User's Manual

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RL78/G22 Multiwavelength Smoke Detector Evaluation Board

Manual: Hardware

RL78 Family

Renesas Electronics
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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.

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware functions and electrical characteristics of the MCU. It is intended for users designing application systems incorporating the MCU. A basic knowledge of electric circuits, logical circuits, and MCUs is necessary in order to use this manual.

The manual comprises an overview of the product; descriptions of the CPU, system control functions, peripheral functions, and electrical characteristics; and usage notes.

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 Multiwavelength Smoke Detector solution. 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 for Hardware	Hardware specifications (pin assignments, memory maps, peripheral function specifications, electrical characteristics, timing charts) and operation description Note: Refer to the application notes for details on using peripheral functions.	RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Hardware)	This User's manual
User's manual for Software	Description of CPU instruction set	RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Software)	R01US0776
Application Note	Information on using peripheral functions and application examples Sample programs Information on writing programs in C language	Available from Renesas Electronics Web site.	
Renesas Technical Update	Product specifications, updates on documents, etc.		

Table of Contents

RENESAS

RL78/G22

Multiwavelength Smoke Detector Evaluation Board Manual (Hardware)

1. Introduction

The purpose of this User's Manual (Hardware) is to explain the functions of the Multiwavelength Smoke Detector POC Board (hereinafter referred to as the POC Board) using the RL78/G22 microcontroller and AFE (Analog Front-End IC).

The hardware and sample software are for reference purposes only for development, and we do not guarantee that they will work as products. When using hardware and sample software, please use it after sufficient evaluation in an appropriate environment.

Operation check device

The sample software has been confirmed to work with the following devices implemented in Multiwavelength Smoke Detector.

- RTK7RL22SMD00000BJ (Smoke Detector board)
- R7F102GBE2DNP#YJ1 (on-board-MCU)
- RAA23910X (on-board-AFE)

1.1 System Benefits from Renesas Component Integration

- RAA23910X of low-power analog front-end ICs for the Smoke Detector include 2x LED drivers, 2x Photodiode inputs with programmable gain transimpedance amplifiers, ADC + DAC, linear regulator for MCU power, and 3.3V or 9V operation. and the cost of the entire system can be greatly reduced.
- The highly integrated AFE can be used for light detection of different IR wavelengths, which greatly improves the accuracy of the Smoke Detector and allows consideration of UL217 or UL268 compliant Multiwavelength Smoke Detector systems.
- Data Flash with a small-pin, low-cost RL78/G22 microcontroller enables non-volatile data storage such as alarm counters and operating hour meters.
- Minimum BOM counts and small solution sizes are possible.

1.2 Features of Analog Front-End IC RAA23910X

The highly integrated RAA23910X includes all the peripherals and features required for a Multiwavelength Smoke Detector system, primarily focused on residential smoke detector design. Therefore, it is easy to realize an electronic circuit for Multiwavelength Smoke Detector with only two main components: MCU + AFE.

- 8-bit DAC adjustable current (45mA ~ 300mA, or 90mA ~ 600mA)
- Photodetector TIA amplifier + PGA (programmable gain up to 160 MV/A)
- 10-bit ADC for photodetector input
- General Purpose I/O - Single-wire TX/RX interface
- LDOs for microcontroller power supplies
- SPI interface

The AFE has all the integration features and flexible parameterization features (e.g., LED current selection, PGA gain setting, etc.) to enable flexible implementation to solve different system approaches.

2. POC board configuration

2.1 POC Board Power Supply

The POC board provides a wide range of power inputs. The specifications of each power supply are described below.

2.1.1 Power Specifications

Table 2-1 shows the voltage and current specifications for each power supply.

Table 2-1. Input Power and Current Specifications

Use	Name	Expected connectivity devices	Input voltage	Current limiting	Detail
For normal operation.	Mains power.	Receiver (P-type 2nd grade, etc.).	24～40V	max.160uA	2.1.4
For debugging.	USB power supply.	USB host device (Micro-B)	5V±5%	No restrictions.	2.1.5
	E2 Lite power supply.	E2 Lite	3.3V±5%		2.1.6
	User serial power supply.	USB-to-serial converter.	5V±5% or 3.3V±5%		2.1.7
	Debug power supply on the main PCB.	Regulated DC power supply. (or E2 emulator Lite via jump wire, USB serial converter, etc.)	5V±5% or 3.3V±5%		2.1.8

2.1.2 The operating voltage of the internal circuit.

The POC board can change the operating voltage of the internal circuit by soldering the short pad. See Table 2-2 for the short-pad settings for each operating voltage mode.

Be sure to set the solder short on the short pad to 5V or 9V (2.7V) mode. (If the settings are incorrect, abnormal operation or destruction of the board and components may occur.)

It can operate in both 5V and 9V (2.7V) modes when powered from the mains but operates in 5 V mode when powered from the debug supply.

Table 2-2. Internal circuit operating voltage short pad setting.

Detachment point. (Perforation by TH)

Operating voltage mode.	Default settings. (Shipment status)	The operating voltage of the internal circuit.		Short pad settings. (S: Short / O: Open)									
		AFE (including LED/PD for transmitting light)	MCU	SP1	SP2	SP6	SP10	SP11	SP12	SP13	SP14	SP15	SP9
5V mode.	Default.	5V	5V	S	O	S	S	O	O	S	O	S	O
9V (2.7V) mode.	-	9V	2.7V	O	S	O	O	S	S	O	S	O	O

Also, refer to **Figure 2-1** or the silk printing on the board for the location of each short pad.

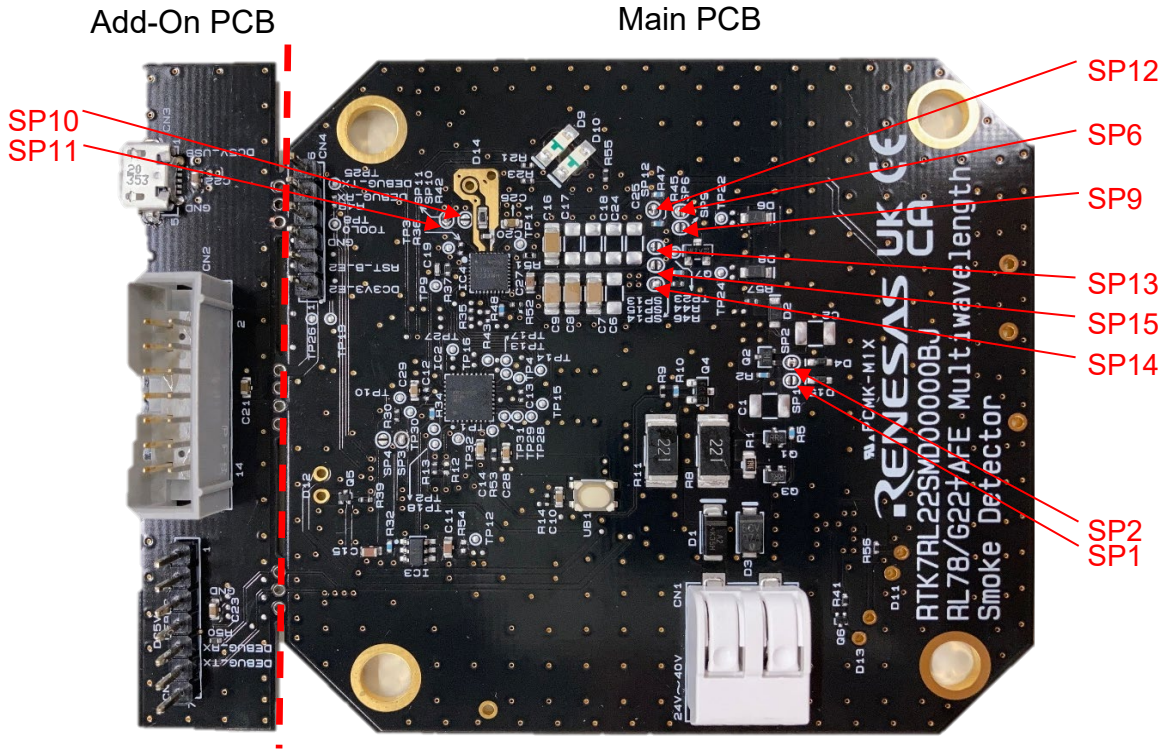


Figure 2-1. Position of the Short Pad

This board can be separated the Add-On PCB from the Main PCB.

2.1.3 Backflow prevention circuit

A diode OR circuit is mounted on the power supply section of the POC board to protect against reverse voltage even when power is supplied from multiple power supplies at the same time. (See **Figure 2-2**)

However, since the E2 Lite power supply is configured so that it does not go through the diode OR circuit so that the voltage detection function of the emulator can be used, care must be taken when setting a short pad that differs from the operating voltage of the internal circuit in Section 2.1.2. (See Section 2.1.6 for more information on the E2 Lite power supply.)

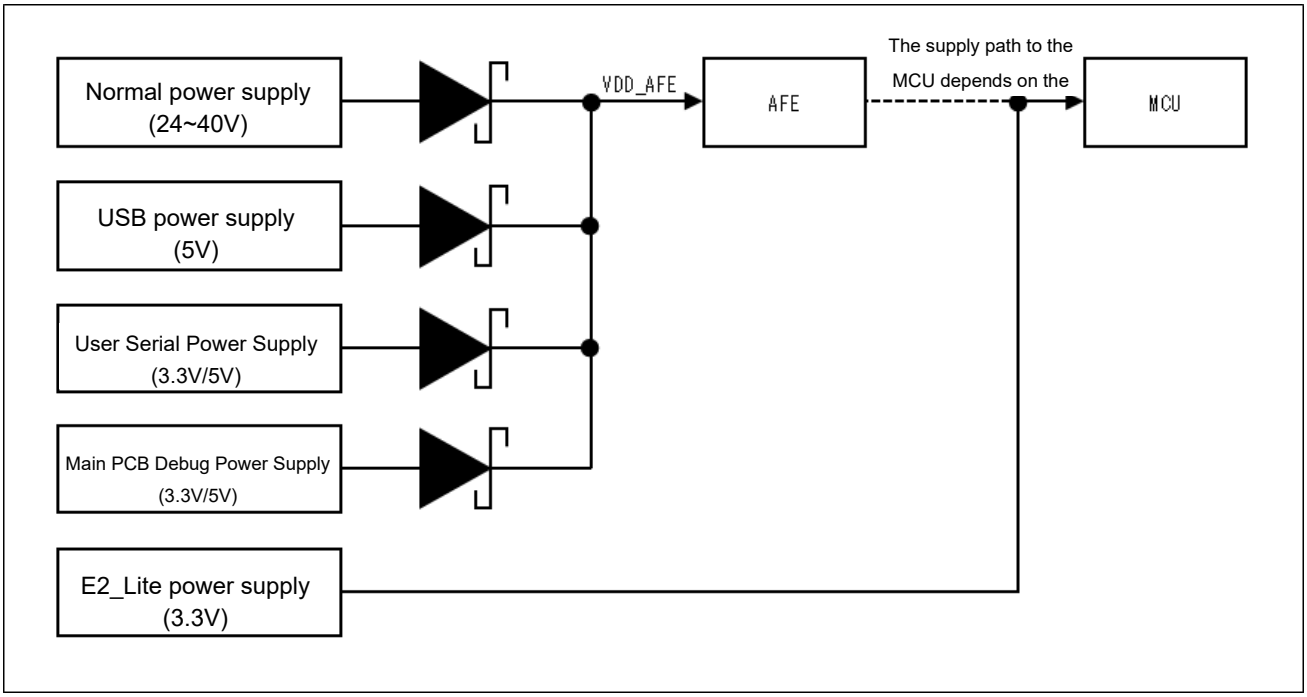


Figure 2-2. Power Diode OR Schematic

2.1.4 Main Power supply (Main PCB)

It is assumed that the power port for the receiver connection is in, and 24~40V is entered. The port is followed by a current-limiting circuit (see Section 2.2), which typically limits the input current from the receiver to a max. of 160uA. However, by driving the notification signal generation circuit (see Section 2.3) with the GPIO of the MCU, it is possible to draw a current of min. 52 mA from the receiver (continuous consumption).

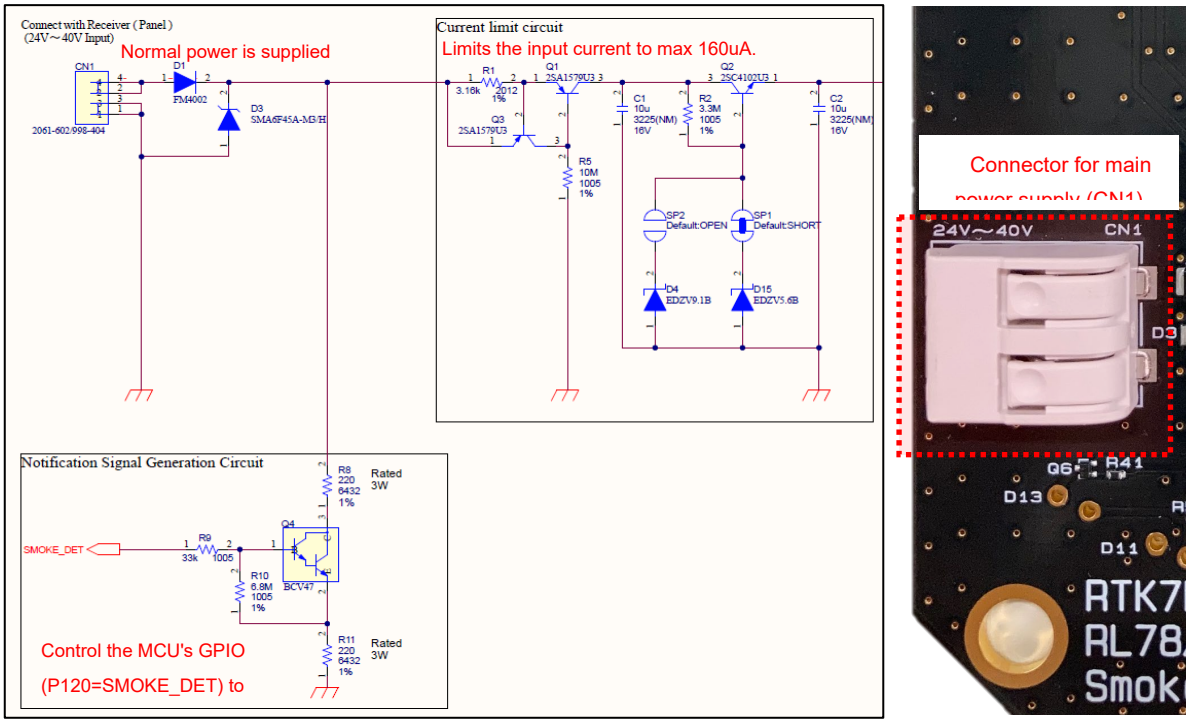


Figure 2-3. Main Power Schematic

2.1.5 USB Power supply (Add-On PCB)

It is a power port for connecting to a USB Micro-B terminal (USB host device such as a PC) and can supply 5V. This port is used for power supply and does not have USB communication or negotiation functions. In addition, the power supply line from this port does not pass through a current-limiting circuit, so power can be supplied without a current limit of max. 160uA.

