EU045 Evaluation Kit

Hardware User's Guide

Contents

1. Overview

This is Renesas EU045 Air Quality Sensor solution kit.

It demonstrates Air Quality and further environmental sensors to allow quick evaluation of Renesas ZMOD gas sensors, relative humidity / temperature and ambient light sensors[1]. Its Bluetooth® 5.0 communication allows nice and easy visualization of data on a contemporary GUI running on a Smartphone or Tablet, and it comes along with Li-Ion battery, charger and Qi standard wireless power transfer.

The EU045 evaluation kit is available in three variants, basically differing in the assembled air quality sensor:

Kit Name / Order Code	Description	Gas Sensor	Color	
Y-EU045-BLUEPUCK / EU045-IAQEV1Z	Indoor Air Quality	ZMOD4410	Blue	
Y-EU045-GREENPUCK / EU045-OAQEV1Z	Outdoor Air Quality Sensor	ZMOD4510	Green	
Y-EU045-YELLOWPUCK / EU045-RQAEV1Z	Refrigerator Air Quality Sensor	ZMOD4450	Yellow	

[1] Only first lot of EU045

2. Purpose of this document

This Hardware user manual provides you in-depth details on the hardware of this solution kit.

2.1 EU045 Solution Kit Features

- Sensors

  One of the followings, depending on the EU045 kit variant:

  - Indoor air quality sensor (BLUE variant) [-20°C to +40°C]
  - Outdoor air quality sensor (GREEN variant) [-20°C to +40°C]
  - Refrigeration air quality (YELLOW variant) [0°C to +25°C]

  plus

  - Temperature and humidity sensor
  - Ambient light sensor (fitted in lots with S/N: A20* and A21* only)
- Connectivity
  - Bluetooth® 5.0 LE with fallback option to BLE 4.1 (for older smartphones)
    - Operating frequency range: 2402÷2480 MHz
    - Power level: +4 dBm
  - Qi standard wireless charging of integrated Li-Ion battery
  - Micro USB connector for wired charging of Li-Ion battery (5 V / 400 mA)
    - port also connected to the RA4W1 wireless MCU
  - Debug/programming connector with JTAG SWD Interface for the RA4W1 MCU.
  - Debug/programming connector with E1 Interface for the RL78 MCU (adapter required).
  - 2x 3.3V UART trace ports : one connected to the RA4W1 and another one connected to the RL78 (for details see SW user manual [1]).
- Push buttons
  - 1x general-purpose button connected to RA4W1
  - 1x RA4W1 MCU reset button
- 1x RGB LED
- 1x ON/OFF switch
- 350mAh 3.7V rechargeable Li-Ion battery
- IP64

2.2 Features of integrated Renesas components

The EU045 solution kit features

- Sensors
  - HS3001 – high performance relative humidity and temperature sensor
  - ISL29020 - ambient light sensor (fitted in lots with S/N: A20* and A21* only)

  one of the followings gas sensors, depending on the EU045 kit variant:
  - ZMOD4410 - gas sensor module for TVOC and indoor air quality sensor (BLUE variant)
  - ZMOD4510 - gas sensor module for outdoor air quality sensor (GREEN variant)

  - ZMOD4450 - gas sensor module for refrigeration air quality (YELLOW variant)
- Renesas Qi Standard Wireless Power Receiver P9222-R
- Renesas Li-Ion Charger with power path management ISL9301
- Renesas Ultra-Low Iq DCDC Buck/Boost regulator ISL9122A
- Renesas RA4W1 Microcontroller for Bluetooth® 5.0 LE communication
  - 48 MHz Arm® Cortex-M4 core
  - 512 kB code flash +8 KB data flash + 96 kB SRAM
  - integrated Bluetooth® LE 5 peripheral
  - 56-pin QFN package

- Renesas RL78/G13 Microcontroller for sensor data evaluation, using AI algorithms
  - 32 MHz Renesas Low Power CISC architecture
  - 64 KB code flash + 4 kB data flash + 4 kB SRAM
  - 32-pin NWQFN package

2.3 ISL29020 – IMPORTANT NOTE

After a first EU045 production lot, the ISL29020 will not be fitted anymore because this part is in not recommend for new design. While releasing a major firmware upgrade with ULP modem, this has been respected. Users must pay attention on which firmware version is loaded and running on their boards. By default, users receive only working combinations.

In the upgrade, the ZMOD libraries have been updated introducing the support for Ultra Low Power (ULP) mode. Moreover, an autodetection of the presence of light sensor (ISL29020) has been implemented in order to be able to run hardware with / without light sensor being not assembled.

In this document, firmware version “A” and version “B” will be used to distinguish the initial from the upgraded releases, as indicated in Table 1.

Version	Firmware Versions		Boards Compatibility		Notes
	RL78	RA4W1	ISL29020 light sensor fitted	ISL29020 light sensor NOT assembled	
A	< 0.2.0	< 0.4.0	OK	NO	Pre-upgrade versions
B	≥ 0.2.0	≥ 0.4.0	OK	OK	Upgraded versions • Updated ZMOD4410 libraries • Updated ZMOD4510 libraries • Autodetect ISL29020

Table 1: Firmware versions differences.

2.4 Components layout

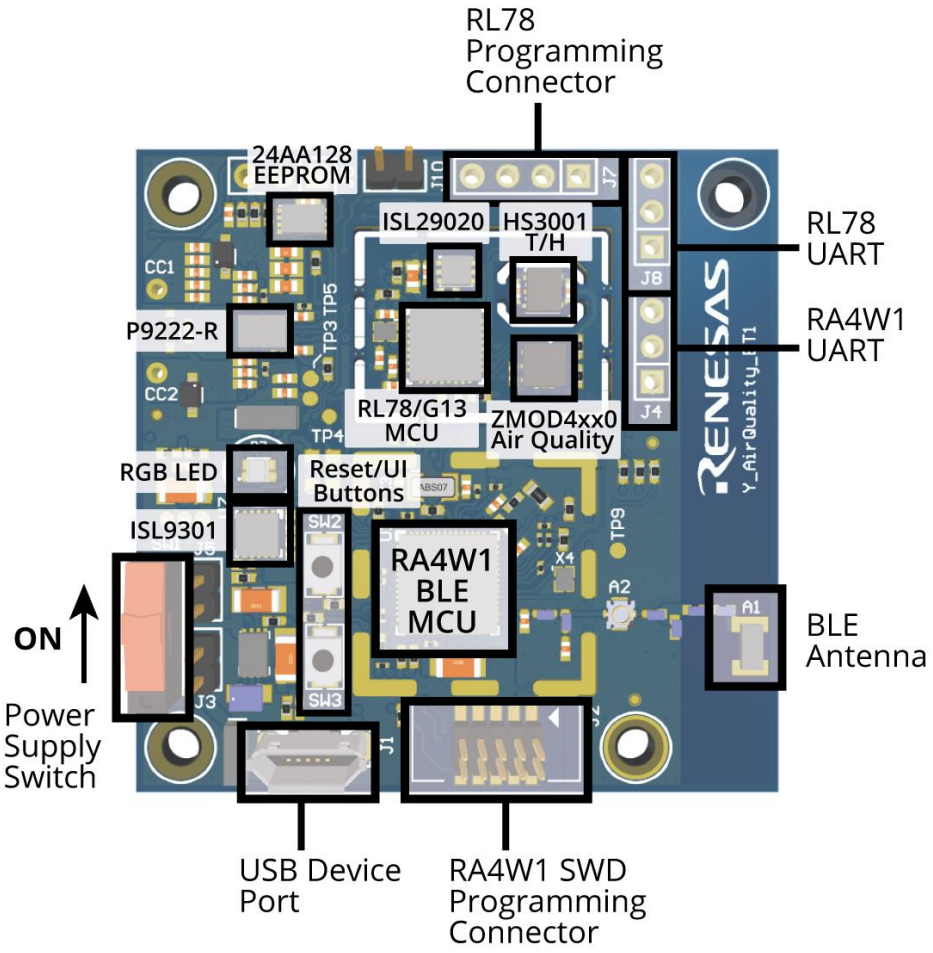

Figure 1: EU045 board top side.

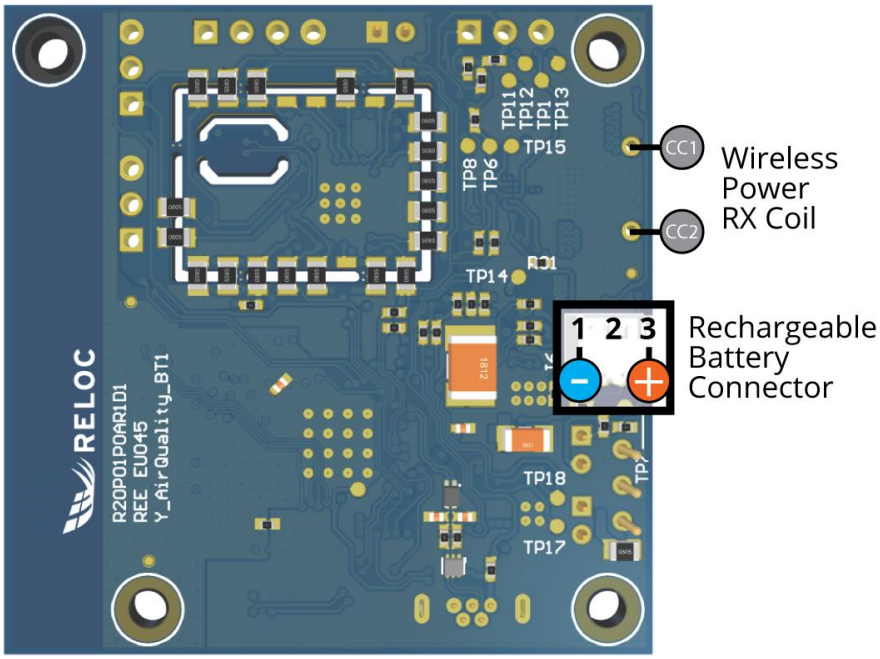

Figure 2: EU045 board bottom side.

2.5 Mechanical positioning in the case

Figure 4 shows the PCB orientation in the case of a green variant. The two holes of the cover must be aligned with the D7 multicolor LED and with the light sensor ISL29020 as shown below.

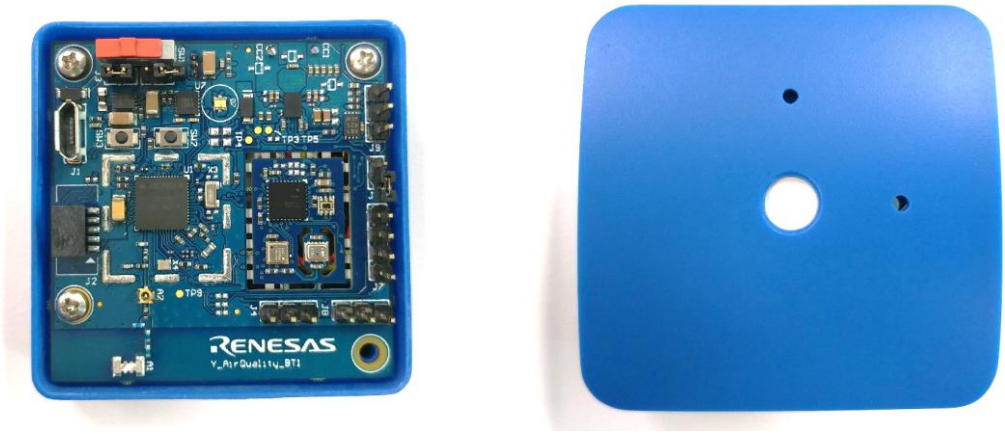

Figure 4: Top view of the case with and without the top cover.

Figure 3: Coil and battery positioning.

The Li-Ion battery is placed just under the PCB while the charger coil is on the bottom of the case, with the black support upwards.

2.6 Default Jumper Settings

Jumper	Section	Default state	Function
J3	Power supply	CLOSED	Provide the +3.3 V main power supply to the RA4W1.
J5	Wireless charger	OPEN	Disable parameters loading of the P9222-R from external EEPROM.
J10	Wireless charger	OPEN	Disable the write access to the external EEPROM U9.

