UM11524

First Field Verification Tool User manual

Rev. 1 — 24 February 2021 User manual

Document information

Information	Content
Keywords	SEN-SPI-BOX, FFV Tool
Abstract	FFV Tool User manual

Revision history

Rev	Date	Description
1	20210224	• Initial release

1 Introduction

This document describes how to use the SEN-SPI-BOX kit for NXP automotive sensor evaluation with the “NXP First Field Verification Tool” software.

The intent of this document is to get started, from the hardware configuration to the software manipulation, in order to communicate with NXP sensors and get interactive data.

Figure 1. NXP Sensor SPI/I^{2}C Master Kit - SEN-SPI-BOX

2 Getting started

2.1 Kit contents/packing list

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Figure 2. SEN-SPI-BOX kit contents

The SEN-SPI-BOX evaluation board contains:

- One Sensor SPI Master Kit (SEN-SPI-BOX)
- One USB Type A USB cable
- One NXP MDI ribbon cable (16-pin)
- One Beagle ribbon cable (10-pin)
- One debug cable
- One 8 GB microSD card
- One microSD to PC adapter

If DSI3 or PSI5 protocol is required, a SEN-DSI3-ADAPTER and a SEN-PSI5-ADAPTER may be ordered separately.

SEN-xxxx-ADAPTER kit contains:

- One SEN-xxxx-ADAPTER
- Two, 2-wire twisted cables

2.2 Finding kit resources and information on the NXP website

NXP Semiconductors provides online resources for this evaluation board and supported devices on http://www.nxp.com. The information page for the SEN-SPI-BOX evaluation board is at http://nxp.com/SEN-SPI-BOX. The information page provides overview information, documentation, software and tools, parametrics, ordering information and a Getting Started tab. The Getting Started tab provides quick-reference information applicable to using the SEN-SPI-BOX evaluation board, including the downloadable assets referenced in this document.

3 Hardware description

The NXP SEN-SPI-BOX kit provides a full-solution of built-in functionalities to communicate with any SPI/I²C sensor. The kit graphs real-time data, executes custom scripts and verifies sensor status. The board is a generic SPI/I²C evaluation board, compatible with some of the NXP sensor families such as FXLS9xxxx automotive digital accelerometers. The list of compatible sensors is non-exhaustive and may evolve in the future.

Figure 3 shows how to couple the SEN-SPI-BOX with a SEN-GEN6-SKT board for the FXLS9xxxx evaluation.

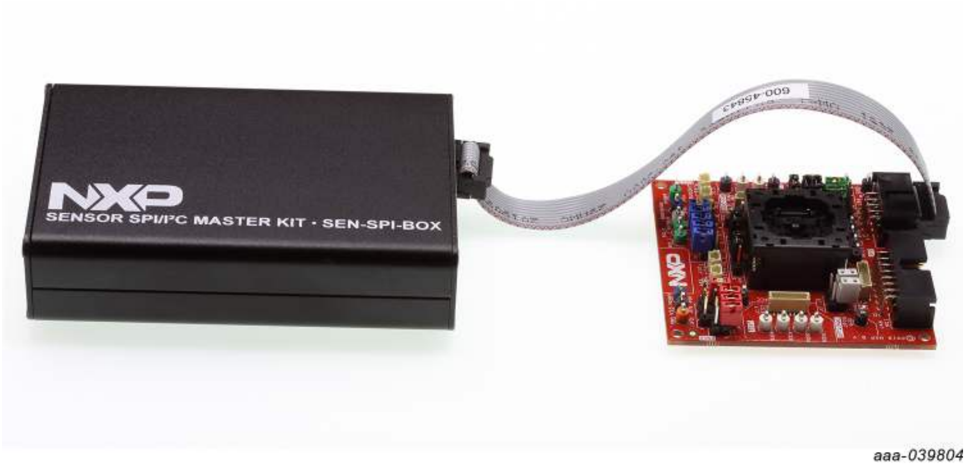

Figure 3. Attaching the SEN-GEN6-SKT board to the SEN-SPI-BOX

3.1 Kit overview

The kit contains an NXP SEN-SPI-BOX evaluation board, three different cables compatible with dedicated NXP sensor boards, a microSD card for built-in boot loading capability, and a USB Type-B cable to connect the kit to a computer.