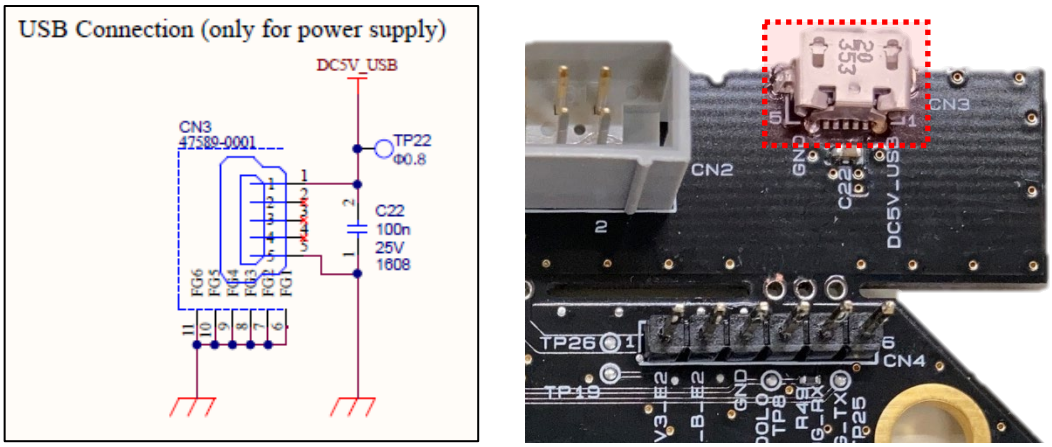


Figure 2-4. Micro-USB Power Supply

2.1.6 E2 Lite Power supply (Add-On PCB)

It is a port for connecting to the E2 Lite emulator and can supply 3.3V. Normally, the power supply from this port is supplied only to the MCU, so the LEDs and PDs for AFE and transmit light do not operate.

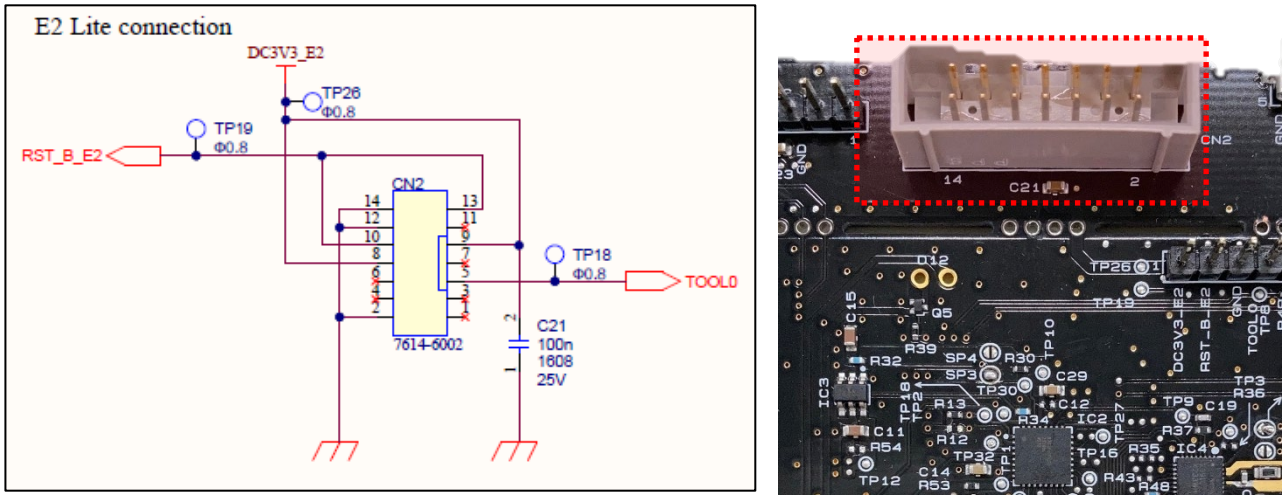


Figure 2-5. E2 Lite power supply

However, it is possible to supply power to the AFE by changing the settings of the short pad as follows, but care must be taken because the LED for transmitting light may not work.

Table 2-3. Short Pad Settings for AFE Operation Using E2 Lite

Short pad settings. (S: Short / O: Open)							
SP1	SP2	SP6	SP10	SP11	SP14	SP15	SP9
S	O	S	S	O	O	O	S

The settings of SP1 and SP2 are not directly related to the operation of the E2 Lite power supply, but they should be set as described above so that a reverse voltage is not applied to the E2 Lite emulator if power is accidentally supplied from the main power supply at the same time.

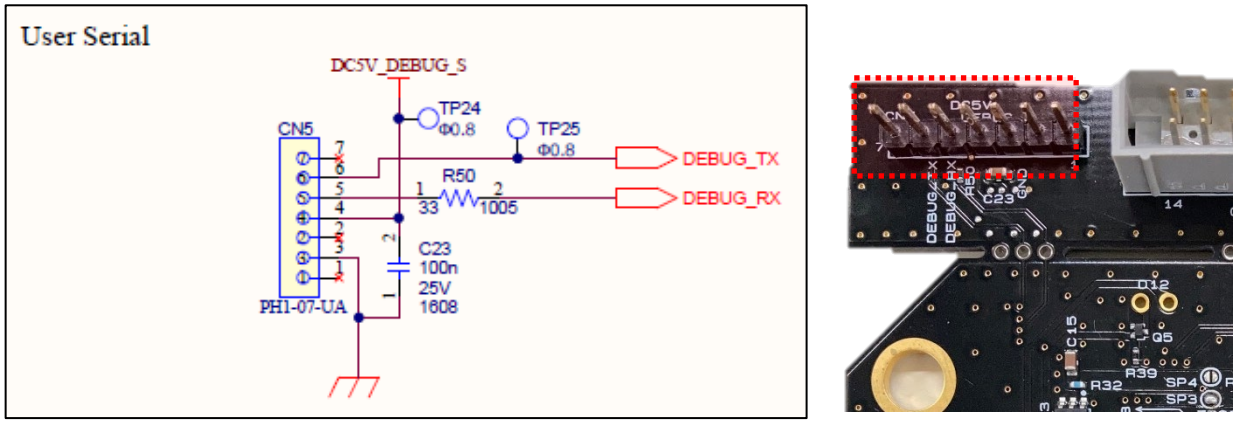
In addition, the power supply line from this port does not pass through a current-limiting circuit, so power can be supplied without a current limit of max. 160uA.

When using the E2 Lite emulator to operate the AFE, transmitting light LEDs, and photodiodes, supply a 5V power supply from the main power supply or the user serial port, etc., instead of supplying power from the E2 Lite.

2.1.7 User Serial Power supply (Add-On PCB)

The power port for connecting to a USB-to-serial converter can supply 5V or 3.3V. However, in the case of a 3.3V supply, care must be taken because the transmitting light LED may not work. In addition, the power supply line from this port does not pass through a current-limiting circuit, so power can be supplied without a current limit of max. 160uA

See Section 2.10 for information on the user serial feature.



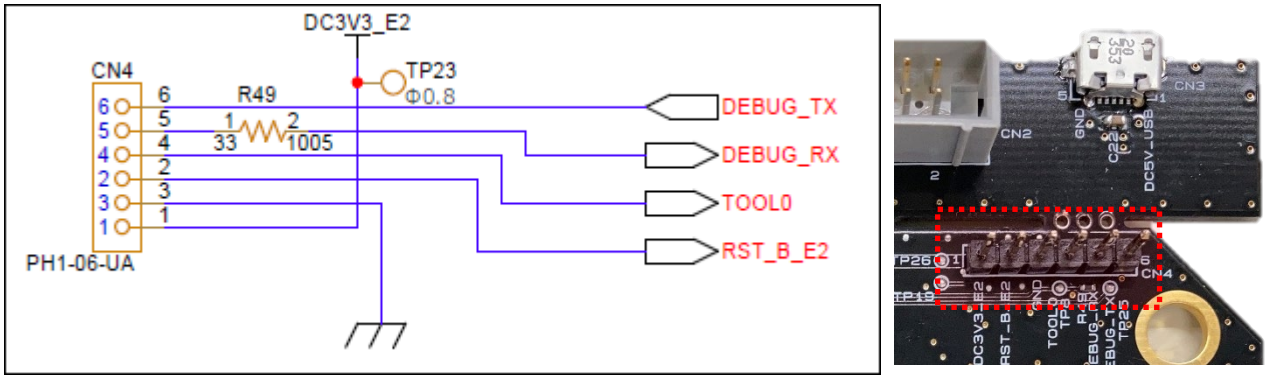
Connector Pin No.	Terminal function
4	Power Input (5V/3.3V)
3	GND

Figure 2-6. User Serial Interface Connection Detail Diagram

2.1.8 Debug Power supply (Main PCB)

It is possible to connect a regulated DC power supply (or E2 Lite and USB serial converter via jump wires) to supply 5V or 3.3V. However, care must be taken because the LED for transmitting light may not operate when 3.3V is supplied. In addition, the power supply line from this port does not pass through a current-limiting circuit, so power can be supplied without a current limit of max. 160uA.

See Section 2.9 for debugging features with the E2 Lite emulator and Section 2.10 for user serial features.



Connector Pin No.	Terminal function
1	Power Input (5V/3.3V)
3	GND

Figure 2-7. Debug Power supply Detail Diagram

2.2 Current Limiting Circuit (for Conventional Type Smoke Detectors)

The POC board has a current limiting circuit after the main power supply. This circuit is implemented to limit the input current to 160uA or less when power is supplied from the receiver (mains power supply). On the other hand, the current is not limited to the debug (USB / E2 Lite / user serial / main PCB debugging) power supply.

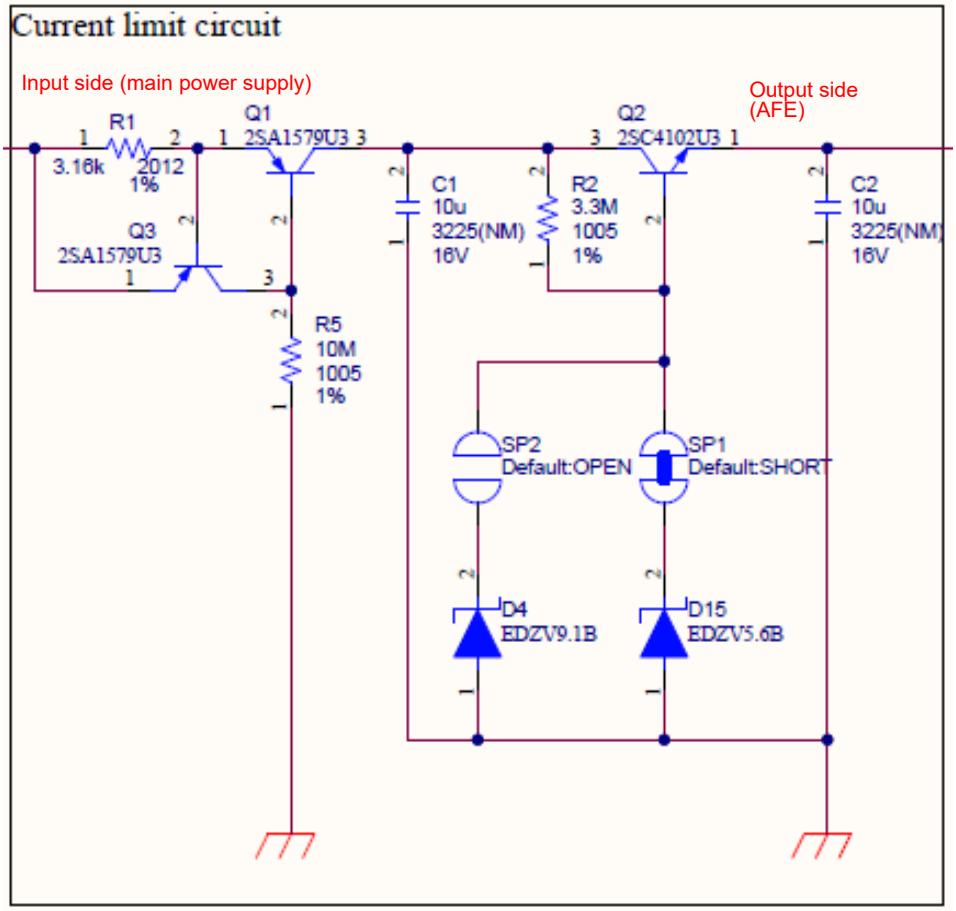
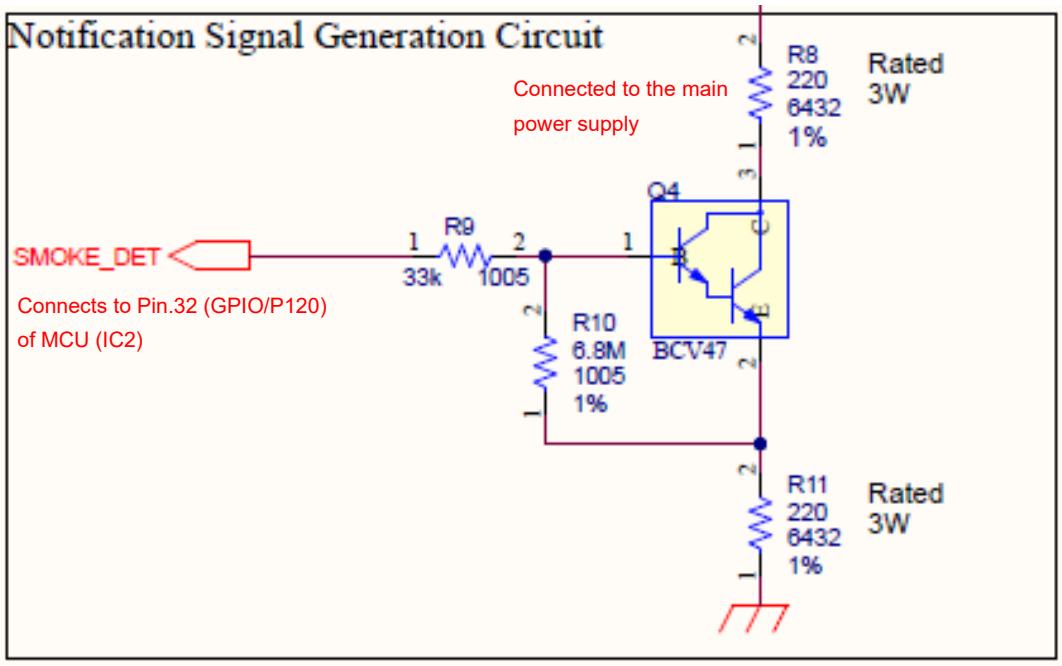


Figure 2-8. Current Limit Schematic

In addition, two Zener diodes are mounted in the current limiting circuit, and it is possible to change the output (VDD_AFE) voltage of the current limiting circuit by switching the solder short circuit of the short pad (SP1 / SP2).In that case, it is necessary to switch appropriately to the subsequent circuit of the current limiting circuit, so change the state of each short pad by referring to Section 2.1.2.

