CCE4502 Evaluation Board V4

IO-Link Device

The CCE4502 Evaluation Board is designed to evaluate and demonstrate the CCE4502 IO-Link Device IC.

Feature Overview

- Renesas ARM Cortex-M33 µC RA4M2
- Programmable via SWD and USB
- Reset Button
- Power and User LED indicator
- Renesas 8 Kbit EEPROM
- Additional on-board protection circuitry
- CCE4502 3.3V Buck Mode IO-Link Device IC
- M12 connector + terminal blocks for IO-Link interface
- Renesas HS3001 Temperature and Humidity Sensor
- Renesas SLG46826V GreenPAK ™ (configured as LED driver)
- All pins accessible via pin-headers for microcontroller and IO-Link Device IC
- Independent use of sections
- IO-Link demonstration Software Stack from IQ² Development (https://www.iq2-development.de)

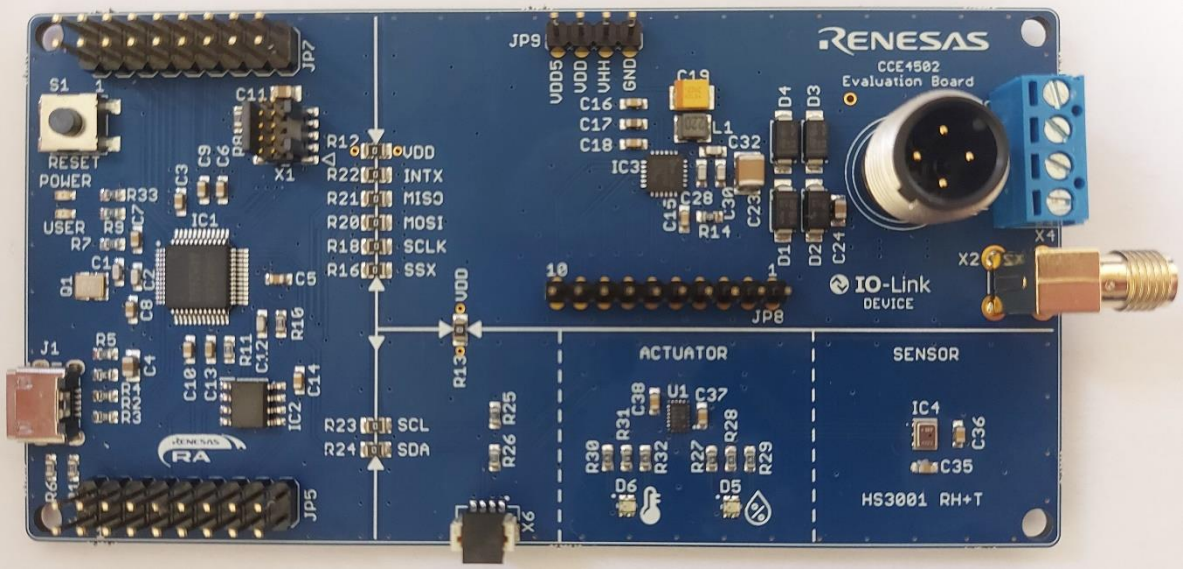

Figure 1. CCE4502 Evaluation Board V4

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1. References

- CCE4502 Datasheet, Renesas Electronics.
- RA4M2 Group Datasheet, Renesas Electronics.
- RA4M2 Group User's Manual: Hardware, Renesas Electronics
- R1EX25008ASA00I#S0 Datasheet, Renesas Electronics
- HS3001 Datasheet, Renesas Electronics
- SLG46826V Datasheet, Renesas Electronics
- IO-Link Interface and System Specification V1.1.2, IO-Link Community.

2. Introduction

The board is divided into three sections:

- **IO-Link Section**

  The IO-Link section contains all necessary circuitry to use one CCE4502 3.3V (Buck Mode) including an M12 A-Coded connector and terminal block for IO-Link communication. Pin headers enable the user to control and monitor the CCE4502 externally.

- **Sensor / Actuator Section**

  The sensor section contains an HS3001 temperature and humidity sensor to provide an example for measurement signals and a Renesas SLG46826V GreenPAK ™ which is configured as multicolor LED driver to act as an actuator.

- **MCU Section**

  The MCU section contains a RA4M2 ARM Cortex-M33 microcontroller from Renesas to control the CCE4502 Device IC as well as the provided sensor and actuator. It also contains an 8 kB EEPROM, USB and SWD debug connector and user and power LED indicators as well as a reset button.

For maximum flexibility, the sections can be used separately and independently from each other. This allows to evaluate the CCE4502 Device IC with every suitable MCU.

The evaluation board is compliant to IO-Link Interface and System Specification V1.1.2

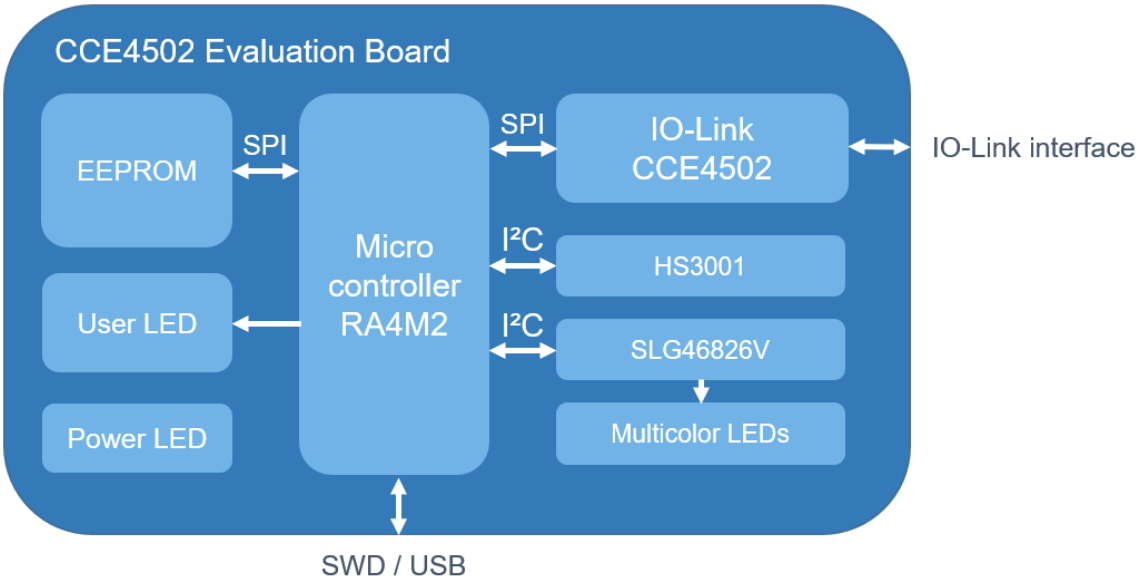

Figure 2. System Diagram

3. System Requirements

The CCE4502 Evaluation Board is ready to use with a preinstalled IO-Link device stack.

