

RX231 Group

R01AN4219EJ0100

Rev.1.00

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

Jan 16, 2018

Introduction

The RX231 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 (RTK5RX2310D00000BR) which is a sample application of the CTSU mutual capacitance method.

Target Devices

RX231 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. CTSU 3D Position Calculation Sample Software (R01AN4101EJ)

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1. Overview

The RTK5RX2310D00000BR is a demonstration kit that detects 3D gesture motion by CTSU of RX231. 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: basically the demo board is already enclosed in a case and uses just three switches.
- Detection distance from about 200 mm (board size: 160 mm x 160 mm)
- Easy-to-use demo (runs with PC demo application)
- Includes all tools and necessary interfaces (USB, BLE, E1 emulator)

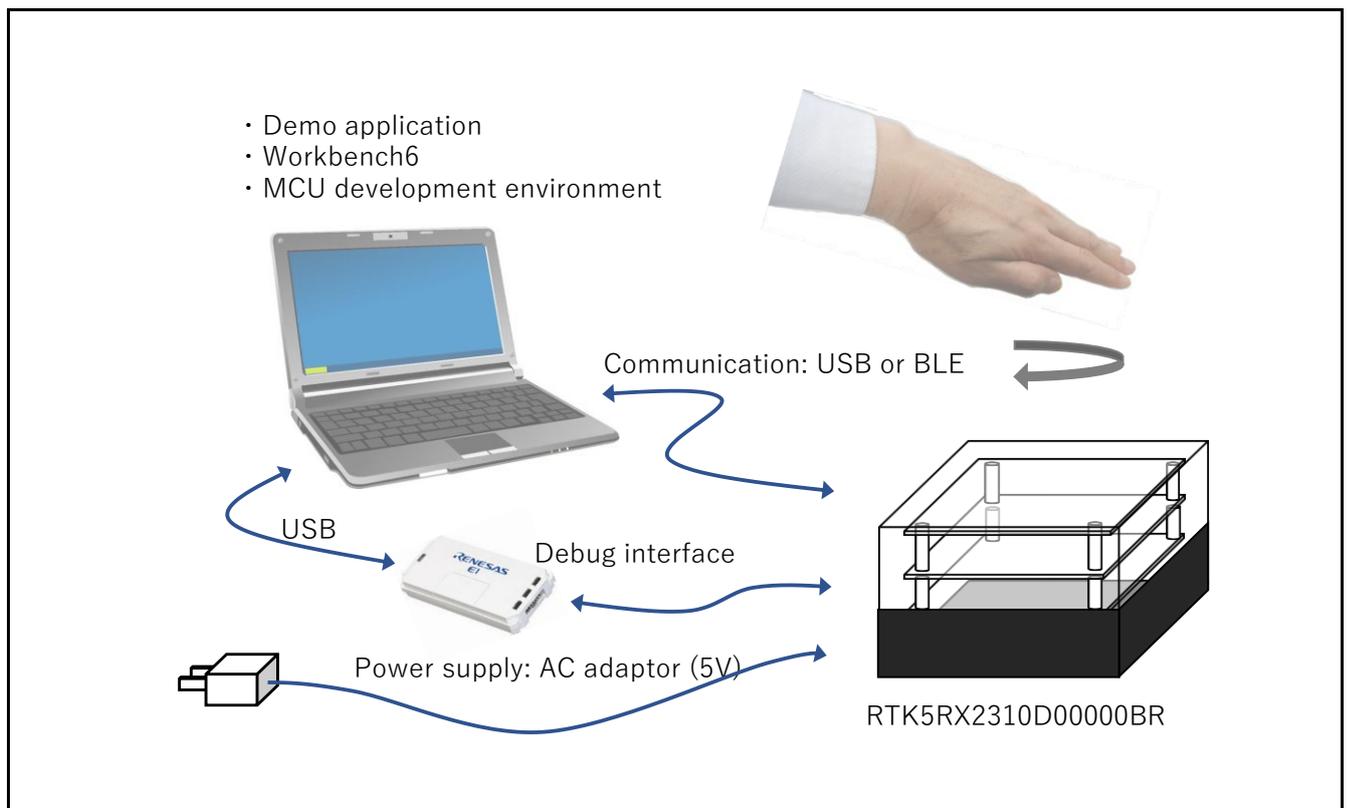


Figure 1-1 3D Gesture Demo System

2. External Appearance

Figure 2-1 to Figure 2-4 show the external appearance and part names related to the 3D Gesture Demo Set.

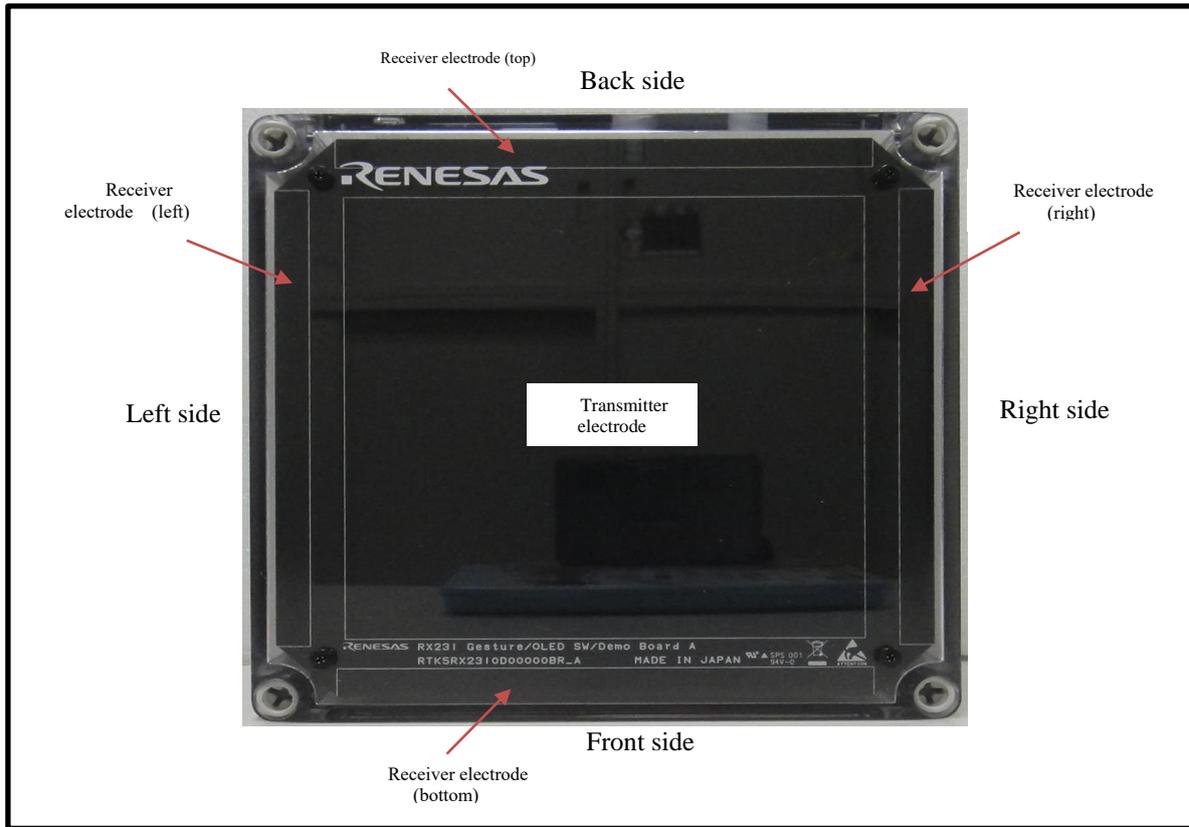


Figure 2-1 External Appearance (top view)

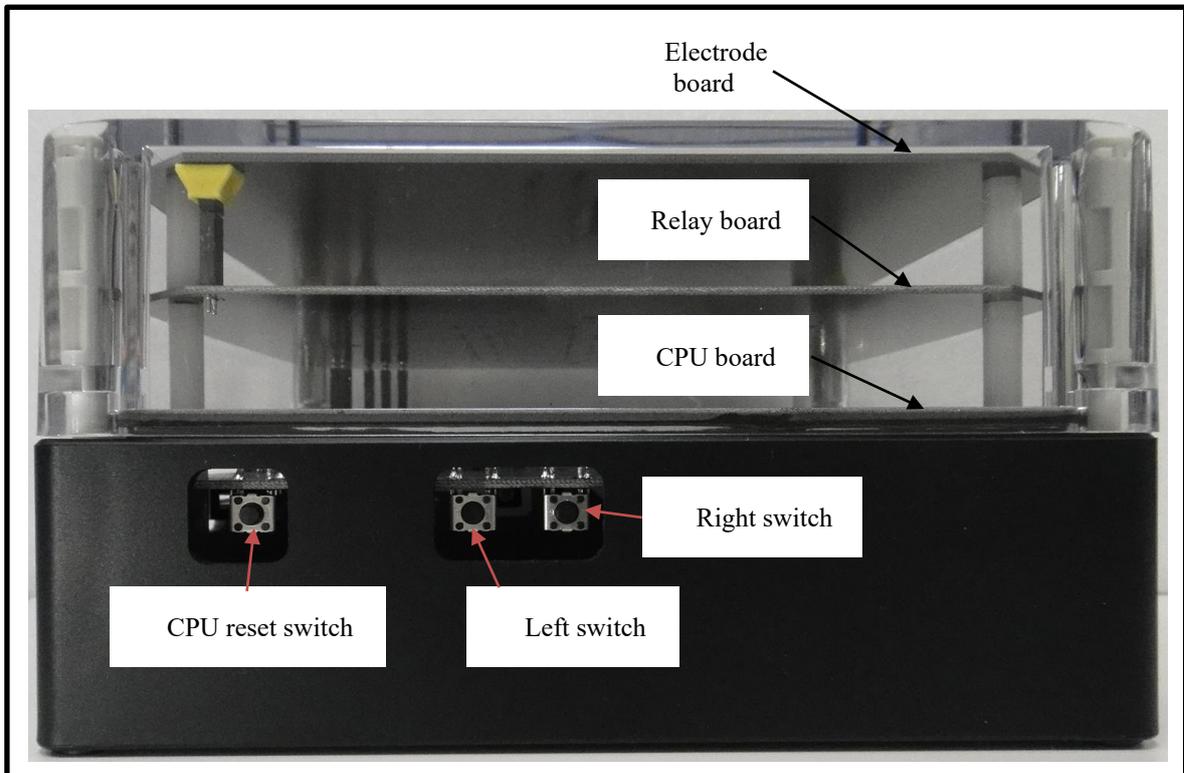


Figure 2-2 External Appearance (front view)

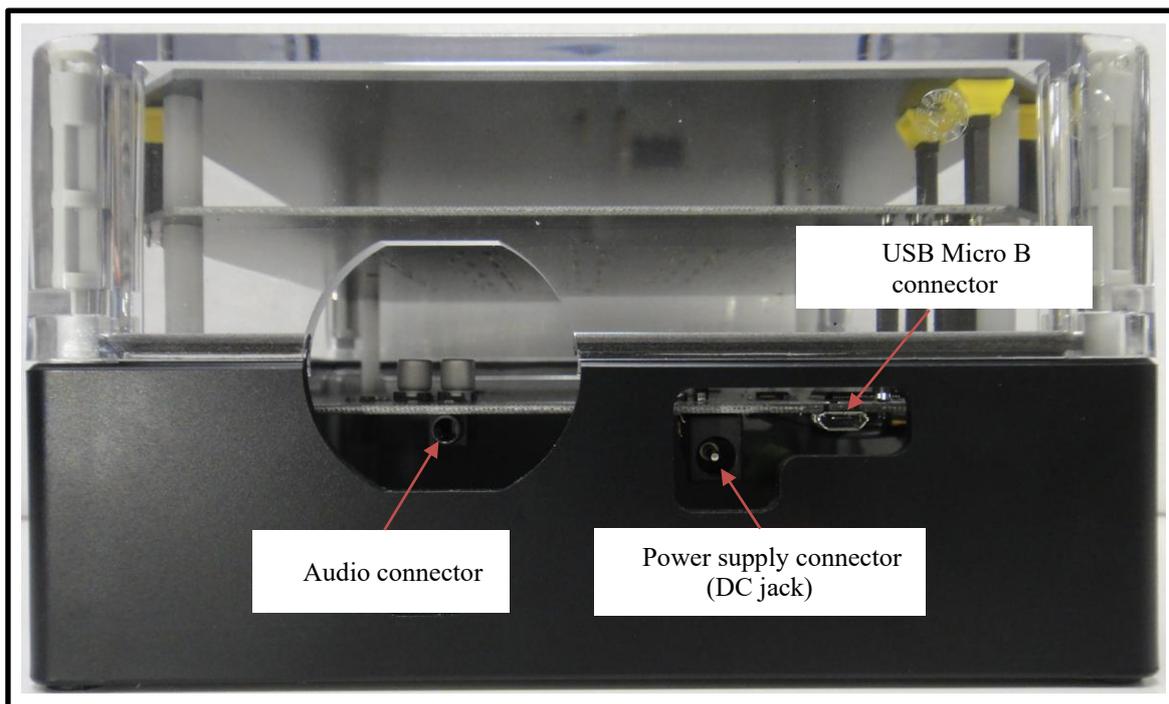


Figure 2-3 External Appearance (back view)

