USER MANUAL

MINI EV-BOARD FOR RADIO MODULES THYONE-I, PROTEUS-III(-SPI), SETEBOS-I

26110110240x0, 2611011021000

VERSION 1.4

OCTOBER 21, 2024

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

****

MUST READ

Check for firmware updates

Before using the product, make sure you use the most recent firmware version, data sheet, and user manual. This is especially important for Wireless Connectivity products that were not purchased directly from Würth Elektronik eiSos. A firmware update on these respective products may be required.

We strongly recommend including the possibility of a firmware update in the customer system design.

Revision history

Manual version	HW version	Notes	Date
1.0	1.0	• Initial version	October 2020
1.1	1.0	• Order number is updated in the schematic `3.7`. • Bill of materials is added in chapter `3.9`. • LFXO crystal part number is updated in chapter `3.6.5`. • Input capacitance variables C_{XC1} and C_{XC2} are changed to C_{XL1} and C_{XL2} respectively `3.6.5`.	January 2021
1.2	1.0	• Added information on Proteus-III-SPI radio module. • Chapter `LFXO crystal` is updated.	February 2021
1.3	1.0	• Added information on Setebos-I radio module. • Corrected JP2 and JP3 in table `6`. • Added footnote in "Supported radio modules" section, mentioning the laser marking modules.	December 2022
1.4	1.0	• Corrected JP2 and JP3 in table `6`. • Chapter `7` is added.	October 2024

Abbreviations

Abbreviation	Name	Description
BDM	Business Development Engineer	Support and sales contact person responsible for limited sales area
Bluetooth LE	Bluetooth Low Energy	
COM port	Communication port	
EV	Evaluation	
ESD	Electro Static Discharge	
FTDI	Future Technology Devices International	
GND	Ground	
HIGH	High signal level	
IO	Input & Output	
JTAG	Joint Test Action Group	
LED	Light Emitting Diode	
LFCLK	Low frequency clock	
LFXO	Low frequency crystal oscillator	
LOW	Low signal level	
NFC	Near Field Communication	
OTA	Over the air	
PC	Personal Computer	
PCB	Printed Circuit Board	
RF	Radio frequency	Describes everything relating to the wireless transmission.
RPS	Radio Protocol Selection	Pin of the Setebos-I module for selection of radio protocol (Proprietary or Bluetooth Low Energy)
SMA	SubMiniature version A	
SPI	Serial Peripheral Interface	
SWD	Serial Wire Debug	
THT	Through-hole technology	
UART	Universal Asynchronous Receiver Transmitter	Universal Asynchronous Receiver Transmitter allows communicating with the module of a specific interface.
USB	Universal Serial Bus	
VDD	Voltage Drain Drain	Supply voltage

Contents

1 Supported radio modules

The EV-Board described in this manual can be used to evaluate the following products:

Order code	Product Name	Description
2611011024000	Proteus-III	Bluetooth® LE 5.1 radio module with smart antenna configuration
2611011024000	Proteus-III-SPI	Variant of the Proteus-III radio module providing a SPI instead of an UART for host connection
2611011021000	Thyone-I	2.4 GHz proprietary radio module with smart antenna configuration
2611011024020	Setebos-I	2.4 GHz combo module Bluetooth® LE & proprietary with smart antenna configuration

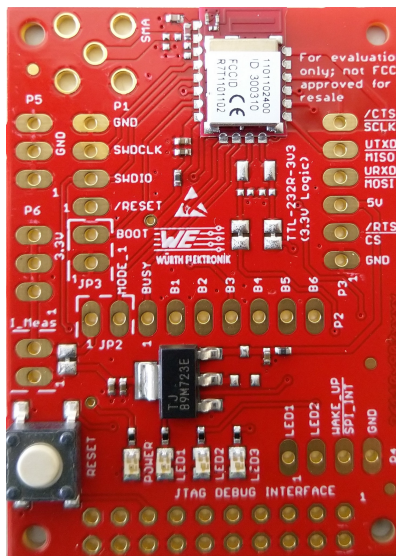| Order code	Product Name
2611069024001	Mini EV-Board Proteus-III [1]
2611119024011	Mini EV-Board Proteus-III-SPI
2611079021001	Mini EV-Board Thyone-I
2611129024021	Mini EV-Board Setebos-I

Table 1: Compatibility

Figure 1: Product image

[1]Please be aware that the mini EV-Board can be delivered with a module containing a label or a laser marking.

Content 2611069024001	Quantity
Mini EV-Board with Proteus-III On-board PCB Antenna connection	1
Packaging: ESD safe cover	1

Table 2: Content Mini EV-Board Proteus-III

Content 2611119024011	Quantity
Mini EV-Board with Proteus-III-SPI On-board PCB Antenna connection	1
Packaging: ESD safe cover	1

Table 3: Content Mini EV-Board Proteus-III-SPI

Content 2611079021001	Quantity
Mini EV-Board with Thyone-I On-board PCB Antenna connection	1
Packaging: ESD safe cover	1

Table 4: Content Mini EV-Board Thyone-I

Content 2611129024021	Quantity
Mini EV-Board with Setebos-I On-board PCB Antenna connection	1
Packaging: ESD safe cover	1

Table 5: Content Mini EV-Board Setebos-I

2 Functional description

The mini EV-Board is an intuitive, application oriented and cost effective version of the EV-Kit. It offers the user the possibility to develop hard- and software for the corresponding radio module.

By default, the mini EV-Board is not assembled with connectors and pin headers. The necessary components shall be assembled by the user based on the need and application.

The mini EV-Board is intended for experienced developers, as additional accessories and basic soldering skills are necessary to take the board into operation.

Accessories required:

- Additional assembly components listed in the table 6.
  Connector kit article number: 699100.

- Soldering equipment

- (optional) TTL-232R-3V3 FTDI cable [1] in case of Proteus-III, Thyone-I or Setebos-I

For the connection to a micro controller or PC the EV-Board is equipped with placeholders for standard 2.54mm headers which is connected to the pins of the radio module. Pin headers can be soldered to the placeholders to access the module pins. Jumpers allow to set the module into defined modes.

In case of Proteus-III, Thyone-I and Setebos-I, the mini EV-Board can be connected to an USB port of a PC using TTL-232R-3V3 FTDI cable.

2.1 Taking into operation - PC (Proteus-III/Thyone-I/Setebos-I only)

To take the mini EV-Board into operation using a PC, additional assembly as described in the chapter 3.2 is necessary.

The corresponding FTDI driver package (*www.ftdichip.com/Drivers/VCP.htm*) has to be installed on the PC.
The installation guidelines shall be followed:
(*https://www.ftdichip.com/Support/Documents/InstallGuides.htm*)

The TTL-232R-3V3 FTDI cable [1] shall be connected to the connector P3 of the EV-Board. It is important that the VDD is stable and able to reliably supply the module's static and peak current consumption as specified by the module manual.

For Setebos-I, the pin B1 on connector P2 assumes the function RPS (Radio Protocol Selection): the logic level on this pin shall be used to determine whether the module should boot the Proprietary firmware (and work as a Thyone-I module) or the Bluetooth Low Energy 5.1 firmware (and work as a Proteus-III module). Please refer to chapter 3.6.7 for further details.

> ⓘ   Incorrect orientation of TTL-232R-3V3 FTDI cable will damage the RF module.

The next step is to connect the EV-Board to the PC using the TTL-232R-3V3 FTDI cable. In that way a COM port can be detected and installed on the PC. In the device manager the COM port name of the TTL-232R-3V3 FTDI cable can be found. A COM port shall appear for example: "COM12" in Windows systems or "/dev/ttyUSB0" in Linux systems.

The WE UART Terminal PC tool [2] or any other serial terminal program (like hterm for Windows) has to be run and the corresponding COM port has to be opened using the default settings of the mounted radio module.

> ⓘ   When taking the Setebos-I module into operation with the WE UART Terminal PC tool, either the Proteus-III or the Thyone-I module has to be selected on the graphical interface, depending on the mode defined through the logic level of the RPS pin.

After the module is powered through the TTL-232R-3V3 FTDI cable or an alternative power supply, the reset button should be pressed to ensure a clean start-up of the module.

The detailed module specific quick start instructions can be found in the corresponding user manuals [3, 4, 5].

2.2 Taking into operation - Host controller

To take the mini EV-Board into operation using a host controller, additional assembly as described in the chapter 3.2 is necessary.

An external power supply shall be connected to the EV-Board. The power supply option 3 or 4 from the table 18 shall be used. It is important that the VDD is stable and able to reliably supply the module's static and peak current consumption as specified by the module manual.

The next step is to connect the communication lines of the module to the host controller. The headers P1, P2 and P3 can be used to connect the module pins and host.

For Setebos-I, the pin B1 on connector P2 assumes the function RPS (Radio Protocol Selection): the logic level on this pin shall be used to determine whether the module should boot the Proprietary firmware (and work as a Thyone-I module) or the Bluetooth Low Energy 5.1 firmware (and work as a Proteus-III module). Please refer to chapter 3.6.7 for further details.

The detailed module specific quick start instructions can be found in the corresponding user manuals [3, 4, 5] .

