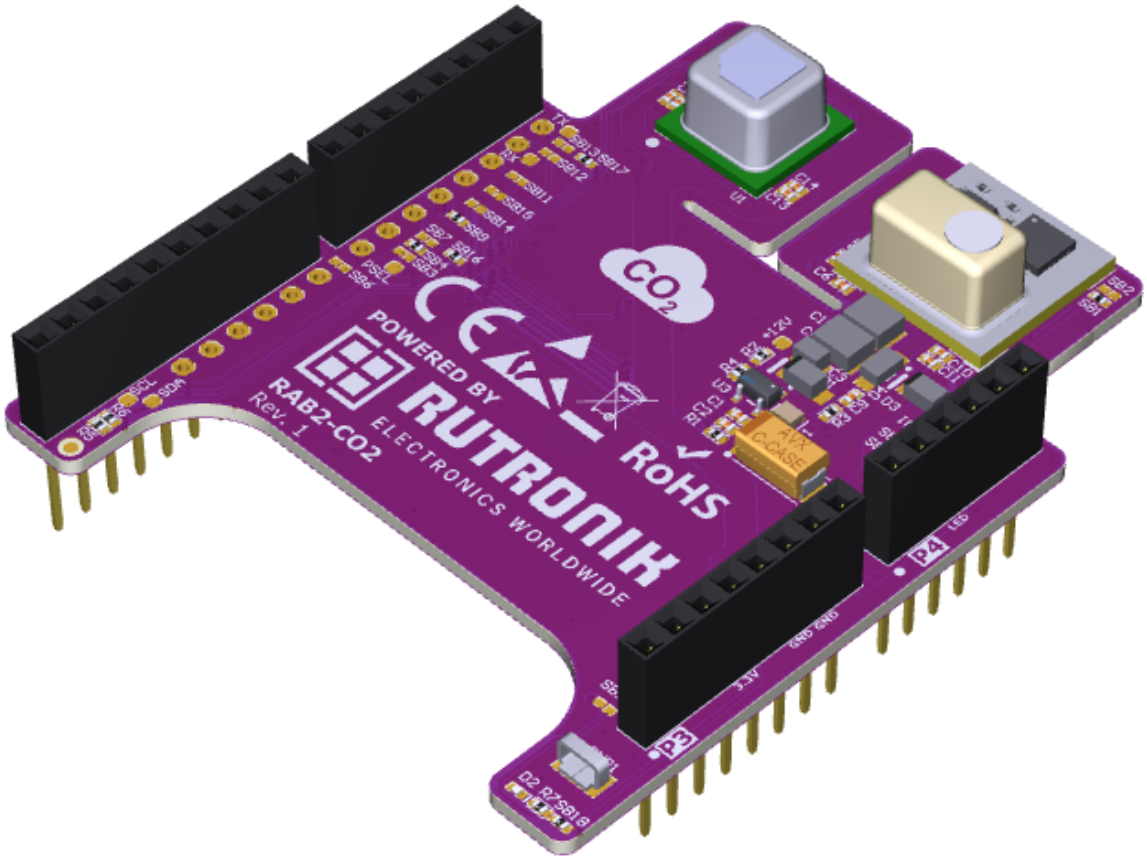
RAB2-CO2
User Manual



VERSION 1.1
April 2022

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Version history

Table 1. Version history

Version	Date	Rationale
0	December 20, 2021	First draft.
1.0	April 2022	Rev. 1 Release.

Introduction

RAB–CO2 is an evaluation board to familiarize with environmental CO_2 and relative humidity and Temperature sensing using a quick measurement with two independent CO_2 sensors and let customers develop their own solutions. It enables faster Time-to-Market for products where CO_2 and relative humidity and temperature level measurement in air is needed. RAB-CO2 was designed by Rutronik to promote outstanding products selected only from his suppliers. RAB-CO2 designed as Arduino compatible shield board. It is stackable to incorporate to complex evaluation system.

Features

The board have the following features:

- Infineon CO_2 sensor.
- Sensirion CO_2 and RH/T sensor.
- Single supply 3.3V voltage.
- Adam-Tech Arduino compatible headers.
- Keystone test point.
- 12V integrated DC Boost converter for PAS CO2 sensor.
- Fuse protection.
- Indication LED.

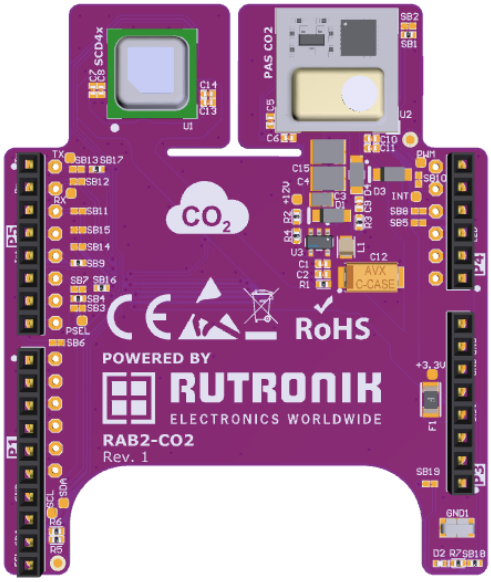

Fig. 1. RAB2-CO2 Evaluation Board's 3D Layout.

Overview of the board layout

Figure 1 shows the main board's view. The key CO_2 sensors are located in front of the board to be easily reach sensitive sensors area to be avoid obstacles for the CO_2 gas. The board due to its universal shape is compatible with many Arduino control boards. The board mounted on RDK2 Rutronik development board is shown in figure 2.

