

USER MANUAL

PROTEUS-II USB RADIO STICK

2608036024011

VERSION 1.4

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	1.1	<ul style="list-style-type: none">• Initial version of the manual	February 2020
1.1	1.1	<ul style="list-style-type: none">• Updated Declaration of EU conformity to latest Version of EN 300 328 after successfully passing corresponding delta test in chapter Regulatory compliance information.	November 2020
1.2	1.1	<ul style="list-style-type: none">• Updated Declaration of EU conformity in chapter Regulatory compliance information.	December 2020
1.3	1.1	<ul style="list-style-type: none">• Updated document style• Function description is part of the Proteus-II user manual [1]	April 2023
1.4	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 Proteus-II is a radio module that provides wireless connectivity capabilities in the 2.4 GHz frequency band. The Proteus-II USB radio stick incorporates the Proteus-II in a USB stick form factor enabling easy interfacing with any USB enabled device like personal computer or laptop. The Proteus-II USB radio stick allows quick set-up of a radio link between PC and any system with integrated Proteus-II radio module.

1.1 Ordering information

WE order code	Description
2608036024011	Radio dongle including Proteus-II

Table 1: Ordering information

2 Functional description

The Proteus-II USB radio stick consists of Proteus-II radio module along with an 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 of the Proteus-II USB radio stick 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 Proteus-II USB radio stick.

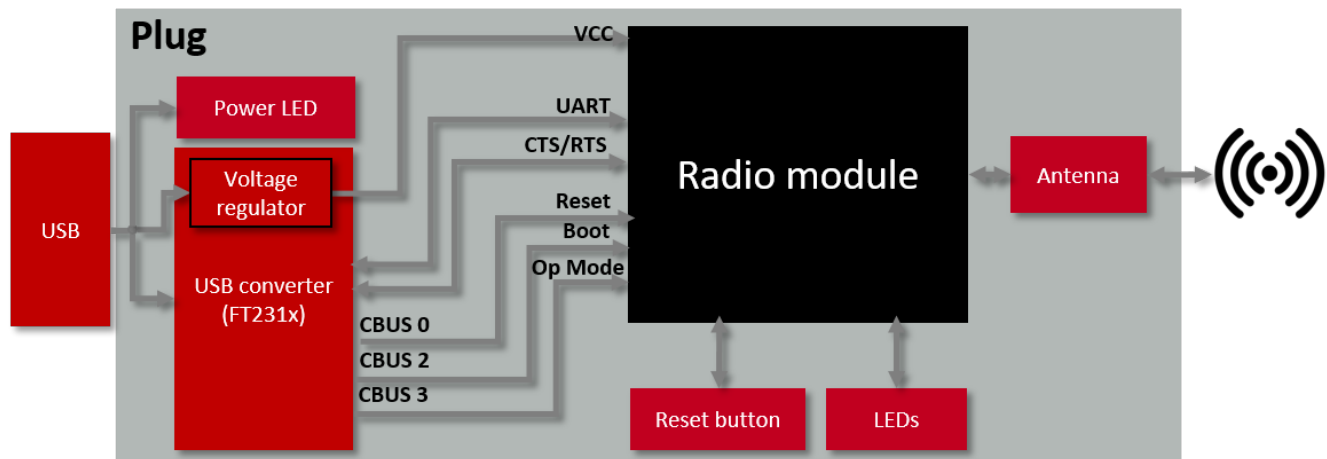


Figure 1: Block diagram of the Proteus-II USB radio stick



For detailed function description of the Proteus-II USB radio stick, please refer to the user manual of the underlying radio module Proteus-II [1] .

2.1 Typical Setup

The Proteus-II USB radio stick offers a command based API or a transparent interface ("Peripheral Only" mode) on it's UART.



The Proteus-II USB radio stick does not integrate into the possibly existing Bluetooth® interface of any host like a Windows or Linux PC.

In the first setup shown below the PC does not need to implement any Bluetooth® specific functions or drivers, just the command API of the Proteus-II needs to be implemented using a serial port connection (via VCP or D2XX).

This API allows to select the central role, scan for devices and performing the steps to connect to other Proteus Bluetooth® LE devices.

