# FUNDAMENTALS
# RADIO COMMUNICATION
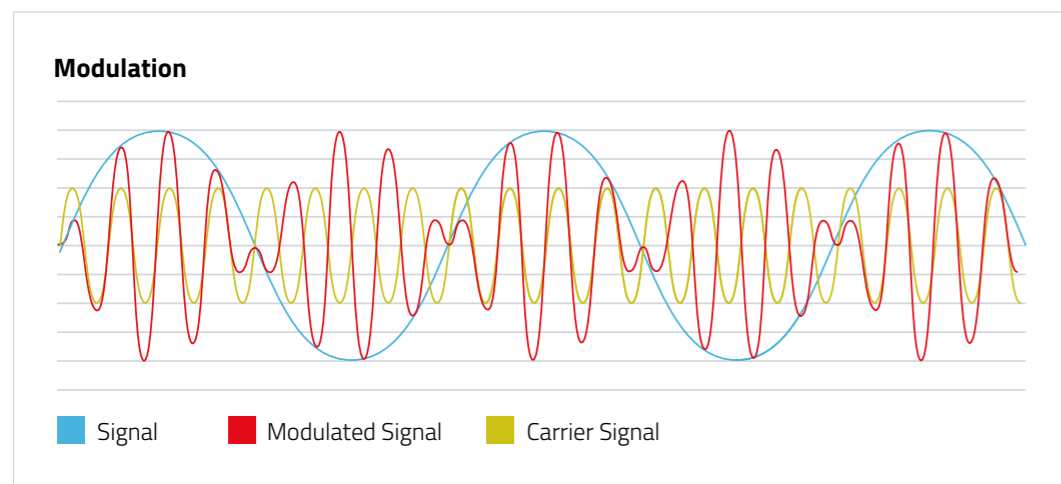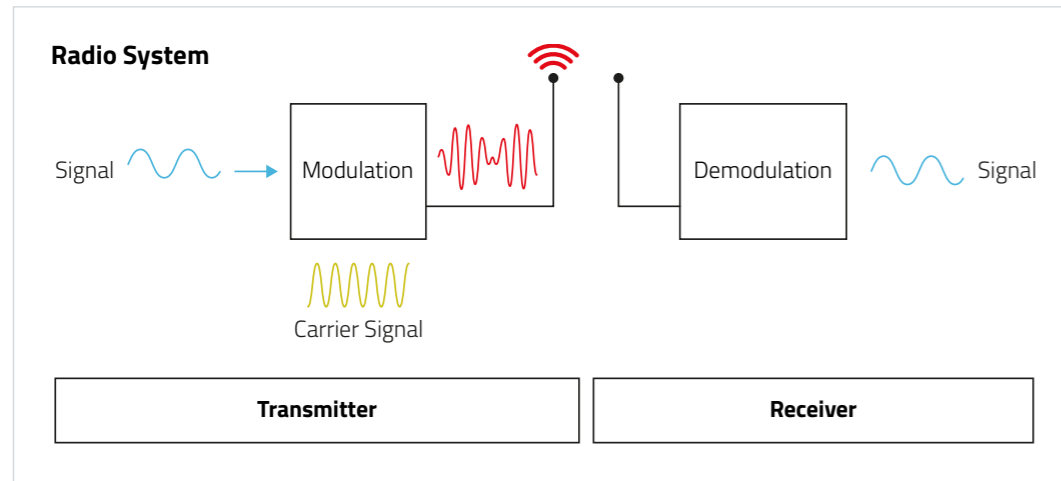
## The History of Radio Technology

Radio technology is a wireless method of transmitting signals by means of modulated electromagnetic waves. In 1884 James Clerk Maxwell predicted the existence of radio waves, which was experimentally confirmed by Heinrich Hertz on November 11th, 1886.

**There are five main key facts, which have to be considered:**

**1.** Transmission of the Signal
**2.** Link Budget
**3.** Duty Cycle
**4.** Access
**5.** Integration of Radio Technology

## 1. Transmission of the Signal

For the Transmission the signal will be modulated on a carrier signal, mostly sinus with constant amplitude. Thereby the amplitude or frequency will be adopted in the rhythm of the transmitted signal. The modulated wave is radiated by an antenna and received on the otherside with an antenna too. Due to demodulation at the receiver the transmitted signal can be used.

**Radio System**



Signal → Modulation → → Demodulation → Signal

Carrier Signal

| Transmitter | Receiver |

**Modulation**



■ Signal  ■ Modulated Signal  ■ Carrier Signal

## Range Estimation

When a radio connection is planned, the given circumstances define largely the requirements for radio range, operating temperature and available space.

**ANR010 Range Estimation**
we-online.com/ANR010

### Model 1: Friis Transmission for Free Space

Friis transmission for Free Space is a model to calculates the path loss, to estimate the range of a radio link in a free space environment. Free field condition: The first Fresnel zone is free of objects.

This model makes the assumption, that the emitted power is radiated equally in every direction (isotropic) and calculates the power loss only taking into account the decreasing power density of the wavefront with increasing distance to the origin, without any reflection, absorption or attenuation.
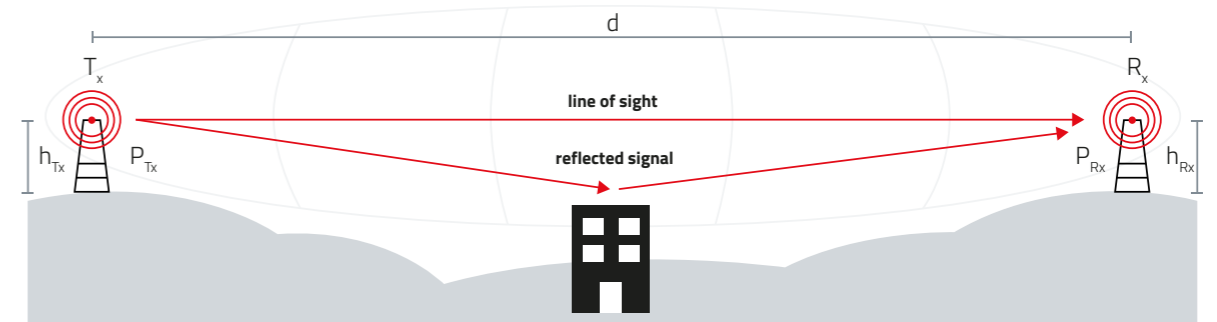


It should be known, that the lower the frequency is, the higher is the possible range of the transmission path.

$f \downarrow \sim d \uparrow$    $\downarrow \sim$ Antenna size $\uparrow$

### Model 2: Two-ray Ground Reflection

The two-ray ground reflection model is applied, when transmitter and receiver are in line of sight but the first Fresnel zone is not free of objects. So the calculation considers the received power of the direct line of sight path and in addition the power of the reflection path with slight phase difference.