2.3 Notification signal generation circuit (for Conventional Type Smoke Detectors)

The POC board has a circuit that generates a notification signal to the main power supply (receiver). The notification signal is an operation in which the input current from the main power supply (receiver) is forcibly drawn min. 52 mA or more, and the activation or disabling of the notification signal can be controlled by the GPIO pin (port P120) of the MCU.



Presence or absence of notification signals	GPIO(P120) Output level
Notifications Disabled	Low
Notifications Enabled (min.52mA drawn from mains)	High

Figure 2-9. Notification signal generation circuit diagram

2.4 Microcontroller (RL78/G22)

The POC board is equipped with Renesas' RL78/G22 as an MCU. Figure 2-10 shows the schematic around the MCU.

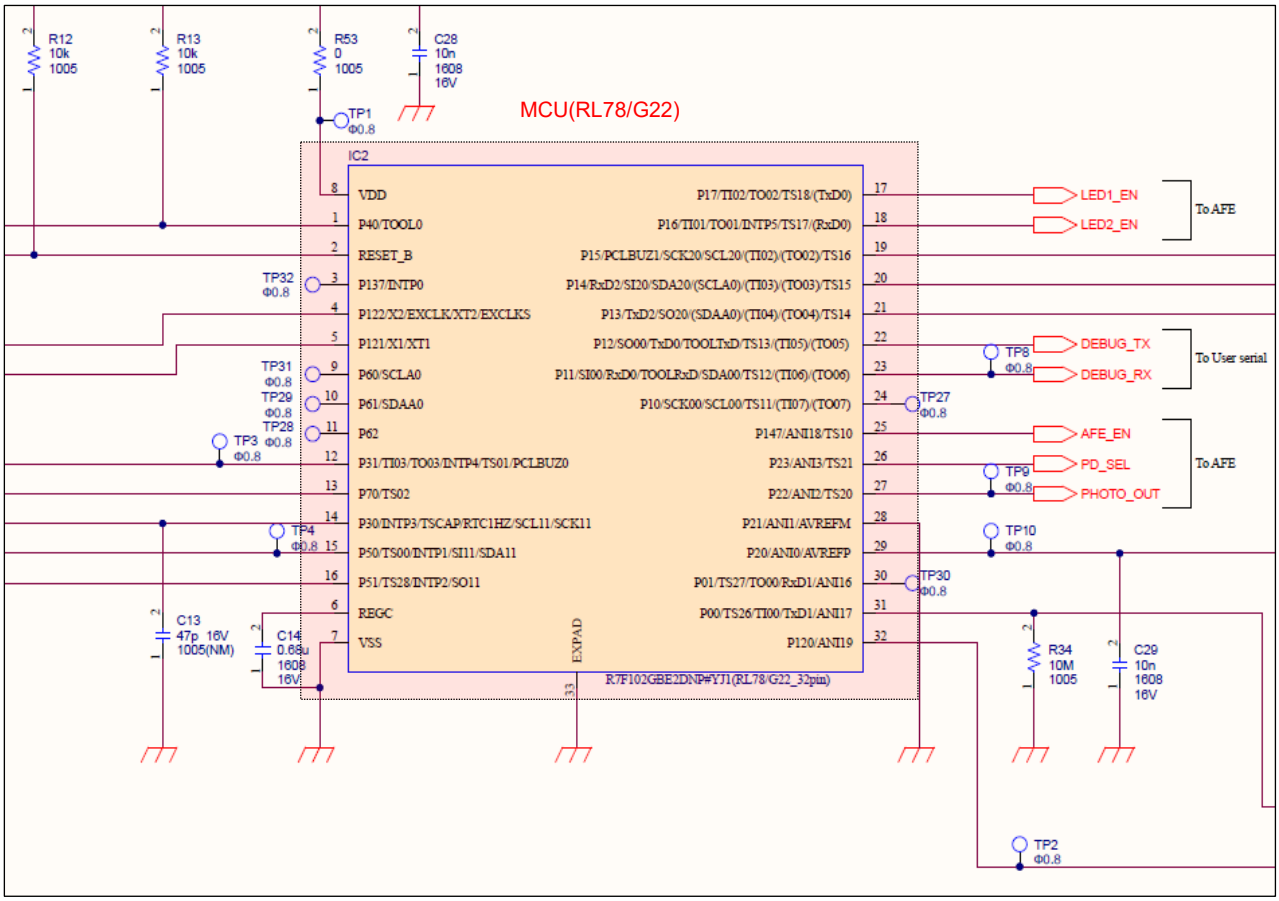


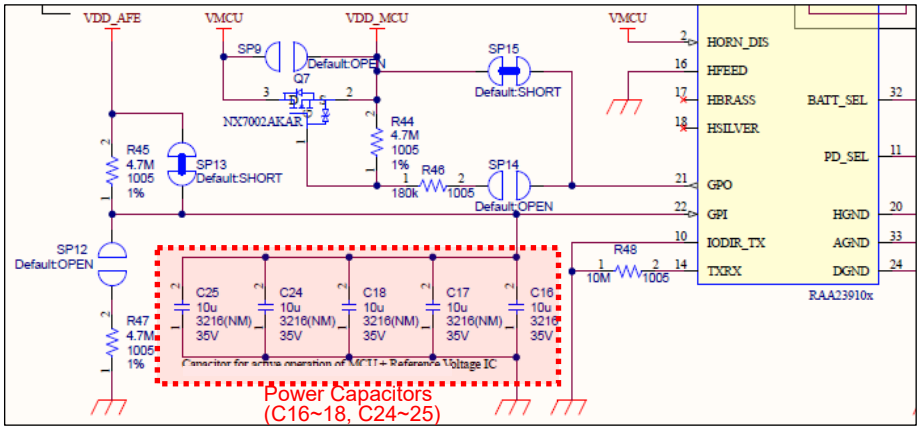
Figure 2-10. Schematic around MCU (RL78/G22)

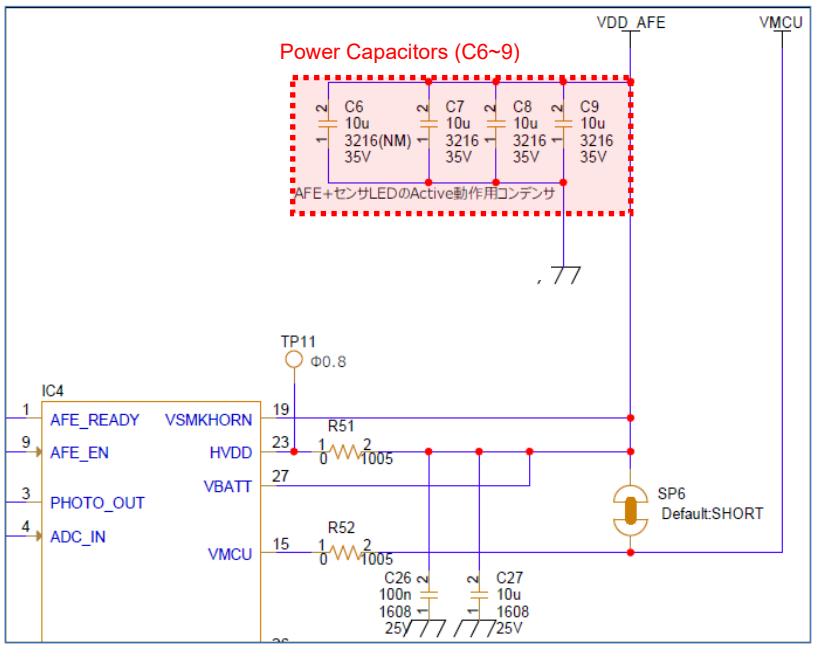
The main features of the MCU are excerpted below.

- CPU: RL78 core(max.32MHz)
- VDD = 1.8 to 5.5 V
- Memory: Code Flash 32 or 64KB (The MCU covered in this document is 64 KB) / SRAM 4KB / Data Flash 2KB
- Timers: 16-bit timer x8ch / Watchdog timer x1ch / 32-bit interval timer 32-bit x1ch mode, 16-bit x2ch mode, 8-bit x4ch mode
- Analog input: 8/10-bitA/D converter x10ch (The MCU covered in this document is 8ch)
- On-chip oscillator：32.768kHz~32MHz(High-Speed / Middle-Speed / Low-Speed)

When powered by the mains, the MCU is powered through a current-limiting circuit (see Section 2.2), so low-power operation is primarily assumed.

When operating at non-low power, it is necessary to pre-charge the power capacitors (C6~9/C16~18/C24~25) on the board during low power. As shown in Figure 2-11, select the capacitance according to the operating time and operation content at non-low power and mount additional power capacitors. In addition, this board has a 10uF power capacitor mounted on C7~C9 and C16 as standard.





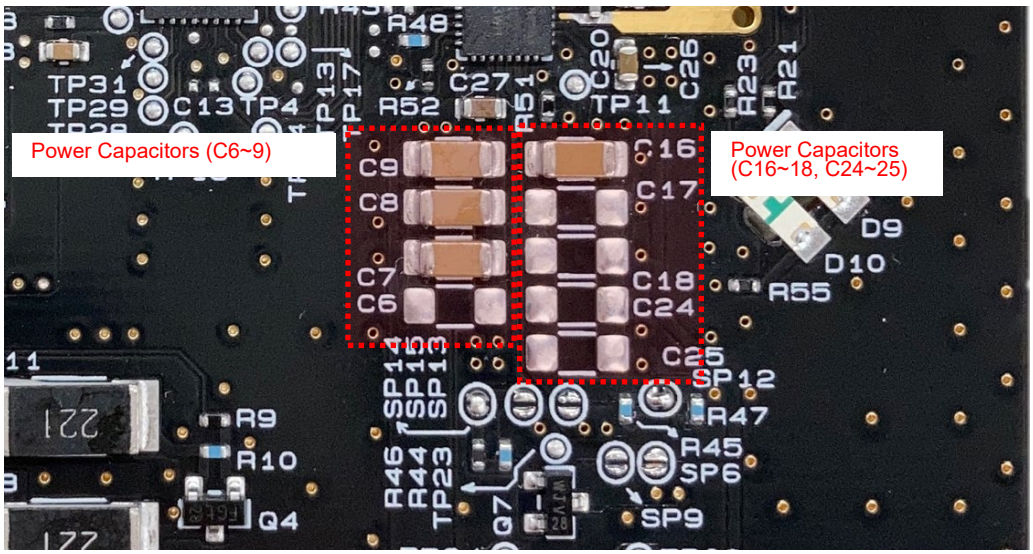


Figure 2-11. Power Capacitor Implementation

2.4.1 Microcontroller Pinouts and Features

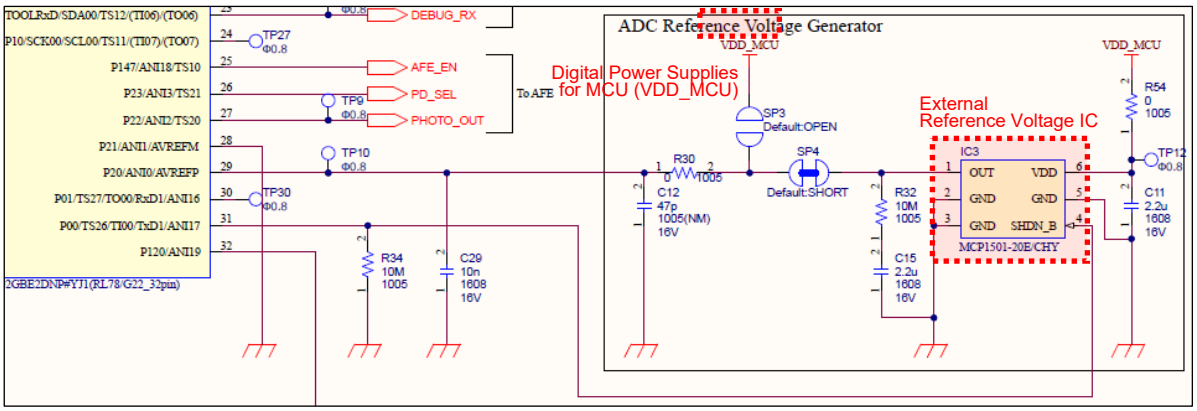
Table 2-4. Microcontroller Pinouts and Features

PIN	PORT	Features / Contents
1	P40	TOOL0/E2 Lite for debugging
2	-	nRESET for debugging
3	P137	INTP0
4	P122	LED switching for smoke detection1_ON
5	P121	LED switching for smoke detection2_ON
6	-	REGC
7	-	VSS (GND)
8	-	VDD (VDD_MCU:5V or 3.3V)
9	P60	(Unused)
10	P61	(Unused)
11	P62	(Unused)
12	P31	AFE_RDY
13	P70	SPI_CS
14	P30	SPI_SCK
15	P50	SPI_MISO
16	P51	SPI_MOSI
17	P17	for smoke detection LED 1_EN
18	P16	for smoke detection LED 2_EN
19	P15	User switch
20	P14	Indicator LED (green)
21	P13	Indicator LED (red) for alarms
22	P12	DEBUG_TX (for user serial)
23	P11	DEBUG_RX (for user serial)
24	P10	(Unused)
25	P147	AFE_EN
26	P23	PD_SEL
27	P22	PHOTO_OUT
28	P21	(GND)
29	P20	VREFP (Reference voltage input)
30	P01	(Unused)
31	P00	SHDN (For reference voltage IC shutdown)
32	P120	SMOKE_DET (For communication signal generation circuits)

2.5 ADC Analog Reference Voltage

This board can select the analog reference voltage of the MCU from the following two voltage sources.