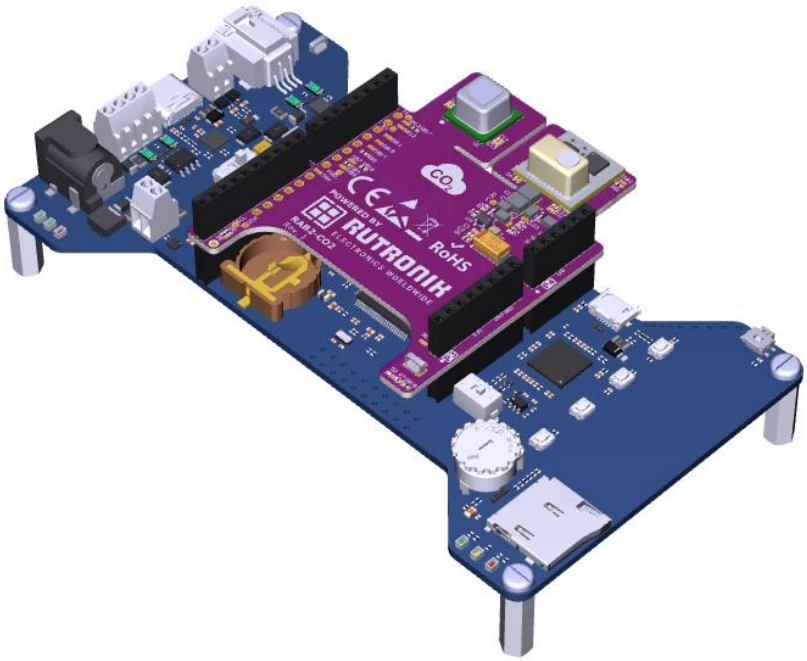

Fig. 2. RAB2-CO2 board mounted on RDK2 Rutronik development board.

Functional block diagram

Figure 2 shows the functional block diagram of the board. There is main I2C bus for both sensors. PAS-CO2 sensor can be configured to UART communication or simple PWM output signal. This sensor has additional interrupt signal which has connection to Arduino GPIO connector.

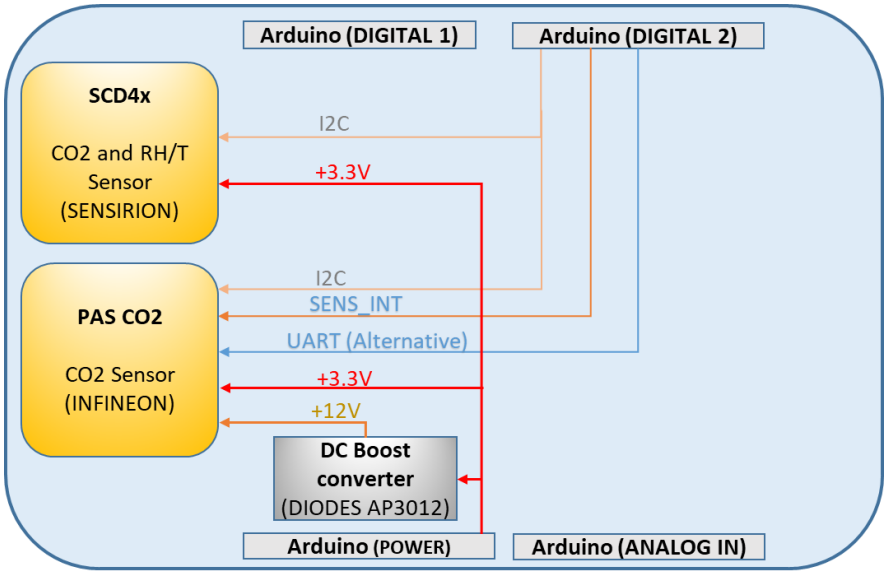

Fig. 3. RAB2-CO2 block diagram.

Board power source select

RAB-CO2 board is powered from 3.3V single power supply trough Arduino connectors. Alternatively it can be powered from separate 3.3V and 12v optional directly without using boost converter. To do this following power selection solder bridge SB5 configuration should be changed from default open to closed. The boost converter should be also disabled by changing solder bridge SB15 from open to close configuration.

Table 2. Power source configuration

Solder No.	Default configuration, using DC-DC boost converter	12V from Arduino pins
SB5	Open	Closed
SB15	Open	Closed
SB11	Open	Open

Board power consumption

RAB-CO2 board contains two CO_2 sensors. The measurements of both sensors depend on the measurement algorithm, it can be continuous or single. By default, continuous periodic measurement is performed for both sensors. In the table 5.shown the current ratings of PAS CO2 sensor. The current during measurement are displayed in table.

Table 3. Current ratings of PAS CO2 sensor

Parameter	Voltage, Pin	Typical value, Unit	Maximum value, Unit
Peak current(1)	3.3V, VDD3.3	10 mA	20 mA
Peak current (1)	12V, VDD12	130	150mA
Average current(1)	3.3V, VDD3.3	6.1mA	-
Average current(1)	12V, VDD12	0.8mA	-
Average power(1)	-	30mW	-

1) Based on datasheet, The current rating refers to 1 measurement/ 60 seconds as a typical sampling frequency

Table 4. Current ratings of SCD-41-D-R2

Parameter	Voltage, Pin	Typical value, Unit	Maximum value, Unit
Peak current (2)	3.3V, VDD	175 mA	205 mA
Average current	3.3, VDD	15 mA	18 mA

2) Based on datasheet

There is available Estimating the power consumption with the XENSIV_PAS_CO2_Power_calculator - KBA234210

The attention should be taken in to account before choosing the right power source for Arduino compatible control board. The RDK2 evaluation control board from Rutronik is fully compatible with RAB_CO2 board.