As long as the free space requirements are not met, it should be known, that the higher the antenna is mounted above ground, the higher is the possible range of the transmission path.

$h_{Tx} \uparrow \sim d \uparrow$    $h_{Rx} \uparrow \sim d \uparrow$

# FUNDAMENTALS
## RADIO COMMUNICATION

<div style="background:red">

### Conclusion

In a lot of cases there is the need of long distances with regard to the antenna height, so usually the two ray ground model is a good fitting estimation. Only for some special cases with the free space condition fulfilled the Friis model is useful. Having a closer look to the models there are several interesting points to mention.
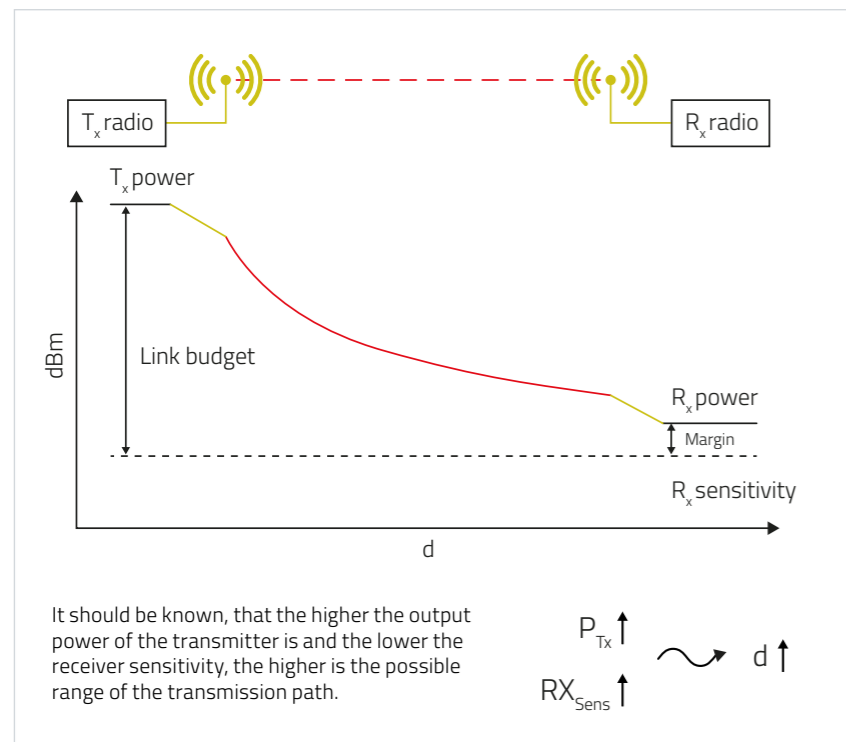
**The Dependency of the Frequency**
Often it is mentioned in general, that the lower the frequency is, the greater the range is. We have learned, that this is only the case when free field conditions are met. But there are other effects of the frequency, as the fact, that for higher frequencies smaller objects will cause reflections, or that for low frequencies it might be hard to find an antenna with acceptable size and efficiency.

**The Influence of the Antenna Height on the Range**
The higher the antennas can be placed, the longer is the range that can be reached. Placing an antenna directly above ground reduces the range so radical, a layman could hardly imagine.

</div>

### 2. Link Budget (power of the carrier)

A link budget is an accounting of all of the power gains and losses that a communication signal experiences in a telecommunication system; from a transmitter, through a medium (free space, cable, waveguide, fiber, etc.) to the receiver. It is an equation giving the received power from the transmitter power, after the attenuation of the transmitted signal due to propagation, as well as the antenna gains and feedline and other losses, and amplifications of the signal in the receiver or any repeaters it passes through.

It should be known, that the higher the output power of the transmitter is and the lower the receiver sensitivity, the higher is the possible range of the transmission path.

$P_{Tx} \uparrow \quad \rightsquigarrow \quad d \uparrow$

$RX_{Sens} \downarrow$

| Power [dBm] | Power [watt] |
|---|---|
| - 120 dBm | 1 fW |
| - 110 dBm | 0.01 pW |
| - 100 dBm | 0.1 pW |
| - 90 dBm | 1 pW |
| - 80 dBm | 10 pW |
| - 70 dBm | 100 pW |
| - 60 dBm | 1 nW |
| - 50 dBm | 10 nW |
| - 40 dBm | 100 nW |
| - 30 dBm | 1 µW |
| - 20 dBm | 10 µW |
| - 10 dBm | 100 µW |
| - 1 dBm | 794 µW |
| 0 dBm | 1 mW |
| 1 dBm | 1.26 mW |
| 10 dBm | 10 mW |
| 20 dBm | 100 mW |
| 30 dBm | 1 W |
| 40 dBm | 10 W |

### 3. Duty Cycle

A duty cycle or power cycle is the fraction of one period in which a signal or system is active. Duty cycle is commonly expressed as a percentage or a ratio. A period is the time it takes for a signal to complete an on-and-off cycle. E.g. using a duty cycle of 10 %, means that the used transmitter is allowed to send 6 minutes in between one hour.

**Duty Cyle**

$$DC = \frac{t_{on}}{t_{on} + t_{off}}$$
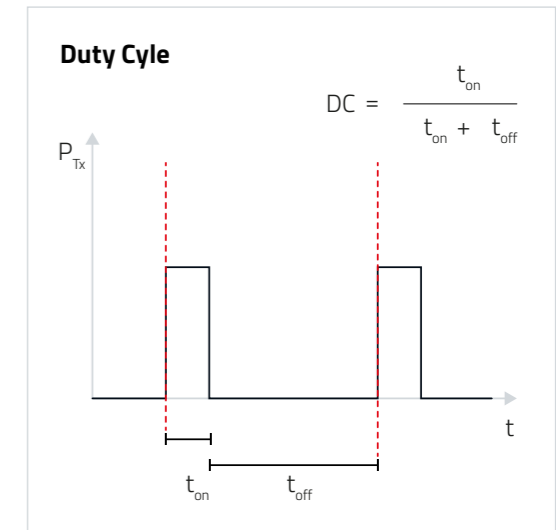
### 4. Polite Spectrum Access – listen before talk

When an application uses polite spectrum access, the duty cycle restrictions are loosened. Polite spectrum access encompasses two aspects: Listen Before Talk (LBT) and Adaptive Frequency Agility (AFA). LBT defines that the device must listen if the medium is already in use by a Clear Channel Assessment (CCA) check. When the medium is in use, the device must wait a random backoff interval or change the frequency before checking again. The latter is called AFA.

