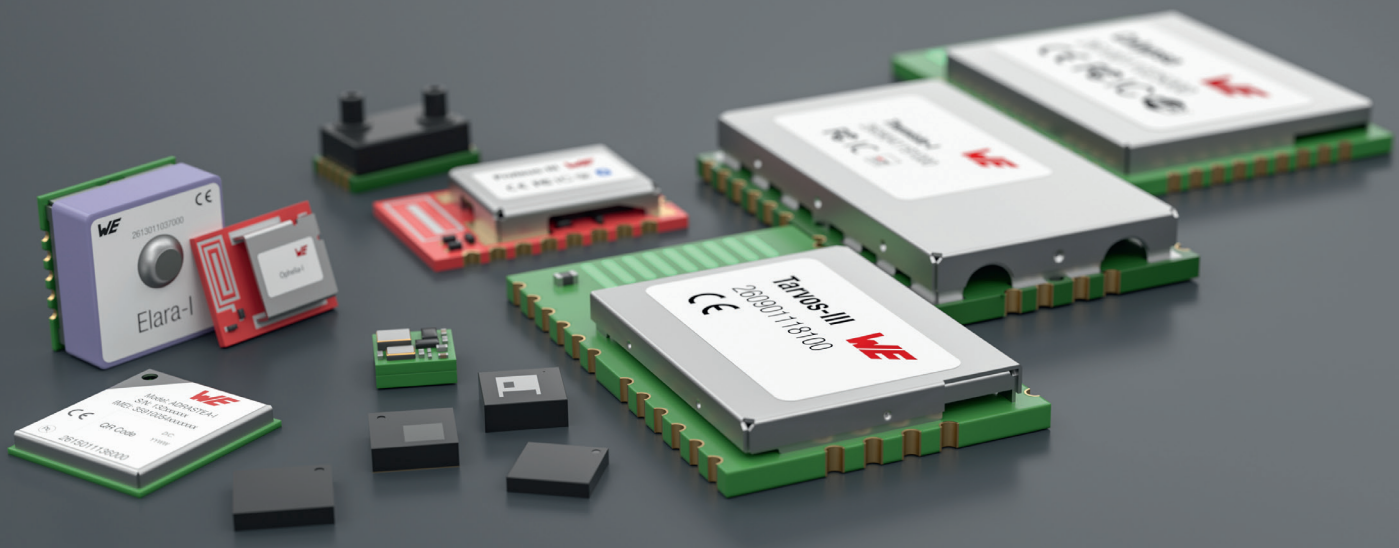

ANR019

Proteus-III UART vs SPI

A comparison

Version 1.1

July 19, 2023

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

Revision history

Manual version	Notes	Date
1.0	• Initial version	March 2021
1.1	• Updated `Important notes`, meta data and document style	July 2023

Abbreviations

Abbreviation	Name	Description
CLK	Clock	SPI line for the clock signal
CS	Chip Select	SPI line to select the slave device.
I/O	Input/output	Pinout description.
MISO	Master In Slave Out	SPI line for data transmission from slave to master.
MOSI	Master Out Slave In	SPI line for data transmission from master to slave.
Payload		The intended message in a frame / package.
RF	Radio frequency	Describes wireless transmission.
SPI	Serial Peripheral Interface	Allows the serial communication with the module.
UART	Universal Asynchronous Receiver Transmitter	Allows the serial communication with the module.
[HEX] 0xhh	Hexadecimal	All numbers beginning with 0x are hexadecimal numbers. All other numbers are decimal, unless stated otherwise.

Contents

1 Introduction

The Proteus-III is a Bluetooth® LE module based on the nRF52 Nordic Semiconductors SoC which presents various Bluetooth® LE and low power features. It provides a command based UART interface that allows the configuration and control by simple commands.

Besides of that, there is a second variant of the Proteus-III, the so called Proteus-III-SPI radio module that provides the functions of the Proteus-III via SPI interface.

This application note describes what are the key facts to be considered, when choosing between the UART variant Proteus-III and the SPI variant Proteus-III-SPI.

