

USER MANUAL

FAMILY EVALUATION BOARD FOR
RADIO MODULES OPHELIA-III,
PROTEUS-I, -II, -III, -III-SPI,
SETEBOS-I, THYONE-I

2608011x240x0,
26110110240x0,
2611011021000, 2611011022000

VERSION 1.5

OCTOBER 16, 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	<ul style="list-style-type: none">Initial version	June 2022
1.1	1.0	<ul style="list-style-type: none">Corrected content in chapter 3.6	December 2022
1.2	1.0	<ul style="list-style-type: none">Updated meta data	May 2023
1.3	1.0	<ul style="list-style-type: none">Added the BYOF radio module Ophelia-III	April 2024
1.4	1.0	<ul style="list-style-type: none">Added the BYOF radio module Ophelia-III to the "Supported radio modules" section.	July 2024
1.5	1.0	<ul style="list-style-type: none">UART baudrate information added in chapter 3.6.2.	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	
BYOF	Build Your Own Firmware	Radio module without firmware, to be used to develop custom firmware
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
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1 Supported radio modules

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

Order code	Product name	Description
2608011024000	Proteus-I	Bluetooth® LE 4.2 module - PCB antenna
2608011024010	Proteus-II	Bluetooth® LE 5.0 module - PCB antenna
2611011024000	Proteus-III	Bluetooth® LE 5.1 module - smart antenna configuration ¹
2611011024010	Proteus-III-SPI	Variant of the Proteus-III radio module providing an SPI instead of a UART for host connection
2611011024020	Setebos-I	2.4 GHz combo module Bluetooth® LE & proprietary - smart antenna configuration
2611011021000	Thyone-I	2.4 GHz proprietary radio module - smart antenna configuration
2611011022000	Ophelia-III	BYOF radio module without firmware

Order code	Product Name
2608049024001	Family Board Proteus-I
2608049024011	Family Board Proteus-II
2611149024001	Family Board Proteus-III
2611149024011	Family Board Proteus-III-SPI
2611149024021	Family Board Setebos-I
2611149021001	Family Board Thyone-I
2611149022001	Family Board Ophelia-III

Table 1: Order codes

¹Please be aware that the family board can be delivered with a module containing a label or a laser marking.

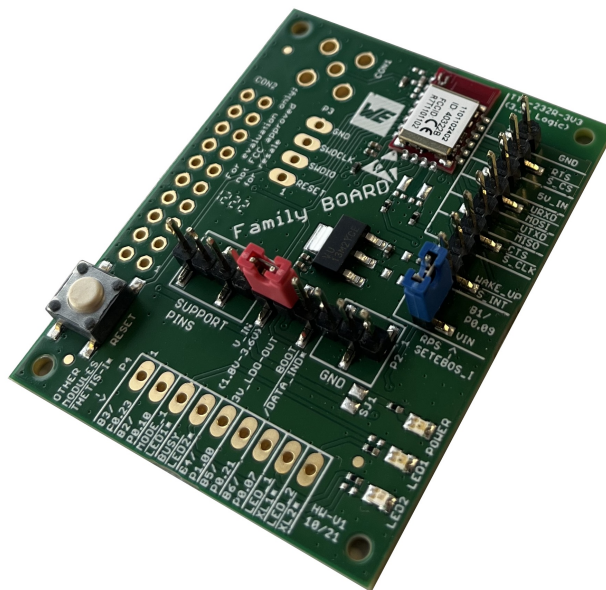


Figure 1: Product image



Note that the Ophelia-III Family Board will contain an RF module with a label. When ordered as a separate module (261101102000), the Ophelia-III will have a laser marking, as shown in the picture 2.



Figure 2: Ophelia-III laser marking

Content 2608049024001	Quantity
Family Board with Proteus-I integrated PCB antenna	1

Table 2: Content Family Board Proteus-I

Content 2608049024011	Quantity
Family Board with Proteus-II integrated PCB antenna	1

Table 3: Content Family Board Proteus-II

Content 2611149022001	Quantity
Family Board with Ophelia-III (label marking) on-board PCB antenna connection	1

Table 4: Content Family Board Ophelia-III

Content 2611149024001	Quantity
Family Board with Proteus-III on-board PCB antenna connection	1

Table 5: Content Family Board Proteus-III

Content 2611149024011	Quantity
Family Board with Proteus-III-SPI on-board PCB antenna connection	1

Table 6: Content Family Board Proteus-III-SPI

Content 2611149024021	Quantity
Family Board with Setebos-I on-board PCB antenna connection	1

Table 7: Content Family Board Setebos-I

Content 2611149021001	Quantity
Family Board with Thyone-I on-board PCB antenna connection	1

Table 8: Content Family Board Thyone-I

2 Functional description

The Family Board is an intuitive, application oriented and cost effective EV board version to evaluate a wide range of Würth Elektronik eiSos radio modules. It offers the user the possibility to develop hard- and software for the corresponding radio module.

By default, the Family Board is assembled with pin headers to take the module into operation. The necessary components shall be assembled by the user based on the need and application.

The Family Board is a balance for both experienced and non-experienced developers, as additional accessories and basic soldering skills are necessary to evaluate all the functions of the radio module.

Out of the box, the board supports minimum test scope. With additional accessories and basic soldering skills it is possible to enlarge test scope of the radio module.

Accessories required to test full scope of the radio module are:

- Additional assembly components listed in the table 9 and soldering equipment
- TTL-232R-3V3 FTDI cable [?]

All pins are available on pads where a pin header can be soldered in. The pins that are needed for minimal pin configuration are available on already equipped headers, e.g. to connect a micro controller or a PC and to set jumpers to choose operating modes of the radio module.

2.1 Taking into operation - PC

To use the TTL-232R-3V3 FTDI cable [?], the corresponding FTDI driver package [?] has to be installed on the PC following the installation guidelines [?].

The TTL-232R-3V3 FTDI cable shall be connected to the pin header P1 of the Family 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. A minimum board supply current of 50mA is necessary.



Incorrect orientation of TTL-232R-3V3 FTDI cable will damage the radio module. For easy orientation, the pin number 1 and signals are labeled.

The next step is to connect the Family 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 [?] 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.

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 the correct functionality of the module.

The detailed module specific quick start instructions can be found in the corresponding radio module user manuals [?, ?, ?, ?, ?, ?].



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 user interface, depending on the jumper setting.

2.2 Taking into operation - Host controller

To take the Family Board into operation using a host controller, the pin header P1 shall be used.

An external power supply shall be connected to the Family Board. The power supply option 3 or 4 from the table 22 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. A minimum board supply current of 50mA is necessary.

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.

The detailed module specific quick start instructions can be found in the corresponding radio module user manuals [?, ?, ?, ?, ?, ?].