Feel free to check our YouTube channel for video tutorials, hands-ons and webinars relating to our products:
www.youtube.com/user/WuerthElektronik/videos

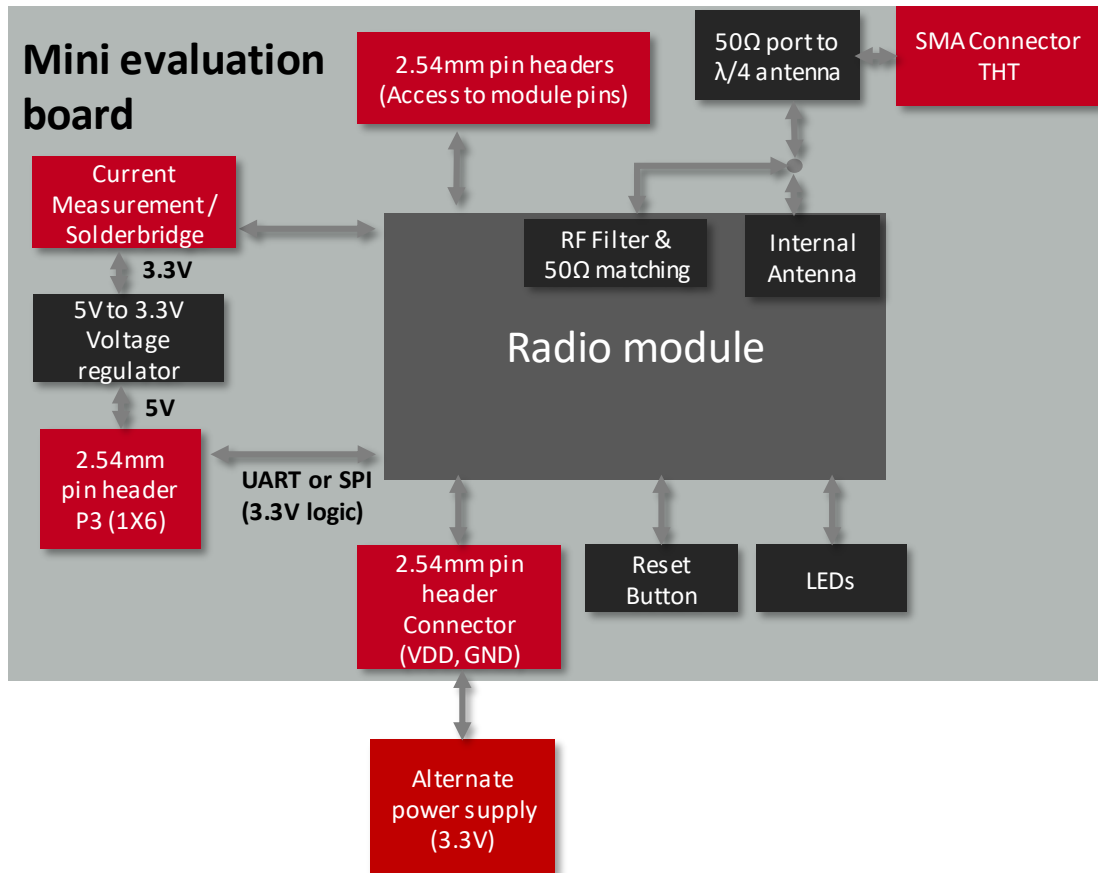# 3 Development board

3.1 Block diagram

Figure 2: Block diagram
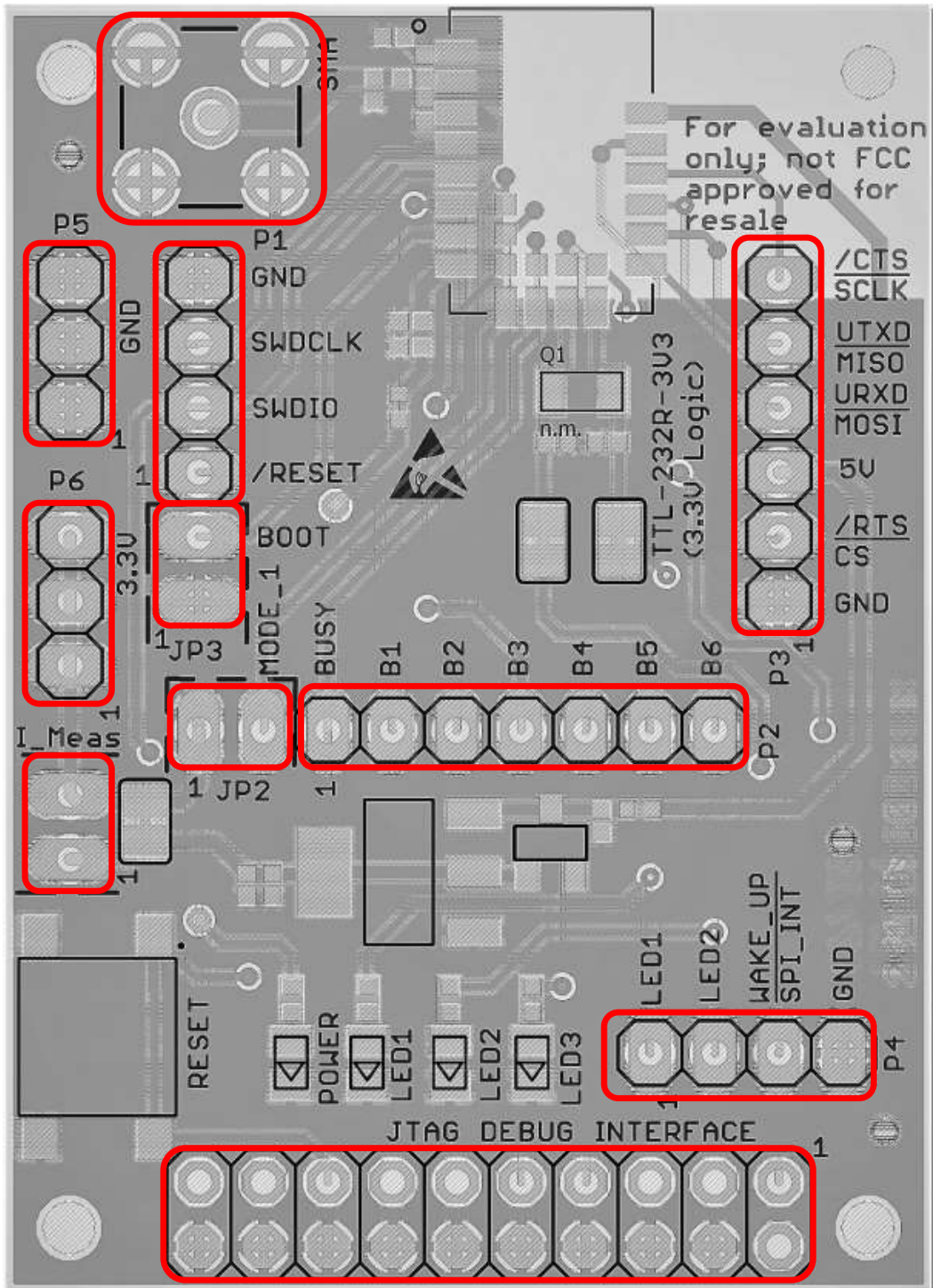
3.2 Additional assembly

Figure 3: Additional assembly

The table 6 lists the additional assembly components for the EV-Board. All the components listed in the table 6 are THT components.

Placeholder	Function	Pins	WE Article Number
I_Meas	Current measurement	1X2	*61300211121*
JP2	Operation mode set	1X2	*61300211121*
JP3	Boot mode set	1X2	*61300211121*
JTAG	JTAG Debug interface	2X10	*61302021121*
P1	Access to module pins	1X6	*61300611121*
P2	Access to module pins	1X7	*61300711121*
P3	TTL-232R-3V3 FTDI cable connection / Access to module pins	1X6	*61300411121*
P4	Access to module pins	1X4	*61300411121*
P5	Ground connection	1X3	*61300311121*
P6	3.3 V Connection	1X3	*61300311121*
SMA	External antenna connection	1X4	*60312002114503*
2.54mm Jumpers	I_Meas, JP2, JP3	1X3	*60900213421*

Table 6: Additional assembly components

Connector kit containing all the components listed in the table 6 is available. Connector kit article number: 699100.

STOP Based on the necessity the required components shall be assembled.

! Holes with 2mm diameter on all the four corners are available for Spacer or Standoff connections
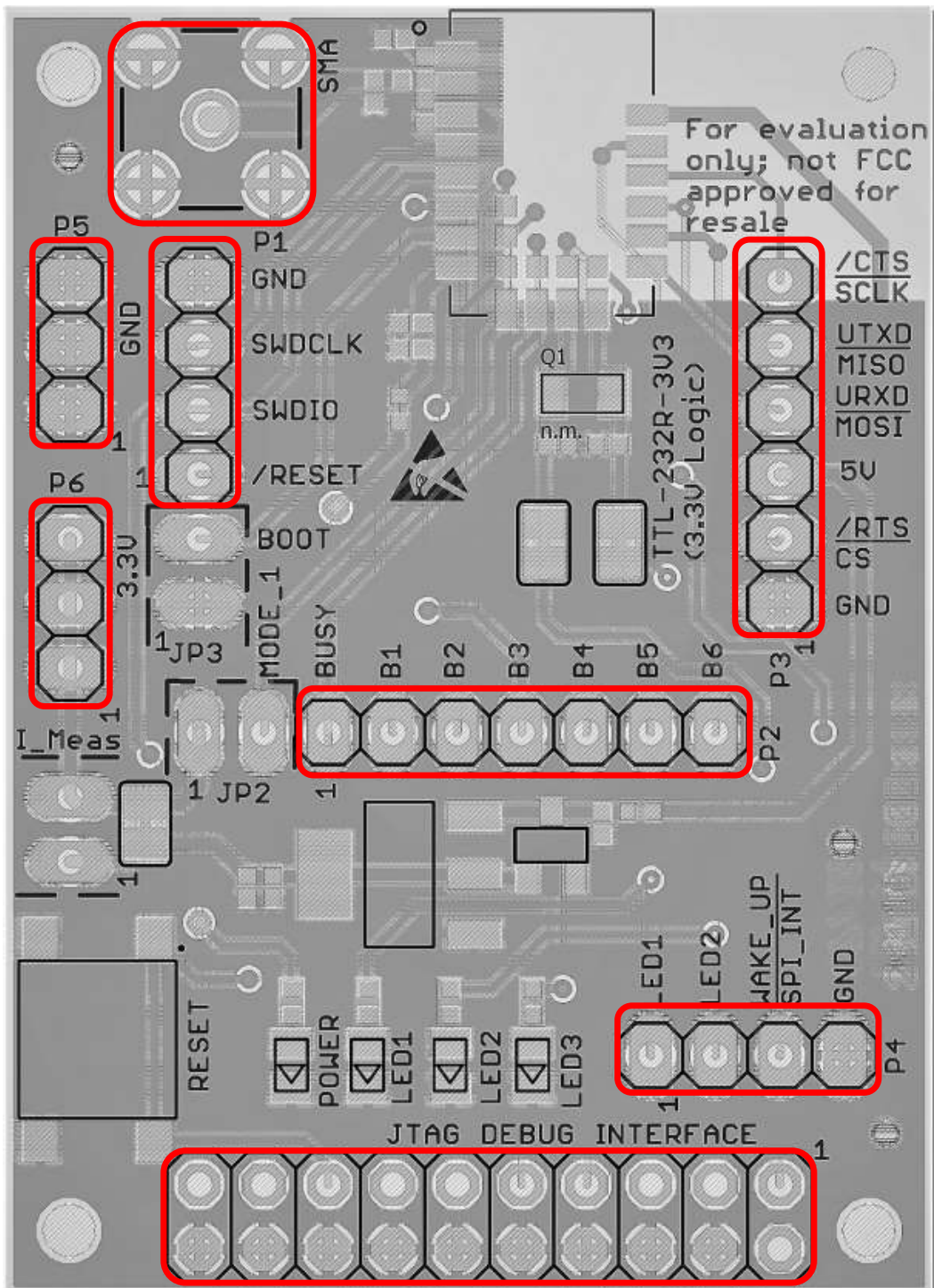
3.3 Connectors and ports