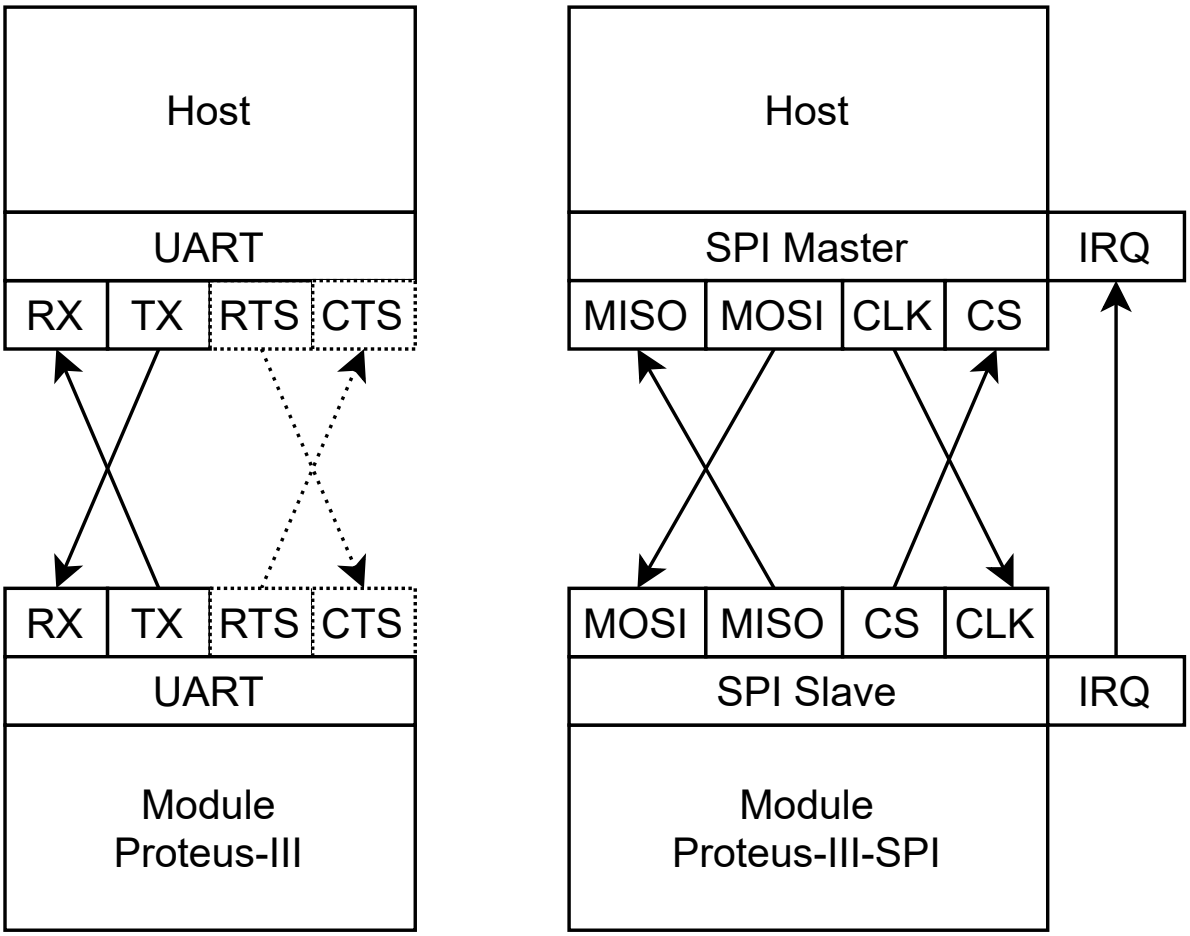

Figure 1: Module to host connection

2 Proteus-III vs Proteus-III-SPI

This chapter collects all the points that have to be considered, when choosing between Proteus-III and Proteus-III-SPI as interface to the Bluetooth® LE world.

2.1 Hardware facts

The Proteus-III and Proteus-III-SPI use the same hardware. Both share the same foot print and use the same pins. Only the UART pins of the Proteus-III are replaced by the SPI pins on the Proteus-III-SPI. Furthermore, the *WAKE_UP* pin on the Proteus-III-SPI has a shared function, as it is used as SPI interrupt pin in case the module has not been set to deep sleep mode. In case the module is sleeping, its function is to wake-up the radio module.

