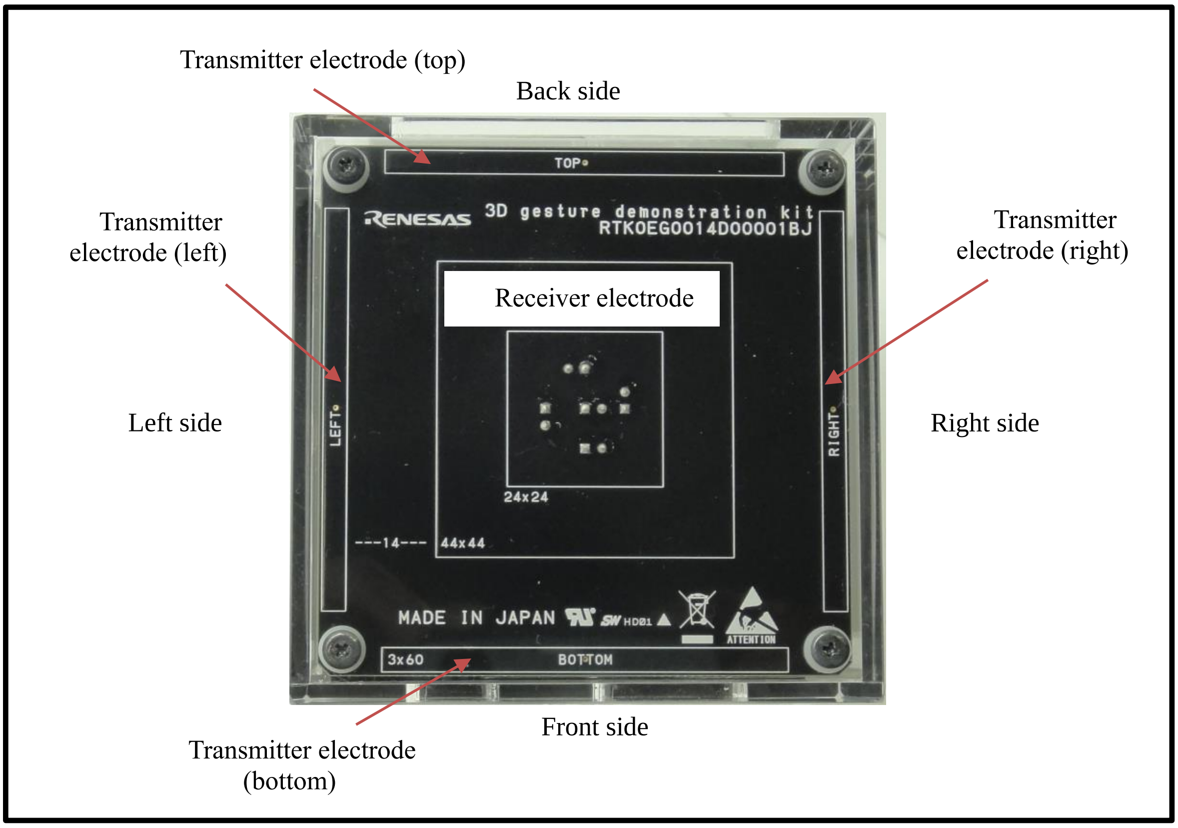


**Figure 2-1 External Appearance (top view)**

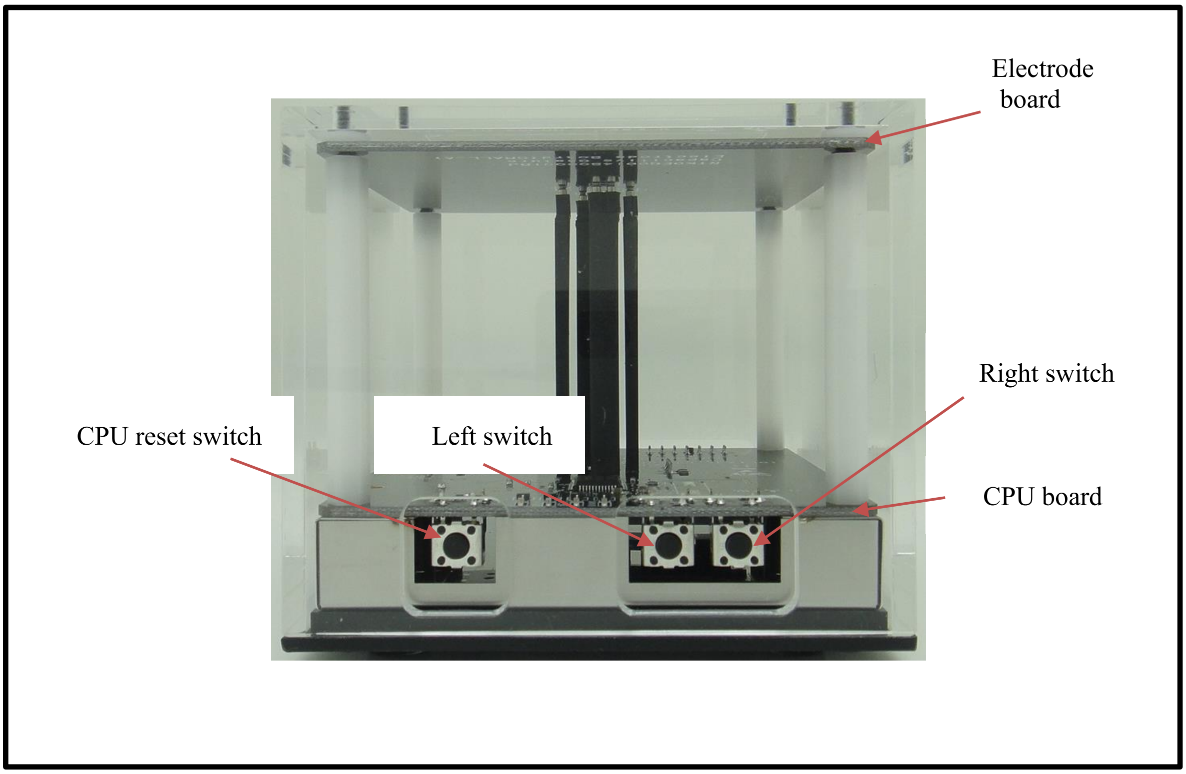


**Figure 2-2 External Appearance (front view)**

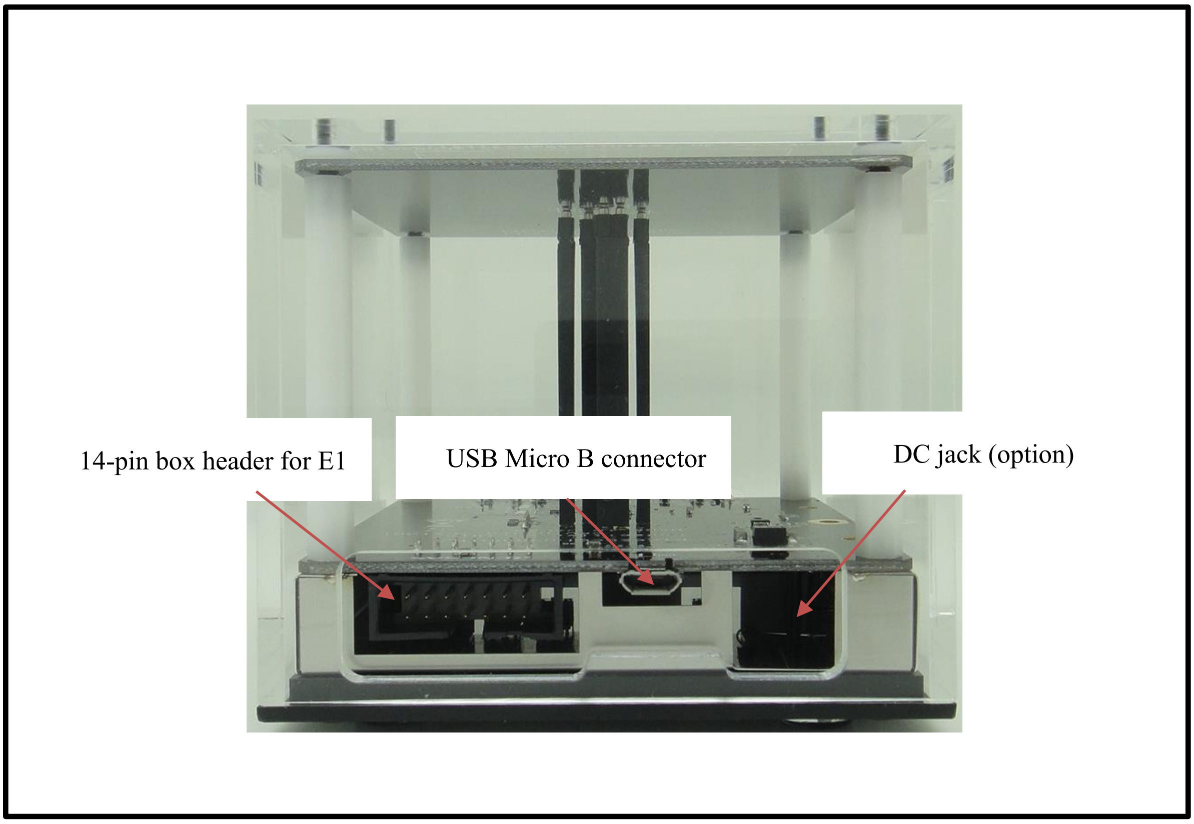


**Figure 2-3** External Appearance (back view)

## 3. Hardware Specification

**Table 3-1 Hardware Specification**

| Item | Description | Notes |
|---|---|---|
| Board size | 80.0×80.0[mm] | Upper board: electrode board<br>Lower board: CPU board |
| CPU | RX130<br>(R5F51305ADFL) | ROM: 128KB RAM: 16KB<br>Data flash: 8KB<br>Package: 48-pin LFQFP (0.5mm pitch)<br>Operating ambient temperature: -40～85℃ |
| Clock input | On-chip oscillator | |
| | External 8MHz crystal unit | Option |
| LEDs | Power supply: 1 orange | |
| | Function display:<br>2 orange, 2 green | CPU port control |
| Switches | Push switch: 3 | ・ CPU reset switch<br>・ Left switch<br>・ Right switch |
| | Slide switch: 4 | ・ Power supply input selection (USB/DC jack)<br>・ CPU drive voltage selection (5V/3.3V)<br>・ For internal adjustment (2). Settings cannot be changed. |
| Gesture detection electrodes | Receiver electrode: 4 | Top, bottom, left, right |
| | Transmitter electrode: 1 | |
| USB serial conversion interface | Connector: USB Micro B | |
| | IC: FTDI's FT232RL | Full-speed transfer |
| Wireless module | RL78/G1D built-in module:<br>RY7011A0000DZ00<br>Conversion board:<br>RTK0EN0013A01001BJ | Bluetooth v4.1 specification<br>(Low Energy, single mode) |
| Debug interface | 14-pin box header for E1 | |
| Power supply | USB bus powered (VBUS): 5V | |
| | Power supply connector (DC jack): 5V | Φ5.5mm, center plus, option |

