ANR008 WIRELESS CONNECTIVITY SDK

APPLICATION NOTE

VERSION 1.4

MAY 28, 2020
## Revision history

<table>
<thead>
<tr>
<th>Manual version</th>
<th>SW version</th>
<th>Notes</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>3.0.0</td>
<td>• Initial version of this document</td>
<td>April 2019</td>
</tr>
<tr>
<td>1.2</td>
<td>3.0.0</td>
<td>• Updated file name to new AppNote name structure. Updated important notes, legal notice &amp; license terms chapters.</td>
<td>June 2019</td>
</tr>
<tr>
<td>1.3</td>
<td>3.1.0</td>
<td>• Updated supported modules</td>
<td>September 2019</td>
</tr>
<tr>
<td>1.4</td>
<td>3.2.0</td>
<td>• Updated supported modules</td>
<td>May 2020</td>
</tr>
</tbody>
</table>

* For SDK version history see chapter Software history
## Abbreviations and abstract

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>Checksum</td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>Duty cycle</td>
<td>Active transmission time per hour expressed as percentage. 1% means, channel is occupied for 36 seconds per hour.</td>
</tr>
<tr>
<td>FSE</td>
<td>Field Sales Engineer</td>
<td>Support and sales contact person responsible for limited sales area.</td>
</tr>
<tr>
<td>0xhh [HEX]</td>
<td>Hexadecimal</td>
<td>The prefix 0x indicates hexadecimal values. All other numbers are decimal values.</td>
</tr>
<tr>
<td>HIGH</td>
<td>High signal level</td>
<td></td>
</tr>
<tr>
<td>LOW</td>
<td>Low signal level</td>
<td></td>
</tr>
<tr>
<td>LPM</td>
<td>Low power mode</td>
<td>Operation mode with reduced energy consumption.</td>
</tr>
<tr>
<td>LRM</td>
<td>Long range mode</td>
<td>Tx mode increasing the RX sensitivity by using spreading and forward error correction</td>
</tr>
<tr>
<td>LSB</td>
<td>Least significant bit</td>
<td></td>
</tr>
<tr>
<td>MSB</td>
<td>Most significant bit</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>Payload</td>
<td>The real, non-redundant information in a frame/packet.</td>
</tr>
<tr>
<td>RF</td>
<td>Radio frequency</td>
<td>Describes everything relating to the wireless transmission.</td>
</tr>
<tr>
<td>SDK</td>
<td>Software development kit</td>
<td>Software code that implements the command interface of various Würth Elektronik eiSos products</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver Transmitter - a serial data transmission interface</td>
<td></td>
</tr>
<tr>
<td>VDD</td>
<td>Supply voltage</td>
<td></td>
</tr>
</tbody>
</table>
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1 Introduction

The Würth Elektronik eiSos wireless modules provide an easy to use radio interface to any embedded application. The module’s interface with the host processor of the embedded application via UART can be operated using a command interface.

The Wireless Connectivity SDK is a set of software tools that enable quick software integration of Würth Elektronik eiSos wireless modules into any of the most commonly used host processors. It consists of a collection of C-code developed on the Raspberry Pi 3 platform. It contains the drivers for radio modules as well as sample projects that use the UART and USB peripheral of Raspberry Pi 3 to communicate with the attached radio device.

Figure 1: Wireless connectivity SDK driver as part of the end product
1.1 Motivation

The aim of the Wireless Connectivity SDK is to minimize the effort required on customer side to enable his host MCU to communicate with Würth Elektronik eiSos radio modules. It contains the implementation of all available commands in pure C-code. In order to integrate any Würth Elektronik eiSos wireless module, the user has to simply port the corresponding C-code to his host processor. This significantly reduces the time needed for developing the software interface to the radio module.

Würth Elektronik eiSos products, like the 868MHz proprietary radio module Tarvos-III, use a so called command interface for configuration and operation tasks. This interface provides up to 30 commands that accomplish tasks like updating various device settings, transmit/receive data and putting the module into one of various low power modes.

There are Würth Elektronik eiSos wireless modules that can operate in transparent mode in addition to the standard command mode. When using the transparent mode, the device does not interpret the commands sent via UART. Please make sure that the connected radio device runs in command mode to use the Wireless Connectivity SDK.