### 5. Integration of Radio Technology

One of the last steps before a product with integrated wireless technology can be launched on the market is the certification. Manufacturers of products with integrated RF-technology may only market these with the necessary certification. The following graphics display the three options which are available for integrating wireless technology.
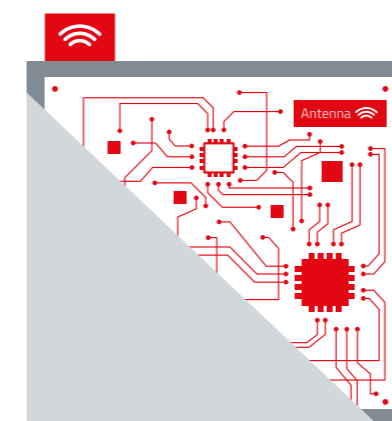
**1** Device without certified radio chip and antenna

- ⊕ Flexible
- ⊖ High effort
- ⊖ High costs
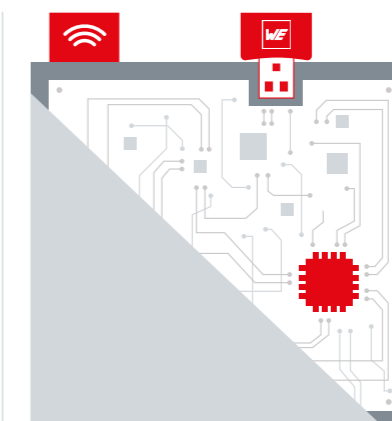
**2** Device with external radio dongle

- ⊕ Plugable
- ⊕ Easy integration
- ⊖ Not that flexible
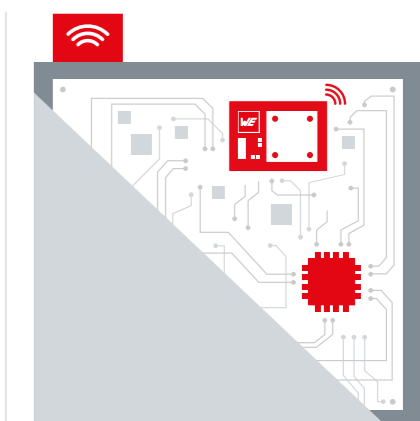
**3** Device with certified radio module and antenna

- ⊕ Low design effort
- ⊕ Fully integrated
- ⊕ Low Certification effort
- ⊖ Not that flexible

# CERTIFICATION
# & CONFORMITY

## Which Certification Rules apply where?

A product that is to be launched globally must meet the certification or conformity criteria of each country it is to be marketed in. It is a kind of a prove to the authorities, that the explained facts (1), (2), (3) and (4) are compliant to regulations, laws, norms, standards and so on. There is no worldwide certification applicable to all countries. The following presents the various certification systems.

Legend:
- CE RED
- FCC
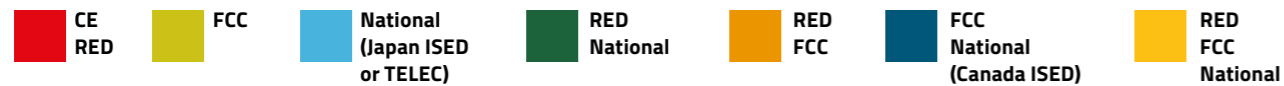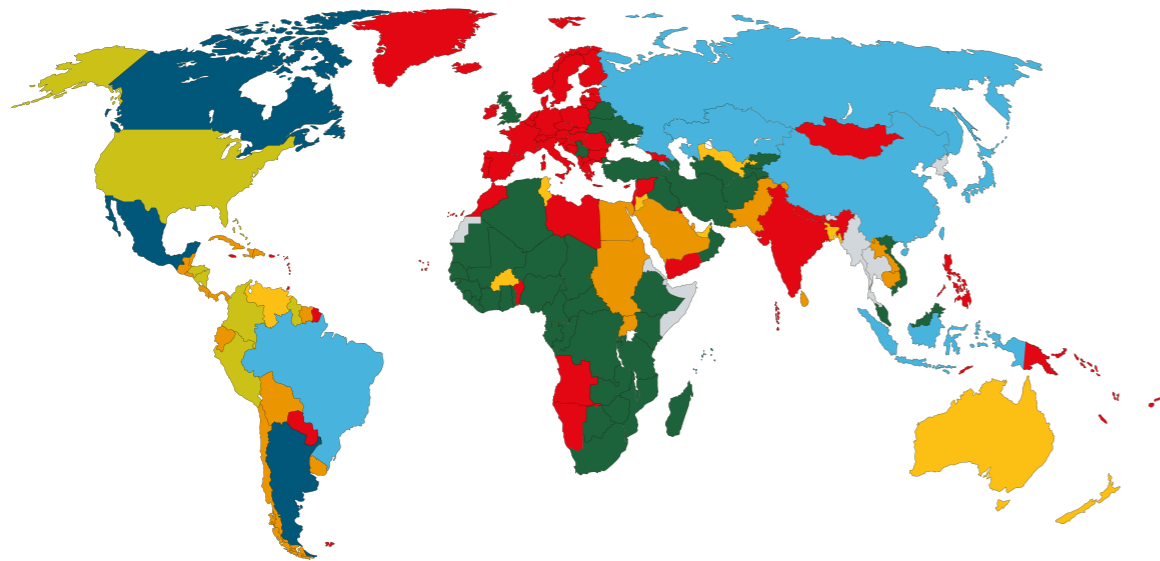- National (Japan ISED or TELEC)
- RED National
- RED FCC
- FCC National (Canada ISED)
- RED FCC National

## Different Certification Systems

**CE**

For products distributed in the European market the CE mark is required. The manufacturer applies the CE mark after fulfilling the Radio Equipment Directive (RED). The tests may be conducted either by the manufacturer himself or by an accredited laboratory. As self declaration the manufacturer is responsible for the products conformity to legal restrictions and regulations.

**National**

For all other markets national regulations apply. For example, a product introduction in Canada or Japan require ISED or TELEC certification. Most countries are close to CE or FCC. Deadlines, requirements and measurements can differ.

**FCC**

In North America, however, products with wireless technology require FCC certification. A certification through an verified authority with measurements is mantadory.

**IC  UKCA**

These, similar to other national regulations, are based on the existing certification bodies, so that only a small amount of additional testing is required. E.g. Canada or United Kingdom.

## Certificate Examples

### Europe: Declaration of Conformity

$C\epsilon$

EU DECLARATION OF CONFORMITY

Radio equipment:        2611011024000

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: 2611011024000**

The object of the declaration described above is in conformity with the relevant Union harmonization legislation: Directive 2014/53/EU and 2011/65/EU.
Following harmonized norms or technical specifications have been applied:

EN 300 328 V2.1.1 (2016-11)
EN 301 489-1 V2.1.1 (2017-02)
EN 301 489-17 V3.1.1 (2017-02)
EN 62368-1:2014 + AC:2015 + A11:2019

The **manufacturer** declares, that....