# 4. Block Diagram

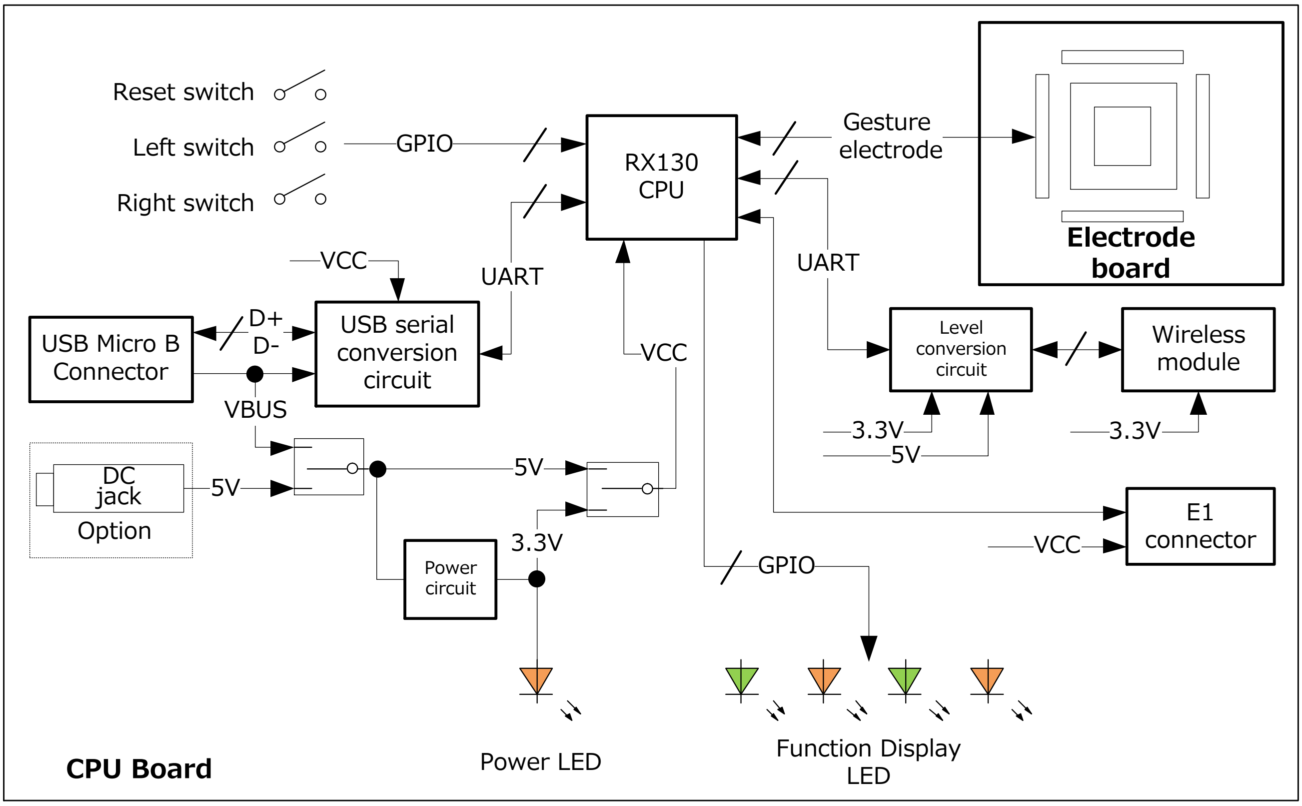


**Figure 4-1 Block Diagram**

# 5. Circuit Diagram

## 5.1 CPU Board: RTK0EG0014C00001BJ

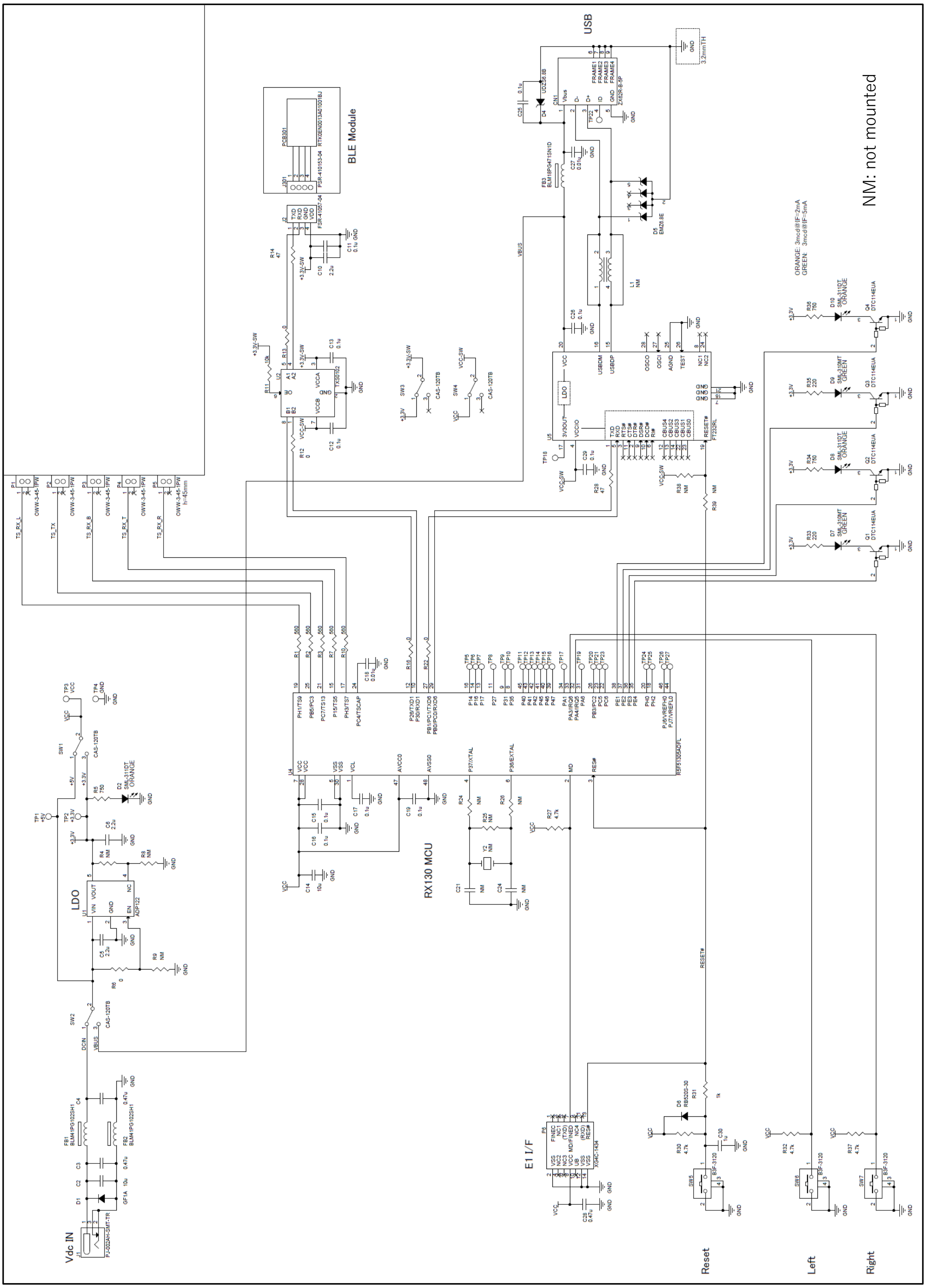


**Figure 5-1 CPU Board (RTK0EG0014C00001BJ) Circuit Diagram**

## 5.2 Electrode Board: RTK0EG0014B00001BJ

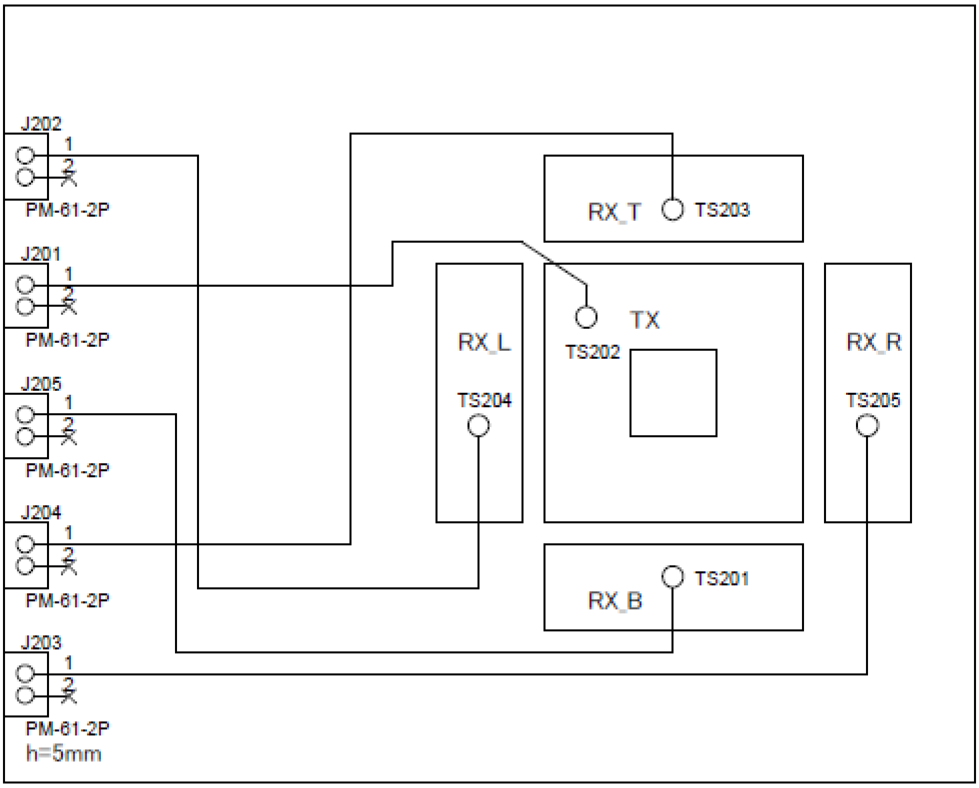


**Figure 5-2 Electrode Board (RTK0EG0014B00001BJ) Circuit Diagram**

# 6. CPU Board Layouts

## 6.1 CPU Board: RTK0EG0014C00001BJ

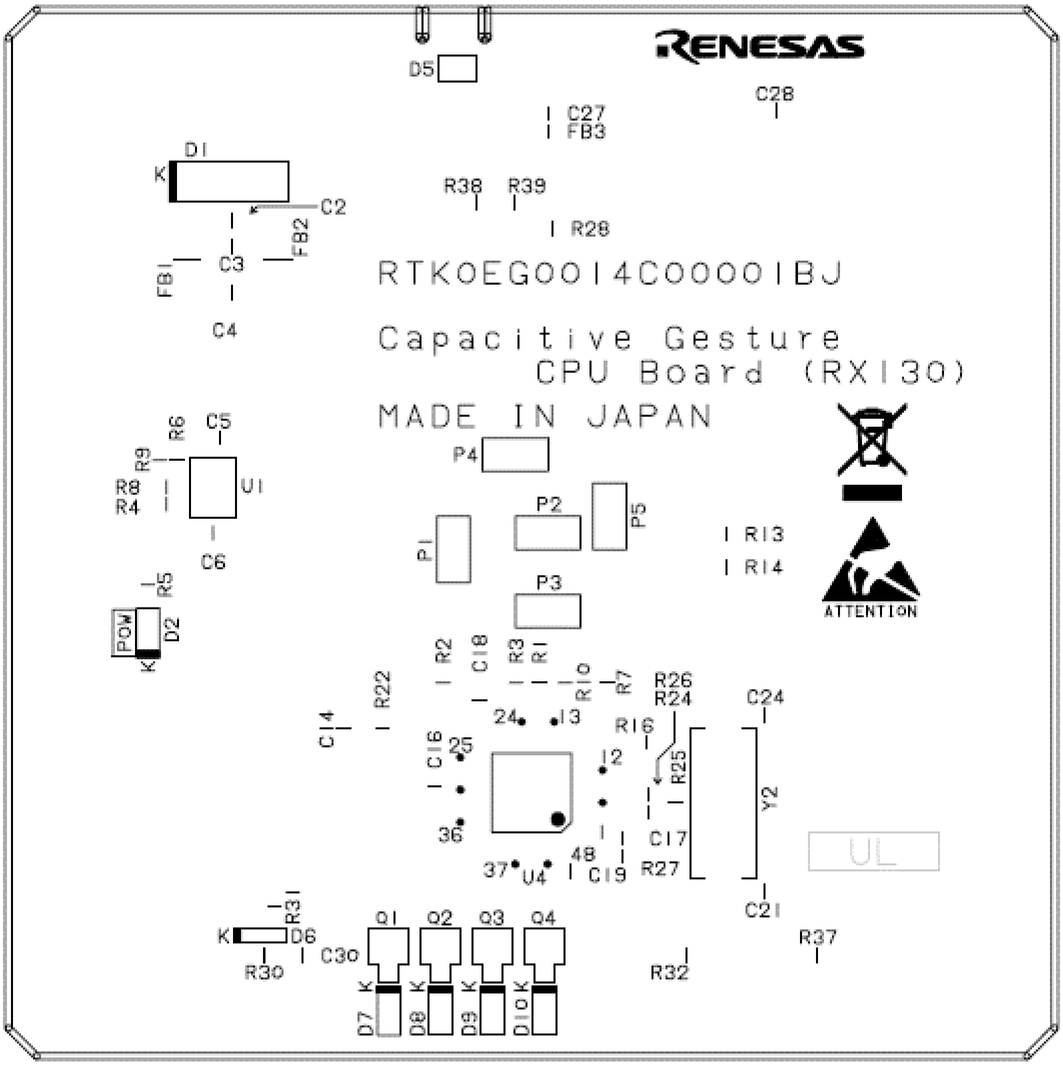


**Figure 6-1 Component Side Silkscreen (top