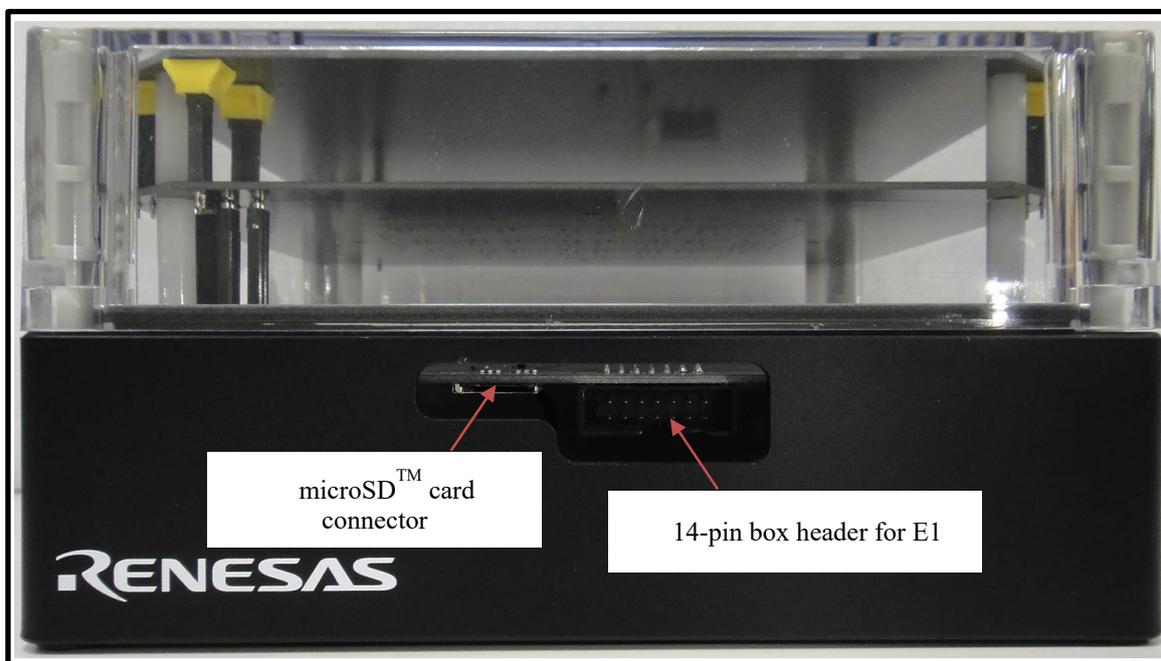


Figure 2-4 External Appearance (left side view)

3. Hardware Specification

Table 3-1 Hardware Specification

Item	Description	Notes
Board size	160.0×160.0[mm]	Upper board: electrode board Middle board: relay board Lower board: CPU board
CPU	RX231 (R5F52318BDFP)	ROM: 512KB RAM: 64KB Data flash: 8KB Package: 100-pin LFQFP (0.5mm pitch) Encryption: yes CAN: yes SD host interface: yes Operating ambient temperature: -40~85°C
Clock input	RX231 main clock: 16MHz	Crystal unit
	RX231 subclock: 32.768kHz	Crystal unit
	Audio D/A converter: 11.2896MHz	Crystal oscillator (option)
	Wireless module built-in CPU subclock for RL78/G1D: 32.768kHz	Crystal unit
LEDs	Function display: 2 orange, 2 green	CPU board control
Switches	Push switch: 3	<ul style="list-style-type: none"> • CPU reset switch • Left switch • Right switch
	DIP switch: 1	USB boot mode setting
Gesture detection electrodes	Receiver electrode: 4	Top, bottom, left, right
	Transmitter electrode: 1	
Wireless module	RL78/G1D built-in module: RY7011A0000DZ00	Bluetooth v4.1 specification (Low Energy, single mode)
USB interface	USB Micro B connector	Full-speed transfer
Debug interface	14-pin box header for E1	
SD host interface (option)	microSD™ card connector	Default speed mode
Audio output (option)	Audio connector: φ 3.5mm stereo mini jack	Output level: 1Vrms (0dB at playback, IC output terminal) External load resistance: 12Ω or more
	D/A converter IC: PCM1774 (manufactured by TI)	
Power supply	Power supply connector (DC jack): 5V	Φ 5.5mm, center plus board internal voltage: 3.3V

4. Block Diagram

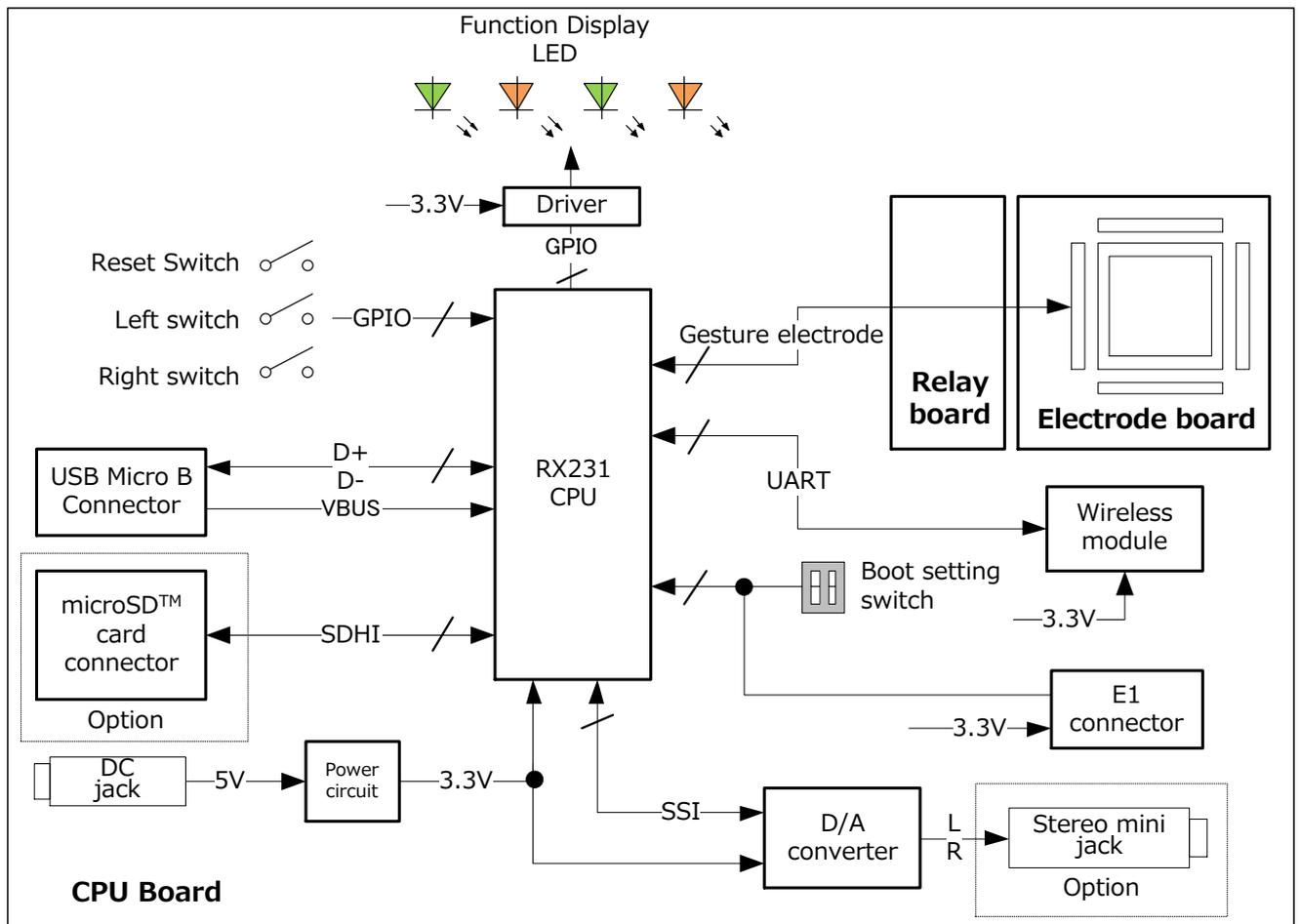


Figure 4-1 Block Diagram

5. Circuit Diagram

5.1 CPU Board

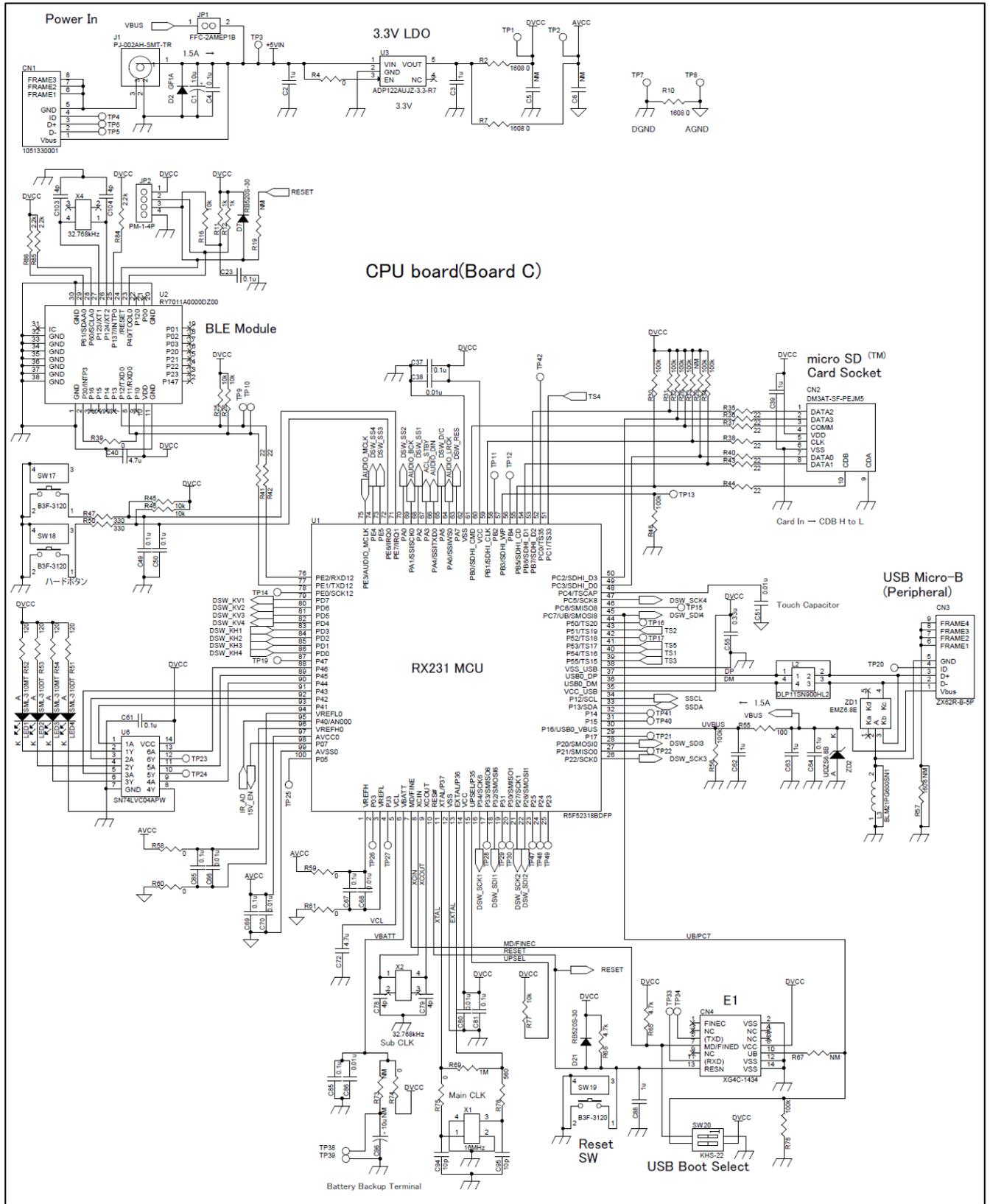


Figure 5-1 CPU Board Circuit Diagram (1/2)