3 Development board

3.1 Block diagram

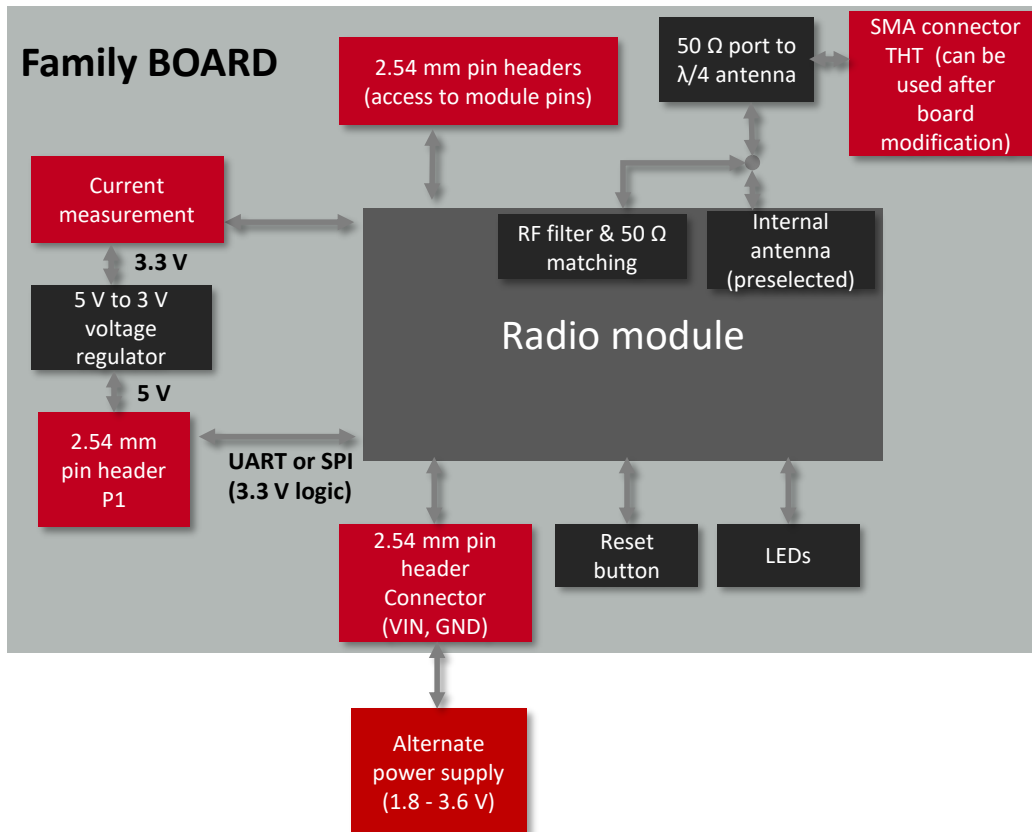


Figure 3: Block diagram

3.2 Additional assembly

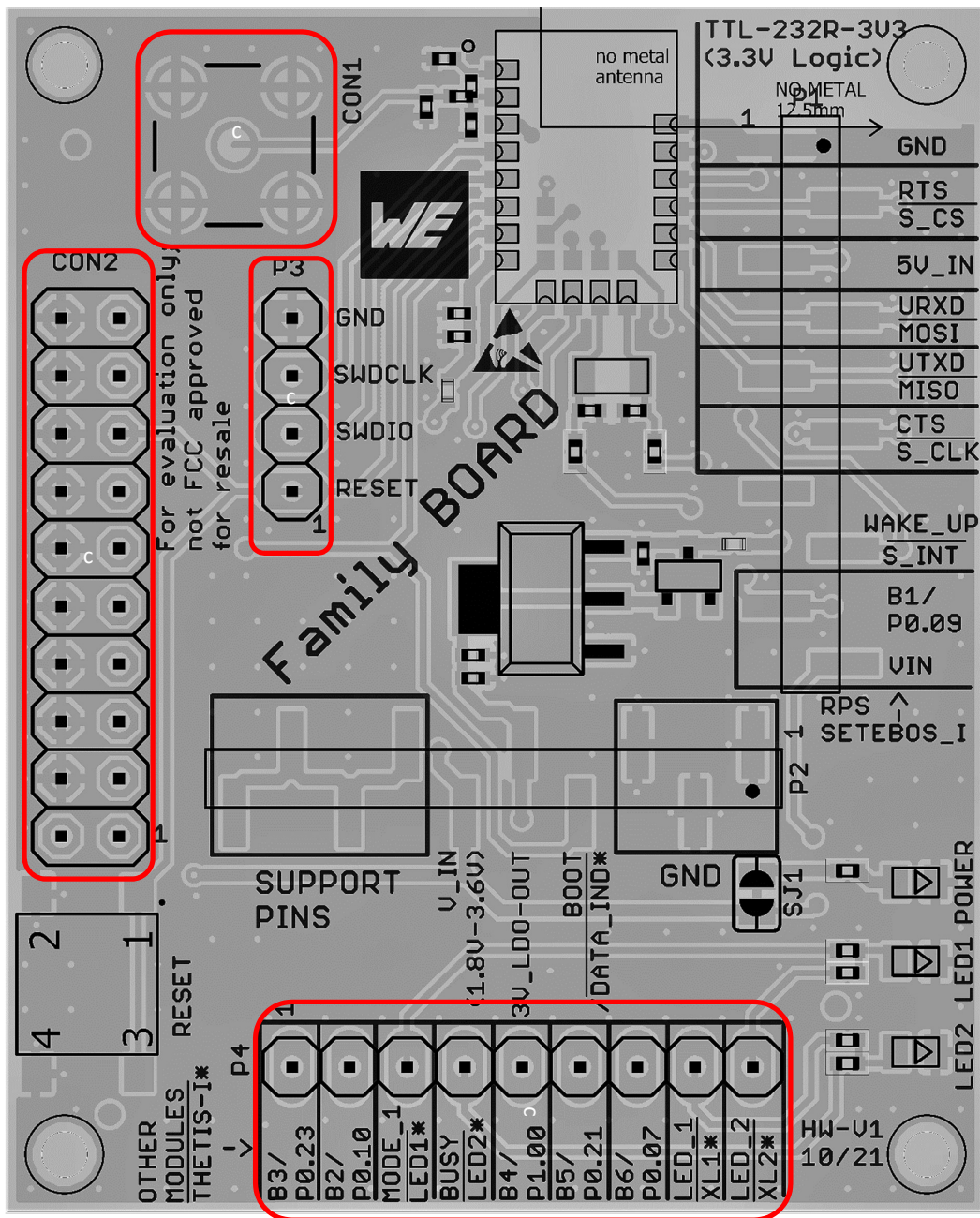


Figure 4: Additional assembly

The table 9 lists the additional assembly components for Family Board. All the components listed in table 9 are THT components.

Placeholder	Function	Pins	WE Article Number
P3	Module debug access pins	1X4	<i>61300411121</i>
P4	Module GPIO access pins	1X9	<i>61300911121</i>
CON1	External antenna connection	5	<i>60312002114503</i>
CON2	Debugging interface	2X10	<i>61302021121</i>

Table 9: Additional assembly components



Holes with 2 mm diameter on all the four corners are available for spacer or standoff connections