The commands of such an interface can be divided into 3 categories:

1. Requests: The host requests the module to trigger any action, e.g. in case of the request CMD_RESET_REQ the host asks the module to perform a reset.

2. Confirmations: On each request the module answers with a confirmation message as a feedback on the requested operation status. In case of a CMD_RESET_REQ, the module answers with a CMD_RESET_CNF to tell the host whether the reset will be performed or not.

3. Indications and Responses: In case of special events, the module indicates the same spontaneously to the host. The CMD_DATAEX_IND indicates for example that data was received via radio.

The commands itself have the following format:

<table>
<thead>
<tr>
<th>Start byte</th>
<th>Command</th>
<th>Length</th>
<th>Payload</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>1 Byte</td>
<td>1 Byte</td>
<td>Length Bytes</td>
<td>1 Byte</td>
</tr>
</tbody>
</table>

Example: CMD_DATA_REQ of the Tarvos-III

The CMD_DATA_REQ has the command number 0x00. It serves a simple data transfer. The length field indicates the number of bytes to be transmitted via radio.

Format:

<table>
<thead>
<tr>
<th>Start byte</th>
<th>Command</th>
<th>Length</th>
<th>Payload</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>0x00</td>
<td>1 Byte</td>
<td>Length Byte</td>
<td>1 Byte</td>
</tr>
</tbody>
</table>

Sending "Hello World!"
<table>
<thead>
<tr>
<th>Start byte</th>
<th>Command</th>
<th>Length</th>
<th>Payload</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>0x00</td>
<td>0x0C</td>
<td>0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x21</td>
<td>0x0F</td>
</tr>
</tbody>
</table>

Where we send 12 bytes (0x0C), which are "Hello World!" (0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x21) and the resulting checksum is 0x0F.

To use the complete feature set of such a radio device, all available commands of the corresponding command interface have to be implemented on the custom host processor. This involves considerable effort for the user and this is exactly the reason why Würth Elektronik eiSos offers the Wireless Connectivity SDK.

The steps for porting are explained in more detail in chapter 3.
2 Wireless Connectivity SDK overview

The Wireless Connectivity SDK is developed on the Raspberry Pi 3 platform. It contains the radio module drivers as well as example projects demonstrating simple applications.

The radio modules supported by the different versions of the Wireless Connectivity SDK are shown in Table 1.

The Evaluation board for a specific radio module can also be used with this SDK. As the Evaluation boards also include the FTDI UART to USB converter IC the "Plug" variant of the module driver package can also be used to interface the Evaluation boards.

<table>
<thead>
<tr>
<th>SDK version</th>
<th>Radio standard</th>
<th>Radio module &amp; usb dongle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0.0</td>
<td>Proprietary 868 MHz</td>
<td>Tarvos-II, Tarvos-II Plug, Tarvos-III</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
<tr>
<td>1.2.0</td>
<td>Proprietary 868 MHz</td>
<td>Tarvos-II, Tarvos-II Plug, Tarvos-III</td>
</tr>
<tr>
<td></td>
<td>Proprietary 2.4 GHz</td>
<td>Thalassa Plug</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
<tr>
<td>1.6.3 &amp; 2.0.0</td>
<td>Bluetooth® LE</td>
<td>Proteus-I, Proteus-II</td>
</tr>
<tr>
<td></td>
<td>Proprietary 169 MHz</td>
<td>Titania</td>
</tr>
<tr>
<td></td>
<td>Proprietary 434 MHz</td>
<td>Thadeus</td>
</tr>
<tr>
<td></td>
<td>Proprietary 868 MHz</td>
<td>Tarvos-I, Tarvos-I Plug, Tarvos-II, Tarvos-II Plug, Tarvos-III, Tarvos-III Plug</td>
</tr>
<tr>
<td></td>
<td>Proprietary 915 MHz</td>
<td>Telesto-I, Telesto-II, Telesto-III, Telesto-III Plug</td>
</tr>
<tr>
<td></td>
<td>Proprietary 2.4 GHz</td>
<td>Triton, Thalassa, Thalassa Plug</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
<tr>
<td>3.0.0</td>
<td>Bluetooth® LE</td>
<td>Proteus-I, Proteus-II</td>
</tr>
<tr>
<td></td>
<td>Proprietary 169 MHz</td>
<td>Titania</td>
</tr>
<tr>
<td></td>
<td>Proprietary 434 MHz</td>
<td>Thadeus</td>
</tr>
<tr>
<td></td>
<td>Proprietary 915 MHz</td>
<td>Telesto-I, Telesto-II, Telesto-III, Telesto-III Plug</td>
</tr>
<tr>
<td></td>
<td>Proprietary 2.4 GHz</td>
<td>Triton, Thalassa, Thalassa Plug</td>
</tr>
<tr>
<td></td>
<td>Wi-Fi / WLAN</td>
<td>Calypso</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
</tbody>
</table>