The Würth Elektronik eiSos Wireless Connectivity SDK [2] includes an example implementation as C source code which can be ported with minimum effort to any host.

In the second typical setup the smart phone includes a Bluetooth® LE chipset and Bluetooth® LE stack (as part of the smart phone operating system) offering API's for Bluetooth® LE to any app on the smart phone. This app needs to implement Proteus-II profiles and characteristics (UUIDs) as well as the protocol used by Proteus-II.

The Proteus-II Application Note "Advanced User Guide" [3] provides all information required for developers.

The Proteus-II USB radio stick in this setup is being used as peripheral device that offers it's services. This peripheral mode can be used either in command mode or in the so called "Peripheral Only Mode", which offers a transparent UART to Bluetooth® LE (and vice versa) interface once a central device initiated a connection and the connection setup negotiation between the two roles was successful.

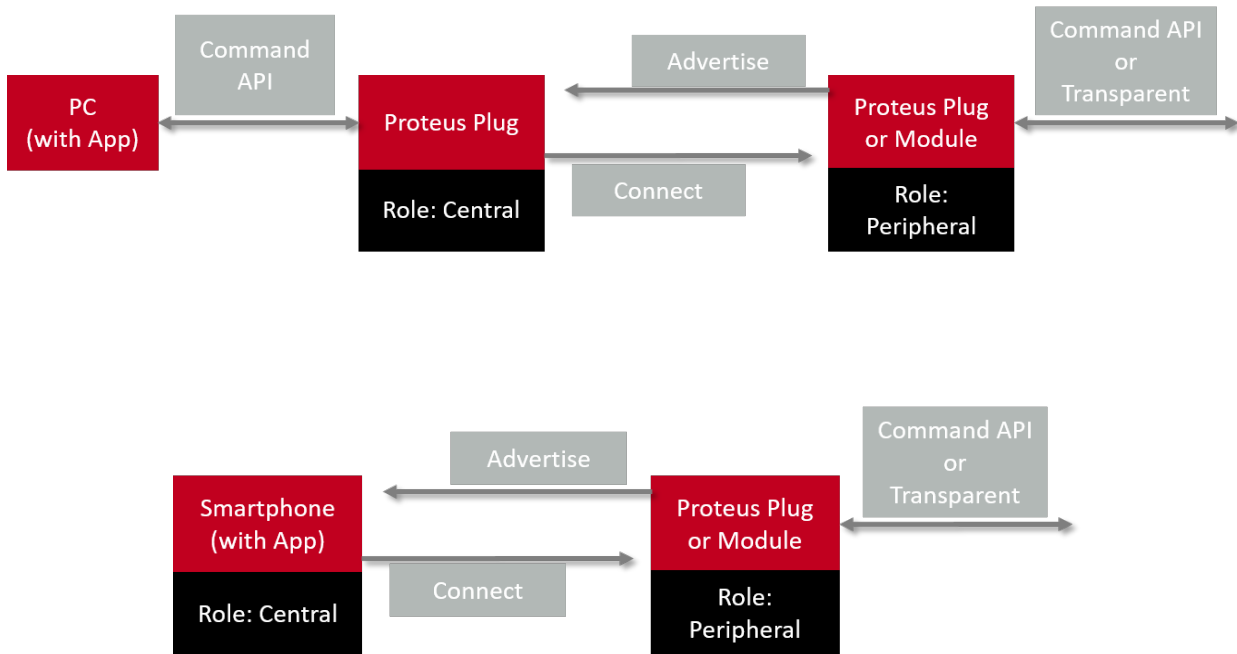


Figure 2: Typical setups for Proteus-II USB radio stick

2.2 Taking into operation

To use the Proteus-II USB radio stick, the drivers of FTDI converter IC has to be installed. This can be achieved by following the FTDI "Install Guides" available at the link below. The VCP driver for Windows OS will also install D2XX drivers in parallel. In case of modern Linux Kernels the VCP driver is already part of the Kernel:

Windows VCP: <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 Proteus-II user manual [1] 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 radio stick's reset button or using the CBUS0 pin (see chapter 2.2.3.1). This reset procedure is also recommended after each reboot of the PC.