3.3 Connectors and ports

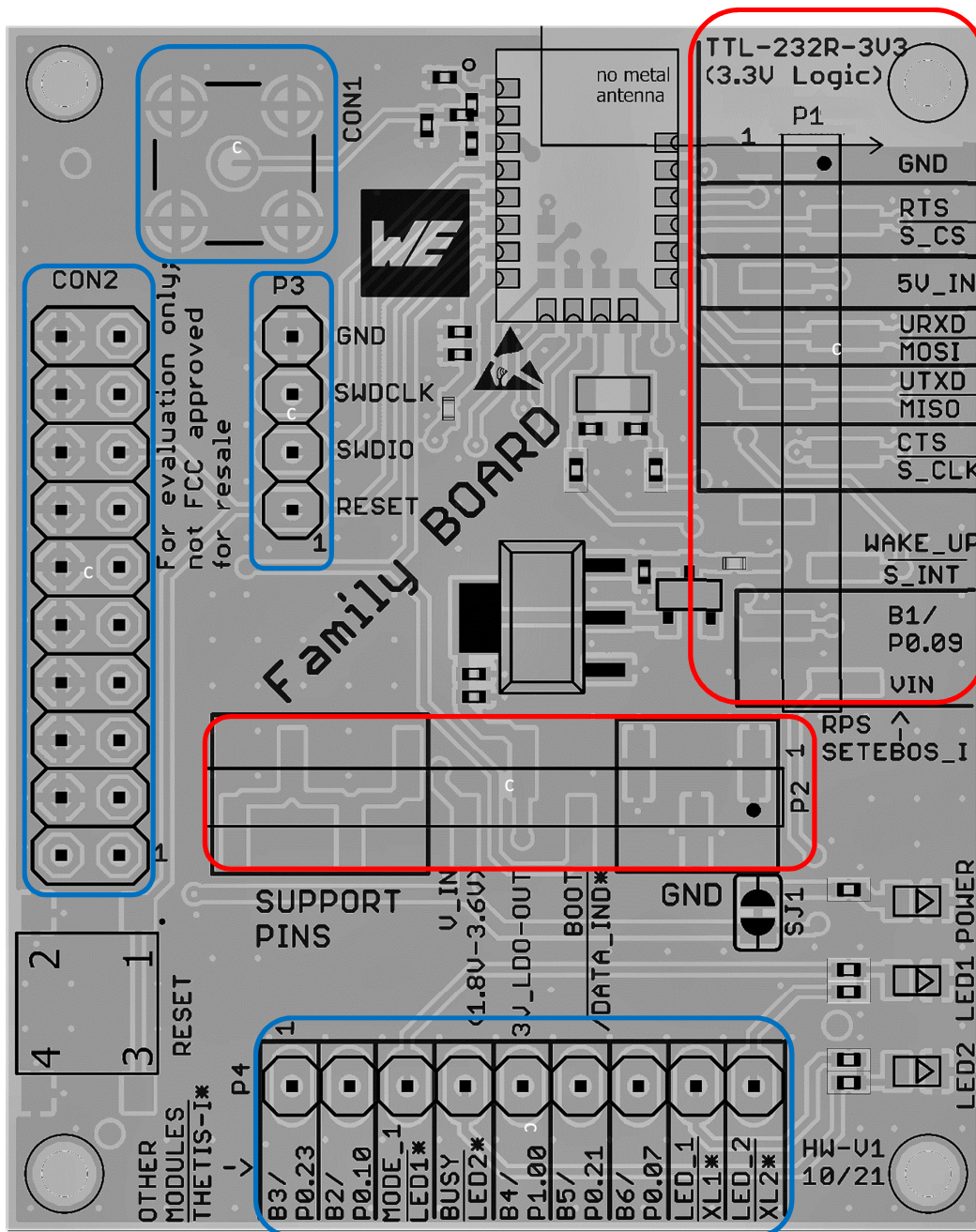


Figure 5: Connectors

3.3.1 P1: Module communication access pins / TTL-232R-3V3 FTDI cable connector**3.3.1.1 Proteus-I, Proteus-II**

P1	nRF52832	Board connection	Proteus-I,-II
1	GND	GND	GND
2	P0.04	Module pin 14	/RTS
3	-	5 V0 (Board power supply)	-
4	P0.03	Module pin 13	URXD
5	P0.02	Module pin 12	UTXD
6	P0.28	Module pin 15	/CTS
7	-	-	-
8	P0.29	Module pin 16	WAKE_UP
9	-	-	-
10	VDD	V_IN (Module VDD)	Power supply

Table 10: Pin header P1

3.3.1.2 Ophelia-III, Proteus-III, Proteus-III SPI, Setebos-I, Thyone-I

P1	nRF52840, Ophelia-III	Board connection	Proteus-III, Setebos-I, Thyone-I	Proteus-III-SPI
1	GND	GND	GND	GND
2	P0.11	Module pin 15	/RTS	SPI_CS
3	-	5 V0 (Board power supply)	-	-
4	P1.09	Module pin 14	URXD	SPI_MOSI
5	P1.08	Module pin 13	UTXD	SPI_MISO
6	P0.12	Module pin 16	/CTS	SPI_CLK
7	-	-	-	-
8	P0.03	Module pin 17	WAKE_UP	WAKE_UP/ SPI_INT
9	P0.09	Module pin B1	Not applicable (Proteus-I,-II) RESERVED (Proteus-III, Thyone-I) RPS (Radio Protocol Select, for Setebos-I)	RESERVED
10	VDD	V_IN (Module VDD)	Power supply	Power supply

Table 11: Pin header P1



P1 pin header pin 1 to 6 are used to connect the TTL-232R-3V3 FTDI cable. P1 pin header can also be used for direct host connection.



In case of Setebos-I, the pin B1/RPS on pin header P1 is used to select the radio protocol (proprietary or Bluetooth® LE 5.1).

3.3.2 P2: Power supply / Current Measurement

P2	Board connection	Function
1	GND	GND
2	GND	GND
3	GND	GND
4	P0.01	BOOT (Other Modules)
5	On-board LDO Output	3V Output
6	V_IN	Module Power supply (VDD)
7	Open Pins 1x4	Support pins for more connection
8	Open Pins 1x4	Support pins for more connection
9	Open Pins 1x4	Support pins for more connection
10	Open Pins 1x4	Support pins for more connection

Table 12: Pin header P2

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



Support pins shall be used to provide multiple connection to the same net. Pin header P2 pins 7-10 are connected internally. For instance, a jumper can be set on P2 pin 6-7 providing V_IN access on the pin header P2 Pin 8,9,10.

3.3.3 P3: Module debug access pins

P3	Module connection	Function
1	P0.21 (Proteus-I, Proteus-II) P0.18 (Ophelia-III, Proteus-III, Proteus-III-SPI, Setebos-I, Thyone-I)	RESET
2	SWDIO	SWDIO
3	SWDCLK	SWDCLK
4	GND	GND

Table 13: Pin header P3

3.3.4 P4: Module GPIO access pins

3.3.4.1 Proteus-I, Proteus-II

P4	nRF52832	Board connection	Proteus-I,-II
1	-	-	-
2	-	-	-
3	P0.10	Module pin 8	MODE_1
4	P0.09	Module pin 9	BUSY
5	-	-	-
6	-	-	-
7	-	-	-
8	P0.00	Module pin 10	LED_1
9	P0.02	Module pin 11	LED_2

Table 14: Pin header P4

3.3.4.2 Ophelia-III, Proteus-III, Proteus-III-SPI, Setebos-I, Thyone-I

P4	nRF52840, Ophelia-III	Board connection	Proteus-III, Proteus-III-SPI, Setebos-I, Thyone-I
1	P0.23	Module pin B3	RESERVED
2	P0.10	Module pin B2	RESERVED
3	P0.19	Module pin 9	MODE_1
4	P0.22	Module pin 10	BUSY
5	P1.00	Module pin B4	RESERVED
6	P0.21	Module pin B5	RESERVED
7	P0.07	Module pin B6	RESERVED
8	P0.00	Module pin 11	LED_1
9	P0.01	Module pin 12	LED_2

Table 15: Pin header P4

3.3.5 CON2: Debugging Interface-2x10 pin header

CON2	nRF52840	Function
1		VDD
7	SWDIO	SWDIO
9	SWCLK	SWCLK
15	P0.21 (Proteus-I, Proteus-II) P0.18 (Ophelia-III, Proteus-III, Proteus-III-SPI, Setebos-I, Thyone-I)	RESET
4,6,8,10,12,14,16,18,20	GND	GND
2,3,5,11,13,17,19	-	-

Table 16: JTAG debugging interface

3.3.6 SMA

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

CON1	Connection
Inner	Module RF pin
Outer	4 x GND

Table 17: Pin header SMA

3.3.6.1 Proteus-I/-II

For Proteus-I and Proteus-II modules, the integrated antenna variant is assembled on the Family Board.



For these radio modules, the use of the external antenna is not possible on the Family Board.

3.3.6.2 Smart antenna

The so called "smart antenna" solution allows to use the external antenna or internal antenna of the radio module just via mounting external components to the module.

By default, internal PCB antenna connection is used. In order to use an external SMA antenna, 2 pF capacitor (0402) on position C1 shall be populated. C2 shall be removed, C8, C11 and C12 should be left unpopulated.



Optional: Experts have the possibility to use C1, C8 and C11 for additional filtering or fine tuning to the actually used antenna. C1 = 2pF rematches the module to the Family Board providing best performance at the SMA connector.

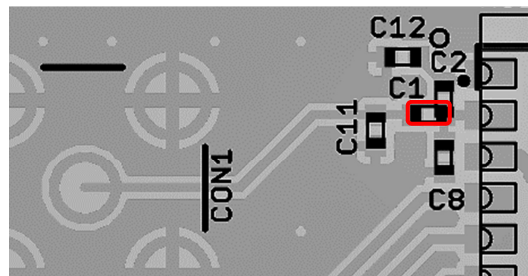


Figure 6: Capacitor connection to external antenna

In order to use the internal PCB antenna of the module, a 2 pF capacitor (0402) on position C2 shall be populated. C1 shall be removed, C8 and C11 should be left unpopulated.

