RA4M2 Group

Voice Recognition Demo Board

Introduction

This application note explains the hardware specifications of Renesas Electronics' voice recognition demo board RTK0EA0006D00001BJ, which uses RA4M2 MCU.

Target Device

RA4M2 Group

Related Document

1. RA4M2 Group Voice Recognition Sample Software (AmiVoice Micro) (R11AN0539EJ0100)
2. RA4M2 Group Voice Recognition Sample Software (Voice Trigger Middleware) (R11AN0540EJ0100)

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1. Outline

The features and system configuration of this product are shown below.

(1) Compact board

- Size
  40mm × 45.5mm: exclude emulator board
  40mm × 60mm: include emulator board

(2) Voice Recognition using Electret Condenser mic

(3) PC Demo application applicable

(4) A mechanism for external connection (Optional)

- External SPI / UART / I2C devices can be connected from the PMOD interface connector
- External UART / I2C device can be connected from the extended serial connector
- External touch sensor electrodes can be connected from through holes for capacitive touch sensor connection

(5) Emulator connector

(6) The MCU board and emulator board can be separated

(7) Power supply by USB bus power

(8) RGB LED for voice recognition result confirmation

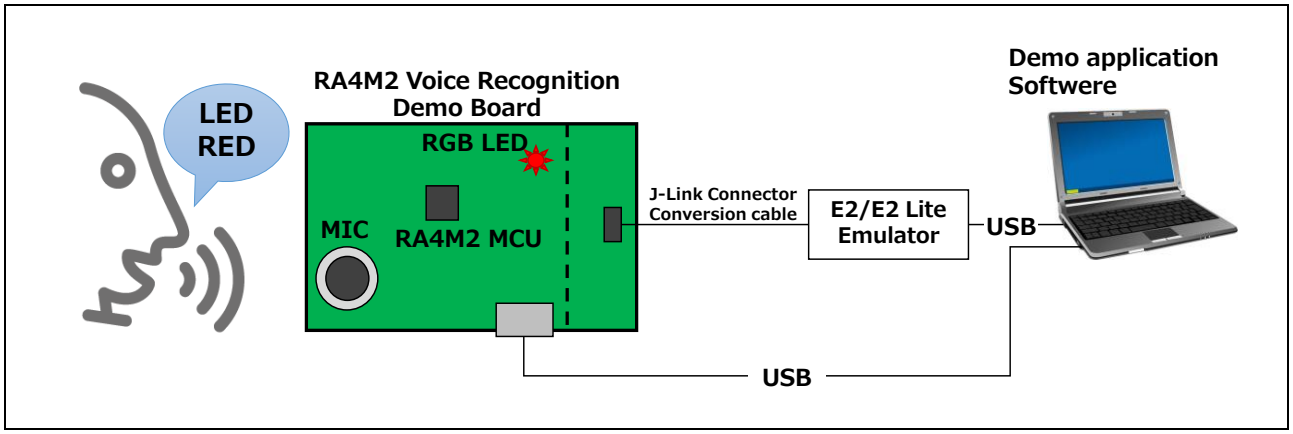


Figure 1.1 System configuration

2. Product External Appearance

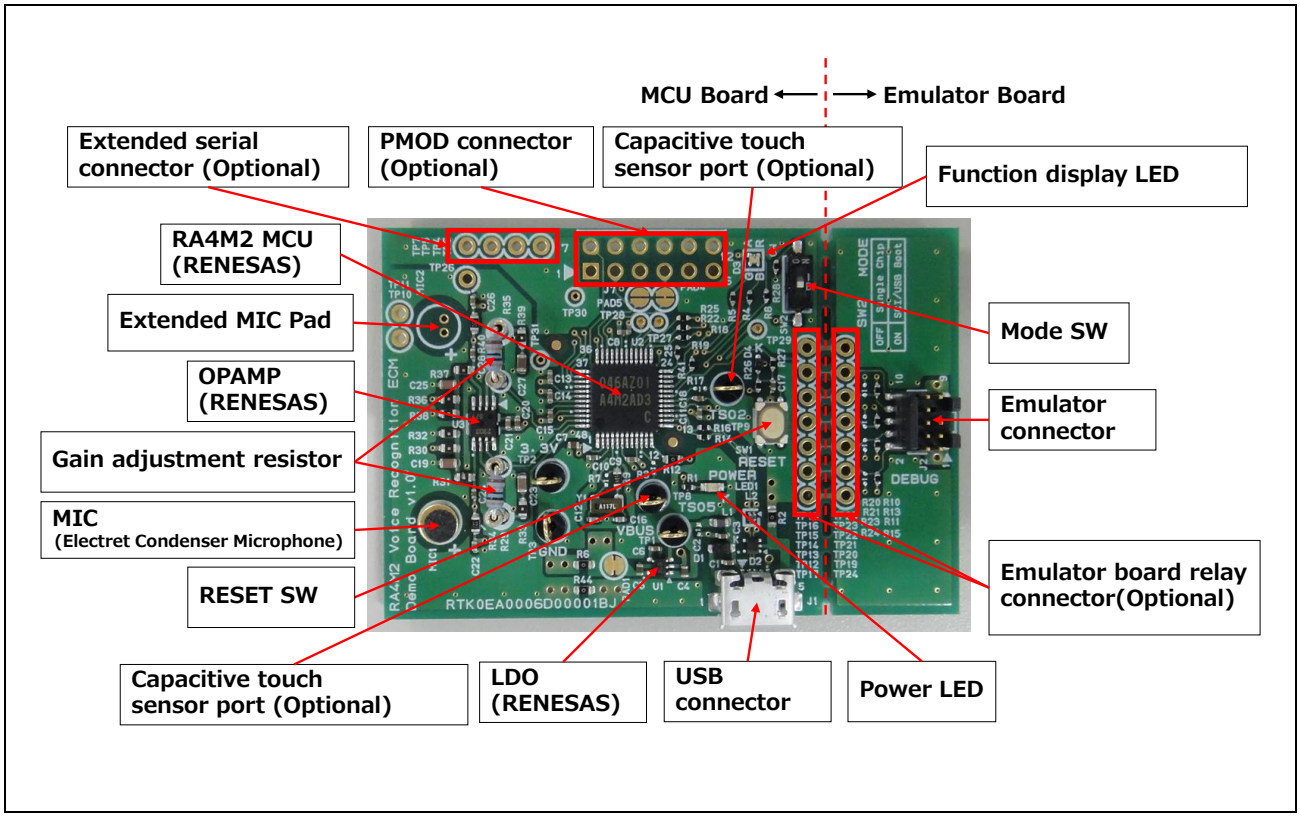


Figure 2.1 Product external appearance

3. Hardware specifications

Table 3.1 Hardware specifications (1/2)

Item	Description	Remarks
Board size	• MCU Board 40.0 × 45.5[mm] • Emulator Board 40.0 × 13.5[mm]	MCU Board + Emulator Board 40 × 60[mm] (Include slit)
Power supply	USB bus power (VBUS) 5V	
MCU	RENESAS R7FA4M2AD3CFL	• Max. operating frequency: 100MHz Arm Cortex-M33 core • Code flash: 512KB • Data flash: 8KB • SRAM: 128KB • 48pin LQFP package (0.5mm pitch) • Operating temperature: -40°C to 105°C
Internal power supply	Circuit voltage: 3.3V LDO IC: RENESAS ISL9003A	Output current : 150mA max
Clock	• MCU main clock High-speed on-chip oscillator • MCU sub clock 32.768kHz crystal	
MIC	CUI DEVICES CMEJ-0415-42-LP	• Electret condenser microphone • Omni-directional • Sensitivity: -42dBV/Pa • MIC2 is optional.
MIC AMP	• Amp Gain: • 46dB(201 times), Default value • OPAMP IC: RENESAS READ2303G	Amplifier gain can be changed by replacing the external resistor.
LED	Power LED: orange color × 1 pc	
	Function display: 3-color (RGB) LED × 1 pc	MCU port control
Switch	System reset switch	Push switch × 1 pc
	Mode switch	DIP switch × 1 bit
USB connector	USB Micro B × 1 pc	USB2.0 full speed
Emulator connector	J-Link 9-pin Cortex-M adopter × 1 pc	
PMOD connector	2.54mm pitch,12 pin (6pin × 2) × 1 pc	Optional

Table 3.2 Hardware specifications (2/2)

Item	Description	Remarks
Serial connector for expansion	2.54mm pitch, 4 pin (4 pin × 1) × 1 pc	Optional
Emulator board relay connector	2.54mm pitch, 7 pin (7 pin × 1) × 2 pc	Optional
Capacitive touch sensor port	Φ1mm through-hole × 2 pc	Optional Dumping resistor is not mounted.