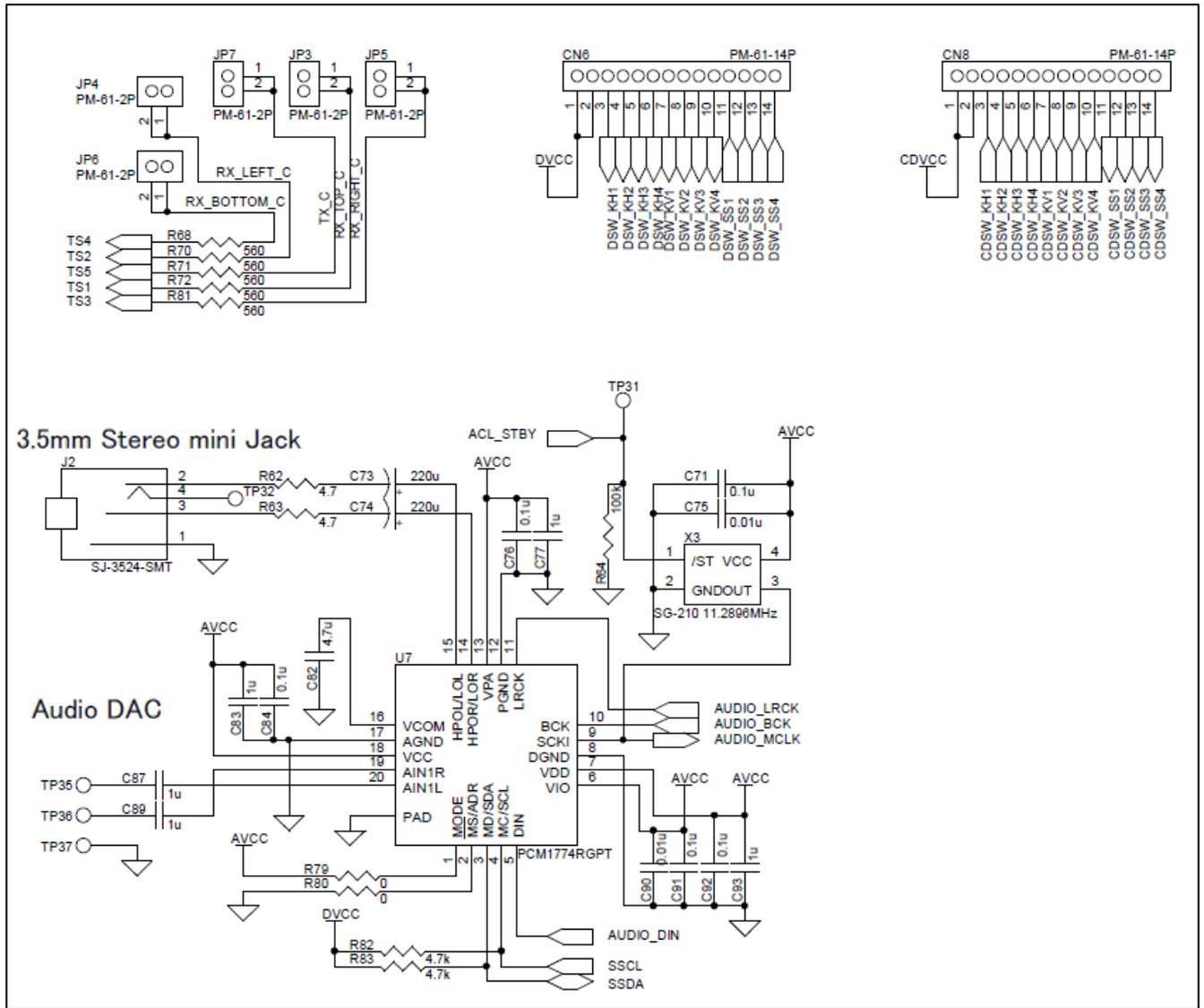


Figure 5-2 CPU Board Circuit Diagram (2/2)

5.2 Relay Board

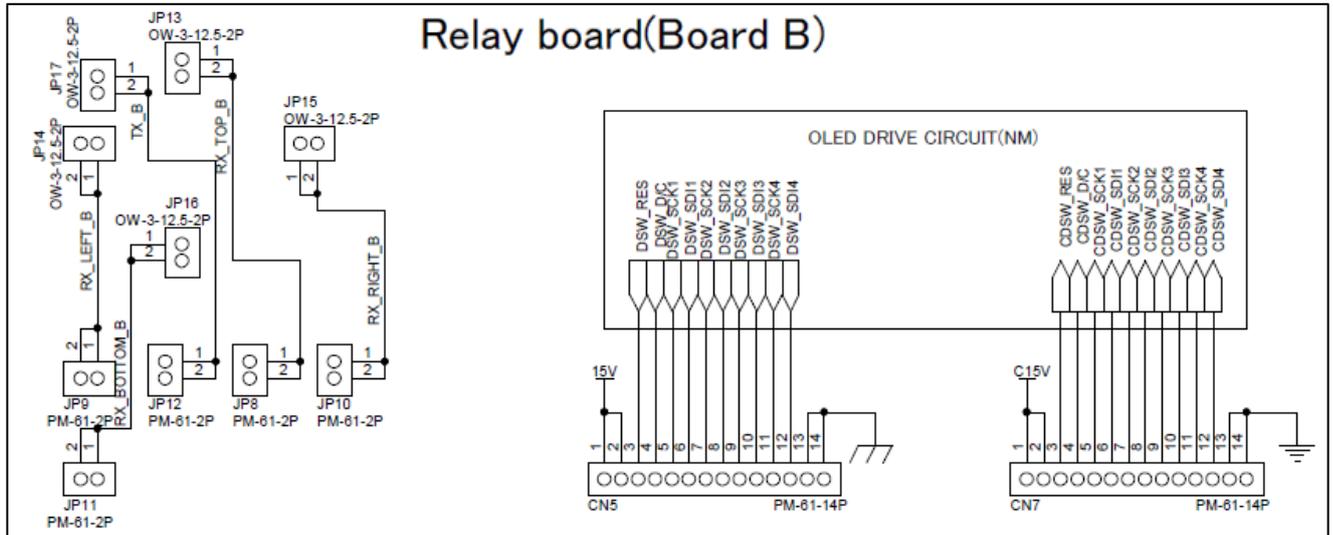


Figure 5-3 Relay Board Circuit Diagram

5.3 Electrode Board

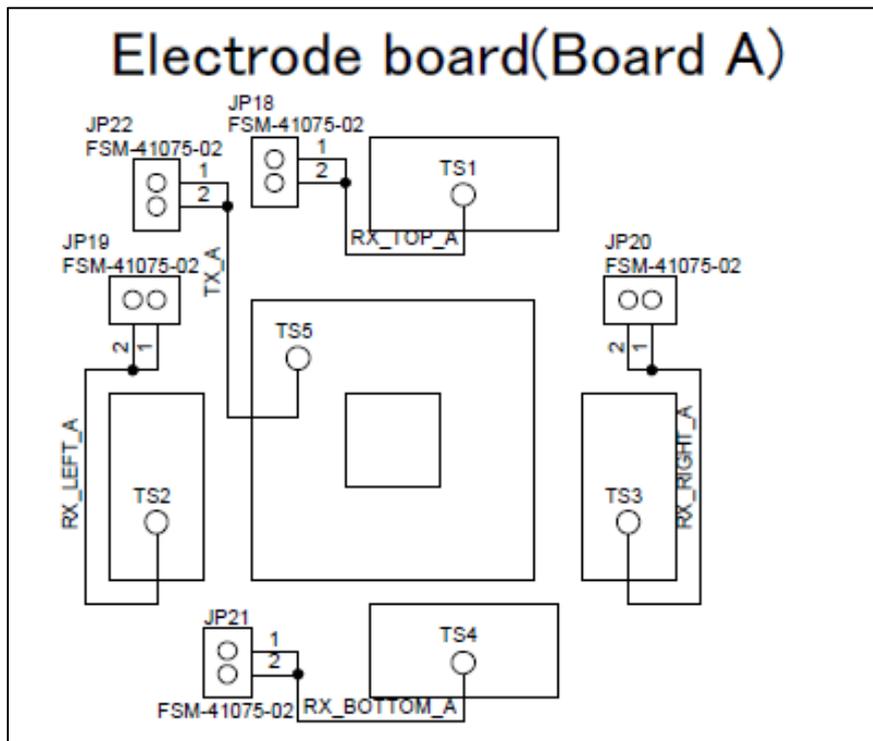


Figure 5-4 Electrode Board Circuit Diagram

6. BOM (parts list)

Table 6-1 BOM (1/2)

Item	Quantity	Reference	Part	Manufacture	Part number	Remarks
1	1	CN1	1051330001	Molex	1051330001	NM
2	1	CN2	DM3AT-SF-PEJM5	HIROSE	DM3AT-SF-PEJM5	
3	1	CN3	ZX62R-B-5P	HIROSE	ZX62R-B-5P	
4	1	CN4	XG4C-1434	OMRON	XG4C-1434	
5	4	CN5,CN6,CN7,CN8	PM-61-14P	MAC EIGHT	PM-61-14P	NM
6	1	C1	10u	Nichicon	UWX1C100MCL2GB	10uF,16V
7	11	C2,C3,C39,C62,C63,C77,C83,C87,C88,C89,C93	1u	MURATA	GRM188B31A105KA61	
8	17	C4,C23,C37,C49,C50,C61,C64,C65,C67,C69,C71,C76,C81,C84,C85,C91,C92	0.1u	MURATA	GRM188B11E104KA01	
9	2	C5,C6	NM			1608 CAP PAD
10	9	C38,C51,C66,C68,C70,C75,C80,C86,C90	0.01u	MURATA	GRM188B11H103K	
11	3	C40,C72,C82	4.7u	MURATA	GRM188B31A475KE15	
12	1	C55	0.33u	MURATA	GRM188B11A334K	
13	2	C73,C74	220u	Nichicon	UUD1A221MCL1GS	
14	4	C78,C79,C103,C104	4p	MURATA	GRM1885C1H4ROCA01D	
15	2	C94,C95	10p	MURATA	GRM1885C1H100JA01D	
16	1	C96	10u NM	Nichicon	UWX1C100MCL2GB	NM
17	1	D2	GF1A	Vishay	GF1A-E3/67A	
18	2	D7,D21	RB520S-30	ROHM	RB520S-30	
19	1	JP1	FFC-2AMEP1B	HONDA TSUSHIN KOGYO	FFC-2AMEP1B	NM
20	1	JP2	PM-1-4P	MAC EIGHT	PM-1-4P	NM
21	10	JP3,JP4,JP5,JP6,JP7,JP8,JP9,JP10,JP11,JP12	PM-61-2P	MAC EIGHT	PM-61-2P	
22	5	JP13,JP14,JP15,JP16,JP17	OW-3-12.5-2P	MAC EIGHT	OW-3-12.5-2P	
23	5	JP18,JP19,JP20,JP21,JP22	FSM-41075-02	HIROSUGI- KEIKI	FSM-41075-02	
24	1	J1	PJ-002AH-SMT-TR	CUI	PJ-002AH-SMT-TR	
25	1	J2	SJ-3524-SMT	CUI	SJ-3524-SMT	
26	2	LED1,LED3	SML-310MT	ROHM	SML-310MT	
27	2	LED2,LED4	SML-310DT	ROHM	SML-310DT	
28	1	L2	DLP11SN900HL2	MURATA	DLP11SN900HL2	NM
29	1	L3	BLM21PG600SN1	MURATA	BLM21PG600SN1	NM
30	3	R2,R7,R10	1608 0	ROHM	MCR03EZPJ000	
31	10	R4,R39,R58,R59,R60,R61,R74,R75,R79,R80	0	ROHM	MCR03EZPJ000	
32	2	R11,R12	1k	ROHM	MCR03EZPJ102	

Table 6-2 BOM (2/2)

