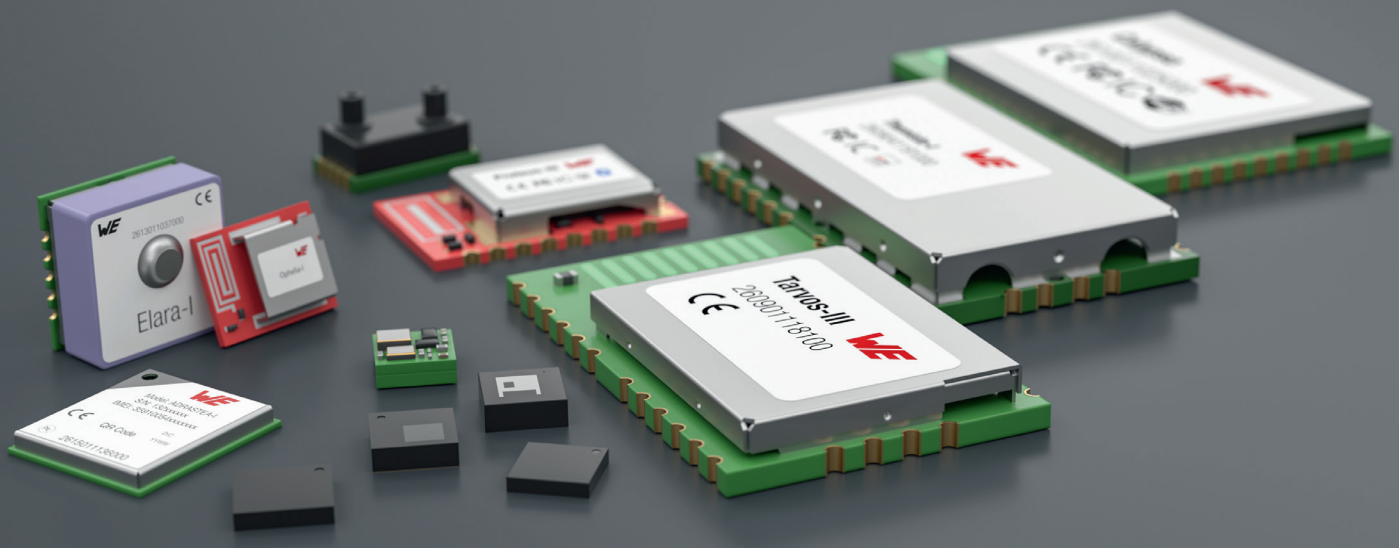

ANR008

Wireless Connectivity SDK

Version 1.16

January 16, 2026

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

Contents

1 Abbreviations

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

2 Revision history

Manual version	Version for STM32	Notes	Date
1.0	-	• Initial version of this document	April 2019
1.2	-	• Updated file name to new application note name structure. Updated important notes, legal notice & license terms chapters.	June 2019
1.3	-	• Updated supported modules	September 2019
1.4	-	• Updated supported modules	May 2020
1.5	-	• Updated supported modules • Updated supported libraries • Updated installation instructions • Added description for SPI interfaces	February 2021
1.6	-	• Fixed wrong links • Updated installation description of FTDI drivers • Renamed USB radio sticks variants	August 2021
1.7	1.0.0	• Added new driver for STM32 micro controllers (see chapter 4). • Restructured chapters for better overview	August 2021
1.8	1.2.0	• The STM32 SDK is now the primary version of the SDK. The Raspberry Pi version has been archived. • Updated supported modules • Updated chapter 4 (Wireless Connectivity SDK)	May 2022
1.9	1.5.0	• Updated SDK history of STM32 version (chapter 4.3)	April 2023

1.10	1.7.2	• Wireless Connectivity SDK for Raspberry has been archived • Updated `Important notes` and meta data	July 2023
1.11	2.0.0	• Removed documentation Wireless Connectivity SDK for Raspberry Pi (legacy version) • Explained new structure of Wireless Connectivity SDK for STM32 of version 2.0.0	January 2024
1.12	2.1.0	• Updated chapter `Version history`	June 2024
1.13	2.2.0	• Updated chapter `Version history`	September 2024
1.14	2.3.0	• Updated chapter `Version history`	January 2025
1.15	2.4.0	• Updated chapter `Version history` and `Host integration`	March 2025
1.16	2.5.0	• Added information of SDK version 2.5.0 • Updated chapter `Host integration`	January 2026

⋆ For SDK version history see chapter `Version history`

3 Introduction

The wireless modules from Würth Elektronik eiSos provide an easy to use radio interface to any embedded application. The host processor of the embedded application can control the module by sending commands via UART to the module's command interface.