- External Reference Voltage IC
- Digital Power Supplies for MCU (VDD_MCU)



Which voltage source to choose	Reference voltage level (accuracy)	Short Pad Settings (S: Short / O: Open)	
		SP3	SP4
External Reference Voltage ICs	2.048V(±1%)	O	S
Digital Power Supplies for MCUs (VDD_MCU)	In 5V mode: 5V (*) In 9V mode: 2.7V (±5%)	S	O

Note: * The voltage accuracy in 5V mode is 4.63~5.05V for mains power supply. The voltage accuracy during debug power supply depends on the accuracy of the source.

Figure 2-12. ADC Analog Reference Power Supply Selection Diagram

Each voltage source can be switched by a short-pad and can be selected using the settings shown in Figure 2-12.

When combining the short pad with an open and short, be careful not to short-circuit SP3 and SP4 at the same time. (If the current is not followed and energized, it may cause abnormal operation or destruction of the board/components.)

In addition, when using an external reference voltage IC, it is necessary to control the SHDN_B pin of the external reference voltage IC from the GPIO (P00 Pin.31) of the MCU. Since the SHDN_B pin is in the default Low (shutdown) state due to a pull-down resistor (10MΩ), control it to High (shutdown release) by the user program when using.

However, if the shutdown is released continuously when power is supplied by the main power supply (power is supplied via a current-limiting circuit), the power capacitor (see Section 2.4) may be discharged and the MCU power supply voltage may drop, resulting in an MCU shutdown. Therefore, when using an external reference voltage IC, set the shutdown release period according to the amount of charge charged by the power supply capacitor (see Section 2.4) or supply power from the debug power supply.

2.6 User Switch and Indicator LEDs

The POC board has the user interface peripheral circuit shown in Figure 2-13, and the user program can control the operation by the user switch and the light emission of the indicator LED.

Ref No.	Name	Corresponding GPIO (Pin No.)
UB1	User Switch	P15(Pin.19)
D9	Indicator LED (green)	P14(Pin.20)
D10	Indicator LED (red)	P13(Pin.21)

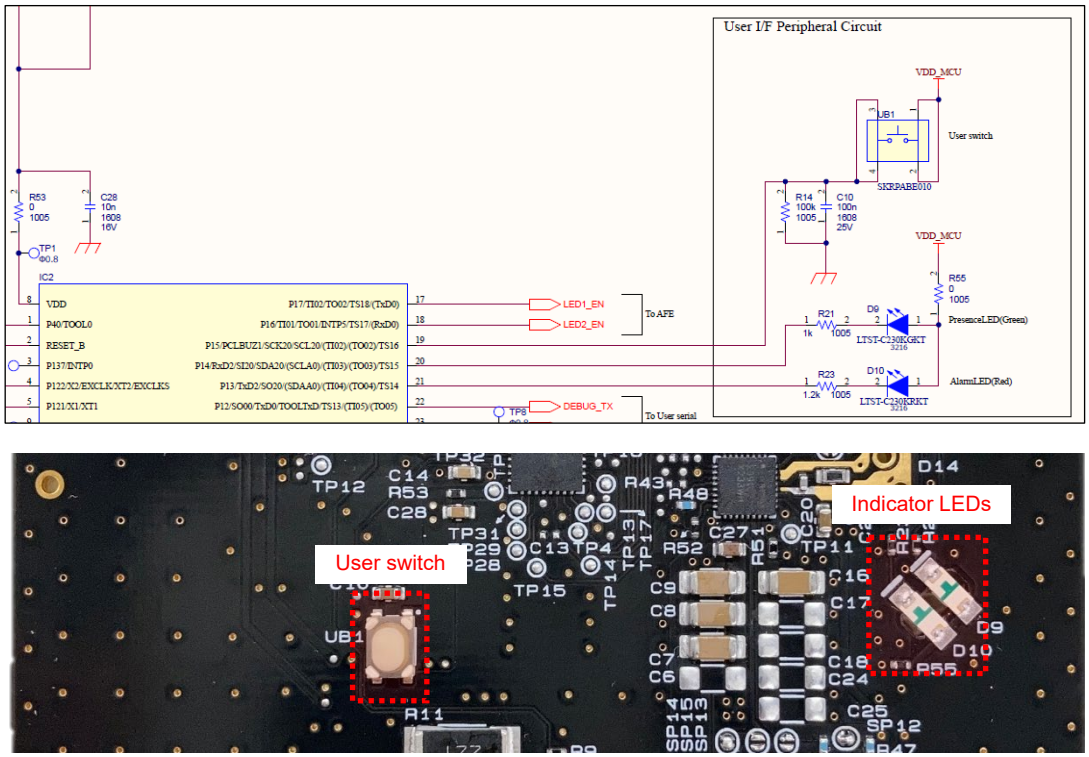


Figure 2-13. User switch and Indicator LEDs

2.6.1 User Switch

Figure 2-14 shows the relationship between the pressed and non-pressed states of the user switch and the pin state of the MCU.

The state of the buttons	GPIO P15 pin status
Press	High (VDD_MCU voltage level)
Non-pressed	Low (GND level)

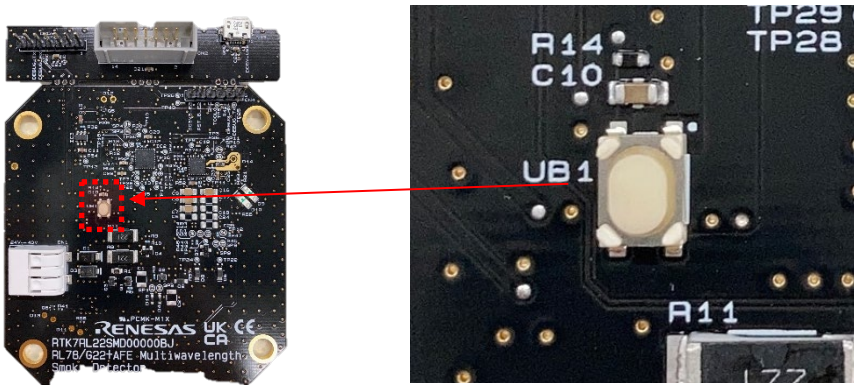


Figure 2-14. User Switch

While this button is pressed VDD_MCU a short circuit between the power supply and GND is always via 100 kΩ. Therefore, if this button is pressed continuously while power is supplied by the main power supply (power supply via a current limiting circuit), the power supply capacitor (see Section 2.4) will be discharged, causing the power supply voltage of the MCU to drop, and the MCU may stop or not start.

Therefore, when using the user switch, set the pressing time according to the charge amount of the electrolytic capacitor (see Section 2.4) or supply power from the debug power supply.

2.6.2 Indicator LEDs

Figure 2-15 shows the correspondence between the indicator LEDs and the GPIO ports. The indicator LEDs (green and red) are lit when the MCU's GPIO is driven low. In addition, the indicator LEDs are mounted on the board in Figure 2-15.

Ref No.	Name	Corresponding GPIO (Pin No.)
D9	Indicator LED (green)	P14(Pin.20)
D10	Indicator LED (red)	P13(Pin.21)

GPIO Control	LED Status
High	Off
Low	lighting

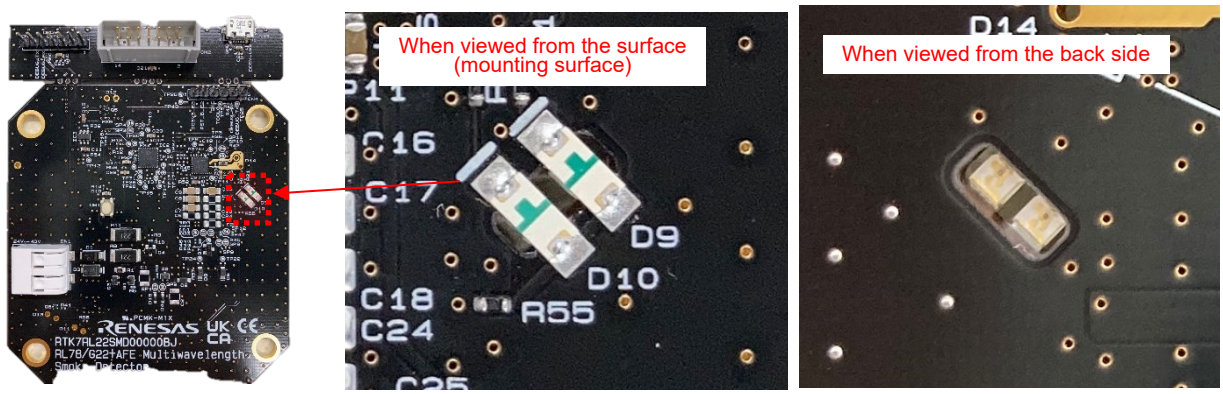


Figure 2-15. Indicator LEDs

When this LED is lit, there is always a short circuit between the VDD_MCU power supply and GND via 1 kΩ. Therefore, if the LED is continuously lit when power is supplied by the main power supply (when power is supplied via a current-limiting circuit), the power capacitor (see Section 2.4) will be discharged, causing the MCU supply voltage to drop and the MCU may stop or not start.

Therefore, when using the indicator LEDs, keep the lighting time according to the power capacitor (see Section 2.4) or supply power from the debug power supply.

2.7 Analog Front-End IC RAA23910X

The POC board is equipped with RAA23910X as an analog front-end IC.

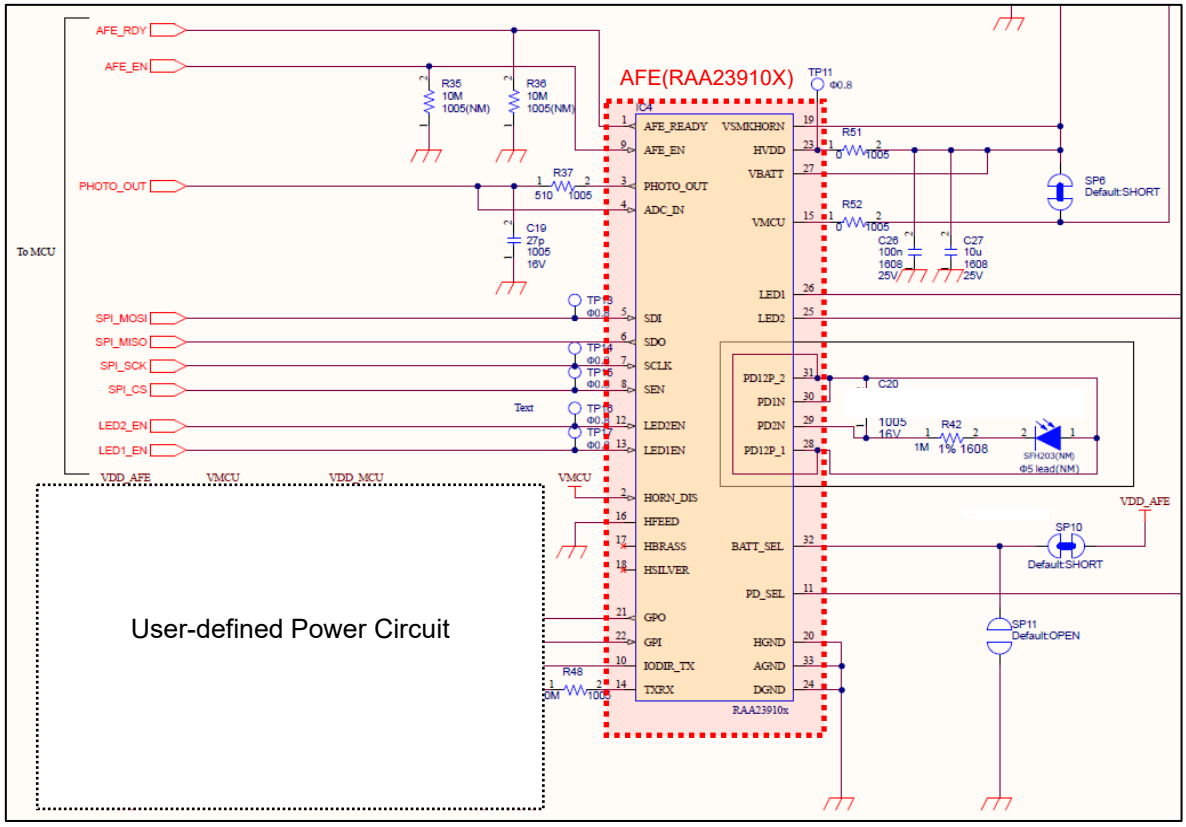


Figure 2-16. Analog Front-End IC (RAA23910X)

The main features of AFE are listed below.

- Selectable IC Power Supply and LDO Output
  It accepts a supply voltage of 3-5V or 9V. A 2.7V LDO output is available when supplied with 9V.
- SPI interface
  It has 31 volatile registers that are accessible via the SPI protocol (4MHz).
- LED driver (8-bit DAC/2ch)
  It has two 8-bit DACs for LED drive with adjustable drive current (45mA~300mA or 90mA~600mA). his board can drive a total of 2 channels of LEDs by controlling the LED switching circuit from the MCU. (See Section 2.8.1)
- Photodetector circuit (10-bit ADC/TIA/PGA/1ch)
  It has a photodetector amplifier (TIA/, PGA) and a 10-bit ADC for photodetection. The output voltage of the photodetector amplifier can be AD converted inside the AFE and stored in an internal register, or output directly from the PHOTO_OUT pin. In the POC board, the PHOTO_OUT pin is connected to the ADC input (ANI2 Pin.27) of the MCU, so conversion is possible using the ADC on the MCU side. (See Section 2.8.2)
- User-defined power circuits
  When using a Renesas microcontroller in the development of a conventional Smoke Detector, such a circuit is required for the user-defined power supply circuit.
  It has a switching circuit to generate an external IC reset signal. As for the reset release operation, when the GPI input > 3.5 V, the GPO is output on (GPO = VSMKHORN voltage) and then the GPO output is maintained until the GPI voltage drops below 3.0 V (with a hysteresis of tr = 3.5 / tf = 3.0). When the GPO output is off, it is in a floating state (no internal pulldown). In this board, the AFE bypasses the power path of the MCU power supply (VDD_MCU) and functions so that the VDD_MCU voltage is supplied after the VDD_AFE voltage rises.