To get started, the following tools are required:

- 18-30V (24V typ.) Power Supply (IO-Link Master)
- Debug probe (for programming via SWD) or Micro USB Cable (for programming via USB)
- For programming via SWD: IDE and Coding tool, e.g. Renesas e² Studio

4. Getting Started

Programming via SWD

1. Set Boot Mode to Single Chip (no Jumper at JP5 Pin 3 - Pin 4)
2. Connect debug probe to SWD connector (X1)
3. Power on the Evaluation Board (IO-Link interface L+ = 24V, L- = GND)
4. Start programming with your preferred IDE

Programming via USB

1. Set Jumper to connect JP5 Pin 3 - Pin 4.
2. Connect PC to USB connector (X5)
3. Power on the Evaluation Board (IO-Link interface L+ = 24V, L- = GND)
4. Flash the software stack to the board, using the Renesas Flash Programmer (RFP)

Demonstration using the preinstalled IO-Link Stack

1. Set Boot Mode to Single Chip (no Jumper at JP5 Pin 3 - Pin 4)
2. Import the IODD into the Master Application (IODD can be downloaded at www.Renesas.com)
3. Connect the Evaluation Board to an IO-Link Master using the M12 connector or X3 and X4
4. Start communication

For reinstalling the demonstration IO-Link software stack, please download the stack from www.Renesas.com and follow the procedures described above.

5. Power Supply

The Evaluation Board is supplied via the L+ voltage of the IO-Link interface. The CCE4502 has a wide input voltage range of 9-36V, however it is recommended to use the typical supply voltage for IO-Link devices of 18-30V (typ. 24V).
The IO-Link interface comprises L+, L- and CQ, and it can be accessed via the M12 connector or terminal clamps (X2). Four SMAJ33A TVS diodes are used to provide additional protection.

In buck converter mode, a regulated voltage of 7 V is generated at port VHH. It is capable of supplying up to 50 mA for external devices.

At port VDD, a regulated voltage of 3.3 V is generated by a LDO regulator. This regulator supplies the digital I/O pads of the CCE4502, the MCU, the sensor / actuator. VDD can supply additional external components, but the overall combined external load of VHH and VDD must not exceed 50 mA. The current consumption of the MCU, the sensor / actuator must be below this limit.

Port VDD5 is the output of an LDO regulator with a regulated voltage of 5 V. External components can be supplied by this port with a maximum load of 10 mA.

6. Sections

The CCE4502 Evaluation Board is divided into three sections, the MCU section, the IO-Link section, and the Sensor/Actuator Section.

All sections can be used in combination with an IO-Link Device software stack to demonstrate a fully functional, ready-to-use IO-Link Device.

If required, all sections can be used independently of each other. The connection between the sections can be disconnected by removing the 0R resistors R12, R13, R16, R18 and R20 – R24.

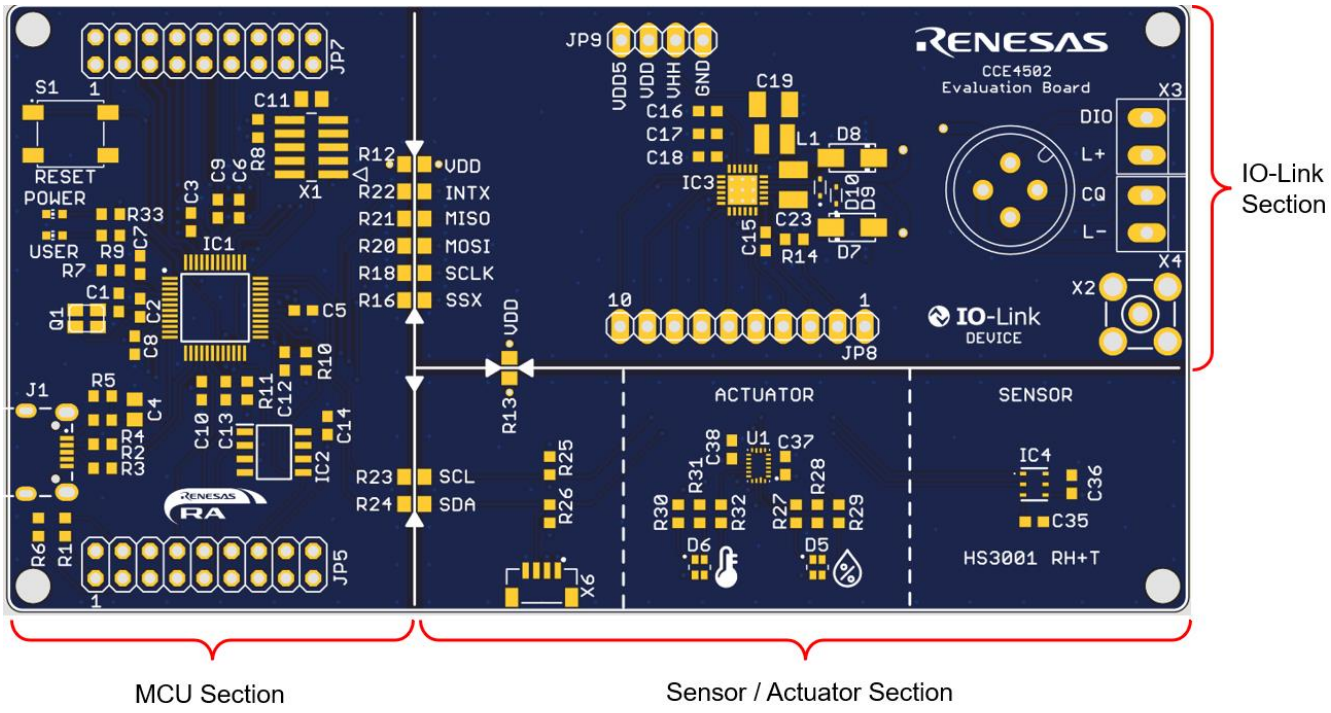

Figure 3. Sections Overview

6.1 IO-Link Section

The IO-Link section contains the CCE4502 IO-Link Device IC in the 3.3V buck mode variant and the reference design for using it, IO-Link communication connectors, and connectors for the use of an external MCU.