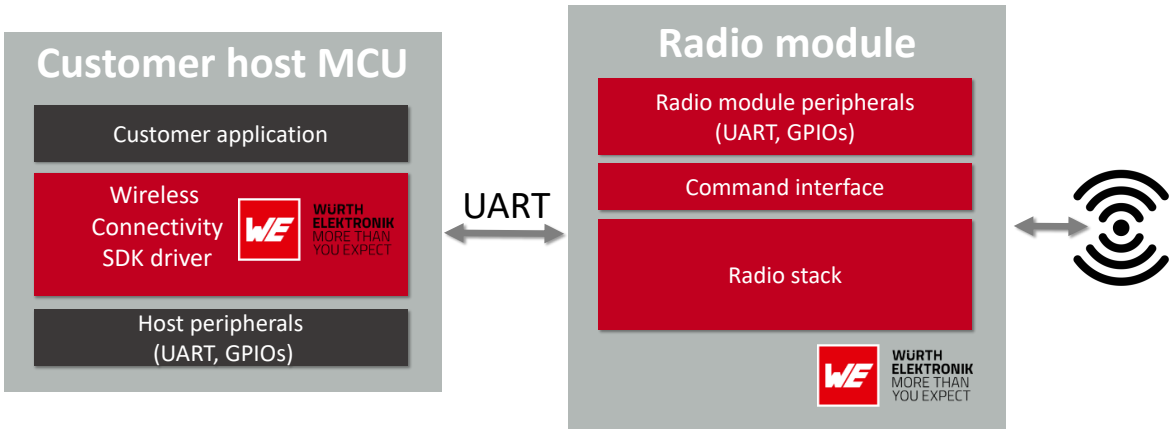

Figure 1: Wireless connectivity SDK driver as part of the end product

The Wireless Connectivity SDK is a set of software tools that enable quick software integration of Würth Elektronik eiSos wireless modules into external host processors. It consists of examples and platform independent drivers in C-code that use the host's UART to communicate with the connected radio device.

The Wireless Connectivity SDK has been developed and tested on the STM32 platform, but it is designed in a way that it can be copied and used by any other host processor platform. The C-code of examples, command interface definition and platform dependent functions are separated from each other.

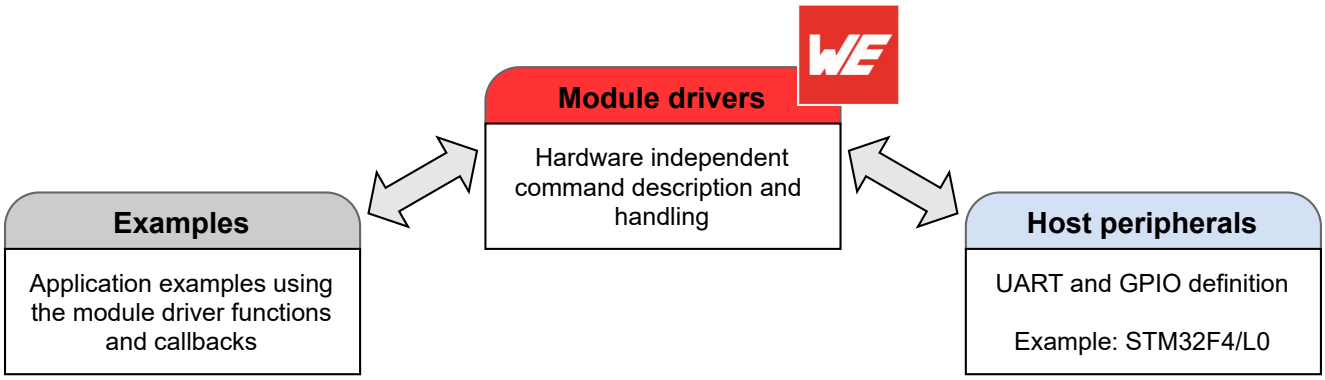

Figure 2: Structure of the Wireless Connectivity SDK

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 pure C-code implementation of all commands supported by the radio modules. In order to integrate any Würth Elektronik eiSos wireless module, the user has to copy the corresponding C-files to the application project and provide the platform specific parts (GPIO and UART handling) of his host processor (HAL).

3.1 Motivation

In this chapter the Tarvos-III is taken as example to describe the benefits of the Wireless Connectivity SDK. Nevertheless, the same arguments hold for any other radio module using command mode.