2.8 Photoelectric Detection Components (LEDs for Transmitting Light, Photodiode)

The POC substrate has through-holes (hereinafter referred to as TH) for mounting 'LEDs and photodiodes for transmitting light', and up to three LEDs can be mounted. The details are described separately for the sender and receiver, respectively. Figure 2-17 shows the position of the transmitting light LED and photodiode on the board (back side of the board).

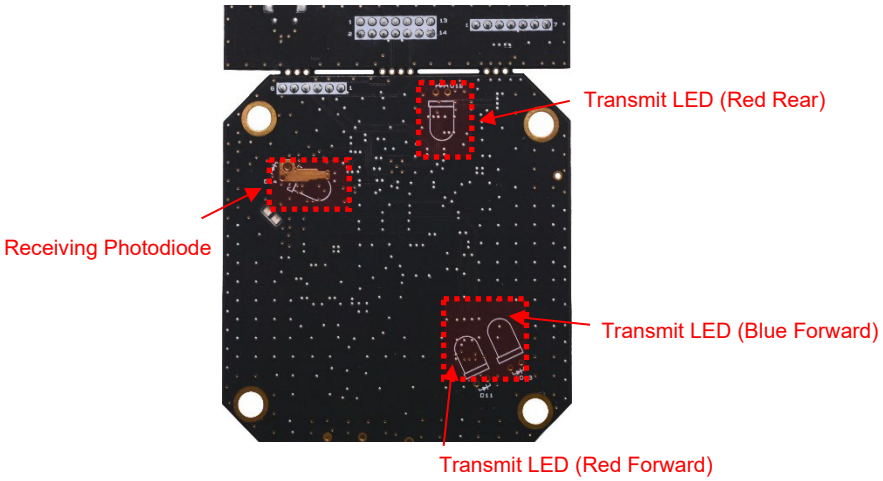


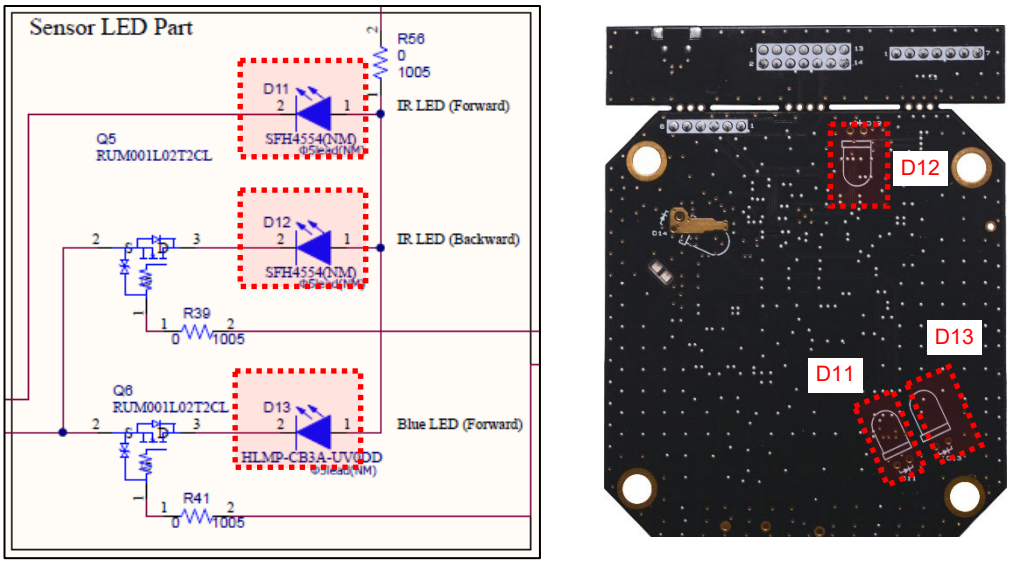
Figure 2-17. LEDs for Transmitting Light, Photodiode

2.8.1 Transmit (LED for transmitting light)

This board has 3 channels of TH that can be mounted on LEDs for transmitting light.

Figure 2-18 shows the correspondence between the schematic and the mounting point. (For the orientation of the anode and cathode, refer to the substrate silk near TH.)

There is a switching circuit in 'the LED section for transmitting light', and it is possible to select whether to connect D12 or D13 to the LED2 terminal of the AFE by driving the GPIO of the corresponding MCU to high. The current drive of the LED can be controlled by the AFE. Refer to the AFE(RAA23910X) data sheet for details.



Ref No.	GPIO pins for switching	Connection AFE terminals
D11	None (non-switchable, always enabled)	LED1(Pin.26)
D12	P122 (Connect at High)	LED2(Pin.25)
D13	P121 (Connect at High)	

Figure 2-18. LED Schematic and Mounting Location

2.8.2 Receive (photodiode)

This board has one TH channel for mounting photodiodes for infrared light receiving. Figure 2-19 shows the correspondence between the circuit diagram and the mounting location. (For the orientation of the anode and cathode, refer to the substrate silk near TH.)

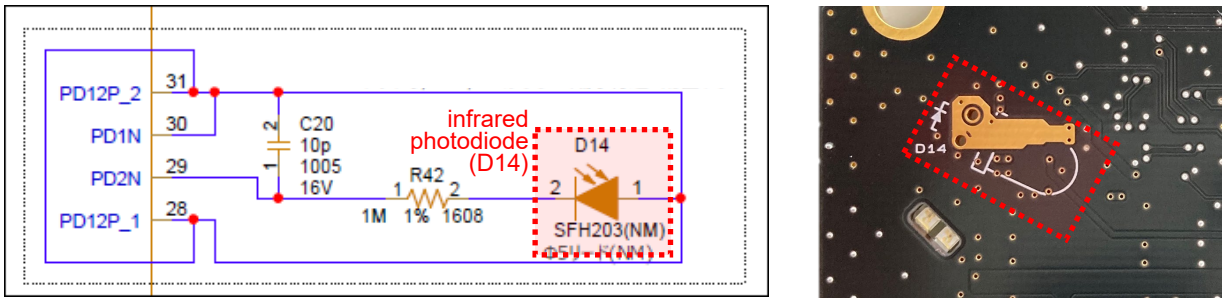


Figure 2-19. Photodiode Schematic and Mounting Location

The photodiode light receiving signal is connected to the optical receiver (TIA/PGA) with a built-in AFE, and the amplifier can be set from the AFE register. Refer to the AFE(RAA23910X) data sheet for more information.

In addition, the output voltage of the amplifier can be AD converted inside the AFE and stored in an internal register, or it can be output directly from the PHOTO_OUT pin shown in Figure 2-20. In this board, the PHOTO_OUT pin is connected to the ADC input (ANI2 Pin.27) of the MCU, so conversion is possible using the ADC on the MCU side. (See Section 2.5 for the MCU analog reference voltage source.)

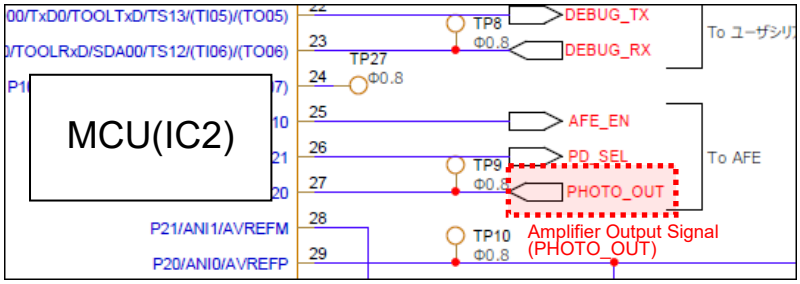


Figure 2-20. PHOTO_OUT Signal Output

2.9 Emulator Interface for RL78/G22 Debugging

The Add-On PCB of the POC board has an E2 Lite emulator 14-pin connector shown in Figure 2-21, through which program installation is possible.

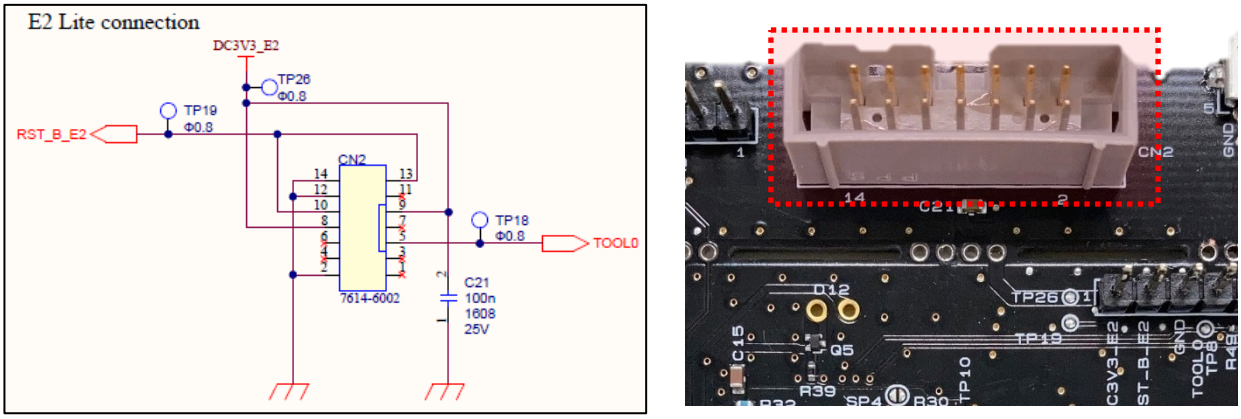


Figure 2-21. E2 Lite Emulator Interface 14Pin Connector

However, when the power supply is performed from E2 Lite during debugging, some functions on the board will not work due to the supply voltage (see Section 2.1.6). Therefore, it is recommended to supply power from a USB power supply (see Section 2.1.5) when debugging.

The POC board has a debug connector on the Main PCB, as shown in Figure 2-22, which allows the program to be installed after the Add-On PCB is disconnected. However, since the debug connector on the main PCB is a 2.54 pitch pin header, a separate jumper wire is required when connecting a debug tool (E2 Lite, etc.).

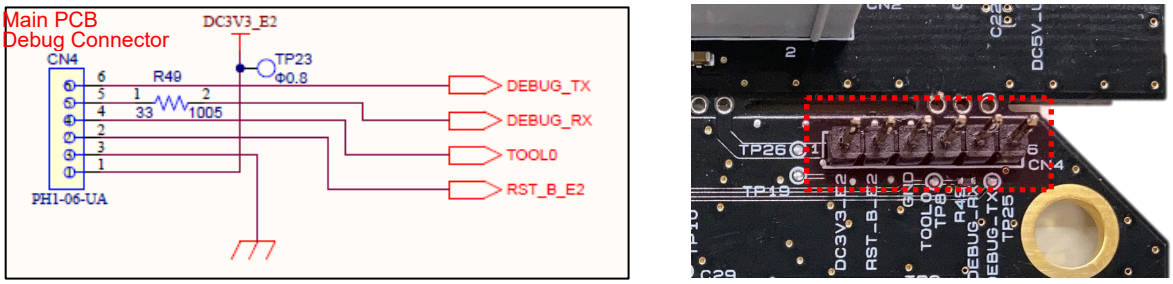


Figure 2-22. Debug Connector

2.10 User Serial Interface

The POC board has a serial communication pin on the Add-On PCB that can be used for a variety of use cases, as shown in

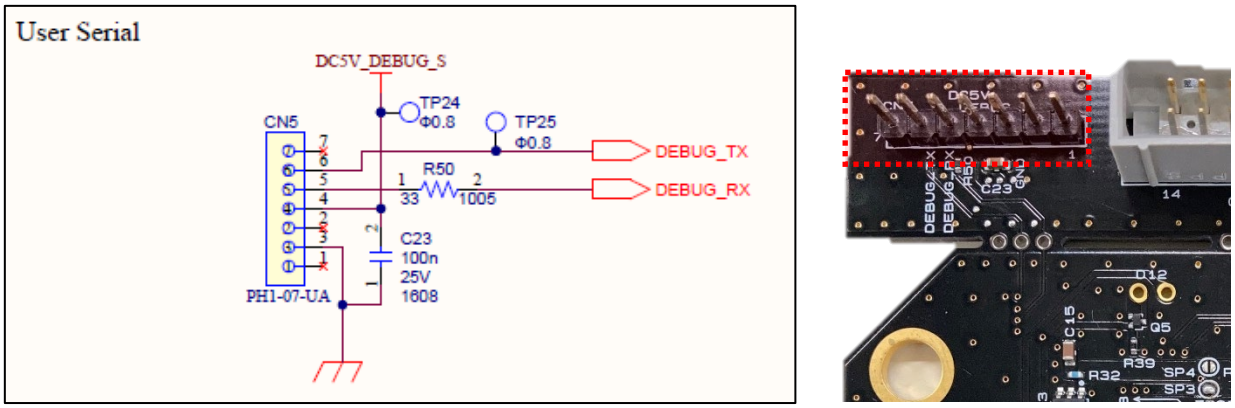
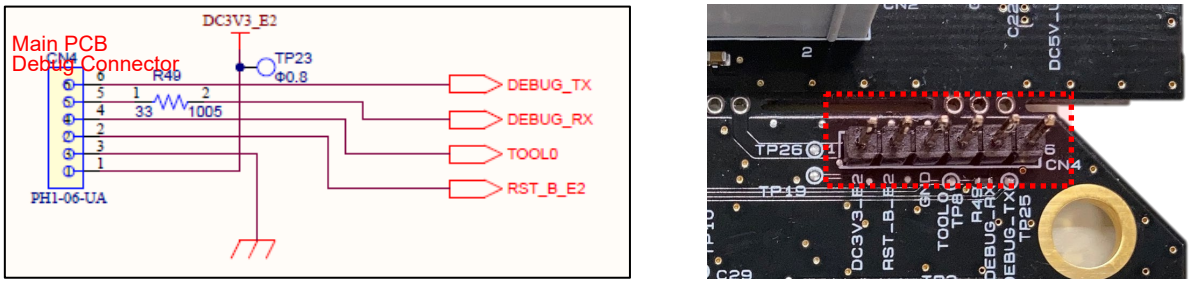


Figure 2-23.