### US, CA, JP, ... : Certification necessary

ID-Code (Interference provision)

Japanese Radio Law Compliance.
This device is granted pursuant to the Japanese Radio Law.
This device should not be modified (otherwise the granted designation number will become invalid)

The MAC address of the radio device maintains the format 00:18:DA:xx:xx:xx. The latter part xx:xx:xx of the MAC address coincides with the serial number of the device.

Due to the size of the Proteus-III label, the certification label of the Proteus-III is not placed onto the module label.

2611011024000:          [R] 201-190950

The **regulation body** certifies that....

## Benefits of Certification and Conformity

Be smart and ensure that your product will pass the certification process!

Obtain assurance – Precertification is half the battle won and reduces the final test effort.

Save time and money - the likelihood that the end product will pass is much greater with pre-certification.

**All Würth Elektronik radio modules are either certified and / or declared for conformity. This simplifes the approval process of such a radio module within the end-application significantly.**

# WHY USING
# A RADIO MODULE?



### HW  Hardware

- Powerful RF-Chips
- Design of Ready-to-use Modules
- Antenna-Design
- Edge Castellation allows hand soldering in prototyping or small series production

### FW  Firmware

- WE-ProWare Radio Stack
- Requirement for approval (CE, FCC, IC, TELEC)
- 20 years of experience
- Developed for industrial and medical requirements
- Easy to handle and to integrate

### SW  Software

- Plug & Play PC-Software for easy evaluation, testing and updating
- Mobile Apps for easy evaluation & testing
- Design libraries available for fast PCB design for Altium and Eagle
- Software Development Kit (C-Files) for comfortable coding of the HOST-controller system

## ADDED VALUES

In comparison there is big potential for saving time and money by using an RF-module instead of the single RF-IC. With a pure HW-RF-module you can save HW-development resources, since the required circuitry is completely included. An integrated antenna enables an easy integration, even with a minimum of RF knowledge.
The software integration, testing and certification effort will be minimized if the Firmware is already available, because the FW is linked to module certification.

✔ FASTEN TIME TO MARKET    ✔ LOWER DEVELOPMENT COST    ✔ INCREASE MARKET SUCCESS

### Why "Build-Your-Own-Device" is 2nd best Time wise



| | Evaluation | Hardware Design | Software Development | Application Testing | Certification & Listings |
|---|---|---|---|---|---|
| IC / SoC | IC Level | | | | |
| Radio Module (HW only) | Module Level | | | | |
| Radio Module WE-ProWare | Module Level | | | | |

0 %          50 %          100 %

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# WHY "BUILD-YOUR-OWN-DEVICE"
# IS 2ND BEST CHOICE

The situation for every system designer, purchaser or similar related functions is always the same. It needs to be compared between an **"Off-the-shelf" solution** or a **"Build-Your-Own-Device" solution**. For this process we want to offer a list of key aspects, which Würth Elektronik sees as important to be able to take this decision. We differentiate between three main categories in costs.

| | What is necessary to consider? | |
|---|---|---|
| | Würth Elektronik "Off-the-Shelf" radio module | Customer "Build-Your-Own-Device" |

### 1. FIXED COSTS

**Module Buy-Price**
The buying price of the radio module should compare apples by apples. A Würth Elektronik Module always comes with in a package of Hardware (radio module), Firmware (µC & RF stack) and the needed Software for evaluation. One price includes all features. "Building-Your-Own Device" needs to consider ADDITIONALLY the following investments.

**Hardware Development**
The hardware costs are more than just the Bill of Materials for like Microcontroller, IC, Oscillator, Antenna, PCB, LNA, and more. It needs to be taken into account the development itself, the necessary rework during the prototype-to-series phases, the antenna design and possible revisions while the device is already in the market. Using an "Off-the-shelf" solution makes all this mainly unnecessary, as Würth Elektronik is taking care of that for you.

**Firmware Development**
The Firmware running on a radio modules is an accumulation of the one-time software development costs, the recurring costs for software maintenance and required updates and don't forget the necessary documentation. This can simply sum up in a 6-digit Euro investment and following needs to be broken down to each single radio module. Würth Elektronik eiSos modules require a minimum of configuration like communication between module and host microcontroller into the end application from the system designer. A budget of a few days is realistic.

**Required Measurement Equipment**
The final step while taking the radio module into operation is the necessity of measuring all electrical parameters. Therefore it requires to have measurement tools like a Signal Generator, Spectrum & Signal Analyzer and Oscilloscope available, which represent another 6-digit investment, unless those have already been purchased before.

| | Würth Elektronik | Customer |
|---|---|---|
| Module Buy-Price | €€ | € |
| Hardware Development | | € |
| Firmware Development | | €€ |
| Required Measurement Equipment | | €€ |

### 2. VARIABLE & FIXED COSTS

**Certifications, Conformity, Declaration**
A product that is to be launched globally must meet the certification or conformity criteria of each country it is to be marketed in. It can be compared with the typical iceberg model, where the measurements, the official certificate or the official stamp only represents the tip. For a "Build-Your-Own-Device" solution it requires a comprehensive knowledge of all those regulations in each country and following a huge time investment, also for the documentation. Würth Elektronik radio modules come along with the Declaration of Conformity following the Radio Equipment Directive for Europe and on top with a variety of different certifications complying to regulations in the United States, Canada, Japan and some even with the Chinese law. To be on the safe side with the end device, Würth Elektronik recommends a simple and very low cost delta measurement in the final device, as all the documentation will be provided to the customers test lab. Using a USB radio stick from Würth Elektronik makes it even easier – Plug & Play, ready to operate at lowest possible costs.

| | Würth Elektronik | Customer |
|---|---|---|
| Certifications, Conformity, Declaration | € | €€ |

### 3. OPPORTUNITY COSTS

**Avoid Delayed Market Entry and loose Money**
Last but not least, deciding for a "Build Your Own Device" solution will set you back several month in most of the cases. Simply, it is missing sales in the market. Instead, using an "Off-the-shelf" radio module solution from Würth Elektronik and starting to sell the end device earlier will accelerate the market release of the end device. It is like gaining time and early profit.

| | Würth Elektronik | Customer |
|---|---|---|
| Avoid Delayed Market Entry and loose Money | | € |