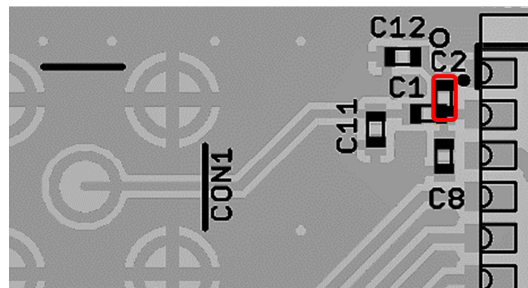


Figure 7: Capacitor connection to internal antenna

3.4 Jumpers

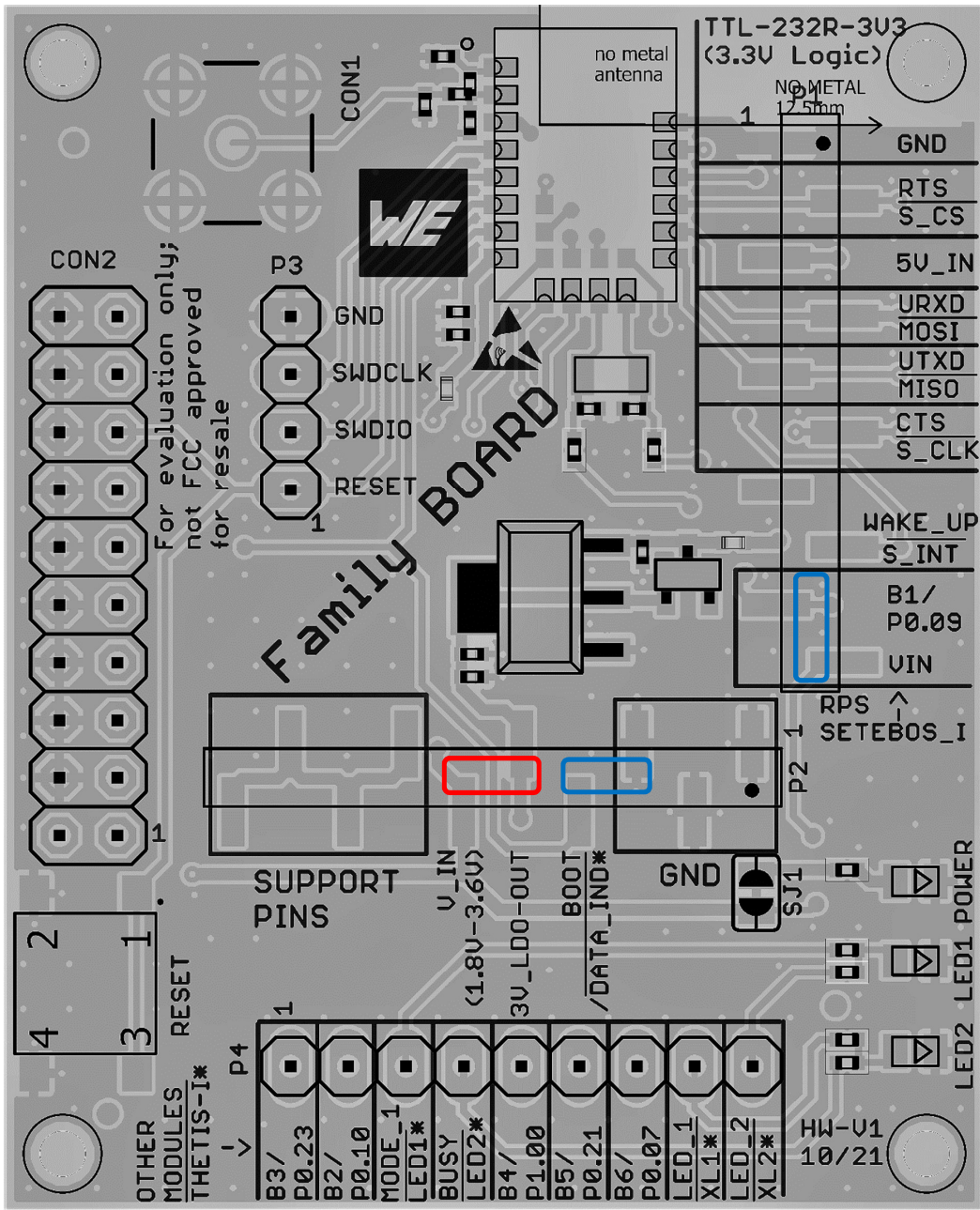


Figure 8: Jumpers

Pins	Function	Default state
P2 Pin (5-6)	Current measurement	set
P1 Pin (9-10)	Setebos-I functions	not set
P2 Pin (3-4)	Boot mode	not set

Table 18: Jumpers

3.4.1 Current measurement

When the module is powered through the P1 connector, the radio module is supplied via a 3 V low drop out voltage regulator. By default, a jumper is set on Pin (5-6) of pin header P2. For current measurement the jumper can be removed and a current meter can be connected instead to the pin header P2 Pin (5-6). In this default configuration the power LED is on the VDD line of the module showing when the module is powered. The current to the power LED is included in the measured current.

For accurate current measurement the solder bridge SJ1 can be disconnected using a cutter. By cutting the solder bridge SJ1, power to the LED is disconnected.



By default, the current consumption of the power LED is included in the current measured between P2 Pins (5 - 6). To avoid this, SJ1 can be disconnected.

P2	Function
5	3V LDO Output
6	V_IN

Table 19: Pin header P2



Current measurement using P2 Pin (5-6) jumper is possible only if the module is powered through connector P1.

3.4.2 Setebos-I functions

By default, P1 Pin (9-10) jumper is not set. Thus, the Setebos-I module's internal pull down resistor sets the module to work as Proteus-III. If a jumper is set on P2 Pin (9-10), the Setebos-I works as Thyone-I radio module. Decisive is the level during boot up, which is the time shortly after reset or power up. After boot up, the modules stays in the selected mode until a reboot is triggered.

P1	Function
9	B1/ RPS (Radio Protocol Select)
10	V_IN

Table 20: Pin header P1

3.4.3 Boot mode

By default, P2 Pin (3-4) jumper is not set. If P2 Pin (3-4) jumper is set during power up, the module starts in boot loader mode to be ready for firmware update. For application start-up, the jumper shall be not set during power up.



- For Proteus-III (2611011024000) and Proteus-III-SPI (2611011024010), boot loader mode allows over the air (OTA) firmware update.
- For Thyone-I module (2611011021000), boot loader mode allows firmware update via UART.
- For Setebos-I module (2611011024020), the boot loader of the Proteus-III is used.
- Ophelia-III module (2611011022000) contains no firmware, neither a bootloader.