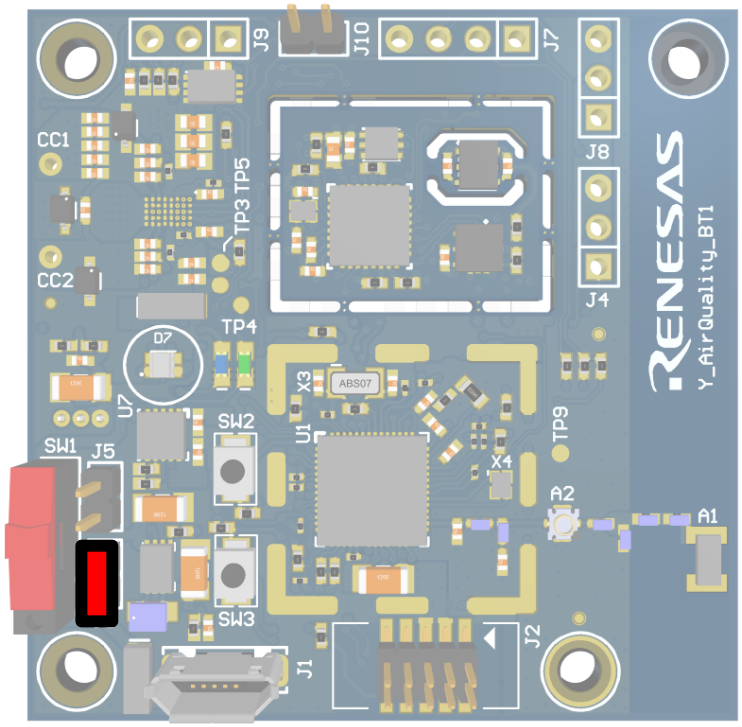

Figure 5: Default jumper settings, red boxes indicate a closed jumper.

3. EU045 solution kit Components

Figure 6 shows the EU045 block diagram.

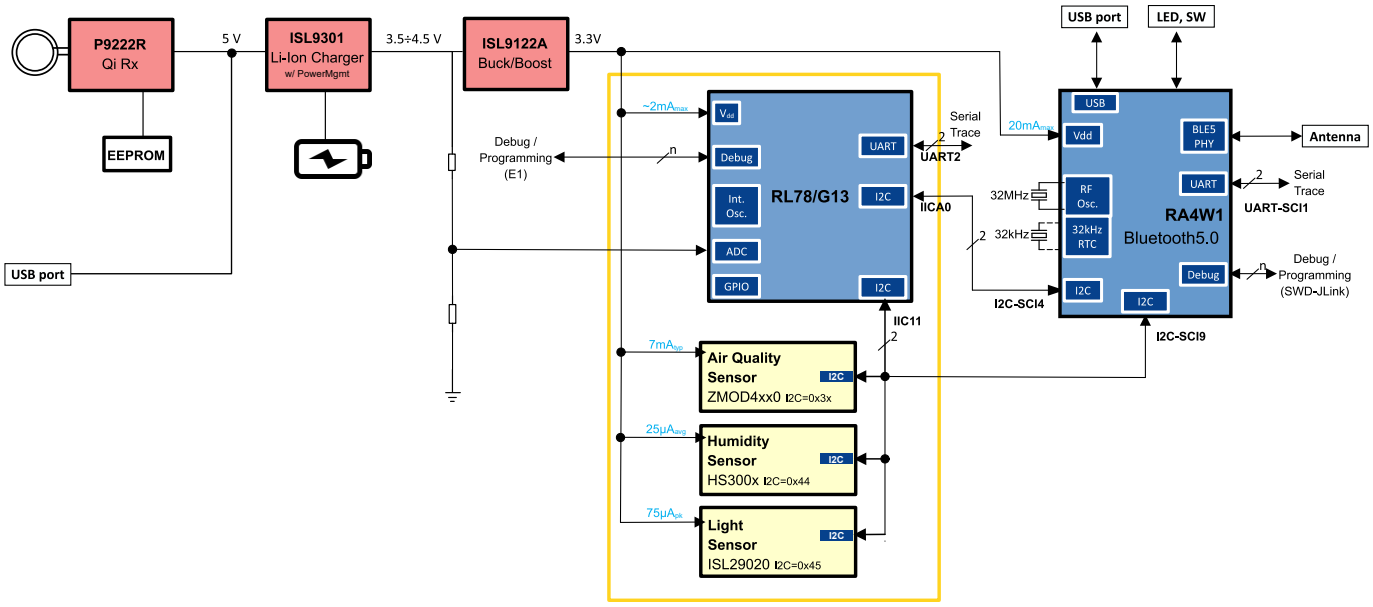

Figure 6: Block diagram. Light Sensor not fitted in all board lots.

The RL78 MCU is connected to the sensors via I2C bus with master role, and, at the same time, provides information to the RA4W1 by means of another I2C bus, this time acting as I2C slave. The RA4W1 reads the sensors' data from the RL78 and makes them available through Bluetooth® LE air interface.
A direct connection between the sensors I2C bus and the RA4W1 is also available on the EU045 solution kit, but is currently not used by the firmware. It could be useful in case the user wants to bypass / skip use of the RL78/G13 for his final application.

Each MCU has a dedicated serial trace port (UART) which can be used to print debug information and visualize those by means of standard terminal program and UART2USB cable.

The EU045 solution kit user interface includes two buttons, SW2 (RA4W1 Reset) + SW3, and an RGB LED.

It should be noted that the circuit section highlighted by the yellow box represents an "MCU-plus-sensors" sub-module, which could be used "as-is" as a building block for different applications. It can be electrically and/or even mechanically detached from the rest of the solution kit to use separately. Further sub-module details are described in the following sections.

3.1 Power Supply

The EU045 solution kit features a 350 mAh rechargeable Li-Ion battery, which can be charged using either

- integrated Qi-standard wireless charging receiver, i.e. using any legacy Qi pod as transmitter
- USB device port

The ISL9301 battery charger has been configured to perform the following charging profile:

Parameter	Value	Function
I_{REF}	389 mA	Charging current level.
I_{MIN}	31.5 mA	End Of Charge (EOC) current threshold. CHG pin will toggle.
$t_{TIMEOUT}$	1.5 h	Total charging period, after this period the charger is terminated.

The ISL9122A DC/DC buck-boost regulator is connected to the output of the battery charger to generate the 3.3 V main power supply with ultra-low quiescent current. Buck/Boost function is needed to allow battery voltages above and below 3.3V, i.e. to get everything out of the battery with best efficiency.

The RL78 MCU and the sensors are directly connected to the 3V3_BUS power rail, the RA4W1 is instead supplied through J3 allowing to measure its power consumption.

The power supply chain is depicted in Figure 7.

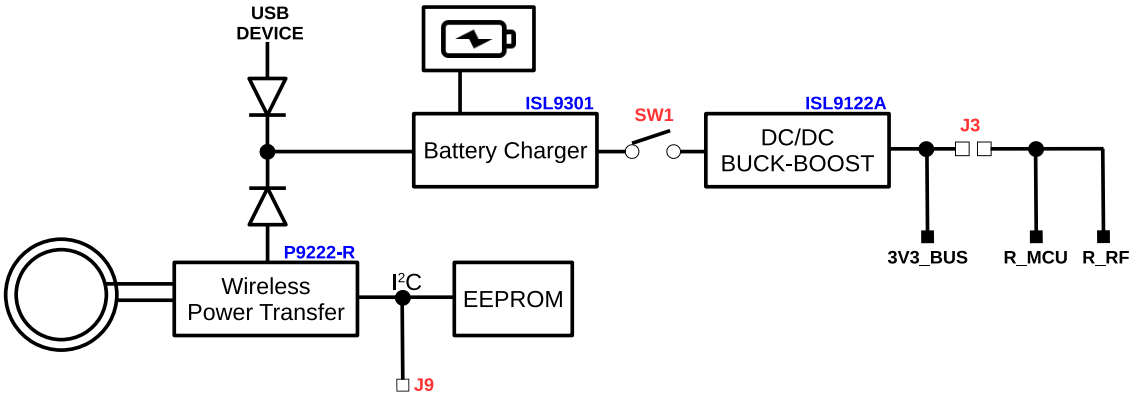

Figure 7: Power supply block diagram.

An external EEPROM is connected to the P9222-R Wireless Power Transfer allowing optional fine-tuning of the internal P9222-R parameters, e.g. foreign object detection. This can be performed by loading device-specific parameters on the EEPROM (using the I2C bus available on J9) and enabling their usage closing the J5 jumper.

However, in default setup of EU045 solution kit this EEPROM is not needed and thus not used.

3.2 Sensors module

The sensors section of the EU045 solution kit has been designed to be detached and used stand-alone in other systems. Several 0R resistors have been used to connect this module to the rest of the EU045 solution kit. By removing those, the user can electrically detach the MCU+sensor module from the battery and the Bluetooth sections. This sensor module can also be mechanically cut out, if needed.

Figure 8 and Figure 9 show module top and bottom views.

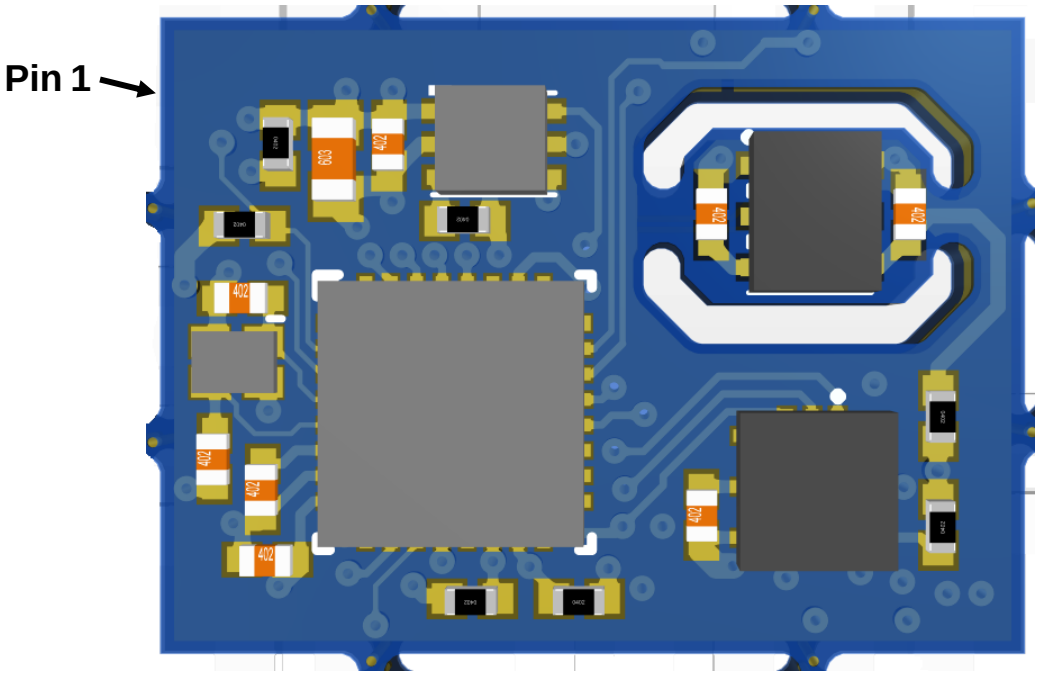

Figure 8: Sensors module Top view.

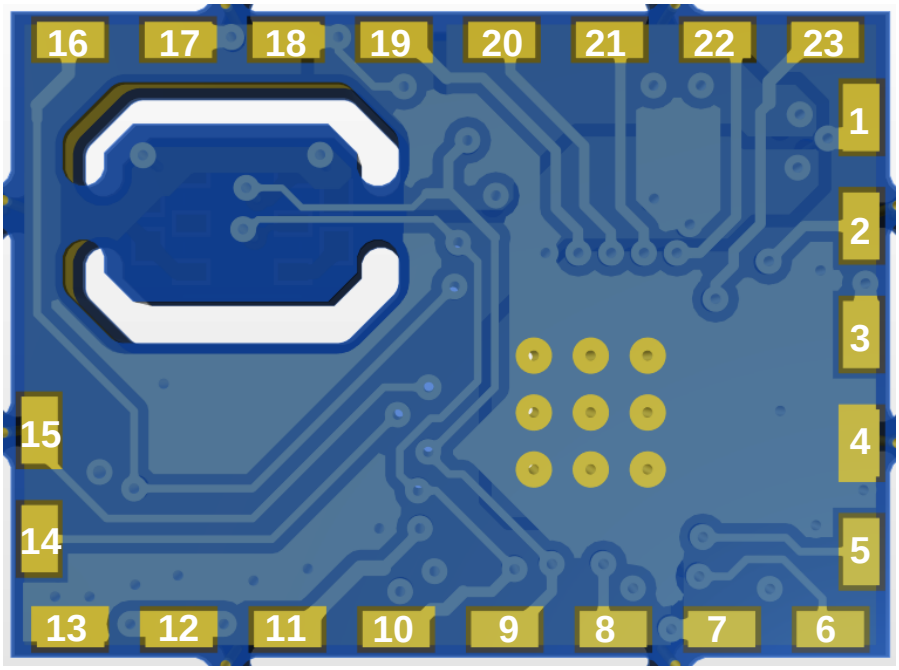

Figure 9: Sensors module Bottom view.