view)**

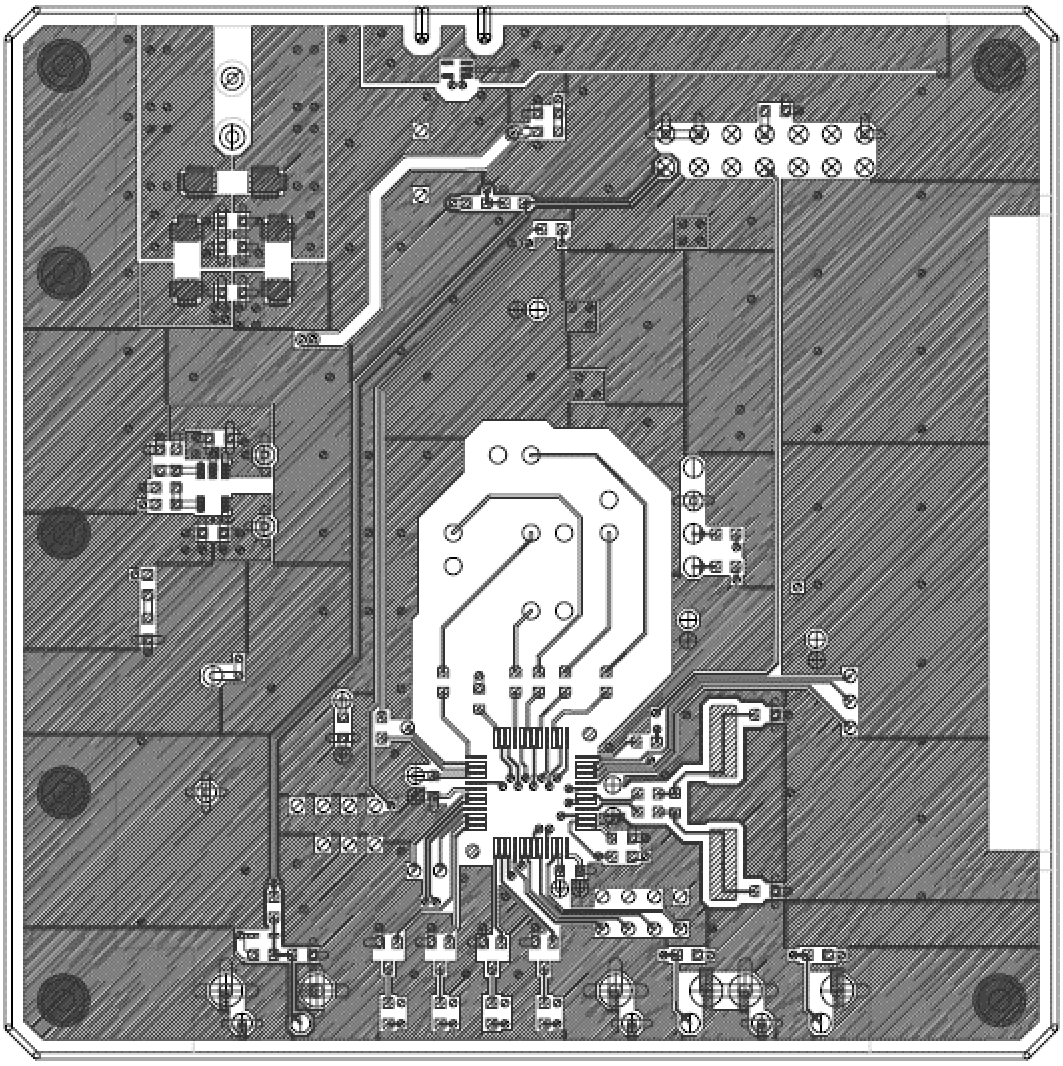

**Figure 6-2 1st Layer Pattern (top view)**

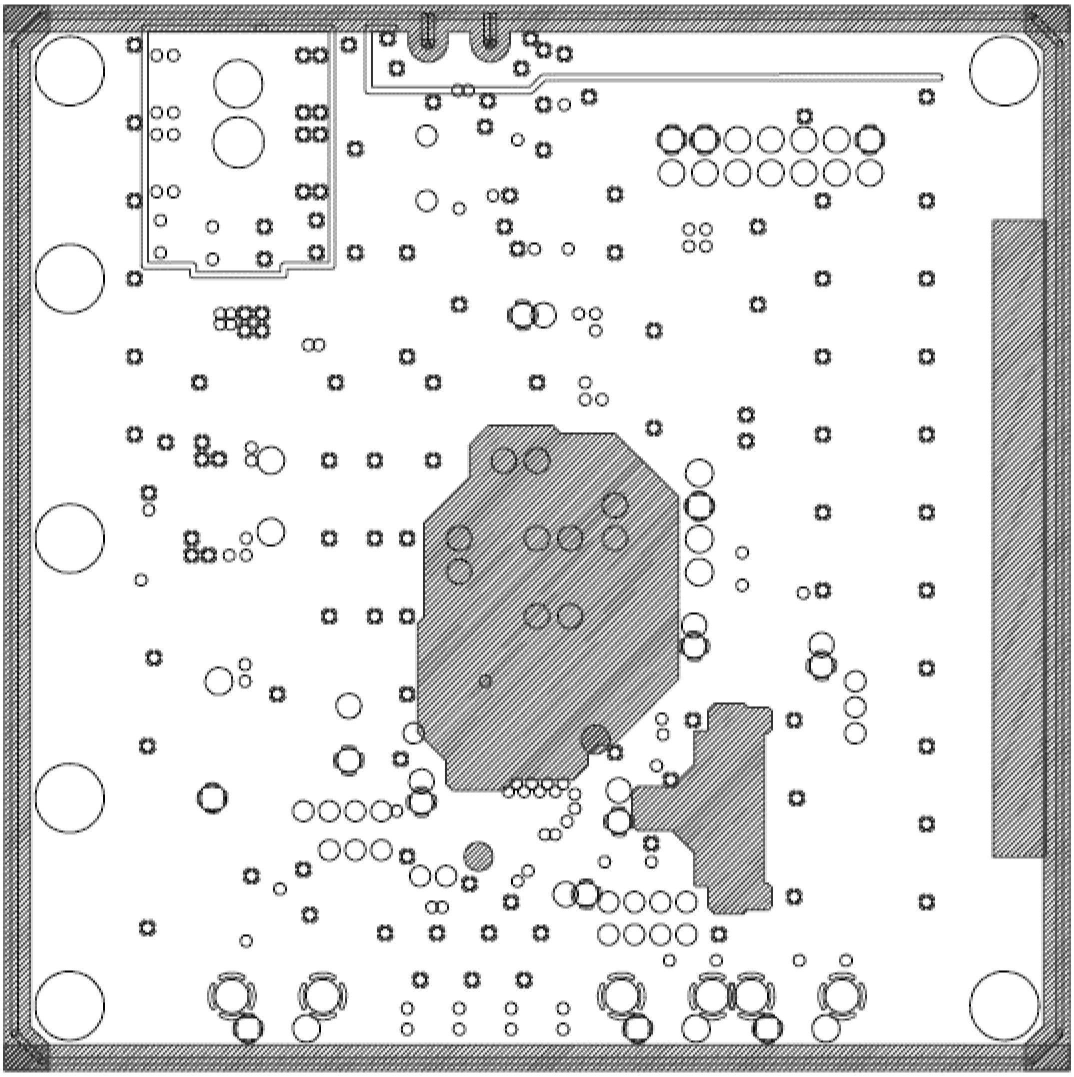

**Figure 6-3 2nd Layer Pattern (top view, negative-positive inversion)**

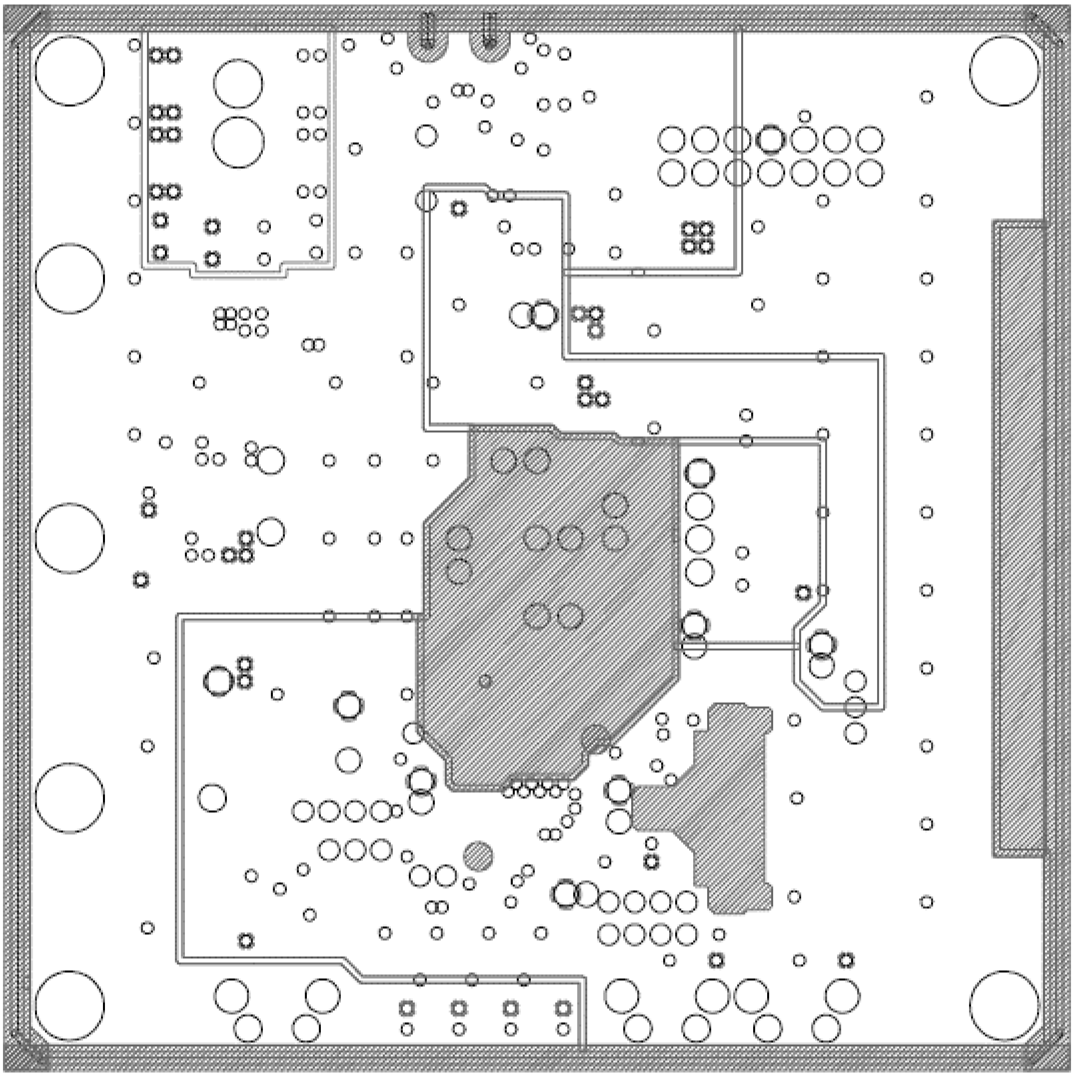