I2C/UART interface selection

Default RAB2-CO2 board interface is I2C. The PAS-CO2 interface selected by SB3 and SB4 solder bridges. On the board, there are two solder bridges to configure communication interface. To enable UART interface needs to be pulled up to 3.3V PSEL signal by disconnecting and connecting SB3. PSEL

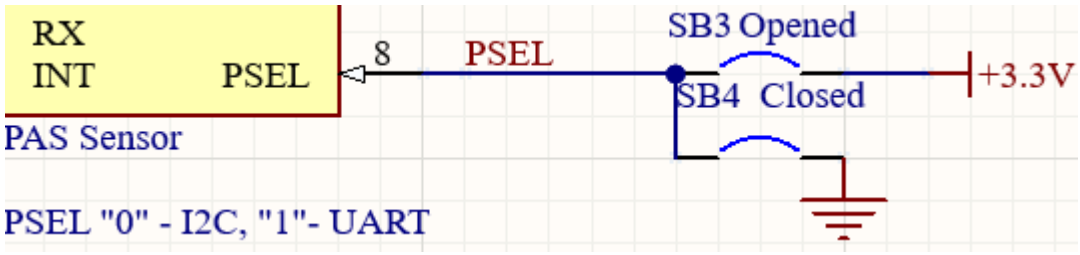

Fig. 4. Communication interface configuration.

Alternatively, PSEL can be controlled by HOST controller trough Arduino connector P5 (Digital2) Pin 6. To do this solder bridge SB7 needs to be connected and SB3, SB4 disconnected. Be aware there is pullup resistors on I2C bus line, which is not used in UART. To fully disconnect I2C interface additionally SB12, SB13 needs to be connected and SB16, SB17 solder bridges needs to be disconnected.

Indication

There are indication LED, which is controlled by control board. By default LED is connected to analog in arduino header P4 pin 3.

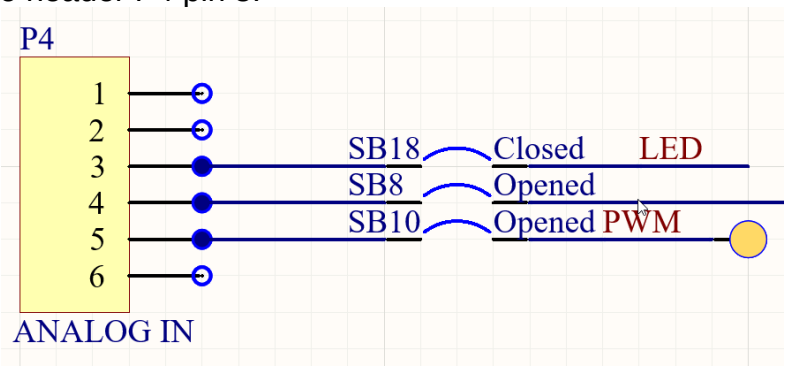

Fig. 5. Communication interface configuration.

Table 5. I2C/UART configuration

Solder bridge No.	Default configuration I2C communication	UART communication
SB3	Open	Open
SB4	Closed	Open
SB7	Open	Closed
SB12	Open	Closed
SB13	Open	Closed
SB16	Closed	Open
SB17	Closed	Open

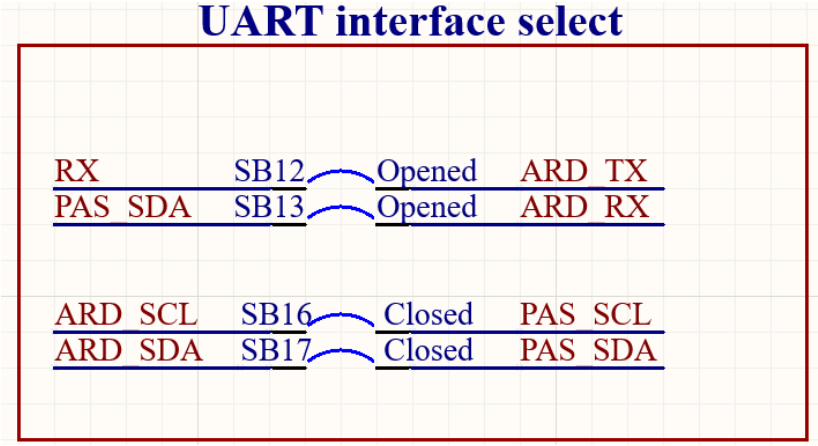

Fig. 6. I2C interface full disconnect.

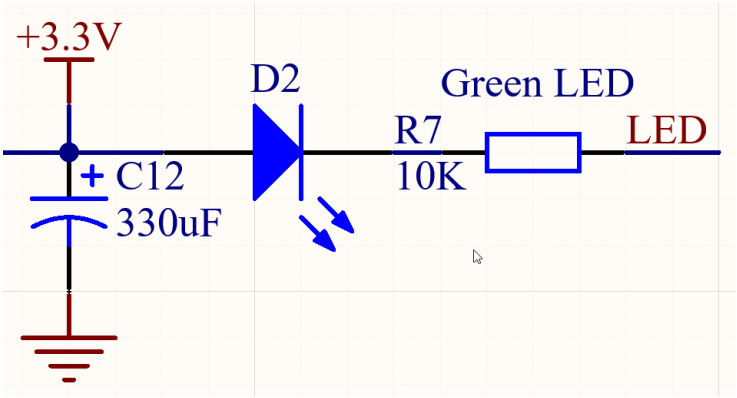

Fig. 7. Indication LED's location on the board.