3.2.1 Pinout

Pin	PAD	Function
1	PD4	RESET
2	PD3	P137/INTP0
3	PD1	VDD (RL78 only) – To be connected to a 3.3 V source
4	PD2	GND
5	PD24	P60/SCLA0 – IICA0: I2C bus (slave module interface)
6	PD6	P61/SDAA0 – IICA0: I2C bus (slave module interface)
7	PD7	P62
8	PD8	P31
9	PD9	P30/SCL11 – IIC11: I2C bus (sensors)
10	PD10	P50/SDA11 – IIC11: I2C bus (sensors)
11	PD11	P51
12	PD12	VDD (sensors only) – To be connected to a 3.3 V source
13	PD13	GND
14	PD14	P14/RXD2 – UART2: Uart serial trace
15	PD15	P13/TXD2 – UART2: Uart serial trace
16	PD16	P23/ANI3
17	PD17	P11/RXD0 – UART0: optional Uart
18	PD18	P12/TXD0 – UART0: optional Uart
19	PD19	P21/AVREFM
20	PD20	P20/AVREFP
21	PD21	P01/ANI16
22	PD22	P00/ANI17
23	PD5	TOOL0 – Debug/Programming interface

3.2.2 RL78/G13 MCU

The RL78/G13 MCU is part of the sensors submodule and oversees the sensor configuration, data reading, sensor data evaluation using AI algorithms and data distribution.

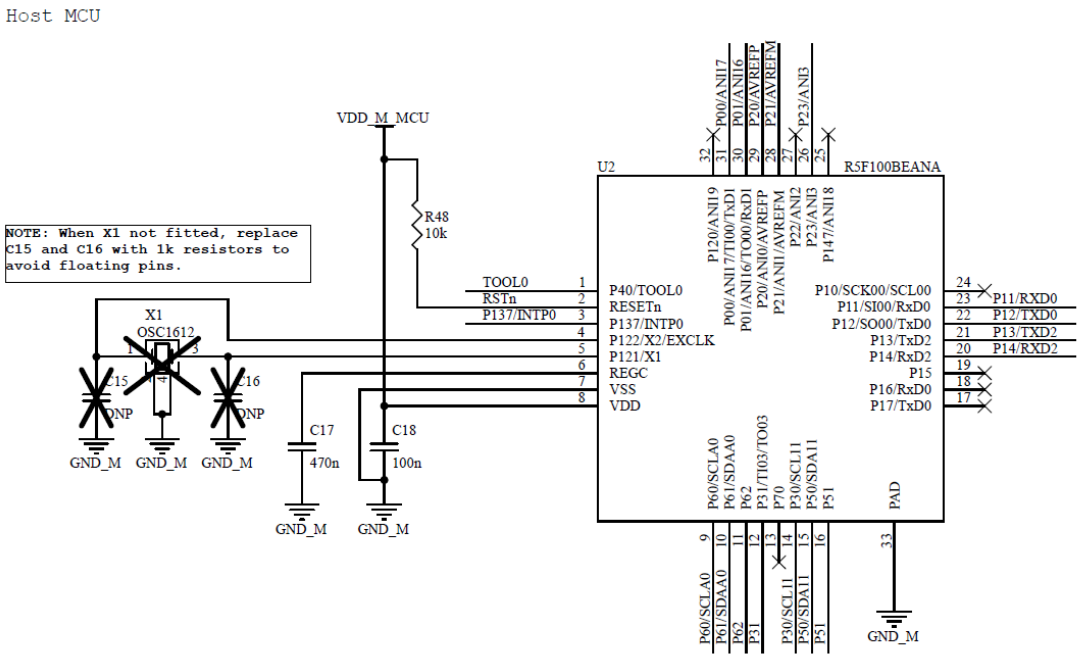

Figure 10: RL78/G13 MCU section.

This MCU can be programmed using the J7 connector (Figure 11). An adapter is required to use the standard E1 connector, see chapter 7.

The TOOL0 pin is also connected to an RA4W1 UART port. This also allows the RL78 serial programming via BLE wireless MCU, RA4W1, refer to [10] for more details.

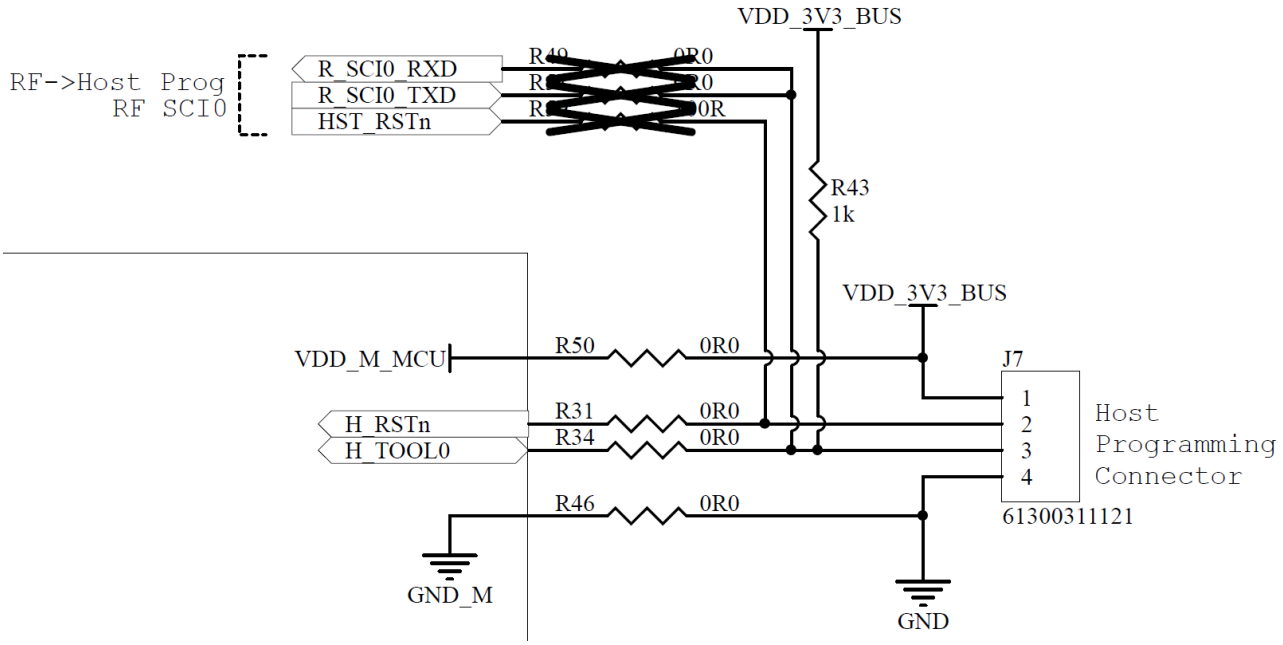

Figure 11: RL78/G13 Debug/Program interface.

A voltage divider, connected to P01/ANI16, provides a reference used for battery level sensing implemented on the RL78 MCU.

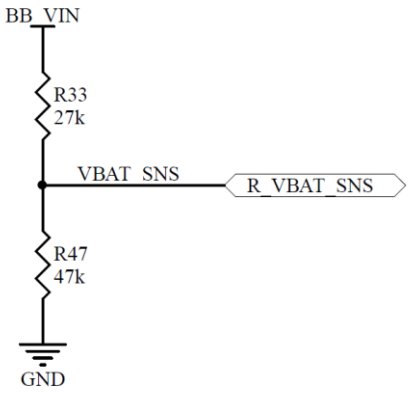

Figure 12: Battery sensing.

3.2.2.1 Debug port

The UART2 module (available on J8, see Figure 13) is used for debugging purpose (3.3V level)

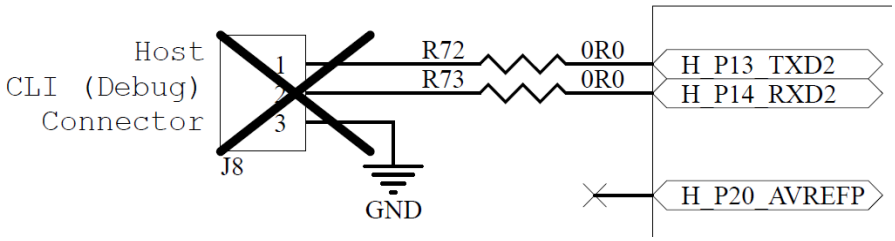

Figure 13: RL78/G13 Debug serial.

J8 Pin	Function
1	RL78 serial TX
2	RL78 serial RX
3	GND

3.2.3 HS3001 - Temperature and Humidity Sensor

This sensor is connected to the IIC11 I2C bus – address 0x44.

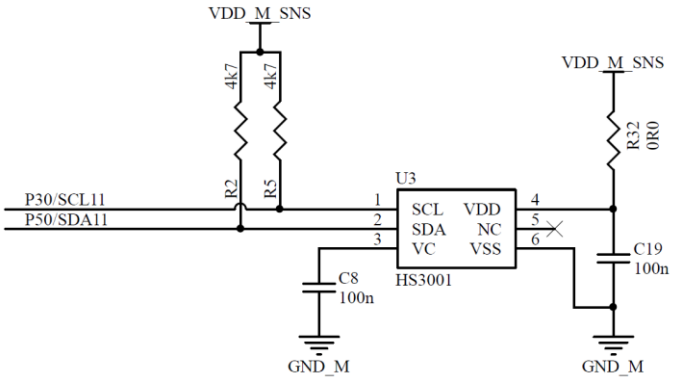

Figure 14: HS3001 section.

3.2.4 ISL29020 - Light Sensor

This sensor is connected to the IIC11 I2C bus – address 0x45.

IMPORTANT NOTE: The ISL29020 is fitted in lots with S/N: A20* and A21* only.

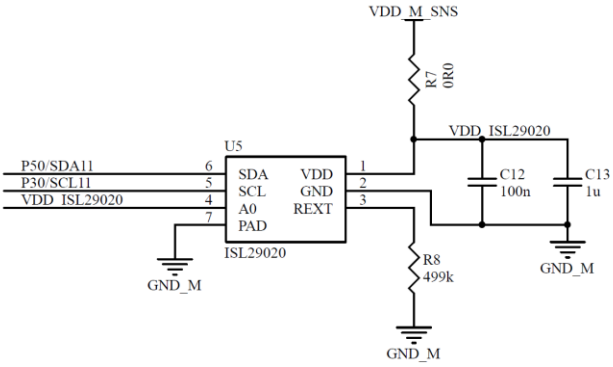

Figure 15: ISL29020 section.

3.2.5 ZMOD4xx0 - Gas Sensor Module

Depending on the EU045 solution kit's variant, a different ZMOD sensor is integrated:

- EU045 BLUE version: ZMOD4410 Indoor Air Quality – I2C address 0x32
- EU045 GREEN version: ZMOD4510 Outdoor Air Quality – I2C address 0x33
- EU045 YELLOW version: ZMOD4450 Refrigeration Air Quality – I2C address 0x32

The gas sensor is connected to the IIC11 I2C bus.