4. Block Diagram

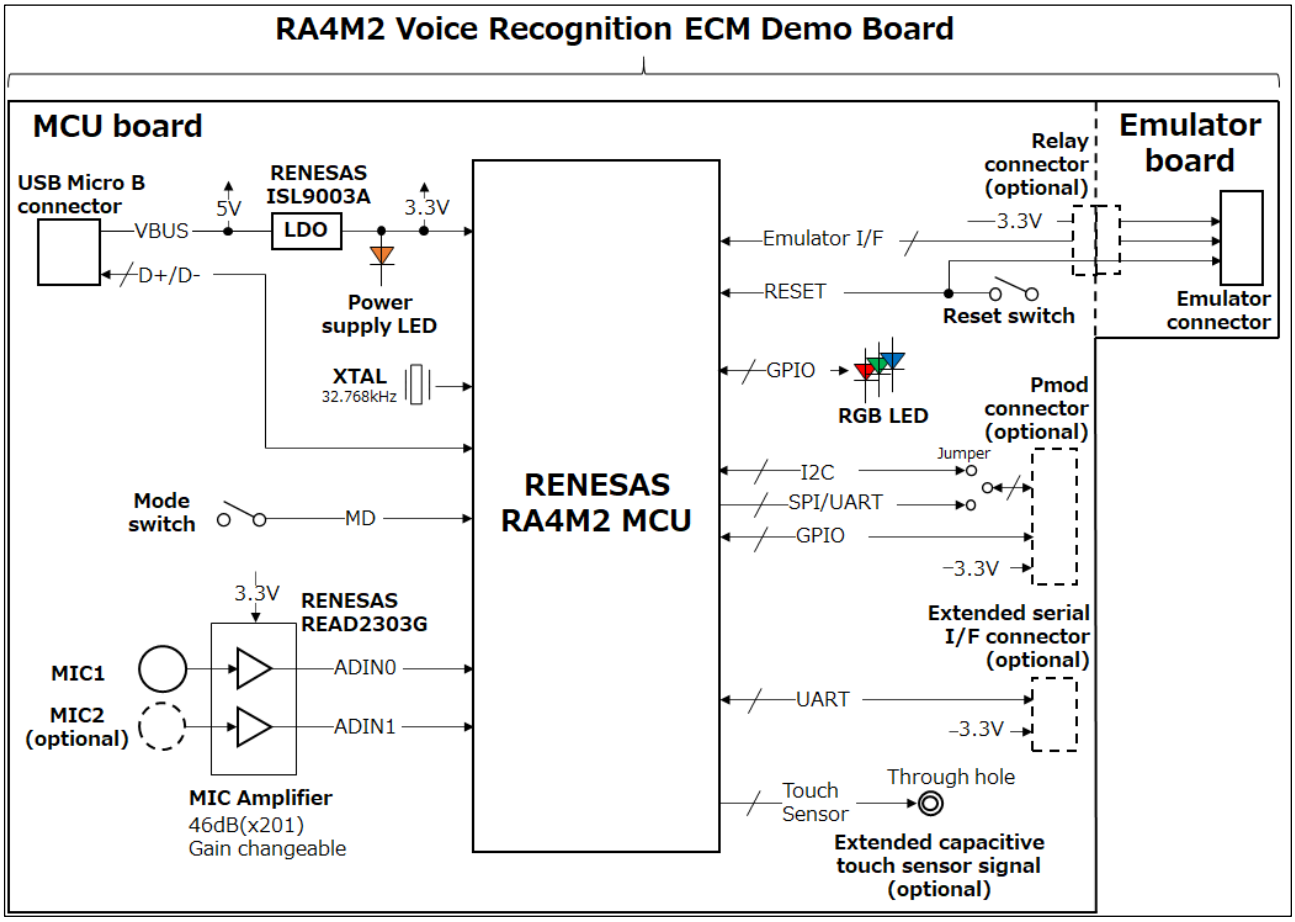


Figure 4.1 Block Diagram

5. Power supply

Power is supplied from the USB connector and turn on LED1

PAD1 is a jumper pad for connecting LED output to MCU circuit. Power is suppled from USB connector when PAD1 is short status(default) as Figure 5.1 shows.

If PAD1 is open, bridge between the pads with solder and make it short.

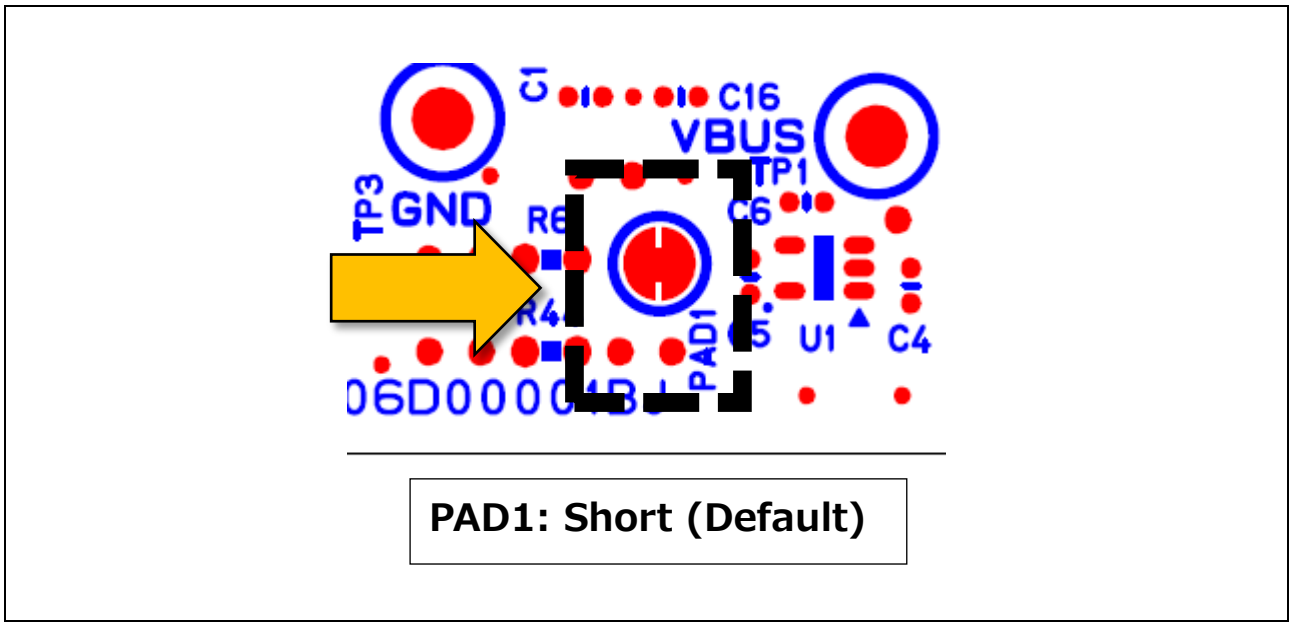


Figure 5.1 Jumper pad setting (power)

6. Voice Recognition Circuit

This product realizes voice recognition using an electret condenser mic, a mic amplifier circuit, and an A/D converter inside the MCU.

Refer related document for voice recognition demo application with this product.

6.1 I/O Port Assignment

Table 6.1 shows the I/O port assignments for voice recognition.

Table 6.1 I/O assignment for voice recognition circuit

I/O port name / I2C signal name	Remark
P000/AN000	MIC1
P001/AN001	MIC2 (optional)

6.2 Amplifier gain

Table 6.2 shows the amplifier gain setting.

The amplifier gain is changeable by controlling gain adjustment resistor (R29, R35).

Table 6.2 Amplifier gain setting

Component reference	Component reference	Gain
MIC1	U3B	Gain = 1 + (R29 / R33) Default value: 1 + (300K / 1.5K) = 201 (46dB)
MIC2	U3A	Gain = 1 + (R35 / R39) Default value: 1 + (300K / 1.5K) = 201 (46dB)

6.3 Function display LED

Functional display LED is controlled by I/O port.

Table 6.3 shows the I/O port assignment for function display LED.