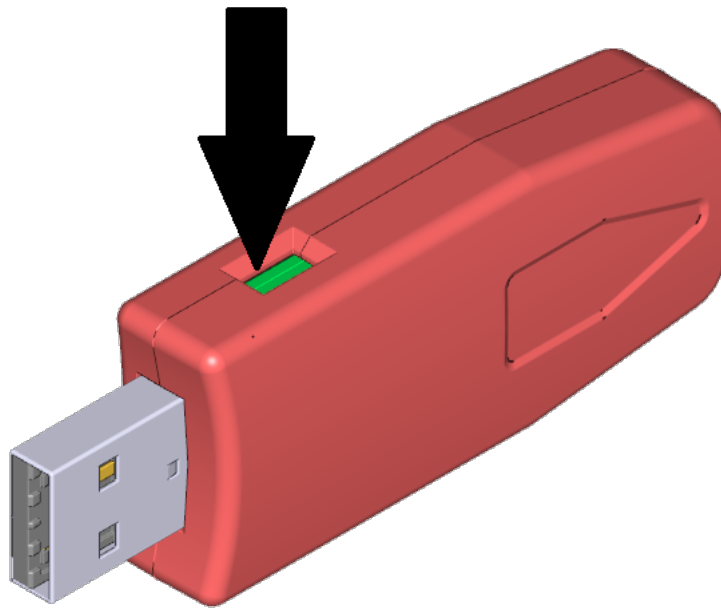


Figure 3: Reset button on the Proteus-II USB radio stick

2.2.1 Timing parameters - Reset and power-up

After resetting the Proteus-II USB radio stick a `CMD_GETSTATE_CNF` is sent (when in Command Mode) to the serial interface as soon as the Proteus-II is ready for operation. In Peripheral Only mode this information is not available as a UART signal or on the USB interface.

Description	Typ.	Unit
Ready after reset	77	ms

The USB dongle has a delay τ implemented in the reset line towards the module to ensure stable VCC and stable FT231x signal levels after plugging the dongle into the USB of the host. This will introduce an additional typical delay of $\tau = 50$ ms in case of a Proteus-II USB radio stick power-up and reset. The reset function of the Proteus-II USB radio stick (via push-button, CBUS0 or `CMD_RESET_REQ`) has also this additional delay.

2.2.2 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

2.2.3 Usage of CBUS pins

To switch the CBUS pins static HIGH or LOW and thus to use the provided pins functions of the Proteus-II 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>

Examples 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>

2.2.3.1 Resetting the Proteus-II USB radio stick using the CBUS pin

The */RESET* pin of the Proteus-II 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

2.2.3.2 Switching from command mode to peripheral only mode and vice versa

The operation mode of the Proteus-II USB radio stick can be defined by applying the right voltage level at the *OP_MODE* pin of the Proteus-II during its start-up phase. As this pin is connected to the CBUS3 pin of the built-in FTDI converter chip, the CBUS3 pin can be controlled by the host.



Additional care has to be taken when configuring the pins on the FTDI converter. The EEPROM content of the chip is changed by this action. Any misconfiguration may prevent the normal operation of the USB dongle. This method is not intended for periodic use. The factory defaults of the CBUS pins are: CBUS0 to CBUS2 - GPIO, CBUS3 - CBUS_Drive_0

By default, the CBUS3 pin of the FT231X is configured as FT_CBUS_Drive_0 (static LOW) such that the Proteus-II USB radio stick starts in command mode. To start the USB radio stick in peripheral only mode, configure the CBUS3 pin as FT_CBUS_Drive_1 (static HIGH) and perform a reset of the device, as specified in chapter 2.2.3.1 .

In case the USB radio stick shall start in command mode again, configure the CBUS3 pin as FT_CBUS_Drive_0 (static LOW) and perform a reset of the device, as specified in chapter 2.2.3.1 .

For reasons of simplicity, Würth Elektronik eiSos provides a small Windows PC tool¹, that uses the FTDI D2XX driver instructions to set the Proteus-II USB radio stick into the desired operation mode.