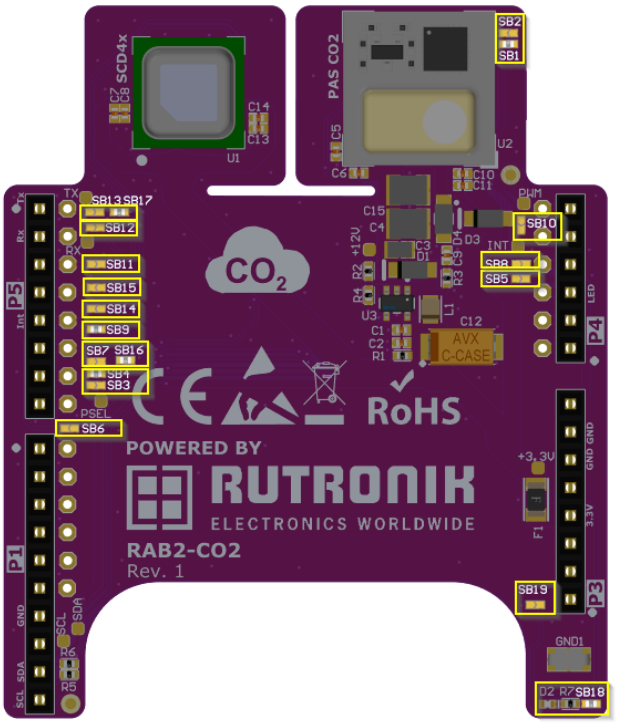

Fig. 8. Solder bridge locations on the board.

Connections

The board contains Arduino connectors for open-source electronics prototyping platforms. Following tables represent all Arduino connectors and his description.

Table 6. Arduino headers pinout

P1(Digital) Pinout		
Pin No.	**Name**	**Description**
1	n.c. (SENS_IINT)	N.C. by default, alternative function is PAS CO2 sensor interrupt
2	n.c.	-
3	n.c.	-
4	n.c.	-
5	n.c.	-
6	n.c.	-
7	GND	Ground connection
8	n.c.	-
9	ARD_SDA	I^2C data
10	ARD_SCL	I^2C clock
P3 (Power) Pinout		

Pin No.	Name	Description
1	n.c.	-
2	n.c.	-
3	n.c.	-
4	3.3V	3.3 V DC power input (for low power operation)
5	n.c.	5 V DC power input
6	GND	Ground connection
7	GND	Ground connection
8	n.c. (12V)	N.C. by default, alternative function is PAS CO2 sensor 12V power input

P4 (Analog In) Pinout

Pin No.	Name	Description
1	n.c.	-
2	n.c.	-
3	LED (n.c.)	Indication LED
4	n.c. (SENS_IINT)	N.C. by default, alternative function is PAS CO2 sensor interrupt
5	n.c.(PWM)	N.C. by default, alternative function is PAS CO2 sensor PWM output
6	n.c.	-

P5 (Digital2) Pinout

Pin No.	Name	Description
1	n.c. (Tx)	N.C. by default, alternative function is PAS CO2 UART TX
2	n.c. (Rx)	N.C. by default, alternative function is PAS CO2 UART RX
3	n.c. (SHDN)	N.C. by default, alternative function is 12V DC boost converter enable signal
4	n.c.	-
5	SENS_INT (n.c.)	PAS CO2 sensor interrupt output signal
6	n.c. (PSEL)	N.C. by default, alternative function PSEL - PAS CO2 interface selection
7	n.c. (LED)	N.C. by default,
8	n.c.	-

Solder Bridge configuration

The RAB2-CO2 board default configuration of solder bridges is described in table below. This configuration can be changed depending on which function needs to be configured.

Table 7 Solder bridge configuration

Solder Bridge	Circuit	Default configuration
SB1	PWM output enable	Closed
SB2	PWM output disable	Open
SB3	PAS CO2 interface selectin (I^2C)	Open
SB4	PAS CO2 interface selectin (UART)	Closed
SB5	12 V voltage enable trough Arduino pins	Open
SB6	PAS CO2 sensor interrupt output on Arduino header P1 pin 1	Open
SB8	PAS CO2 sensor interrupt output on Arduino header P4 pin 4	Open
SB9	PAS CO2 sensor interrupt output on Arduino header P5 pin 5	Closed
SB10	PAS CO2 sensor PWM output on Arduino header P4 pin 5	Open
SB11	12V boost converter control on Arduino header P5 pin 3	Open
SB12	PAS CO2 UART Rx input	Open
SB13	PAS CO2 UART Tx output	Open
SB14	PAS CO2 I2C SCL input	Closed
SB15	PAS CO2 I2C SDA data	Closed
SB16	Interrupt and 12V boost converter direct control	Open

Firmware Examples

RDK2 Demo

For normal operation with RAB-CO2 needs MCU controller with I2C or UART interface. Out of the box firmware example is prepared for Rutronik development kit RDK 2 and KitProg debug UART interface. All sensor values are presented in the terminal window. The refresh rate is 5 seconds. Please take attention the values are in raw format and without compensation.

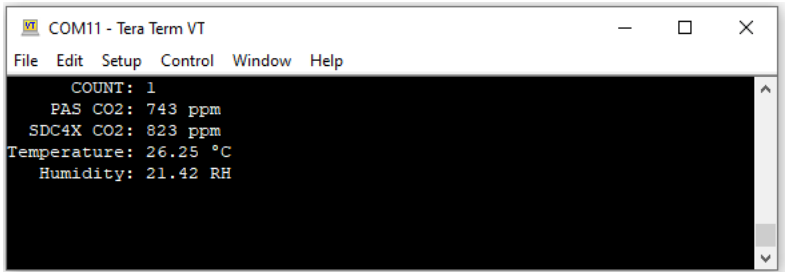

Fig. 9. RDK2 and RAB2-CO2 demo firmware.

RAB2-CO2 4D 4.3"LCD Demo

Another firmware example was realized together with LCD display from 4D systems and RDK2 Rtronik development board. The part number used form this demo is Gen4-uLCD-43DCT-CLB display with touch capabilities. This example is prepared for Rutronik development kit RDK 2 and KitProg. All sensor values are presented in LCD screen.