Function display LED turns on when I/O port output is Low and turns off when High.

Table 6.3 I/O assignment of LED for functional display

Component Reference	Lighting color	I/O port name
D3	Blue	P103
	Green	P301
	Red	P408

7. Switch

7.1 Reset Switch

Press SW1 to reset input for RA4M2 MCU and emulator.

7.2 Mode Switch

When power supplied with SW2 on, RA4M2 MCU operates either SCI boot mode or USB boot mode.

8. Connectors

Table 8.1 to 8.7 shows the connector specification.

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

8.1 USB connector

Table 8.1 shows USB connector specification.

Table 8.1 USB connector specification

Component reference: J1		
Pin number	**Signal name**	**Type / I/O direction**
1	VBUS	POWER
2	D-	IN/OUT
3	D+	IN/OUT
4	NC	-
5	GND	POWER

8.2 Emulator connector

The MCU board and emulator board can be separated. When use these boards separately, use TP12 to TP18 as the relay connector on the MCU side, and TP19 to TP25 as the relay connector on the emulator side. Use a 2.54 mm pitch 1-row 7-pin connector for the relay connector.

Table 8.2 shows the emulator connector signal table, and Table 8.3 shows the relay connector signal table.

Table 8.2 Emulator connector

Component reference: J2		
Pin number	**Signal name**	**Type / I/O direction**
1	+3.3V	POWER
2	SWDIO	IN/OUT
3	GND	POWER
4	SWCLK	IN
5	GND	POWER
6	TXD	OUT
7	NC	-
8	RXD	IN
9	GND	POWER
10	RES#	IN/OUT

Table 8.3 Relay connector (optional)

Component reference		**Signal name**	**Type / I/O direction**
MCU side	**Emulator side**		
TP12	TP19	SWDIO	IN/OUT
TP13	TP20	SWCLK	IN
TP14	TP21	TXD	OUT
TP15	TP22	RXD	IN
TP16	TP23	RES#	IN/OUT
TP17	TP24	+3.3V	POWER
TP18	TP25	GND	POWER

8.3 PMOD connector (optional)

8.3.1 SPI/UART connection

Table 8.4 shows the signal table for SPI or UART communication using the PMOD connector.

Figure 8.1 shows the jumper pad settings in the above case.

Table 8.4 Signal table of the PMOD connector (SPI/UART)

Component reference: J7		
Pin number	**Signal name**	**Type / I/O direction**
1	P104/IRQ1	IN/OUT
2	TXD0/MOSI0	OUT
3	RXD0/MISO0	IN
4	SCK0	OUT
5	GND	POWER
6	+3.3V	POWER
7	P402	IN/OUT
8	P015	IN/OUT
9	P014	IN/OUT
10	P013	IN/OUT
11	GND	POWER
12	+3.3V	POWER

Use with PAD4 short and PAD5 open as shown in Figure 8.1.

If PAD4 is open, bridge the pads with solder and short the pads.

Also, if the PAD5 is bridged with solder, remove the solder and open the pads.

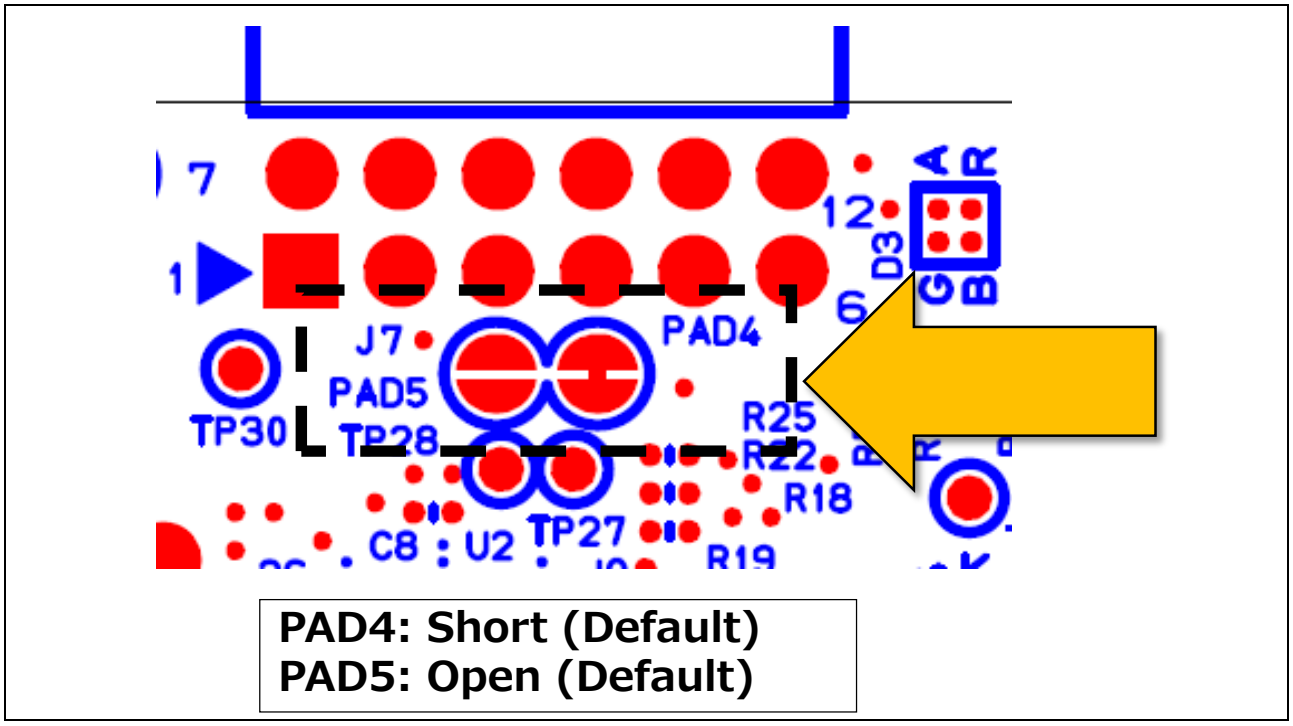


Figure 8.1 Jumper pad setting (SPI/UART)

8.3.2 I2C connection

Table 8.5 shows the signal table for I2C communication using the PMOD connector.

Also, Figure 8.2 shows the jumper pad setting in above case.

Table 8.5 Signal table of the PMOD connector (I2C)

Component reference: J7		
Pin number	**Signal name**	**Type / I/O direction**
1	P104/IRQ1	IN/OUT
2	P101	IN/OUT
3	SCL0	IN/OUT
4	SDA0	IN/OUT
5	GND	POWER
6	+3.3V	POWER
7	P402	IN/OUT
8	P015	IN/OUT
9	P014	IN/OUT
10	P013	IN/OUT
11	GND	POWER
12	+3.3V	POWER

As Figure 8.2 shows, cut the bridge pattern of PAD4 and open the pad.

Also, bridge the PAD5 with solder and short the pad.

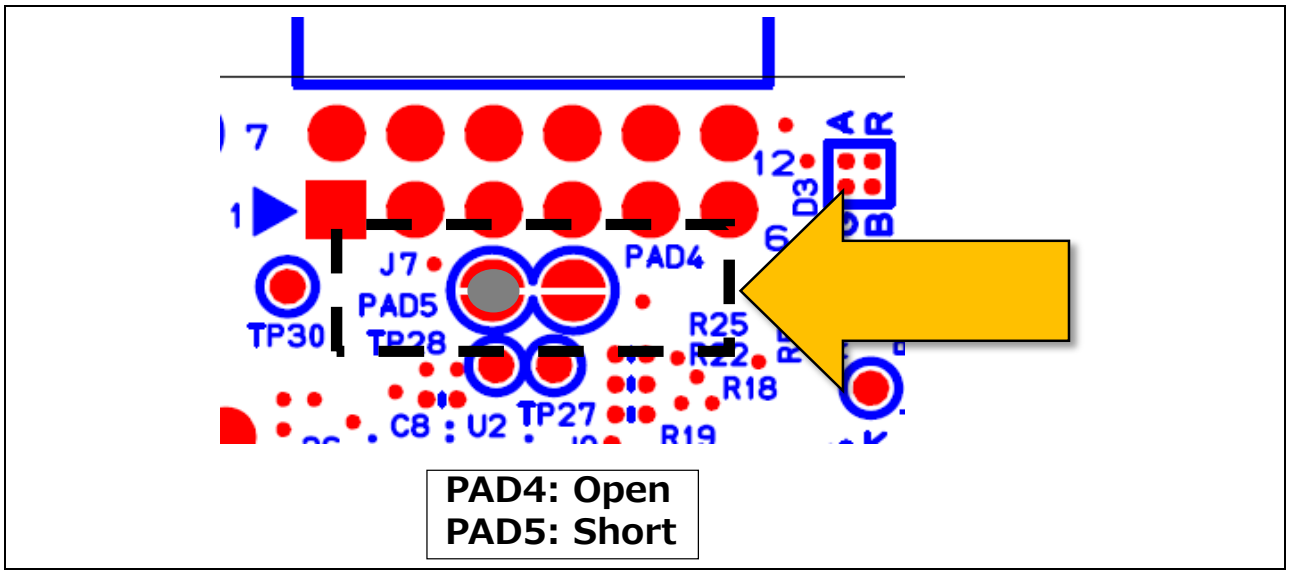


Figure 8.2 Jumper pad setting (I2C)

8.4 Serial connector for expansion (optional)

Table 8.6 shows the signal table for UART / I2C communication using the expansion serial connector.