The SPI interface (SSX1, SCLK, MOSI, MISO and INTX) of the CCE4502 device grants access to all registers of the CCE4502. Therefore, all features of both IO-Link channels CQ1 and DIO can be enabled. The interface allows access to internal supervisor circuitry, such as the overtemperature detection, overvoltage detection and the output overcurrent protection. Furthermore on-chip logic, for example framehandler and wakeup detection, can be used to ease the IO-Link communication. This reduces the computation overhead for the microcontroller.

Besides SPI, it is possible to control the outputs of CQ1 and DIO, and the input of CQ1 directly through the SIO ports of the CCE4502 device, that is, RXD1, TXD1, TXD2 and TXEN1.
Note that when SPI is omitted, all IO-Link protocol handling must be performed by the connected MCU. However, this allows using the CCE4502 as a simple level shifter from 3.3 V / 5 V logic signals to IO-Link compliant levels

The IO-Link communication can either be established using the M12 A-Coded connector (X5) or the terminal blocks X3 and X4.

The CLK_EXT port is used as clock output port if port K1 is low and as clock input port if port K1 is high. In clock output mode, the clock of the calibrated internal oscillator is switched to CLK_EXT or CLK_EXT is floating, depending on the CLK_OUT register of the CCE4502. By default, CLK_OUT register is configured to disable the clock output. In clock input mode, the logic core is clocked by the signal applied externally to CLK_EXT (X2).

6.2 MCU Section

The MCU section contains a RA4M2 ARM Cortex-M33 microcontroller (IC1) from Renesas and an 8 kB EEPROM (IC2) from Renesas.

Two LEDs are used to indicate the status of the Board: the “POWER” LED indicates that the Board is powered on (VDD is powered), and the “USER” LED can be freely configured by the user. The demonstration IO-Link software stack utilizes the “USER” LED as parameter to be turned on or off by the IO-Link Master.

The microcontroller can be programmed via USB (J1) or SWD interface (X1), see 4. Getting Started.

The MCU can be booted in two different boot modes: Single-Chip mode and USB boot mode. To select the boot mode, the corresponding jumper must be set on JP5 when a reset is released:

- Single Chip mode: no jumper at JP5
- USB boot mode: set jumper to connect JP5 pin 3 to pin 4

For maximum accessibility of the RA4M2, all relevant pins are connected to the pin-headers JP5 and JP7.

6.3 Sensor / Actuator Section

The sensor / actuator section contains a HS3001 temperature and humidity sensor and a SLG46826V GreenPAK ™ in LED driver configuration serving as an actuator, which can be used for demonstration and evaluation of the IO-Link communication.

The HS3001 as well as the SLG46826V are controlled via I²C. Please note that the I²C pull-up resistors are placed on the sensor / actuator section.

The I²C interface can also be used by an external I²C master via X4 or JP5 pin 15 and pin 18 to easily reconfigure the GreenPAK ™. In the delivery state, the GreenPAK ™ is already programmed, and no action is necessary. Resetting the GreenPAK ™ to the delivery state can be done in three ways:

- Program manually over I²C (download the I²C register data from www.Renesas.com)
- Program with the *Go Configure Software Hub* using a GreenPAK ™ Development Board (Download the GreenPAK ™ Project File from www.Renesas.com)
- Flash the Evaluation Board with the IO-Link demonstration stack (download the IO-Link demonstration stack from www.Renesas.com)

LED D5 (temperature) and LED D4 (humidity) are used as indicators for the current temperature and humidity values. Table 1 shows the standard threshold ranges.

Table 1 Temperature and humidity thresholds

		Green	Yellow	Orange	Red
Temperature In °C	**Threshold range High**	20-22	22-25	25-30	>30
	Threshold range Low		18-20	16-18	<16
Humidity In %	**Threshold range High**	45-55	55-60	60-70	>70
	Threshold range Low		30-45	20-30	<20

The thresholds can be adjusted by the IO-Link Master in the parameters section.

7. Schematic and Layout

7.1 Connectors

Figure 4 shows all connectors of the CCE4502 Evaluation Board.