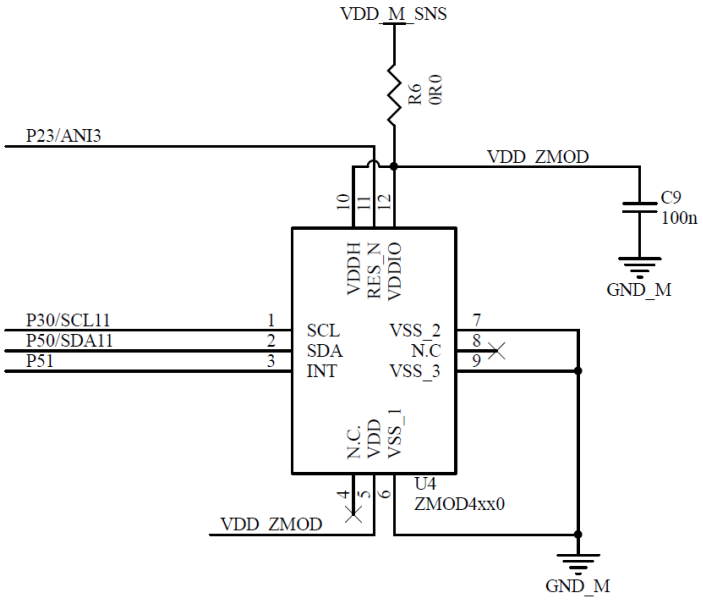

Figure 16: ZMOD4xx0 section.

3.3 RA4W1

The Renesas RA4W1 MCU can be programmed using the 10-pin SWD connector J2, directly connected to the MCU, Figure 17 by using Segger® J-Link.

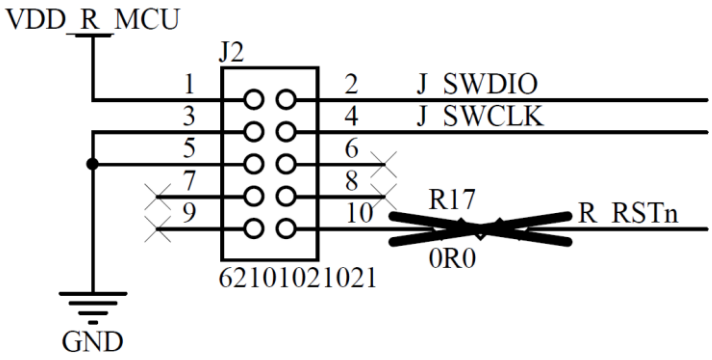

Figure 17: RA4W1 Debug/Programming SWD connector

3.3.1 Debug Port

On J4 an UART interface (connected to SCI1) is used for debugging purpose (3.3V level). It can be enabled / disabled in the Software, see SW User Guide.

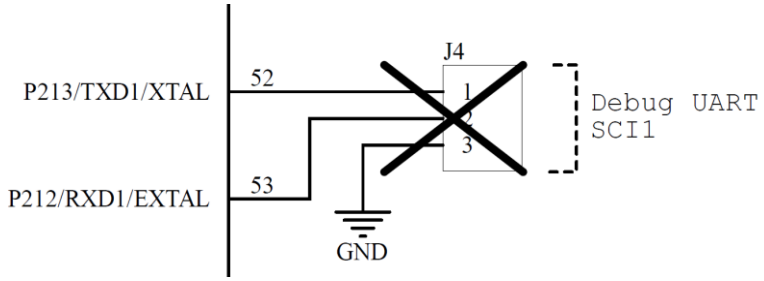

Figure 18: RA4W1 Debug serial

J4 Pin	Function
1	RA4W1 serial TX
2	RA4W1 serial RX
3	GND

3.4 USB Device Port

The USB Device port J1 is directly connected to the RA4W1 MCU.

The +5 V coming from this USB port can be used to supply the EU045 solution kit and charge the lithium battery. A diode avoids conflicts with the wireless power source.

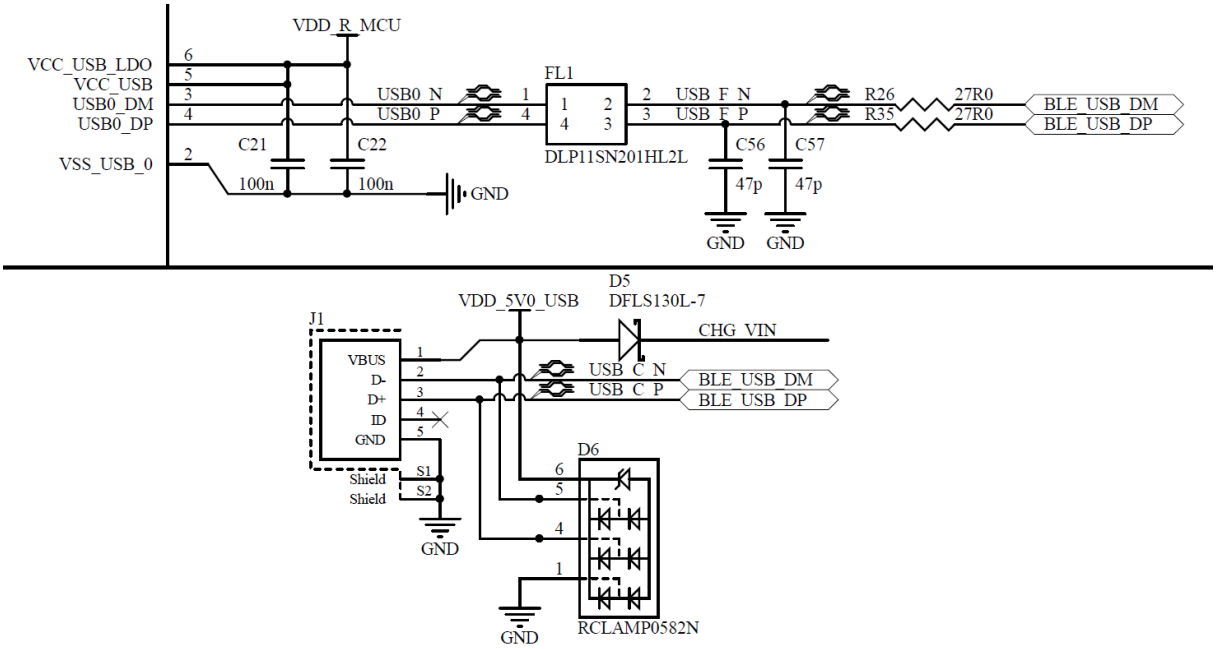

Figure 19: RA4W1 USB Device.

3.5 LEDs and Buttons

A RGB LEDs is connected to the RA4W1 MCU.

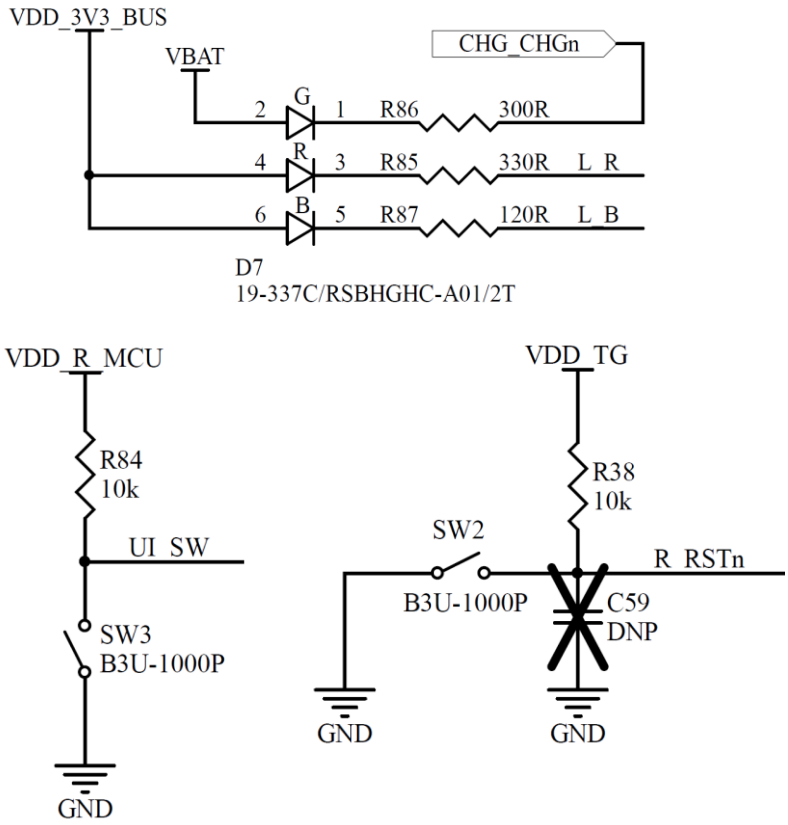

Figure 20: LEDs and buttons connections.

The three colors have different connections and purposes:

LED Color	Function
RED	Connected to the pin P414 of the RA4W1. General purpose. See SW User Manual for details.
BLUE	Connected to the pin P404 of the RA4W1. General purpose. See SW User Manual for details.
GREEN	Connected to the CHG pin of the battery charger U7. When on indicates that the battery is charging.

As shown in Figure 20, there are also two push buttons:

- SW2: used as a reset button for the RA4W1
- SW3: used as a general-purpose button, connected to P106 (KR06).

4. Power Consumption

The RL78 and the RA4W1 firmware have been improved with the upgrade (see section 2.3), significantly reducing the power consumption. The following information are related to the Version **B** only.

The current has been measured after the SW1 switch, excluding the wireless charger and the battery manager ICs contributions, but including the ultra-low Iq DCDC buck/boost converter.

In Figure 21 the current consumption of a EU045-IAQEV1Z kit (aka Blue-Puck), with the ZMOD4410 in normal mode, is shown.

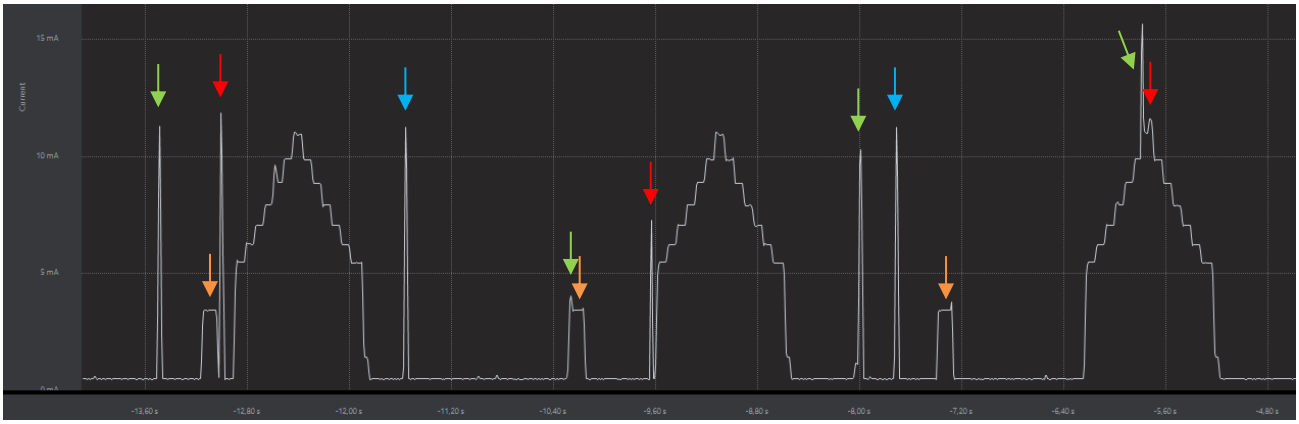

Figure 21: Typical current consumption of a Blue-puck board when the ZMOD is working in normal mode. BLE Advertising 5 s, HS3001 Measure Delay 3 s, ISL29020 Delay 3 s.