The 868 MHz proprietary radio module Tarvos-III uses the so called **command interface**[1] for configuration and operation tasks. This interface provides numerous commands that accomplish tasks like updating various device settings, transmitting/receiving radio data and setting the module into one of various low power modes.
The commands of the interface can be divided into 3 groups:

1. Requests: The host requests the module to trigger an action. 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 it is ready to start the reset process or not.
3. Events (Indications and Responses): The radio module informs the host about a special event, which is not the result of a request. The `CMD_DATAEX_IND` for example indicates that data has been received via radio.

All command messages (requests, confirmations, events) have the following format:

Start byte	Command	Length	Payload	CS
0x02	1 Byte	1 Byte	Length Bytes	1 Byte

[1] There are Würth Elektronik eiSos wireless modules that support a second operation mode, the so called transparent mode. When using the transparent mode the device does not accept commands sent via UART. Please make sure that the connected radio device runs in command mode as specified in the respective radio module user manual, when using the Wireless Connectivity SDK.

Example: CMD_DATA_REQ of the Tarvos-III

The `CMD_DATA_REQ` command has the number **0x00**. It provides the option to transmit payload data via radio. The length field indicates the number of bytes to be transmitted via radio.

Format:

Start byte	Command	Length	Payload	CS
0x02	**0x00**	1 Byte	Length Bytes	1 Byte

Example: Sending "Hello World!"

Start byte	Command	Length	Payload	CS
0x02	**0x00**	0x0C	0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x21	0x0F

With the above command, we are sending 12 bytes (0x0C), corresponding to the ASCII string "Hello World!" (0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x21). The resulting checksum is 0x0F, which is an XOR combination of the previous bytes.

To use the complete feature set of the Tarvos-III, all available commands of the command interface have to be implemented on the custom host processor. This involves considerable effort for the user. To avoid that effort Würth Elektronik eiSos offers the Wireless Connectivity SDK, which provides the C-code implementation of the whole command interface in platform independent style.

4 Wireless Connectivity SDK

4.1 Content and structure

The radio modules supported by the latest version of the Wireless Connectivity SDK are:

SDK version	Radio standard	Radio module & USB dongle
2.5.0	Bluetooth® / Bluetooth® LE combo	Skoll-I
	Bluetooth® LE	Proteus-II, Proteus-III, Proteus-e, Proteus-IV
	Cellular	Adrastea-I
	LoRa WAN	Daphnis-I
	Proprietary 868 MHz	Tarvos-III, Thebe-II, Thebe-II-IND, Tarvos-e
	Proprietary 915 MHz	Telesto-III, Themisto-I
	Proprietary 2.4 GHz	Thyone-I, Thyone-e
	WiFi / WLAN	Calypso, Cordelia-I
	WiFi / Bluetooth® LE combo	Stephano-I
	Wireless M-BUS	Metis-e, Metis-II, Metis-I, Mimas-I

Table 3: Wireless Connectivity SDK for STM32

The driver is designed in a way, that several modules of different type can be run at the same time. See the "multi module" examples present in the Wireless Connectivity SDK.

At the topmost level, the Wireless Connectivity SDK directory structure looks as follows.

```
/
└── WCON_SDK ..... Root directory of the SDK
    ├── Examples ..... Wireless modules' example codes
    ├── global ..... STM32 shared functions
    ├── STM32F4xx ..... STM32F4 driver (HAL, peripherals, ...) and project file
    ├── STM32L0xx ..... STM32L0 driver (HAL, peripherals, ...) and project file
    ├── WCON_Drivers ..... Platform independent wireless module drivers
    └── Readme.md ..... Readme file
```

Figure 3: Folder structure

The root directory of the Wireless Connectivity SDK (**WCON_SDK**) contains the STM32 shared functions and HAL driver directories for each supported family of STM32 micro controllers (STM32F4xx and STM32L0xx) as well as the **WCON_Drivers** and **Examples** directory. Within

the **WCON_Drivers** directory, each supported radio module has its own subdirectory containing the **platform independent** implementation of its command interface. In the **Examples** directory you can find many application examples for all of the radio modules, separated in module specific subdirectories as well.