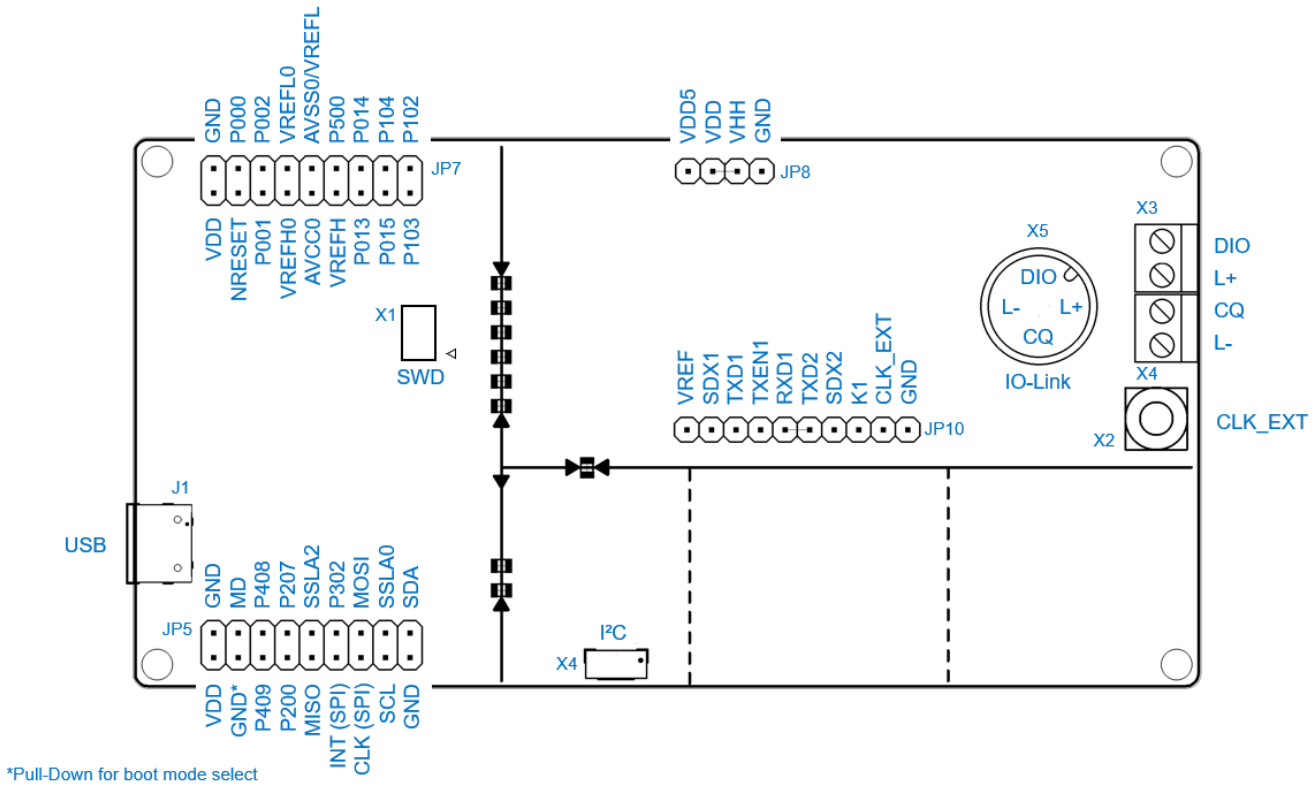

Figure 4. Connectors

7.2 Schematic

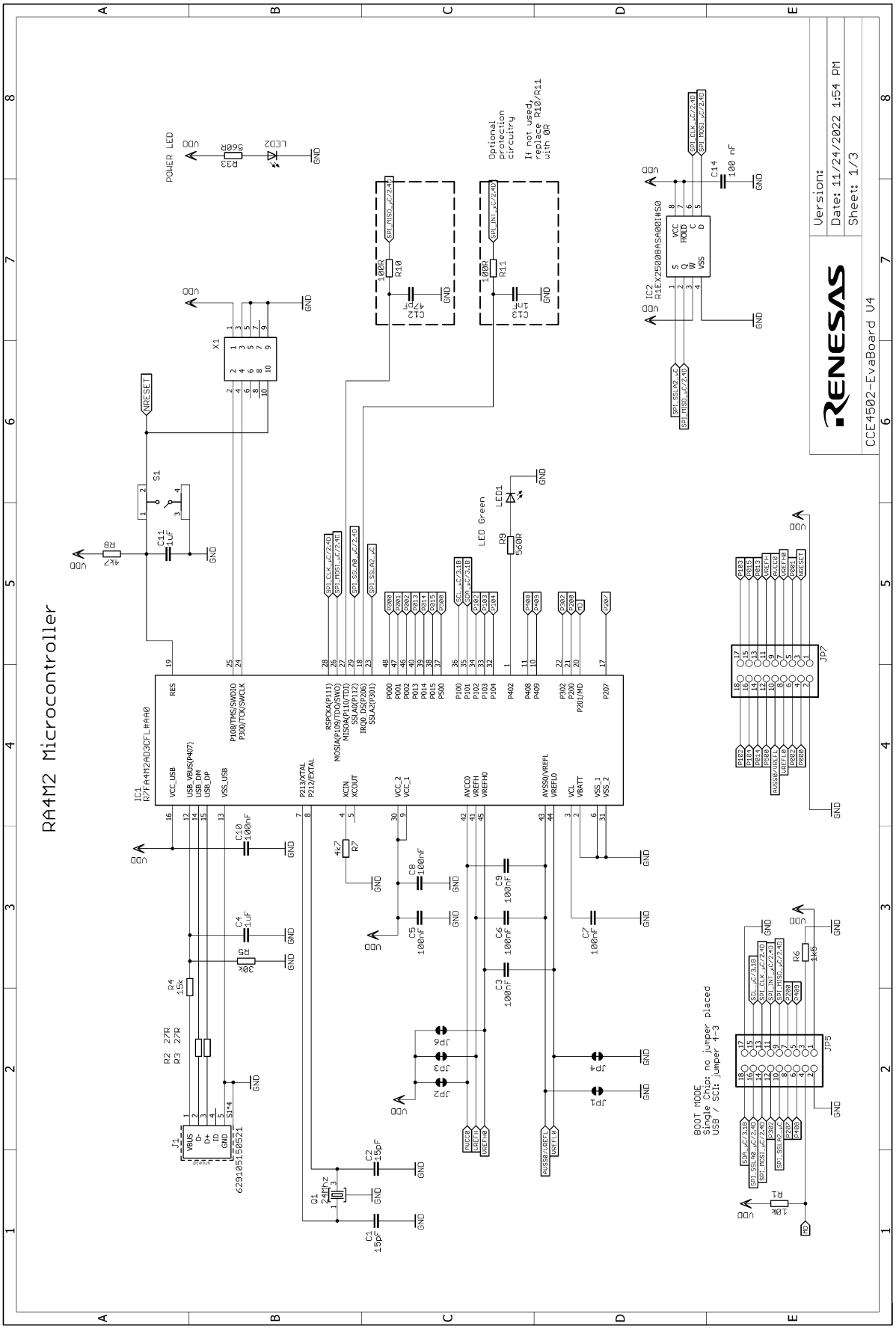

Figure 5. Schematics 1

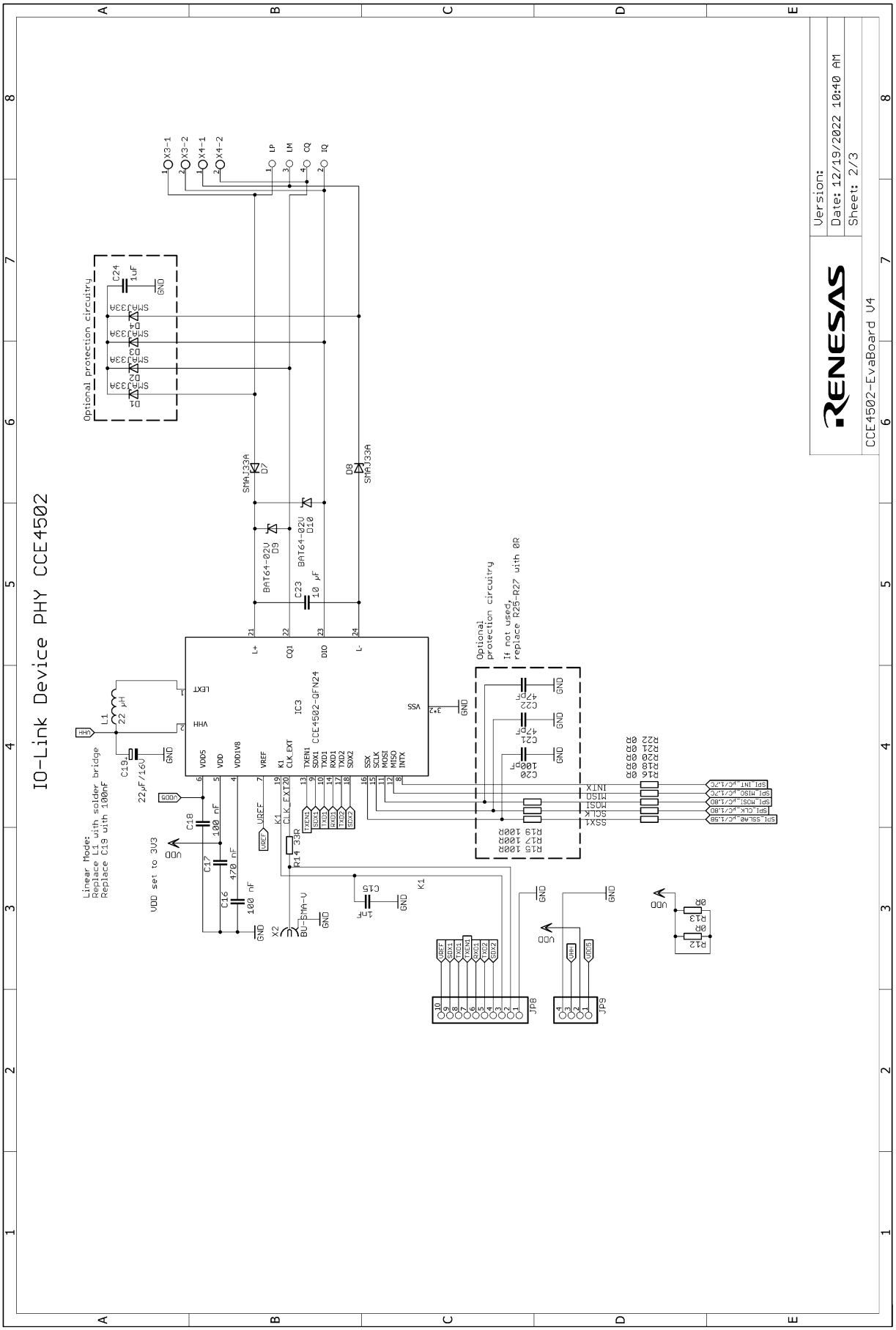

Figure 6. Schematics 2

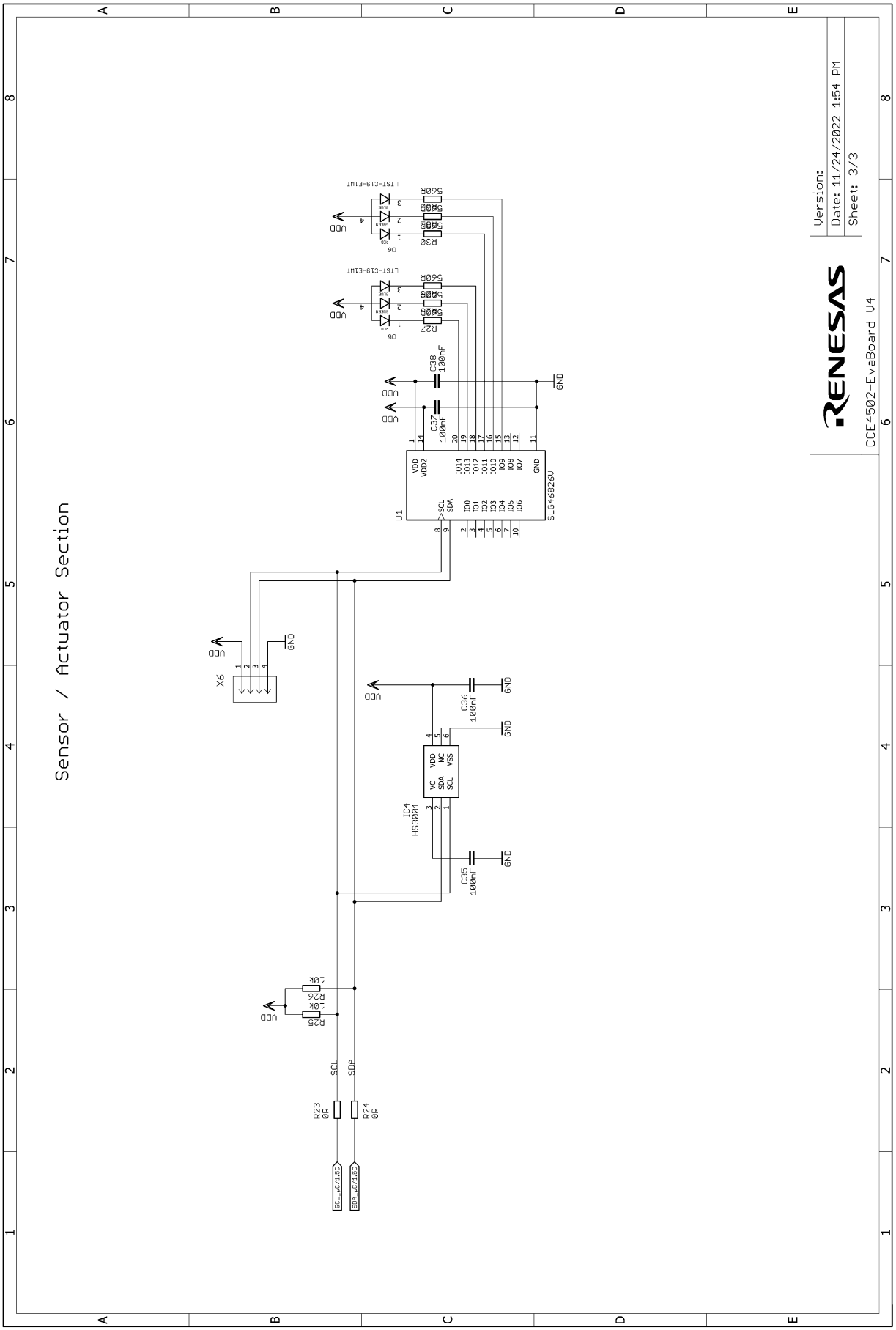

Figure 7. Schematics 3

7.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
2	C1, C2	CAP, SMD, 0603, 15pF, 50V, 10%, X7R	Any	Any
3	C12, C21, C22	CAP, SMD, 0603, 47pF, 50V, 10%, X7R	Any	Any
2	C13, C15	CAP, SMD, 0603, 1nF, 50V, 10%, X7R	Any	Any
1	C17	CAP, SMD, 0603, 470nF, 50V, 10%, X7R	Any	Any
1	C19	22 µF 16 V 10 %	AVX	TPSB226K016R0600
1	C20	CAP, SMD, 0603, 100pF, 50V, 10%, X7R	Any	Any
1	C23	CAP, SMD, 1210, 10µF, 50V, 10%, X7R	Any	Any
10	C3, C5, C6, C7, C8, C9, C10, C14, C16, C18, C35, C36, C37, C38	CAP, SMD, 0603, 100nF, 50V, 10%, X7R	Any	Any
3	C4, C11, C24 (C24 not placed)	CAP, SMD, 0805, 1µF, 50V, 10%, X7R	Any	Any
3	D1, D2, D3, D4 (Not placed)	TVS DIODE 33VWM 53.3VC DO214AC	Littlefuse Inc.	SMAJ33A
2	D5, D6	LED RGB DIFFUSED CHIP SMD	Lite-on Inc.	LTST-C19HE1WT