Figure 4: Connectors

3.3.1 P1, P2, P4: Module access pins

P1	nRF52840	Function
1	P0.18	RESET
2	SWDIO	SWDIO
3	SWCLK	SWCLK
4		GND

Table 7: Pin header P1

P2	nRF52840	Function
1	P0.22	BUSY
2	P0.09	B1, RSVD (Proteus-III / Thyone-I) RPS (Radio Protocol Select, Setebos-I)
3	P0.10	B2, RSVD
4	P0.23	B3, RSVD
5	P1.00	B4, RSVD
6	P0.21	B5, RSVD
7	P0.07	B6, RSVD

Table 8: Pin header P2

P4	nRF52840	Function
1	P0.00/XL1	LED1
2	P0.01/XL2	LED2
3	P0.03	WAKE_UP / SPI_INT
4		GND

Table 9: Pin header P4

In case of Setebos-I, the pin B1/RPS on pin header P2 is used to select the radio protocol (Proprietary of Bluetooth Low Energy 5.1)

3.3.2 P3: TTL-232R-3V3 FTDI cable connector

P3	nRF52840	Function
1		GND
2	P0.11	/RTS (SPI_CS)
3		5 V
4	P1.09	URXD (SPI_MOSI)
5	P1.08	UTXD (SPI_MISO)
6	P0.12	/CTS (SPI_SCLK)

Table 10: Pin header P3

> In case of Proteus-III, Thyone-I or Setebos-I, the pin header P3 is used to connect the TTL-232R-3V3 FTDI cable. P3 can also be used for direct host connection.

3.3.3 P5, P6: Alternative power supply connection

P5	Connection
1,2,3	GND

Table 11: Pin header P5

P6	Connection
1,2,3	3.3 V power supply

Table 12: Pin header P6

All the information related to the power supply are described in the chapter `3.6.1`.

3.3.4 JTAG Debugging Interface

JTAG	nRF52840	Function
1		VDD
7	SWDIO	SWDIO
9	SWCLK	SWCLK
15	P0.18	RESET
4,6,8,10,12,14,16,18,20		GND
2,3,5,11,13,17,19		Not Connected

Table 13: JTAG debugging interface

3.3.5 SMA

SMA connector is used to connect an external antenna.
The 2.4 GHz antenna Himalia (2600130021) is a perfect match.

SMA	Connection
Inner	Module RF pin
Outer	4 x GND

Table 14: Pin header SMA

STOP In order to use an external SMA antenna, 22 pF capacitor (0402) on position C1 shall be populated. C2, C8, C11 and C12 should be left unpopulated.

! Optional: Experts have the possibility to use C11, C1 and C8 for additional filtering or fine tuning.
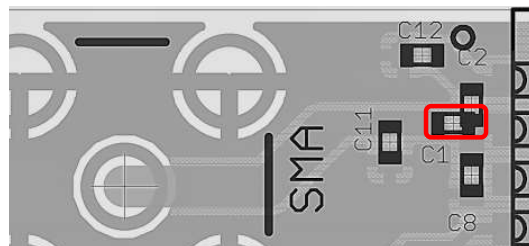

Figure 5: Capacitor connection to external antenna

! In order to use the internal PCB antenna of the module, a 2.4 nH inductor (0402) on position C2 and a 0.3 pF capacitor (0402) on position C12 shall be populated respectively. C1, C8 and C11 should be left unpopulated.
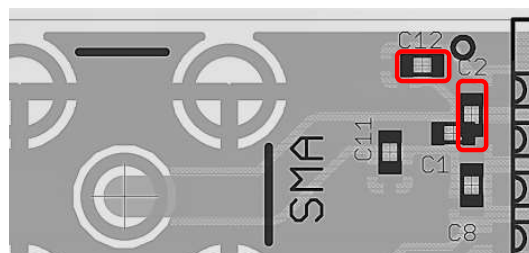
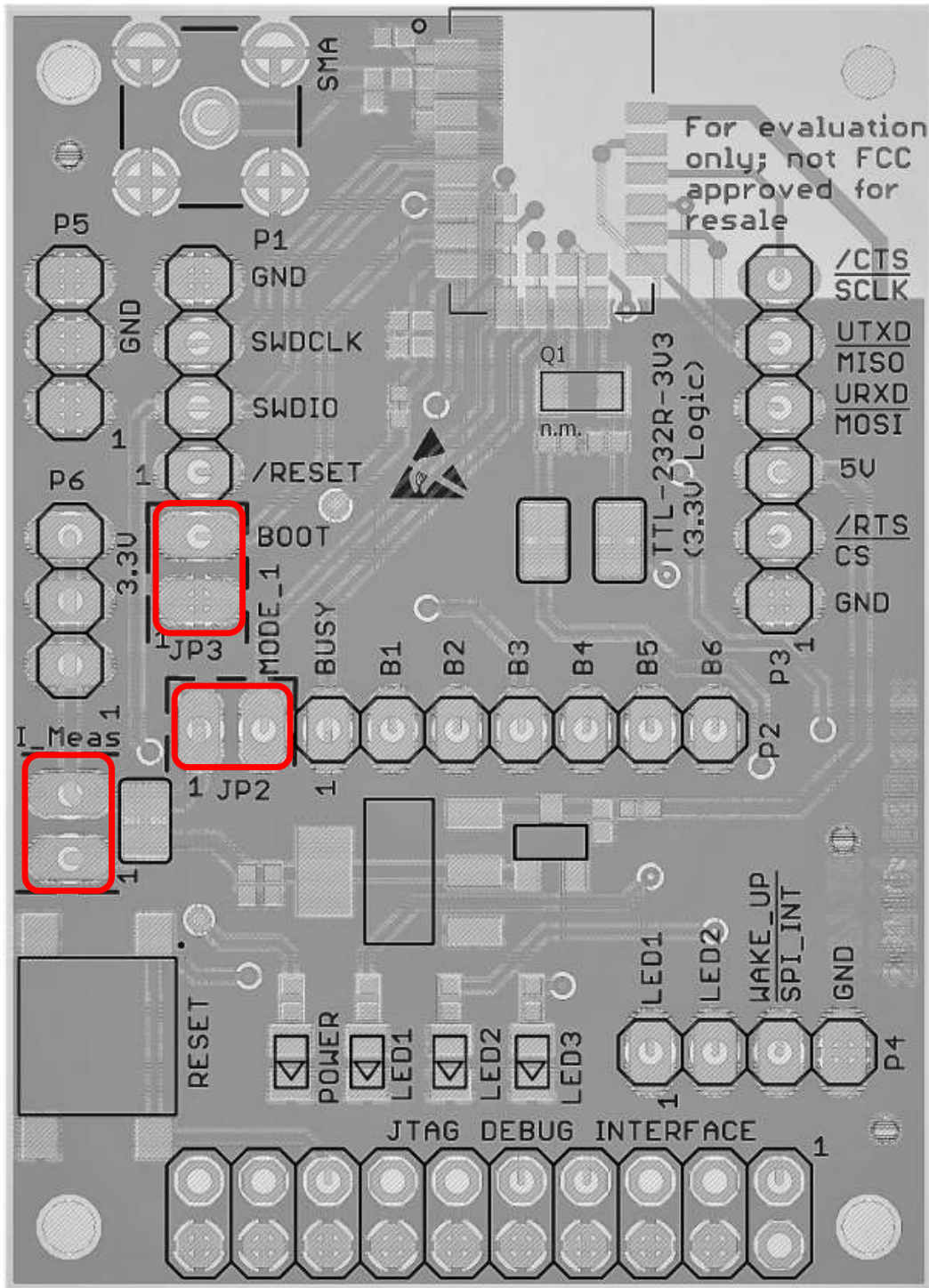Figure 6: Capacitor connection to internal antenna

3.4 Jumpers

Figure 7: Jumpers

3.4.1 I_Meas: Current measurement

By default, I_Meas pin header is not assembled and solder bridge near the I_Meas jumper SJ2 is connected.