Use a 2.54 mm pitch 1-row 4-pin connector.

Table 8.6 Signal table of the serial connector for expansion

Component reference	Signal name	Type / I/O direction
TP4	TXD1/SDA1	IN/OUT
TP5	+3.3	POWER
TP6	RXD1/SCL1	IN/OUT
TP7	GND	POWER

8.5 Capacitive Touch sensor port (optional)

Table 8.7 shows a signal table for measuring the capacitance of external electrodes using the optional capacitive touch sensor port.

When connecting external electrodes, following are required.

- Mount 560Ω on R3 and R17
- Solder the wire from the external electrode to the through hole shown in Table 8.7.

Table 8.7 Signal table of the capacitive touch sensor signal

Component reference	Signal name	Type / I/O direction
TP8	P409/TS05	IN/OUT
TP9	P206/TS02	IN/OUT

9. Circuit diagram

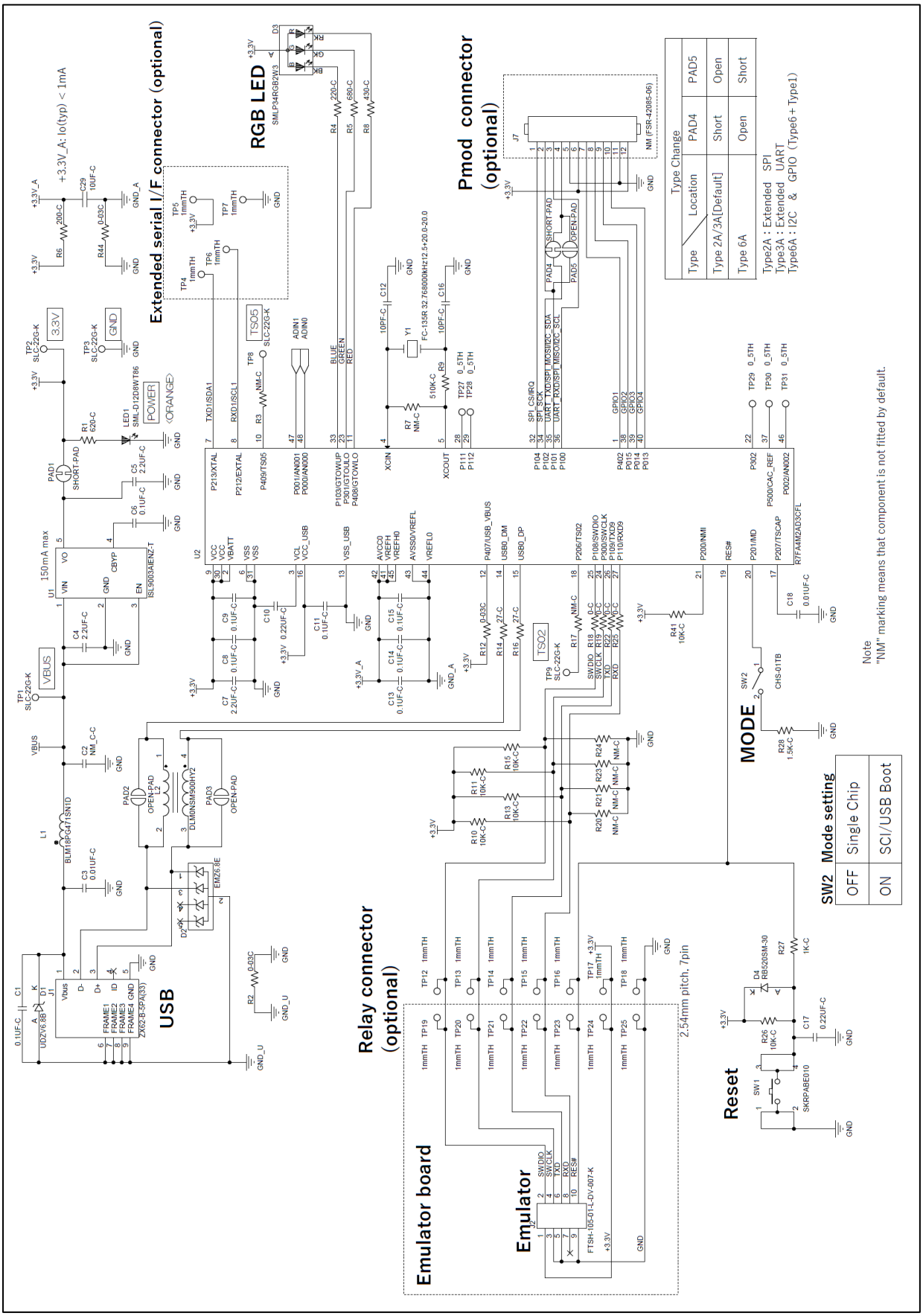


Figure 9.1 Circuit diagram (1/2)