The kit is powered by an NXP Kinetis® K64F Cortex M4 Microcontroller.

Figure 4. SEN-SPI-BOX overview

Figure 5. SEN-SPI-BOX interfaces

3.2 Pinout

The NXP MDI (16-pin) and Beagle (10-pin) connectors can be used with their own dedicated ribbon cable or with breadboard jumper wires.

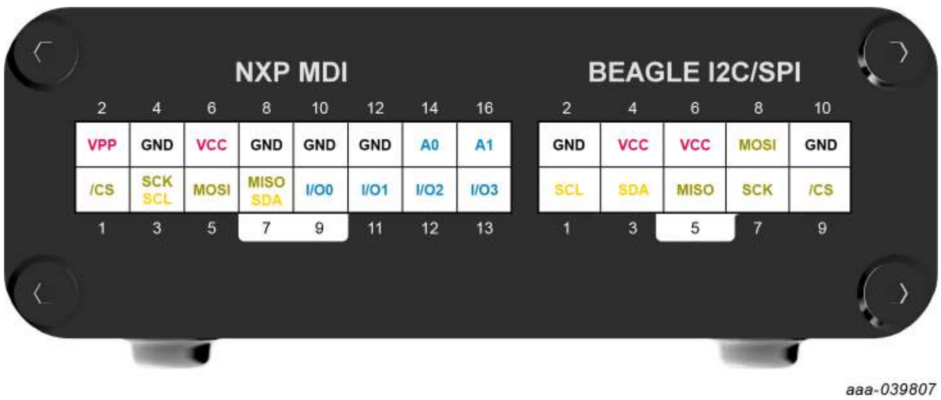

Figure 6. NXP MDI and Beagle connector pinout

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3.2.1 NXP MDI connector

Table 1. NXP MDI connector pinout

Pin	Label	Description
6	**VCC**	Power supply: off, 3.3 V or 5 V
2	**VPP**	High-voltage supply: off, 10.5 V or 13.5 V
4,8,10,12	**GND**	Ground
1	**/CS**	SPI chip select
3	**SCK/SCL**	SPI serial clock / I²C serial clock
5	**MOSI**	SPI output
7	**MISO/SDA**	SPI input / I²C serial data
9, 11, 13, 15	**I/Ox**	Configurable input/output
14, 16	**Ax**	Analog input

3.2.2 Beagle connector

Table 2. Beagle connector pinout

Pin	Label	Description
4, 6	VCC	Power supply: off, 3.3 V or 5 V
2, 10	GND	Ground
9	/CS	SPI chip select
7	SCK	SPI serial clock
8	MOSI	SPI output
5	MISO	SPI input
1	SCL	I²C serial clock
3	SDA	I²C serial data

3.2.3 Beagle debug cable

To directly connect any sensor, use the debug cable (to be plugged into the Beagle connector).

Figure 7 identifies the debug cable pinout connections.

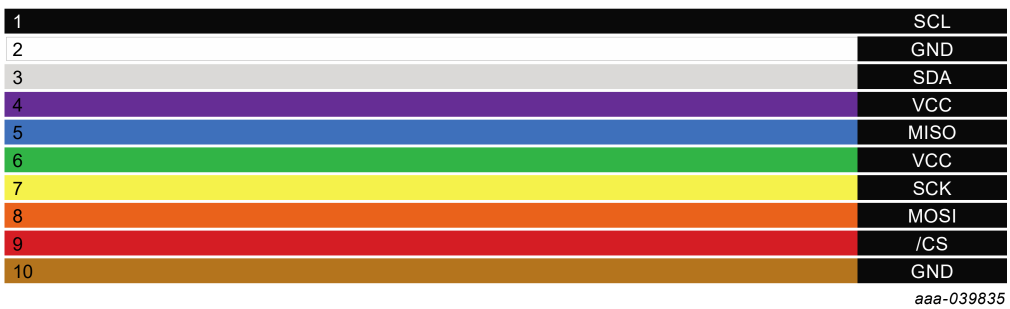

Figure 7. Debug cable pinouts

3.3 LED indicators

3.3.1 Rear view

Figure 8. Status indicators

- Status: Blinks green if running, if red, something is wrong
- Power: Red when board is powered
- Activity: Fast blink when communicating with the software (red for input, green for output, orange when directional)