The power LED is on the VDD line of the module and shows that the module is sourced. To measure module power consumption and to disconnect the power LED, the resistor R4 shall be desoldered.

If the module is sourced through the P3 connector, the current consumption of the module can be measured on the I_Meas pin header. For this measurement, the solder bridge SJ2 shall be disconnected using a cutter and a current meter shall be connected to the I_Meas pin header. For normal operation a jumper is set on the I_Meas pin header.

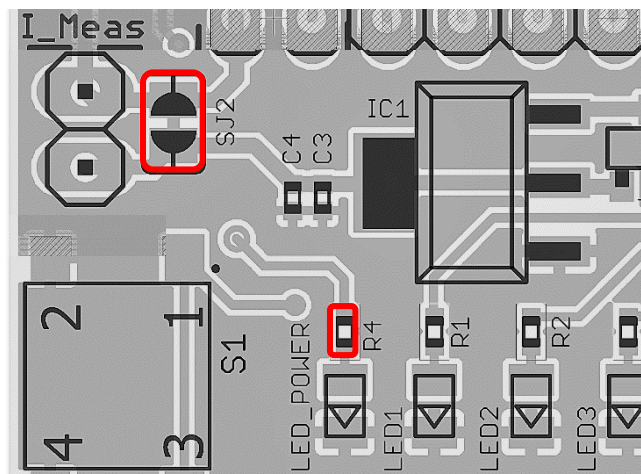| I_Meas	Function
1	3.3 V LDO Output
2	VDD

Table 15: Pin header I_Meas

Figure 8: Current measurement

> **STOP** By default the solder bridge SJ2 is connected. For power consumtion measurement, the solder bridge shall be disconnected using a cutter and resisto R4 shall be desoldered.

Current measurement using I_Meas jumper is possible only if the module is powered through connector P3.

3.4.2 JP2: Operation mode

By default, JP2 is not assembled. If Jumper JP2 is set during power up or reset, the module starts in transparent mode. For command mode operation, JP2 shall be left open during power up or reset.

JP2	nRF52840	Function
1		VDD
2	P0.19	MODE_1

Table 16: Pin header JP2

3.4.3 JP3: Boot mode

By default, JP3 is not assembled. If jumper JP3 is set during power up, the module starts in bootloader mode. For command mode operation the module JP3 shall be left open during power up.

- For Proteus-III (2611011024000) and Proteus-III-SPI (2611011024010) module, bootloader mode allows only over the air (OTA) firmware update.

- For Thyone-I module (2611011021000), bootloader mode allows firmware update only via UART.

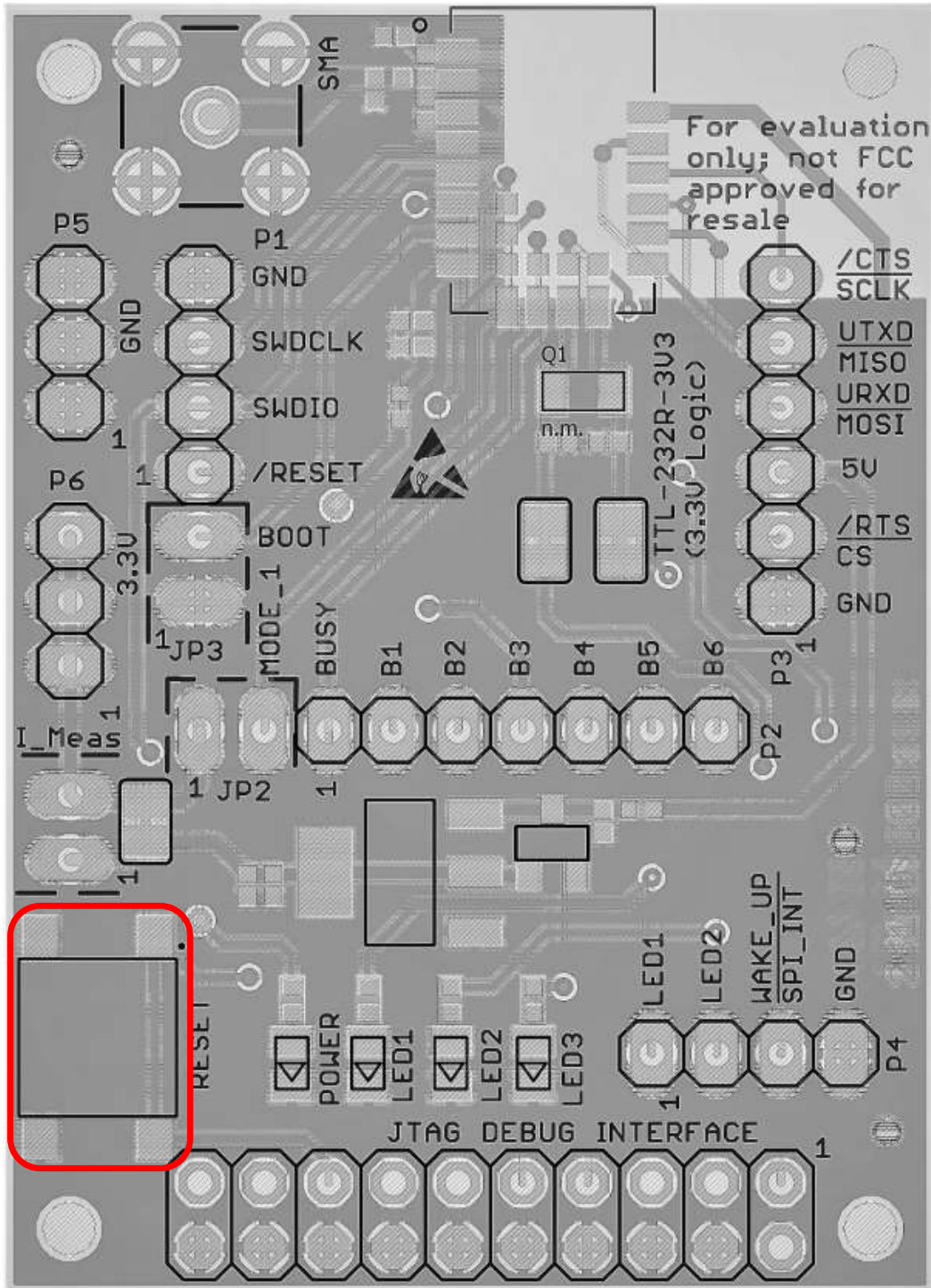| JP3	nRF52840	Function
1		GND
2	P0.02	BOOT

Table 17: Pin header JP3

3.5 Reset button

Figure 9: Buttons

On IC level the active low reset input is configured with a pull up resistor. The module provides a /RESET pin that is connected to this button so that the module can be restarted properly. Please refer to the module specific manual for detailed information [4] [5] [3].

3.6 Function blocks

3.6.1 Power supply

The mini EV-Board can be powered either by TTL-232R-3V3 cable or by an external power supply. The table 18 lists the connection for different power supply options.

Nr.	Power supply	Connector	I_Meas jumper	Solder bridge	I_Meas current meas.	Supported modules
1	TTL-232R-3V3 cable	P3	Open	Connected	No	Proteus-III / Thyone-I / Setebos-I
2	TTL-232R-3V3 cable	P3	Set	disconnected	Yes	Proteus-III / Thyone-I / Setebos-I
3	External supply	P3 Pin-3 (5 V) P3 Pin-1 (GND)	Set	disconnected	Yes	All
4	External supply	P5 (GND) P6 (VDD)	Open	Open	No	All

Table 18: Power supply option

> **STOP** By default solder bridge is connected and pin headers are not assembled.

3.6.1.1 Connector P3, power supply through TTL-232R-3V3

The EV-Board can be sourced by TTL-232R-3V3 cable through P3 connector. TTL-232R-3V3 cable powers the board with 5 V supply. The integrated voltage regulator regulates the connected voltage 5 V down to 3.3 V and supplies the remaining parts of the circuit. If the module is sourced, the power *Power LED* lights up.

3.6.1.2 Connector P3, power supply through external source

The EV-Board can be sourced by an external power supply through the P3 connector Pin-3 (5 V) and P3 Pin-1 (GND). If the module is sourced, the power *Power LED* lights up.

3.6.1.3 Connectors P5 and P6, power supply through external source

The development board can be sourced by an external power supply through the P5 (GND) and P6 (3.3 V) connector. If the module is sourced, the power *Power LED* lights up.

> To use this option I_Meas jumper and SJ2 shall be left open.

3.6.2 UART / USB

The TTL-232R-3V3 cable is used for USB/UART connection between PC and the EV-Board. The IO level of the TTL-232R-3V3 cable is 3.3 V. Using the FTDI-driver the PC will show a virtual COM-Port which can be used to communicate with the module.

3.6.3 UART direct

If a micro-controller is to be connected to the module, use the *P3* connector. The UART of the host can be directly connected to P3 (Pins are labelled on the EV-Board). The module *RXD* line must be handled accordingly by your host (i.e. pulled up while inactive and during module boot-up).
Beware of IO level compatibility. The host must obey the values stated in the module's manual. Especially the IO level restrictions must be implemented by a host system (i.e. using a level shifter to use the allowed IO levels).

3.6.4 SPI direct

If a micro-controller is to be connected to the module, use the *P3* connector and *WAKE_UP/SPI_INT* (*P4* pin 3). The SPI of the host can be directly connected to these pins. For easy orientation the pins are labelled on the EV-Board with its functions.
Beware of IO level compatibility. The host must obey the values stated in the module's manual. Especially the IO level restrictions must be implemented by a host system (i.e. using a level shifter to use the allowed IO levels).