2	D7, D8	TVS DIODE 33VWM 53.3VC DO214AC	Littlefuse Inc.	SMAJ33A
2	D9, D10	DIODE SCHOTT 40V 250MA SC79-2-1	Infeneon	BAT6402VH6327XTSA1
2	LED1, LED2	LED GREEN CLEAR SMD	Lite-on Inc.	LTST-C191KGKT
1	IC1	MCU RA4 ARM CM33 100MHZ 512K/128	Renesas Electronics	R7FA4M2AD3CFL#AA0
1	IC2	EEPROM 8KBIT SPI 5MHZ 8SOP	Renesas Electronics	R1EX25008ASA00I#S0
1	IC3	CCE4502 IO-Link Device IC 3.3V Buck Mode	Renesas Electronics	CCE4502 CC 3.3B-QFN
1	IC4	SENSOR HUMIDITY 90% RH SMD	Renesas Electronics	HS3001
1	J1	CONN RCPT USB2.0 MICRO B SMD R/A	Würth Elektronik	629105150521
5	JP1, JP2, JP3, JP4, JP6	Trace Cut Jumper	-	-
2	JP5, JP7	CONN HEADER VERT 18POS 2.54MM	Würth Elektronik	61301821121
1	JP8	CONN HEADER VERT 10POS 2.54MM	Würth Elektronik	61301011121
1	JP9	CONN HEADER VERT 4POS 2.54MM	Würth Elektronik	61300411121
1	L1	FIXED IND 22UH 220MA 1.3 OHM SMD	Würth Elektronik	744032220
1	Q1	CRYSTAL 24.0000MHZ 10PF SMD	Diodes Incorporated	FL2400022

3	R1, R25, R26	RES, SMD, 0603, 10kOhm, 50V, 1.0%, 100mW	Any	Any