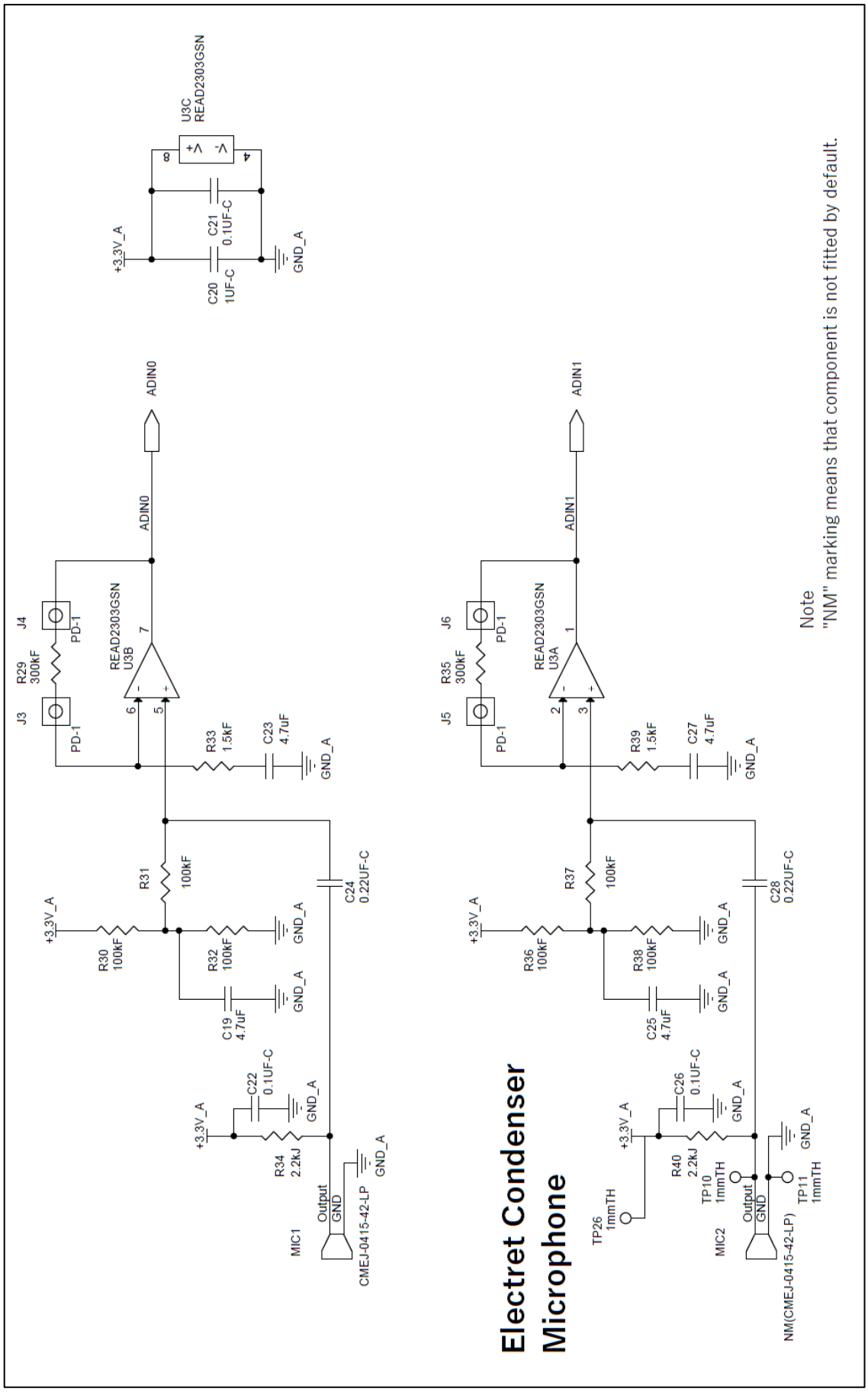


Figure 9.2 Circuit diagram (2/2)

10. Board layout diagram

All board layout diagram is viewed from component side.