P2	nRF52840	Function
3	GND	GND
4	P0.02	BOOT

Table 21: Pin header P2

3.5 Reset button

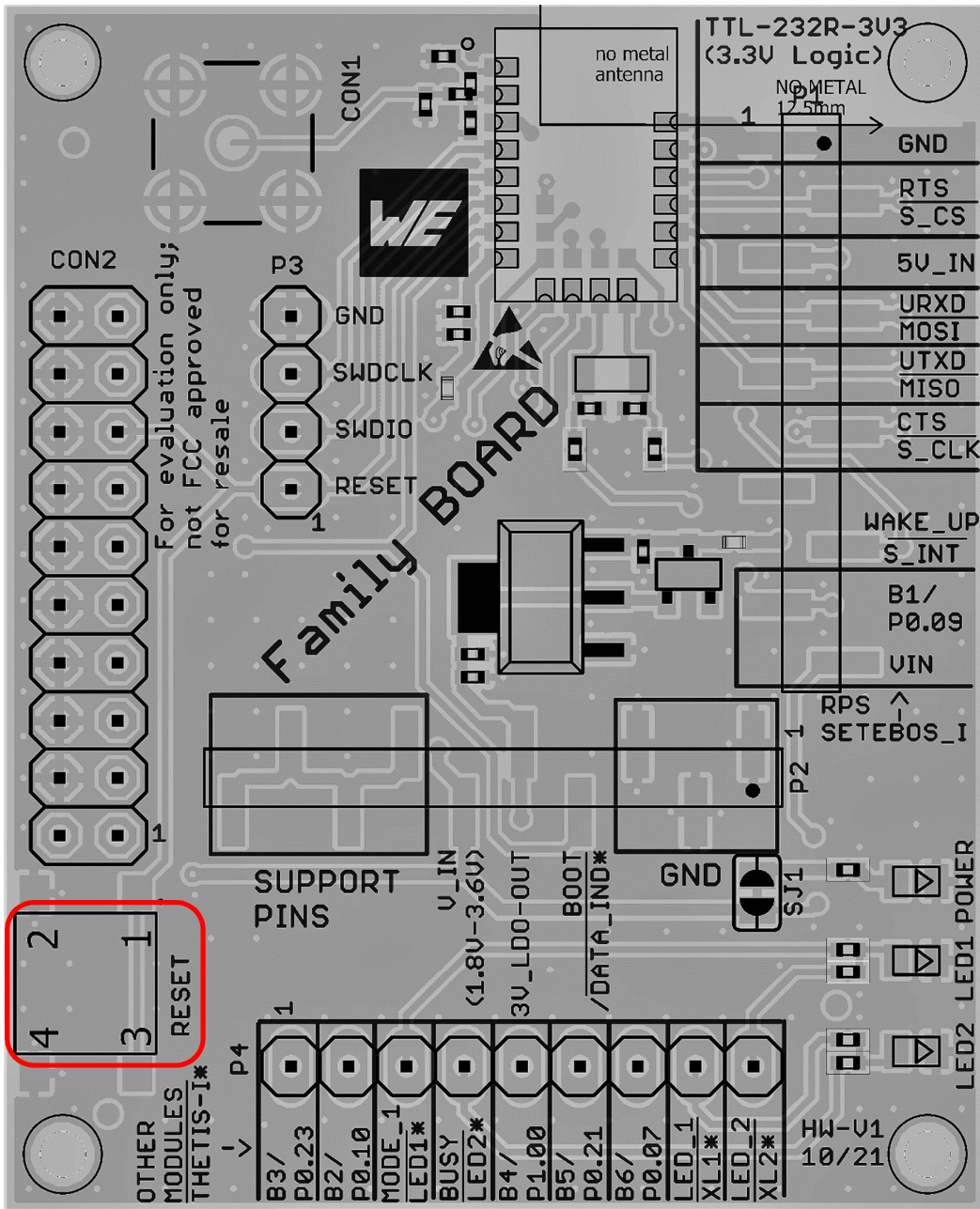


Figure 9: Buttons

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 [?, ?, ?].

3.6 Function blocks

3.6.1 Power supply

The Family Board can be powered either by TTL-232R-3V3 cable or by an external power supply. The table 22 lists the connection for different power supply options.

No	Power supply	Supply @	Multimeter or jumper	SJ1	residual current
1	TTL-232R-3V3 cable	P1	P2 Pin 5-6	Connected	Uncorrected
				Disconnected	Corrected
2	External supply	P1 dedicated pins Pin 3: 5 V, Pin 1: GND	P2 Pin 5-6	Connected	Uncorrected
				Disconnected	Corrected
3	External supply	P2 dedicated pins Pin 1, 2 or 3: GND Pin 7, 8, 9 or 10: 3.3 V	P2 Pin 7-6	Connected	Uncorrected
				Disconnected	Corrected

Table 22: Power supply option



By default, the power LED is connected through a solder bridge. Current measurement with connected solder bridge (SJ1) results in additional current. Solder bridge shall be disconnected for accurate current measurement.

3.6.1.1 Pin header P1, power supply through TTL-232R-3V3

The Family Board can be powered by TTL-232R-3V3 cable through P1 connector. TTL-232R-3V3 cable powers the board with 5 V supply. The integrated voltage regulator regulates the connected 5 V down to 3 V and supplies the remaining parts of the circuit. For current measurement the device is connected to header P2, to Pin 5 (*3V_LDO_OUT*) to Pin 6 (*VDD_MOD / V_IN*).

If the solder bridge SJ1 is closed the *Power LED* lights up when the module is supplied, but the current through the LED is included in the current measurement through P2 Pin (5-6). If the solder bridge SJ1 is open the current measurement is corrected, no additional current beside the current to the module is measured, but the power LED is no longer indicating whether the module is supplied. Figure 10 is illustrating this.

3.6.1.2 Pin header P1, power supply through dedicated pins

The Family Board can be powered by an external power supply through connector P1 Pin 3 (*5 V_IN / 5 V0*) and Pin 1 (*GND*). With SJ1 closed the *Power LED* lights up when the module is powered. With SJ1 open the LED is not lighting but the current is measured corrected. Figure 10 is illustrating this.

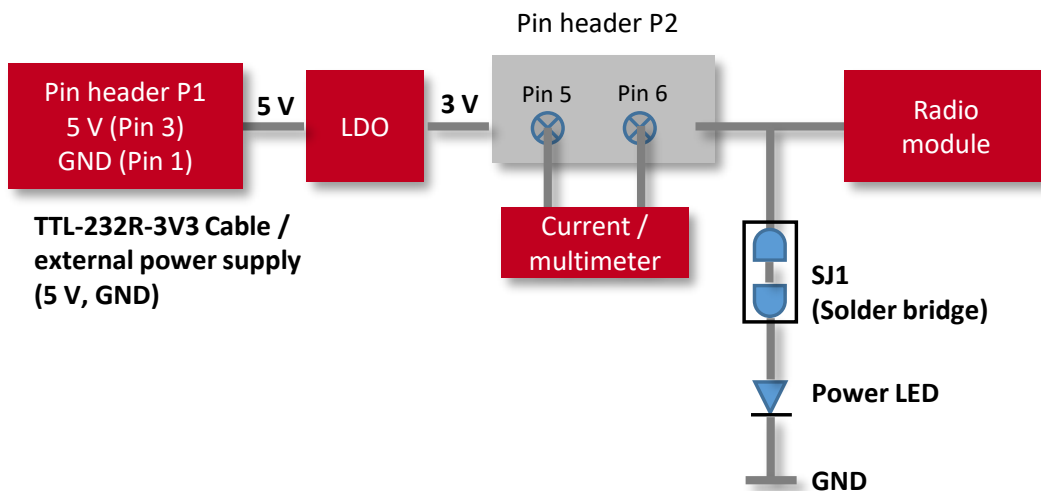


Figure 10: Power supply corresponding to table 22 No 1 and 2

3.6.1.3 Pin header P2, power supply through external source

The Family board can be powered by an external power supply through the pin header P2. GND is connected to Pin 1-3.

1.8 V-3.6 V is connected either directly to Pin-6 (*VDD_MOD / V_IN*) and the current is measured in series as illustrated in the upper picture of Figure 11.

Or it is connected to Pin 8-10 (*V_EXT / SUPPORT PINS*) and the current is measured on header P2 Pin 7 (*V_EXT / SUPPORT PINS*), which is internally connected with Pin 8, 9, 10 to Pin 6 (*VDD_MOD / V_IN*) as illustrated in the lower picture of Figure 11. With SJ1 open the LED is not lighting but the current is measured corrected.

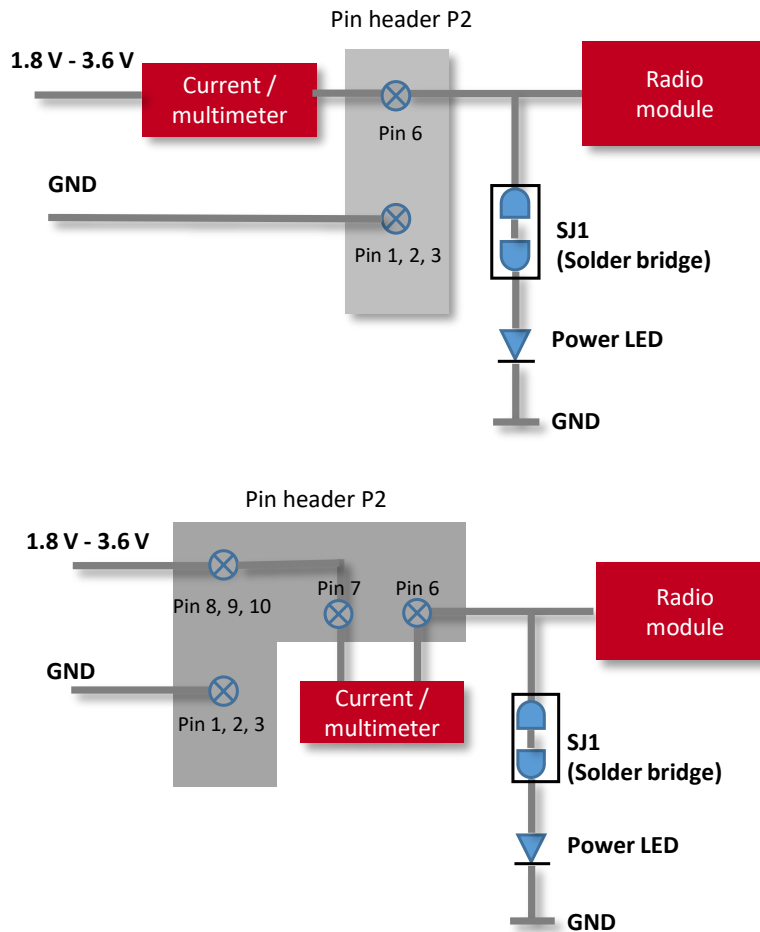


Figure 11: Power supply corresponding to table 22 No 3

3.6.2 UART / USB

The TTL-232R-3V3 cable is used for USB/UART connection between PC and Family 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.