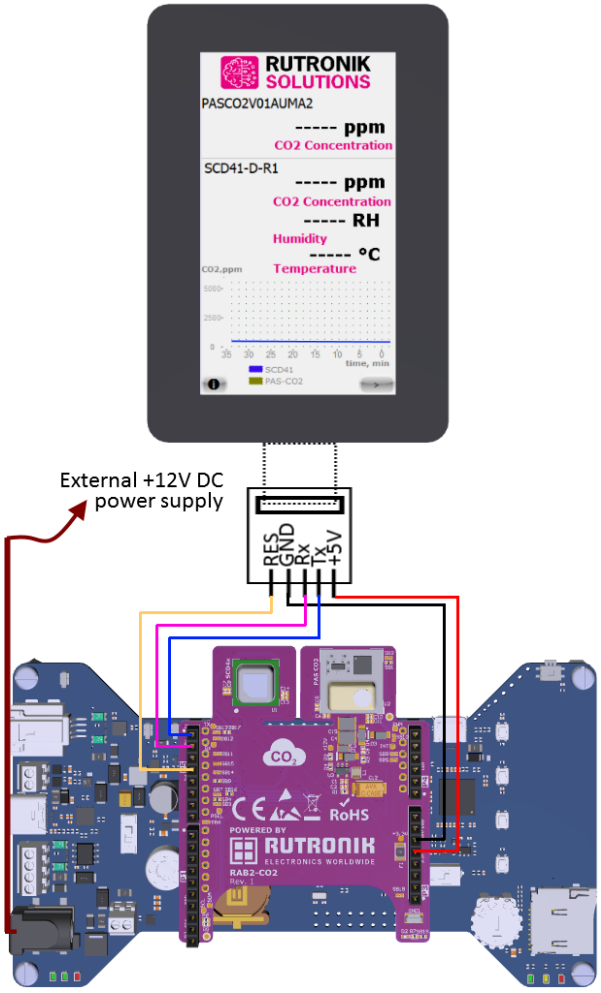

Fig. 10. RAB2-CO2 RDK2 4D LCD DEMO connection diagramm.

EMC TEST RESULTS

RAB2-CO2 board EMC radiated emissions is shown below. The radiated emissions comply to CISPR 32 class B.

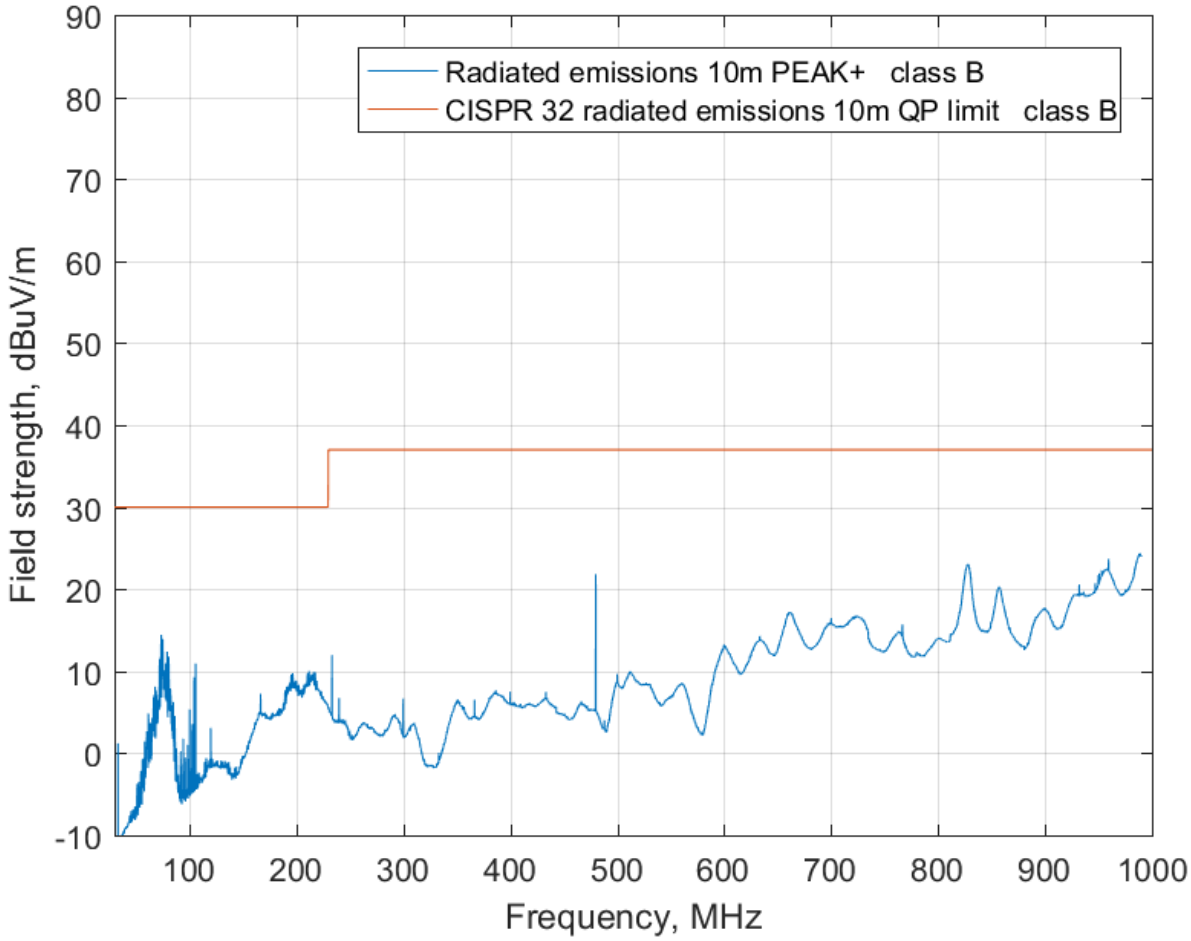

Fig. 11. Radiated emissions and class B line.