**Figure 6-4 3rd Layer Pattern (top view, negative-positive inversion)**

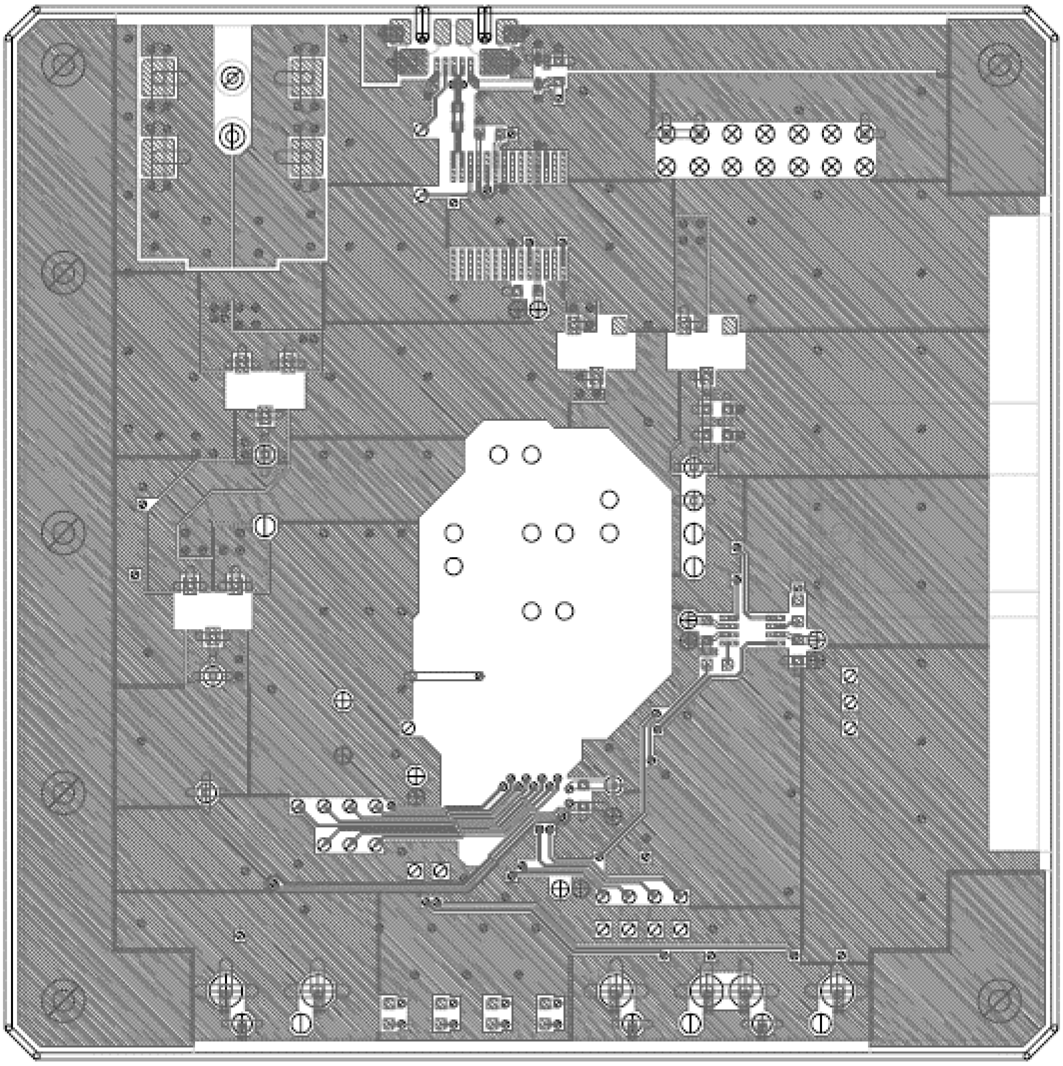

**Figure 6-5 4th Layer Pattern (top view)**

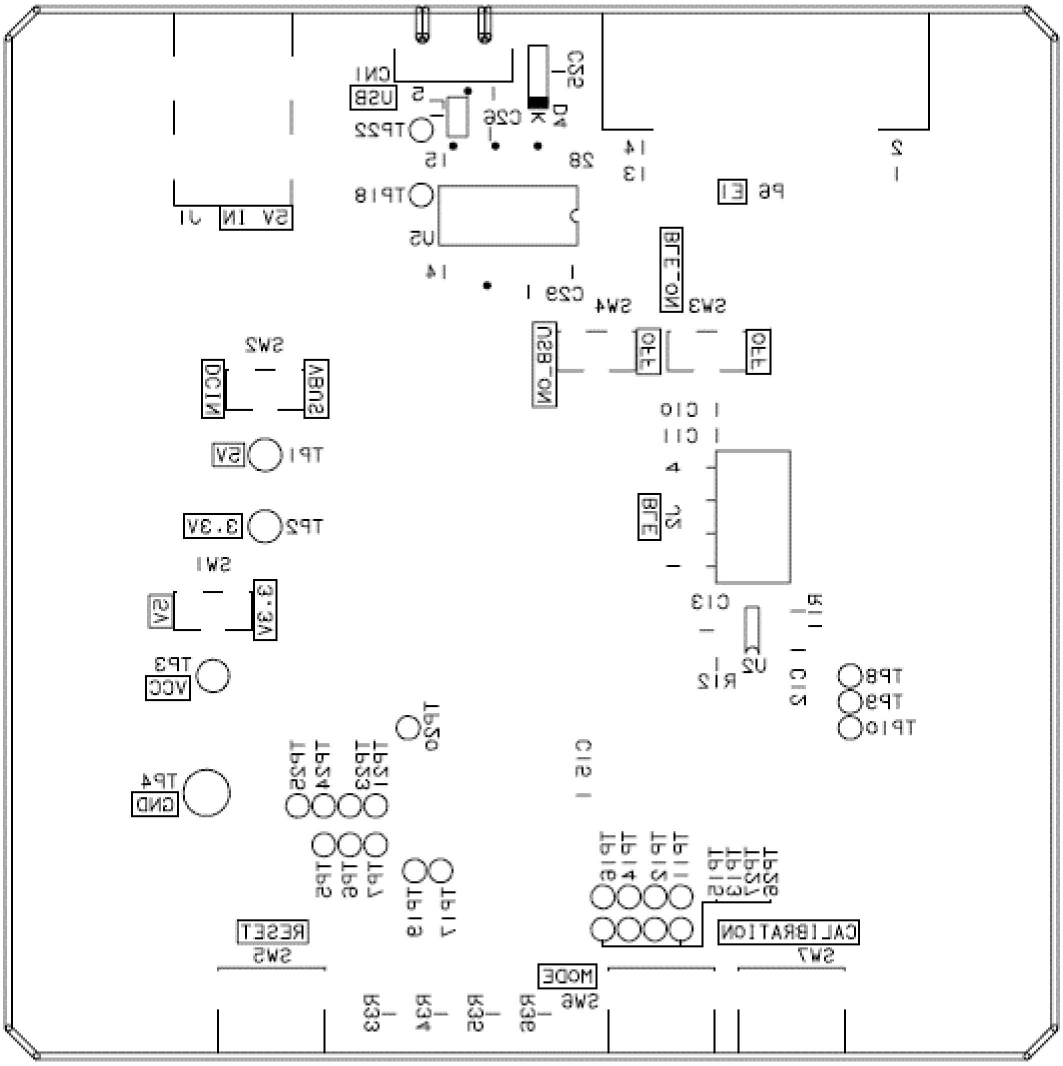


**Figure 6-6 Solder Side Silkscreen (top view)**

## 6.2 Electrode Board: RTK0EG0014B00001BJ