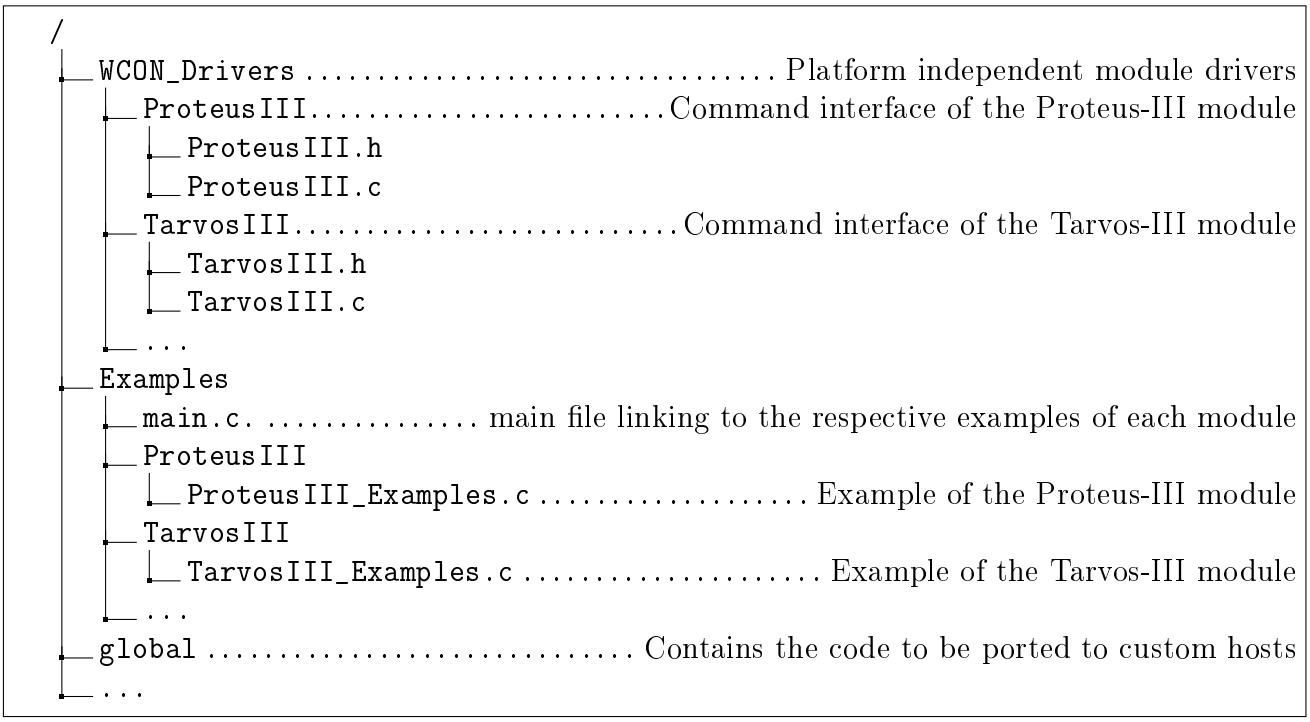

Figure 4: Folder structure

4.2 Host integration

As described in the previous chapter, the platform dependent part of the Wireless Connectivity SDK provides implementations for the STM32L0 and STM32F4 platforms. In order to use the drivers with a different type of host micro controller, the platform-dependent code for UART-, GPIO- and timing-control must be updated to the new platform. The steps needed are shown in the following example, on base of the Proteus-III drivers and example.

4.2.1 Copy platform independent code

The directories **WCON_SDK/WCON_Drivers/global** and **WCON_SDK/WCON_Drivers/ProteusIII** have to be copied to the application project of the new platform.

The file **WCON_SDK/WCON_Drivers/global/global_types.h** declares global variable types used by the drivers to interact with the platform dependent function implementation (like UART and GPIO control). No change of this file is needed.

```
/**
* @brief Marks the pin as input or output pin.
*/
typedef enum WE_Pin_Type_t
{
    WE_Pin_Type_Input = (uint8_t)0, /**< Input pin */
    WE_Pin_Type_Output = (uint8_t)1 /**< Output pin */
} WE_Pin_Type_t;

/**
* @brief Defines pin pull type.
*/
typedef enum WE_Pin_PullType_t
{
    WE_Pin_PullType_No = (uint8_t)0, /**< No pull up / pull down */
    WE_Pin_PullType_Up = (uint8_t)1, /**< Pull up */
    WE_Pin_PullType_Down = (uint8_t)2 /**< Pull down */
} WE_Pin_PullType_t;
```

Code 1: Code snippet of the file global_types.h

4.2.2 Implement the platform functions for GPIO- and timing-control

The file **WCON_SDK/WCON_Drivers/global.h** declares global functions for the use of GPIO- or timing-related features of the underlying host controller. These functions must be implemented for the new platform by the user.