Table 1: Radio module support in the Wireless Connectivity SDK
<table>
<thead>
<tr>
<th>SDK version</th>
<th>Radio standard</th>
<th>Radio module &amp; usb dongle</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.0</td>
<td>Bluetooth® LE</td>
<td>Proteus-I, Proteus-II</td>
</tr>
<tr>
<td></td>
<td>Proprietary 169 MHz</td>
<td>Titania</td>
</tr>
<tr>
<td></td>
<td>Proprietary 434 MHz</td>
<td>Thadeus</td>
</tr>
<tr>
<td></td>
<td>Proprietary 915 MHz</td>
<td>Telesto-I, Telesto-II, Telesto-III, Telesto-III Plug, Themisto-I</td>
</tr>
<tr>
<td></td>
<td>Proprietary 2.4 GHz</td>
<td>Triton, Thalassa, Thalassa Plug</td>
</tr>
<tr>
<td></td>
<td>Wi-Fi / WLAN</td>
<td>Calypso</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
<tr>
<td>3.2.0</td>
<td>Bluetooth® LE</td>
<td>Proteus-I, Proteus-II, Proteus-II Plug, Proteus-III, Proteus-III Plug</td>
</tr>
<tr>
<td></td>
<td>Proprietary 169 MHz</td>
<td>Titania</td>
</tr>
<tr>
<td></td>
<td>Proprietary 434 MHz</td>
<td>Thadeus</td>
</tr>
<tr>
<td></td>
<td>Proprietary 915 MHz</td>
<td>Telesto-I, Telesto-II, Telesto-III, Telesto-III Plug, Themisto-I</td>
</tr>
<tr>
<td></td>
<td>Proprietary 2.4 GHz</td>
<td>Triton, Thalassa, Thalassa Plug, Thyone-I, Thyone-I Plug</td>
</tr>
<tr>
<td></td>
<td>Wi-Fi / WLAN</td>
<td>Calypso</td>
</tr>
<tr>
<td></td>
<td>Wireless M-BUS</td>
<td>Metis-II, Metis-II Plug, Metis-I, Metis-I Plug, Mimas-I, Mimas-I Plug</td>
</tr>
</tbody>
</table>

Table 2: Radio module support in the Wireless Connectivity SDK
2.1 Content of the Wireless Connectivity SDK

The Wireless Connectivity SDK is delivered as a zip-file.

Besides the various sample projects, there is a directory named drivers that contains the definition of the serial communication to the connected radio module. The subdirectory global contains all the shared functions as well as the definitions of the serial communication and GPIO interfaces of the underlying host.

The definition of the serial and USB interfaces of the Raspberry Pi is included.

In addition, each supported radio module has its own driver directory that contains the implementation of its command interface. Besides the definition of the commands, a thread is defined that checks for the confirmation and indication messages that are transmitted from the radio module to the host. Furthermore, functions that use specific radio module pins, like a pin reset or pin wake-up, are defined here.

```
/  
  |drivers .............................. Contains the code to be ported to custom hosts
  |  
  |  |global
  |  |  |global.h .......................... Declares all functions to be defined on custom hosts
  |  |  |global.c ............................ Implements shared functions
  |  |  |global_ftdi.c ....................... UART and GPIO of the FTDI USB driver for RPi
  |  |  |global_serial.c .................... UART and GPIO of the serial interface of the RPi
  |  |  |
  |  |  ... Triton ............................ Command interface of the Triton module
  |  |  |  |Triton.h
  |  |  |  |Triton.c
  |  |  |
  |  |  ... ThebeI ............................ Command interface of the Thebe-I module
  |  |  |  |ThebeI.h
  |  |  |  |ThebeI.c
  |  |  |
  |  |  ... Example_Triton ........................ Demo project using Triton module
  |  |  |  |main.c
  |  |  |  |Example_Triton.cbp
  |  |  |
  |  |  ... Example_ThebeI ........................ Demo project using Thebe-I module
  |  |  |  |main.c
  |  |  |  |Example_ThebeI.cbp
  |  |
  |  ... 
```
3 Host integration