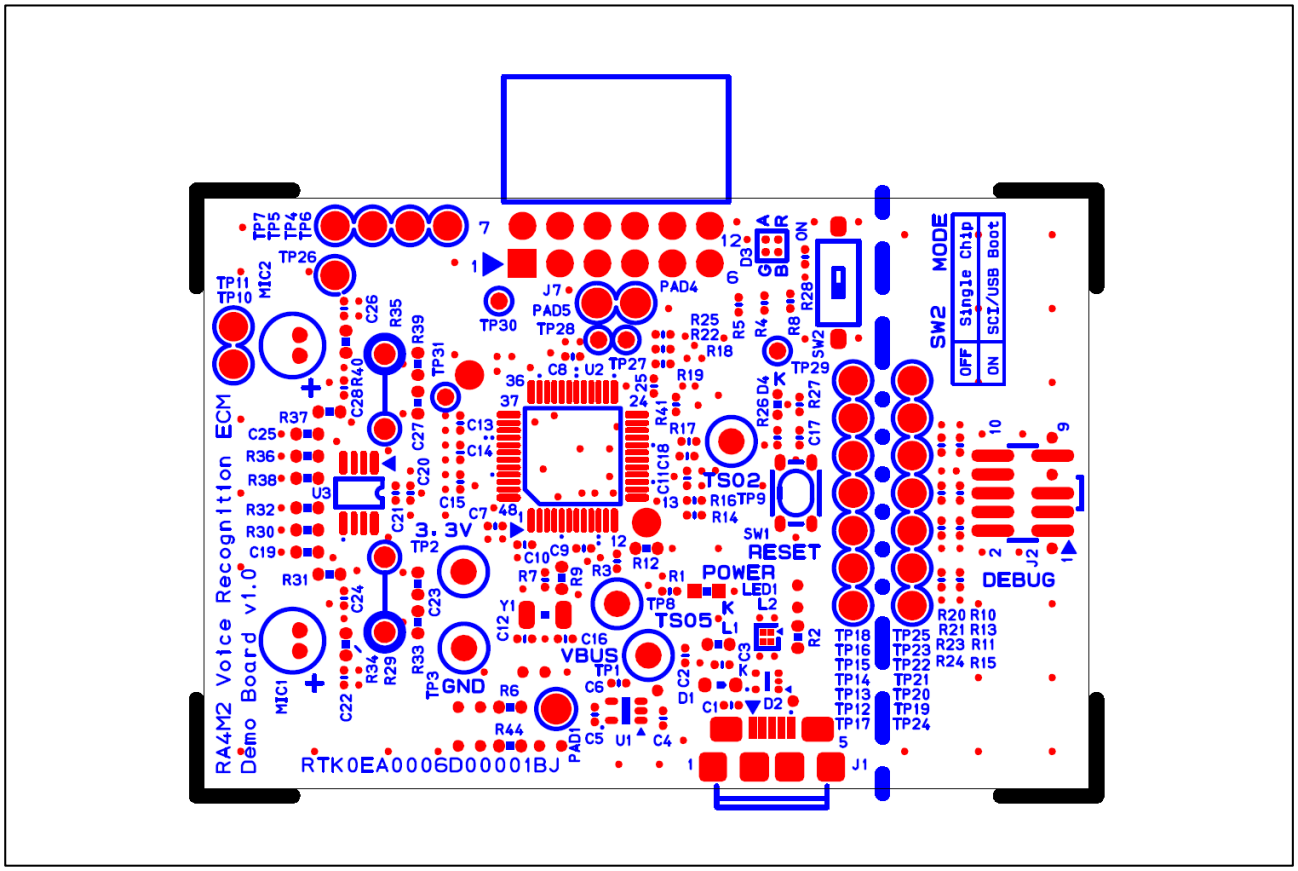


Figure 10.1 Component Side Silkscreen

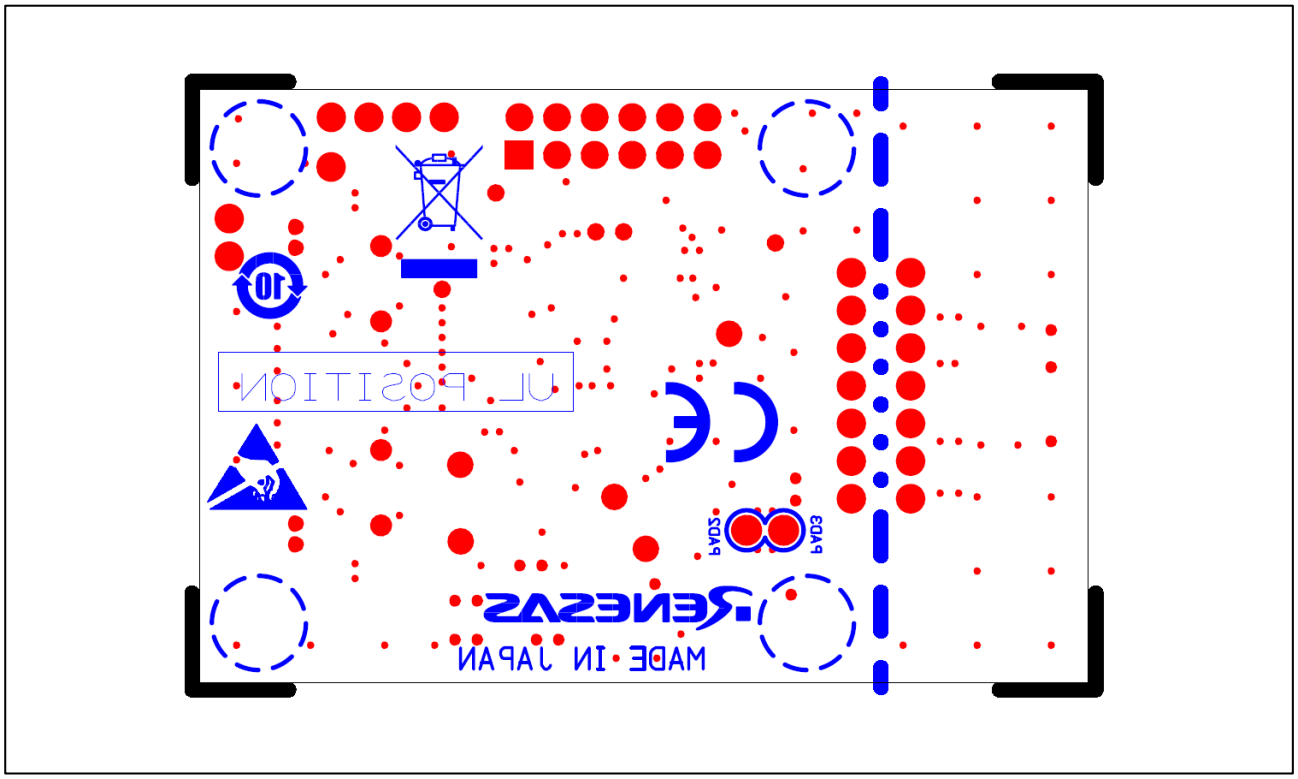


Figure 10.2 Solder side silkscreen

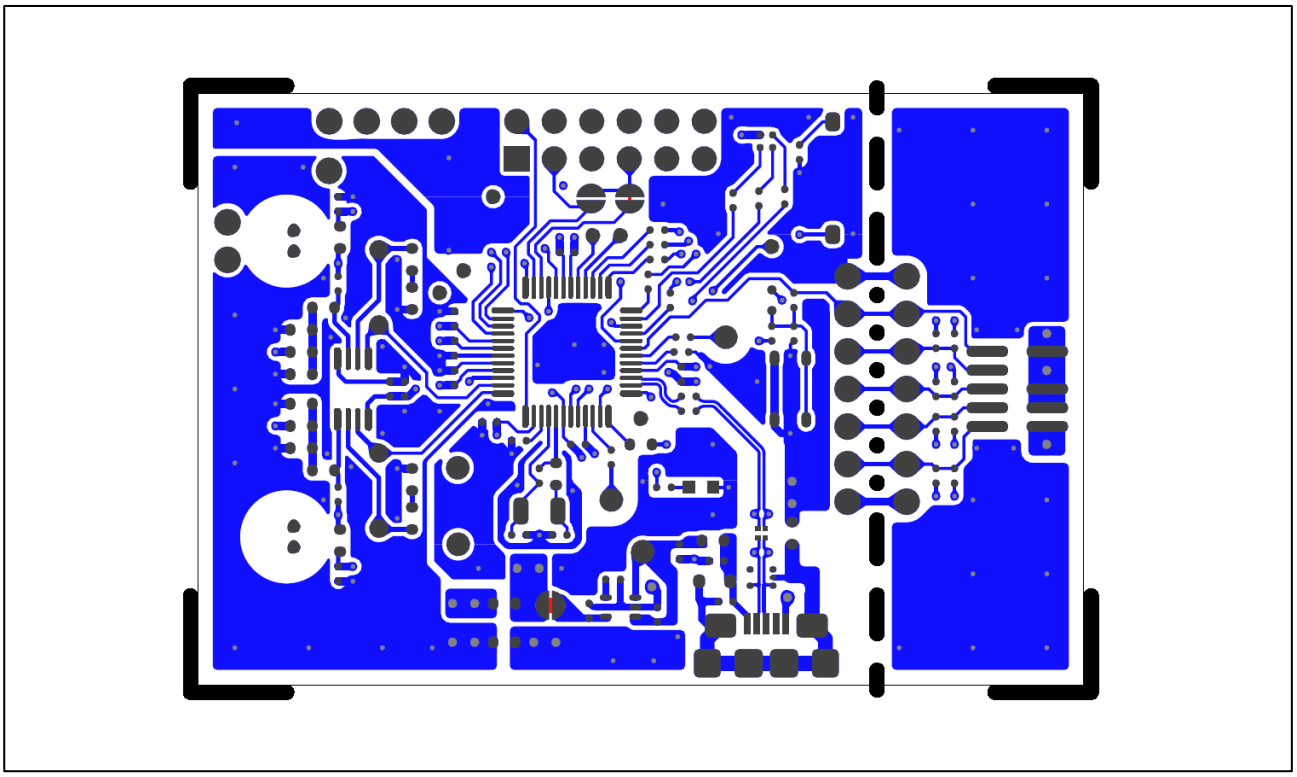


Figure 10.3 1st layer pattern

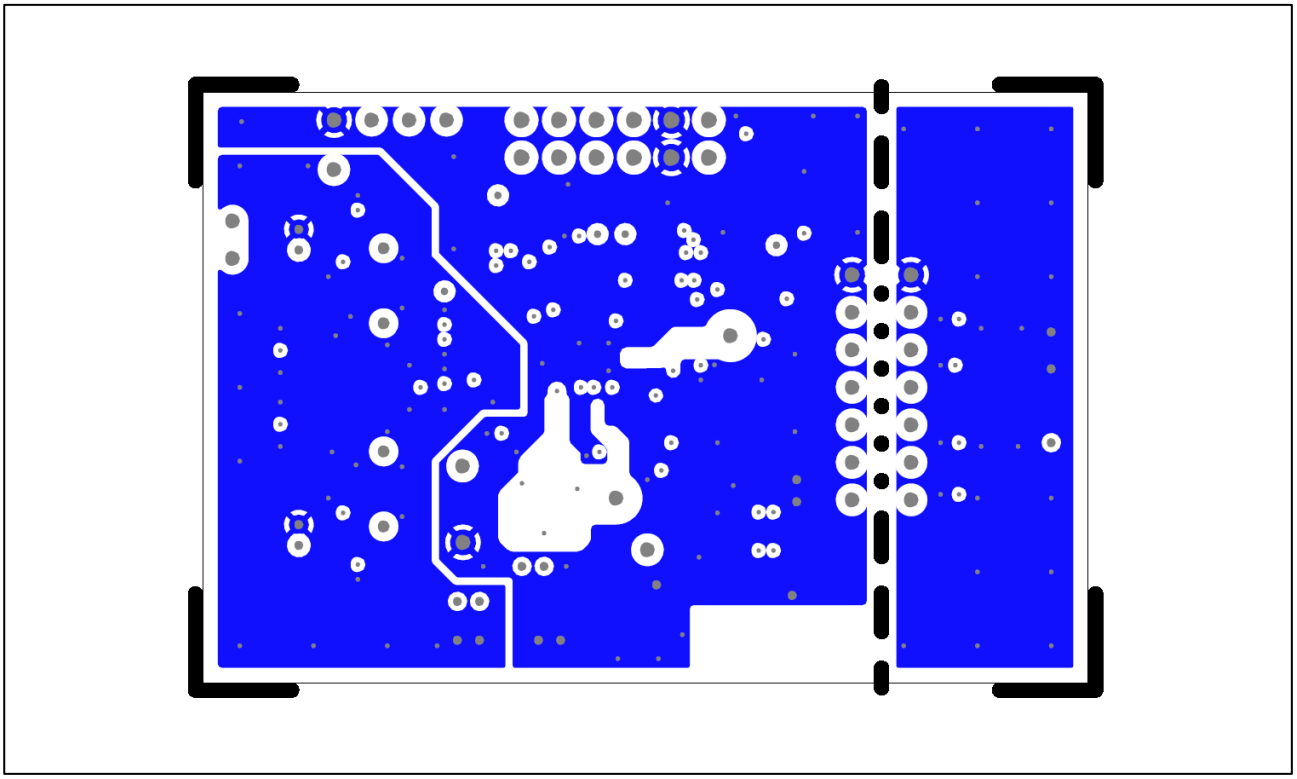