When no tasks are running, the measured current is about 500 µA, the RA4W1 is placed in Software Standby and the RL78 in HALT mode. The 1-second large peaks are mainly due to the ZMOD4410 internal heater and are repeated each 3 seconds. Instead, the short spikes are caused by:

- the BLE advertising (blue arrows)
- the other sensors sampling (red arrows)
- the communication between the two microcontrollers (green arrows)
- the blinking LED D7 (orange arrows)

Enabling the ULP mode of the ZMOD4410 in EU045-IAQ, the internal heater usage is drastically reduced. The period of the large “house-type” peaks is about 90 seconds (vs. ~5sec in the standard mode), lowering the

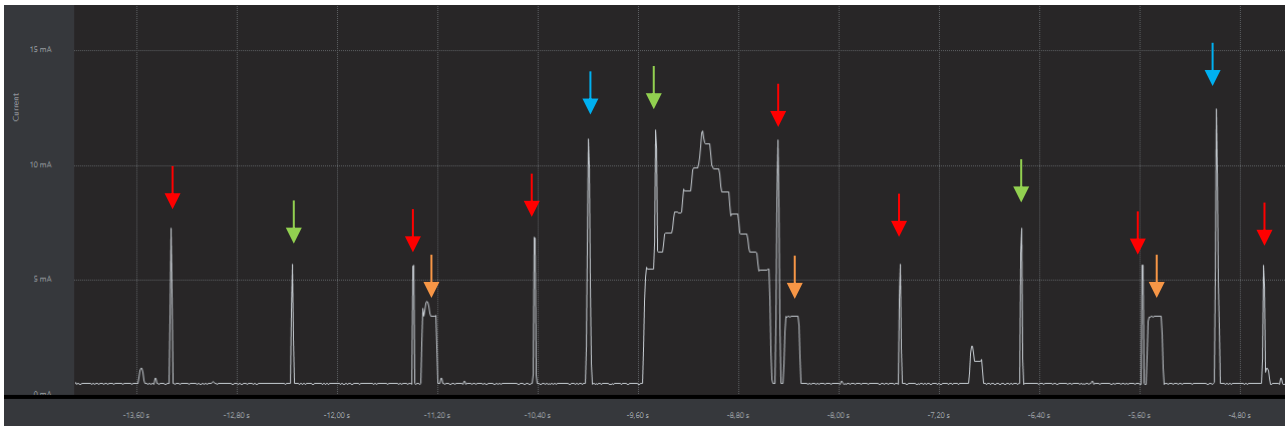

Figure 22: Typical current consumption of a Blue-puck board when the ZMOD is working in ULP mode. BLE Advertising 5 s, HS3001 Measure Delay 3 s, ISL29020 Delay 3 s. The ZMOD heater’s peaks have a period of about 90 s.

average consumption as reported in Figure 22.

5. BOM

n.	Manufacturer	Manufacturer P/N	Description	Proj. Reference	pcs/ unit	Mount	Section
1	Mitsubishi Materials	AM03DP-ST01	Antenna 2.4 GHz	A1	1	YES	EU045
2	Murata	MM8030-2610RJ3	RF Connector Coaxial w/ Switch	A2	1	YES	EU045
3	TDK	WR303050-12F5-ID (alt. Wurth 760308102213)	Wireless RX Coil	A3	1	YES	EU045
4	BAK	YOBLP422339PACK	Battery rechargeable 3V7 370mAh	BAT1	1	YES	EU045
5	-	1206 10u 16V 10% TAJB106K016YNJ	Capacitor Polarized SMD	C1	1	YES	EU045
6	-	0402 DNP	Capacitor Ceramic SMD	C10, C11, C30, C34, C59	7	NO	EU045
7	-	0402 1k 1/16W	Resistor SMD	C15[2], C16[2]	2	YES	EU045
8	-	0603 1u 16V 10%	Capacitor Ceramic SMD	C13	1	YES	EU045
9	-	0402 470n	Capacitor Ceramic SMD	C17	1	YES	EU045
10	-	0402 100n 50V	Capacitor Ceramic SMD	C18, C25, C26, C27, C28, C29, C61	7	YES	EU045
11	-	0201 100n 16V 20% GRM033C71C104K	Capacitor Ceramic SMD	C2, C3, C20, C21, C22, C23, C24	7	YES	EU045
12	-	0402 47n 50V	Capacitor Ceramic SMD	C31, C35	2	YES	EU045
13	-	0402 15n 25V	Capacitor Ceramic SMD	C32, C36	2	YES	EU045
14	-	0402 3n3 50V	Capacitor Ceramic SMD	C33	1	YES	EU045
15	-	0201 100n 25V	Capacitor Ceramic SMD	C37, C45, C60	3	YES	EU045
16	-	0402 4u7 16V	Capacitor Ceramic SMD	C38, C39	2	YES	EU045
17	-	0402 2u2 16V 10% GRM155R61C225K	Capacitor Ceramic SMD	C4	1	YES	EU045

[2] C15 and C16 are replaced with resistors when the X1 is not populated, avoiding floating pins.

18	-	0603 DNP	Capacitor Ceramic SMD	C40	1	NO	EU045
19	-	0603 10u 25V	Capacitor Ceramic SMD	C41, C42	2	YES	EU045
20	-	0201 100n 50V	Capacitor Ceramic SMD	C43	1	YES	EU045
21	-	0402 1u0 16V	Capacitor Ceramic SMD	C44, C46	2	YES	EU045
22	-	0402 2u2 16V	Capacitor Ceramic SMD	C47	1	YES	EU045
23	-	1812 4u7 25V	Capacitor Ceramic SMD	C48	1	YES	EU045
24	-	0402 10n 50V	Capacitor Ceramic SMD	C49, C50, C52	3	YES	EU045
25	-	0201 4u7 6V3 20% GRM035R60J475M	Capacitor Ceramic SMD	C5	1	YES	EU045
26	-	1206 10u 6V3 ECS-T0JY106R	Capacitor Ceramic SMD	C51, C53	2	YES	EU045
27	-	0805 10u 6V3	Capacitor Ceramic SMD	C54, C55	2	YES	EU045
28	-	0402 47p 50V	Capacitor Ceramic SMD	C56, C57	2	YES	EU045
29	-	0402 1u	Capacitor Ceramic SMD	C58	1	YES	EU045
30	-	0402 470n 25V 10% GRT155R61E474K	Capacitor Ceramic SMD	C6	1	YES	EU045
31	-	0402 0p5 GCM1555C1HR50BA16	Capacitor Ceramic SMD	C7	1	YES	EU045
32	-	0402 100n 16V 10% GCM155R71C104K	Capacitor Ceramic SMD	C8, C9, C12, C14, C19, C62	6	YES	EU045
33	-	0402 0p2 GJM1555C1HR20WB01	Capacitor Ceramic SMD	CF1	1	YES	EU045
34	Bourns	DNP (CDSOD323-T18C)	TVS Diode CDSOD323-T18C	D1, D2, D3	3	NO	EU045
35	Diodes Inc	DFLS130L-7	DFLS130L - 1A SCHOTTKY Barrier Rectifier	D4, D5	2	YES	EU045
36	Semtech	RCLAMP0582N	TVS Diodes USB	D6	1	YES	EU045
37	Everlight	19-337C/RSBHGHC-A01/2T (alt. Everlight EAST1616RGBA8)	LED RGB 0606 SMD	D7	1	YES	EU045
38	Murata	DLP11SN201HL2L	EMI Filter DLP11SN_L2L Series 200 at 100MHz 110mA 5V	FL1	1	YES	EU045
39	Wurth	614105150721	USB 2.0 Mini Type B, Receptacle, Vertical, THT	J1	1	YES	EU045
40	Wurth	62101021021	WR-PHD 1.27 mm Dual SMT Pin Header	J2	1	YES	EU045
41	Wurth	62000211121	Conn Pin Header 2POS 2.00mm TH	J3, J5, J10	3	YES	EU045
42	Wurth	61300311121	Conn Pin Header 3POS 2.54mm TH	J4, J8, J9	3	YES	EU045
43	Molex	530480310	Conn 3POS 1.25mm TH	J6	1	YES	EU045
44	Wurth	61300311121	Conn Pin Header 4POS 2.54mm TH	J7	1	YES	EU045
45	Sullins Connector Solutions	SPN02SYBN-RC	JUMPER 2mm	JMP1, JMP2, JMP3	3	YES	EU045
46	-	0402 2n4 LQW15AN2N4B00	Inductor SMD	L1	1	YES	EU045
47	-	0402 6n2 LQW15AN6N2B00	Inductor SMD	L2	1	YES	EU045
48	-	0402 1n8 LQW15AN1N8C00	Inductor SMD	L3	1	YES	EU045
49	-	0402 7n5 LQG15HS7N5J02	Inductor SMD	L4	1	YES	EU045
50	Wurth	0603 1u 74479262210	Inductor SMD	L5	1	YES	EU045
51	-	LED 0603 SMD Green (DNP)	LED 0603 SMD Green	LED1	1	NO	EU045
52	-	LED 0603 SMD Blue (DNP)	LED 0603 SMD Blue	LED2	1	NO	EU045
53	-	0402 1n5 LQG15HS1N5S02	Inductor SMD	LF1	1	YES	EU045

54	-	0402 0R0	Resistor SMD	LM1	1	YES	EU045
55	-	0201 10k 1/16W	Resistor SMD	R1, R18	2	YES	EU045
56	-	0402 DNP	Resistor SMD	R10	1	NO	EU045
57	-	0201 0R0	Resistor SMD	R11, R12	2	YES	EU045
58	-	0402 0R0 1/16W	Resistor SMD	R13, R27, R30, R39, R40, R41, R42, R63, R68, R69, R76	11	YES	EU045
59	-	0402 DNP 1/16W	Resistor SMD	R17, R49, R51, R58, R80	5	NO	EU045
60	-	0402 100k 1/16W	Resistor SMD	R19, R24	2	YES	EU045
61	-	0603 4k7	Resistor SMD	R2, R5	2	YES	EU045
62	-	0402 10k 1/16W	Resistor SMD	R20, R22, R23, R38, R77, R81, R84	7	YES	EU045
63	-	0402 1M 1/16W	Resistor SMD	R21	1	YES	EU045
64	-	0402 270k 1/16W	Resistor SMD	R25	1	YES	EU045
65	-	0402 27R0 1/16W	Resistor SMD	R26, R35	2	YES	EU045
66	-	0402 100R 1/16W	Resistor SMD	R28	1	NO	EU045
67	-	0402 220R 1/16W	Resistor SMD	R29	1	NO	EU045
68	-	0603 0R0 MCR03EZPJ000	Resistor SMD	R3	1	YES	EU045
69	-	0805 0R0	Resistor SMD	R31, R34, R46, R50, R55, R56, R60, R61, R62, R64, R65, R66, R67, R70, R72, R73, R74, R75	18	YES	EU045
70	-	0402 27k 1/16W	Resistor SMD	R33	1	YES	EU045
71	-	0402 15k0 1/16W	Resistor SMD	R36	1	YES	EU045
72	-	0402 30k0 1/16W	Resistor SMD	R37	1	YES	EU045
73	-	0402 0R0 MCR01MZPJ000	Resistor SMD	R4, R14, R15	3	YES	EU045
74	-	0402 1k	Resistor SMD	R43	1	YES	EU045
75	-	0402 47k 1/16W	Resistor SMD	R47	1	YES	EU045
76	-	0603 10k	Resistor SMD	R48	1	YES	EU045
77	-	0402 0R0 1/16W	Resistor SMD	R54, R71	2	NO	EU045
78	-	0805 DNP (0R0)	Resistor SMD	R57	1	NO	EU045
79	-	0402 DNP (100R)	Resistor SMD	R59	1	NO	EU045
80	-	0402 0R0	Resistor SMD	R6, R7, R32, R52, R53	5	YES	EU045
81	-	0402 5k1 1/16W	Resistor SMD	R78, R79	2	YES	EU045
82	-	0603 499k	Resistor SMD	R8	1	YES	EU045
83	-	0402 DNP (10k) 1/16W	Resistor SMD	R82	1	NO	EU045
84	-	0402 330R 1/16W	Resistor SMD	R85	1	YES	EU045
85	-	0402 300R 1/16W	Resistor SMD	R86	1	YES	EU045
86	-	0402 120R 1/16W	Resistor SMD	R87	1	YES	EU045
87	-	0805 0R0	Resistor SMD	R88	1	YES	EU045
88	-	0402 4k7 1/16W	Resistor SMD	R9, R16	2	YES	EU045
89	Wurth	36103166S	Shield cabinet	SHL1	1	NO	EU045
90	Wurth	450301014042	EMC Switch Slide TH Mini SPDT	SW1	1	YES	EU045
91	Omron	B3U-1000P	EMC Switch Tactile	SW2, SW3	2	YES	EU045