Item	Quantity	Reference	Part	Manufacture	Part number	Remarks
33	6	R16,R25,R26,R45,R46,R77	10k	ROHM	MCR03ERTJ103	
34	4	R19,R33,R67,R73	NM			1608 RES PAD
35	10	R28,R29,R30,R31,R32,R34,R48,R56,R64,R78	100k	ROHM	MCR03ERTJ104	
36	9	R35,R36,R37,R38,R40,R41,R42,R43,R44	22	ROHM	MCR03ERTJ220	
37	2	R47,R50	330	ROHM	MCR03ERTJ331	
38	4	R51,R52,R53,R54	120	ROHM	MCR03ERTJ121	
39	1	R55	100	ROHM	MCR03ERTJ101	
40	1	R57	1608 NM			1608 RES PAD
41	2	R62,R63	4.7	ROHM	MCR03ERTJ4R7	
42	4	R65,R66,R82,R83	4.7k	ROHM	MCR03ERTJ472	
43	6	R68,R70,R71,R72,R76,R81	560	ROHM	MCR03ERTJ561	
44	1	R69	1M	ROHM	MCR03EJPJ105	
45	3	R84,R85,R86	2.2k	ROHM	MCR03EJPJ222	
46	3	SW17,SW18,SW19	B3F-3120	OMRON	B3F-3120	
47	1	SW20	KHS-22	OTAX	KHS-22	
48	5	TP1,TP2,TP3,TP7,TP8	WL-1			1.5mm DIA SMD PAD
49	39	TP4,TP5,TP6,TP9,TP10,TP11,TP12,TP13,TP14,TP15,TP16,TP17,TP19,TP20,TP21,TP22,TP23,TP24,TP25,TP26,TP27,TP28,TP29,TP30,TP31,TP32,TP33,TP34,TP35,TP36,TP37,TP38,TP39,TP40,TP41,TP42,TP47,TP48,TP49	WL-1			1mm DIA SMD PAD
50	5	TS1,TS2,TS3,TS4,TS5	WL-1			ELECTRODE PATTERN
51	1	U1	R5F52318BDFP	RENESAS	R5F52318BDFP	
52	1	U2	RY7011A0000DZ00	RENESAS	RY7011A0000DZ00	
53	1	U3	ADP122AUJZ-3.3-R7	ANALOG DEVICES	ADP122AUJZ-3.3-R7	
54	1	U6	SN74LVC04APW	TI	SN74LVC04APW	
55	1	U7	PCM1774RGPT	TI	PCM1774RGPT	
56	1	X1	16MHz	EPSON	FA-238 16MHz	
57	2	X2,X4	32.768kHz	SII	SSP-T7-FL 32.768kHz	
58	1	X3	SG-210 11.2896MHz	EPSON	SG-210 11.2896MHz	
59	1	ZD1	EMZ6.8E	ROHM	EMZ6.8ET2R	
60	1	ZD2	UDZS6.8B	ROHM	UDZSTE-176.8B	

”NM” marking means that component is not fitted by default.

7. Circuit Board Layouts

7.1 CPU Board

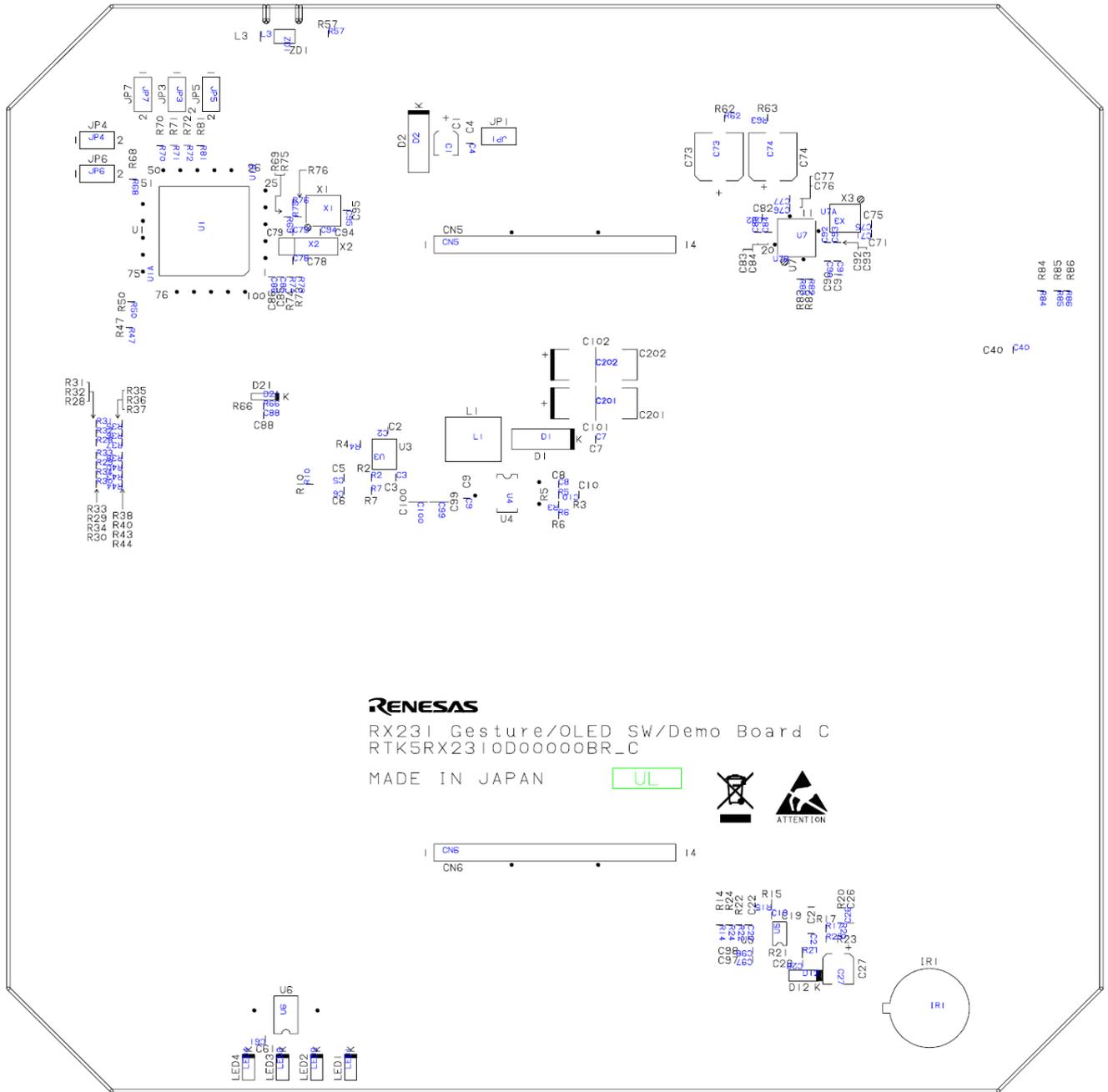


Figure 7-1 Component Side Silkscreen (top view)

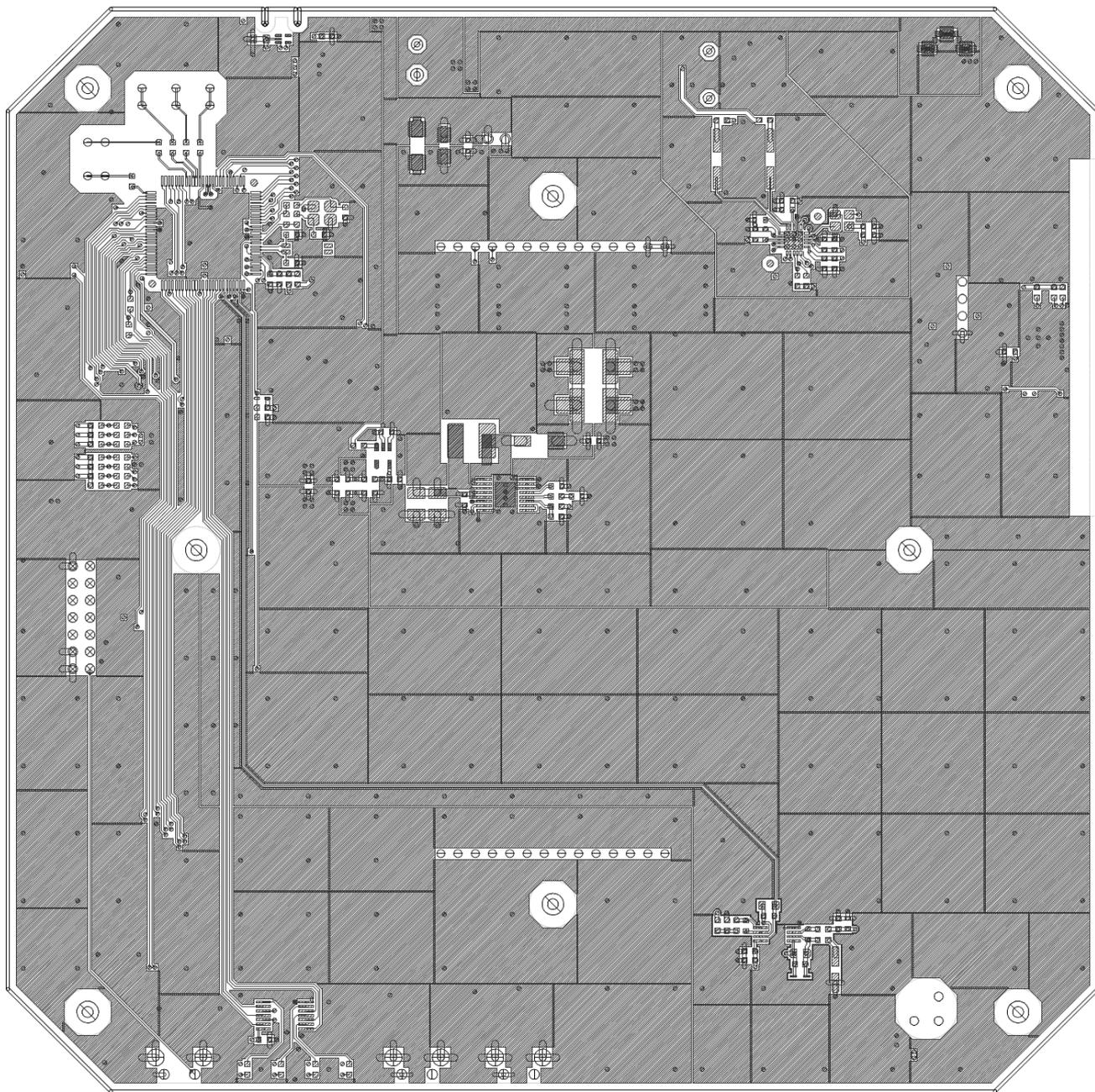


Figure 7-2 1st Layer Pattern (top view)