For STM32, the functions are implemented in the **WCON_SDK/global/global.c** file.

```
/**
* @brief Switch pin to output high/low
*
* @param[in] pin Output pin to be set
* @param[in] out Output level to be set
* @return true if request succeeded, false otherwise
*/
```

```
extern bool WE_SetPin(WE_Pin_t pin, WE_Pin_Level_t out);

/**
* @brief Milliseconds delay function.
*
* @param[in] delay: Delay in milliseconds
*/
extern void WE_Delay(uint32_t delay);
```

Code 2: Code snippet of the file global.h

The file **WCON_SDK/global/global_platform.h** declares additional platform dependent global variable types and functions.

As the Wireless Connectivity SDK has been developed on the STM32 base, by default it contains the definition on how it's done on STM32 platform. This definition must be updated to the GPIO definition of the underlying host controller platform.

```
/**
* @brief Configuration of a STM32 pin.
*/
typedef struct WE_STM32_Pin_t
{
    GPIO_TypeDef* port;
    uint32_t pin;
} WE_STM32_Pin_t;

#define WE_STM32_PIN(PORT_ID, PIN_ID) ((WE_STM32_Pin_t){.port = PORT_ID, .pin = PIN_ID})
```

Code 3: Code snippet of the file global_platform.h

The definition of the GPIO type must contain all needed information to uniquely determine the GPIO number on the underlying platform. On STM32 it's done by the port and pin number of a GPIO.

4.2.3 Implement the platform functions for UART-control

Up to now, the GPIO- and timing-related functions have been implemented on the new platform. Only UART functions, like UART transmission, are missing.

As already declared in the **WCON_SDK/WCON_Drivers/global/global_types.h** file, the driver needs a certain format of the required functions to access the platform's UART.

```
/**
* @brief Handle one or several bytes received via UART.
*
* @param[in] received_bytesP: Pointer to the buffer of bytes received via UART
* @param[in] length: Number of received bytes
*
* @return None
*/
typedef void (*WE_UART_HandleRxByte_t)(uint8_t* received_bytesP, size_t length);
```

```
/**
* @brief Initialization and start of the UART using the provided settings (baud rate, flow
    control,...).
*
* @param[in] baudrate: Baud rate
* @param[in] flow_control: The type of flow control
* @param[in] parity: The type of parity
* @param[in] RXbyte_handlerP: Function pointer to the byte handler that will be called
    whenever bytes are received
*
* @return True in case initialization succeeded, false otherwise
*/
typedef bool (*WE_UART_Init_t)(uint32_t baudrate, WE_FlowControl_t flow_control,
    WE_Parity_t parity, WE_UART_HandleRxByte_t* RXbyte_handlerP);

/**
* @brief De-initialization of the UART.
*
* @return True in case de-initialization succeeded, false otherwise
*/
typedef bool (*WE_UART_DeInit_t)();

/**
* @brief Transmit data via UART.
*
* @param[in] dataP: Pointer to buffer of data to be sent via UART
* @param[in] length: Number of bytes to be sent
*
* @return True in case UART data transmission succeeded, false otherwise
*/
typedef bool (*WE_UART_Transmit_t)(const uint8_t* dataP, uint16_t length);
```

Code 4: Code snippet of the file global_types.h

For STM32 the files **global_L0xx.h/c** and **global_F4xx.h/c** contain the implementation of these functions. For the custom host a source and header file containing the respective UART functions must be created and added to the project.

```
/**
* @brief Initialize and start the UART.
*
* @param[in] baudrate Baud rate of the serial interface
* @param[in] flowControl Enable/disable flow control
* @param[in] parity Parity bit configuration
* @param[in] rxByteHandlerP Pointer to the handle rx byte function inside the driver
*/
extern bool WE_UART1_Init(uint32_t baudrate,
WE_FlowControl_t flowControl,
WE_Parity_t parity,
WE_UART_HandleRxByte_t *rxByteHandlerP);

/**
* @brief Transmit data via UART.
*
* @param[in] data Pointer to data buffer (data to be sent)
* @param[in] length Number of bytes to be sent
*/
```

```
extern bool WE_UART1_Transmit(const uint8_t *data, uint16_t length);
```

Code 5: Functions needed for custom host

4.2.4 (Optional) Implement debug messages

In the **WCON_SDK/WCON_Drivers/global/debug.h** file, the functions to print the debug messages of the driver are declared. In case this feature is of interest, the debug functions must be implemented by the user for the new platform.