5	R10, R11, R15, R17, R19	RES, SMD, 0603, 100Ohm, 50V, 1.0%, 100mW	Any	Any
9	R12, R13, R16, R18, R20, R21, R22, R23, R24	RES, SMD, 0805, 0 Ohm, 50V, 1.0%, 100mW	Any	Any
1	R14	RES, SMD, 0603, 33Ohm, 50V, 1.0%, 100mW	Any	Any
2	R2, R3	RES, SMD, 0603, 27Ohm, 50V, 1.0%, 100mW	Any	Any
1	R4	RES, SMD, 0603, 15kOhm, 50V, 1.0%, 100mW	Any	Any
1	R5	RES, SMD, 0603, 30kOhm, 50V, 1.0%, 100mW	Any	Any
1	R6	RES, SMD, 0603, 1.5kOhm, 50V, 1.0%, 100mW	Any	Any
2	R7, R8	RES, SMD, 0603, 4.7kOhm, 50V, 1.0%, 100mW	Any	Any
8	R9, R27, R28, R29, R30, R31, R32, R33	RES, SMD, 0603, 560Ohm, 50V, 1.0%, 100mW	Any	Any
1	S1	SWITCH TACTILE SPST-NO 0.05A 12V	Würth Elektronik	430481035816
1	U1	GPAK MIXED SIGNAL MATRIX	Renesas Electronics	SLG46826V
1	X1	CONN HEADER SMD 10POS 1.27MM	Samtec Inc.	FTSH-105-01-F-DV-K
1	X2	CONN SMA JACK R/A 50 OHM PCB	TE Connectivity	5-1814400-2
2	X3, X4	TERM BLK 2POS SIDE ENT 3.5MM PCB	Würth Elektronik	691103110002
1	X5	M12 Connector	Binder	09 0431 212 04
1	X6	CONN HEADER SMD 4POS 1MM	TE Connectivity	1734595-4