3.3.2 Front view

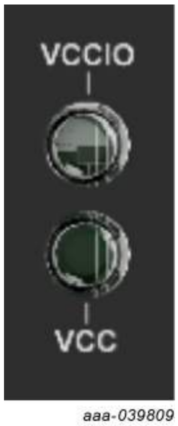

Figure 9. Front LED indicators

- VCCIO: Green if VCCIO is turned on
- VCC: Green if VCC is turned on

3.4 Block diagram

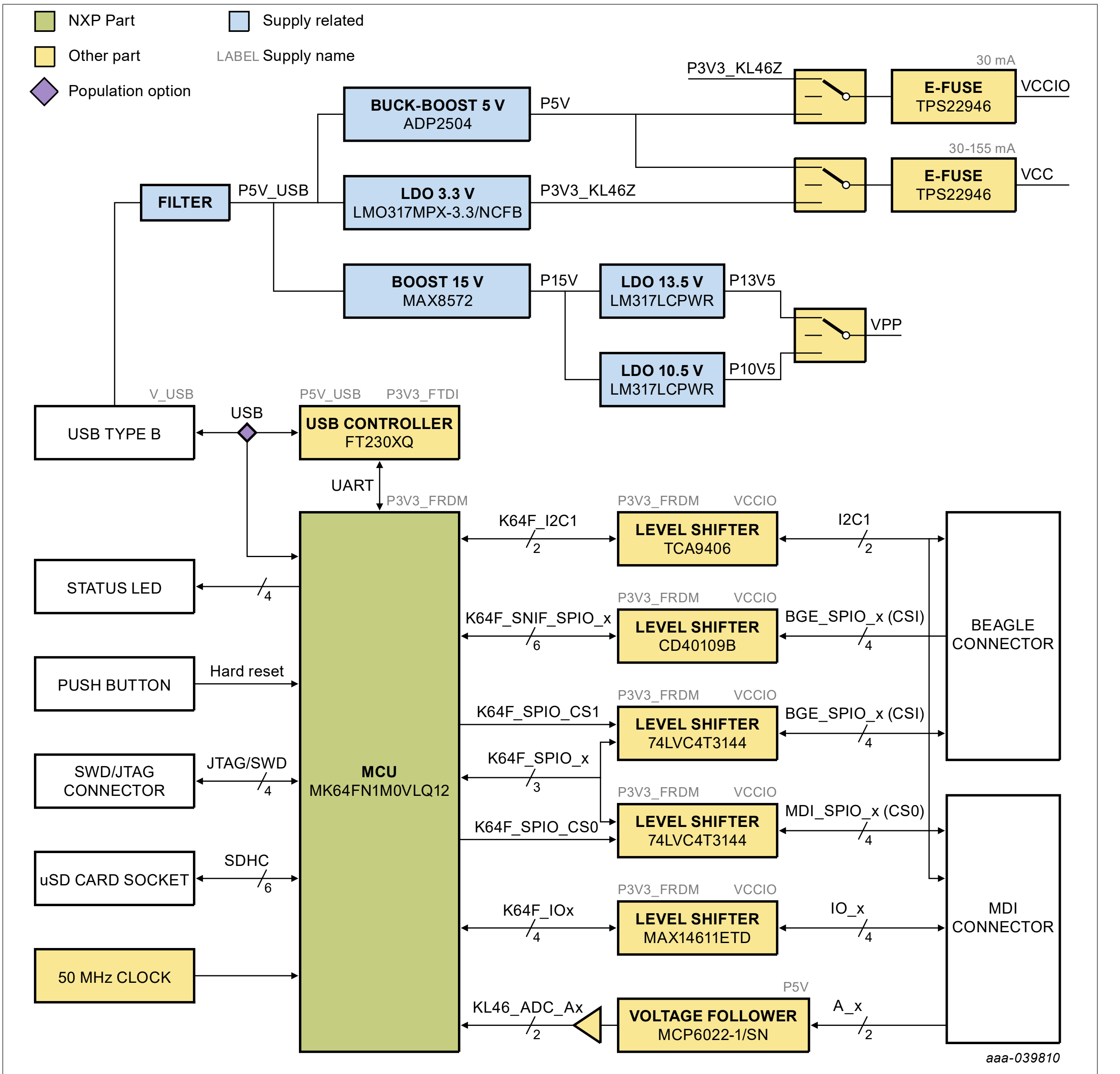

Figure 10. Block diagram

4 Setting up the FFV Tool kit

4.1 Software installation

4.1.1 Download software

Go to http://www.nxp.com/SEN-SPI-BOX to download the software.

4.1.2 System requirements

The computer system hosting the Sensor FFV Tool software and SEN-SPI-BOX hardware must meet the following requirements:

- Windows 10 (x86, x64). Although Windows Vista, 7 are anticipated to work as well, these systems have not been tested and are not supported.