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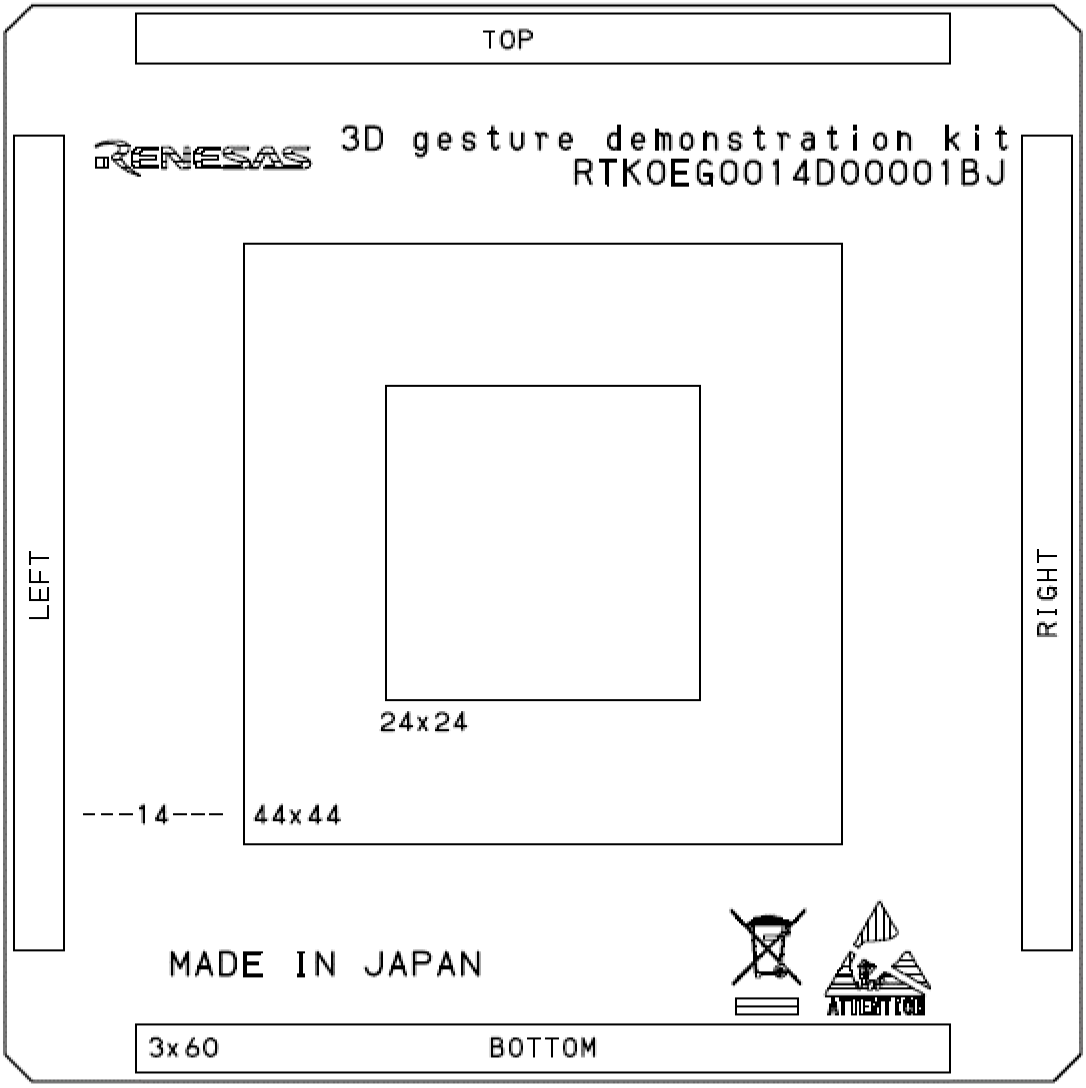


**Figure 6-7 Component Side Silkscreen (top view)**

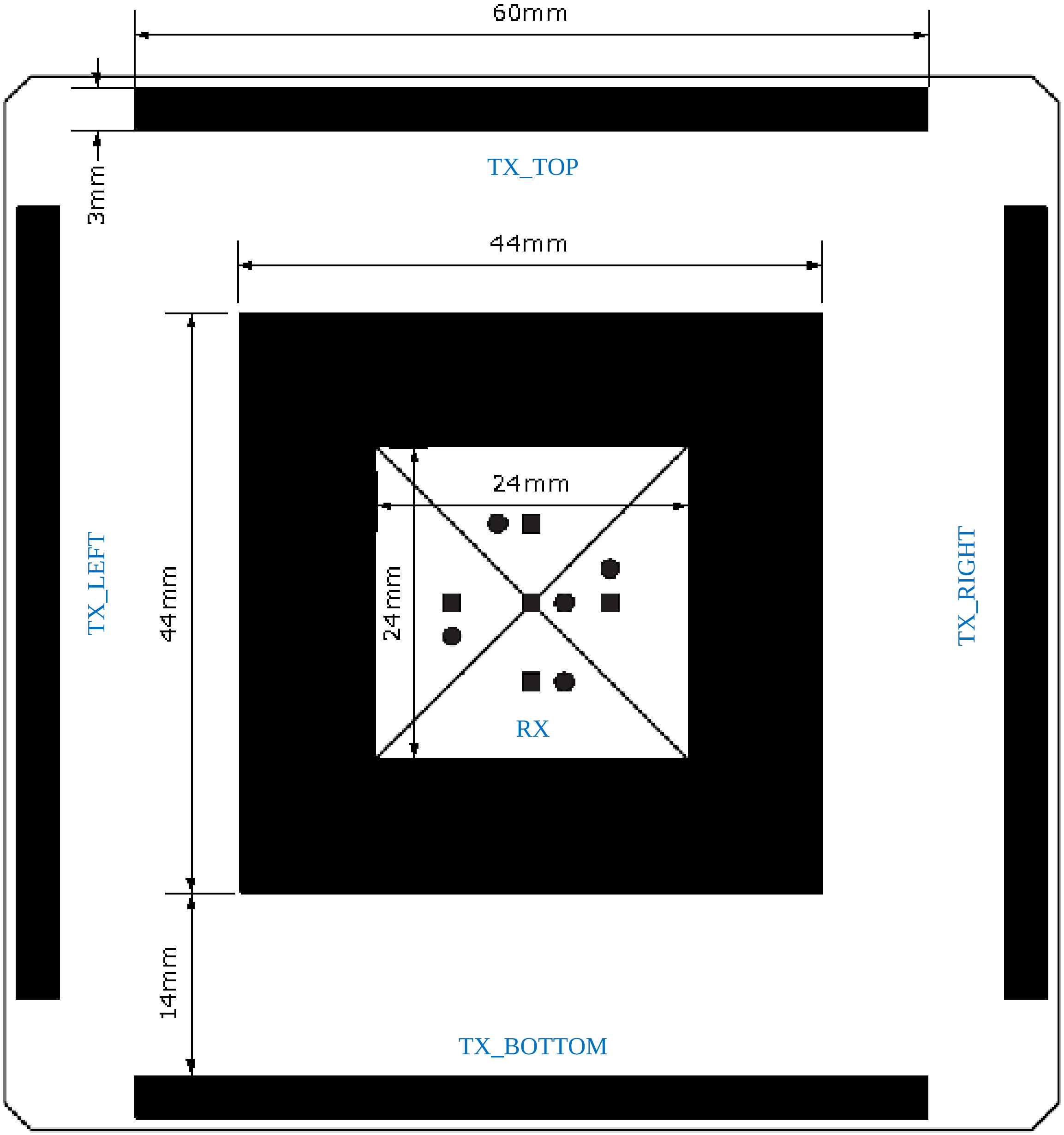


**Figure 6-8 Component Side Pattern (top view)**

The TX and 4 RX electrodes are all copper solid patterns.