For STM32 it is done in the **WCON_SDK/global/debug.c** file, which simply forwards the string to the *printf* function, which is connected to the Nucleo's UART2 peripheral.

```
/**
* @brief Prints the debug message.
*
* @param[in] level: The level of the message to be printed
* @param[in] file: The file from which the message came
* @param[in] func: The function from which the message came
* @param[in] format: Format string (printf-style) for the message
* @param[in] ... Additional arguments for the format string
*/
void WE_Debug_Print(unsigned int level, const char* file, const char* func, const char*
    format, ...);
```

Code 6: Code snippet of the file debug.h

4.2.5 Run the first example

With this step, the driver has been successfully attached to the new platform. To run a first example on the new controller, the new GPIO and UART functions must be used in the example code, before the module's initialization function can be called (here: **ProteusIII_Examples()** in file **ProteusIII_Examples.c**).

```
    static ProteusIII_Pins_t ProteusIII_pins = {
        .ProteusIII_Pin_Reset = WE_PIN((void*)&WE_STM32_PIN(GPIOA, GPIO_PIN_10)),
        .ProteusIII_Pin_SleepWakeUp = WE_PIN((void*)&WE_STM32_PIN(GPIOA, GPIO_PIN_9)),
        .ProteusIII_Pin_Boot = WE_PIN((void*)&WE_STM32_PIN(GPIOA, GPIO_PIN_7)),
        .ProteusIII_Pin_Mode = WE_PIN((void*)&WE_STM32_PIN(GPIOA, GPIO_PIN_8)),
        .ProteusIII_Pin_Busy = WE_PIN((void*)&WE_STM32_PIN(GPIOB, GPIO_PIN_8)),
        .ProteusIII_Pin_StatusLed2 = WE_PIN((void*)&WE_STM32_PIN(GPIOB, GPIO_PIN_9)),
    };

    /**
    * @brief Definition of the uart
    */
    static WE_UART_t ProteusIII_uart;

    /**
    * @brief The application's main function.
    */
    void ProteusIII_Examples(void)
    {
        ProteusIII_uart.baudrate = PROTEUSIII_DEFAULT_BAUDRATE;
```

```
ProteusIII_uart.flowControl = WE_FlowControl_NoFlowControl;
ProteusIII_uart.parity = WE_Parity_None;
ProteusIII_uart.uartInit = WE_UART1_Init;
ProteusIII_uart.uartDeinit = WE_UART1_DeInit;
ProteusIII_uart.uartTransmit = WE_UART1_Transmit;

ProteusIII_Init(
&ProteusIII_uart,
&ProteusIII_pins,
ProteusIII_OperationMode_CommandMode,
callbackConfig);
```

Code 7: Selection of GPIO and UART

Note that here the GPIO definition (i.e. WE_STM32_PIN) and the UART functions (i.e. WE_UART1_Init,...) must be replaced with the functions of the new platform instead.

4.3 Version history

Version 1.0.0 "Release"

- Initial version of the SDK

Version 1.1.0 "Release"

- Added driver for the Calypso WiFi radio module

Version 1.2.0 "Release"

- Added driver for the Proteus-e Bluetooth LE module
- Updated Proteus-III driver

Version 1.3.0 "Release"

- Improvement of the Thyone-I driver

Version 1.4.0 "Release"

- Improvement of the Calypso driver

Version 1.5.0 "Release"

- Improvement of the Proteus-III driver
- Added Proteus-II driver
- Restructured AT-command codes for coming radio modules

Version 1.7.0 "Release"

- Added driver for Adrastea-I

Version 2.0.0 "Release" January 2024

- Added driver for Daphnis-I, Stephano-I
- Changed driver structure to support multiple modules at the same time
- Implemented a second UART interface on STM32F4xxxx and STM32L0xxxx
- Added example for multi module support

Version 2.1.0 "Release" June 2024

- Added functions of firmware version 3.3.0 of radio modules Tarvos-III, Telesto-III, Thebe-II, Themisto-I
- Bug fix in writing user settings of Proteus and Thyone variants
- Bug fix in Stephano-I driver
- Improvements in UART definition and debug interface for STM32

Version 2.2.0 "Release" September 2024

- Added products Thebe-II-IND and Metis-e
- Final release Thyone-e
- Updated base64 implementation
- Bugfix Adrastea-I MQTT commands

- Bugfix Stephano-I Bluetooth® LE command

Version 2.3.0 "Release" January 2025

- Added products Cordelia-I, Tarvos-e and Skoll-I
- Added support for Daphnis-I firmware version 1.4.0
- Cleaned debug and release configuration
- Restructured directories to make drivers platform independent
- Code improvements
  - Moved Adrastea-I, Stephano-I and Calypso event definitions from RAM to flash
  - Bugfix in Adrastea-I driver dealing with empty strings
  - Bugfix in Calypso-I file transfer driver
  - Metis-e is no longer resetted when driver initialized. This needs to be done in the application.
  - Bugfix in wake-up function of Tarvos-III/Telesto-III/Thebe-II/Themisto-I