# HARDWARE

## Speed up your time-to-market

Our modules are fully developed, **tested and validated**. The modules include all essential components. Running WE-ProWare radio stack on our modules ensures a reliable communication through standard protocols and proven RF performance.
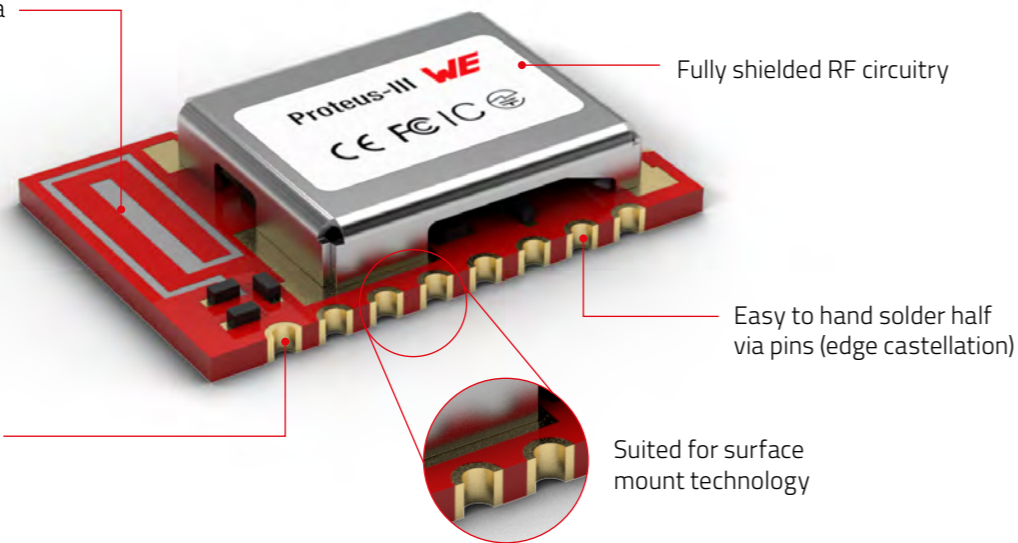
## Open New Markets
## One footprint for different frequencies

Most of our modules offer the **same foot print** and form factor. Make use of this feature to easily exchange modules and adapt your application to specific requirements.

Best-in-class integrated PCB antenna

Fully shielded RF circuitry

Easy to hand solder half via pins (edge castellation)

Standard 50 Ohm antenna interface for an external antenna

Suited for surface mount technology

### ADVANTAGES

✔ Faster developement with a complete RF-module
✔ Possibility to work with RF even if there are limited resources in man power or knowlege
✔ No Antenna Design necessary. Integrated antenna!
✔ Easy soldering, even by hand for smaller quantities in Prototype-phase or for small series
✔ Design in guide for all modules
✔ Design in support by Hardware-, Software- and Application-engineers

## One Hardware Platform

Committing today on a wireless technology for tomorrow seems impossible. Würth Elektronik offers you a high degree of freedom with one radio module footprint for a lot of radio modules to expand your application with different radio protocols at any time without any layout changes. It is one quality proven hardware base, that prevents you from enormous costs of re-design in future already today.

E.g. choose between a Bluetooth®, Wirepas™ or proprietary radio module or the combined variant of proprietary and Bluetooth®.

## Design Libraries

▪ Available for fast PCB-unbundling
▪ For Altium and Eagle

**Altium**

E **EAGLE**

# INTEGRATED
# ANTENNA MATCHING

## Design based on Simulation

The focus of the integrated antenna is for highly miniaturised design. The design ideas are optimized by antenna simulation for best performance. Beside the commonly used parameter of antenna dimensions also the influence of the ground plane of the motherboard is considered in the simulation.
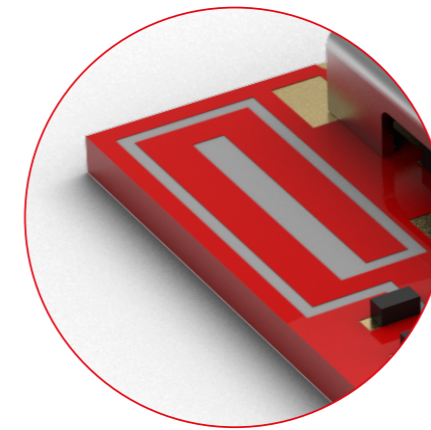
**Simulation**

**Measurement**
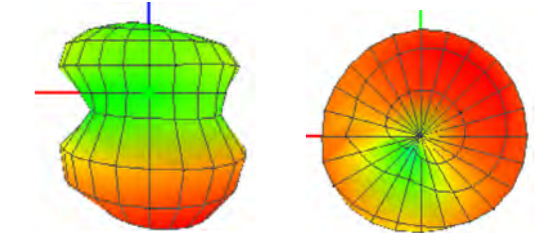
**Contact our RF engineers today!**

antenna.matching@we-online.com

## Verification evaluation board

A second step of optimisation is the verification of the design by measuring it's radiated power and characteristics.

Transceiver RF-pad internally matched to 50 Ohm ❶

❷ Optional external matching

❸ Internal antenna matching

Picture: Evaluation board Thyone-I
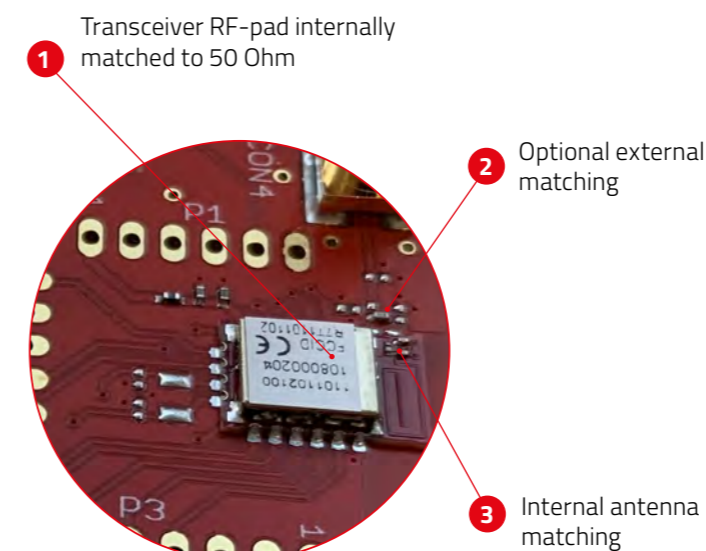
## Impedance Matching

With the internal antenna matching the integrated antenna is perfectly matched to the evaluation board.

An external matching is optional possible to either match any antenna to the module as well as re-matching the integrated antenna to different environmental conditions.

The RF pin is internally matched to 50 Ohm.

# EXTERNAL
## ANTENNA MATCHING

### Performance Optimization

The matching of an external antenna, which can be a Multilayer Chip Antenna or even a RF-connector can be a simple process when the fundamentals of impedance measurement and matching are understood and a logical iterative process is followed. Würth Elektronik is offering not just the components for a matched Antenna Network, we can also support in the process of designing. Our RF-Design engineers will assist you with antenna matching and performance optimization during the design and testing phase of your wireless product.

### Smith Chart

The WE-MCA Multilayer Chip Antenna has a very diverse applications portfolio when it comes to wireless data transfer on different frequencies.