3.6.5 LFXO crystal

For higher LFCLK accuracy (better than ±250 ppm) a low frequency crystal oscillator of 32.768 kHz (LFXO) shall be used. A crystal, 3.2 ×1.6 mm package, for example *830009706*, can be placed on the EV-Board to position Q1. The needed load capacitance can be reached with capacitors C9 and C10, 0402 package.

nRF52840 pin P0.00/XL1 and P0.01/XL12 are connected to module pad LED_1 and LED_2 respectively. If an LFXO is mounted to the EV-Board the solder bridge SJ1 and SJ3 shall be disconnected using a cutter, therefore the LED1 and LED2 function is no longer available.

> For standard firmware the external crystal is not needed. To enable use of the LFXO a custom firmware is required.
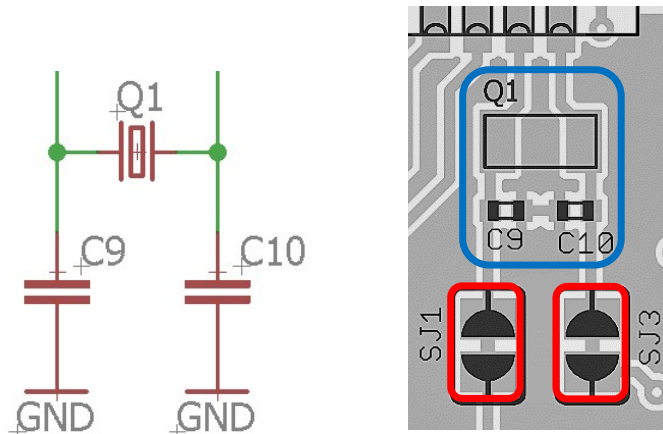
Figure 10: LFXO assembly

STOP By default the LED_1 and LED_2 functions of the module are used.

! To use the LFXO function, the two solder bridges near the LFXO place holder shall be disconnected using a cutter.

The input capacitance of the pad LED_1 and LED_2 are 4 pF. The values of C9 and C10 can be calculated as follows.

The load capacitance of LFXO is given by

$$C_l = \frac{C9_l * C10_l}{C9_l + C10_l} \tag{1}$$

If $C9_l = C10_l$ = C, then

$$C_l = \frac{C}{2} \tag{2}$$

whereas,

$$C9 = C - C_{XL1} - C_{PCB} \tag{3}$$

$$C10 = C - C_{XL2} - C_{PCB} \tag{4}$$

C_l = Load capacitance of LFXO crystal.
C_{XL1} = Input capacitance of Pad LED_1 (4 pF)
C_{XL2} = Input capacitance of Pad LED_2 (4 pF)
C_{PCB} = Parasitic capacitance of PCB Parasitic capacitance of the PCB can vary depending on design and track length. It can vary from 0.5 pF to 2 pF.

For the crystal *830009706* with load capacitance of 9 pF and parasitic capacitance of 2 pF. The value of C9 and C10 results in 12 pF which was also tested on the EV-Board.

Depending on parasitic capacitance of PCB, a capacitance of 12 pF may be a good starting value for C9 and C10.

3.6.5.1 LFXO Design guidelines

1. LFXO shall be placed away from high frequency components and traces.

2. The ground connection for the load capacitor shall be short using ground vias.

3. The crystal shall be placed close to the module.

4. PCB traces between module and the crystal shall be kept short.

5. Load capacitors shall be low leakage and temperature stable (NPO or COG) type.

6. The differential traces shall be kept to the same length.

7. Ground area shall be placed under crystal and connected to the main ground plane.

8. Open traces to the pins shall be avoided to reduce parasitic capacitance and coupling effects.

9. Ground area shall be used between the crystal traces and other PCB traces for better decoupling.

3.6.6 Programming interface

The EV-Board provides a place holder for 2×10 pin connector. It can be used to connect directly to a JTAG flash adapter used for development. Please take care of the correct mounting of the flash adapter. The recommended flash adapter is one of the "Segger J-Link" family.

3.6.7 Radio Protocol Selection (Setebos-I only)

For Setebos-I only, the pin B1/RPS on the connector P2 shall be used to select the radio protocol used by the module.

- A low level during and shortly after reset starts the module with Bluetooth Low Energy 5.1 firmware: the module works as a Proteus-III.

- A high level during and shortly after reset starts the module with Proprietary firmware: the module works as a Thyone-I.

By default, B1/RPS pin is pulled down and the module works therefore as a Proteus-III.
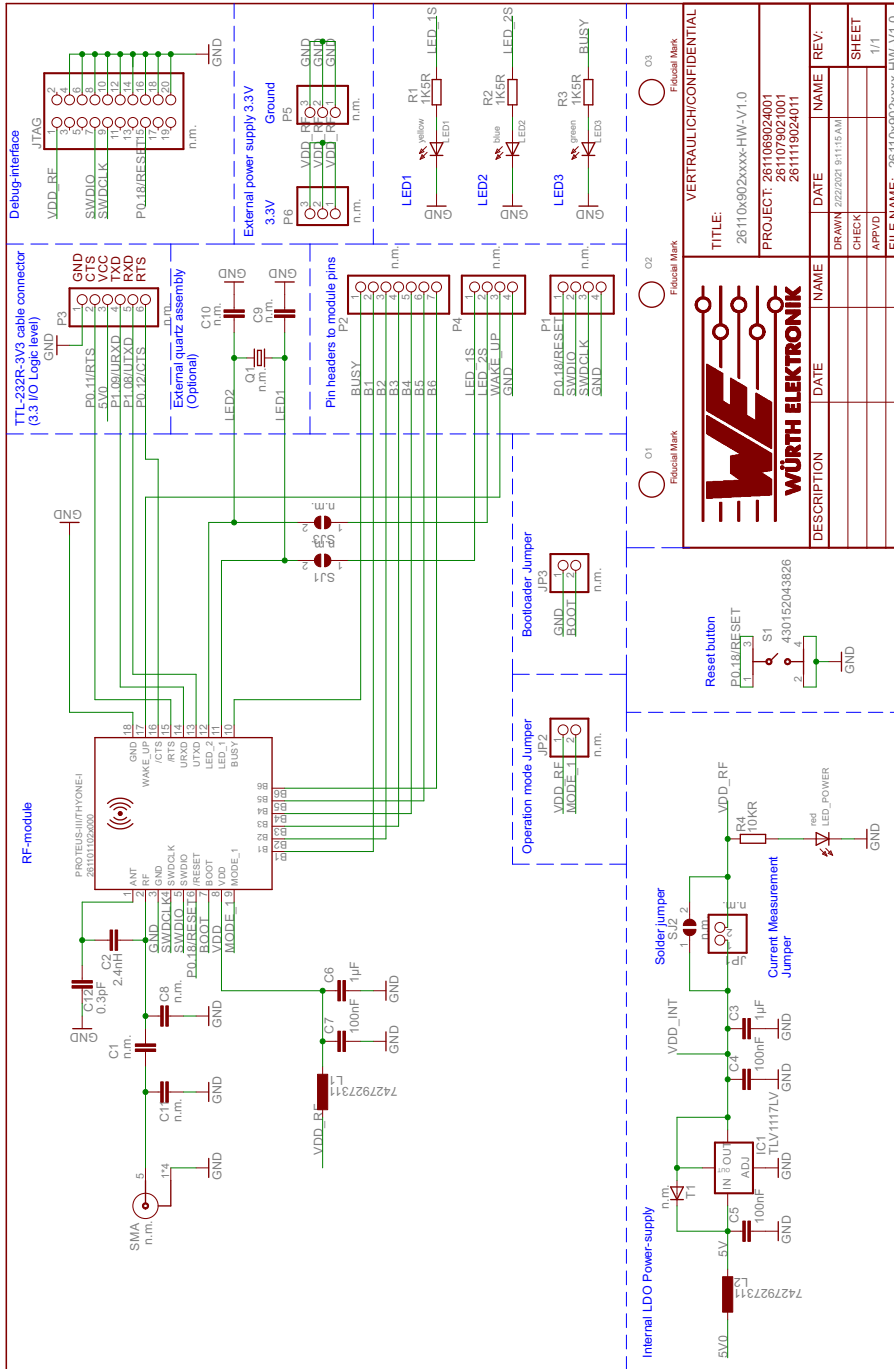
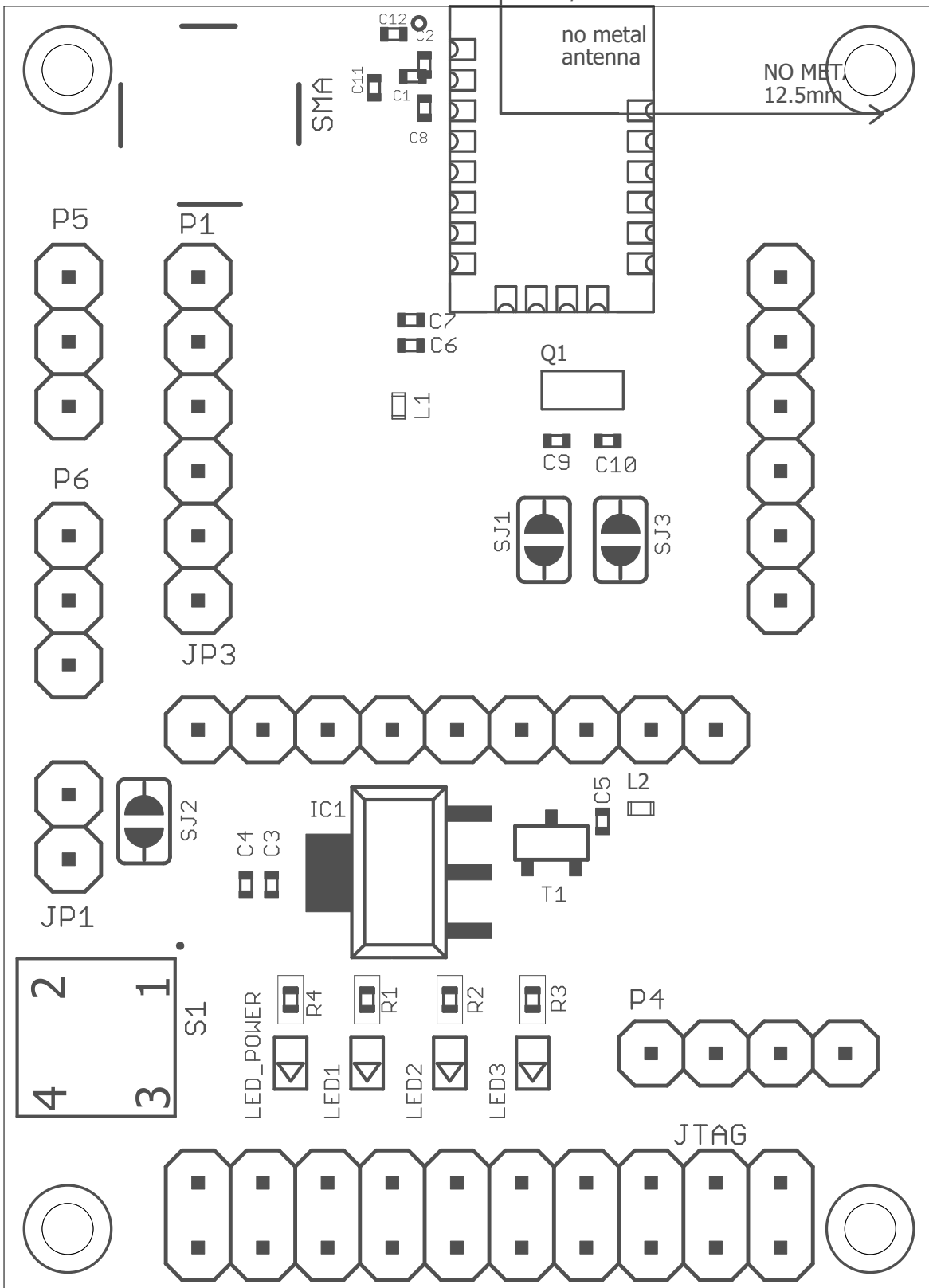## 3.7 Schematic