Ports (GPIO/UART)	User Serial Connector Pin No.
P12/TxD0	6
P11/RxD0	5
GND	3

Figure 2-23. User Serial Connector

In addition, the main PCB has a debug connector shown in
Figure 2-24, which enables serial communication even when the Add-On PCB is disconnected.



Ports (GPIO/UART)	Main PCB Debug Connector Pin No.
P12/TxD0	6
P11/RxD0	5
GND	3

Figure 2-24. Debug Connector

In addition, this connector is intended to be connected to a USB-serial converter that has a power supply function, and can supply power to the board. (See Section 2.1.8)

3. BOM (Bill of Materials)

This chapter describes the components used on the board.

3.1 Main Components

The main components of the POC board are shown in Table 3-1.

Table 3-1. Main Bill of Materials

Name	Model name	detail
MCU	R7F102GBE2DNP#YJ1 (RL78/G22)	In addition to the industry's lowest level of low current consumption of 37.5 uA/MHz CPU operation and 200 nA at STOP (4 KB of SRAM retention), this microcontroller is equipped with a wide variety of capacitive touch channels.
AFE	RAA23910X	UL217 or UL268 compliant low-power analog front-end IC for photoelectric smoke detectors. It is combined with a minimum of external components to provide smoke detection functionality.

3.2 Components for Smoke Detection

Smoke detection requires LEDs for transmitting light, photodiodes, and smoke chambers.

3.3 List of Mounted Parts

The mounted components of this board are shown in Table 3-2～Table 3-3.

Table 3-2. List of Mounted Parts (1/2)

Name	Ref.	Number of parts	Model name	constant	package
connector	CN1	1	2061-602/998-404	-	-
connector	CN2	1	7614-6002BL	-	-
connector	CN3	1	47589-0001	-	-
connector	CN4	1	PH1-06-UA	-	-
connector	CN5	1	PH1-07-UA	-	-
capacitor	C7,C8,C9,C16	4	GRM319R6YA106MA12D	10uF	3216
capacitor	C10,C21,C22,C23,C26	5	GCJ188R71E104KA12D	100nF	1608
capacitor	C11,C15	2	GRM188C71C225KE11D	2.2uF	1608
capacitor	C14	1	GRM188C71C684KA12D	0.68uF	1608
capacitor	C19	1	GJM1555C1H270FB01D	27pF	1005
capacitor	C20	1	GCM1555C1H100JA16D	10pF	1005
capacitor	C27	1	GRM188R61E106KA73J	10uF	1608
capacitor	C28,C29	2	GCM188R71H103KA37J	10nF	1608
diode	D1	1	FM4002	-	DO-214AC
diode	D2,D6,D8	3	RB160VAM-60TR	-	SOD-323HE
diode	D3	1	SMA6F45A-M3/H	-	DO-221AC (Slim SMA)
diode	D4	1	EDZVT2R9.1B	-	1608
diode	D9	1	LTST-C230KGKT	-	3216
diode	D10	1	LTST-C230KRKT	-	3216
diode	D15	1	EDZVT2R5.6B	-	-
MCU	IC2	1	R7F102GBE2DNP#YJ1	-	HWQFN-32
Reference Voltage IC	IC3	1	MCP1501-20E/CHY	-	SOT-23
AFE	IC4	1	RAA23910X	-	QFN-32
transistor	Q1,Q3	2	2SA1579U3T106R	-	SOT-323
transistor	Q2	1	2SC4102U3T106R	-	SOT-323
Darlington Transistor	Q4	1	BCV47,215	-	TO-236AB
Nch MOSFET	Q5,Q6	2	RUM001L02T2CL	-	VMT3
Nch MOSFET	Q7	1	NX7002AKAR	-	SOT-23-3

Table 3-3. List of Mounted Parts (2/2)

Name	Ref.	Number of parts	Model name	constant	package
resistor	R1	1	ESR10EZPF3161	3.16kΩ	2012
resistor	R2	1	RK73H1ETTP3304F	3.3MΩ	1005
resistor	R5	1	RK73H1ETTP1005F	10MΩ	1005
resistor	R8,R11	2	3522220RJT	220Ω	6432
resistor	R9	1	ERJ-2RKF3302X	33kΩ	1005
resistor	R10	1	RK73H1ETTP6804F	6.8MΩ	1005
resistor	R12,R13	2	ERJ-2RKF1002X	10kΩ	1005
resistor	R14	1	ERJ-2RKF1003X	100kΩ	1005
resistor	R21	1	ERJ-2RKF1001X	1kΩ	1005
resistor	R23	1	ERJ-2RKF1201X	1.2kΩ	1005
resistor	R30,R39,R41,R51, R52,R53,R54,R55, R56,R57	10	ERJ-2GE0R00X	0Ω	1005
resistor	R32,R34,R48	3	RK73H1ETTP1005F	10MΩ	1005
resistor	R37	1	ERJ-2RKF5100X	510Ω	1005
resistor	R42	1	ERJ-3EKF1004V	1MΩ	1608
resistor	R44,R45,R47	3	RK73H1ETTP4704F	4.7MΩ	1005
resistor	R46	1	ERJ-2RKF1803X	180kΩ	1005
resistor	R49,R50	2	ERJ-2RKF33R0X	33Ω	1005
tactile switch	UB1	1	SKRPABE010	-	SMD SW
Infrared LED	D11,D12	2	SFH 4554	850nm	Lead-type (5mm Bullet-shaped)
Blue LED	D13	1	HLMP-CB3A-UV0DD	470nm	Lead-type (5mm Bullet-shaped)
photodiode	D14	1	SFH 203	400-1100nm	Lead-type (5mm Bullet-shaped)

3.4 Unassembled parts

The parts in Table 3-4 are for various adjustments, so implement them according to your use case.

Table 3-4. Unassembled parts

Name	Ref.	Number of parts	Model name	constant	package
capacitor	C1, C2	2	-	10uF	3225
capacitor	C6, C17, C18, C24, C25	5	-	10uF	3225
capacitor	C12 ,C13	2	-	47pF	1005
resistor	R35, R36	2	-	10MΩ	1005
resistor	R43	1	-	10kΩ	1005

4. POC Board Layout

The specifications and layout of the POC board are described.

4.1 POC Substrate Structure

The POC board has separate connector mounting positions for debugging, and it is possible to separate the board at the boundary part. (See Figure 4-1)

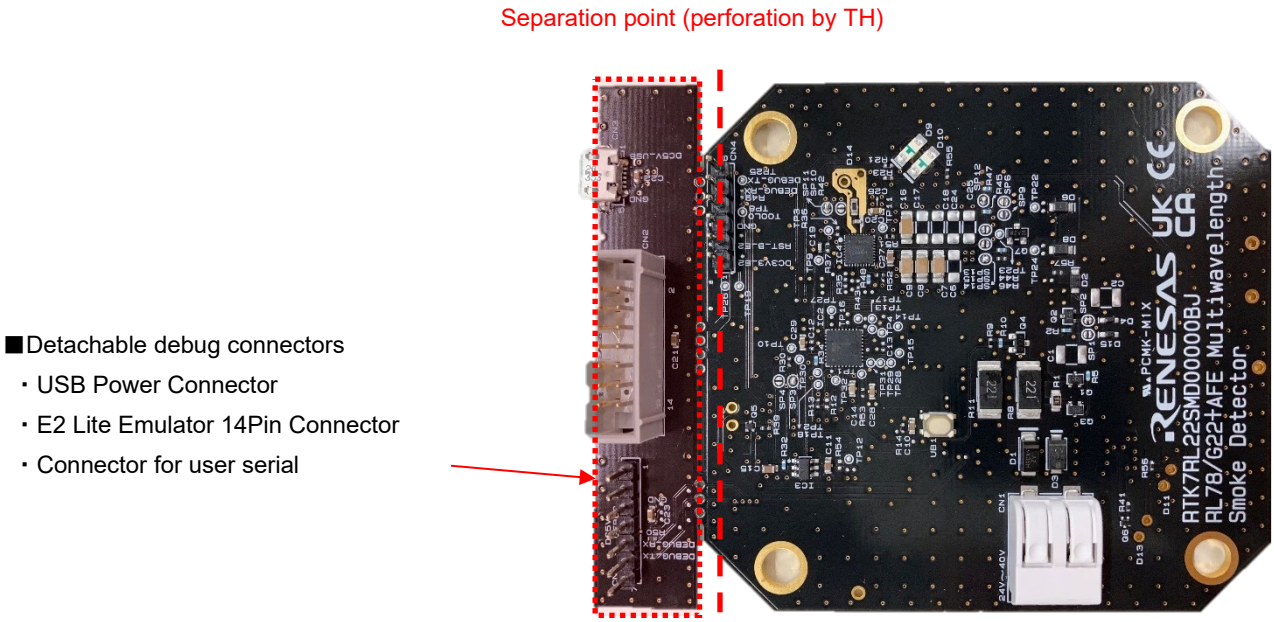


Figure 4-1. Disconnecting the POC Board

Separate the above connectors according to the application, such as installing the board and the smoke chamber or incorporating it into the housing.

4.2 POC Substrate Specifications

The POC board specifications are shown in Table 4-1.

Table 4-1. POC Substrate Specifications

item	specification
Substrate size	horizontal 75.50mm x vertical 95.50mm
PCB Specifications	4-layer penetration
Plate thickness	1.6mm
material	FR-4(Glass epoxy)
Surface layer copper foil thickness	18um
Inner layer copper foil thickness	35um
Surface Treatment	Electroless gold
Resist (double-sided)	Black (glossy)
Silk (double-sided)	white

4.3 Front (L1 Layer) / Back (L4 Layer) Layout (Transparent View)

Figure 4-2 shows the layout of the POC board with a transparent view of the front and back sides.

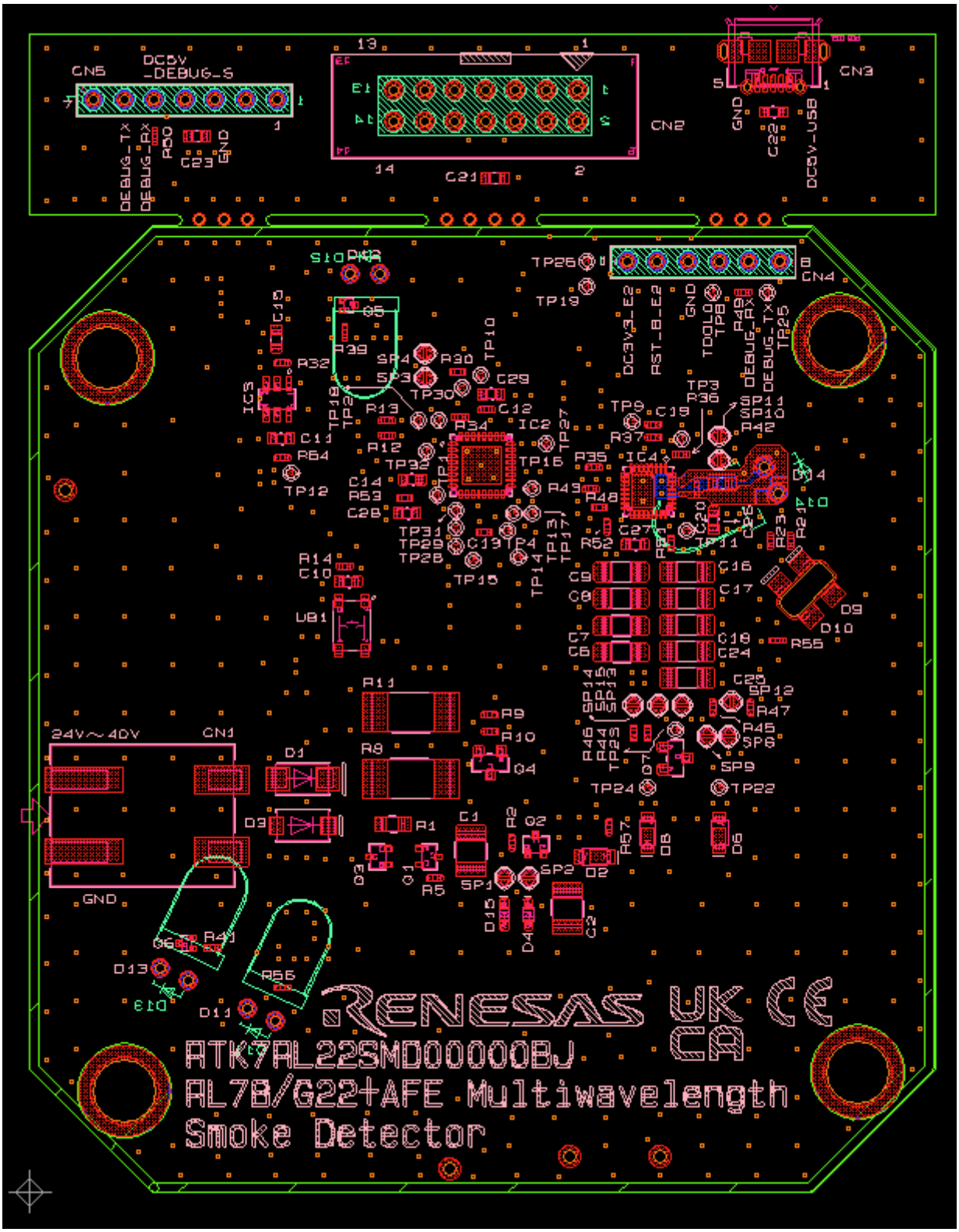


Figure 4-2. Front and back side layout (transparent view)

4.4 Surface Layout (L1 Layer: Component Mounting Surface)

The surface layout of the POC board is shown in Figure 4-3.