- For each SEN-SPI-BOX, a USB (V3.0) port must be available on the host PC. NXP anticipates the SEN-SPI-BOX will work with USB V1.1 or V2.0 ports. However, NXP has not tested the SEN-SPI-BOX with USB V1.1 or V2.0 ports.
- The screen size shall be at least 1024 x 768 pixels. NXP does not recommend using screens with resolution smaller than 1024 x 768 pixels. Although the software runs on screens with lower resolution, the GUI and forms are less convenient to use.
- Software to display Adobe PDF documents is required to read the documentation and the data sheets.

4.1.3 Setup

Double-click the downloaded .msi file and follow the instructions.

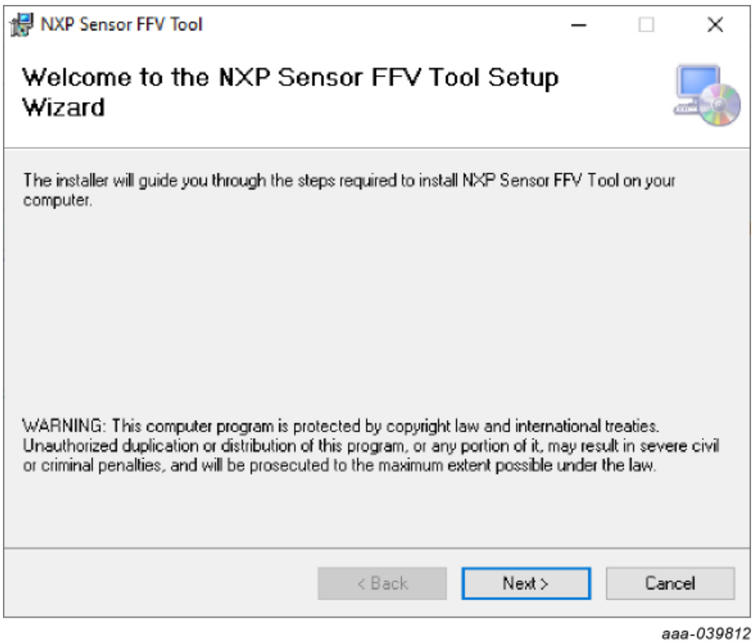

Figure 11. NXP Sensor FFV tool setup

NXP recommends using the default installation folder, however the installation location can be customized.