SCHEMATIC

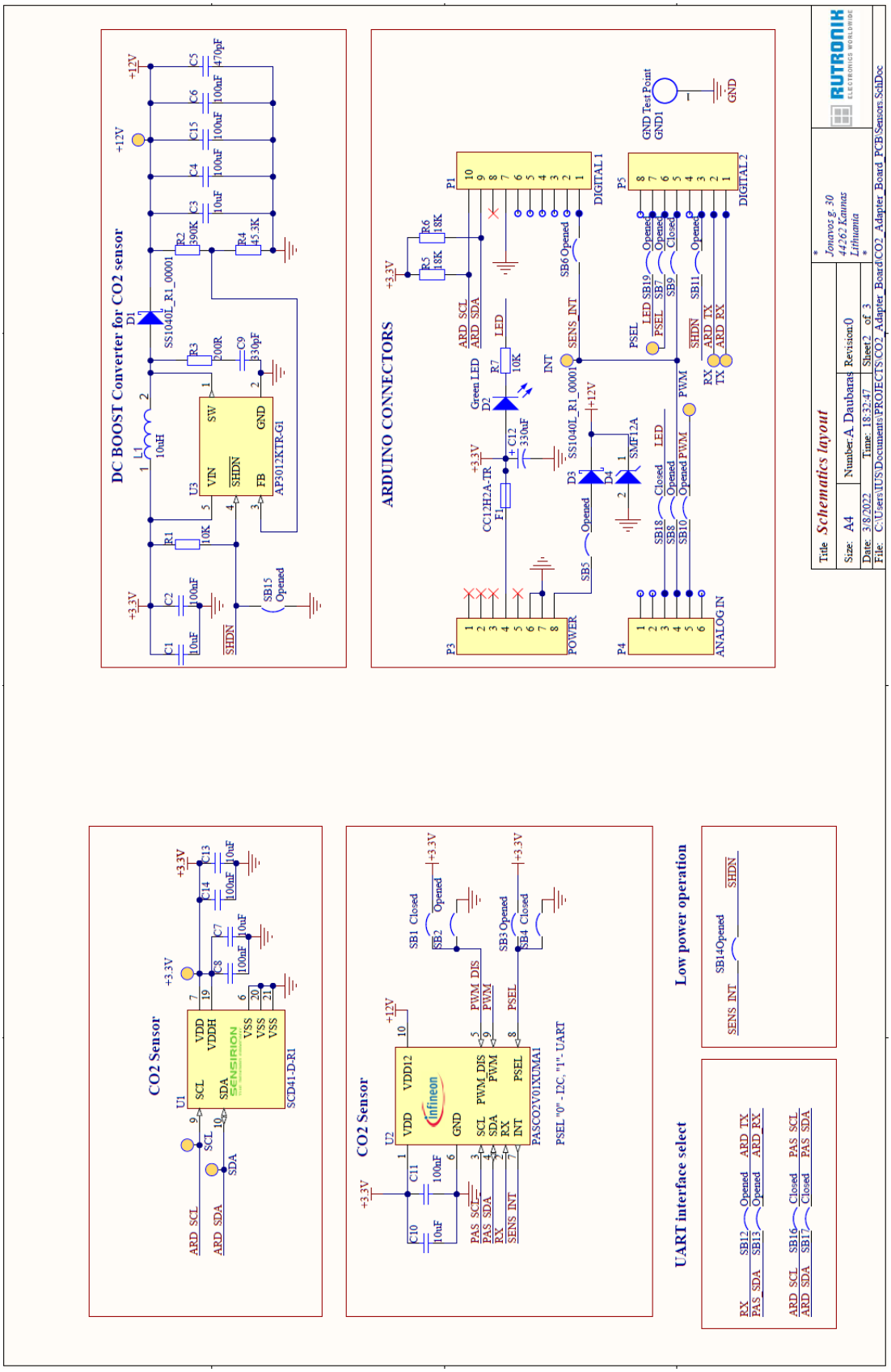

Fig. 12. RAB2-CO2 schematic.