In order to establish a stable UART communication between the FTDI USB to UART converter chipset and the radio module’s chipset, the difference between the baud rates of each entity must not exceed the respective immunity level. Both devices use an internal clock to generate the configured UART baud rate. Due to the fixed clock frequency, only specific baud rates can be run without frequency error.

To figure out which baud rates of the radio module can be evaluated using the mounted FTDI chipset (FT232R or FT231X), it is important to know the real baud rate B with its introduced error. To get them, the FTDI’s clock of 3000 kHz must be divided by the respective prescaler P :

$$B = \frac{3000}{P} \text{ [kBaund]}$$

The supported prescalers P can be chosen as:

$$P \in \{1, 1.5\} \text{ or } P = 2 + (N \cdot 0.125) \text{ with } N \in \{0, 1, 2, 3, 4, \dots\}$$

When a baud rate is configured in the FTDI chip, the prescaler is chosen that meets the closest baud rate. In that case, the real baud rate differs from the configured one, introducing a UART clock error, which may lead to UART communication issues.

Example: In case the desired baud rate $B_{desired} = 1250$ kBaund, the desired prescaler is $P_{desired} = \frac{3000}{1250} = 2.4$. The closest prescaler P is determined by $P = 2 + (N \cdot 0.125) = 2.375$ with $N = 3$. This results in a real baud rate $B = \frac{3000}{2.375} = 1263$ kBaund, which introduces an error of $\frac{B - B_{desired}}{B_{desired}} = 1.04$ % with respect to the desired baud rate.

Desired baud rate [kBaund]	Closest prescaler P	Real baud rate B [kBaund]	Error [%]
3000	1	3000	0
2500	1.5	2000	-20
2000	1.5	2000	0
1500	2	1500	0
1250	2.375	1263	1.04
1411.764706	2.125	1411.764706	0
⋮	⋮	⋮	⋮
1000	3	1000	0
921.6	3.25	923.0769231	0.16
⋮	⋮	⋮	⋮
230.4	13	230.7692308	0.16
⋮	⋮	⋮	⋮
115.2	26	115.3846154	0.15
⋮	⋮	⋮	⋮

38.4	78.125	38.4	0
⋮	⋮	⋮	⋮
19.2	156.25	19.2	0
⋮	⋮	⋮	⋮
9.6	312.5	9.6	0
⋮	⋮	⋮	⋮

Table 23: Example baud rates

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 P1. 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 *P1* connector. The SPI of the host can be directly connected to these pins. 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 Family Board to position Q1. The needed load capacitance can be reached with capacitors C9 and C10, 0402 package.

nRF52840 / nRF52832 pin P0.00/XL1 and P0.01/XL2 are connected to module pad LED_1 and LED_2, respectively. If an LFXO is assembled to the EV-Board, the resistors R3 and R5 shall be assembled, therefore the LED1 and LED2 function is no longer available. Refer to the figure 12 for necessary modification.



By default, Q1, C9, C10 shall not be assembled and R3, R5 shall be assembled.



For standard firmware, the external crystal is not needed. To enable use of the LFXO, a custom firmware is required.

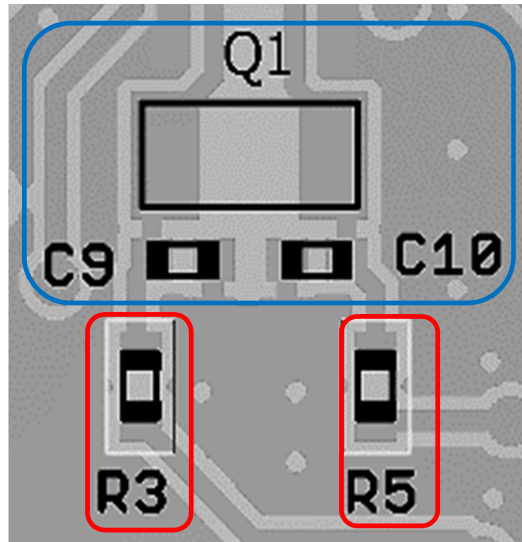


Figure 12: LFXO assembly



To use the LFXO function, Q1, C9, C10 shall be assembled and R3 ,R5 are not assembled.

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

$$C_l = \frac{C_{9l} * C_{10l}}{C_{9l} + C_{10l}} \quad (1)$$

If $C_{9l} = C_{10l} = C$, then

$$C_l = \frac{C}{2} \quad (2)$$

whereas,

$$C_9 = C - C_{XL1} - C_{PCB} \quad (3)$$

$$C_{10} = C - C_{XL2} - C_{PCB} \quad (4)$$

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 Family Board.

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

3.6.6 Programming interface

The Family Board provides solder pads 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 orientation of the flash adapter. The recommended flash adapter is one of the "Segger J-Link" family.

3.6.7 LEDs

3.6.7.1 Ophelia-III, Proteus-I, Proteus-II, Proteus-III, Proteus-III-SPI, Thyone-I, Setebos-I

For Ophelia-III, Proteus-I, Proteus-II, Proteus-III, Proteus-III-SPI, Thyone-I, Setebos-I radio modules, the resistors R6 and R7 are assembled and the resistors R1 and R2 are not assembled.