As described in chapter 2.1 the functions in the Wireless Connectivity SDK have been developed on the Raspberry Pi platform. To use all the features of the radio module, the module’s drivers in the SDK have to be ported to the new custom platform.

In the following example, the steps involved in porting the drivers of the Bluetooth® LE 4.2 radio module, Proteus-I, to a custom platform is described.

- The directories drivers/global and drivers/Proteusl as well as the file WE_common.h have to be integrated to the custom project.

- In the function InitDriver of the file ProteusI.c, a thread is defined that listens to confirmation and indication messages that are transmitted from the attached radio module to the host processor.
  Case 1: Threads are supported, the rxthread has to be ported to the host’s thread system.
  Case 2: Threads are not supported, a state machine has to be created that periodically checks for incoming UART bytes.

void *rx_thread()
{
    while(1)
    {
        /* wait for 1ms, then check if new RX data is available */
        delay (1);
        while (BytesAvailable())
        {
            /* interpret received byte */
            if (ReadByte(&readBuffer))
            {
                ...
            }
        }
    }
}

Code 1: Code snippet of the rxthread

- The file global.h declares the shared functions that deal with the serial interface as well as the usage of GPIOs for pin related functions.

/* Switch pin to input/output high/low with/without pullup/pulldown */
* input:
*  − pin_number: number of pin
*  − inout: input or output
*  − pull: pullup, pulldown or no pull
*  − out: output level high or low
* *
* return: true, if success
* false, otherwise
*/
extern bool SetPin( int pin_number, SetPin_InputOutput_t inout, SetPin_Pull_t pull,
                   SetPin_Out_t out);

P*/
* Open the serial interface
* input:
*  − baudrate: baudrate of the interface
* return: true, if success
* false, otherwise
Here the definition of these functions, depending on the custom host peripherals, has to be created by the user. The existing files `global_serial.c`, `global_ftdi.c` and `global.c` can be removed from the project as it contains the corresponding implementation for the Raspberry Pi.

After dealing with the `rxthread` and the definition of the functions declared in `global.h`, the driver is functional. The corresponding demo project can be considered as a basis for application development on the custom platform.
4 Attaching Würth Elektronik eiSos radio modules / dongles to the Raspberry Pi

For creating custom applications on the basis of the Raspberry Pi, connect the pins of the module to corresponding pins on the Raspberry Pi (power supply, ground, serial interface and other pins like reset). Please refer to figure 2 to get an overview of the pins of the Raspberry Pi used in the driver application examples.

Figure 2: Extended connector from Raspberry Pi

Alternatively, Würth Elektronik eiSos USB dongles such as the Tarvos-II Plug & Tarvos-III Plug can be directly connected to the USB-interface of the Raspberry Pi. If a USB dongle is to be used, the D2xx driver from FTDI has to be installed first (see section 4.1).

Depending on the chosen interface, the corresponding file (global_serial.c or global_ftdi.c), has to be included into the project.

Some products, such as Tarvos-II Plug, operate in transparent mode by default. In this case the device does not interpret the commands sent by the Wireless Connectivity SDK and thus communication fails. In this case first set the default operation mode to command mode, for example by using the Würth Elektronik eiSos software tool ACC.

4.1 Installation of the FTDI driver

To run a Würth Elektronik eiSos USB dongle such as the Tarvos-II Plug on the Raspberry Pi, the FTDI library is used and has to be installed.

To do so, first download the latest D2xx Linux driver for the ARMv6 hard-float architecture
from
To install the FTDI driver the following commands have to be run in the terminal. It is assumed that the driver is version 1.4.6 and saved to the ~/Downloads directory.