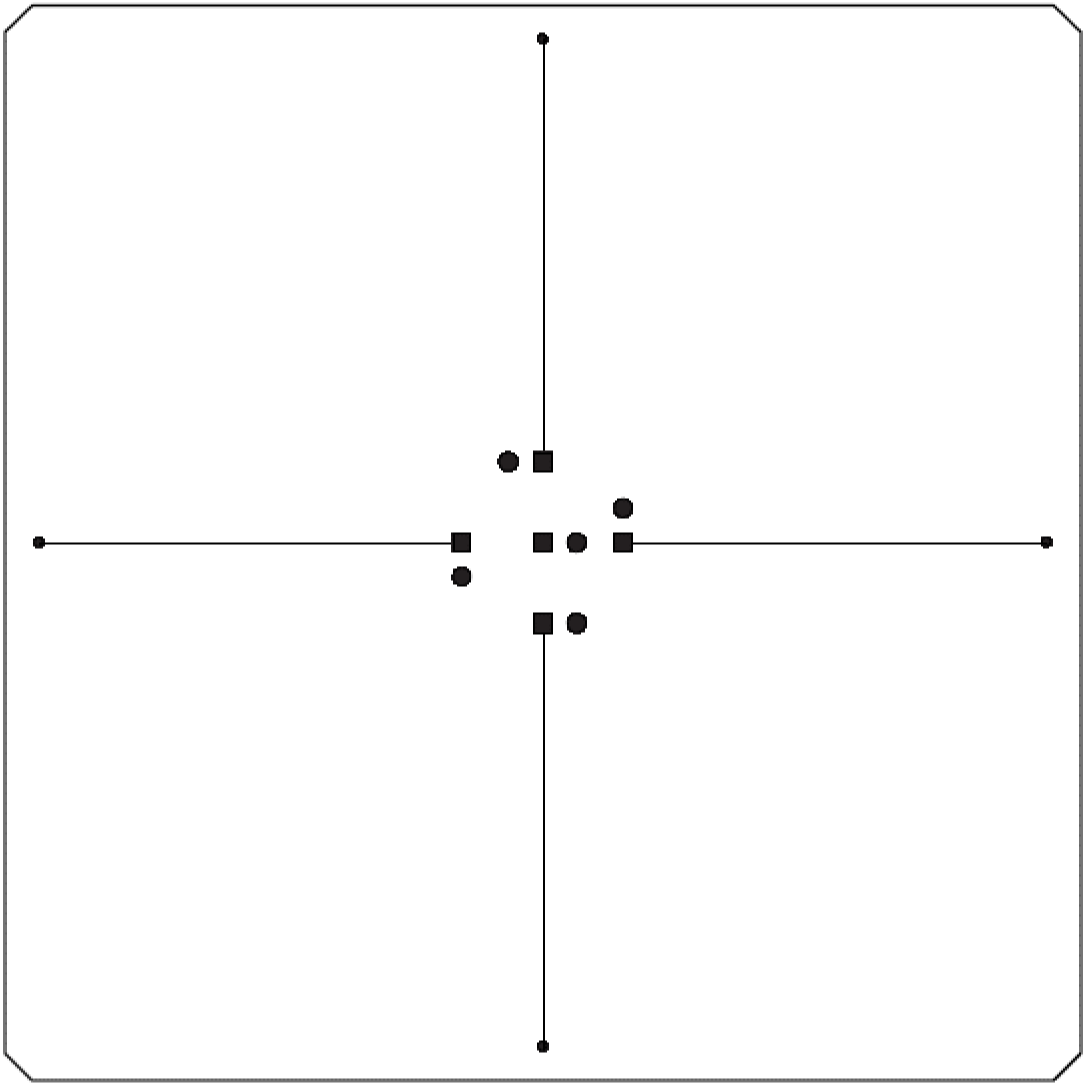

**Figure 6-9 Solder Side Pattern (top view)**

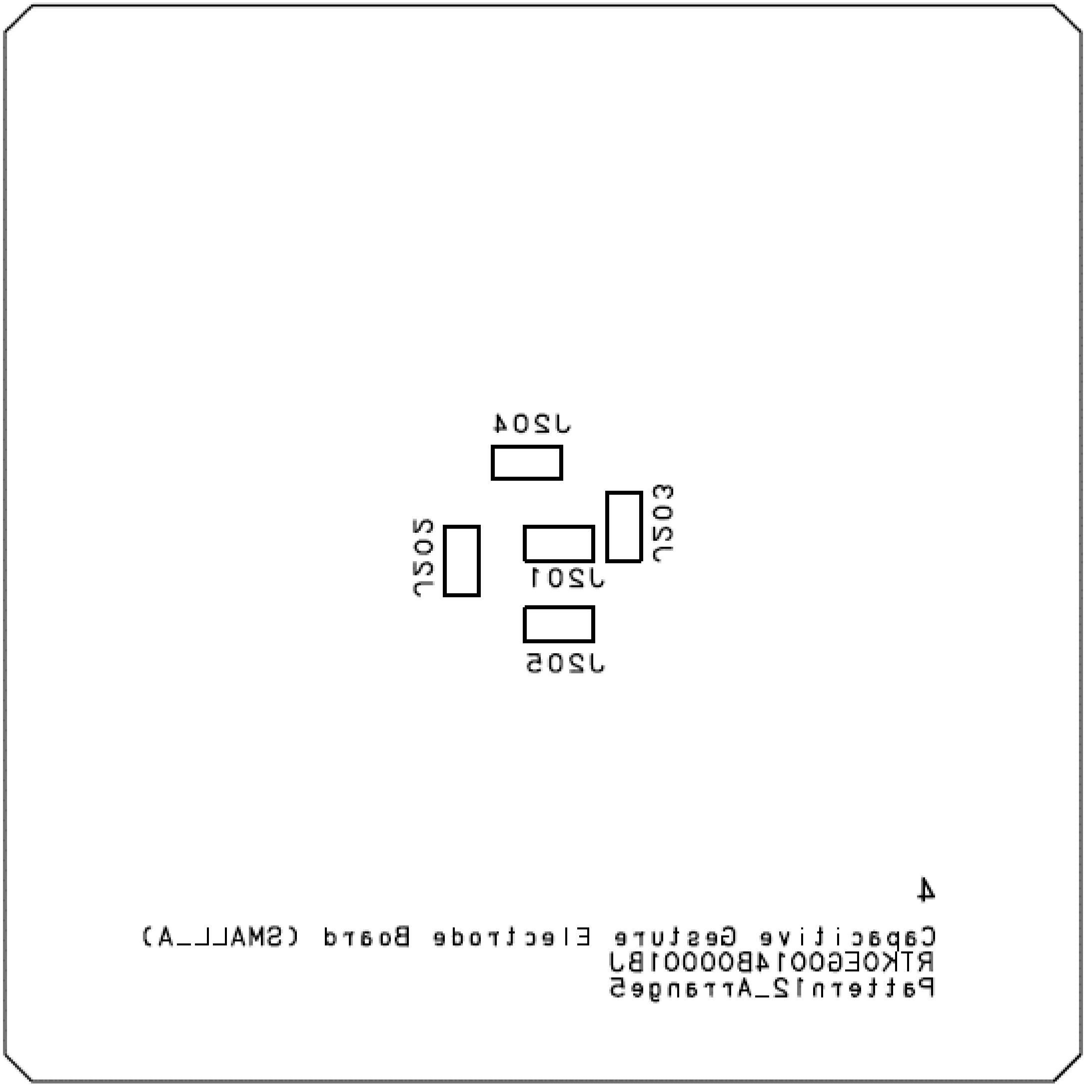


**Figure 6-10 Solder Side Silkscreen (top view)**

# 7. CPU Board/Electrode Board: BOM (parts list)

**Table 7-1 CPU Board/Electrode Board: BOM (1/3)**

| Item | Quantity | Reference | Part | Manufacturer | Part number | Remarks |
|---|---|---|---|---|---|---|
| 1 | 1 | CN1 | ZX62R-B-5P | HIROSE | ZX62R-B-5P | MICRO USB B CONNECTOR SMD |
| 2 | 2 | C2,C14 | 10u | MURATA | GRM188R61E106MA73D | CAP CERAMIC 10UF 25V X5R 1608 |
| 3 | 3 | C3,C4,C28 | 0.47u | MURATA | GRM188B31E474KA75D | CAP CERAMIC 0.47UF 25V B 1608 |
| 4 | 3 | C5,C6,C10 | 2.2u | MURATA | GRM188B31C225KE14D | CAP CERAMIC 2.2UF 16V B 1608 |
| 5 | 10 | C11,C12,C13,C15,C16,C17,C19,C25,C26,C29 | 0.1u | MURATA | GRM188B11E104KA01 | CAP CERAMIC 0.1UF 25V B 1608 |
| 6 | 2 | C18,C27 | 0.01u | MURATA | GRM188B11H103K | CAP CERAMIC 0.01UF 50V B 1608 |
| 7 | 2 | C21,C24 | NM | | | 1608 PAD |
| 8 | 1 | C30 | 1u | MURATA | GRM188B31E105KA75D | CAP CERAMIC 1UF 25V B 1608 |
| 9 | 1 | D1 | GF1A | Vishay | GF1A-E3/67A | DIODE 50V 1A |
| 10 | 3 | D2,D8,D10 | SML-311DT | ROHM | SML-311DTT86 | LED ORANGE 1608 |
| 11 | 1 | D4 | UDZS6.8B | ROHM | UDZSTE-176.8B | DIODE ZENER 6.8V 200MW UMD2 |
| 12 | 1 | D5 | EMZ6.8E | ROHM | EMZ6.8ET2R | DIODE ZENER ARRAY 6.8V EMD5 |
| 13 | 1 | D6 | RB520S-30 | ROHM | RB520S-30 | DIODE SCHOTTKY 30V 200MA EMD2 |
| 14 | 2 | D7,D9 | SML-310MT | ROHM | SML-310MTT86 | LED GREEN 1608 |
| 15 | 2 | FB1,FB2 | BLM41PG102SH1 | MURATA | BLM41PG102SH1 | FERRITE BEAD 1 KOHM 4.5x1.6 |
| 16 | 1 | FB3 | BLM18PG471SN1D | MURATA | BLM18PG471SN1 | FERRITE BEAD 470 OHM 1608 |
| 17 | 1 | J1 | PJ-002AH-SMT-TR | CUI | PJ-002AH-SMT-TR | DC JACK |
| 18 | 1 | J2 | FSR-41057-04 | Hirosugi-Keiki | FSR-41057-04 | 2.54MM PITCH RIGHT ANGLE SOCKET PIN |
| 19 | 5 | J201,J202,J203,J204,J205 | PM-61-2P | MAC EIGHT(MAC8) | PM-61-2P | STACKING CONNECTOR 1x2P H=5mm |
| 20 | 1 | J301 | PSR-410153-04 | Hirosugi-Keiki | PSR-410153-04 | 2.54MM RIGHT ANGLE HEADER 1x4PIN |
| 21 | 1 | L1 | NM | MURATA | DLP11SN900HL2L | COMMON MODE CHOKE COIL 150MA 90 OHM SMD |
| 22 | 1 | PCB301 | RTK0EN0013A01001BJ | RENESAS | RTK0EN0013A01001BJ | RL78/G1D CONVERSION BOARD |