Figure 11: Schematic sheet
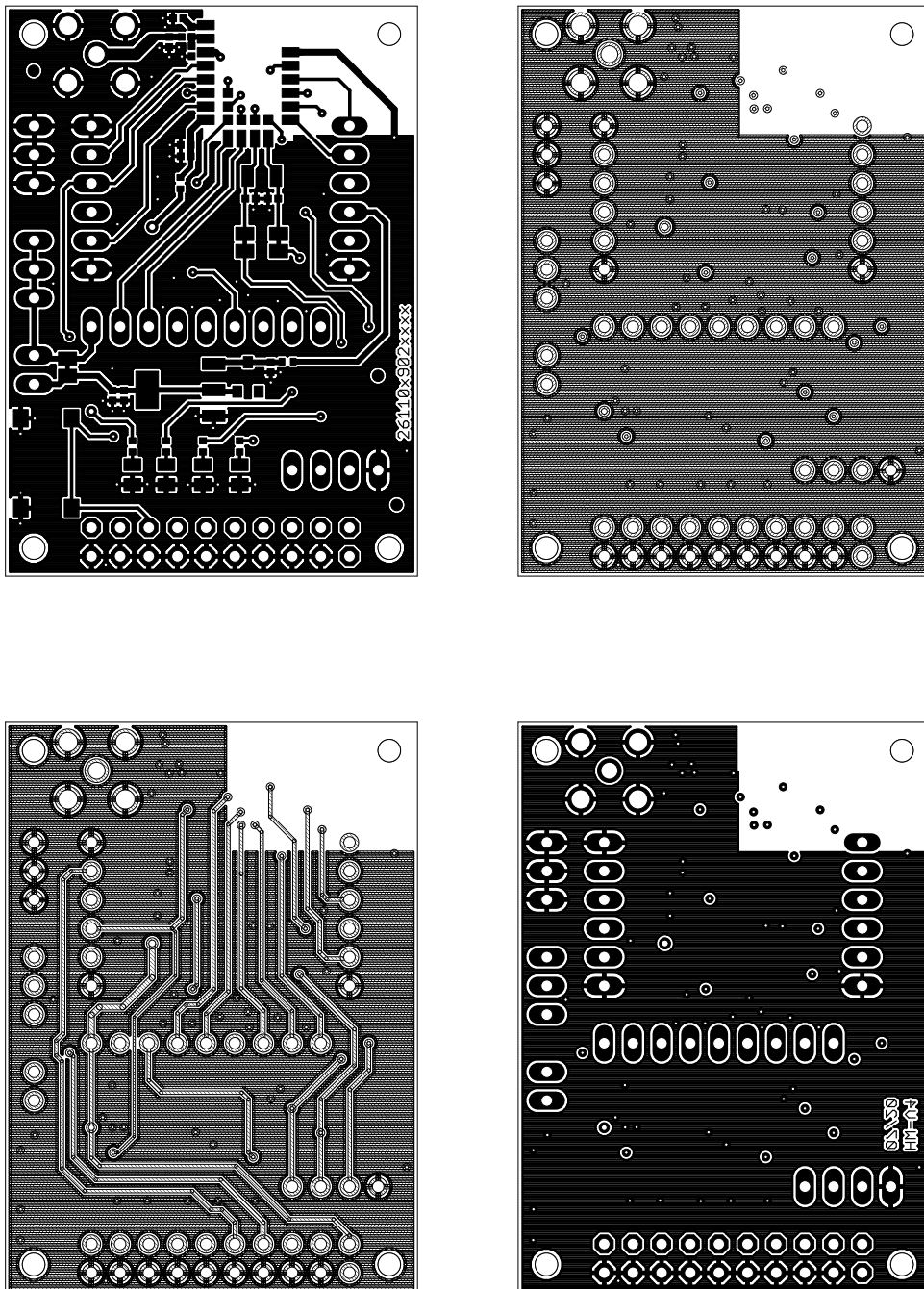
3.8 Layout

Figure 12: Assembly diagram

Figure 13: Top, bottom & internal layers

3.9 Bill of materials

Part	Value	PACK	MANUFACTURER	NR
C1	n.m.	0402		
C2	2.4nH	0402	Würth Elektronik	7447820024
C3	1µF	0402	Würth Elektronik	885012105012
C4	100nF	0402	Würth Elektronik	885012205037
C5	100nF	0402	Würth Elektronik	885012205037
C6	1µF	0402	Würth Elektronik	885012105012
C7	100nF	0402	Würth Elektronik	885012205037
C8	n.m.	0402		
C9	n.m.	0402		
C10	n.m.	0402		
C11	n.m.	0402		
C12	0.3pF	0402	Würth Elektronik	885392005001
IC1	LDO, 3V3		Diodes Incorporated	AZ1117IH-3.3TRG1
			On Semiconductor	NCP1117ST33T3G
			Texas Instruments	TLV1117LV
JP1	n.m.			
JP2	n.m.			
JP3	n.m.			
JTAG	n.m.			
L1	7427927311	0402	Würth Elektronik	7427927311
L2	7427927311	0402	Würth Elektronik	7427927311
LED1	yellow		Würth Elektronik	150080YS75000
LED2	blue		Würth Elektronik	150080BS75000
LED3	green		Würth Elektronik	150080GS75000
LED_POWER	red		Würth Elektronik	150080RS75000
O1	OPT_MARKE			
O2	OPT_MARKE			
O3	OPT_MARKE			
P1	not mounted			
P2	not mounted			
P3	not mounted			
P4	not mounted			
P5	not mounted			
P6	not mounted			
Proteus-III /Thyone-I /Setebos-I	261101102x0x0		Würth Elektronik	261101102x0x0 (EV Board dependant)
Q1	not mounted			
R1	1K5R	0402		
R2	1K5R	0402		
R3	1K5R	0402		
R4	10KR	0402		
S1	430152043826		Würth Elektronik	430152043826
SJ1	not mounted			
SJ2	not mounted			
SJ3	not mounted			
SMA	not mounted		Würth Elektronik	
T1	not mounted			

4 Regulatory compliance information

4.1 European Conformity

Pursuant to Article 1 (2.) of the EU directive 2014/53/EU, Article 1 (2.) the directive does not apply to equipment listed in Annex I (4.): custom-built EV-Kits designed for professionals to be used solely at research and development facilities for such purposes.

4.2 FCC

Pursuant to §2.803 (c) of Title 47 Chapter I Subchapter A Part 2 Subpart I, the EV-Kit falls under the FCC exception. Therefore it is marked as "For evaluation only; not FCC approved for resale".

4.3 Exemption clause

Relevant regulation requirements are subject to change. Würth Elektronik eiSos does not guarantee the accuracy of the before mentioned information. Directives, technical standards, procedural descriptions and the like may be interpreted differently by the national authorities. Equally, the national laws and restrictions may vary with the country. In case of doubt or uncertainty, we recommend that you consult with the authorities or official certification organizations of the relevant countries. Würth Elektronik eiSos is exempt from any responsibilities or liabilities related to regulatory compliance.

Notwithstanding the above, Würth Elektronik eiSos makes no representations and warranties of any kind related to their accuracy, correctness, completeness and/or usability for customer applications. No responsibility is assumed for inaccuracies or incompleteness.

5 References

[1] TTL-232R-3V3 FTDI cable. `https://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS_TTL-232R_CABLES.pdf`.

[2] Würth Elektronik. WE UART Terminal PC tool (Smart Commander). `https://www.we-online.de/wcs-software`.

[3] Würth Elektronik. Setebos-I user manual. `https://www.we-online.de/katalog/de/manual/2611011024020`.

[4] Würth Elektronik. Proteus-III user manual. `https://www.we-online.de/katalog/de/manual/2611011024000`.

