



USER MANUAL

THETIS-I USB RADIO STICK

2611086021011

VERSION 1.2

OCTOBER 8, 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 of the manual	March 2021
1.1	1.0	<ul style="list-style-type: none">Updated document style	April 2023
1.2	1.2	<ul style="list-style-type: none">Added chapter Supported UART baud rates and Important notice UKCA	October 2024

Abbreviations

Abbreviation	Name	Description
API	Application Programming Interface	
BDM	Business Development Engineer	Support and sales contact person responsible for limited sales area
COM Port	Communication Port	
FCC	Federal Communications Commission	
FTDI	Future Technology Devices International	USB-to-Serial converter chip
GPIO	General Purpose Input/Output	
HIGH	High signal level	
LOW	Low signal level	
MCU	Micro Controller Unit	
PC	Personal Computer	
RED	Radio Equipment Directive	
RF	Radio frequency	Describes everything relating to the wireless transmission.
UART		Universal Asynchronous Receiver Transmitter allows communicating with the module of a specific interface.
USB	Universal Serial Bus	
VCP	Virtual COM Port	
VDD	Supply voltage	
WE	Würth Elektronik	

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1 Introduction

The Thetis-I is a radio module that provides wireless connectivity capabilities in the 2.4 GHz frequency band. The Thetis-I USB Radio Stick incorporates the Thetis-I in a USB stick form factor enabling easy interfacing with any USB enabled device like personal computer or laptop. The Thetis-I USB Radio Stick allows quick set-up of a radio link between PC and any system with integrated Thetis-I radio module.

1.1 Ordering information

WE order code	Description
2611086021011	Thetis-I USB Radio Stick

Table 1: Ordering information

1.2 Wirepas™ technology

As an official partner of Wirepas™, Würth Elektronik eiSos is authorized to make commercial use of Wirepas firmware for the purposes of normal business.

2 Functional description

The Thetis-I USB Radio Stick consists of Thetis-I radio module along with a serial-to-USB adapter that enables direct connection to any USB compatible device. An FTDI serial-to-USB converter chip **FT231X** connects the USB interface to the UART pins of the integrated radio module. Besides UART, additional digital GPIO pins (CBUS) are connected to the radio module to provide special functions like reset. Figure 1 illustrates all the functional components of Thetis-I USB Radio Stick.

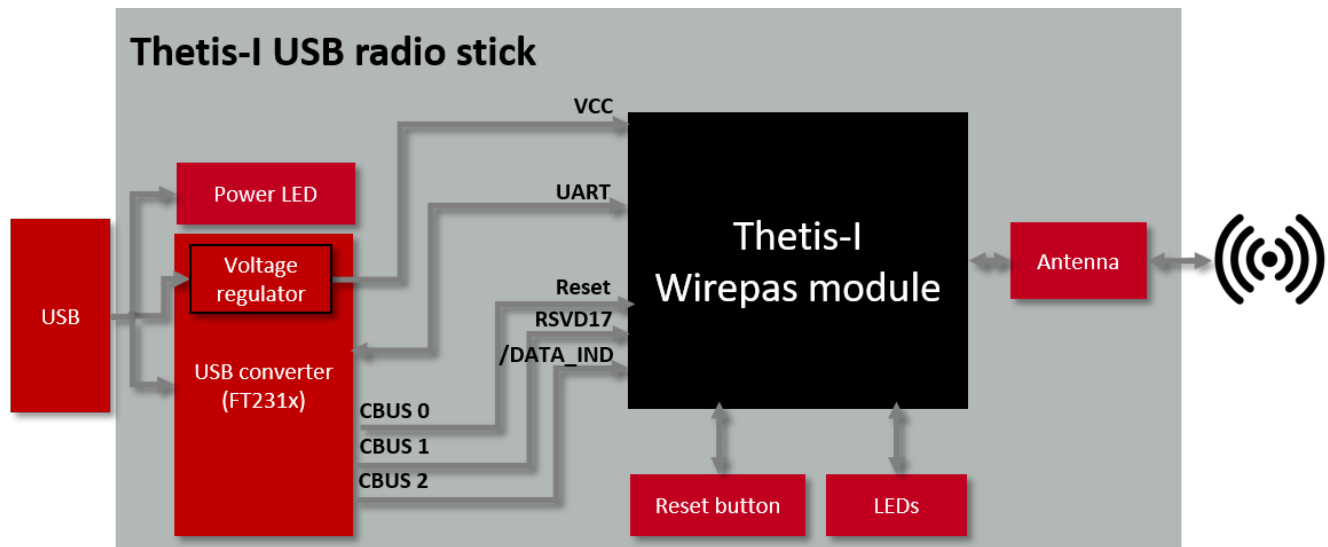


Figure 1: Block diagram of the Thetis-I USB Radio Stick

2.1 Typical setup

The Thetis-I USB Radio Stick offers the Wirepas Mesh API on its UART interface. Please refer to the Wirepas dual MCU manual [1] for the full documentation.

Two or more modules or USB radio sticks can communicate with each other if they share the same Wirepas network ID, channel and encryption as well as authentication keys. Based on the network configuration, data can be:

- broadcast;
- multicast to a group;
- unicast to a specific module.

The role of the Thetis-I USB Radio Stick can be:

- sink;
- routing node;
- non-routing node.

In the frame of the Wirepas EV-Kit and together with the PC tool Wirepas Commander [2], the USB radio stick can be used in a prototype Wirepas network consisting of the USB radio stick itself, a mini EV-Board, and three sensor nodes. Please refer to the Wirepas EV-Kit user manual [3].

2.2 Taking into operation

The serial-to-USB FTDI converter chip **FT231X** requires special drivers to be installed for proper operation. The Virtual COM Port (VCP) drivers have to be installed by following the "Installation Guides" found under: <https://www.ftdichip.com/Drivers/VCP.htm>



It is recommended to restart the PC after installation of drivers.

On proper installation of the drivers, the module appears as a virtual COM port on the PC (ttyUSBx on Linux, COMx on Windows) in case of the VCP driver use. This COM port can be opened in any serial emulator program or user written software to communicate with the radio module.

The radio module responds to commands in a specific format. Please refer to the corresponding Thetis-I user manual [4] for the complete description of the command set.



When connecting the USB radio stick to the PC, it is recommended to reset the USB radio stick once. This can be done using the USB stick reset button or using the CBUS0 pin (see chapter 2.2.2.1). This reset procedure is also recommended after each reboot of the PC.

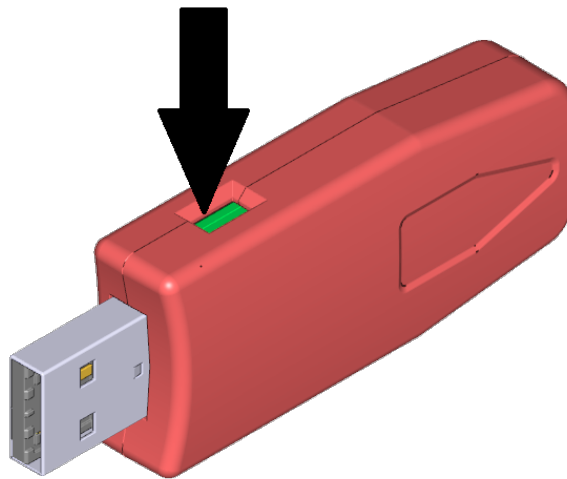


Figure 2: Reset button on the Thetis-I USB Radio Stick

2.2.1 Supported UART baud rates

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 :

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

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 $B_{desired} = 1250$ kBaud, 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 $B = \frac{3000}{2.375} = 1263$ kBaud, which introduces an error of $\frac{B - B_{desired}}{B_{desired}} = 1.04\%$ with respect to the desired baud rate.

Desired baud rate [kBaud]	Closest prescaler P	Real baud rate B [kBaud]	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 2: Example baud rates

2.2.2 Usage of CBUS pins

To switch the CBUS pins static HIGH or LOW and thus to use the provided pins functions of the Thetis-I radio module, the D2XX driver of FTDI has to be used. This driver is part of the previous mentioned VCP driver installation in case of Windows OS. In case of Linux, a manual installation is required.

Please follow FTDI's "Installation Guides" for proper D2XX install:

<https://www.ftdichip.com/Drivers/D2XX.htm>

Example codes and tutorials for "how to use the D2XX driver within your own software tool" can be found in the software example section of:

<https://www.ftdichip.com/Support/SoftwareExamples/CodeExamples.htm>

2.2.2.1 Resetting the Thetis-I USB Radio Stick using the CBUS pin

The */RESET* pin of the Thetis-I can be used to reset the integrated radio module. As the */RESET* pin is connected to the CBUS0 pin of the integrated FTDI chip, the radio module can be reset by pulling the CBUS0 pin low for at least 100 ms and releasing it to high level again.

By default, the CBUS0 pin of the FT231X is configured as FT_CBUS_GPIO (bit bang), such that the FTDI D2XX driver function `SetBitMode` can be used.

```
/* prep: create and connect an FTDI device instance */  
  
/* set CBUS0 to output level LOW */  
SetBitMode(0x10, FTDI.FT_BIT_MODES.FT_BIT_MODE_CBUS_BITBANG);  
  
/* hold CBUS0 for at least 100~ms on LOW level */  
wait_ms(100);  
  
/* clear FTDI receive and send buffers */  
Purge(FTDI.FT_PURGE.FT_PURGE_RX | FTDI.FT_PURGE.FT_PURGE_TX);  
  
/* set CBUS0 to output level HIGH */  
SetBitMode(0x00, FTDI.FT_BIT_MODES.FT_BIT_MODE_RESET);  
  
/* a delay according to the reset timing parameter will occur (see manual) */  
  
/* disconnect and close the FTDI device instance */
```

Code 1: Pin reset via CBUS0 using the D2XX driver

3 Regulatory compliance information

3.1 Important notice EU

The use of RF frequencies is limited by national regulations. The Thetis-I USB Radio Stick has been designed to comply with the RED directive 2014/53/EU of the European Union (EU).

The Thetis-I USB Radio Stick can be operated without notification and free of charge in the area of the European Union. However, according to the RED directive, restrictions (e.g. in terms of duty cycle or maximum allowed RF power) may apply.

3.2 Important notice UKCA

The UK's government has laid legislation to continue recognition of current EU requirements for a range of product regulations, including the CE marking. The Radio Equipment Regulation 2017/1206 is within the scope of this announcement, among others.

Consequently, the Thetis-I USB Radio Stick can be sold and utilized in the UK with the CE marking, without the need of UKCA declaration of conformity or UKCA marking.

Source: <https://www.gov.uk/guidance/ce-marking>

3.3 Important notice FCC

The use of RF frequencies is limited by national regulations. The Thetis-I USB Radio Stick has been designed to comply with the FCC Part 15.

The Thetis-I USB Radio Stick can be operated without notification and free of charge in the area of the United States of America. However, according to the FCC Part 15, restrictions (e.g. in terms of maximum allowed RF power and antenna) may apply.

3.4 EU Declaration of conformity



EU DECLARATION OF CONFORMITY

Radio equipment: 2611086021011

The manufacturer: Würth Elektronik eiSos GmbH & Co. KG
Max-Eyth-Straße 1
74638 Waldenburg

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration: 2611086021011

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation Directive 2014/53/EU and 2011/65/EU with its amending Annex II EU 2015/863 . Following harmonised norms or technical specifications have been applied:

EN 300 328 V2.2.2 (2019-07)
EN 301 489-1 V2.2.3
EN 301 489-17 V3.2.4 (2020-09)
EN 62479 : 2010
EN 62368-1:2014 + AC:2015

i.A. G. Exlerdt

Trier, 8th of February 2021

Place and date of issue

3.5 FCC - Federal Communications Commission

The device has been FCC Part 15 B tested.

Contains FCC ID: R7T1101102

The enclosed device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

- (i.) this device may not cause harmful interference and
- (ii.) this device must accept any interference received, including interference that may cause undesired operation.

3.6 IC - Industry Canada

This device contains ISED: 5136A-1101102

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

4 References

- [1] Wirepas. Wirepas Mesh Dual-MCU API Reference Manual, WP-RM-100, version 5.1A. <https://www.we-online.com/man-wirepas-1>.
- [2] Würth Elektronik. Wirepas Commander PC tool. <https://www.we-online.com/Wirepas-Commander>.
- [3] Würth Elektronik. Thetis-I Evaluation Kit user manual. <https://www.we-online.de/katalog/de/manual/2611019021011>.
- [4] Würth Elektronik. Thetis-I user manual. <https://www.we-online.de/katalog/de/manual/2611011021010>.

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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.

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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.

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Contact

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