7.4 Board Layout

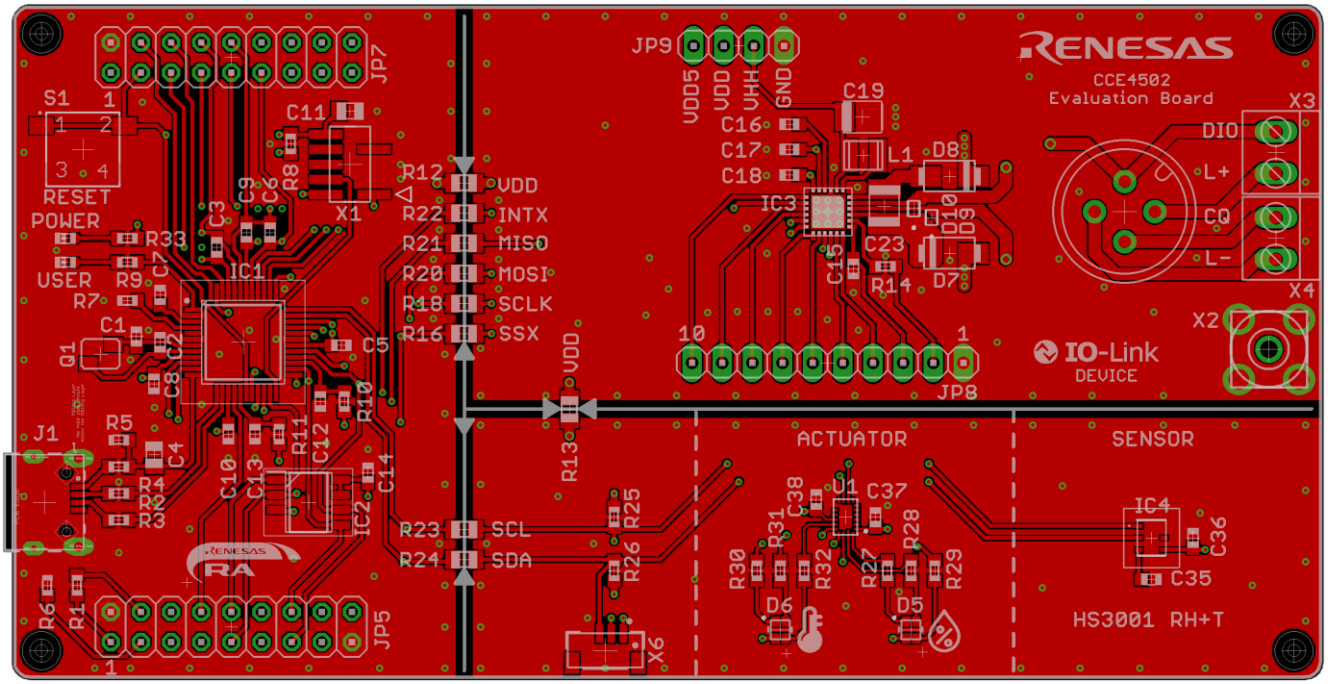

Figure 8. Top Layer

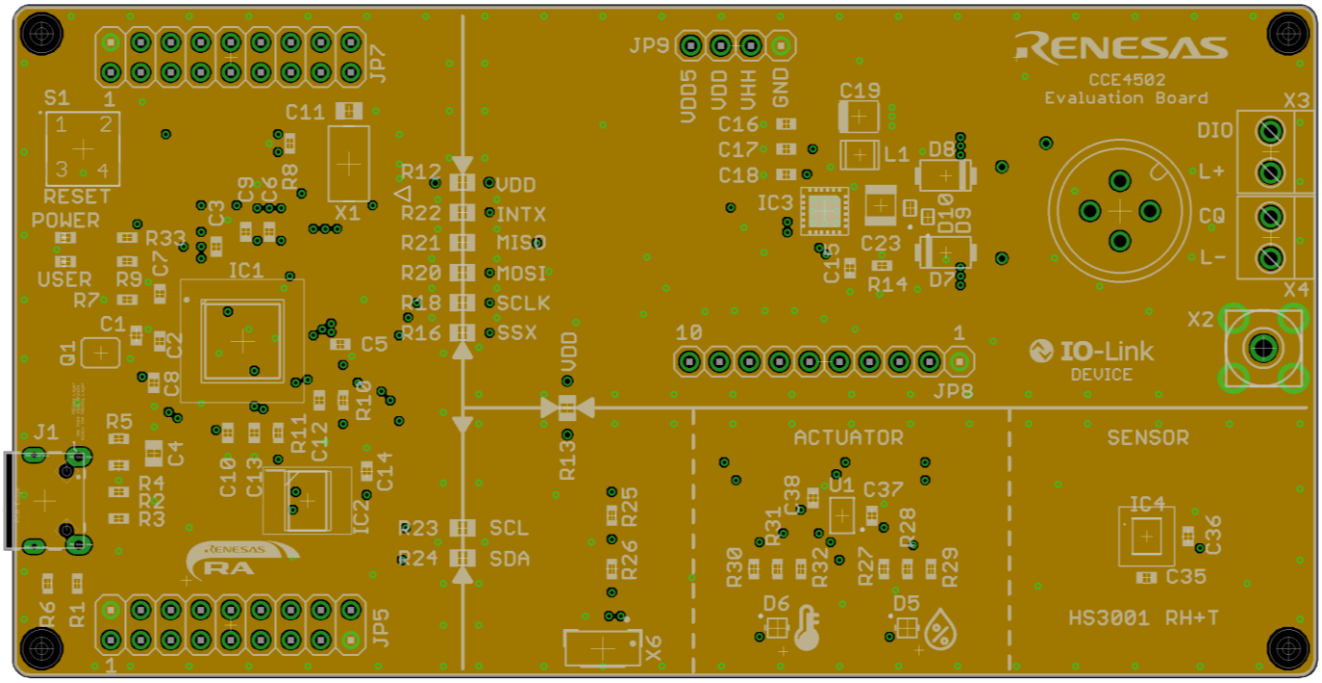

Figure 9. Second Layer (GND)