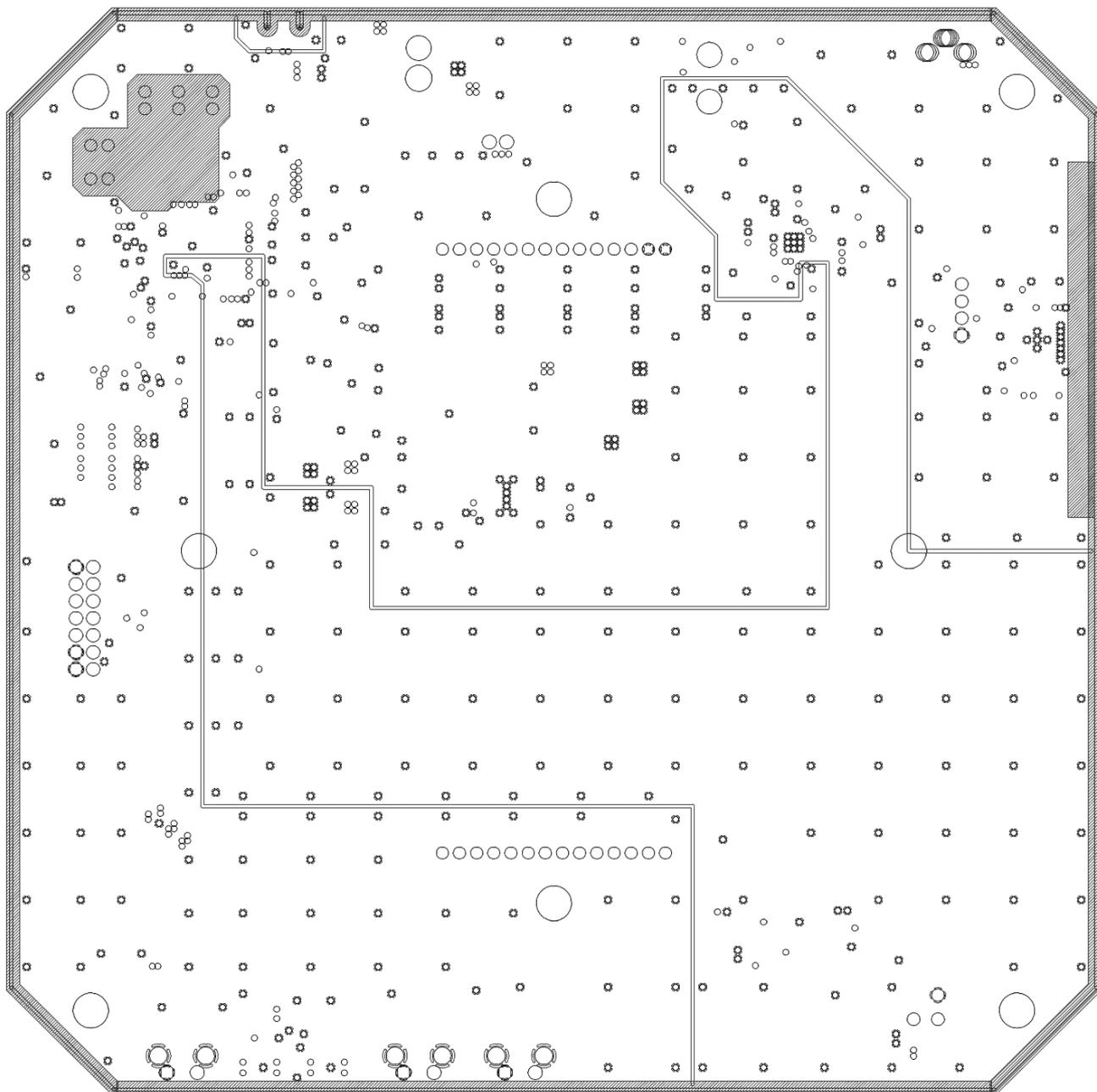


Figure 7-3 2nd Layer Pattern (top view, negative-positive inversion)

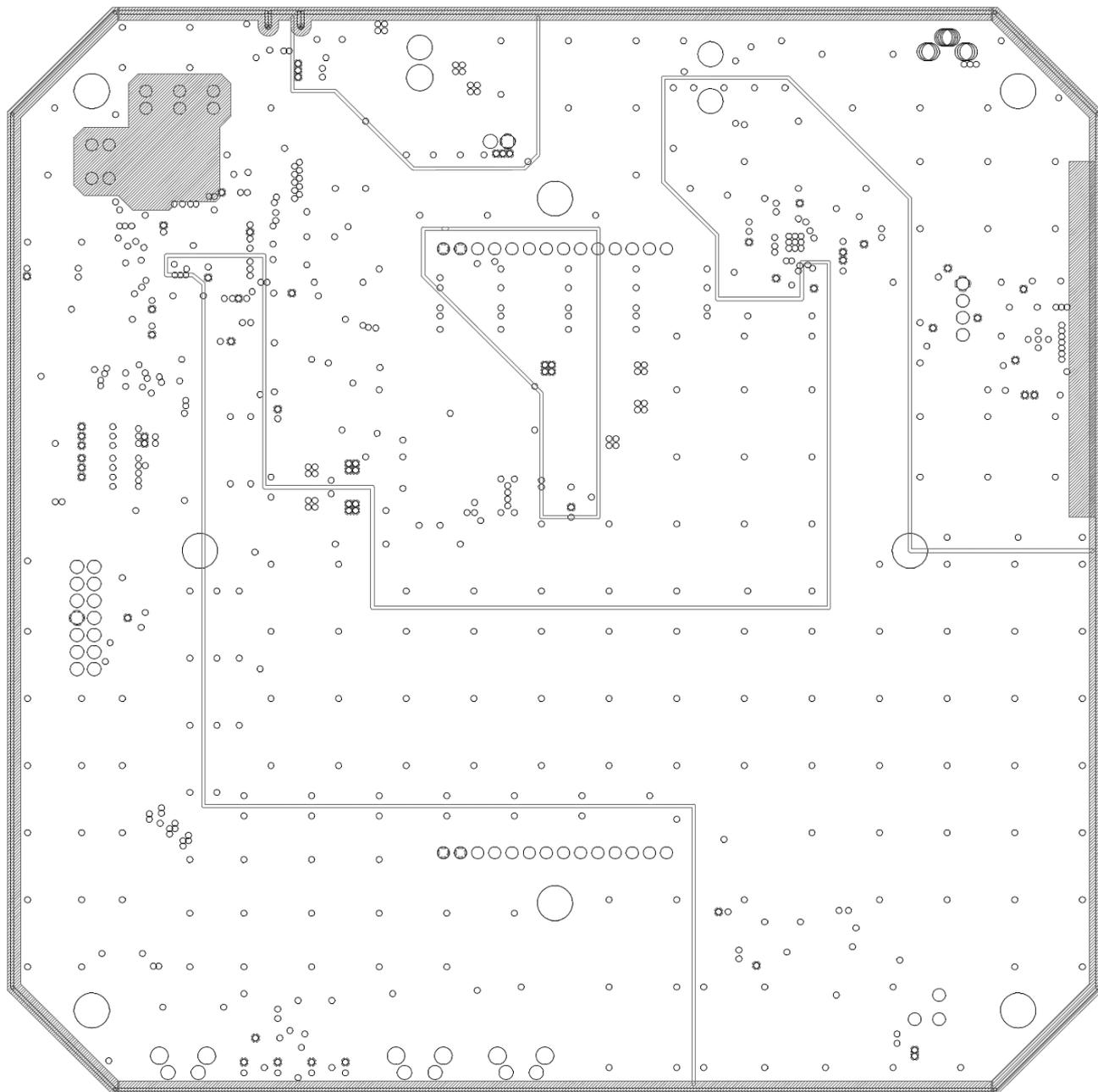


Figure 7-4 3rd Layer Pattern (top view, negative-positive inversion)

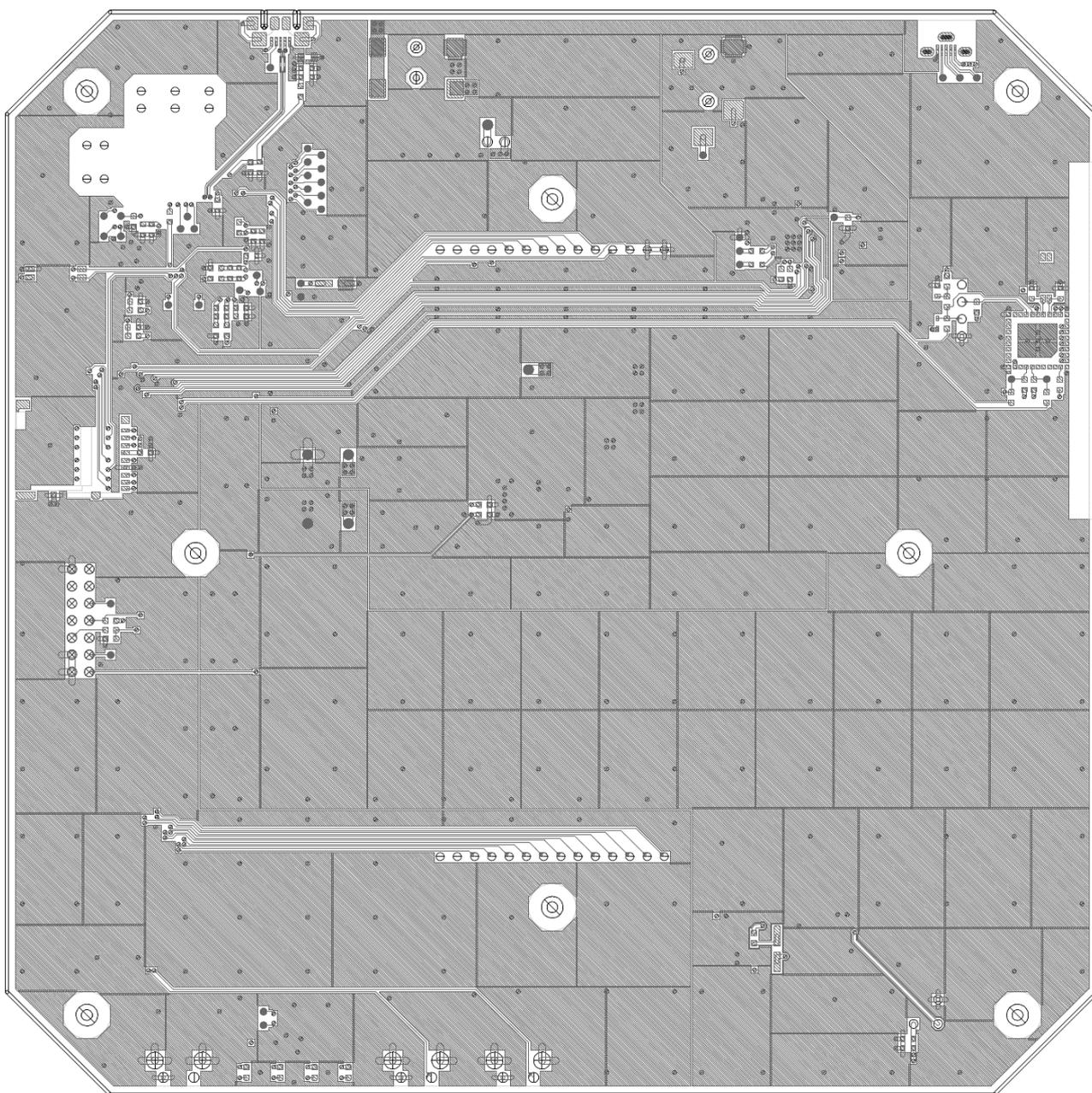


Figure 7-5 4th Layer Pattern (top view)

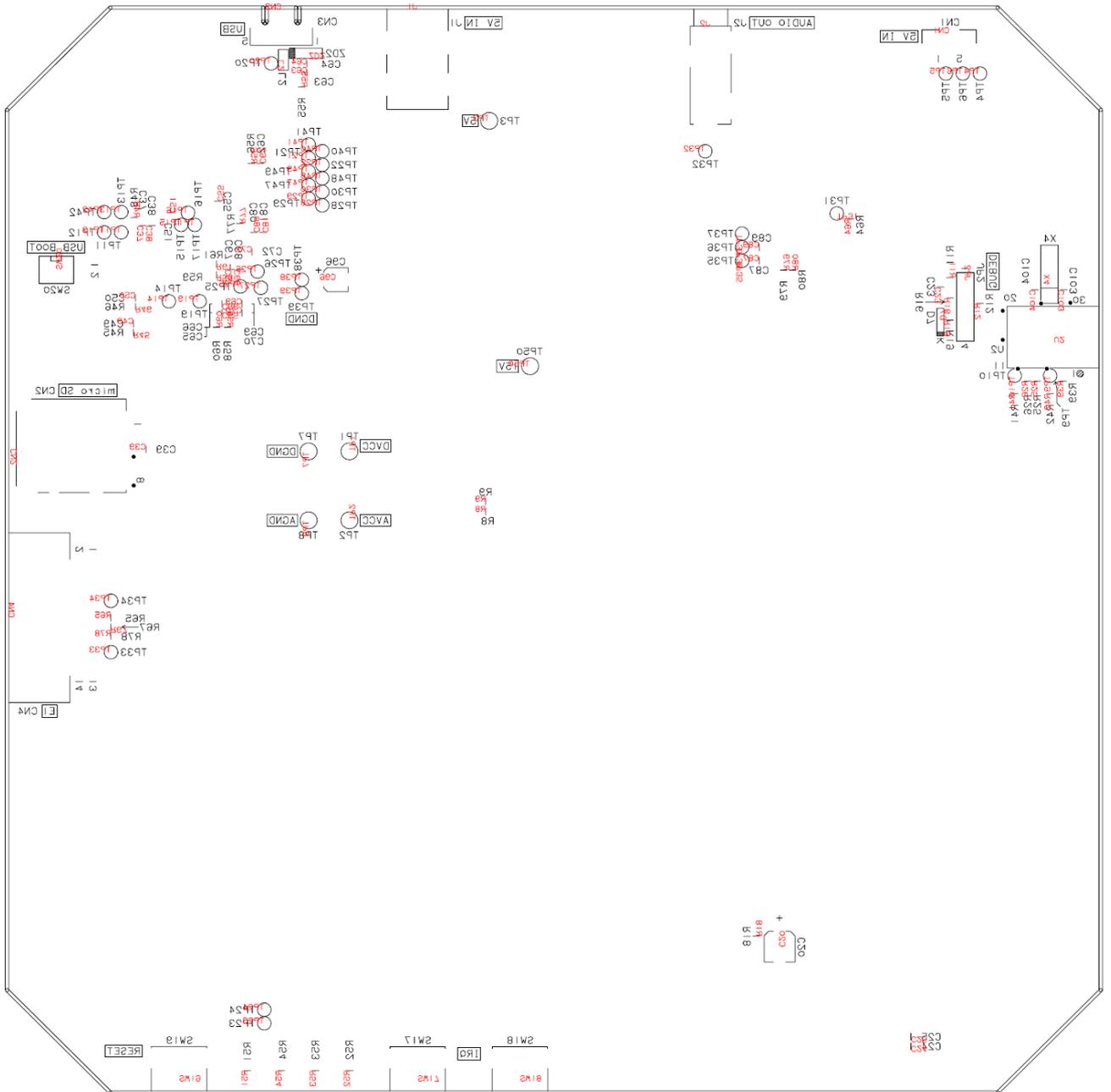


Figure 7-6 Solder Side Silkscreen (top view)