[5] Würth Elektronik. Thyone-I user manual. `https://www.we-online.de/katalog/de/manual/2611011021000`.

6 Important notes

The following conditions apply to all goods within the wireless connectivity and sensors product range of Würth Elektronik eiSos GmbH & Co. KG:

General customer responsibility
 Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

Customer responsibility related to specific, in particular safety-relevant applications
 It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. The same statement is valid for all software source code and firmware parts contained in or used with or for products in the wireless connectivity and sensor product range of Würth Elektronik eiSos GmbH & Co. KG. In certain customer applications requiring a high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health, it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

Best care and attention
Any product-specific data sheets, manuals, application notes, PCNs, warnings and cautions must be strictly observed in the most recent versions and matching to the products revisions. These documents can be downloaded from the product specific sections on the wireless connectivity and sensors homepage.

Customer support for product specifications
Some products within the product range may contain substances, which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case, the Business Development Engineer (BDM) or the internal sales person in charge should be contacted who will be happy to support in this matter.

Product improvements
Due to constant product improvement, product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we inform about major changes. In case of further queries regarding the PCN, the Business Development Engineer (BDM), the internal sales person or the technical support team in charge should be contacted. The basic responsibility of the customer as per section 6 and 6 remains unaffected.
All software like ¨wireless connectivity SDK¨, ¨Sensor SDK¨ or other source codes as well as all PC software tools are not subject to the Product Change Notification information process.

Product life cycle
Due to technical progress and economical evaluation, we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this, we cannot ensure that all products within our product range will always be available. Therefore, it needs to be verified with the Business Development Engineer (BDM) or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products. The approach named above does not apply in the case of EV-Boards. EV-Boards may be changed without any notification.

Property rights
All the rights for contractual products produced by Würth Elektronik eiSos GmbH & Co. KG on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with Würth Elektronik eiSos GmbH & Co. KG. Würth Elektronik eiSos GmbH & Co. KG does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which Würth Elektronik eiSos GmbH & Co. KG components or services are used.

General terms and conditions
Unless otherwise agreed in individual contracts, all orders are subject to the current version of the "General Terms and Conditions of Würth Elektronik eiSos Group", last version available at *www.we-online.com*.

7 Terms of Use for Würth Elektronik eiSos GmbH & Co. KG EV-Boards, evaluation kits and evaluation modules

Würth Elektronik eiSos GmbH & Co. KG provide you as a user with technical data (including data sheets), design resources (including reference designs), recommendations for use or other design recommendations, web tools, safety information and other information in the form of evaluation-boards, -kits or -modules (hereinafter jointly referred to as "EVB") in accordance with the terms and conditions contained here. The EVB is provided in the "as is" state. WE disclaims all express and implied warranties, in particular those concerning the suitability for a certain purpose, the absence of defects or non-violation of third-party rights. The EVB is intended for experienced developers to develop

their application with WE components. As a user, you are solely responsible for: (1) selection of the appropriate WE components for the application, (2) design, validation and testing the application, and (3) assurance that the application meets the applicable standards and all other safety requirements and other applicable requirements. WE may change the EVB without prior notice. WE grants you permission to use the EVB only for developing an application suitable for using WE components. Any other duplication, representation or transfer of the EVB is expressly prohibited. WE does not grant any licenses for the use of the intellectual property rights from WE or third parties. WE is fully indemnified from all claims, damages, costs, losses and liabilities arising from the misuse of this EVB The WE components are provided in accordance with WE's conditions of sale or other applicable conditions available either at *https://katalog.we-online.com* or in conjunction with such WE components. WE's provision of the EVB does not constitute an extended warranty in relation to the WE components.

General warnings
Do not touch the EVB when it is live, and allow charged components, such as capacitors, to discharge completely before handling the EVB. Depending on the individual application, high voltages can occur on the EVB and some components can reach temperatures above 50 °C. Even after disconnecting the EVB from the power source, these conditions remain for a significant time. Please ensure that the appropriate safety precautions are taken when installing and operating this EVB, as one of the following may occur if you handle or use this EVB without observing the relevant safety precautions: - Death - Serious injury - Electric shock - Electric burns - Severe heat burns -
When using the EVB, you undertake to read the instructions for use in full together with the relevant information supplied and/or available on the homepage *www.we-online.de/wcs-manuals* before putting this EVB into operation. The following points have to be observed in particular:
• Do not touch the EVB while it is live.
• The EVB must be fully assembled and all devices to be tested must be connected before voltage is applied to the EVB.
• The EVB should never be left unattended during operation.
• Capacitors must be completely discharged. The capacitors must be actively discharged using a suitable resistor.

Protection against static electricity
Use the unpackaged product only in ESD protected areas. Wear the ESD personal protective equipment prescribed for these areas. Ground all conductive components, including personnel, as prescribed in ESD protected areas. Ensure that the product is only used by trained personnel.

Purpose and use
The EVB is not a finished product and is not intended for general use by the consumer. The EVB is intended exclusively for use in the evaluation of WE components in the lab or in development environments by highly qualified technicians or engineers, familiar with the risks involved in handling electrical or mechanical components, systems and subsystems. The use of the EVB is your full and independent responsibility. The EVB is expressly not intended to be installed in a terminal device or to be part of a terminal device in whole or in part. WE reserves the right, at its own discretion, to make corrections, improvements, adjustments or other changes to the EVB or to discontinue the EVB. The EVB is not intended for use in devices and applications for which a higher safety and reliability standard is prescribed. It is also not approved for use in safety-relevant applications or where personal injury or fatal consequences must be expected in the event of failure.

Operation of the EVB
The EVB may only be operated within the specifications and environmental parameters recommended by WE, as described in the instructions for use. Exceeding the specified parameters (including, but not limited to, input and output voltage, current, power, and ambient conditions) may result in damage to property. If you have questions about these electrical parameters, please contact WE at (regulatory-compliance@we-online.com) prior to connecting peripheral electronics (including the input voltage and intended loads). Any load outside a certain power range may lead to negative consequences, including, but not limited to, unintended or inaccurate evaluations or possibly permanent damage to the EVB or the electronics connected to it. Please ensure that the appropriate safety precautions are taken when working with the EVB, as serious injuries, including severe or even fatal injuries from electric shock or electric burns, may occur if you do not follow the appropriate safety precautions. Under no circumstances should the EVB be touched while live. When the EVB is connected to a power source, some of its components are electrically charged and/or have temperatures above 50 °C. This condition also applies for a short time after disconnecting from the supply voltage until the capacitors are completely discharged and hot components have cooled down. These components include connectors, linear regulators, switching transistors, heat sinks, resistors, diodes, inductors and other components, which can be identified from the documentation in the instructions for use. As with all electronic lab work, only qualified persons with knowledge of electronic performance evaluation, measurement and diagnostic tools, should use the EVB.

Hazards and warnings
Before putting the EVB into operation, please read the instructions for use and especially the various hazards and warnings described therein. The instructions for use contain important safety information on voltages and temperatures. You take full responsibility and liability for the proper and safe handling of the EVB. You agree to comply with all safety requirements, rules and regulations related to the use of the EVB. You also take full responsibility for: (1) establishing safeguards to ensure that the use of the EVB does not cause damage to property, personal injury or death, even if the EVB does not function as described, intended or expected, (2) the test setup in which the EVB is integrated, all safety requirements, rules and regulations and also that no damage to property, personal injury or other hazardous situation occurs even if the EVB fails, and (3) ensuring the safety of all activities performed by you or your employees when using the EVB. In particular, this means that the technical rules VDE [German Electrical Engineering, Electronic and Information Technology Association] 0105-100 and BGI [German trade association information] 891 (or corresponding applicable safety regulations outside Germany) for the operation of electrical test setups must be observed, the test area is protected against unauthorized access or accidental touching, current limitations, and emergency stop mechanisms are functional and test setups are never operated unattended. If you have any questions about the safe use of the EVB, please contact WE at *regulatory-compliance@we-online.com* for more information.

Your responsibility with regard to the applicable laws
• You are responsible for being sufficiently informed about and complying with all international, national, state and local applicable laws, rules and regulations that apply to the handling or use of the EVB by you or your employees.
• The EVB generates, uses and radiates radio frequency energy, but has not been tested for conformity with the limits applicable to the product category, which are applicable according to the European Union regulations for protection against radio frequency interference. Operation of the EVB may cause interference with radio communication. In this case, the costs incurred for necessary measures to remedy the interference are to be borne by the user.

As the EVB is not a finished product, it may not comply with applicable regulatory, safety or certification standards that are normally as-

sociated with other products, such as Directive 2011/65/EC of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of hazardous substances and Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). You take full responsibility for compliance with such standards that apply to the EVB. You also take responsibility for the proper disposal of the components and materials of the EVB.

Exclusion of further rights and rights of use for intellectual property of EVB
The sale of an EVB does not constitute the granting by WE of any license or other right of any kind - expressly or implicitly - including, but not limited to, any patent, copyright, trademark or other proprietary rights. All rights from such patent, copyright, trademark or other proprietary rights are expressly reserved by WE. The EVB must not be used in any manner that directly or indirectly infringes any patent, copyright, trademark or other proprietary rights of WE.

Warranty of EVB
WE ensures that the EVB meets the specifications given in the instructions for use (within the deviations stated therein) for a period of 12 months from the date of purchase and functions in accordance with the instructions for use. On the basis of the underlying statutory provisions, WE shall rectify defects or offer free replacement of the EVB to which damage occurs that is evidently attributable to a defect for which WE is responsible and is at fault. A warranty claim is subject to the user having complied with the statutory duties of inspection and notification of defects and that the EVB has been received by WE no later than ten (10) days after expiry of the warranty period. This warranty is not transferable to others. This warranty does not apply to defects or impairments in performance resulting from incorrect use, use contrary to WE's instructions, improper installation, improper operation or misuse. WE accepts no liability whatsoever for the failure of equipment or other items not manufactured by or for WE, including, but not limited to, equipment or items to which the EVB is attached or for which the EVB is used. WE DOES NOT GRANT ANY WARRANTIES OR ASSURANCES WHATSOEVER, EXPRESS OR IMPLIED, WITH RESPECT TO THE EVB, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MARKETABILITY OR SUITABILITY FOR A PARTICULAR PURPOSE.