**Table 7-2 CPU Board/Electrode Board: BOM (2/3)**

| Item | Quantity | Reference | Part | Manufacturer | Part number | Remarks |
|---|---|---|---|---|---|---|
| 23 | 5 | P1,P2,P3,P4,P5 | OWW-3-45-1PW | MAC EIGHT(MAC8) | OWW-3-45-1PW | STACKING CONNECTOR 1x2P H=45mm |
| 24 | 1 | P6 | XG4C-1434 | OMRON | XG4C-1434 | 14P CONNECTOR, RIGHT ANGLE, TH |
| 25 | 4 | Q1,Q2,Q3,Q4 | DTC114EUA | ROHM | DTC114EUAT106 | DTR 200MW UMT3 |
| 26 | 5 | R1,R2,R3,R7,R10 | 560 | ROHM | MCR03ERTJ561 | RES SMD 560 OHM 5% 1/10W 1608 |
| 27 | 1 | R4 | NM | ROHM | MCR03EZPFX5602 | 1608 PAD |
| 28 | 3 | R5,R34,R36 | 750 | ROHM | MCR03ERTJ751 | RES SMD 750 OHM 5% 1/10W 1608 |
| 29 | 5 | R6,R12,R13,R16,R22 | 0 | ROHM | MCR03EZPJ000 | RES SMD 0 OHM JUMPER 1/10W 1608 |
| 30 | 1 | R8 | NM | ROHM | MCR03EZPFX1002 | 1608 PAD |
| 31 | 1 | R9 | NM | ROHM | MCR03EZPJ000 | 1608 PAD |
| 32 | 1 | R11 | 10k | ROHM | MCR03ERTJ103 | RES SMD 10K OHM 5% 1/10W 1608 |
| 33 | 2 | R14,R28 | 47 | ROHM | MCR03ERTF47R0 | RES SMD 47 OHM 5% 1/10W 1608 |
| 34 | 5 | R24,R25,R26,R38,R39 | NM | ROHM | | 1608 PAD |
| 35 | 4 | R27,R30,R32,R37 | 4.7k | ROHM | MCR03ERTJ472 | RES SMD 4.7K OHM 5% 1/10W 1608 |
| 36 | 1 | R31 | 1k | ROHM | MCR03EZPJ102 | RES SMD 1K OHM 5% 1/10W 1608 |
| 37 | 2 | R33,R35 | 220 | ROHM | MCR03ERTF2200 | RES SMD 220 OHM 5% 1/10W 1608 |
| 38 | 4 | SW1,SW2,SW3,SW4 | CAS-120TB | Nidec Copal Electronics | CAS-120TB | SWITCH SLIDE SPDT 100MA 6V |
| 39 | 3 | SW5,SW6,SW7 | B3F-3120 | OMRON | B3F-3120 | TACT SW, RIGHT ANGLE, TH |
| 40 | 1 | TP1 | +5V | | | 1mm TH, SILK"5V" |
| 41 | 1 | TP2 | +3.3V | | | 1mm TH, SILK"3.3V" |
| 42 | 1 | TP3 | VCC | | | 1mm TH, SILK"VCC" |
| 43 | 1 | TP4 | GND | SUNHAYATO | SLC-22G-K | TEST POINT, SILK"GND" |
| 44 | 23 | TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13,TP14,TP15,TP16,TP17,TP18,TP19,TP20,TP21,TP22,TP23,TP24,TP25,TP26,TP27 | TP | | | 0.5mm TH |

**Table 7-3 CPU Board/Electrode Board: BOM (3/3)**

| Item | Quantity | Reference | Part | Manufacturer | Part number | Remarks |
|---|---|---|---|---|---|---|
| 45 | 1 | TS201 | RX-BOTTOM | | | ELECTRODE PATTERN |
| 46 | 1 | TS202 | TX | | | ELECTRODE PATTERN |
| 47 | 1 | TS203 | RX_TOP | | | ELECTRODE PATTERN |
| 48 | 1 | TS204 | RX_LEFT | | | ELECTRODE PATTERN |
| 49 | 1 | TS205 | RX_RIGHT | | | ELECTRODE PATTERN |
| 50 | 1 | U1 | ADP122 | Analog Devices | ADP122AUJZ-3.3-R7 | LDO 3.3V 300MA TSOT5 |
| 51 | 1 | U2 | TXS0102 | Texas Instruments | TXS0102DCTR | Voltage Level Translator 2ch SM8 |
| 52 | 1 | U4 | R5F51305ADFL | RENESAS | R5F51305ADFL#30 | RX130 MCU 48LQFP |
| 53 | 1 | U5 | FT232RL | FTDI | FT232RL | USB to Serial UART Enhanced IC SSOP-28 |
| 54 | 1 | Y2 | NM | RALTRON | AS-8.000-18-SMD | CRYSTAL 8M HC-49 18PF |

NM indicates “not mounted.”

# 8. EMC Countermeasure Examples

Detection of 3D gestures uses linear data sampled at regular time intervals. Therefore, unlike switches that only judge two values, i.e. ON/OFF, EMC countermeasures for 3D detection is difficult because a noise margin cannot be secured.

In this demo set, noise countermeasures are implemented from both hardware and software standpoints. This document describes examples of hardware-based countermeasures.

Required noise immunity and countermeasures differ depending on user system specifications. The countermeasures shown here are just a few examples and may not applicable to all systems. When implementing countermeasures, please carry out thorough evaluations on your product system.

## 8.1 Power Input Section Filter

The filter circuit shown in Figure 8-1 is added to the demo set to suppress noise input and output from the power cable.

## 8.2 Metal Plate Shielding

The demo set is shielded with the metal plate shown in Figure 8-1 to improve the coupling between the ground (earth) and the CPU board GND, as well as strengthen the GND.

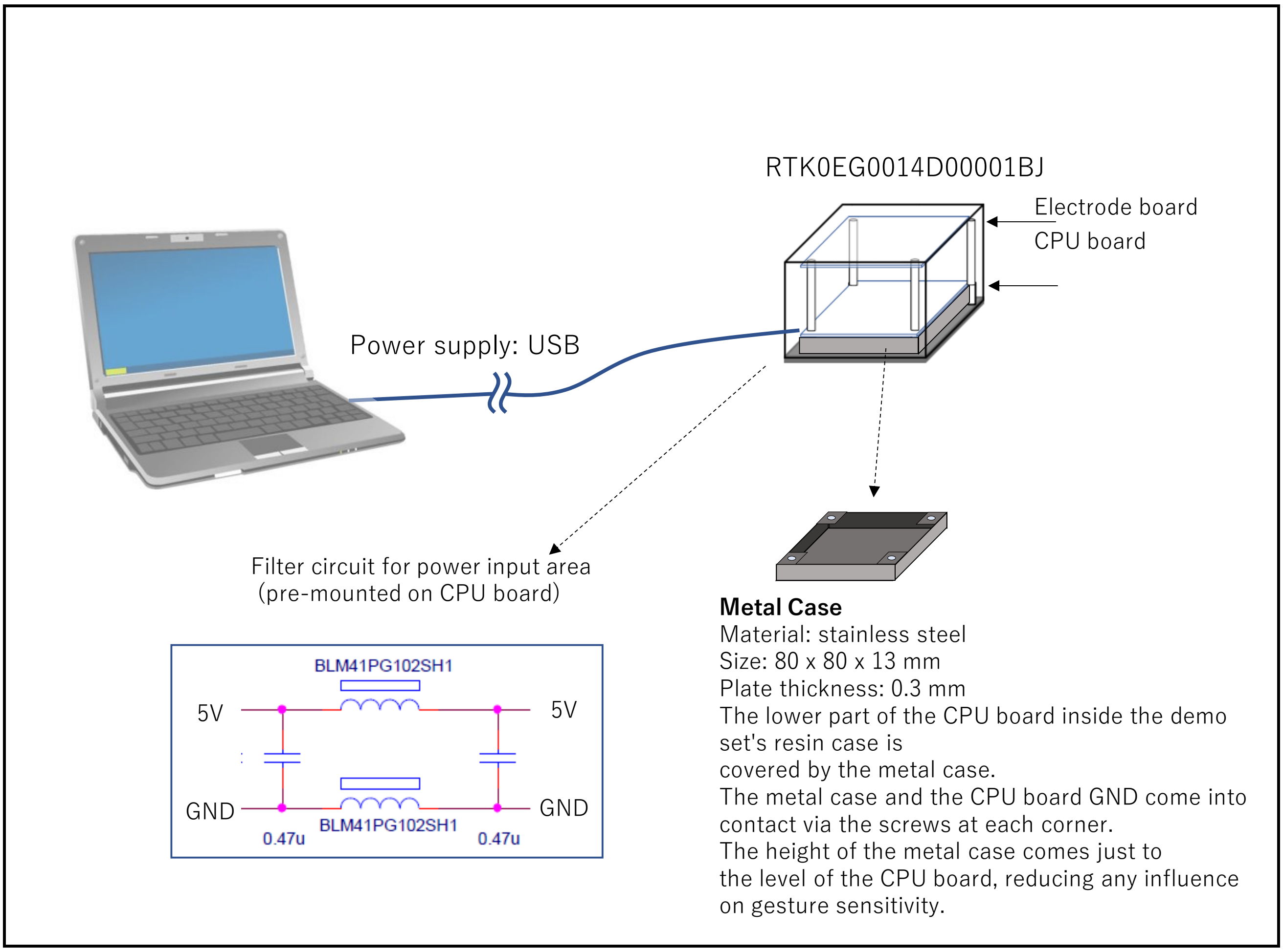


**Figure 8-1 EMC Countermeasure Example**

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Revision History

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Apr 12, 2018 | | First edition issued |

## 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. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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.

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