With the help of the Smith chart, the antenna impedance, consisting of resistive and reactive components, can be easily represented graphically. In a perfectly matched antenna network, the impedance at the operating frequency of the antenna is in the middle of the Smith chart and therefore at 50 Ω. This can be achieved by using RF inductors and/or capacitors. A pi network is particularly useful for this purpose, since it can be used very flexibly for antenna tuning at 50 Ω from almost any other value.
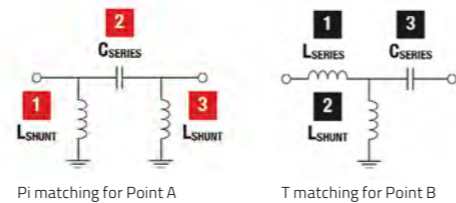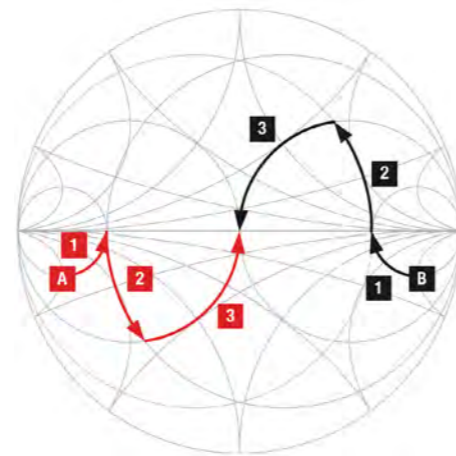
### What we can offer you

- Simulation models
- Optimize antenna performance
- Antenna selection
- Matching circuit
- Antenna placement and positioning
- Measurement of reflection loss

Radio Module with WE-MCA as antenna

Radio Module with RF-connector

we-online.com/katalog/
en/em/connectors/coax

**Matching Circuit**

Pi matching for Point A      T matching for Point B

**OUR SERVICE & SUPPORT**

- ✔ Frequency range of 400-6000 MHz
- ✔ Simulation models
- ✔ Optimized antenna performance
- ✔ Antenna selection
- ✔ Wide range of RF products
- ✔ Matching circuit
- ✔ Placing and matching of the antenna
- ✔ Measurement of the reflection loss

**Contact our RF engineers today!**

antenna.matching@we-online.com

# WÜRTH ELEKTRONIK
## RF COMPONENTS

### Multilayer Chip Antenna

- Extremely low profile
- Power capacity: 5 W max.
- Omni-directional
- Operating temperature: −40 C to +85 C
- High gain
- Wireless communication applications: GSM, WLAN, Bluetooth,
- Home RF, IoT

we-online.com/katalog/en/WE-MCA

Unlike custom designed PCB antennas, the WE-MCA has a consistent omnidirectional radiation pattern. This gives flexibility and variation in the positioning of the antenna in the application.

WE-MCA

| Matching Network | Antenna |

WE-KI

WCAP-CSRF

### Wire Wound Ceramic Inductor [1]

- Excellent Q-factor
- up to 12.5 GHz self resonant frequencies
- High quality
- Up to 2 % inductance tolerance
- High thermal stability
- Operating temperature: −40 C to +125 C
- Custom designs on request

we-online.com/katalog/en/WE-KI

### Multilayer Ceramic Capacitor [1]

- Operating temperature: -55 C to +125 C
- High Performance ceramic
- Minimal Aging for NP0
- Perfect for Filtering

we-online.com/katalog/de/WCAP-CSRF

1) Modelithics® libraries available for Advanced Design System (ADS), Genesys and also for AWR Microwave Office

**AppNotes**

**WE-MCA Multilayer Chip Antenna Placement & Matching**

we-online.com/ANP057

**LC Filter Design With MLCCs: Why The Applied Voltage Matters**

we-online.com/ANP062

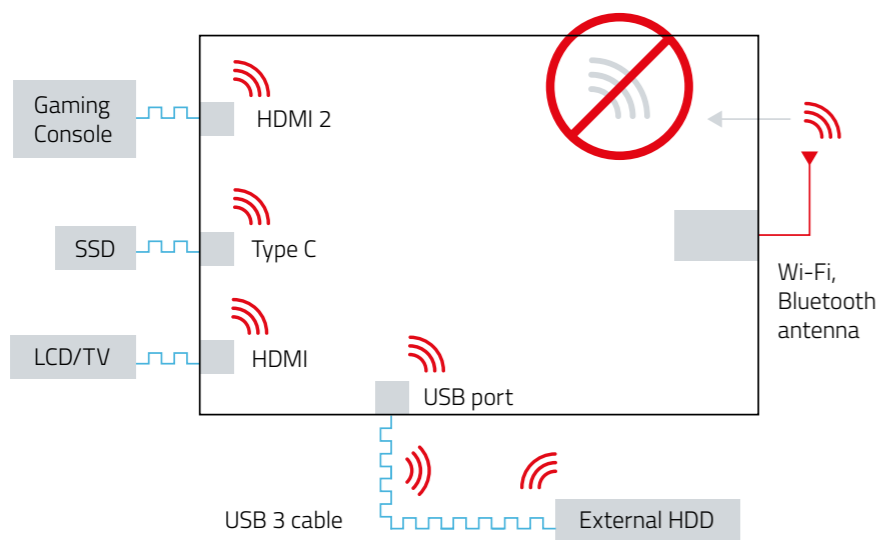# IMPROVE YOUR DESIGN
## GET RID OF NOISE

### Noise at 2.4 / 5.0 GHz

Noise can interfere with the extremely sensitive wireless channels operating at 2.4 / 5.0 GHz bands. Therefore it is important to consider a holistic design of the full application.
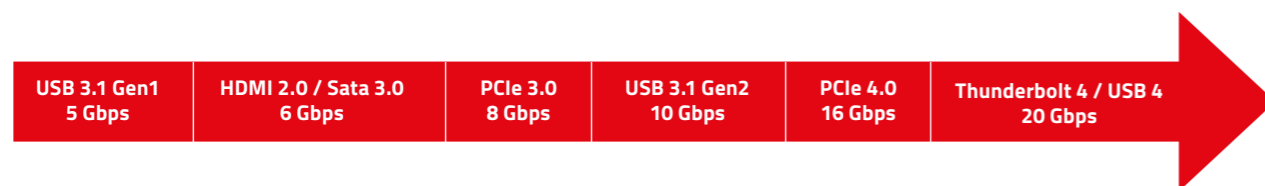
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#### Communication Interfaces – source of noise

Noise can interfere with the extremely sensitive wireless channels operating at 2.4 / 5.0 GHz bands.