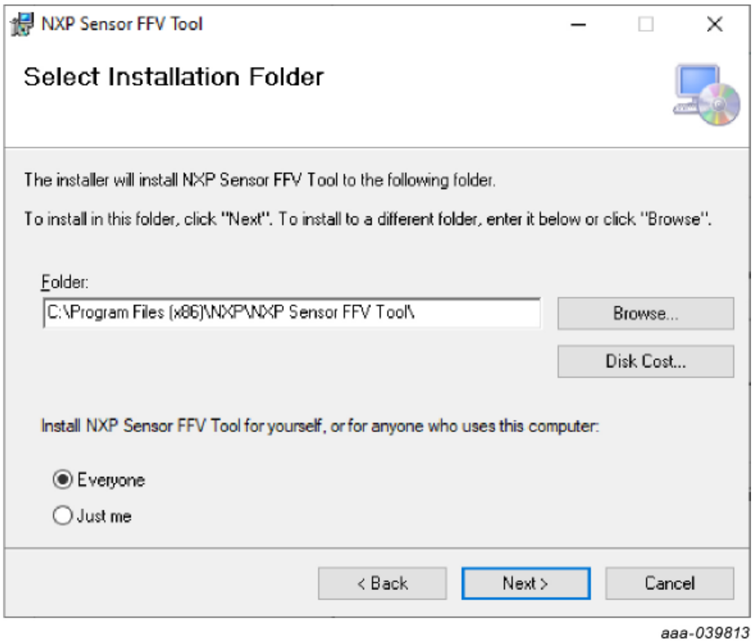

Figure 12. NXP Sensor FFV installation folder

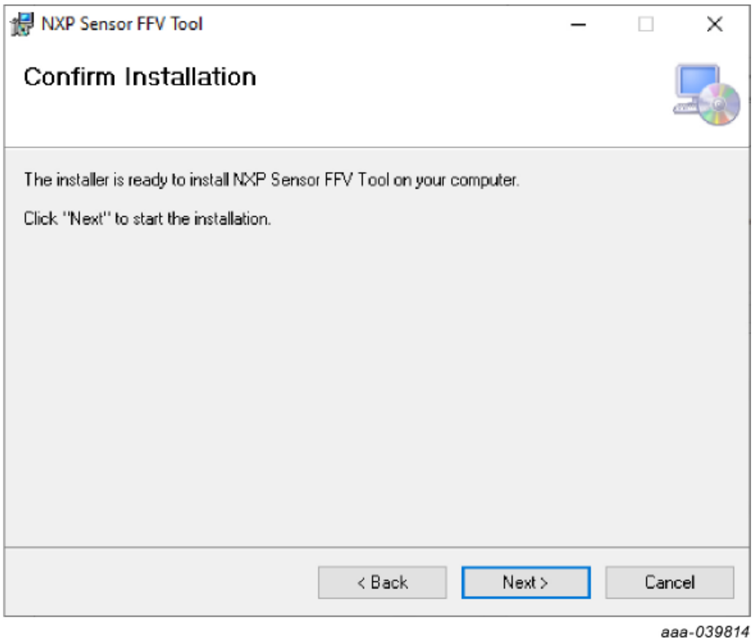

Figure 13. NXP Sensor FFV tool installation confirmation

4.2 Prepare the kit

4.2.1 Connect the kit

Connect the FFV kit via the USB Type-B cable included in the kit.

Figure 14. Connecting the kit via USB Type-B cable

A new USB design should appear in the Windows device manager as shown in Figure 15. There is no need to install a specific driver because the FFV kit uses standard Window COM port drivers (usbser.sys, hhdserial64.sys) already present in Windows-based computers.