92	Renesas	R7FA4W1AD2CNG	IC RF BLE RA4W1	U1	1	YES	EU045
93	Renesas	R5F100BEANA#U0	IC MCU RL78/G13	U2	1	YES	EU045
94	Renesas	HS3001	Sensor Humidity	U3	1	YES	EU045
95	Renesas	ZMOD4410AI1R	Sensors Air Quality IAQ TVOC	U4 - variant-1 (BLUE)	1	YES	EU045
96	Renesas	ZMOD4510AI1R	Sensors Air Quality OAQ	U4 - variant-2 (GREEN)	0	YES	EU045
97	Renesas	ZMOD4450AI1R	Sensors Air Quality RefrigerationAQ	U4 - variant-3 (YELLOW)	0	YES	EU045
98	Renesas	ISL29020IROZ-T7	Sensor Light	U5	1	NO (See section 2.3)	EU045
99	Renesas	P9222-RAZGI8	IC Wireless Power Receiver	U6	1	YES	EU045
100	Renesas	ISL9301IRZ	IC Battery Charger	U7	1	YES	EU045
101	Renesas	ISL9122AIRNZ-T	Regulator Buck Boost 800mA	U8	1	YES	EU045
102	Microchip	24AA128T-I/MNY	IC MEM EEPROM I2C 128k	U9	1	YES	EU045
103	-	OSC1612	Oscillator Crystal SMD 1.6x1.2mm (e.g. NX1612SA series)	X1	1	NO	EU045
104	Abracon	ABS07-32.768KHZ-T	Oscillator 32KHz 12.5pF	X3	1	YES	EU045
105	Kyocera	CX1612DB32000A0WPNC1 (alt. NDK NX1612SA-32MHZ-EXS00A-CS09166)	Oscillator Crystal SMD 1.6x1.2mm	X4	1	YES	EU045
106	Mircovent	MVS-03-FW-300	Membrane	_ENC MB1	1	YES	ENCLOSURE
107	The O-Ring Store LLC	N2.50X037	O-Ring 2.5mm X 37mm (NBR) Buna-N 70 Duro Metric	_ENC ORING	1	YES	ENCLOSURE
108	Dialight	515-1301-0250F	LED PIPE	_ENC PIPE1, PIPE2	2	YES	ENCLOSURE
109	-	-	Screw M2.5	_ENC SCR1, SCR2, SCR3	3	YES	ENCLOSURE
110		Material UP4280 RAL colours: 1018 (YELLOW) 6038 (GREEN) 5005 (BLUE)	Enclosure	_ENC	1	YES	ENCLOSURE
111	Wurth	661100128015	CABLE PRE-CRIMPED 2.54mm	_PAD Cables	4	YES	E1PAD
112	Wurth	61301421821	Conn Socket Header SMD 14POS (2x7) 2.54mm	_PAD J1	1	YES	E1PAD
113	Wurth	61300411121	Conn Pin Header TH 4POS (1x4) 2.54mm	_PAD J2	1	NO	E1PAD
114	Wurth	613004143121 (alt: 61300411821)	Conn Socket Header TH Angled 4POS (1x4) 2.54mm (alt: Conn Socket Header TH 4POS (1x4) 2.54mm)	_PAD J3	1	NO	E1PAD
115	-	0805 10k	Resistor SMD	_PAD R1	1	NO	E1PAD
116	-	0805 1k	Resistor SMD	_PAD R2	1	NO	E1PAD
117	Wurth	661004113322	Conn RCPT HSG 4POS 2.54mm	_PAD TGT connector	1	YES	E1PAD

6. Board Layout

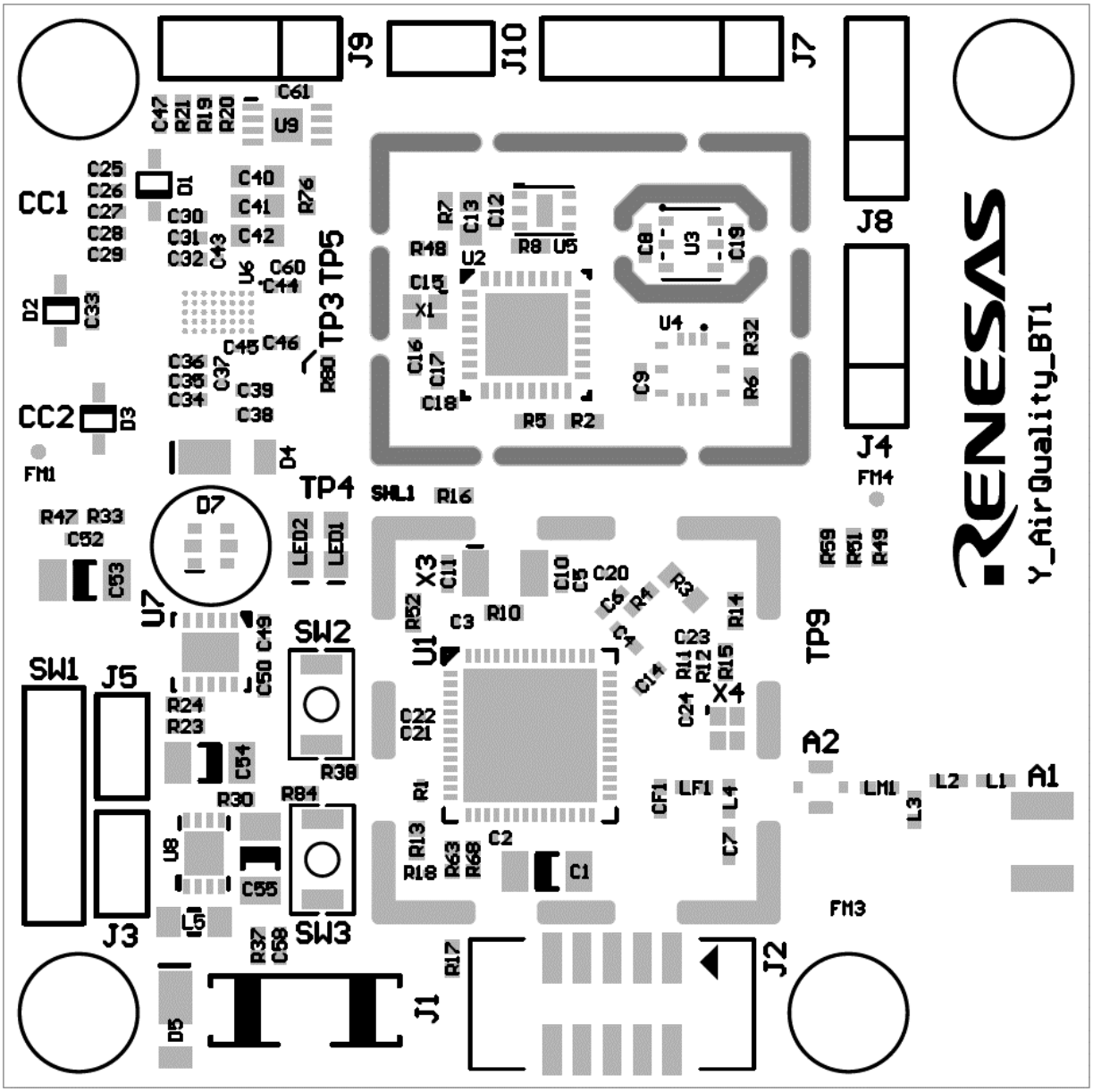

Figure 23: EU045 top side placement.

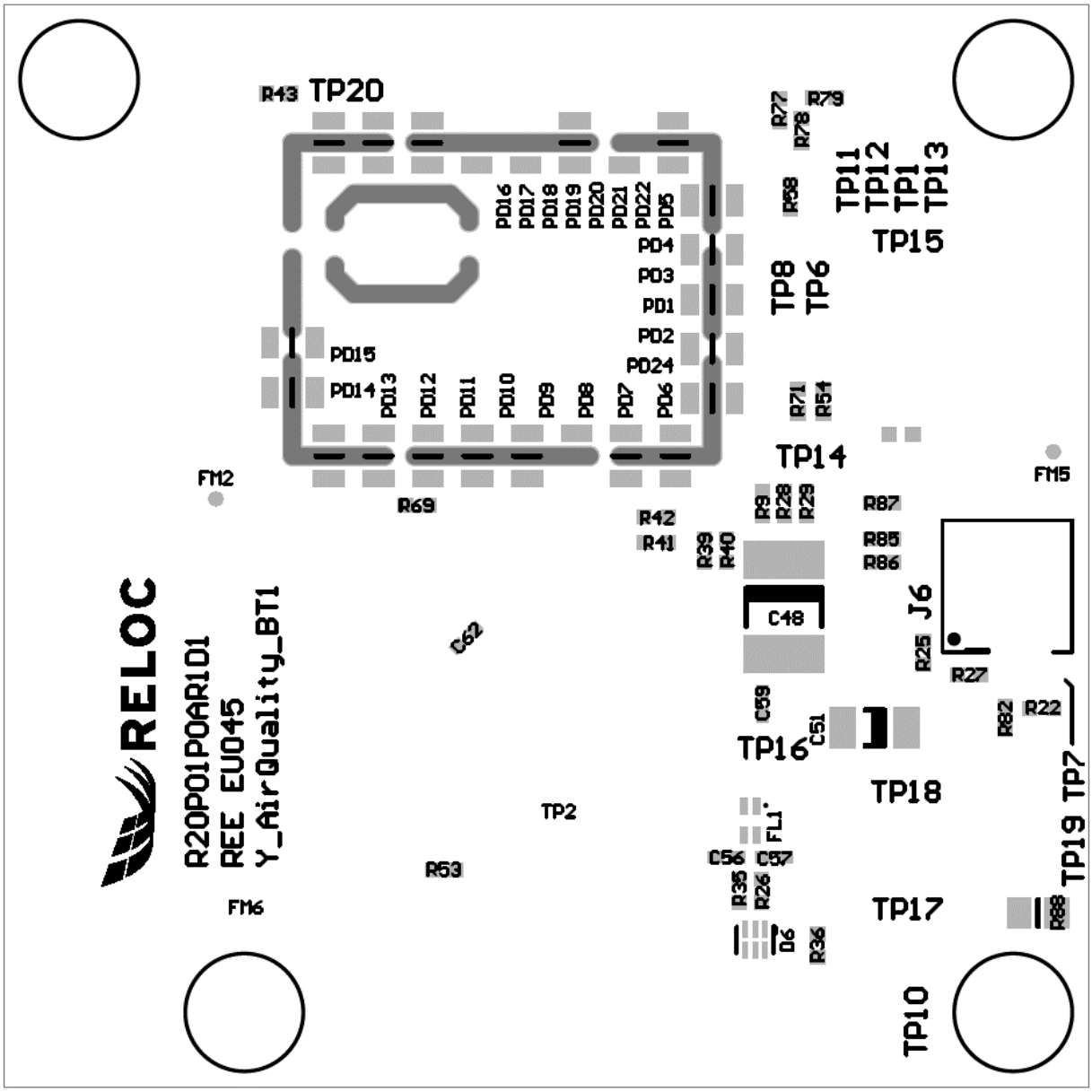

Figure 24: EU045 bottom side placement.

7. RL78/G13 Programming Adapter

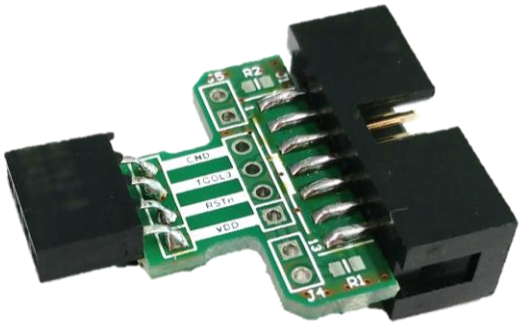

Figure 25: RL78/G13 Adapter

The adapter cable must be connected to the J7 connector on the EU045 board (Figure 26) and, on the other side, to the Renesas E1 Programmer/Debugger cable.

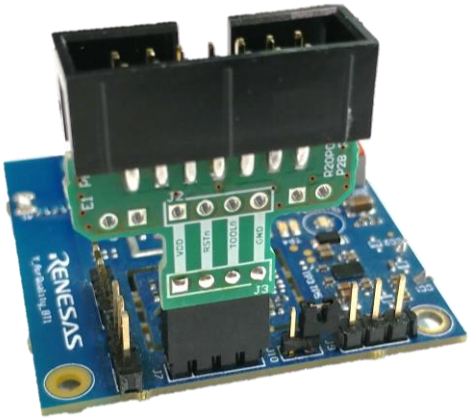

Figure 26: Board connection

Figure 27 shows the schematic of the programming adapter which is required to connect the EU045 board to a standard Renesas E1/E2 emulator.