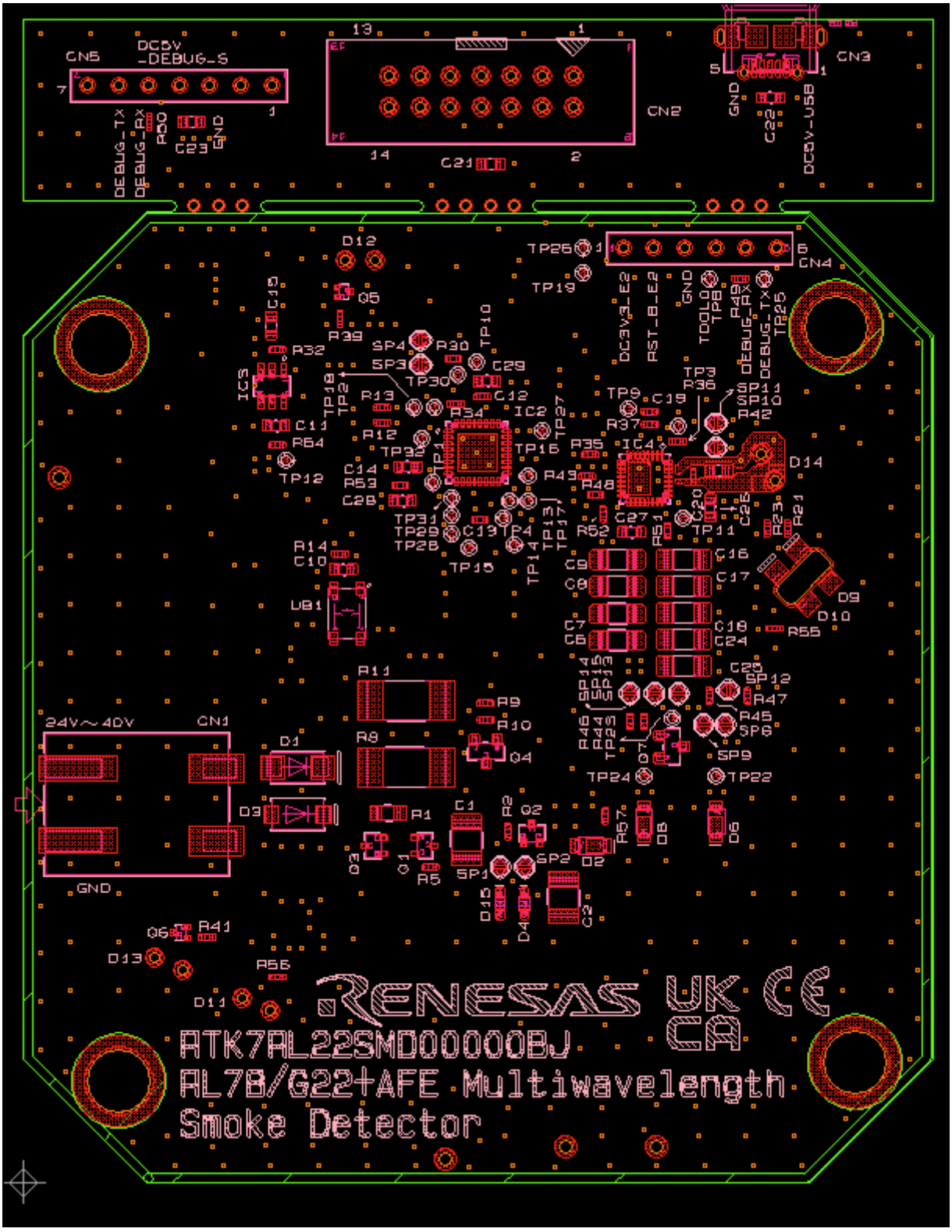


Figure 4-3. Surface Layout

4.5 Back side layout (L4 layer: sensor component mounting surface)

The backside layout of the POC board is shown in Figure 4-4. LEDs for transmitting light and a photodiode can be mounted.

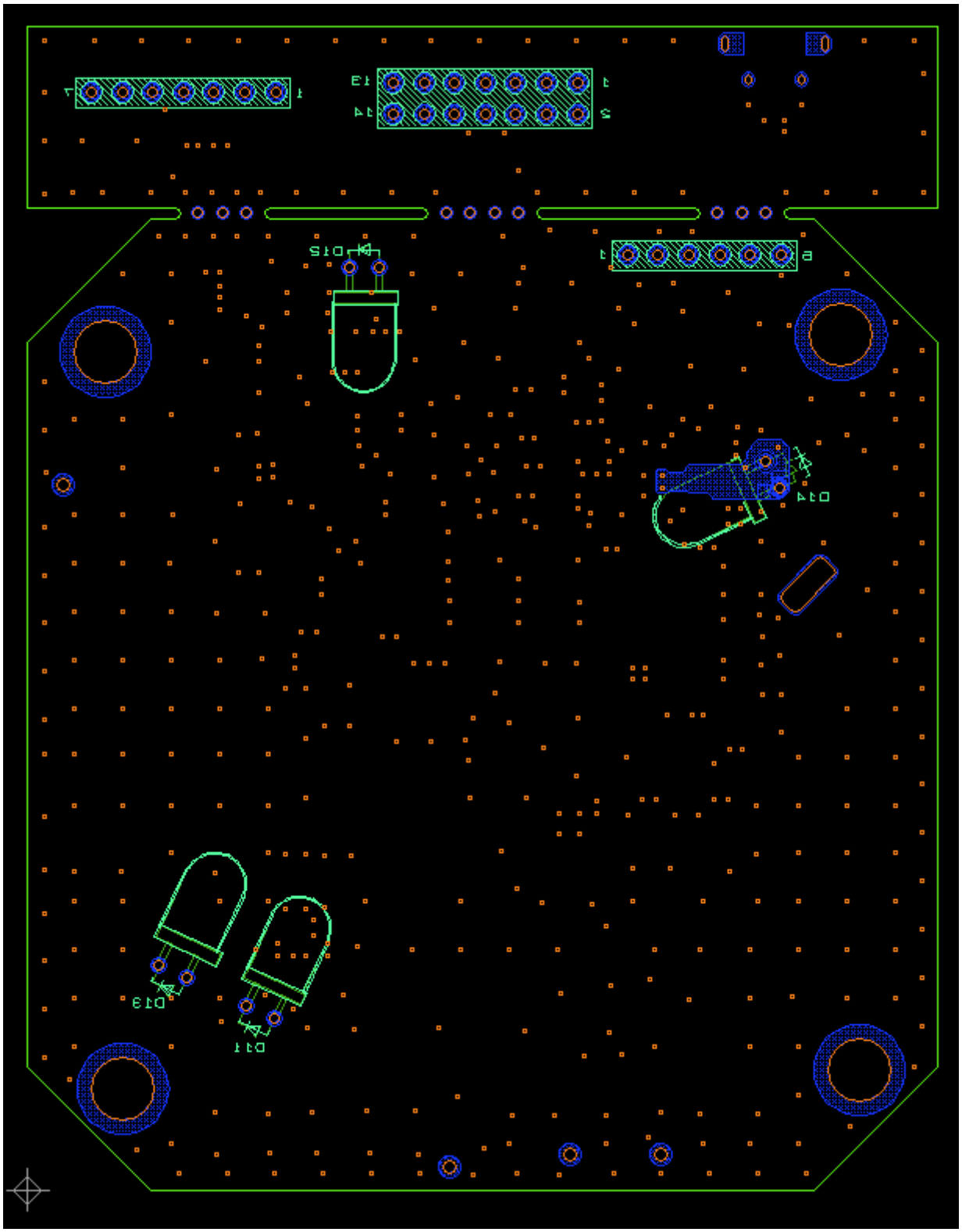


Figure 4-4. Backside Layout

4.6 Installation of photoelectric sensors and a smoke chamber

The POC board can be equipped with a smoke chamber, and LED for transmitting light and a photodiode can be placed on the back of the board (sensor component mounting surface). The fixed position of the smoke chamber is shown in Figure 4-5, and the location of the LEDs and a photodiode is shown in Figure 4-6. For more information about the chamber, please contact your Renesas sales representative.

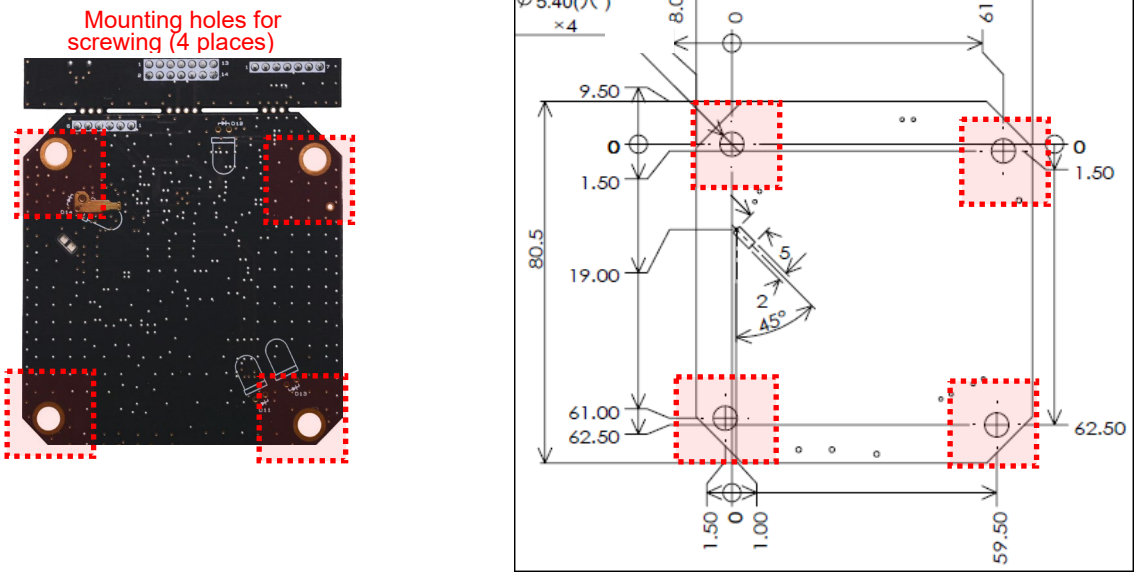


Figure 4-5. POC board fixed position diagram

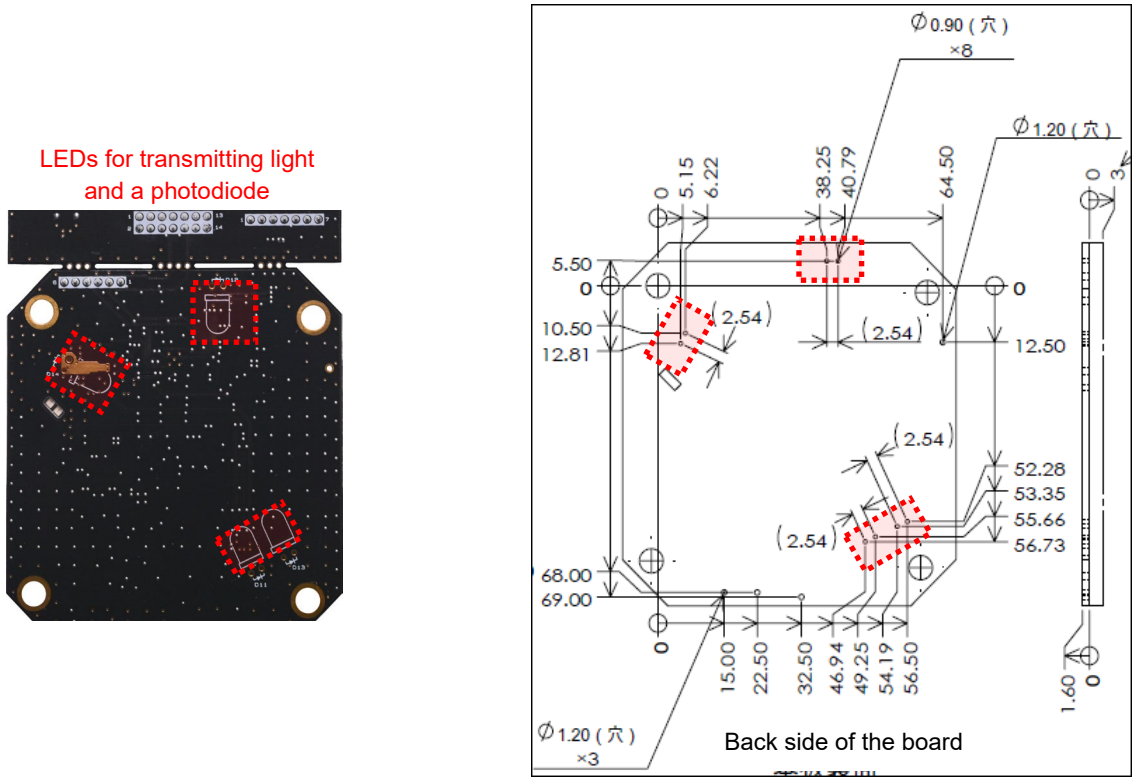


Figure 4-6. Location diagram of LEDs for transmitting light and a photodiode

However, if you want to use only the Main PCB of this board and incorporate it into the case of the Smoke Detector, use the main power connector (CN1) and the main PCB debug connector (CN4).

- Main power connector (CN1)
- Main PCB debug connector (CN4)

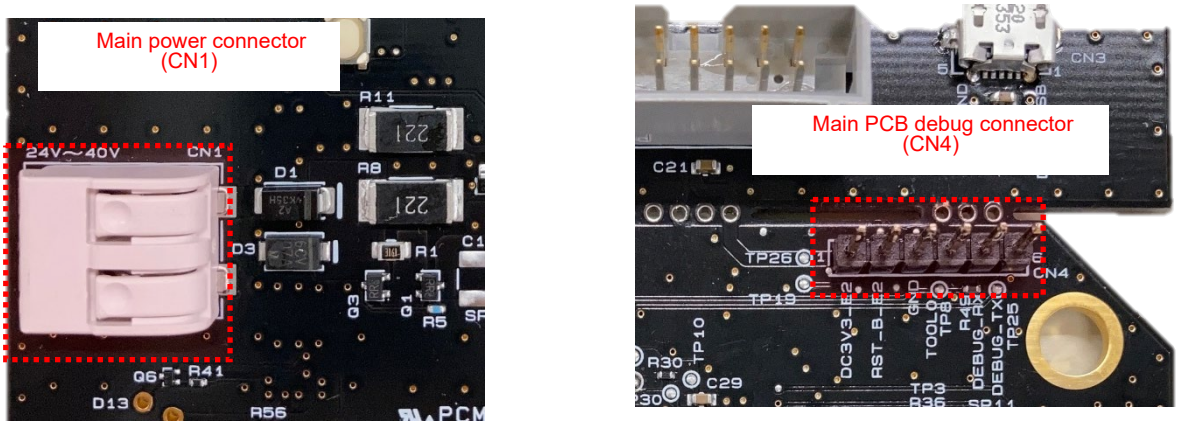


Figure 4-7. Anti-interference cable outlet

5. POC Board Photograph

The appearance of the POC board and the arrangement of the main components are described.