Mechanical Layout

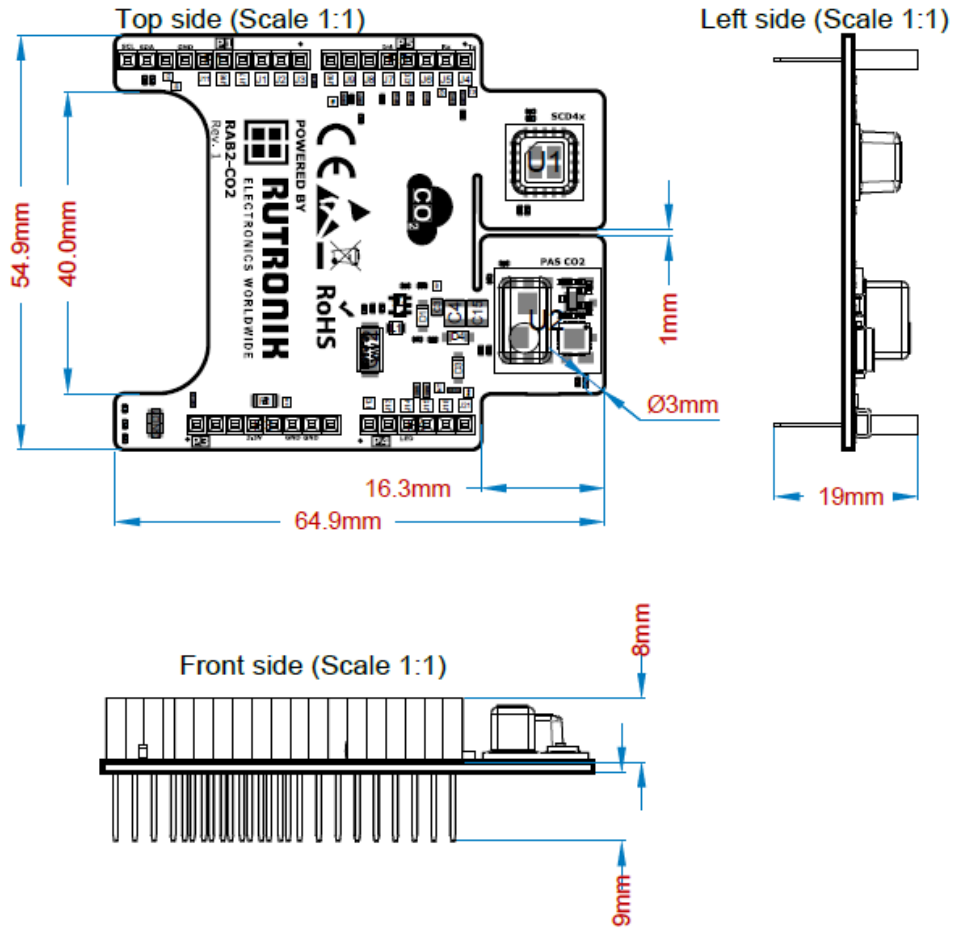

Fig. 13. RAB2-CO2 board drawing and dimensions.

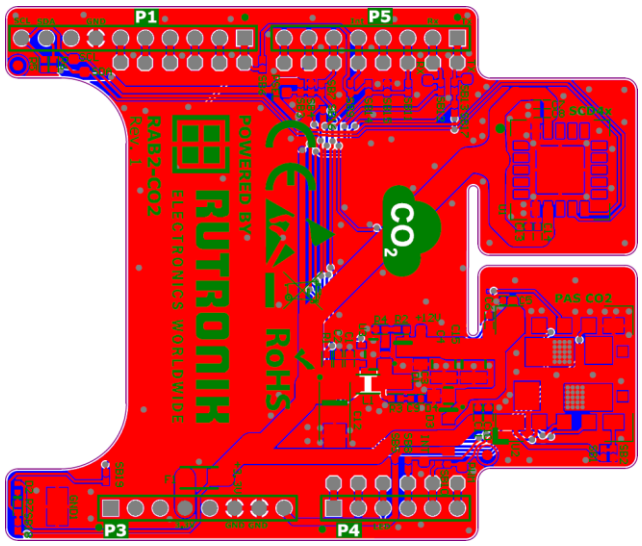

Fig. 13. RAB2-CO2 PCB board bottom view.

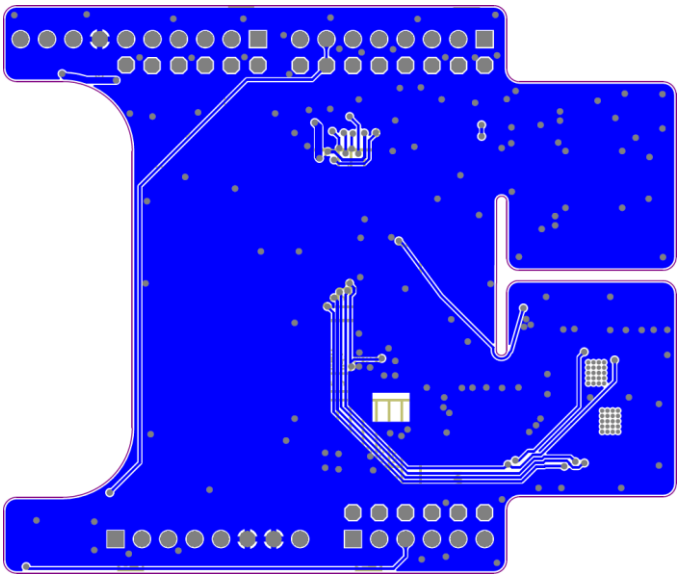

Fig. 14. RAB2-CO2 PCB board bottom view.