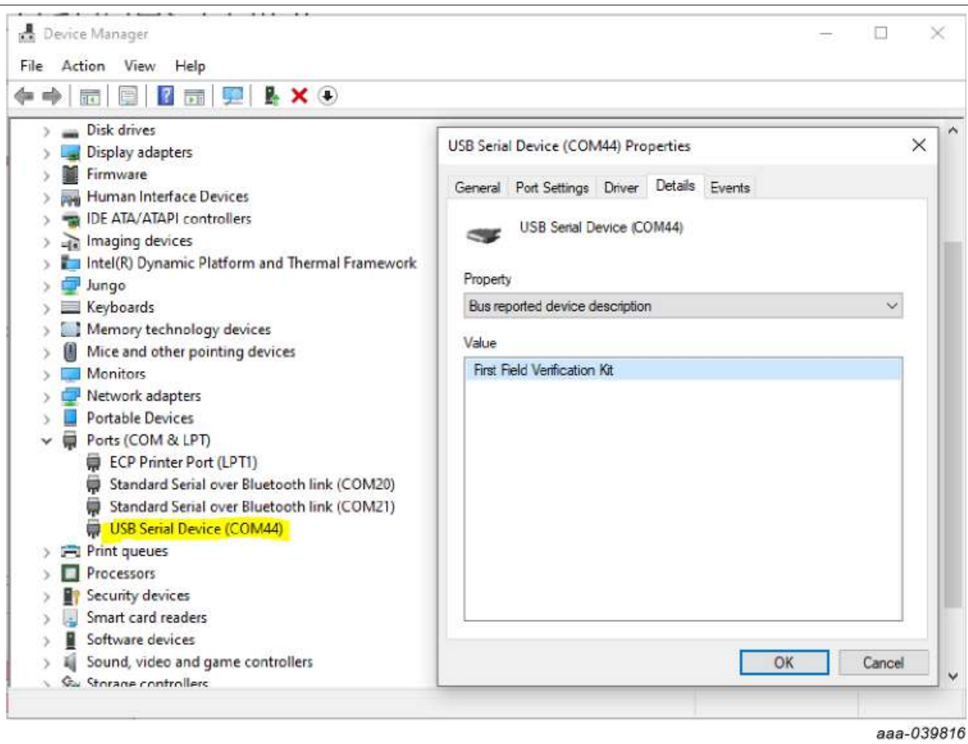

Figure 15. Compatible COM Port drivers

4.2.2 Launch the software

4.2.2.1 Start

Start the GUI through the launcher or double-click a .ffvpkg file (if .ffvpkg is used, skip Section 4.2.2.2 and jump directly to step Section 4.2.2.3)

4.2.2.2 Select a project

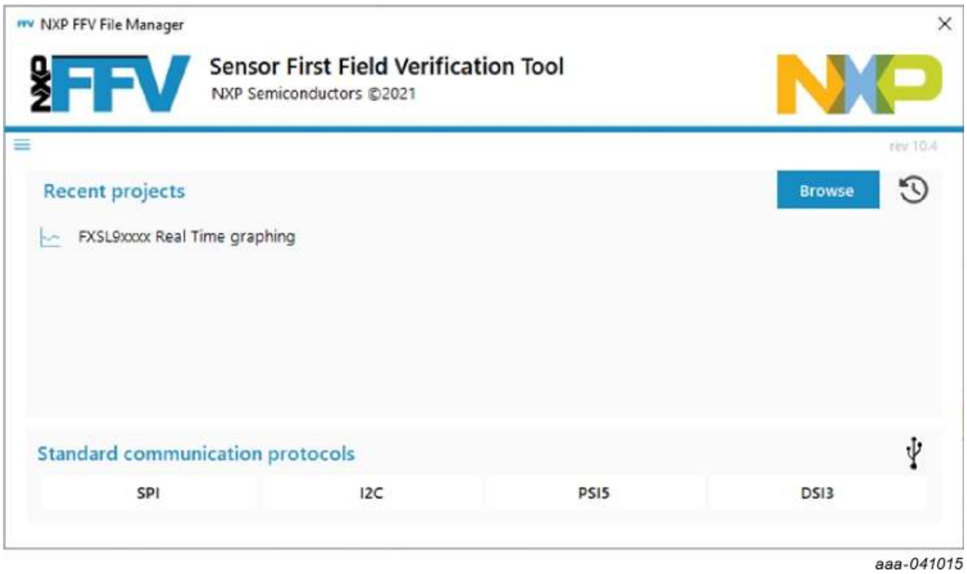

Figure 16. Select a script in the First Field Verification tool

There are several ways to open projects.

Previously Opened Project: Previously opened projects are listed in “Recent projects”. Double-click the "recent project" to reopen the project. To learn more, refer to Section 6.

Figure 17. Open an existing project

NXP Compatible sensor without dedicated package file: The user has an NXP compatible sensor but does not have a dedicated package file. Click the menu bar and review the existing “Predefined sensor packages”. To learn more, refer to Section 6.