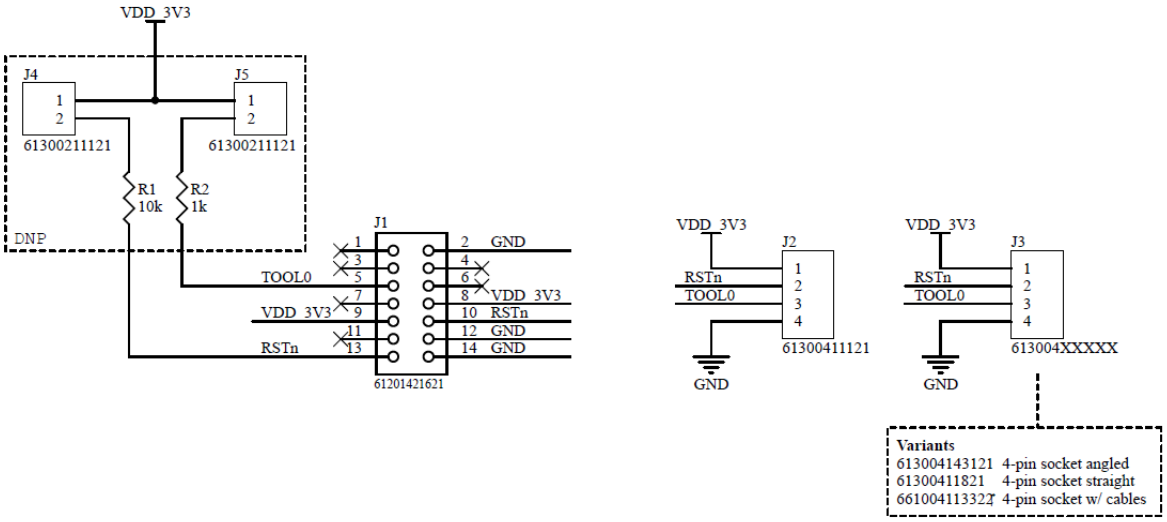

Figure 27: RL78/G13 Adapter schematic.

Refer to [11] for more information.

8. Certifications

The EU045 Air Quality Sensor Solution Kit complies with the laws and regulations described below.

8.1 Europe CE

Hereby, Renesas Electronics Europe GmbH, declares that the EU045 Air Quality Sensor Solution Kit (Y-EU045-BLUEPUCK-1 / Y-EU045-GREENPUCK-1 / Y-EU045-YELLOWPUCK-1) is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.

References

[1] Renesas Electronics, “EU045 – Software User’s Guide” – R30AN0367ED0200.

[2] Renesas Electronics, “EU045 – Quick Start Guide” – R30QS0003ED0200.

[3] Renesas Electronics, “RA4W1 - User’s Manual: Hardware” Mar. 2020 - R01UH0883.

[4] Renesas Electronics, “RL78/G13 - User’s Manual: Hardware” Jun. 2020 - R01UH0146.

[5] Renesas Electronics (IDT), “HS300x Datasheet - High Performance Relative Humidity and Temperature Sensor”, Aug. 6, 2018.

[6] Renesas Electronics, “ISL29020 Datasheet - A Low Power, High Sensitivity, Light-to Digital Sensor With I2C Interface”, Rev 1.00 Aug. 20, 2009.

[7] Renesas Electronics (IDT), “ZMOD4410 Datasheet - Gas Sensor Module for TVOC and Indoor Air Quality”, Jul. 30, 2019.

[8] Renesas Electronics (IDT), “ZMOD4510 Datasheet - Gas Sensor Module for Outdoor Air Quality”, Sep. 9, 2019.

[9] Renesas Electronics (IDT), “ZMOD4450 Datasheet - Gas Sensor Module for Refrigeration Air Quality”, Oct. 30, 2019.

[10] Renesas Electronics, “RL78 Microcontrollers (RL78 Protocol A) Programmer Edition”, Nov. 7, 2011 - R01AN0815EJ0100.

[11] Renesas Electronics, “E1/E20/E2 Emulator, E2 Emulator Lite - Additional Document for User’s Manual - (Notes on Connection for RL78)”, Jul. 2020 - R20UT1994EJ0702.

Revision History

Rev.	Date	Description	
		Page	Summary
0.01	24 Sep 2020		Initial version.
0.02	09 Nov 2020		First revision after Renesas comments.
0.8	07 Dec 2020		Release Candidate.
1.00	25 Jan 2021		Second revision after Renesas comments.
1.10	07 Dec 2021		Added note about ambient light sensor not assembled anymore. Added power consumption section.
2.00	22 Dec 2021		Editorial changes

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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(Rev.4.0-1 November 2017)

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Overview

EU045 is an Air Quality and Environmental Sensors Evaluation Kit.

Three device variants are available, depending on U4 assembled component, i.e.:

- Y-EU045-BLUEPUCK-1 -> U4 = ZMOD4410
- Y-EU045-GREENPUCK-1 -> U4 = ZMOD4510
- Y-EU045-YELLOWPUCK-1 -> U4 = ZMOD4450

Revision History

R1.0
- Project created and released for prototyping

R1.1
- Battery connector fixed
- On-board RL78 TOOL0 pull-up added
- Battery charger status disconnected from RL78 (monitoring based on charger VOUT)
- RGB LED w/ independent color introduced
- R24 changed from 270k to 100k

Manufacturing / Mechanical

RELOC

Renesas

FM1 FM2

FM3 FM4

FM5 FM6

Notes

Title: **BLE Air-Quality Sensor (Y-EU045-xxxxxPUCK-1)**		
Section: Overview		
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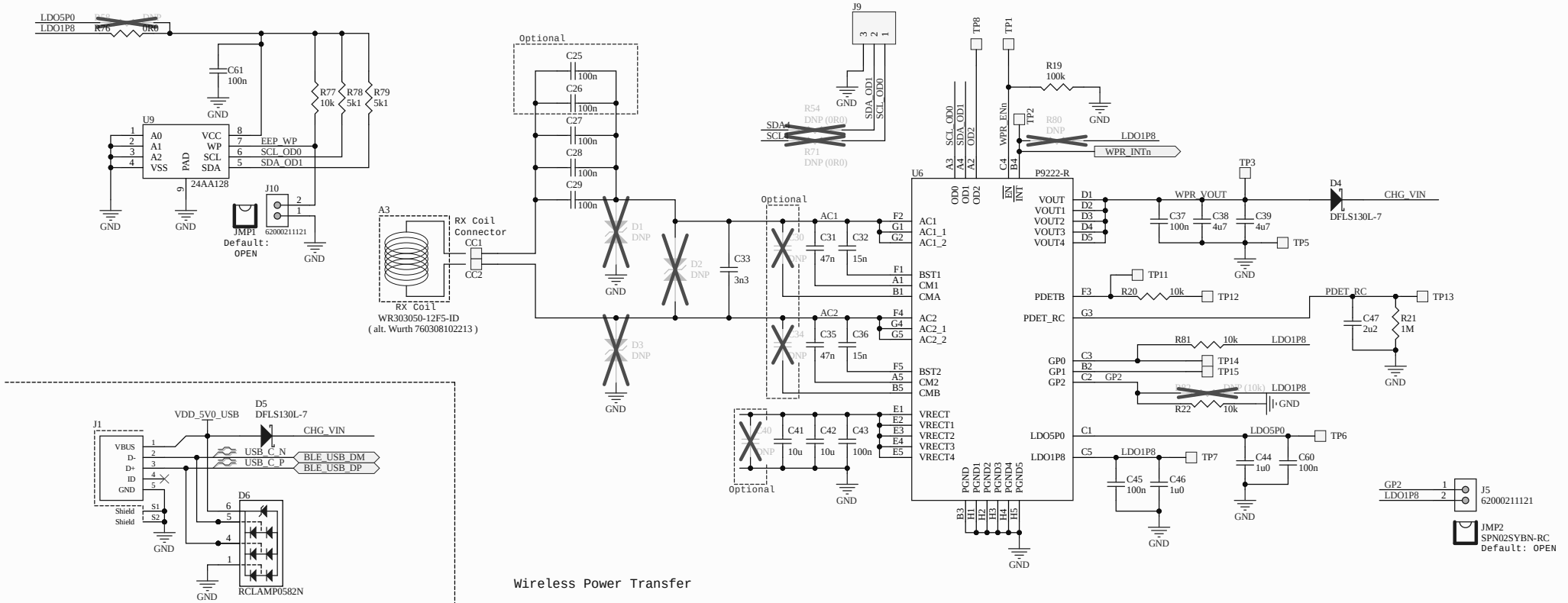
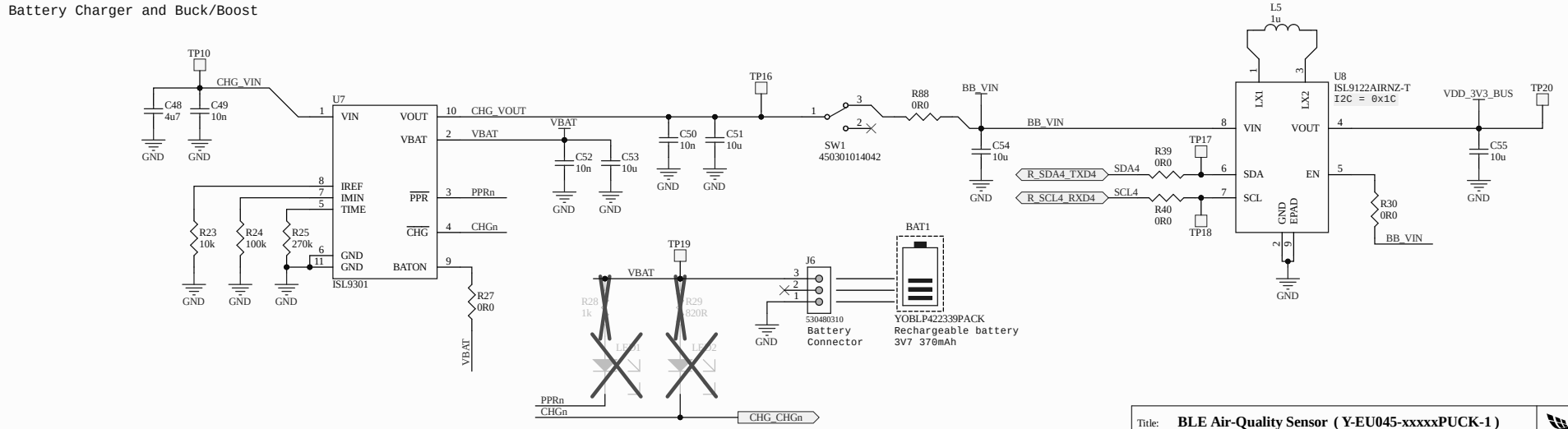
Date: 22/12/2021 Time: 15:11:52		Sheet 1 of 5
File: 01_Overview.SchDoc		

RELOC
RELOC s.r.l.
Strada Langhirano 264/3A
43124 Parma
Italy (www.reloc.it)
PIVA IT02510020346