Bill of Materials

Table 8 Solder bridge configuration

Part Description	Specification	Value	Designator	Footprint	Quantity	Manufacturer	Manufacturer Part No.	Supplier	Supplier part number	Link
Ceramic Capacitor	X5R, 6.3, 20%	10uF	C1, C7, C10, C13	C0402	4	AVX	04026D106MAT2A	Rutronik	KKH1259	https://www.rutronik24.com/search-result/qs:04026D106MAT2A/reset:0
Ceramic Capacitor	X7R, 16V, 10%	100nF	C2, C6, C8, C11, C14	C0402	5	YAGEO	CC0402KRX7R7BB104	Rutronik	KKK19098	https://www.rutronik24.com/product/yageo/cc0402krx7r7bb104/30939.html, https://www.rutronik24.com/product/samsung+em/cl05a105ko5nnnc/31788.html
Ceramic Capacitor	X5R, 16V, 20%	10uF	C3	C0805	1	Yageo	CC0603MRX5R7BB106	Rutronik	KKK22810	https://www.rutronik24.com/search-result/qs:CC0603MRX5R7BB106/reset:0
Ceramic Capacitor	X5R, 16V, 10%	100uF	C4, C15	C1210_L	2	Samsung EM	C1210C107M4PACTU	Rutronik	KKH1210	https://www.rutronik24.com/search-result/qs:C1210C107M4PACTU/reset:0
Ceramic Capacitor	COG/NPO, 16V, 10%	470pF	C5	C0402	1	YAGEO	CC0402JRNPO7BN471	Rutronik	KKS1052	https://www.rutronik24.com/product/samsung+em/cl05a105ko5nnnc/31788.html
Ceramic Capacitor	NPO 50V, 5%	330pF	C9	C0402	1	SAMSUNG	CL05C331JB5NNNC	Rutronik	KKK16720	https://www.rutronik24.com/product/samsung+em/cl05c331jb5nnnc/30359.html
Tantalum capacitor	6.3V, 10%, Case C	330uF	C12	CAPPM6032X280N	1	AVX	TAJC337K006RNJ	Rutronik	KTA7249	https://www.rutronik24.com/product/avx/tajc337k006rnj/81190.html
SCHOTTKY-D. 1A 40V SOD123	40V, 1A		D1	MCC-SOD123_V	1	Diodes	SS1040L_R1_00001	Rutronik	DSKY5802	https://www.rutronik24.com/search-result/qs:SS1040L_R1_00001/reset:0
Typical SMD LED	Green, 5mA	LT QH9G-Q2OO-25-2Z4Y	D2	PICOLED	1	OSRAM	LT QH9G-Q2OO-25-2Z4Y	Rutronik	LED22816	https://www.rutronik24.com/product/osram/ltqh9g-q2oo-25-2z4y-5-r18/7461152.html
SCHOTTKY-D. 1A 40V SOD123	40V, 1A	12VWM, VBr14V	D3	MCC-SOD123_V	1	Diodes	SS1040L_R1_00001	Rutronik	DSKY5802	https://www.rutronik24.com/search-result/qs:SS1040L_R1_00001/reset:0
TVS-DIODE UNI 0,2KW 19.9VC SOD123F	12VWM 19.9VC		D4	ONSC-SOD-123FL-2-498_V	1	LITTELFUSE	SMF12A	Rutronik	DTRL10443	https://www.rutronik24.com/product/littelfuse/smf12a/4235500.html
High I^2t Chip fuse	63V, 2A	CC12H2A-TR	F1	FUSE1206	1	EATON	CC12H2A-TR	Rutronik	FUSE10755	https://www.rutronik24.com/search-result/qs:CC12H2A-TR/reset:0
SMT Test Point	3.81*2.03	5019	GND1	5019_keystone	1	Keystone Electrincs	5019	Rutronik	BAT4950	https://www.rutronik24.com/product/keystone/pn5019/7028403.html
Shielded Wirewound Inductor	FIXED IND 10UH 480MA 1.056OHM SM	10uH	L1	IND_LQH2M_MUR	1	Murata	LQH2MPN100MGRL	Rutronik	LQH2MPN100MGRL	https://www.rutronik24.com/search-result/qs:LQH2MPN100/reset:0
Arduino Connector	10 pos. 2,54mm	RS1-10-G-413	P1	HDR1X10_ARDUINO	1	ADAM TECH	RS1-10-G-413	Rutronik	CONN1443	http://www.adam-tech.com/products.php
Arduino Connector	8 pos. 2,54mm	RS1-08-G-413	P3, P5	HDR1X8_ARDUINO	2	ADAM TECH	RS1-08-G-413	Rutronik	CONN2043	http://www.adam-tech.com/products.php
Arduino Connector	6 pos. 2,54mm	RS1-06-G-413	P4	HDR1X6_ARDUINO	1	ADAM TECH	RS1-06-G-413	Rutronik	CONN2042	http://www.adam-tech.com/products.php
Thick Film Resistor	5% 0,063W	10K	R1, R7	R0402	2	ASJ	CR10-103-JK	Rutronik	WRC40976	https://www.rutronik24.com/product/asj/cr10-103-jk/54295.html
Thick Film Resistor	1% 0,063W	390K	R2	R0402	1	ASJ	CR10-3903-FK	Rutronik	WRC48962	https://www.rutronik24.com/product/asj/cr10-3903-fk/57405.html
Thick Film Resistor	1% 0,063W	200R	R3	R0402	1	ASJ	CR10-2000-FK	Rutronik	WRC34786	https://www.rutronik24.com/product/asj/cr10-2000-fk/51713.html
Thick Film Resistor	1% 0,063W	45.3K	R4	R0402	1	ASJ	CR10-4532-FK	Rutronik	WRC54567	https://www.rutronik24.com/product/asj/cr10-4532-fk/5859460.html
Thick Film Resistor	5% 0,063W	18K	R5, R6	R0402	2	ASJ	CR10-183-JK	Rutronik	WRC50540	https://www.rutronik24.com/product/asj/cr10-183-jk/58325.html
Thick Film Resistor	5% 0,063W	0R	SB1, SB4, SB9, SB16, SB17, SB18	SB_0402	6	Yageo	RC04020R	Rutronik	WRC52534	https://www.rutronik24.com/product/diodes+inc/ap3012ktr-g1/5167002.html, https://www.rutronik24.com/product/yageo/ac0402fr-070rl/1082692.html
CO2 and RH/T sensor module	0-100 %RH		U1	SCD4x	1	Sensirion	SCD41-D-R1	Rutronik	ICENVI1341	https://www.rutronik24.com/product/infineon/pas+co2/16639010.html
PAS CO2	I2C, UART		U2	PAS_CO2	1	Infineon	PASCO2V01AUMA2	Rutronik	ICENVI1416	https://www.rutronik24.com/search-result/qs:pas-co2/reset:0
DC-DC 29V 0.5A U SOT-23-5 SMD	DC-DC 29V 0.5A U SOT-23-5 SMD		U3	FP-SOT25-MFG	1	Diodes	AP3012KTR-G1	Rutronik	ICPWM7805	https://www.rutronik24.com/product/diodes+inc/ap3012ktr-g1/5167002.html

Legal Disclaimer

The evaluation board is for testing purposes only and, because it has limited functions and limited resilience, is not suitable for permanent use under real conditions. If the evaluation board is nevertheless used under real conditions, this is done at one's responsibility; any liability of Rutronik is insofar excluded.