- Communication interfaces radiate noise on a very broad spectrum which can interfere with the Wi-Fi signal
- This can lead to loss of the Wi-Fi signal



Gaming Console — HDMI 2
SSD — Type C
LCD/TV — HDMI
USB port
Wi-Fi, Bluetooth antenna
USB 3 cable — External HDD

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### Signal Integrity and Increase in Data Speed of Highspeed interfaces

Signal integrity defines the quality of an electrical signal and refers to the challenges that arise due to high frequency data transmission. With the high switching speeds of the modern digital I/O interfaces, we are now able to achieve high data rates and bandwidth. At the same time, noise is a big concern for the integrity of these high frequency digital signals.

| USB 3.1 Gen1 5 Gbps | HDMI 2.0 / Sata 3.0 6 Gbps | PCIe 3.0 8 Gbps | USB 3.1 Gen2 10 Gbps | PCIe 4.0 16 Gbps | Thunderbolt 4 / USB 4 20 Gbps |
|---|---|---|---|---|---|



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### Common Mode Chokes - reduce emissions, increase noise immunity

Common mode Filters/Chokes are a very effective way of protecting the data lines against noise interference, while reducing emissions at the same time. Choosing the appropriate common mode choke for a high-speed differential interface requires knowledge about both the application and the filter itself.

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#### WE-CCMF

Ceramic Common Mode Filter:
- Ceramic based choke that works on the principle of the transmission line theory
- Complex inner resonant structure ensures high common mode suppression at wireless frequencies (2.4 & 5.0 GHz)
- Keeps the differential signal intact

we-online.com/katalog/en/WE-CCMF



Insertion Loss vs Frequency

- 748030024 – Common Mode
- 748030024 – Differential Mode
- 748032455 – Common Mode
- 748032455 – Differential Mode
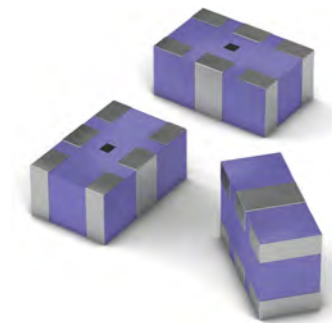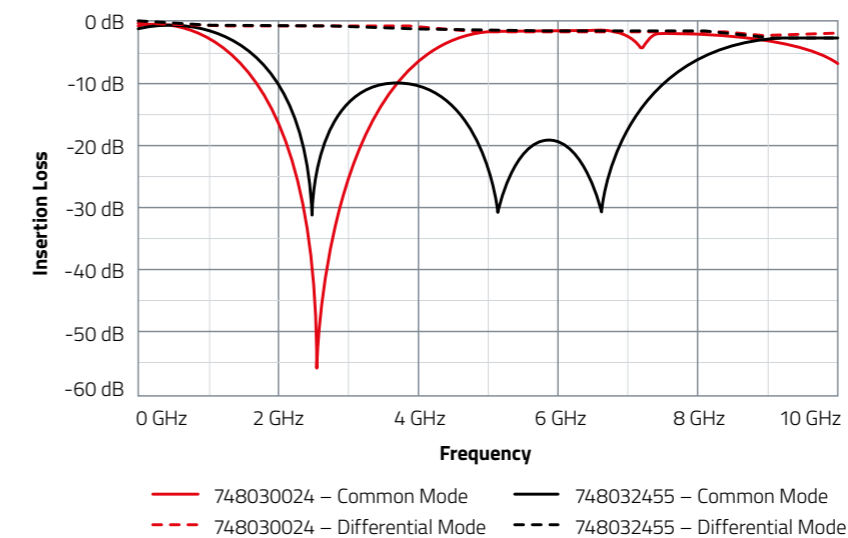
# FIRMWARE:
## WE-PROWARE AS OPERATING SYSTEM

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

WE-ProWare
Profile

BLE
Stack

USER
SETTING

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

WE-ProWare
Radio Stack

USER
SETTING

## EXAMPLE:
## Proprietary Module

Offers Easy-to-Use Command
Interface among other features

More on page 74

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# FIRMWARE:
## WE-PROWARE

### One solution with full flexibility

Our Firmware and radio stack WE-ProWare offers full flexibility through the possibility of using
different radio profiles and/or interfaces while being an off-the-shelf software code to enter the
wireless world immediately. For a simple integration we offer an API to match your needs with the
offerings from the Firmware WE-ProWare

### Profiles

Instead of writing software code, select
options (=profiles). The usable profiles offer
high flexability in:
- Network topology
- Data rate
- Throughput
- Range
- Energy consumption

### API (Application
### Programming Interface)

- Offers communication directly to the module
- Simple AT-Commands, well known and usable
  with nearly every microcontroller, regardless
  of its size

Range

Power

Data

I/O

Data rate

AT Commands

API

Profiles

Interface

BLE

Radio Stack

I2C

WiFi

Proprietary

UART

SPI

### Radio Stack

- Bluetooth® LE Stack for easy communication
  with Smart Devices
- Wi-Fi Stack guarantees high data rates
  and IP based communication
- Proprietary stack developed for industrial
  and medical requirements
- LTE cellular radio stack for global connectivity

### Interface

Different Interfaces available suiting
every application:
- UART
- SPI
- I²C

# RADIO STACK &
# FIRMWARE OPTIONS

**The best Wireless Solution for you – You can choose between the following options:**

## 1. STANDARD FIRMWARE

- RF Module comes with a standardized firmware
- RF Module is subject to further firmware development
- 100% verified, electrical tested and validated
- update functionality given (UART, FOTA, ...)
- packaged in Tape & Reel, ESD und MSL conform

CE  National  ⊜  FC  IC  UK CA

## 2. BUILD YOUR OWN FIRMWARE

**Get every module without WE Firmware to bring your own solution on it.**

- RF Module comes without any standardized firmware
- 100% electrical testing on customer request
- RF Module will have a standard part number
- packaged in Tape & Reel, ESD und MSL conform

C̶E̶  N̶a̶t̶i̶o̶n̶a̶l̶  ⊜̶  F̶C̶  I̶C̶  U̶K̶ C̶A̶

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**Ophelia-I**
Hardware-only module based on Nordic nRF52805 radio chipset

## 3. FIRMWARE FREEZE

**A firmware freeze guarantees a static behaviour of the module and no change in the module at all.**

- RF Module comes with a standardized firmware
- RF Module is NOT subject to further firmware development
- RF Module will have a fixed revision of the firmware e.g. 1.3.1
- RF Module will have a unique part number
- 100% verified, electrical tested and validated
- packaged in Tape & Reel, ESD und MSL conform

## 4. CUSTOM

**A fully customized product with your dedicated application implemented on the module. This might require Würth Elektronik to offer design consultancy services and the product is not available ex stock.**

- RF Module comes with a custom firmware
- RF Module will have a unique part number
- 100% electrical testing on customer request
- packaged in Tape & Reel, ESD und MSL conform
- we can upload your Firmware in our production process to the WE Hardware

Thread | MIOTY | Zigbee | RS485 / CAN | Bluetooth® Mesh | Application on the module

SPI / I²C | Switch status | Sensor measuring | ...