Wireless Power Transfer

Battery Charger and Buck/Boost



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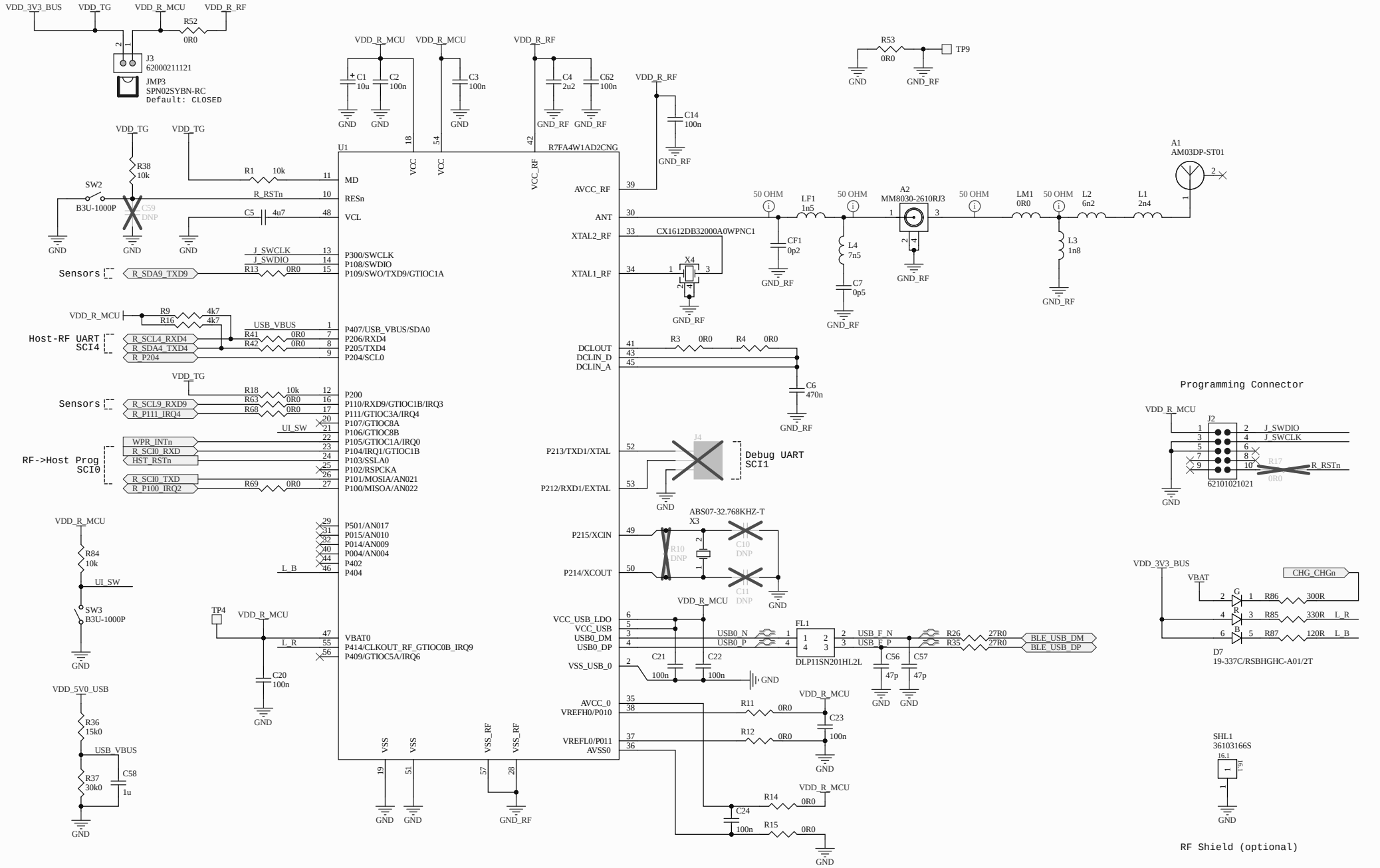

BLE 5.0 System-on-Chip

Title:	**BLE Air-Quality Sensor (Y-EU045-xxxxxPUCK-1)**		
Section:	SoC BLE		
Size: A3	Project code: R20P01P0A	Revision: R1.1	
Date: 22/12/2021	Time: 15:11:53	Sheet 3 of 5	
File: 03_BLE_SoC.SchDoc			

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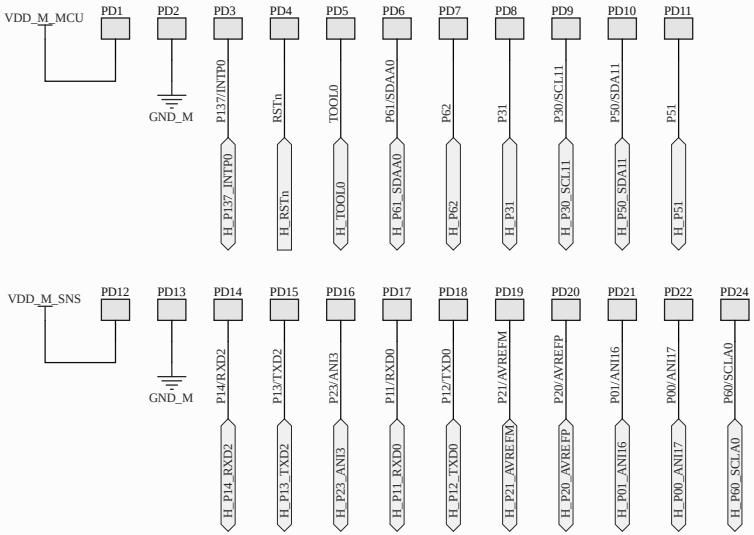
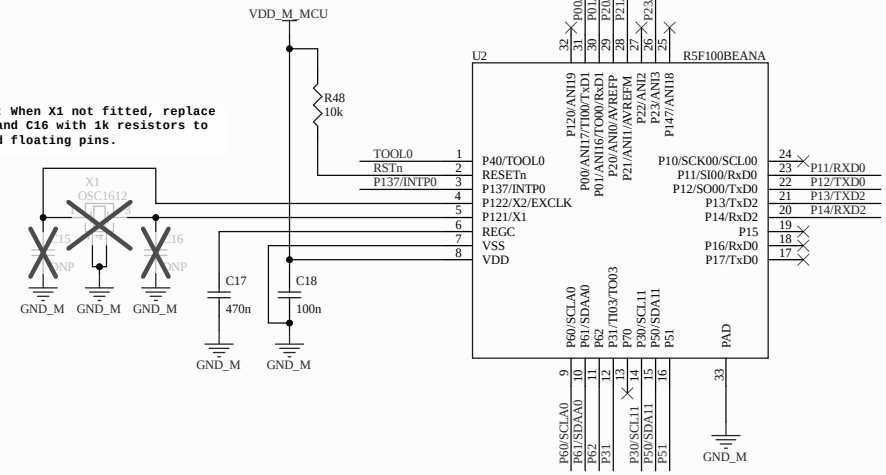
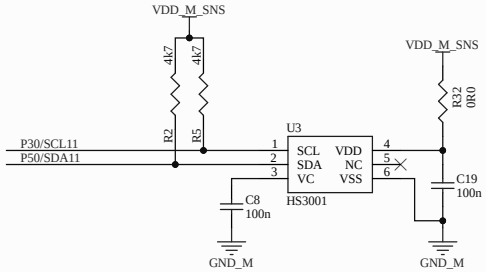


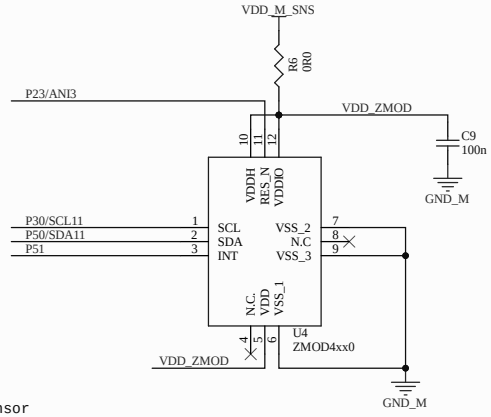
MCU/Sensors Module Pads

Host MCU



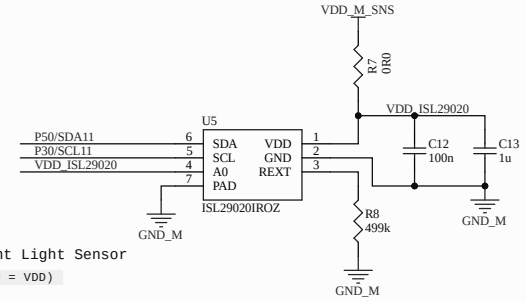


HS3001
Temperature and Humidity Sensor
`I2C = 0x44`



Air Quality Sensor
Assembly options

`ZMOD4410`	`indoor air quality`	`I2C = 0x32`	`-> Model Y-EU045-BLUEPUCK-1`
`ZMOD4510`	`outdoor air quality`	`I2C = 0x33`	`-> Model Y-EU045-GREENPUCK-1`
`ZMOD4450`	`refrigeration air quality`	`I2C = 0x32`	`-> Model Y-EU045-YELLOWPUCK-1`



ISL29020
Digital Ambient Light Sensor
`I2C = 0x45  (A0 = VDD)`

Title:	**BLE Air-Quality Sensor (Y-EU045-xxxxxPUCK-1)**		
Section:	Module MCU/Sensors		
Size: A3	Project code: R20P01P0A		Revision: R1.1
Date: 22/12/2021	Time: 15:11:53		Sheet 4 of 5
File:	04_Module_MCU_Sensors.SchDoc		

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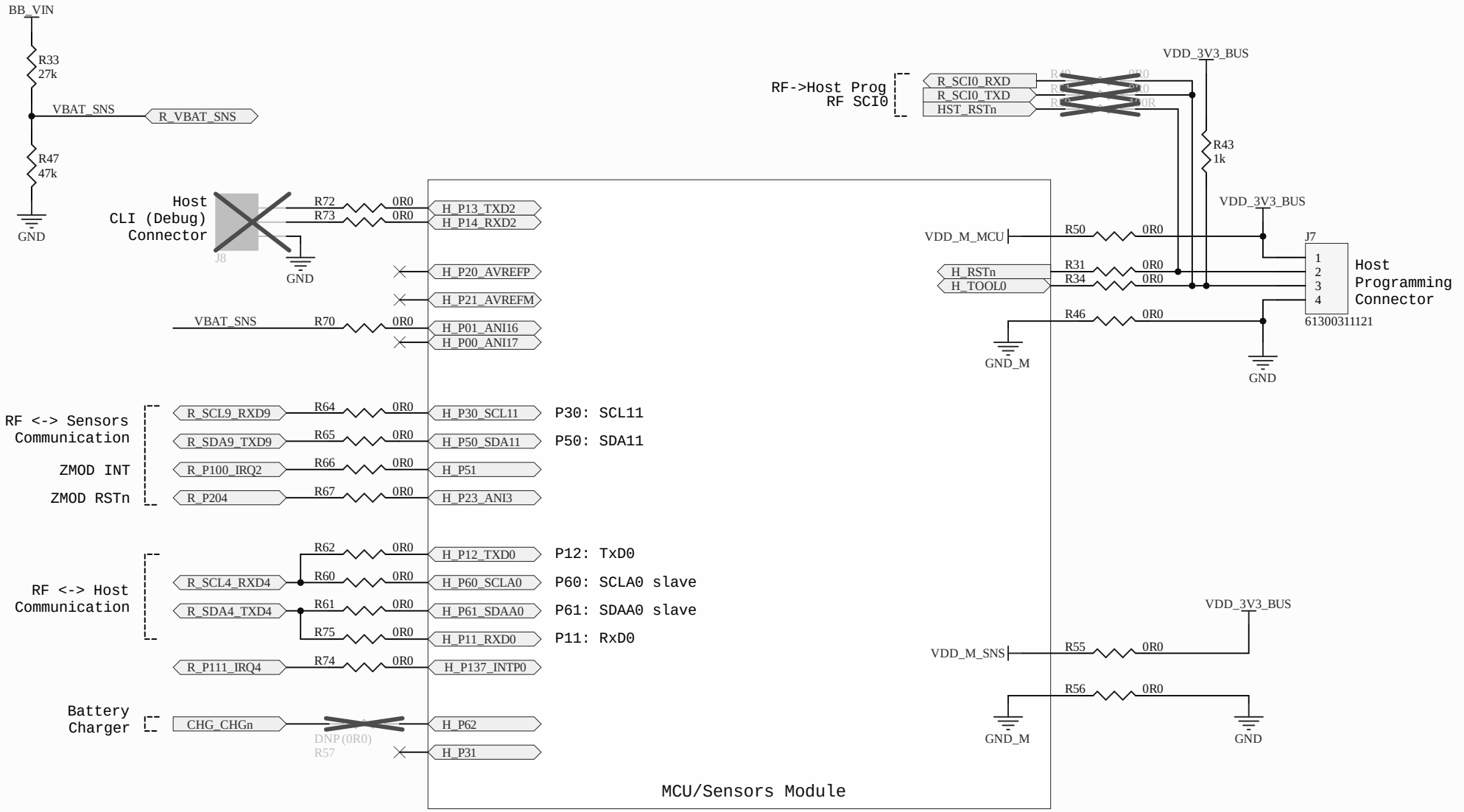

Title: **BLE Air-Quality Sensor (Y-EU045-xxxxxPUCK-1)**		
Section: Module to Puck		
Size: A4	Project code: R20P01P0A	Revision: R1.1
Date: 22/12/2021 Time: 15:11:53		Sheet 5 of 5
File: 05_Module_to_Puck.SchDoc		

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