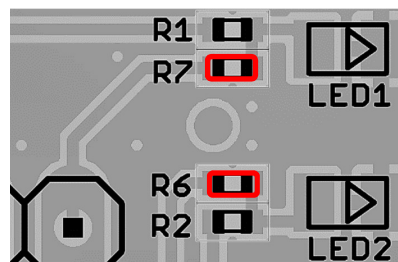


Figure 13: LED resistor R6, R7 assembly

3.7 Schematic - Ophelia-III, Proteus-III, Proteus-III-SPI, Thyone-I, Setebos-I

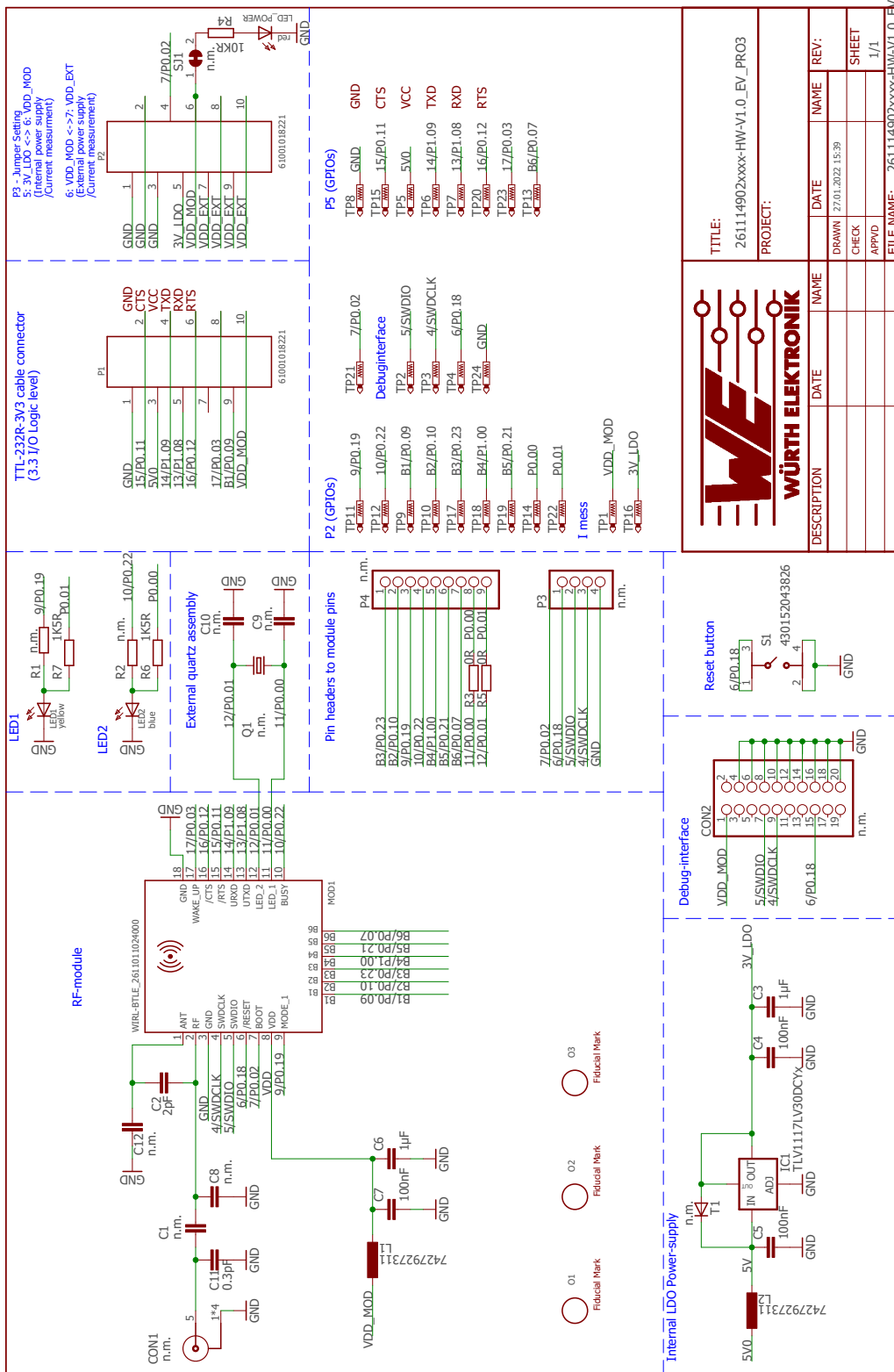
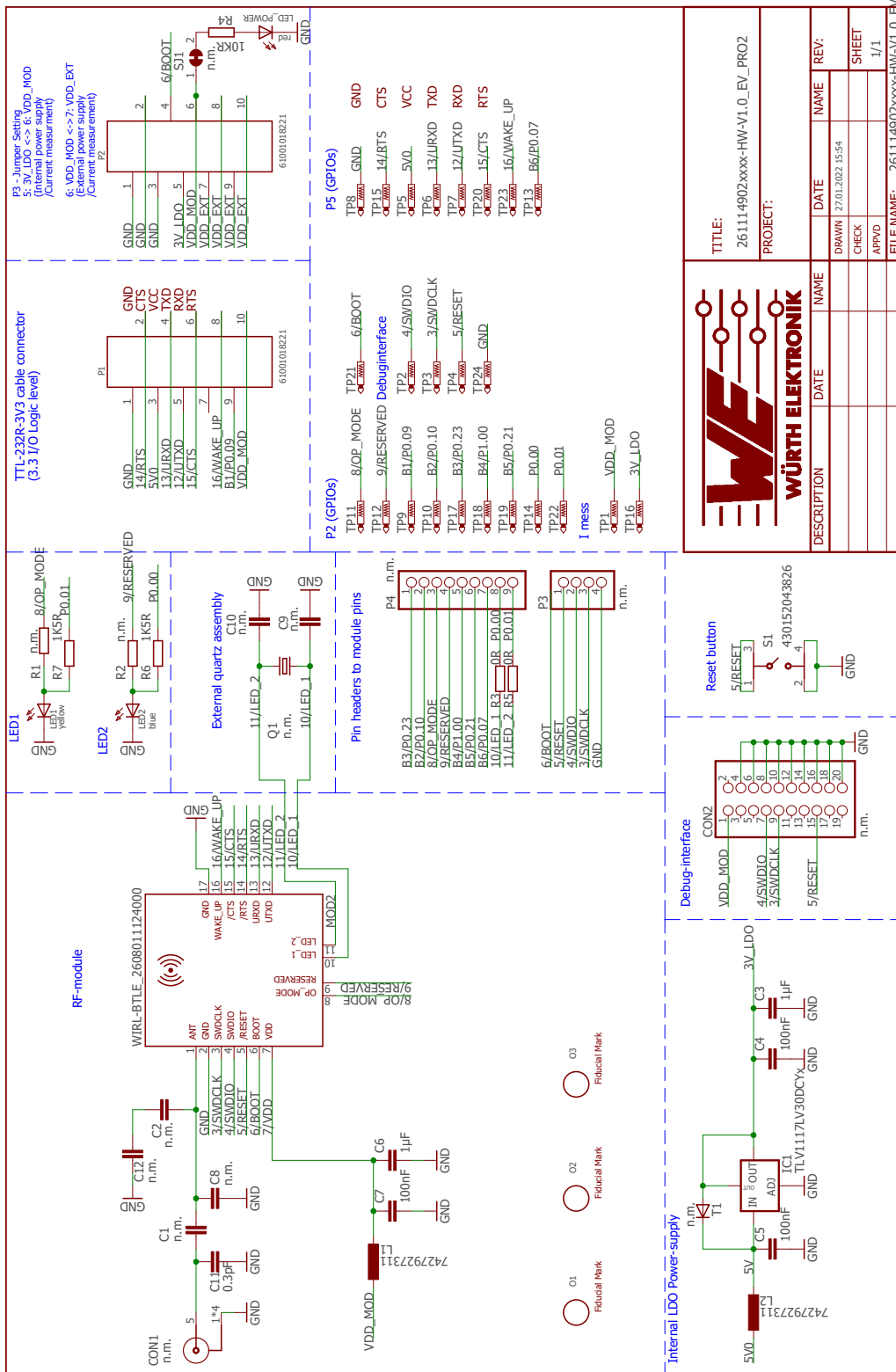


Figure 14: Schematic sheet

3.8 Schematic -Proteus-I, Proteus-II



TITLE:		261114902xxxx-HW-V1.0_EV_PRO2	
PROJECT:			
DATE	NAME	REV:	
27.01.2022 15:54			
CHECK		SHEET	1/1
APPD			
DESCRIPTION		FILE NAME: 261114902xxxx-HW-V1.0_Eb	