7.2 Electrode Board

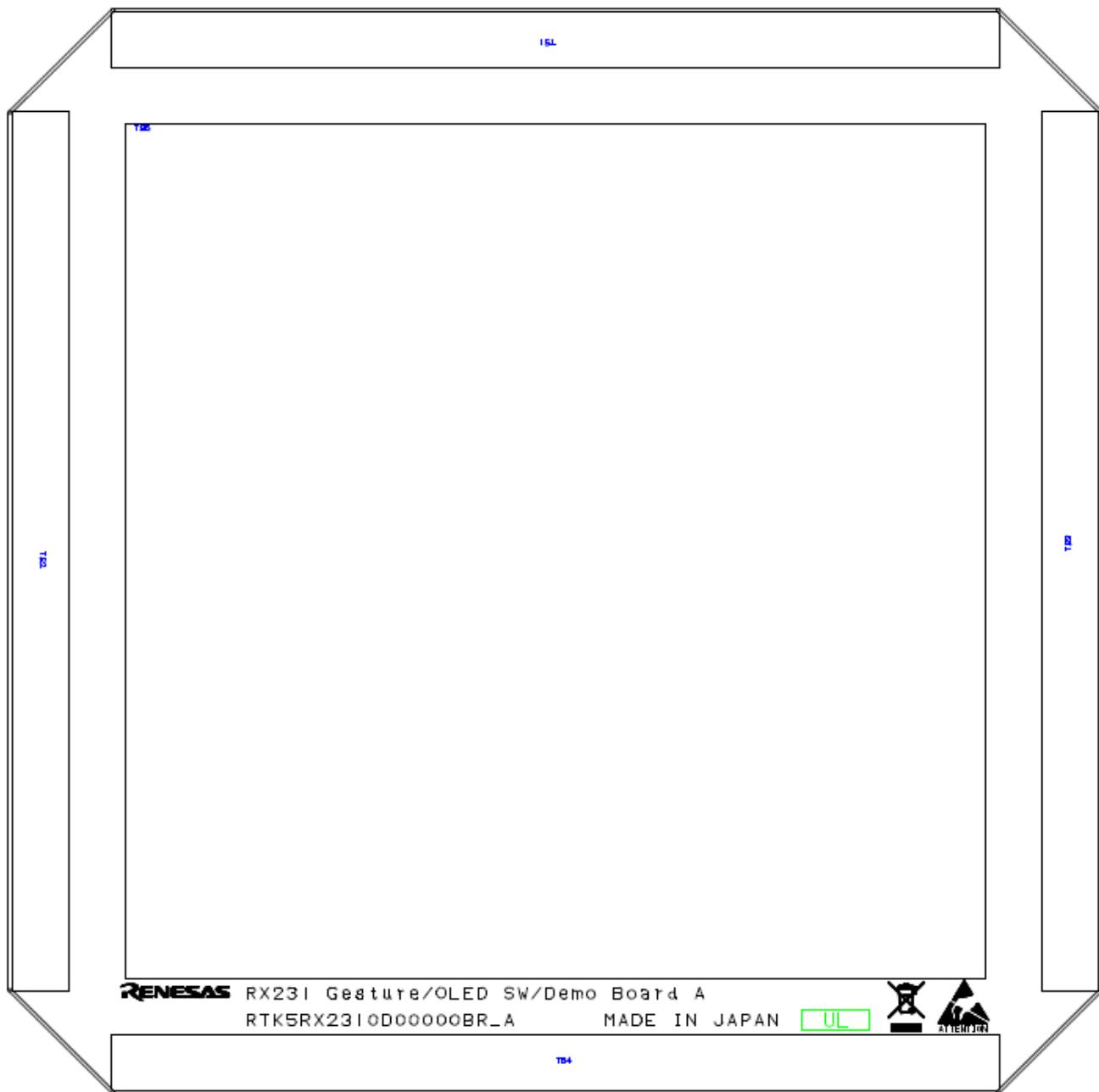


Figure 7-7 Solder Side Silkscreen (top view)

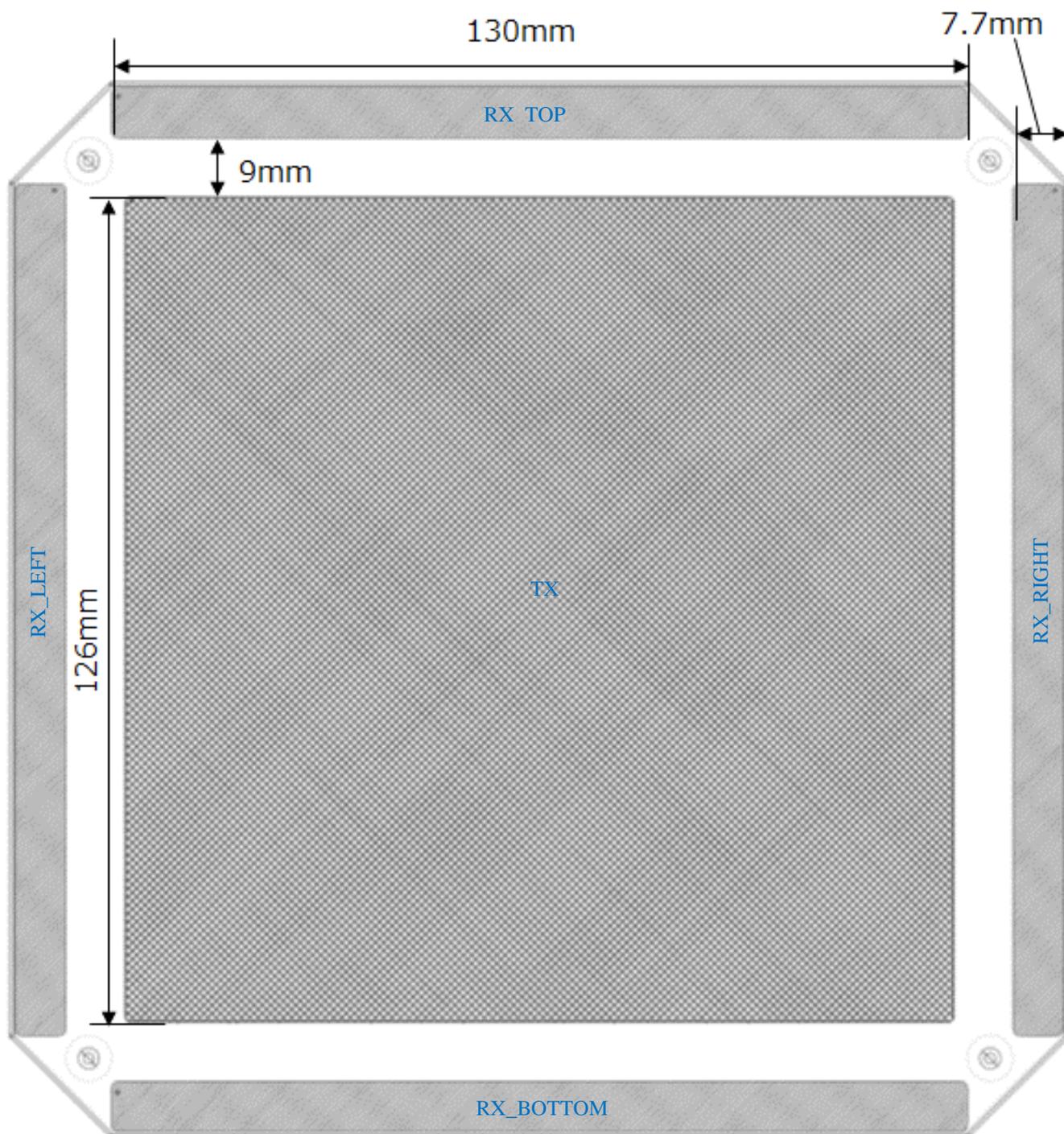
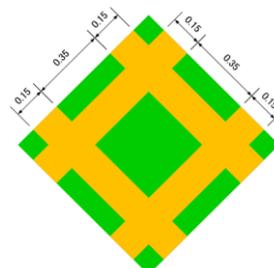


Figure 7-8 Solder Side Pattern (top view)

The TX electrode is a mesh pattern with a copper to blank ratio of 3 to 7. ⇒
 The four RX electrodes are copper solid patterns.



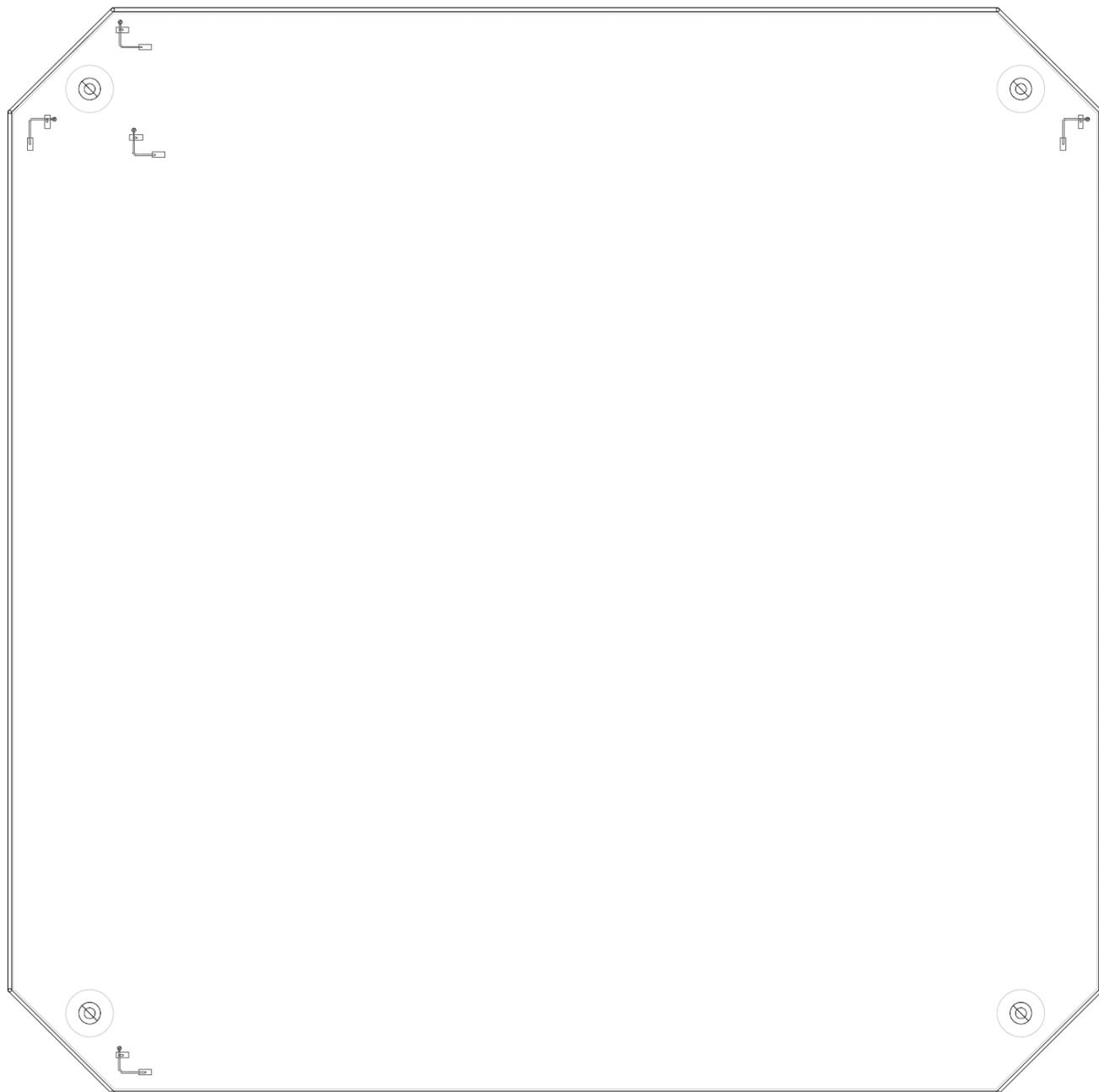


Figure 7-9 Component Side Pattern (top view)