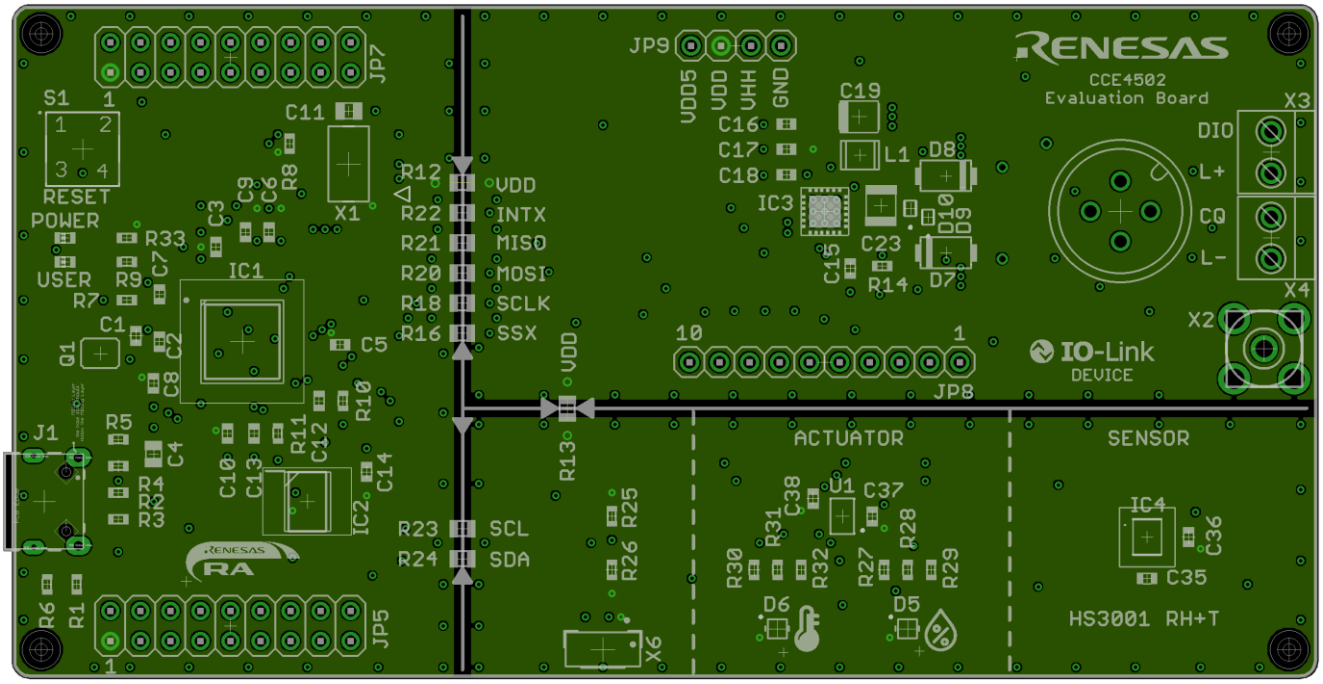

Figure 10. Third Layer (Supply)

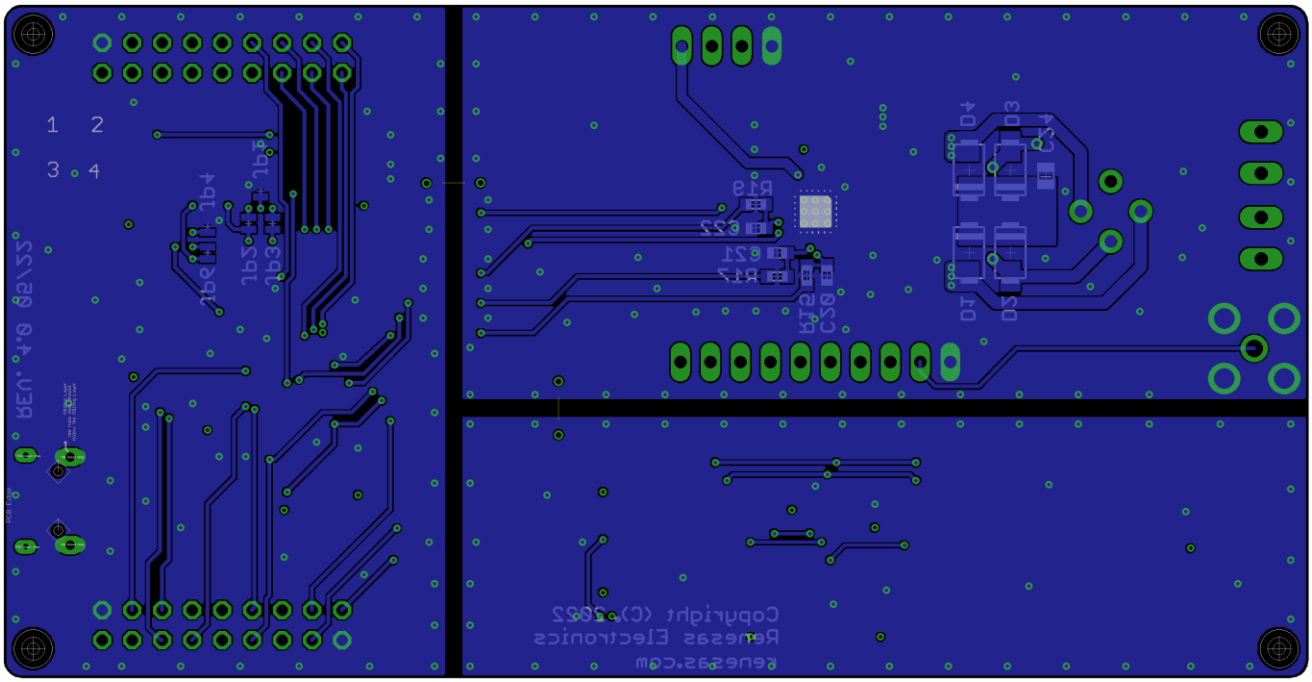

Figure 11. Bottom Layer

8. Ordering Information

Part Number	Description
CCE4502-EVAL-V4	CCE4502 Evaluation Board V4

9. Revision History

Revision	Date	Description
1.00	Jan 05, 2023	Initial release.

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