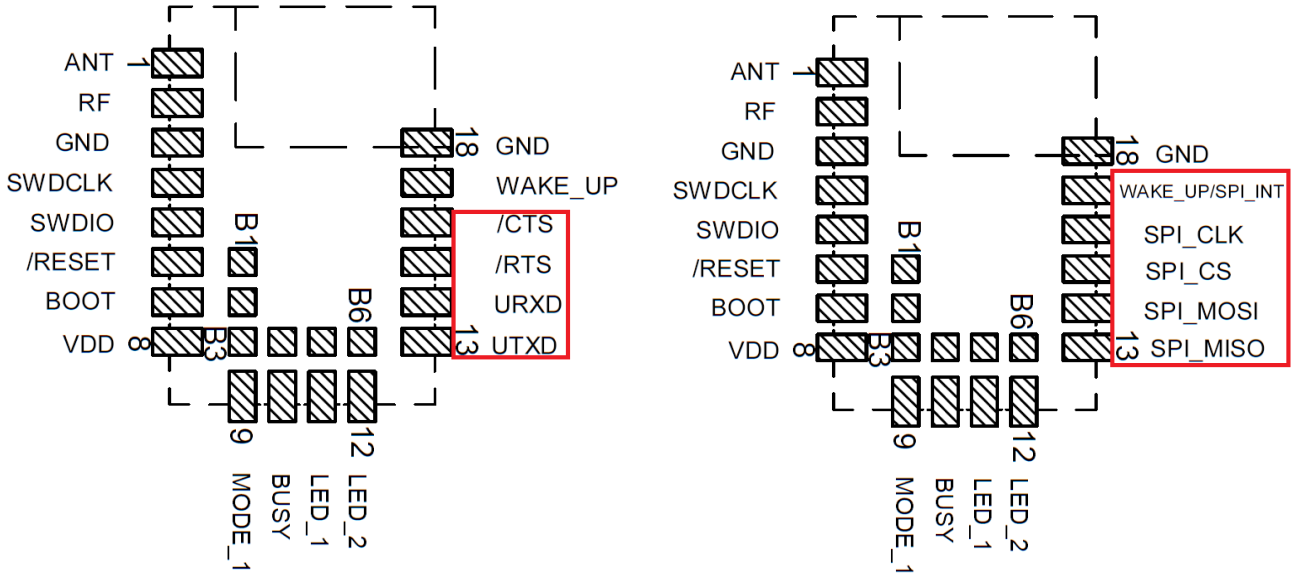

Figure 2: Pinout

Thus from hardware point of view, there is no difficulty to switch between Proteus-III and Proteus-III-SPI (also at a later stage in the development process of the end device).

2.2 Application facts

Except of UART- or SPI-specific features, the Proteus-III and Proteus-III-SPI share the same functions. Nevertheless, both radio modules behave a bit different. The differences are listed in the tables below:

	Proteus-III (UART)	Proteus-III-SPI (SPI slave)
End device layout	The host controller must provide a free UART interface, that must be connected only to the Proteus-III.	The host controller must provide a SPI interface with extra CS line and SPI interrupt line for the Proteus-III-SPI. Several SPI slaves may be connected to the SPI clock and data lines of the SPI master.
Software integration of the UART/SPI	Easy • configure the UART baud rate and flow control • communication can start	Medium • configure the SPI data rate and the SPI mode • implement the SPI interrupt pin • check and adjust the allowed timings of the *SPI_CS* and *SPI_CLK* line • communication can start
Software integration of the module functions	Easy - Use the Proteus-III drivers[1] from Wireless Connectivity SDK [1].	
Maximum data rate	1 MBaud (UART)	8 MBit (SPI)

Throughput [kByte/s]	1Mbit UART can be the bootleneck for high throughputs, in case the radio uses a fast setting • 42.9 (fastest mode: 2 Mbit radio, 8 ms connection interval, high throughput mode on, 1 MBaud UART) • 16 (fast mode: 2 Mbit radio, 30 ms connection interval, high throughput mode on, 1 MBaud UART) • 1.57 (default mode: 1 Mbit radio, 30 ms connection interval, high throughput mode off, 125 kBaud UART)	Boost the throughput[2] if the radio link is not the bottleneck • 64.3 (fastest mode: 2 Mbit radio, 8 ms connection interval, high throughput mode on, 8 Mbit SPI) • 16 (fast mode: 2 Mbit radio, 30 ms connection interval, high throughput mode on, 8 Mbit SPI) • 1.57 (default mode: 1 Mbit radio, 30 ms connection interval, high throughput mode off, 8 Mbit SPI)
EMC		More sensitive due to higher data rate, and thus higher risk.
Available radio certifications	RED, FCC, IC, TELEC	RED, FCC, IC
Operation modes	Command mode and peripheral only mode (transparent UART)	Command mode only
Current consumption	• Lower, in case UART is switched off – by user in command mode – automatically in peripheral only mode if radio connection is closed • Low, otherwise	• Lower, as SPI is only enabled if CS is active

Table 1: Comparison of the keyfacts

[1] For integration of the module drivers into the host microcontroller, the host's peripherals (i.e. UART, SPI) must be adapted in the "global" directory of the driver.
[2] A SPI with a datarate of 700 kBit or faster increases the throughput compared with a 1 MBaud UART, in case the radio is fast enough.

2.3 What to choose now?

2.3.1 Prefer Proteus-III-SPI

Prefer the Proteus-III-SPI if one or several of the following points match your application

- You do not have a free UART interface available, but a SPI interface with free CS pin and SPI interrupt pin.
- You need the highest possible end-to-end throughput.

Be aware that the connection partner must be able to provide all features and dependencies for the chosen throughput, too.

- You need the lowest possible power consumption without reducing the radio performance (i.e. throughput, timing behaviour).

The most effective way to reduce the current consumption is to reduce the transmission power and increase the connection interval (slow down the radio performance).

2.3.2 Prefer Proteus-III

Prefer the Proteus-III (UART) if one or several of the following points match your application:

- None of the Proteus-III-SPI points matches your application.
- You need a simple wire interface that works with minimum configuration.
- You want to use a transparent UART interface to the reduce effort in your software development.
- You cannot use the fastest radio settings (i.e. 2 Mbit phy or 8 ms connection interval) due to backward compatibility reasons to older Bluetooth® LE versions and low cost devices.
- You cannot use large radio packets (243 bytes payload per radio frame, and up to 4 radio frames per connection interval) due to backward compatibility reasons to older Bluetooth® LE versions and low cost devices.

3 References

[1] Würth Elektronik. Wireless Connectivity SDK for Raspberry Pi - Radio module drivers in C-code. https://github.com/WurthElektronik/WirelessConnectivity-SDK.

4 Important notes

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