**Do you have a need for one of the mentioned customizations? Get in contact with us. We will find out, what fits best for you! Contact your local sales or email to:**
wireless-sales@we-online.com

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**A special service for every customer:**

## 5. INDIVIDUALIZED ADAPTION (USER SETTINGS)

**We align our standard firmware to your requirements which simplifies your production process.**

- RF Module comes with a standard firmware
- User Settings adaptions defined by customer
- Continuous & further firmware development only on customer request
- Individualized Adaption (User Settings)
- Firmware freeze on customer request
- RF Module will have a unique part number
- 100% verified and electrical tested
- packaged in Tape & Reel, ESD und MSL conform

We use our proven programming and testing processes to ensure
→ high quality and
→ reliability
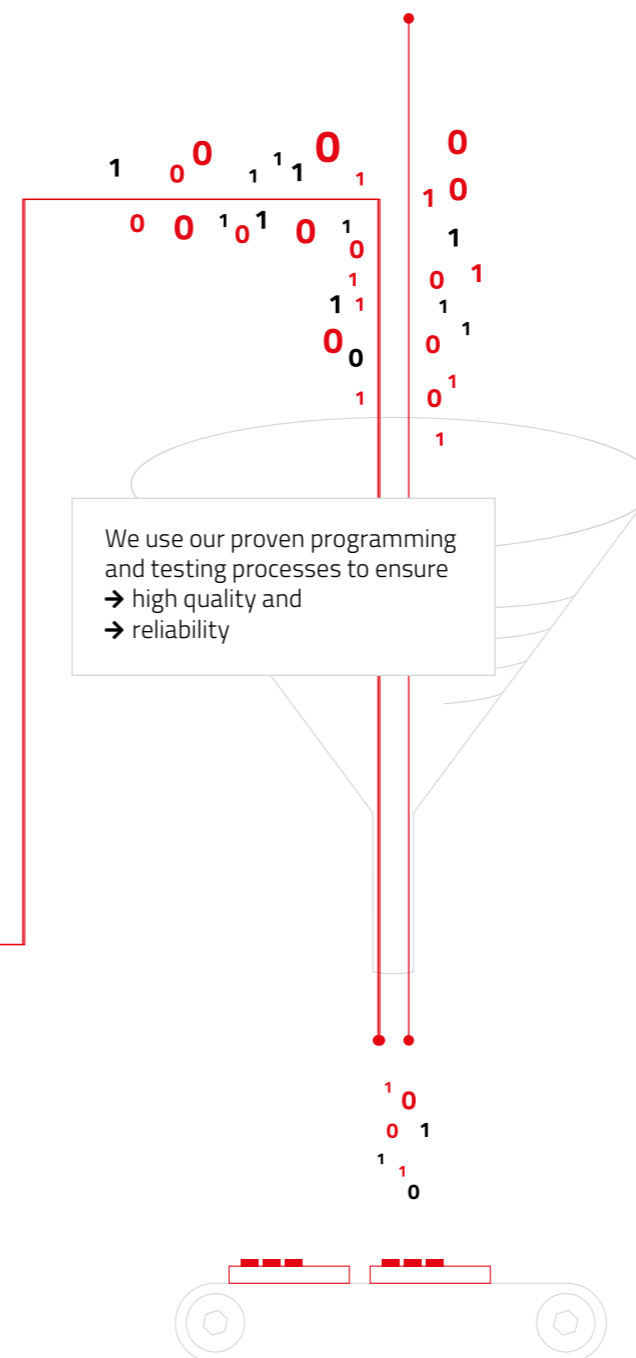
### Exemplary UserSettings

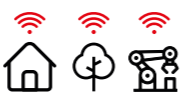| Setting | Calypso | Proteus |
|---|---|---|
| Advertising timing | | ✓ |
| Beacon options | | ✓ |
| Connection timing | | ✓ |
| Device Name | | ✓ |
| Device Information Service Options/Fields | | |
| High Throughput mode on/off | | |
| Profile Options (Base UUID) | | ✓ |
| Scan options | | ✓ |
| Long Range Connect | | |
| WLAN country (EU, US, JP) | ✓ | |
| WLAN mode (STA, P2P/wifi direct) | ✓ | |
| WLAN P2P Parameters | ✓ | |
| WLAN Policy (Power, Connection) | ✓ | |
| WLAN Provisioning Parameters * | ✓ | |
| SNTP Time Servers | ✓ | |
| WLAN STA Profile(s) | ✓ | |
| Radio TX Power | ✓ | ✓ |
| Security options | ✓ | ✓ |
| Sniffer mode on/off | | |
| StaticPasskey (128 bit) | | ✓ |
| UART data rate | | ✓ |
| UART data rate+parity | ✓ | |
| UART flow control on/off (RTS/CTS) | | ✓ |
| OpMode (Command or Transparent UART) | | ✓ |
| Clear Channel Assessment/Listen before Talk | | |
| GPIO control | | |
| UART data rate | | |
| satellite system selection | | |
| Protocol (NMEA or OSP) | | |
| update rate (typ. 1Hz) | | |
| Firmware desciption (e.g. Customer name) | | |
| Secure Boot Key | ✓ | |
| Image Authentication Key | ✓ | ✓ |

# WIRELESS GUIDE

## How to find the suiting product?

This Wireless Guide will help you to find a solution for your application! Answer the following questions, as far as you can and with the information in the last pages, you will be able to take a decision.

**If there is any need of support: Contact us!**
wireless-sales@we-online.com

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### 1. Region



**In which region will the application run or should be used in the future?**

☐ Europe
☐ North America
☐ South America
☐ Asia
☐ worldwide
☐ other:_____

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### 2. Range



**What range do you need to cover in your application?**

☐ 0 - 15 m
☐ 15 - 50 m
☐ 50 - 100 m
☐ 100 - 500 m
☐ 500 m - 2 km
☐ 2 km - 10 km
☐ >10 km

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### 3. Environment



**In which environment will your application be used?**

☐ Indoor
☐ Outdoor
☐ Industrial
☐ Home Automation
☐ other:_____

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### 4. Data

001101
010100
101101

**How much data has to be transmitted? Which data rate is required?**

☐ Very low data rate (up to 1 kbps)
☐ Middle data rate (up to 100 kbps)
☐ High data rate (>100 kbps)
☐ Very high data rate (>500 kbps)

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### 5. Energy



**What about power consumption? How much energy is available? How long should a battery last?**

☐ Long term battery powered
☐ Battery powered
☐ Main powered
☐ other:_____

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### 6. Interface



**Communication to...?**

☐ Smart Device (Mobile, Tablet)
☐ PC, Server, etc.
☐ Device of own development
☐ Special communication interface (Wirepas, wM-Bus, CAN-Bus, ...)
☐ Mesh (Wirepas, Bluetooth® Mesh, Closed Mesh)
☐ other:_____