5.1 Surface (L1 layer: component mounting surface)

Figure 5-1 shows a photograph of the surface of the POC board.

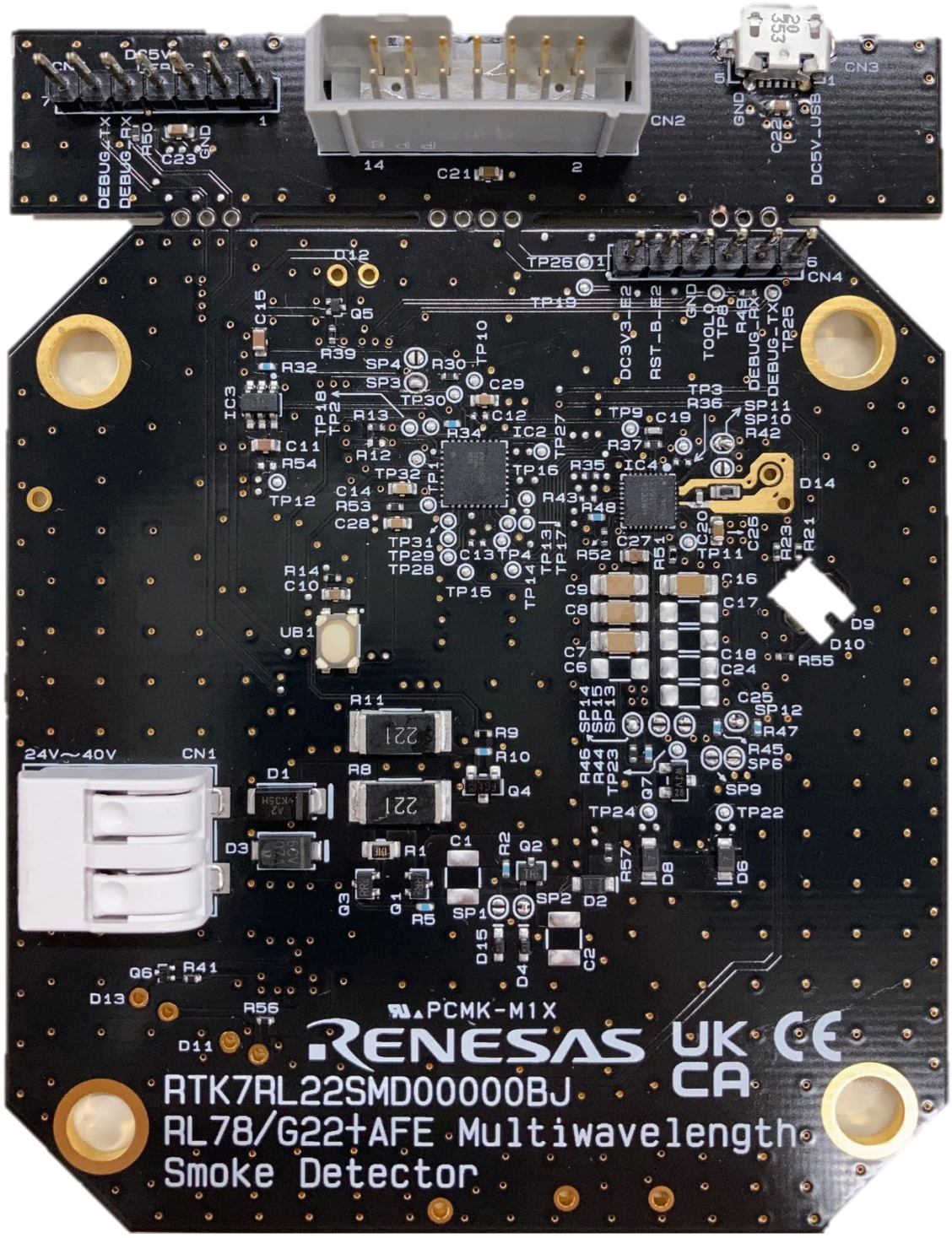


Figure 5-1. Photograph of the surface of the substrate

5.2 Back side (L4 layer: LED and photodiode mounting surface)

Figure 5-2 shows a photo of the back of the POC board.

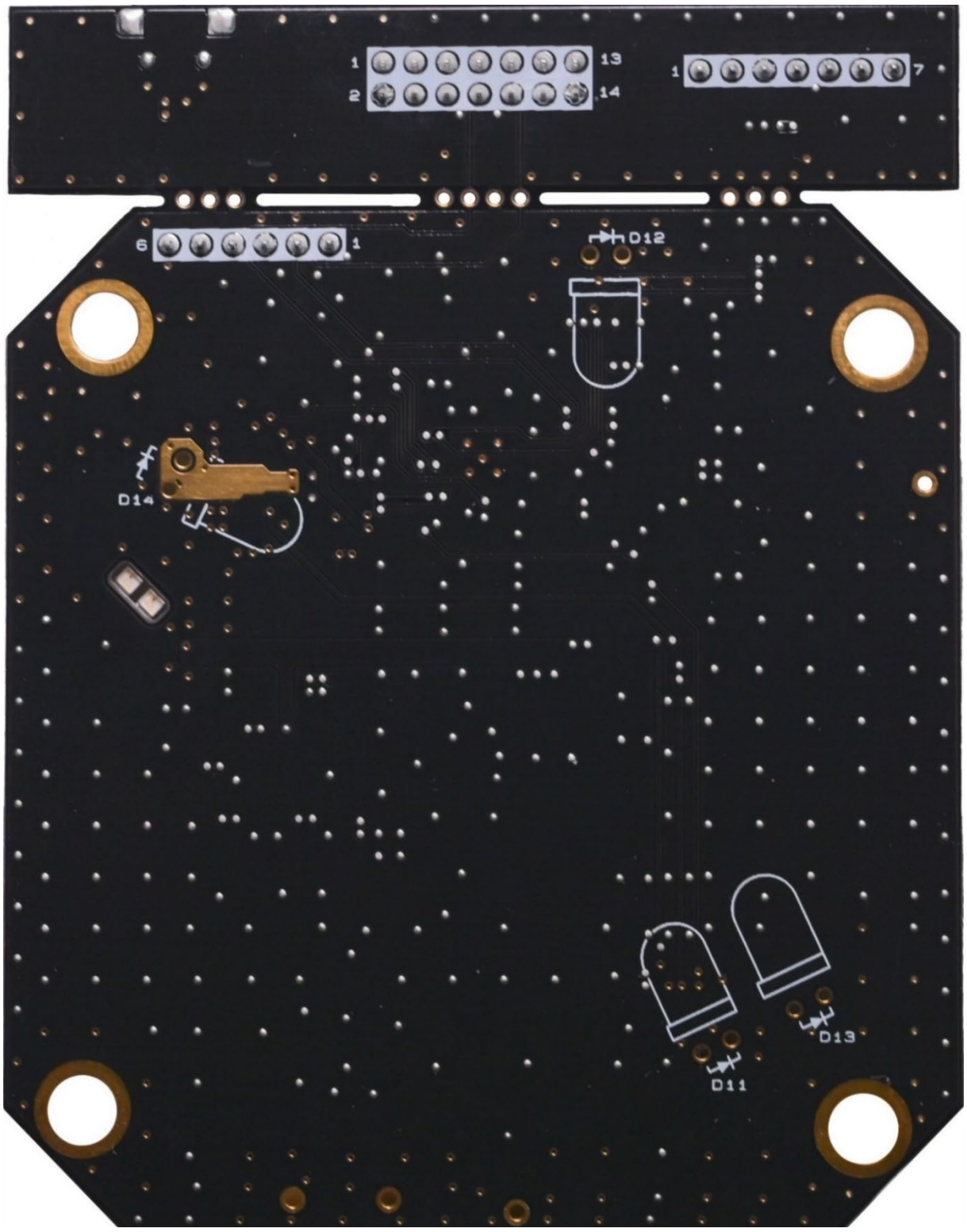
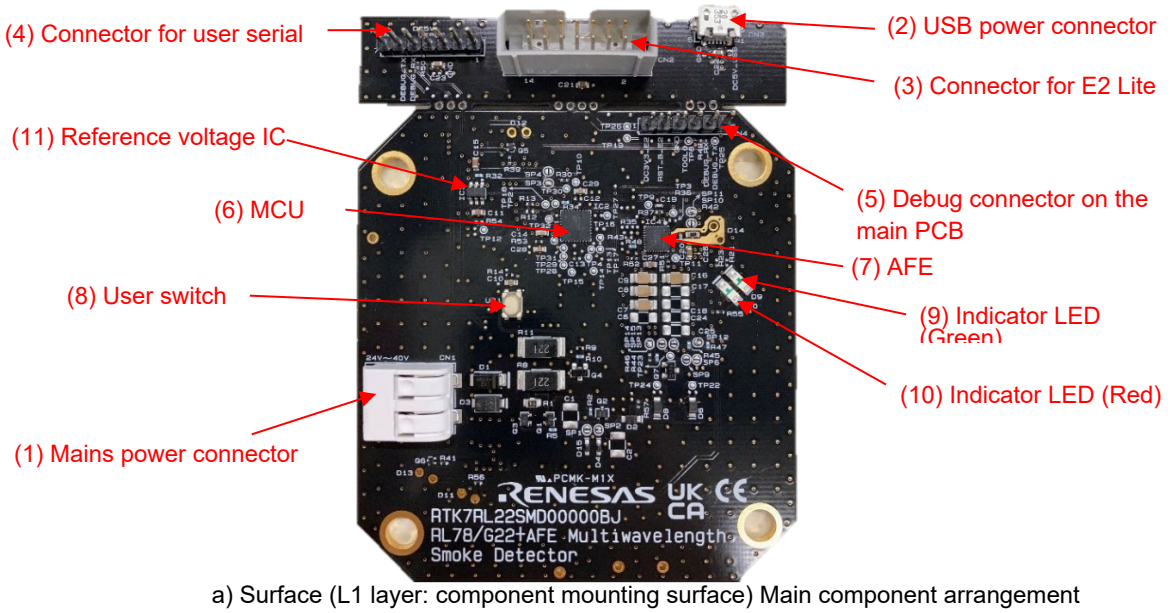


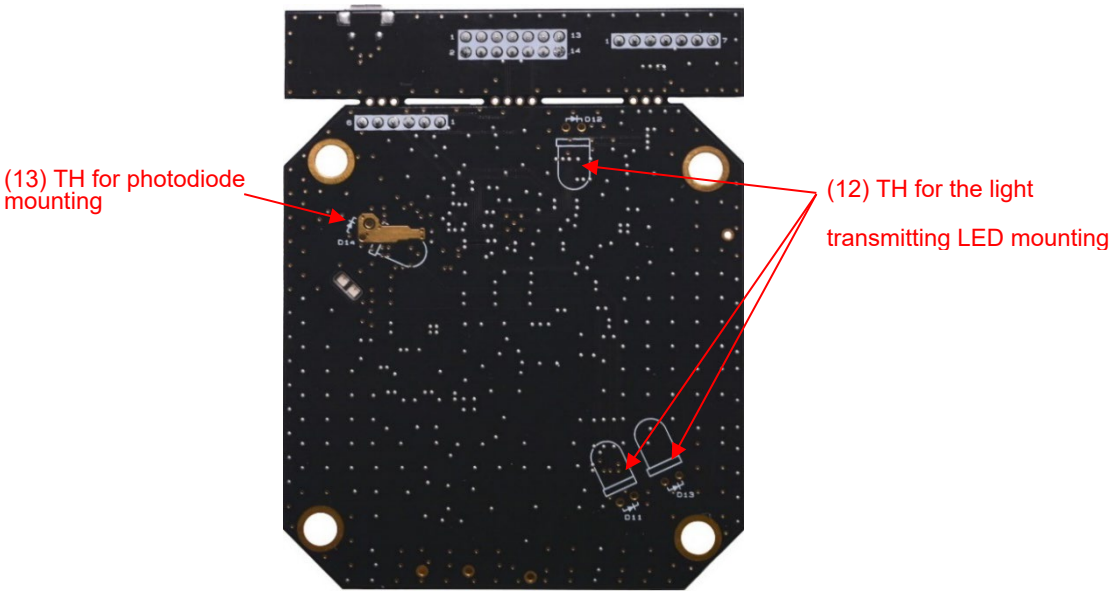
Figure 5-2. Back view of the board

5.3 Placement of Main Components

Figure 5-3 shows the placement of the main components.



a) Surface (L1 layer: component mounting surface) Main component arrangement



b) Backside (L4 layer: sensor component mounting surface) Main component arrangement

(1) Mains power connector
(2) USB power connector
(3) Connector for E2 Lite
(4) Connector for user serial
(5) Debug connector on the main PCB
(6) MCU
(7) AFE
(8) User switch
(9) Indicator LED (Green)
(10) Indicator LED (Red)
(11) Reference voltage IC
(12) TH for the light transmitting LED mounting
(13) TH for photodiode mounting

Figure 5-3. Layout of Main Components

6. Nomenclature

- IC Integrated Circuit
- POC Proof Of Concept
- SW Software
- HW Hardware
- MCU Micro Controller Unit
- CPU Central Processing Unit
- AFE Analog Front End
- LED Light-Emitting Diode
- PD Photodiode
- IR Infrared Radiation
- TIA Transimpedance Input Amplifier
- PGA Programmable Gain Amplifiers
- DAC D/A converter or digital-to-analog Converter
- ADC A/D converter or analog-to-digital Converter
- SPI Serial Peripheral Interface
- UART Universal Asynchronous Receiver Transmitter
- ROM Read-Only Memory
- RAM Random Access Memory
- DC Direct Current
- AC Alternating Current
- LDO Low-Dropout voltage regulator
- GPIO General-Purpose Input and Output
- TX Transmission
- RX Reception
- USB Universal Serial Bus
- PCB Polychlorinated Biphenyl
- PC Personal Computer
- SINI System Initialization
- APP Application
- IDE Integrated Development Environment
- UL Underwriters Laboratories

7. References

[1] RL78/G22 User's Manual: Hardware (R01UH0978)

[2] RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Software) (R01US0776)

[3] RL78/G22 Multiwavelength Smoke Detector Reference Design (R12AN0141)

[4] SCHEMATIC DIAGRAM SMOKE DETECTOR
(RENESAS_SMOKEDETECTOR_R1_20230309.pdf)

[5] MCP1501 High-Precision Buffered Voltage Reference (Datasheet)
(MCP1501_Data_Sheet_DS20005474-3499863.pdf)

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		Page	Summary
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