Figure 10.4 2nd layer pattern

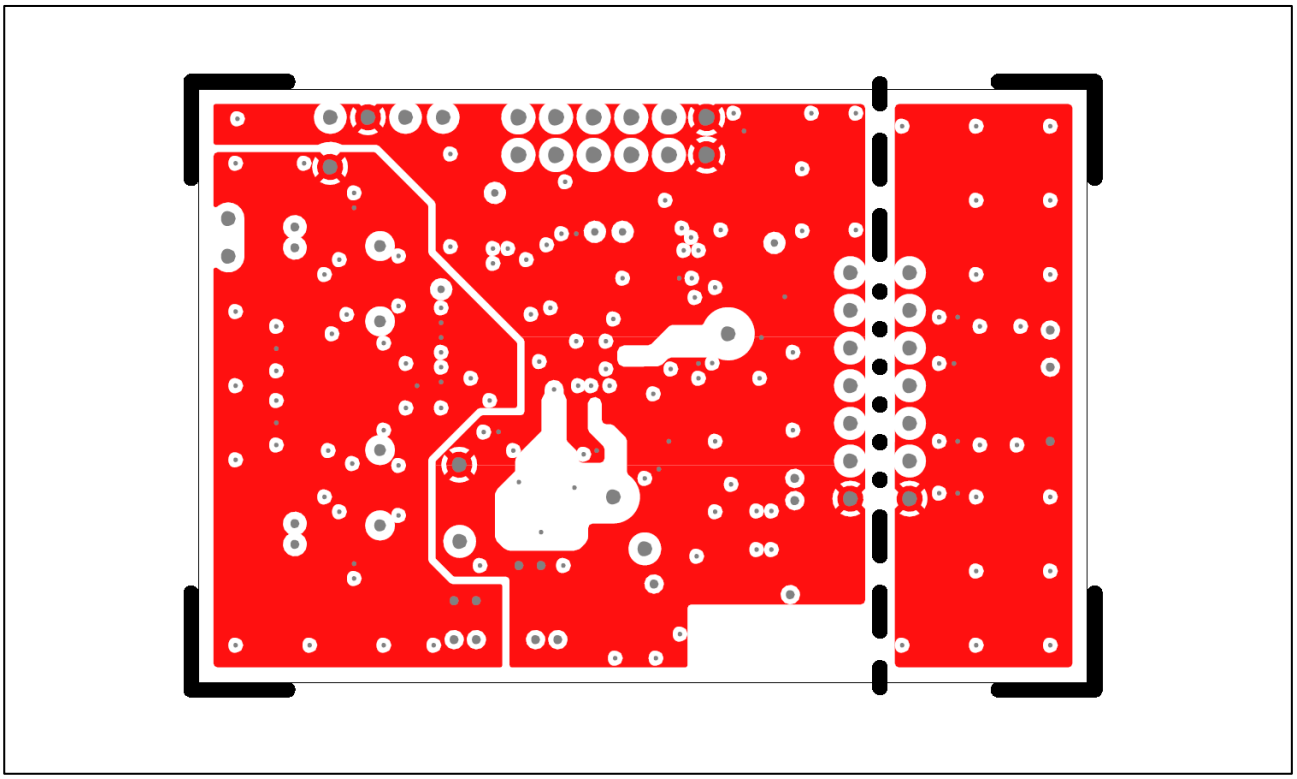


Figure 10.5 3rd layer pattern

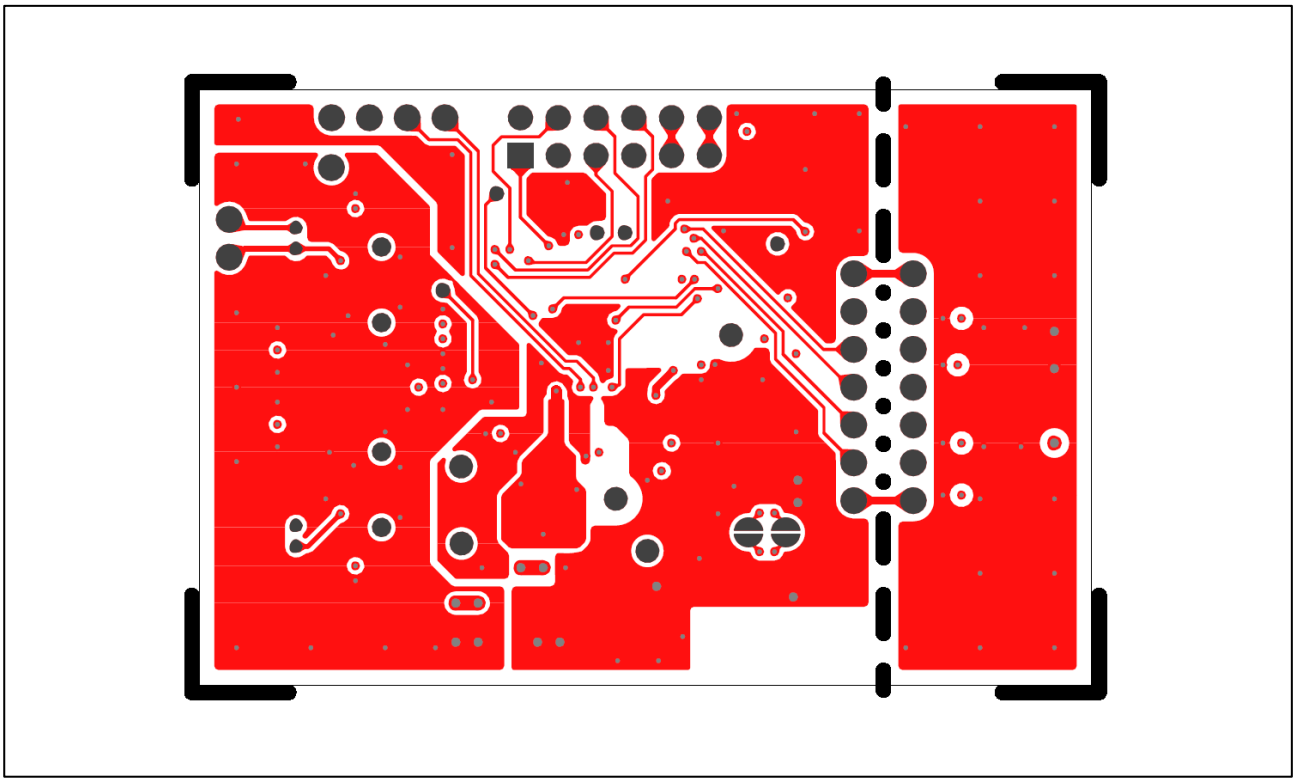


Figure 10.6 4th layer pattern

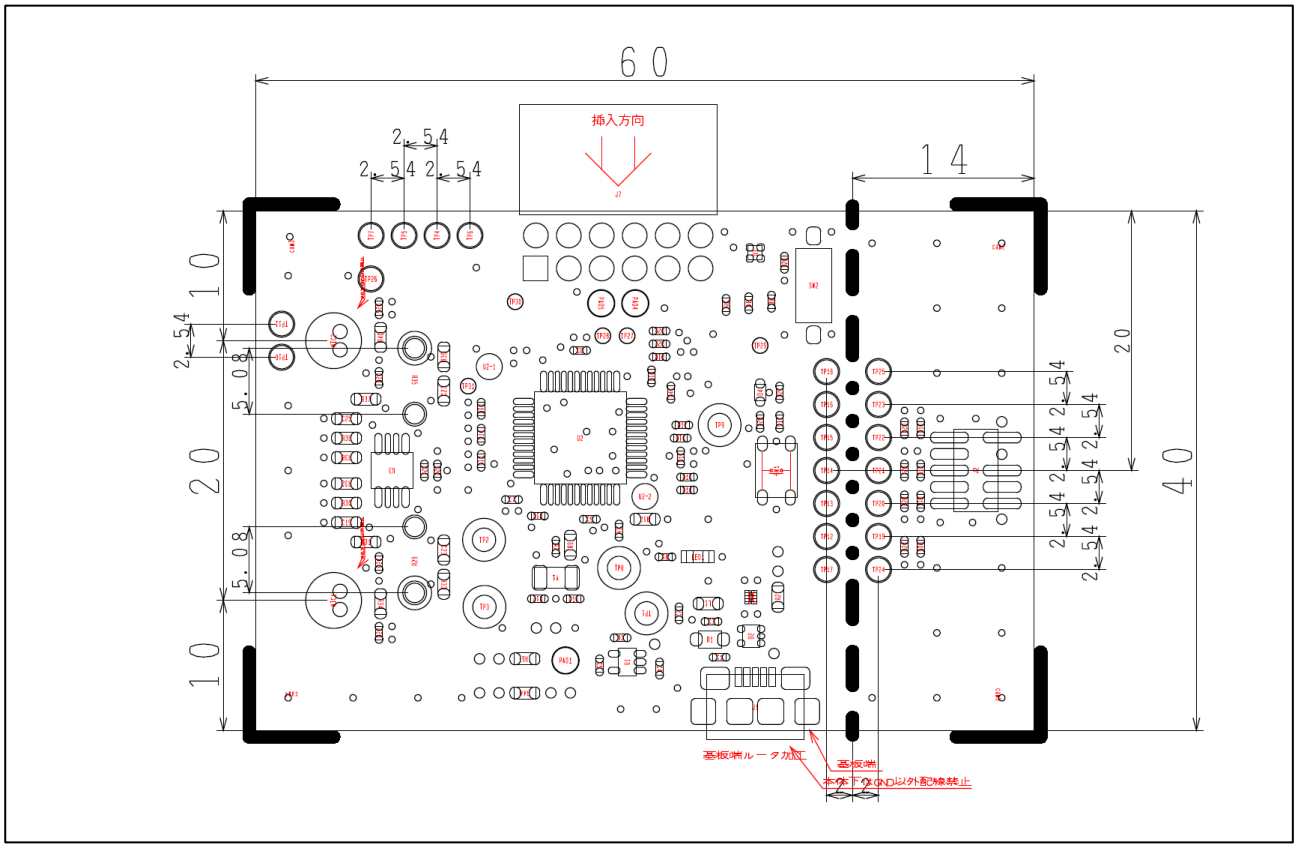


Figure 10.7 External dimensions (Unit: mm)