Figure 15: Schematic sheet

3.9 Layout

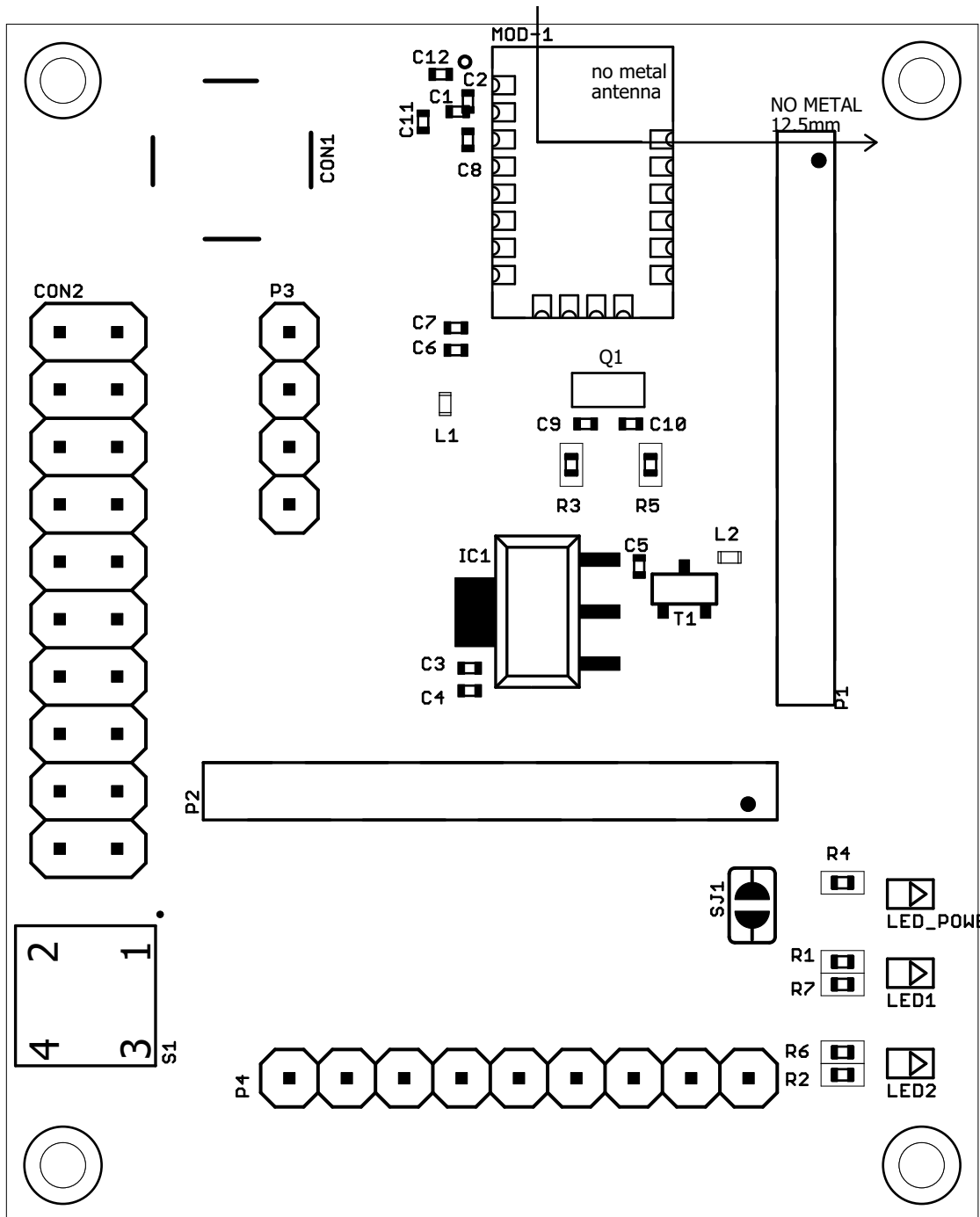


Figure 16: Assembly diagram

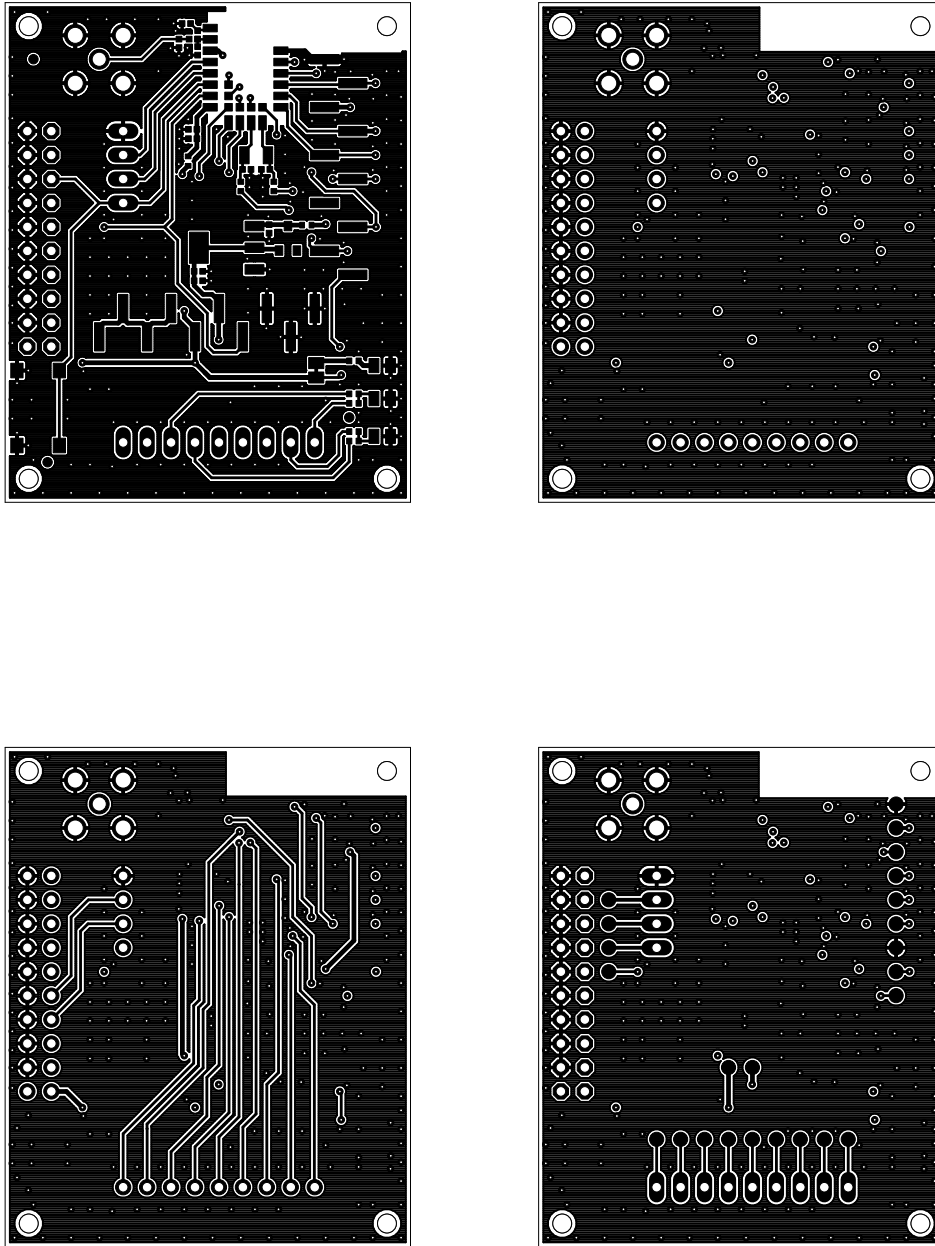


Figure 17: Top, bottom & internal layers

3.10 Bill of materials

Part	Value	HEIGHT	MANUFACTURER	NR
C1	n.m.			
C2	n.m.			
C3	1µF	0.5mm	Würth Elektronik	885012105012
C4	100nF	0.5mm	Würth Elektronik	885012205037
C5	100nF	0.5mm	Würth Elektronik	885012205037
C6	1µF	0.5mm	Würth Elektronik	885012105012
C7	100nF	0.5mm	Würth Elektronik	885012205037
C8	n.m.			
C9	n.m.			
C10	n.m.			
C11	n.m.			
C12	n.m.			
CON1	n.m.			
CON2	n.m.			
IC1	TLV1117LV30DCYx	1.8mm	TI	TLV1117LV30DCYR
L1	7427927311	0.5mm	Würth Elektronik	7427927311
L2	7427927311	0.5mm	Würth Elektronik	7427927311
LED1	yellow	0.75mm	Würth Elektronik	150080YS75000
LED2	blue	0.75mm	Würth Elektronik	150080BS75000
LED_POWER	red	0.75mm	Würth Elektronik	150080RS75000
MOD-1	Proteus-I	2mm	Würth Elektronik	2608011024000
	Proteus-II			2608011024010
	Proteus-III			2611011024000
	Proteus-III SPI			2611011024010
	Setebos-I			2611011024020
	Thyone-I			2611011021000
	Ophelia-III			2611011022000
O1	n.m.			
O2	n.m.			
O3	n.m.			
P1	61001018221	8.5mm	Würth Elektronik	61001018221
P2	61001018221	8.5mm	Würth Elektronik	61001018221
P3	n.m.			
P4	n.m.			
Q1	n.m.			
R1	n.m.			
R2	n.m.			
R3	OR			
R4	10KR			
R5	OR			
R6	1K5R			
R7	1K5R			
S1	430152043826	4.3mm	Würth Elektronik	430152043826
SJ1	n.m.			
T1	n.m.			



The family EV-Board has been designed to mount different radio modules on it. Please note that depending on the radio module's antenna (integrated PCB antenna, external antenna connector or smart antenna configuration), the capacitors C1, C2, C8, C11, C12 on the antenna path may be mounted or not on the family EV-Board. For radio module specific information concerning the parts in the antenna path, please refer to the reference design chapter of the respective radio module user manual [?, ?, ?, ?, ?].

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

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