Limitation of liability for EVB
WE'S OVERALL LIABILITY FOR DAMAGE CAUSED BY WE IS LIMITED TO DAMAGE THAT TYPICALLY OCCURS. WE DOES NOT AC-CEPT ANY LIABILITY FOR LOSS OF PROFIT, CONSEQUENTIAL OR SPECIAL LOSSES, OR SPECIAL, INDIRECT, INCIDENTAL AND CONSEQUENTIAL DAMAGE. HOWEVER, THIS LIMITATION OF LIABILITY DOES NOT APPLY IN THE CASE OF INTENTIONAL OR GROSSLY NEGLIGENT ACTS AND FOR THE DAMAGE RESULTING FROM LOSS OF LIFE, PHYSICAL INJURY, HARM TO HEALTH OR IN CASE OF LEGAL MANDATORY LIABILITY [AS IN GERMAN PRODUCT LIABILITY LAW, ProdHaftG].

8 Legal notice

Exclusion of liability
Würth Elektronik eiSos GmbH & Co. KG considers the information in this document to be correct at the time of publication. However, Würth Elektronik eiSos GmbH & Co. KG reserves the right to modify the information such as technical specifications or functions of its products or discontinue the production of these products or the support of one of these products without any written announcement or notification to customers. The customer must make sure that the information used corresponds to the latest published information. Würth Elektronik eiSos GmbH & Co. KG does not assume any liability for the use of its products. Würth Elektronik eiSos GmbH & Co. KG does not grant licenses for its patent rights or for any other of its intellectual property rights or third-party rights.
Notwithstanding anything above, Würth Elektronik eiSos GmbH & Co. KG makes no representations and/or warranties of any kind for the provided information related to their accuracy, correctness, completeness, usage of the products and/or usability for customer applications. Information published by Würth Elektronik eiSos GmbH & Co. KG regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof.

Suitability in customer applications
The customer bears the responsibility for compliance of systems or units, in which Würth Elektronik eiSos GmbH & Co. KG products are integrated, with applicable legal regulations. Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Würth Elektronik eiSos GmbH & Co. KG components in its applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos GmbH & Co. KG. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. The customer will fully indemnify Würth Elektronik eiSos GmbH & Co. KG and its representatives against any damages arising out of the use of any Würth Elektronik eiSos GmbH & Co. KG components in safety-critical applications.

Trademarks
AMBER wireless is a registered trademark of Würth Elektronik eiSos GmbH & Co. KG. All other trademarks, registered trademarks, and product names are the exclusive property of the respective owners.

Usage restriction
Würth Elektronik eiSos GmbH & Co. KG products have been designed and developed for usage in general electronic equipment only. This product is not authorized for use in equipment where a higher safety standard and reliability standard is especially required or where a failure of the product is reasonably expected to cause severe personal injury or death, unless the parties have executed an agreement specifically governing such use. Moreover, Würth Elektronik eiSos GmbH & Co. KG products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Würth Elektronik eiSos GmbH & Co. KG must be informed about the intent of such usage before the design-in stage. In addition, sufficient reliability evaluation checks for safety must be performed on every electronic component, which is used in electrical circuits that require high safety and reliability function or performance. By using Würth Elektronik eiSos GmbH & Co. KG products, the customer agrees to these terms and conditions.

9 License terms

These License terms will take effect upon the purchase and usage of the Würth Elektronik eiSos GmbH & Co. KG wireless connectivity products. You hereby agree that these license terms are applicable to the product and the incorporated software, firmware and source codes (collectively, "Software") made available by Würth Elektronik eiSos in any form, including but not limited to binary, executable or source code form. The software included in any Würth Elektronik eiSos wireless connectivity product is purchased to you on the condition that you accept the terms and conditions of these license terms. You agree to comply with all provisions under these license terms.

Limited license
Würth Elektronik eiSos hereby grants you a limited, non-exclusive, non-transferable and royalty-free license to use the software and under the conditions that will be set forth in these license terms. You are free to use the provided software only in connection with one of the products from Würth Elektronik eiSos to the extent described in these license terms. You are entitled to change or alter the source code for the sole purpose of creating an application embedding the Würth Elektronik eiSos wireless connectivity product. The transfer of the source code to third parties is allowed to the sole extent that the source code is used by such third parties in connection with our product or another hardware provided by Würth Elektronik eiSos under strict adherence of these license terms. Würth Elektronik eiSos will not assume any liability for the usage of the incorporated software and the source code. You are not entitled to transfer the source code in any form to third parties without prior written consent of Würth Elektronik eiSos.
You are not allowed to reproduce, translate, reverse engineer, decompile, disassemble or create derivative works of the incorporated software and the source code in whole or in part. No more extensive rights to use and exploit the products are granted to you.

Usage and obligations
The responsibility for the applicability and use of the Würth Elektronik eiSos wireless connectivity product with the incorporated firmware in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to you to evaluate and investigate, where appropriate, and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for your respective application or not.
You are responsible for using the Würth Elektronik eiSos wireless connectivity product with the incorporated firmware in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product.
Würth Elektronik eiSos' products with the incorporated firmware are not authorized for use in safety-critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, Würth Elektronik eiSos' products with the incorporated firmware are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. You shall inform Würth Elektronik eiSos about the intent of such usage before design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, you must ensure to have all necessary expertise in the safety and regulatory ramifications of your applications. You acknowledge and agree that you are solely responsible for all legal, regulatory and safety-related requirements concerning your products and any use of Würth Elektronik eiSos' products with the incorporated firmware in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos. YOU SHALL INDEMNIFY WÜRTH ELEKTRONIK EISOS AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WÜRTH ELEKTRONIK EISOS' PRODUCTS WITH THE INCORPORATED FIRMWARE IN SUCH SAFETY-CRITICAL APPLICATIONS.

Ownership
The incorporated firmware created by Würth Elektronik eiSos is and will remain the exclusive property of Würth Elektronik eiSos.

Firmware update(s)
You have the opportunity to request the current and actual firmware for a bought wireless connectivity product within the time of warranty. However, Würth Elektronik eiSos has no obligation to update a modules firmware in their production facilities, but can offer this as a service on request. The upload of firmware updates falls within your responsibility, e.g. via ACC or another software for firmware updates. Firmware updates will not be communicated automatically. It is within your responsibility to check the current version of a firmware in the latest version of the product manual on our website. The revision table in the product manual provides all necessary information about firmware updates. There is no right to be provided with binary files, so called "firmware images", those could be flashed through JTAG, SWD, Spi-Bi-Wire, SPI or similar interfaces.

Disclaimer of warranty
THE FIRMWARE IS PROVIDED "AS IS". YOU ACKNOWLEDGE THAT WÜRTH ELEKTRONIK EISOS MAKES NO REPRESENTATIONS AND WARRANTIES OF ANY KIND RELATED TO, BUT NOT LIMITED TO THE NON-INFRINGEMENT OF THIRD PARTIES' INTELLECTUAL PROPERTY RIGHTS OR THE MERCHANTABILITY OR FITNESS FOR YOUR INTENDED PURPOSE OR USAGE. WÜRTH ELEKTRONIK EISOS DOES NOT WARRANT OR REPRESENT THAT ANY LICENSE, EITHER EXPRESS OR IMPLIED, IS GRANTED UNDER ANY PATENT RIGHT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT RELATING TO ANY COMBINATION, MACHINE, OR PROCESS IN WHICH THE WÜRTH ELEKTRONIK EISOS' PRODUCT WITH THE INCORPORATED FIRMWARE IS USED. INFORMATION PUBLISHED BY WÜRTH ELEKTRONIK EISOS REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE A LICENSE FROM WÜRTH ELEKTRONIK EISOS TO USE SUCH PRODUCTS OR SERVICES OR A WARRANTY OR ENDORSEMENT THEREOF.

Limitation of liability
Any liability not expressly provided by Würth Elektronik eiSos shall be disclaimed.
You agree to hold us harmless from any third-party claims related to your usage of the Würth Elektronik eiSos' products with the incorporated firmware, software and source code. Würth Elektronik eiSos disclaims any liability for any alteration, development created by you or your customers as well as for any combination with other products.

Applicable law and jurisdiction
Applicable law to these license terms shall be the laws of the Federal Republic of Germany. Any dispute, claim or controversy arising out of or relating to these license terms shall be resolved and finally settled by the court competent for the location of Würth Elektronik eiSos registered

office.

Severability clause
If a provision of these license terms is or becomes invalid, unenforceable or null and void, this shall not affect the remaining provisions of the terms. The parties shall replace any such provisions with new valid provisions that most closely approximate the purpose of the terms.

Miscellaneous
Würth Elektronik eiSos reserves the right at any time to change these terms at its own discretion. It is your responsibility to check at Würth Elektronik eiSos homepage for any updates. Your continued usage of the products will be deemed as the acceptance of the change.
We recommend you to be updated about the status of new firmware and software, which is available on our website or in our data sheet and manual, and to implement new software in your device where appropriate.
By ordering a product, you accept these license terms in all terms.

List of Figures

List of Tables

Contact
Würth Elektronik eiSos GmbH & Co. KG
Division Wireless Connectivity & Sensors

Max-Eyth-Straße 1
74638 Waldenburg
Germany

Tel.: +49 651 99355-0
Fax.: +49 651 99355-69
www.we-online.com/wireless-connectivity

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT