PROPRIETARY

INDUSTRY PROVEN & LICENSE FREE

INTRODUCTION

Proprietary Radio Stack

All Wireless Connectivity RF Modules have the WE-ProWare pre-loaded

Our module added value is the WE-ProWare operating system which is fully included. Communication functions are configured with simple AT commands. You can easily swap between radio channels and protocols. All this makes it very easy to enter new markets with your application.

More information on page 74

Proprietary Radio as Bluetooth® LE Alternative

- Connection only with authorized devices by the manufacturer
- Security aspect as argument for the endcustomers
- Closed communication is „invisible" for Smart devices
- Higher throughput possible – no effort with big overhead of Bluetooth®
- Saving Bluetooth® Listing costs
- Business model to build the whole chain as user experience
- Binding the end customer to the product with additional accessory with the same communication

THE IDEA
to connect wireless to a device:

- Parameterization for commissioning
- Start/stop measurement
- Read out results
- Notification danger
- Connecting for service
- Checking device state for predicitve maintanence
- Recalibration

NO STANDARD
radio protocol does fit

- Tried to implement Bluetooth® a few years ago:
  - Bluetooth® classic with to high energy consumption
  - Bluetooth® Listing Costs too high
  - Small quantities cannot carry the high costs
  - Bluetooh® LE not flexible enough for the idea
- Same is valid for Sub-GHz LoRa, SigFox, etc.

THE SOLUTION
Proprietary Communication as solution:

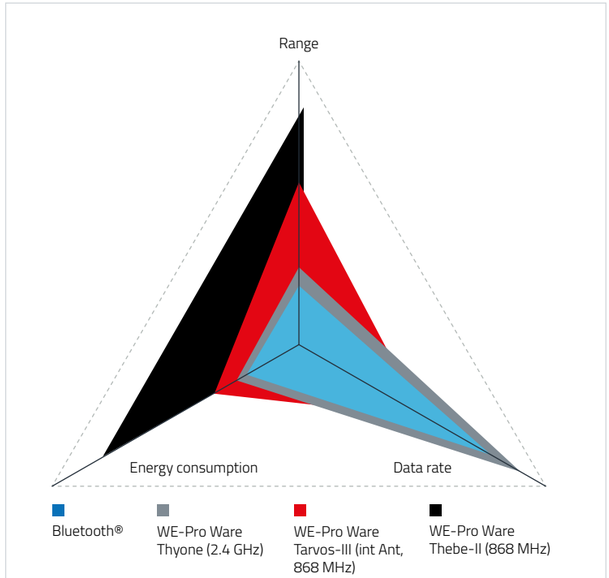
- Easy adaption possible
- Fitting perfectly to the needs
- No license costs arise
- Full control over application

INTRODUCTION

Radio Frequency Spectrum

The radio frequency spectrum is regulated by designated regulatory authorities that define how specific spectrum bands can be used. The ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) bands are free to use without license costs. As there is no single worldwide regulation, national authorities define which of the frequency bands are open for access in each specific country.

Furthermore in ISM bands regulation there is no directive about a specific radio protocol. That means, it doesn't matter if a proprietary radio protocol or standard radio protocols will be chosen. Everybody can use individual firmware within the regulations of the frequency bands (output power, duty cycle, ...). The correlation between data rate, range and battery life could be arranged individually.



Advantages

- Security due to closed system
- More flexibility compared to standard
- More scope for design
- No dependences
- No umbrella organization
- No license fees

Areas of Application

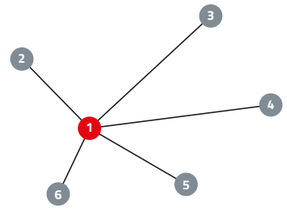
Machine to Machine	(Home) Automation	Wireless Sensor Networks
Internet of Things (IoT)	Monitoring / Control	Medical

... and many others

NETWORK TOPOLOGIES

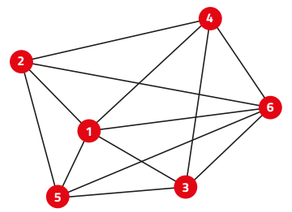
Point to point

Point to point topology is the type of network topology which is used to connect to network nodes directly with each other through some link. In between these two nodes, the data is transmitted using this link.



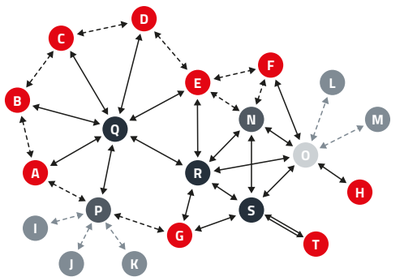
Star

In a star topology all nodes are connected via a central station. All communication is only possible via the central node



Peer to Peer

In peer to peer topology every node has a direct connection to the other nodes and can communicate to each other.



Flooding Mesh

In a flooding mesh topology an indirect communication between nodes is possible. The message will be repeated until it reaches the receiver.

SHORT RANGE DEVICE
FREQUENCY BANDS

Short Range Device (SRD)

A short-range device (SRD) is a radio-frequency transmitter device used in telecommunication for the transmission of information, which has low capability of causing harmful interference to other radio equipment.

Short-range devices are low-power transmitters typically limited up to 500 mW effective radiated power (ERP) or less, depending on the frequency band, which limits their useful range to few hundred meters, and do not require a license from its user.

Frequency [MHz]	Band	TX Power [dBm]	TX Power [mW]	Duty cycle	max. occupied BW*	Notes
169.400 - 169.475	D	+ 27	500	≤ 1 %	50	For metering devices: 10 % DC;
169.400 - 169.4875	E	+ 10	10	≤ 0.1 %	whole band	
169.4875 - 169.5875	F	+ 10	10	≤ 0,001 %	whole band	0,1 % DC during 0:00 and 6:00 local time; Equipment that concentrates or multiplexes individual equipment is excluded.
169.5875 - 169.8125	G	+ 10	10	≤ 0,1 %	whole band	
433.050 - 434.790	H	+ 10	10	10 %	whole band	
433.050 - 434.790	I	0	1	no limits	whole band	-13 dBm / 10kHz PSD when bw > 250 kHz, audio/video applications are excluded
433.050 - 434.790	J	+ 10	10	no limits	25	audio/video applications are excluded
863.0 - 865.0	K	+ 14	25	≤ 0.1 % or psa**	whole band	OBW restictions except audio & video limited to 300 kHz
865.0 - 868.0	L	+ 14	25	≤ 1 % or psa**	whole band	
868.0 - 868.6	M	+ 14	25	≤ 1 % or psa**	whole band	
868.7 - 869.2	N	+ 14	25	≤ 0.1 % or psa**	whole band	
869.4 - 869.65	P	+ 27	500	≤ 10 % or psa**	whole band	
869.7 - 870.0	Q	+ 7	5		whole band	audio / video applications are excluded
869.7 - 870.0	R	+ 14	25	≤ 1 % or psa**	whole band	analogue audio / video are excluded
2400.0 - 2483.5		+ 10	10	no limits	whole band	non specific short range devices
2400.0 - 2483.5		+ 14	25	no limits	whole band	radio determination devices (radar, rfid,...)
2446.0 - 2454.0			500 / 4000		whole band	RFID only

* BW = Band width
**psa = Polite Spectrum Access

- ✔ License free bands
- ✔ Different frequency bands with different regulations
- ✔ Which band fits best your application
- ✔ Limitations in max TX power, Duty cycle and channel spacing

Source: EN 300 220 and EN 300 440

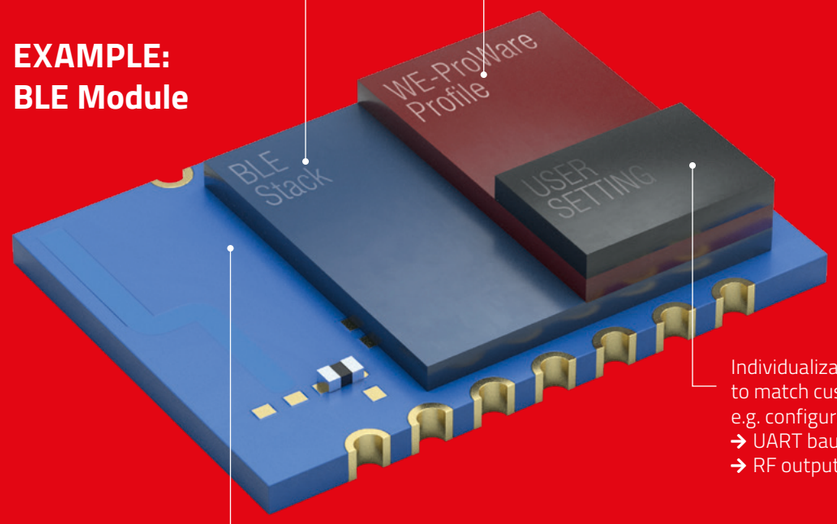
FIRMWARE:
WE-PROWARE AS OPERATING SYSTEM

Fully featured &
"BLE qualified" software stack

SPP-like profile (TX & RX characteristic) DIS, Security Modes, Bonding, FOTA, Automatic BLE Role switch, Low Power Optimization

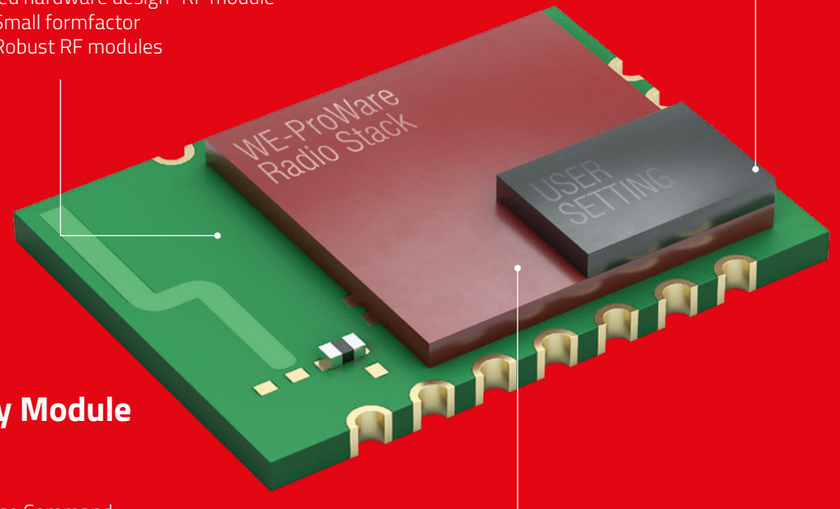
WE-PRO WARE

EXAMPLE:
BLE Module



Individualization of parameters to match customer applications e.g. configuration of
→ UART baudrate
→ RF output power

Fixed hardware design "RF module"
→ Small formfactor
→ Robust RF modules



EXAMPLE:
Proprietary Module

Offers Easy-to-Use Command Interface among other features

PROPRIETARY RADIO STACK
INTRODUCTION & EXPLANATION

WE-ProWare is an Operating System to manage the Würth Elektronik radio modules.

WE-ProWare is a software product marketed under the Würth Elektronik brand and protected by Würth Elektronik.

WE-ProWare is a manufacturer specific, non-public and not free available radio protocol. Following it is no open source software. The software's binary image and sourcecode will not be published.

WE-ProWare is a firmware for Würth Elektronik radio modules which combines user configurable radio parameters, coding, channel access and a communication protocol which are referred to as proprietary. Thus, it does not comply with generally accepted communication standards , i.e. Bluetooth, Wi-Fi, Ethernet or else.

WE-ProWare is owned by and protected by copyright of Würth Elektronik.

WE-ProWare is restricted by license law through manufacturer-specific know-how and/or through patents.

WE-ProWare is a manufacturer-specific wireless transmission technology. It defines the technical aspects on how to transmit and receive data wirelessly between Würth Elektronik radio modules. Proprietary systems are closed systems that enable communication between each other. Following, the software code of WE-ProWare is specifically designed for Würth Elektronik hardware and is neither compatible nor interoperable with hardware from other manufacturers.

The WE-ProWare Radio Stack is an Industry Proven Robust Wireless Connection

With more than 20 years of experience, Würth Elektronik eiSos offers a radio stack ready to run, build and connect out of the box – called WE-ProWare. This radio stack is an easy-to-use and effective networking protocol. Without a radio stack an RF module is pure hardware. Even when Software Developement Kits (SDKs) are offered, you have to spend months, sometimes years, to get your module up and running.

Extensive Features

The WE-ProWare offers you the option to connect external peripherals using numerous interfaces, such as UART or digital and analog I/O. In TRANSPARENT MODE the WE-ProWare radio stack can carry any kind of application data, simple conversion of UART to radio and vice versa. In COMMAND MODE you have full control of all features. The UART interface is used for serial communication as well as for configuration.

It is Pre-loaded on all Wireless Connectivity RF Modules

Our module added value is the WE-ProWare radio stack which is fully included. Communication functions are configured with simple AT commands. You can easily swap between radio channels and protocols. All this makes it very easy to enter new markets with your application.

The WE-ProWare Radio Stack Supports Different Network Topologies, incl.

- ✔ Point to Point
- ✔ Point to Multipoint
- ✔ Peer to Peer
- ✔ Mesh
- ✔ Multi-hop

MORE THAN A RADIO STACK - IT IS AN OPERATING SYSTEM

NO LICENSE FEES

The license fees applicable to be able to run WE-ProWare on Würth Elektronik radio modules is always included in the hardware price, unless otherwise specified. A key difference to generally accepted standards, i.e. Bluetooth, Wi-Fi or else is that, there are no annual membership fees, one-time costs for the device listing or recurring monthly subscription costs.

AREA OF APPLICATION

As an area of application, WE-ProWare as a proprietary radio system is always suitable if the transmitters exchange data with each other and no standardized interface to a public network through mobile phone, tablet and/or notebook is required.

WIRELESS APPLICATIONS

In conclusion, WE-ProWare does perfectly fit in wireless applications when the design of the end devices (e.g. automation machine, control cabinet) and/or the remote control(s) are under full control of the system designer. Using WE-ProWare in this case will save (recurring) license fees and offers a higher degree of flexibility in terms of data throughput, maximum transmission range and energy consumption.

PRODUCT OVERVIEW

	Module	Order Code	Freq. / MHz	Output Power	LoS Range	LoS Test Conditions Antenna height/Datarate	Antenna	Datarate PHY/ RF-Profiles	RF-Channels	RF-Architecture	Power Consumption Rx	Power Consumption Tx	Power Consumption Sleep	Supply Voltage min-max	Communication Modes	Dimensions	Footprint	Chipset	Certification	EVAL-Kit	USB-Radio Stick
Titania		2607011111000	169 MHz	15 dBm / 31.6 mW	3 km	2 m / 1.2 kbps	RF-Pad	1.2 kbps (0) 2.4 kbps (1) 9.6 kbps (2) 25 kbps (4)	5	P2P, star	28 mA	59 mA	10 µA	2 - 3.6 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1	MSP430 + TI-CC1120	CE	✔	✔
Thadeus		2605031141000	433 MHz	10 dBm / 10 mW	1 km	2 m / 4.8 kbps	RF-Pad	4.8 kbps (0)	21	P2P, star	24 mA	38 mA	0.3 µA	2.2 - 3.6 VDC	transparent, command	17 x 27 x 3.6 mm	WE-FP-1	MSP430 + TI-CC1101	CE	✔	
Tarvos-I		2605041181000	868 MHz	11 dBm / 12.5 mW	1 km	2 m / 4.8 kbps	RF-Pad	4.8 kbps (0)	11	P2P, star	24 mA	38 mA	0.3 µA	2.2 - 3.6 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1	MSP430 + TI-CC1101	CE	✔	✔
Tarvos-II		2607021181000	868 MHz	14 dBm / 25 mW	2 km	2 m / 2.4 kbps	RF-Pad	34.4 kbps (0) 2.40 kbps (1) 100 kbps (2)	41	P2P, star, mesh	30 mA	53 mA	3 µA	2 - 3.6 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1	MSP430 + TI-CC1125	CE	✔	✔
Highlight: Tarvos-III		2609011081000	868 MHz	14 dBm / 25 mW	300 m	2 m / 0.625 kbps	PCB	38.4 kbps (0) 100 kbps (2) 0.625 kbps (3) 2.50 kbps (4) 400 kbps (5)	41	P2P, star, mesh	8 mA	26 mA	0.2 µA	2.2 - 3.8 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1+	TI-CC1310	CE	✔	
		2609011181000			10 km	6 m / 0.625 kbps	RF-Pad													✔	✔
Highlight: Thebe-II		2609031181000	868 MHz	27 dBm / 500 mW	20 km	6 m / 0.625 kbps	RF-Pad	38.4 kbps (0) 100 kbps (2) 0.625 kbps (3) 2.50 kbps (4)	4	P2P, star, mesh	12 mA	500 mA	0.9 µA	2.2 - 3.7 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1+	TI-CC1310	CE	✔	
Telesto-I		2607021191000	915 MHz	-2 dBm / 0.6 mW	550 m	2 m / 38.4 kbps	RF-Pad	38.4 kbps (0) 2.40 kbps (1) 100 kbps (2)	51	P2P, star, mesh	30 mA	30 mA	3 µA	2 - 3.6 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1	MSP430 + TI-CC1125	FCC, IC	✔	✔
Telesto-II		2607021191010	915 MHz	15 dBm / 31 mW	700 m	2 m / 38.4 kbps	RF-Pad	38.4 kbps (0)	51	P2P, star, FHSS	30 mA	53 mA	3 µA	2 - 3.6 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1	MSP430 + TI-CC1125	FCC, IC	✔	✔
Telesto-III		2609011091000	915 MHz	14 dBm / 25 mW	40 m	2 m / 400 kbps	PCB	400 kbps (6)	51	P2P, star, mesh	8 mA	26 mA	0.2 µA	2.2 - 3.8 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1+	TI-CC1310	FCC, IC		
		2609011191000	915 MHz	14 dBm / 25 mW	800 m	2 m / 400 kbps	RF-Pad													✔	✔
Themisto-I		2609041191000	915 MHz	25 dBm / 315 mW	10.5 km	6 m / 30 kbps	RF-Pad	400 kbps (6) 240 kbps (8) 30.0 kbps (9)	51	P2P, star, mesh	12 mA	400 mA	0.9 µA	2.2 - 3.7 VDC	transparent, command	17 x 27 x 3.8 mm	WE-FP-1+	TI-CC1310	FCC, IC	✔	
Triton		2603011021000	2400 MHz	0 dBm / 1 mW	600 m	2 m / 1.50 kbps	Chip	1.50 kbps (1) 3.00 kbps (2) 6.00 kbps (3) 12.0 kbps (4) 24.0 kbps (5) 48.0 kbps (6) 72.0 kbps (7)	20	P2P, star	10 mA	38 mA	1 µA	1.9 - 3.6 VDC	command	16 x 27.5 x 3.2 mm	WE-FP-2	STM32 + EM9209	CE, FCC, IC	✔	
		2603011121000	2400 MHz	10 dBm / 10 mW	5 km	6 m / 1.50 kbps	RF-Pad													✔	
Thalassa		2606031021000	2400 MHz	-6 dBm / 250 µW	150 m	2 m / 1.50 kbps	Chip	1.50 kbps (1) 250 kbps (default)	166	P2P, star	21 mA	25 mA	6 µA	2.7 - 3.6 VDC	transparent, command	17 x 30.8 x 3.6 mm	WE-FP-3	MSP430 + TI-CC2500	CE, FCC, IC	✔	✔
		2606031121000	2400 MHz	0 dBm / 1 mW	450 m	2 m / 1.50 kbps	RF-Pad													✔	
Highlight: Thyone-I		2611011021000	2400 MHz	4 dBm / 2.5 mW			SAS -> PCB	125 kbps (0) 500 kbps (1) 1.0 Mbps (2) 2.0 Mbps (3)	39	P2P, star, mesh	7.7 mA	18.9 mA	0.4 µA	1.8 - 3.6 VDC	transparent, command	12 x 8 x 2 mm	WE-FP-4+	nRF52840	CE, FCC, IC, TELEC	✔	✔
			2400 MHz	8 dBm / 6.3 mW	750 m	2 m / 125 kbps	SAS -> RF-Pad														

OUR STRONGEST:
PROPRIETARY 868 MHZ

Tarvos-III

Long range radio module
868 MHz

Thebe-II

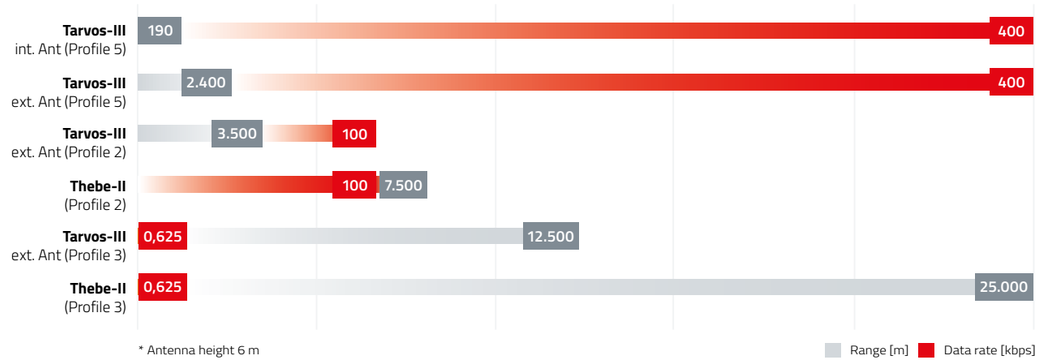
Long range radio module
868 MHz

Characteristics

Long range 10 / 20 km | Small size | Mesh | High penetration

- 2 products - 1 footprint
- Footprint compatible to 915 MHz modules
- Flexibility in design
- Transparent mode
- Flexible addressing
- Powerful
- Interoperable Tarvos-III and Thebe-II
- Adjustable output power

Correlation Range - Data Rate



Differences

	Tarvos-III	Thebe-II
Output power	14d Bm / 25 mW	27 dBm / 500 mW
Range	300 m / 10 km	20 km
RF channels	41	4
Power consumption	8 mA / 26 mA / 0,2 µA	12 mA / 500 mA / 0,9 µA
Antenna	PCB / external	external
	we-online.com/Tarvos-III	we-online.com/Thebe-II

EXCHANGEABILITY
868 MHZ / 915 MHZ

Compatibility Tarvos-Thebe-Telesto-Themisto Series

- Footprint compatible RF-modules
- Alternative usage by only changing the RF-module
- No change in the HW on Host-side required

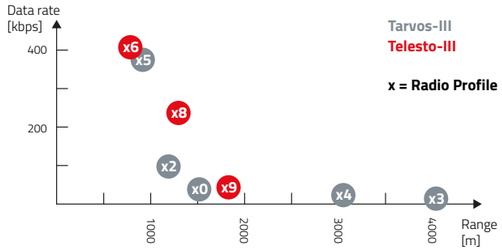
- Flexible use of both frequencies for different regions possible
- 68 MHz and 915 MHz exchangable

- Using Low or High Power modules for different ranges
- Modules with 14 dBm (25 mW): Tarvos-III and Telesto-III
- Modules with 27 dBm (500 mW): Thebe-II and Themisto-I

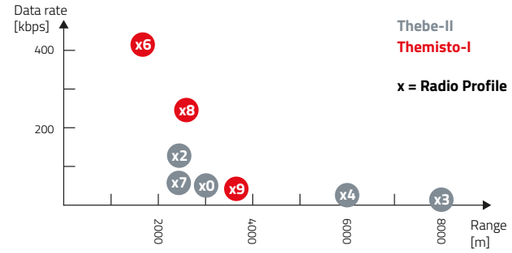
Replacing 868 MHz Radio Modules by their 915 MHz counterparts

we-online.com/ANR015

Tarvos-III & Telesto-III



Thebe-II & Themisto-I



In case, the **Tarvos-III** is replaced by a **Telesto-III** radio module, the following facts have to be considered:

Feature	Information	Actions needed
Form factor & footprint	Both modules have the same form factor and footprint.	None
Pinout	Both modules are pin compatible.	None
Antenna	Both modules are available with integrated antenna and a 50 Ω antenna pad to connect an external antenna.	In case of external antenna, check whether the connected 868 MHz antenna can be also used for 915 MHz.
UART protocol	Both modules provide a command interface using the same commands and functions.	None
Radio configuration	▪ The radio profile 6 of the Telesto-III is comparable in range and speed with the radio profile 5 of the Tarvos-III. In case, the Tarvos-III uses another radio profile, the range of the Telesto-III is lower, but data rate is higher, such that the data can be transmitted much faster. ▪ The channel numbering changes from 100 - 140 (868 - 870 MHz) to 200 - 252 (902 - 928 MHz).	▪ Check the range requirements of your application. ▪ Use the new channel numbers in your application code.
Certification	The 915 MHz range is regulated in North America by the FCC USA and ISED Canada.	Re-testing of the end-device is needed to determine unwanted emissions.

In case, the **Thebe-II** is replaced by a **Themisto-I** radio module, the following facts have to be considered:

Feature	Information	Actions needed
Form factor & footprint	Both modules have the same form factor and footprint.	None
Pinout	Both modules are pin compatible.	None
Antenna	Both modules are available with a 50Ω antenna pad to connect an external antenna.	Check whether the connected 868 MHz antenna can be also used for 915 MHz.
UART protocol	Both modules provide a command interface using the same commands and functions.	None
Radio configuration	▪ The radio profiles of the Themisto-I provide a faster radio transmission at the cost of range. ▪ The channel numbering changes from 129 - 132 (869.45 - 869.6 MHz) to 200 - 252 (902 - 928 MHz).	▪ Check the range and timing requirements of your application. ▪ Use the new channel numbers in your application code.
Certification	The 915 MHz range is regulated in North America by the FCC USA and ISED Canada.	Re-testing of the end-device is needed to determine unwanted emissions.

OUR SMALLEST:
PROPRIETARY 2.4 GHZ

Thyone-I

Proprietary radio module 2.4 GHz

Real size

Characteristics

Long life battery driven application with sleep current = 0.4 µA

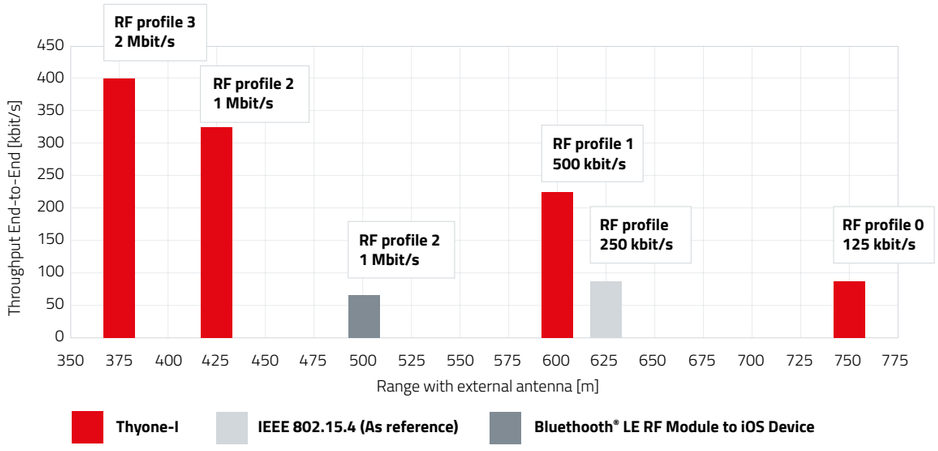
Global availability 2.4 GHz license free band

Mesh

Nano SIM size

- High throughput up to 400 kbit/s
- Range up to 750 m
- Control the GPIOs via remote and local access
- Easy serial cable replacement (transparent mode)
- Test modes for RF measurements
- Smart antenna selection (2-in-1 module)
- Encryption (AES128)
- Certifications: CE, FCC, IC, TELEC

Choose between Long Range and High Troughput



we-online.com/Thyone-I

EXCHANGEABILITY
2.4 GHZ

Exchangeability Thyone-I and Proteus-III

- Footprint compatible RF-modules
- Flexible use of both technologies possible
- Alternative usage by only changing the RF-module
- Future-proof circuit with adaptable interface
- No change in the HW on Host-side required

Take future trends into account and keep the flexibility!

Committing today on a wireless technology for tomorrow seems impossible. How nice would it be to expand your application with different radio protocols at any time without any layout changes. Würth Elektronik offers you a high degree of freedom with the radio module footprint. It is one quality proven hardware base, that prevents you from enormous costs of re-design in future already today. Choose between a Bluetooth®, Wirepas™ or proprietary radio module or the combined variant of proprietary and Bluetooth®.

4-in-1 Footprint

Proteus-III

Thetis-I

Thyone-I

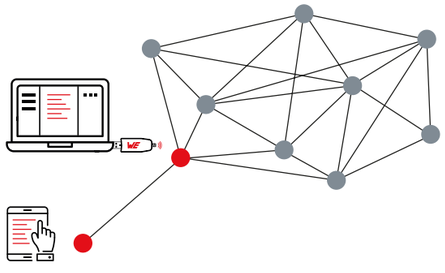
Setebos-I

Proprietary Application with Thyone-I

- For applications with enclosed communication
- Communication invisible for smart devices
- Connection to a standard device only with a certain USB-radio stick possible
- Connected sensors building up a secure network

Usecase

- Secure network set up
- Easy connection between the nodes
- Extending interfaces by connecting a USB-radio stick
- A gateway connecting securely to the network provides the combined result to the user via Bluetooth, Wi-Fi, Cellular, MQTT or on any platform

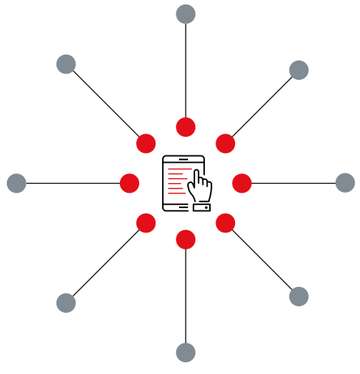


Bluetooth® Application with Proteus-III

- Connecting directly to smart devices
- Parameterization of a sensor
- Reading out results from a measuring device

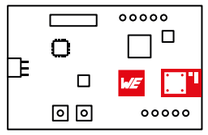
Usecase

- Connecting manually to each sensor via smart device
- Easy and smart consumer-oriented



ADDED VALUES

Development Tools



Eval Boards

- Easy testing
- Rapid prototyping
- FTDI integrated (UART to USB)
- Pins available on header
- Current measurement

we-online.com/EVAL-BLE

More information on page 150

USB-Radio Stick

- USB-FTDI-RF-Module
- Range extension in Flooding Mesh networks
- Radio connection for computer

we-online.com/USB-BLE

More information on page 150

Smart Commander

- PC-Tool for easy testing
- AT-Commands as buttons
- Monitoring UART-Communication
- Export Commands for easy integration in the former HOST-Controller

we-online.com/SmartCommander

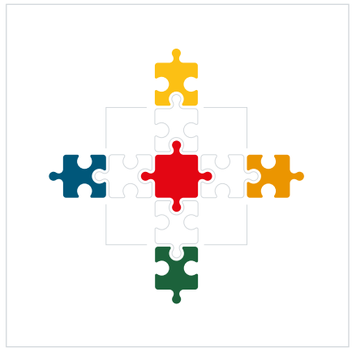
AppNotes

Wireless Connectivity Software Development Kit (SDK)
we-online.com/ANR008

Range Estimation
we-online.com/ANR010

Replacing 868 MHz Radio Modules by their 915 MHz counterparts
we-online.com/ANR015

Proprietary Migration Guide – Replacing a proprietary Radio Module by its successor
we-online.com/ANR016



Software Development Kit

- Typically as C-Files, for mobile Apps platform specific languages
- For comfortable coding of:
  – The HOST-controller system
  – PC Applications & Mobile Apps
- Code examples in Application notes and Manuals

we-online.com/WCO-SDK