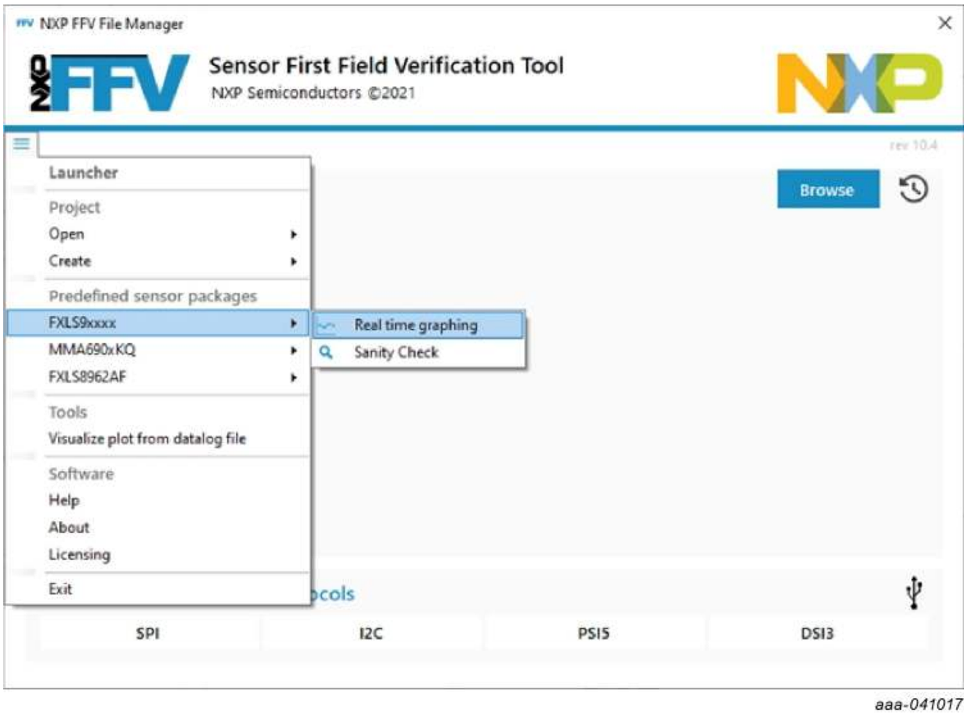

Figure 18. Open a compatible sensor without a dedicated package file

NXP .ffvpkg file: The user has an NXP-provided .ffvpkg file. Click the “Browse” button, select the file and open it. Alternately, drag and drop the file in “Recent projects” adding the file to the "recent projects" list. To learn more, refer to Section 6.

Unsupported device or missing package to communicate with the device: The user has an unsupported device or lacks the necessary package to communicate with the sensor. In this case, use the “Standard communication protocols”. These protocols provide basic functions to communicate with SPI, I^2C, PSI5, or DSI3 sensors. To learn more, refer to Section 5.

Figure 19. Open an unsupported device or missing a package

Note: *PSI5 and DSI3 protocols necessitate special hardware which is sold separately from the SEN-SPI-BOX kit. (SEN-PSI5-ADAPTER and SEN-DSI3-ADAPTER).*

4.2.2.3 FFV kit search

The software scans all the compatible devices. If this operation fails, ensure that everything is properly connected and retry.