Version 2.4.0 "Release" March 2025

- Set default Daphnis-I support to firmware version 1.4.0
- Generalized definition of MCU pins
- Applied newest code style guidelines

Version 2.5.0 "Release" January 2026

- Add support for Bluetooth® LE module Proteus-IV
- Set initial value of GPIOs in initialization function
- Reset GPIOs in deinitialization function
- Separate application print function from driver print function
- Move debug print function implementation from driver to platform part
- Bugfix in STM32F4xxx UART6 RX function
- On UART initialization check for STM32 supported UART baud rates
- Move function description to from source to header file for automatic doxygen documentation
- Improve interpretation of enums in event receive functions
- Rename files of Daphnis examples

5 Running sample applications on the STM32 Nucleo board

5.1 Hardware connections

The Wireless Connectivity SDK has been developed on the STM32 Nucleo-L073RZ [1] and Nucleo-F401RE [2] development boards using STM32CubeIDE [3].

To run the examples provided by the SDK on one of these boards, first connect the respective pins of the board to the radio module[2]. Besides the *VCC*, *GND* and the *UART* pins, other product-specific pins such as the */Reset* pin need to be connected.
Consult the Wireless Connectivity SDK *Readme* file and/or the user manual of the used wireless module for additional information.

Function	Pin	I/O	Function	Pin	I/O
VCC	+3V3	-	GND	GND	-
UART RX	PB7	Input	UART CTS	PA11	Input
UART TX	PB6	Output	UART RTS	PA12	Output
Reset	PA10	Output	Wake_up	PA9	Output
Boot	PA7	Output	Mode	PA8	Output

Table 4: Used pins of the STM32 NUCLEO-L073RZ [4]

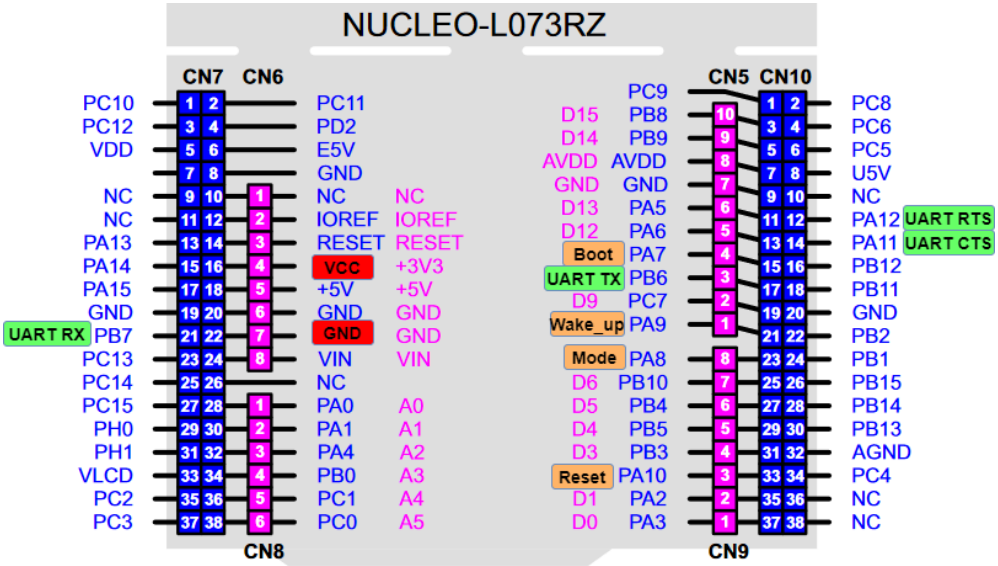

Figure 5: Layout for STM32 NUCLEO-L073RZ [4]

5.2 Run the project with STM32CubeIDE

First download the Wireless Connectivity SDK [5] and save it on your computer. Then install and start the STM32CubeIDE [3]. When starting, you will be asked for a workspace path. In

[2] All needed radio module pins are available for connection on the corresponding EV-Board.

case you already have a workspace from previous projects, select the desired path. In case you want to use a new workspace, create a new empty directory and select that directory.