11. BOM (parts list)

Table 11.1 BOM (1/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
1	MCU	U2	R7FA4M2AD3CFL	Renesas Electronics	Mount	1	
2	OPAMP	U3	READ2303GSN	Renesas Electronics	Mount	1	
3	Crystal Oscillator	Y1	FC-135R 32.768000kHz12.5 +20.0-20.0	Seiko Epson	Mount	1	
4	LDO	U1	ISL9003AIENZ-T	Renesas Electronics	Mount	1	
5	Schottky Diode	D4	RB520SM-30T2R	Rohm	Mount	1	30V, 200mA
6	Zener Diode	D1	UDZVTE-176.8B	Rohm	Mount	1	6.8V
7	Zener Diode Array	D2	EMZ6.8ET2R	Rohm	Mount	1	6.8V
8	Chip LED	LED1	SML-D12D8WT86	Rohm	Mount	1	Orange
9	Chip LED	D3	SMLP34RGB2W3	Rohm	Mount	1	RGB
10	Ferrite Bead	L1	BLM18PG471SN1D	Murata Manufacturing	Mount	1	470Ω@ 100MHz, 1A
11	Common Mode Choke Coil	L2	DLM0NSM900HY2	Murata Manufacturing	Mount	1	
12	Chip Resistor	R2,R12,R44	MCR03EZPJ000	Rohm	Mount	3	0Ω, 5%, 0603(1608 Metric)
13	Chip Resistor	R6	SFR03EZPF2000	Rohm	Mount	1	200Ω, 1%, 0603(1608 Metric)
14	Chip Resistor	R30,R31,R32,R36,R37,R38	ESR03EZPF1003	Rohm	Mount	6	100kΩ, 1%, 0603(1608 Metric)
15	Chip Resistor	R33,R39	ESR03EZPF1501	Rohm	Mount	2	1.5kΩ, 1%, 0603(1608 Metric)
16	Chip Resistor	R34,R40	MCR03EZPJ222	Rohm	Mount	2	2.2kΩ, 5%, 0603(1608 Metric)
17	Chip Resistor	R18,R19,R22,R25	MCR01MZPJ000	Rohm	Mount	4	0Ω, 5%, 0402(1005 Metric)
18	Chip Resistor	R14,R16	MCR01MZPJ270	Rohm	Mount	2	27Ω, 5%, 0402(1005 Metric)
19	Chip Resistor	R4	MCR01MZPF2200	Rohm	Mount	1	220Ω, 1%, 0402(1005 Metric)
20	Chip Resistor	R8	ERJ-2GEJ431X	Panasonic	Mount	1	430Ω, 1%, 0402(1005 Metric)
21	Chip Resistor	R1	MCR01MZPJ621	Rohm	Mount	1	620Ω, 5%, 0402(1005 Metric)
22	Chip Resistor	R5	MCR01MZPJ681	Rohm	Mount	1	680Ω, 5%, 0402(1005 Metric)
23	Chip Resistor	R27	MCR01MZPJ102	Rohm	Mount	1	1KΩ, 5%, 0402(1005 Metric)

Table 11.2 BOM (2/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
24	Chip Resistor	R28	MCR01MZPJ152	Rohm	Mount	1	1.5kΩ, 5%, 0402(1005 Metric)
25	Chip Resistor	R10,R11,R13,R15,R26,R41	MCR01MZPJ103	Rohm	Mount	6	10kΩ, 5%, 0402(1005 Metric)
26	Chip Resistor	R9	MCR03EZPJ514	Rohm	Mount	1	510kΩ, 5%, 0603(1608 Metric)
27	Through Hole Resistor	R29,R35	MFS1/4DC-3003 F	KOA	Mount	2	300kΩ, 1%
28	Ceramic Capacitor	C12,C16	04025A100JAT2A	AVX	Mount	2	10pF, 50V, C0G, 0402(1005 Metric)
29	Ceramic Capacitor	C3,C18	GRM155R71H103JA88D	Murata Manufacturing	Mount	2	0.01uF, 50V, X7R, 0402(1005 Metric)
30	Ceramic Capacitor	C1,C6,C8,C9,C11,C13,C14,C15,C21,C22,C26	GRM155R71H104KE14D	Murata Manufacturing	Mount	11	0.1uF, 50V, X7R, 0402(1005 Metric)
31	Ceramic Capacitor	C10,C17,C24,C28	GRM155R71C224KA12D	Murata Manufacturing	Mount	4	0.22uF, 16V, X7R, 0402(1005 Metric)
32	Ceramic Capacitor	C20	GRM155R6YA105KE11D	Murata Manufacturing	Mount	1	1uF, 35V, X5R, 0402(1005 Metric)
33	Ceramic Capacitor	C4,C5,C7	GRM155R61E225KE11D	Murata Manufacturing	Mount	3	2.2uF, 25V, X5R, 0402(1005 Metric)
34	Ceramic Capacitor	C19,C23,C25,C27	GRM188C71C475KE21D	Murata Manufacturing	Mount	4	4.7uF, 16V, X7S, 0603(1608 Metric)
35	Ceramic Capacitor	C29	GRM188R61C106MA73D	Murata Manufacturing	Mount	1	10uF, 16V, X5R, 0603(1608 Metric)
36	DIP SW	SW2	CHS-01TB	Nidec Copal Electronics	Mount	1	1bit
37	Tactile Switch	SW1	SKRPABE010	Alps Alpine	Mount	1	
38	USB Connector	J1	ZX62-B-5PA(33)	Hirose Electric	Mount	1	micro B, Receptacle
39	Header Connector	J2	FTSH-105-01-L-DV-007-K	Samtec	Mount	1	10P, 1.27mm Pitch, Keying Shroud
40	Check Terminal	TP1,TP2,TP3,TP8,TP9	SLC-22G-K	Sunhayato	Mount	5	
41	Socket Connector	J3,J4,J5,J6	PD-1	MAC8	Mount	4	1P
42	Socket Connector	J7	FSR-42085-06	Hirosugi-Keiki	UnMount	1	12P, right angle, 2.54mm pitch
43	Electret Condenser Microphone	MIC1	CMEJ-0415-42-LP	CUI Devices	Mount	1	Omnidirectional, -42dB
44	Electret Condenser Microphone	MIC2	CMEJ-0415-42-LP	CUI Devices	UnMount	1	Omnidirectional, -42dB

Table 11.3 BOM (3/3)

Item	Parts Type	Reference	Part Number	Manufacture	Impl	Qty	Remarks
45	Ceramic Capacitor	C2	CPAD_1005	-	UnMount	1	0402(1005 Metric)
46	Chip Resistor	R3,R7,R17,R20,R21,R23,R24	RPAD_1005	-	UnMount	7	0402(1005 Metric)
47	Through Hole	TP4,TP5,TP6,TP7,TP12,TP13,TP14,TP15,TP16,TP17,TP18,TP19,TP20,TP21,TP22,TP23,TP24,TP25,TP26	1mmTH	-	-	19	
48	Through Hole	TP10,TP11	1mmTH	-	-	2	For connecting an external microphone.
49	Through Hole	TP27,TP28,TP29,TP30,TP31	0.5mmTH	-	-	5	
50	Solder Bridge Jumper	PAD1,PAD4	SHORT-PAD	-	-	2	
51	Solder Bridge Jumper	PAD2,PAD3,PAD5	OPEN-PAD	-	-	3	
52	Rubber Bumper Stopper	Bumpon1,Bumpon2,Bumpon3,Bumpon4	SJ5382	3M	Mount	4	
53	PCB	PCB1	RTK0EA0006D00001BJ	Chino Giken	-	1	

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug.30.21	-	First release
1.10	Sep.16.21	15, 16, 21, 22	p15, Figure 9.1 Add R6 (200Ω) and C29 (10μF). p16, Figure 9.2 Remove C29 from MIC1 output. p21, Table 11.1 Add R6(200 Ω). P22, Table 11.2 Changed C29 from 0.15μF to 10μF.

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.

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