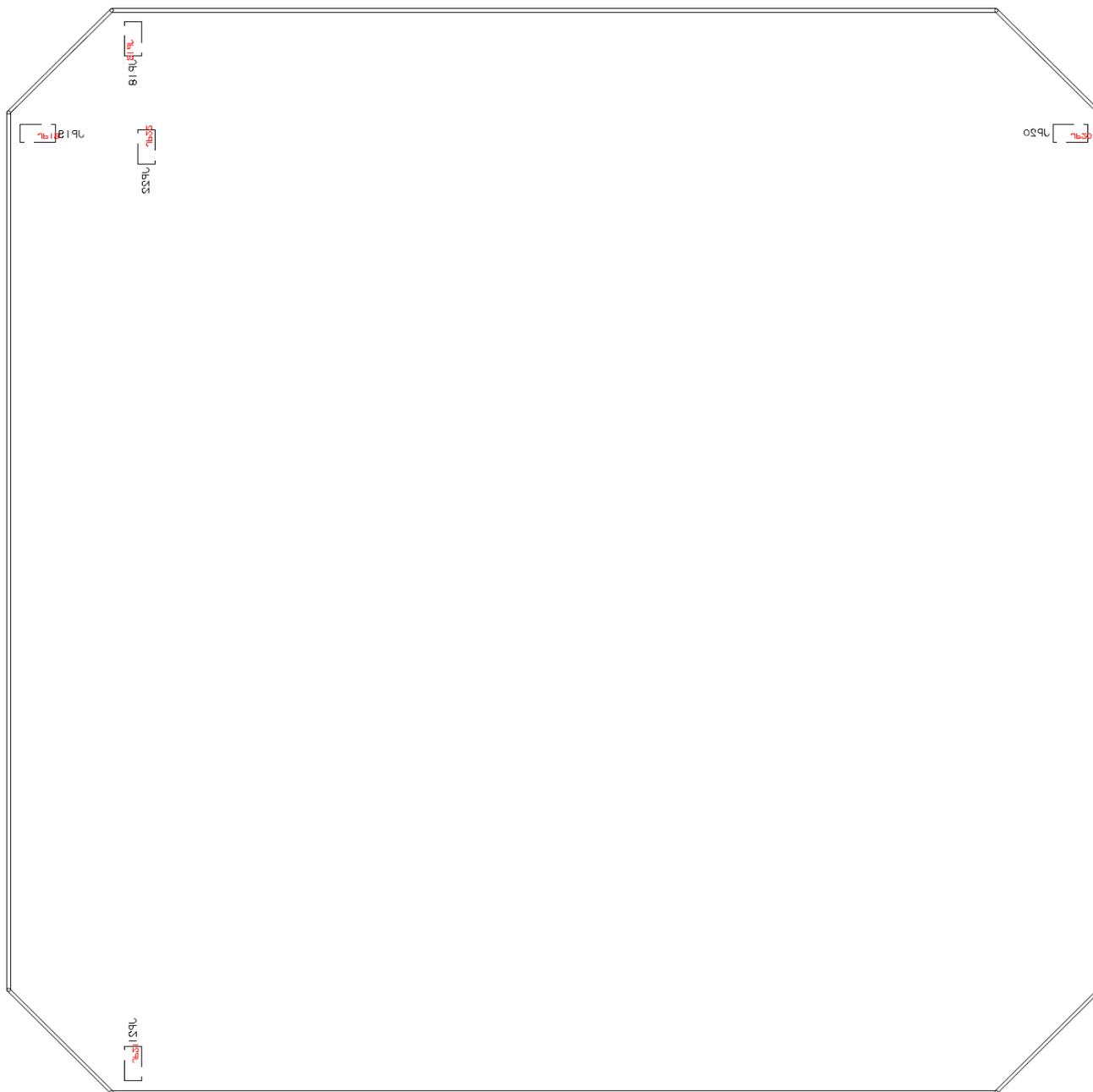


Figure 7-10 Component Side Silkscreen (top view)

7.3 Relay Board

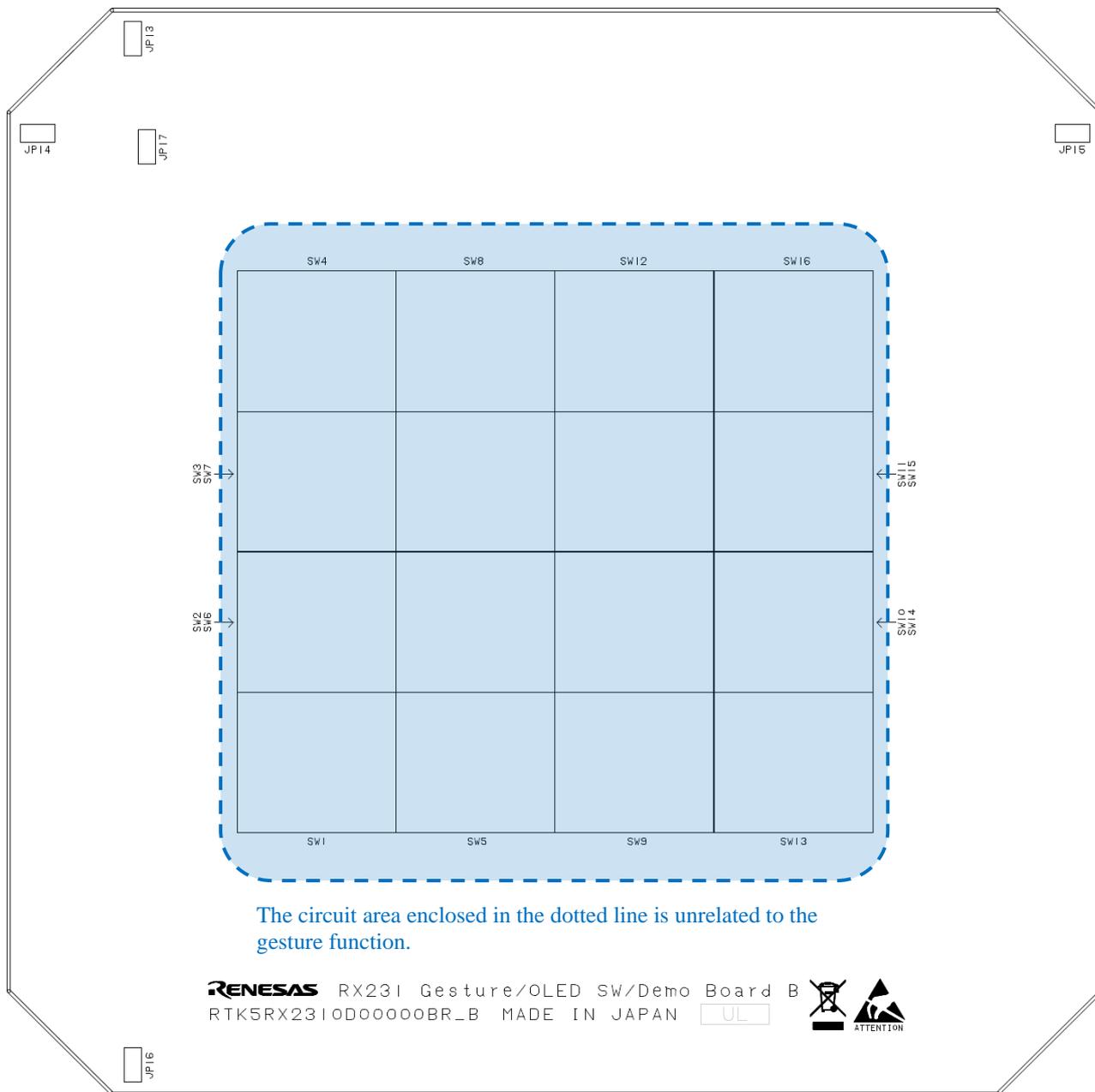


Figure 7-11 Component Side Silkscreen (top view, SW1 to SW16 not used)