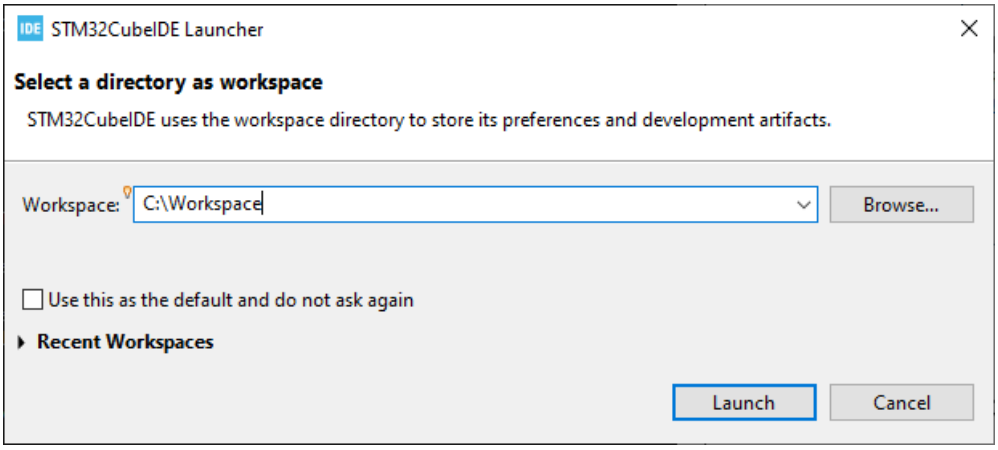

Figure 6: Choose workspace

After the STM32CubeIDE started, go to "File→Open Projects from File System" and select the path where you saved the Wireless Connectivity SDK.

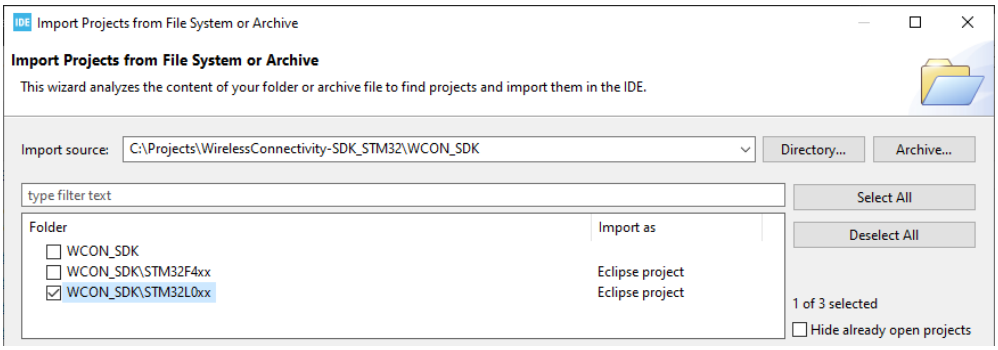

Figure 7: Open project

Select the project which you would like to import depending on the microcontroller family that you intend to use (e.g. STM32L0xx). Press the "Finish" button, so that the project is loaded into the "Project Explorer".

The Wireless Connectivity SDK includes the examples and drivers for all supported products in one STM32CubeIDE project. Thus to evaluate a single product, the right radio module example must be selected first. To do so, open the **main.c** file and comment/uncomment the example functions.

```
/* select the example to run */
//Adrastea_Examples();
//Calypso_Examples();
//DaphnisI_Examples();
//Metis_Examples();
//ProteusE_Examples();
//ProteusII_Examples();
```

```
    ProteusIII_Examples();
    //StephanoI_Examples();
    //ThyoneE_Examples();
    //ThyoneI_Examples();
    //TarvosIII_Examples();
    //TelestoIII_Examples();
    //ThebeII_Examples();
    //ThemistoI_Examples();
    //MultiModule_ProteusIII_TarvosIII_Examples();
```

Code 8: Select example in main.c file

Then press "Build" and "Run" to flash the firmware on the STM32 controller. If the debug build is chosen and flashed on the controller, you can see the debug messages on the serial interface (115200 Baud, 8n1), that is available on the USB connector of the Nucleo board.

6 References

[1] STMicroelectronics. NucleoL073RZ. https://www.st.com/en/evaluation-tools/nucleo-l073rz.html.

[2] STMicroelectronics. NucleoF401RE. https://www.st.com/en/evaluation-tools/nucleo-f401re.html.

[3] STMicroelectronics. STM32CubeIDE. https://www.st.com/en/development-tools/stm32cubeide.html.

[4] STMicroelectronics . UM1724 - User manual - STM32 Nucleo-64 boards (MB1136). https://www.st.com/en/evaluation-tools/stm32-nucleo-boards.html.

[5] Würth Elektronik. Wireless Connectivity SDK for STM32 - Radio module drivers in C-code. https://github.com/WurthElektronik/WirelessConnectivity-SDK_STM32.

7 Important notes

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