¹The tool is only available on request. Please contact your Business Development Engineer (BDM) or mail to WCS@we-online.com.

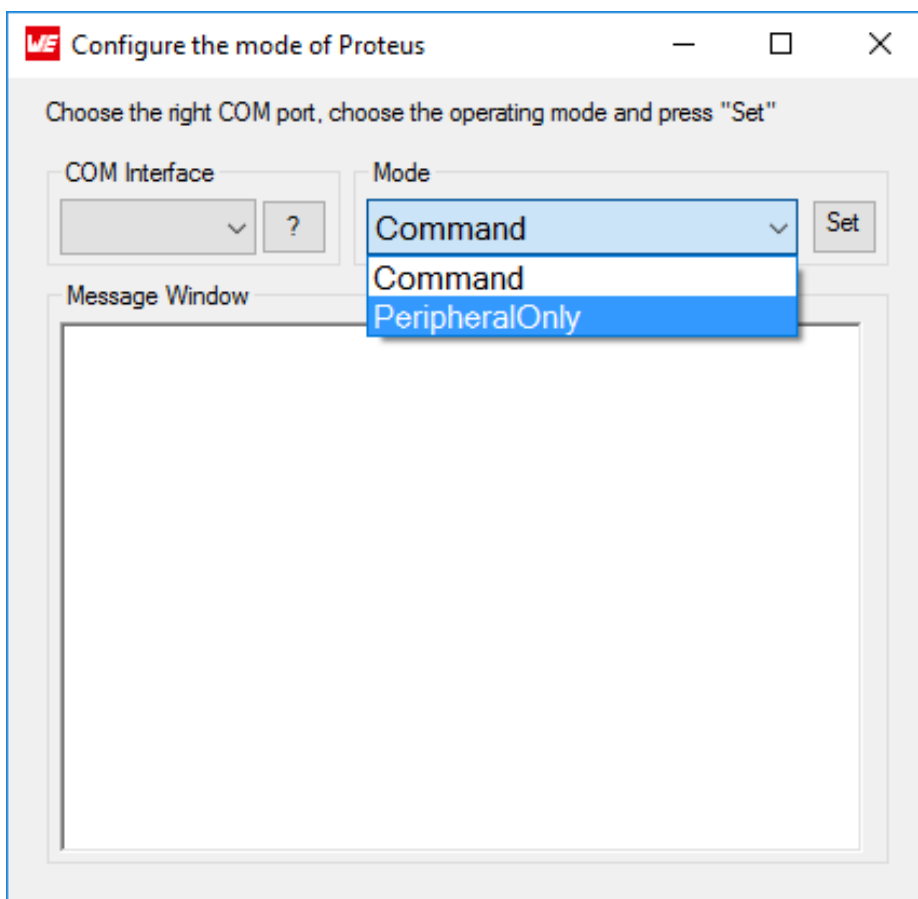


Figure 4: Windows tool to set the Proteus-II USB radio stick to peripheral only mode or command mode

3 Regulatory compliance information

3.1 Important notice EU

The use of RF frequencies is limited by national regulations. The Proteus-II USB radio stick has been designed to comply with the RED directive 2014/53/EU of the European Union (EU). The Proteus-II 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 Proteus-II 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 Proteus-II USB radio stick has been designed to comply with the FCC Part 15.

The Proteus-II 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: 2608036024011

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: 2608036024011

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 (2019-11)
EN 301 489-17 V3.2.4 (2020-09)
EN 62479 : 2010
EN 62368-1:2014 + AC:2015

i.A. G. Exlerdt

Trier, 18th of December 2020

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] Würth Elektronik. Proteus-II user manual. <https://www.we-online.de/katalog/de/manual/2608011024010>.
- [2] Würth Elektronik. Wireless Connectivity SDK for STM32 - Radio module drivers in C-code. https://github.com/WurthElektronik/WirelessConnectivity-SDK_STM32.
- [3] Würth Elektronik. Application note 5 - Proteus-II advanced developer guide. <http://www.we-online.com/ANR005>.

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

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You are responsible for using the Würth Elektronik eiSos wireless connectivity product with the incorporated firmware in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product.

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