1. Go to the directory where the driver is saved
   ```bash
cd ~/Downloads
   ```

2. Unpack the gzip file
   ```bash
tar -xvf libftd2xx-armv6-hf-1.4.6.tgz
   ```

3. Copy the needed header files to the system folder /usr/local/include
   ```bash
   sudo cp release/ftd2xx.h /usr/local/include
   sudo cp release/WinTypes.h /usr/local/include
   ```

4. Copy the libraries to the system folder /usr/local/lib and /usr/lib
   ```bash
   sudo cp release/build/lib* /usr/local/lib
   sudo cp release/build/lib* /usr/lib
   ```

5. As the D2xx driver is incompatible with the FTDI VCP driver in the Linux kernel, the kernel modules “ftdi_sio” and “usbserial” have to be unloaded. To do so, please run:
   ```bash
   sudo modprobe -r ftdi_sio
   sudo modprobe -r usbserial
   ```

6. Now the D2xx driver is ready for use and codeblocks has to be configured to use the library. Thus open the linker settings in Settings → Compiler → Linker Settings and add the library /usr/local/lib/libftd2xx.so to the Link libraries field.

7. In addition, the option -pthread has to be added to the Other linker options field (see figure 3). Close the linker settings again.
8. Now all supported USB dongles can be used.
4.2 FAQ - Frequently asked questions

4.2.1 The initialization function fails, what can I do?

The initialization function usually sets up the serial interface, performs a pin reset and waits for the module’s response. In case this fails, there are several possibilities:

- The module is not powered up. Please check the VCC and GND connection.
- The RESET line is not connected, thus no pin reset was applied.
- The UART RX and UART TX lines are not connected, thus the module response was not transmitted.
- The UART interface does not run well. Please check the UART settings and initialization.
- The connected module or USB dongle does not run in command mode and thus does not respond to a pin reset and/or command request. In this case, set the device to command mode, for example by using the software tool ACC.
- The rxthread function, waiting for module response, does not work correctly.
5 Software history

Version 1.0.0 "Engineering"
• Initial version of the SDK

Version 1.2.0 "Release"
• Added new products
  • Updated driver structure to easily switch between serial and USB interface on Raspberry

Version 1.6.3/2.0.0 "Release"
• Added new products

Version 3.0.0 "Release"
• Added driver for Wi-Fi module Calypso and proprietary high power radio module Thebe-I
  • Replaced old module names by new module names

Version 3.1.0 "Release"
• Added driver for proprietary high power radio module Thebe-II and Themisto-I
  • Bugfix in reset function of Proteus-* drivers
  • Fixed typos in function names and resulting bug in Calypso driver

Version 3.2.0 "Release"
• Added driver for proprietary 2.4 GHz module Thyone-I and Thyone-I Plug
  • Added driver for Bluetooth® LE module Proteus-III and Proteus-III Plug
6 Important notes

The following conditions apply to all goods within the wireless connectivity product range of Würth Elektronik eiSos GmbH & Co. KG:

6.1 General customer responsibility

Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

6.2 Customer responsibility related to specific, in particular safety-relevant applications

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 sourcecode 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.

6.3 Best care and attention

Any product-specific data sheets, manuals, application notes, PCN’s, warnings and cautions must be strictly observed in the most recent versions and matching to the products firmware revisions. This documents can be downloaded from the product specific sections on the wireless connectivity homepage.

6.4 Customer support for product specifications

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 field sales engineer or the internal sales person in charge should be contacted who will be happy to support in this matter.
6.5 Product improvements

Due to constant product improvement, product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we inform about major changes. In case of further queries regarding the PCN, the field sales engineer, the internal sales person or the technical support team in charge should be contacted. The basic responsibility of the customer as per section 6.1 and 6.2 remains unaffected. All wireless connectivity module driver software “wireless connectivity SDK” and its source codes as well as all PC software tools are not subject to the Product Change Notification information process.

6.6 Product life cycle

Due to technical progress and economical evaluation we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this, we cannot ensure that all products within our product range will always be available. Therefore, it needs to be verified with the field sales engineer or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

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7 Legal notice

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