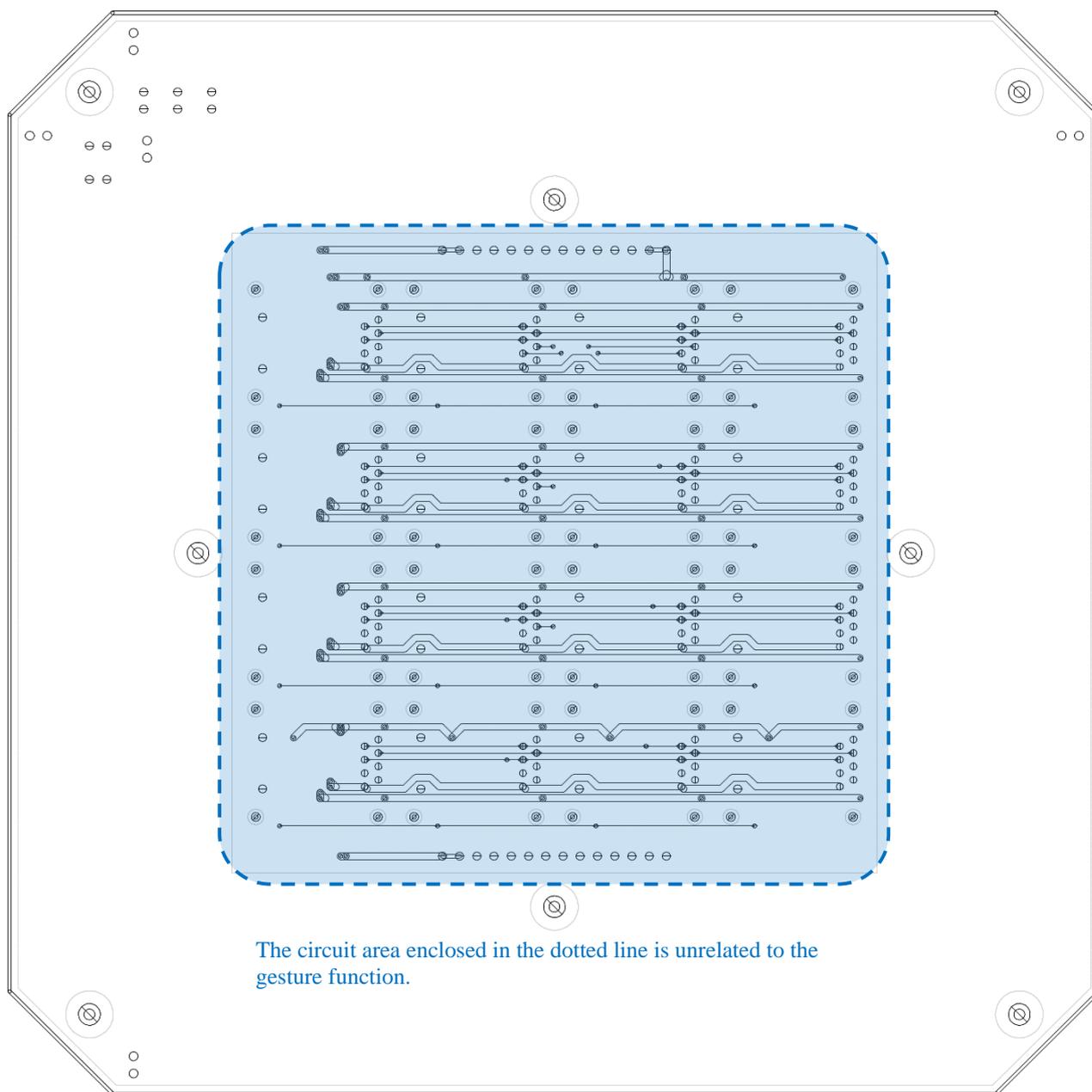
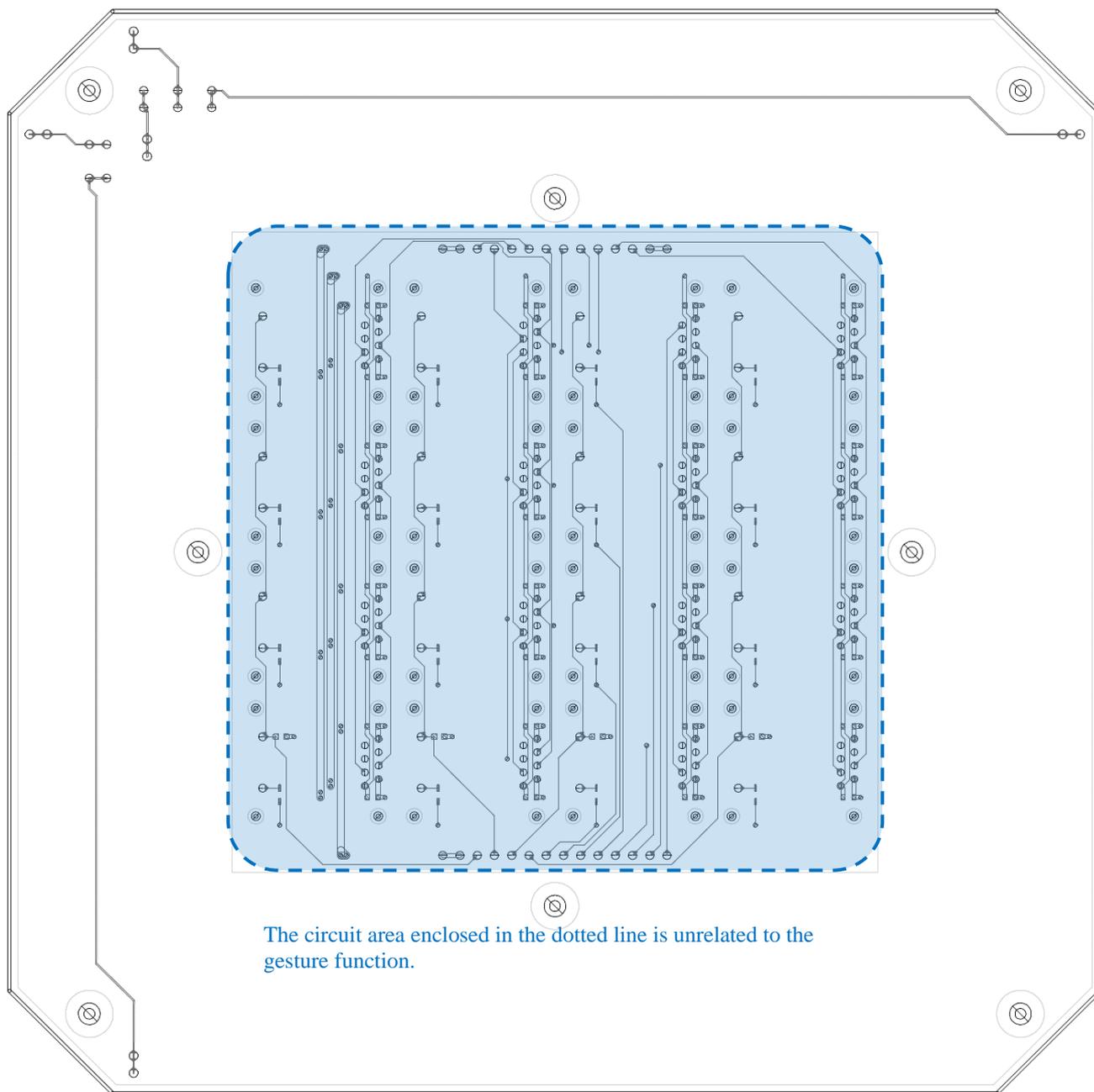


Figure 7-12 Component Side Pattern (top view)



The circuit area enclosed in the dotted line is unrelated to the gesture function.

Figure 7-13 Solder Side Pattern (top view)

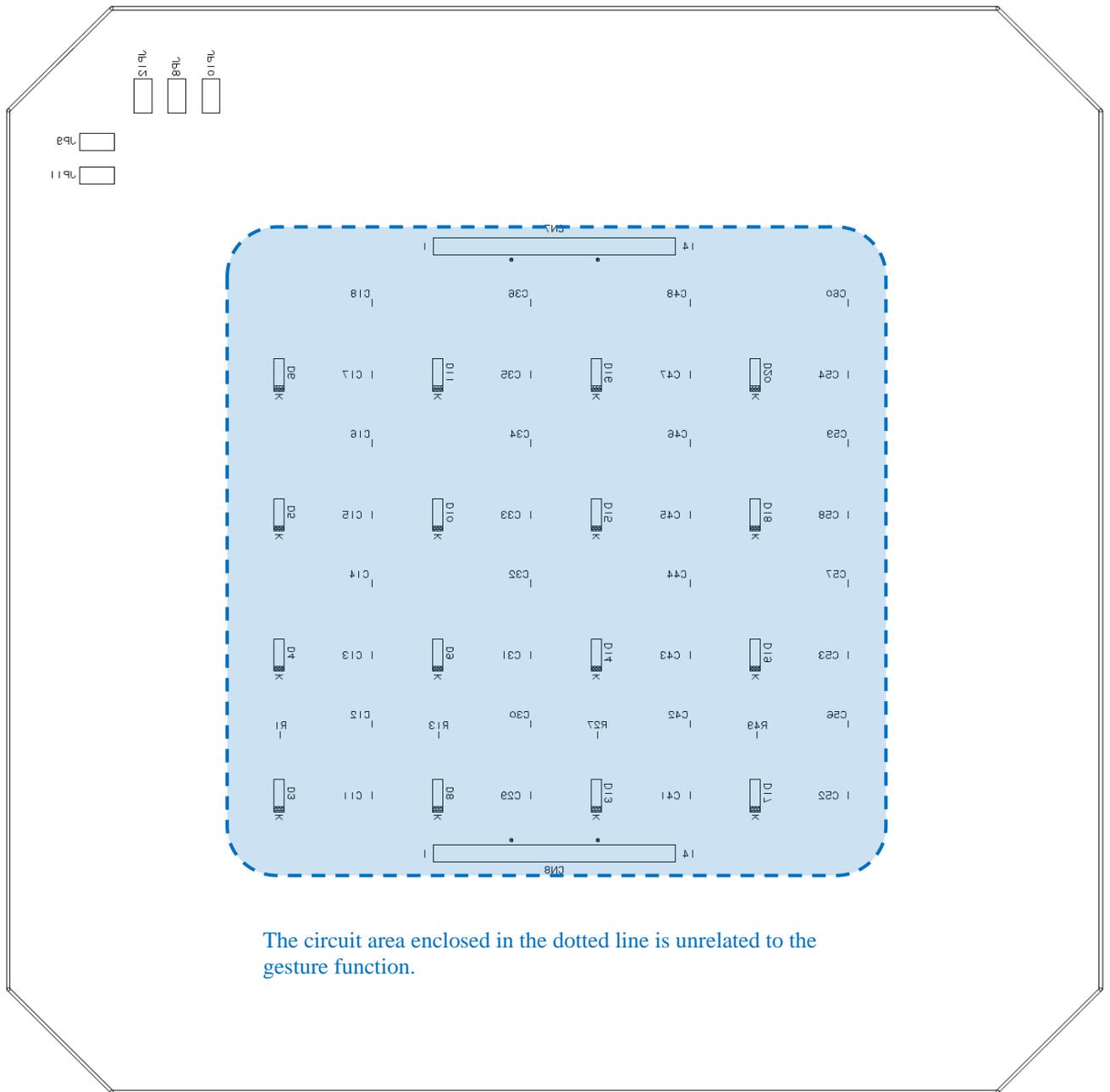


Figure 7-14 Solder Side Silkscreen (top view, jumpers other than JP8 to JP12 are not used)

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, 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 countermeasure 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

In this demo set, the filter circuit shown in Figure 8-1 is added to suppress noise input and output from the power cable during EMC evaluation.

8.2 Metal Plate Shielding

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

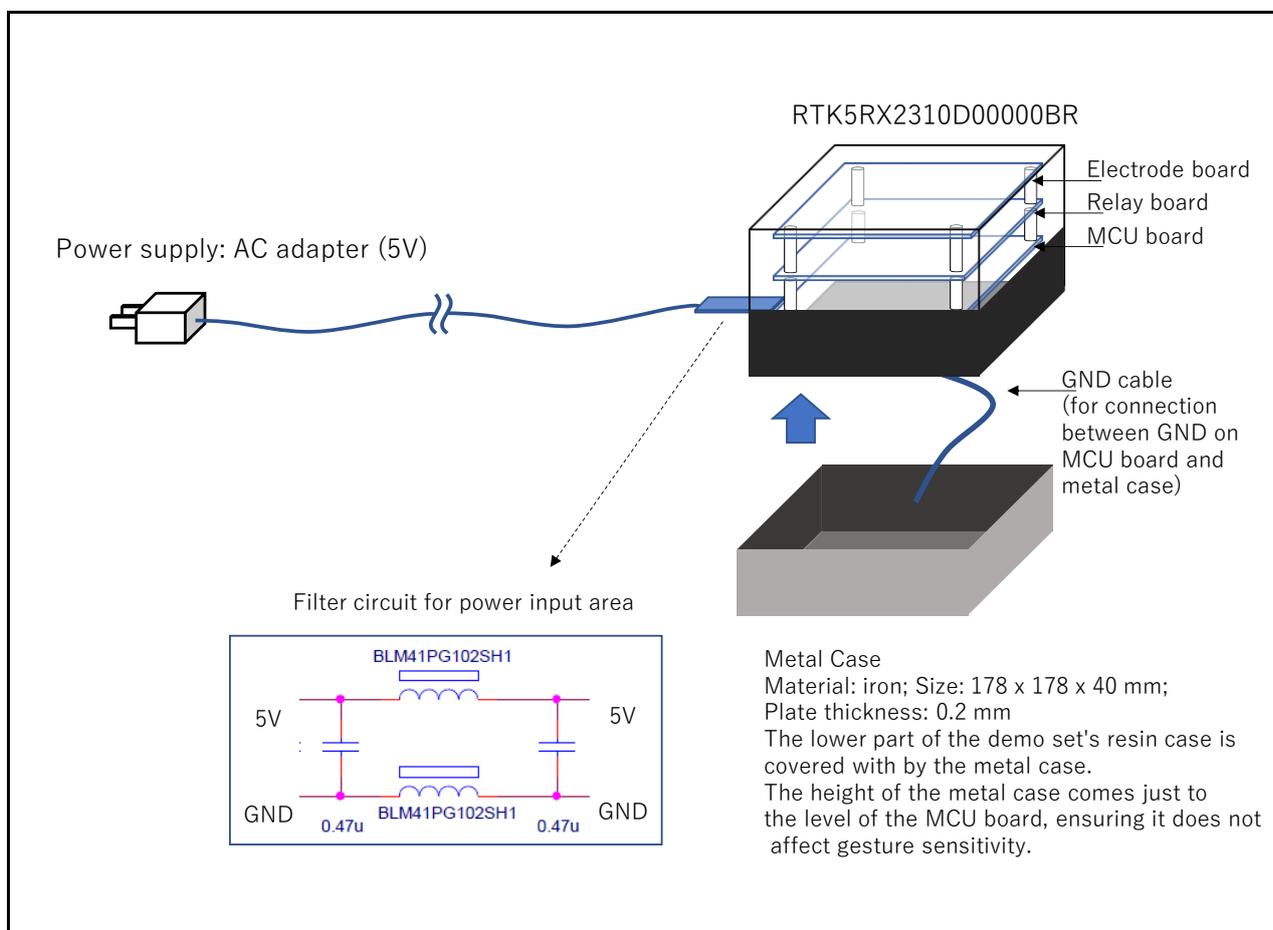


Figure 8-1 EMC Countermeasure Example

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Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jan 16, 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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(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

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