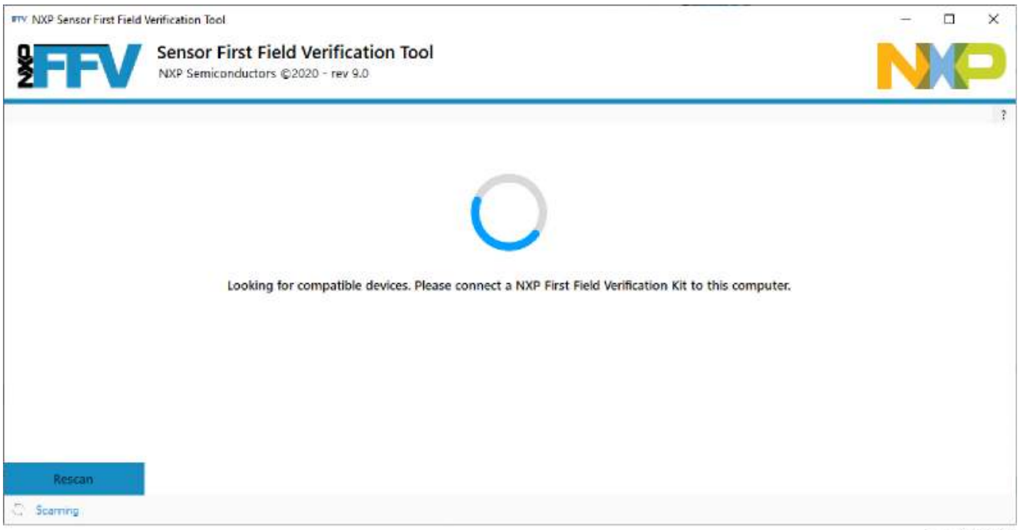

Figure 20. FFV compatible device scan

4.2.2.4 Enable the power supplies

After the software detects the kit, enable and select the voltage for the power supplies as needed.

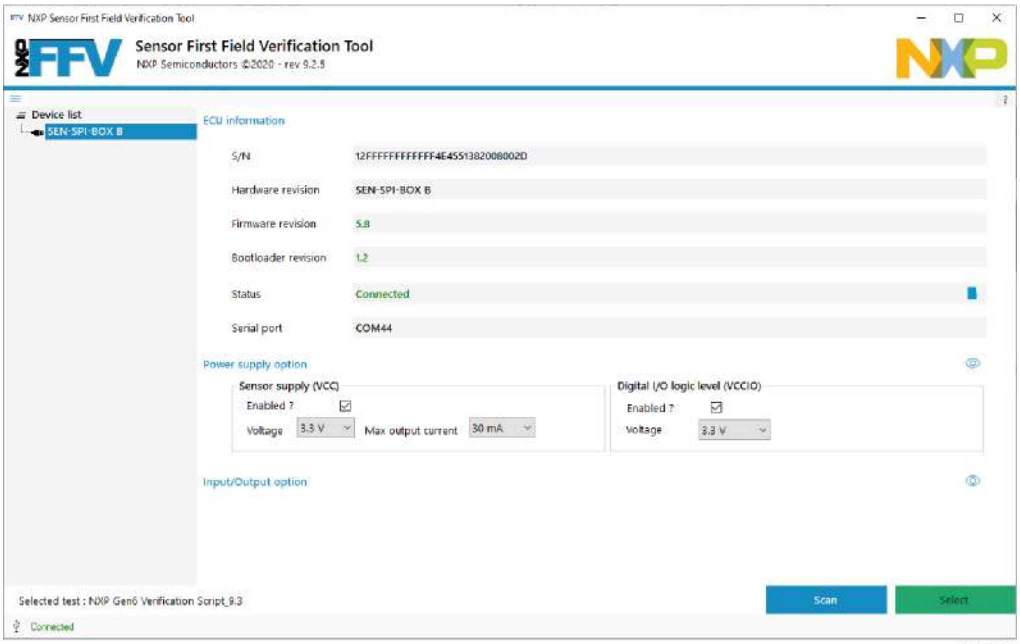

Figure 21. FFV power supply voltage selection

4.2.2.4.1 VCC

When using the FFV kit standalone (no MCU attached to the sensor nor external supply), enable the VCC supply.

If the sensor is already powered by an external source, disable the option.

4.2.2.4.2 VCCIO

VCCIO is the logic voltage of the SPI and I²C interfaces. It must be set to a value compatible with the sensor VCC supply.

4.2.2.4.3 VPP

VPP is the high-voltage supply which could be used in specific cases. It must be carefully used and may damage the sensor if not used correctly.

5 Using standard communication protocols

The SEN-SPI-BOX supports natively SPI and I²C protocols.

To add PSI5 and/or DSI3 automotive protocol interfaces to the SEN-SPI-BOX, adapter boards may be purchased separately.

5.1 Native protocols

When SPI or I²C protocol is selected from the “Standard communication protocol” block, it opens as shown in Figure 22.

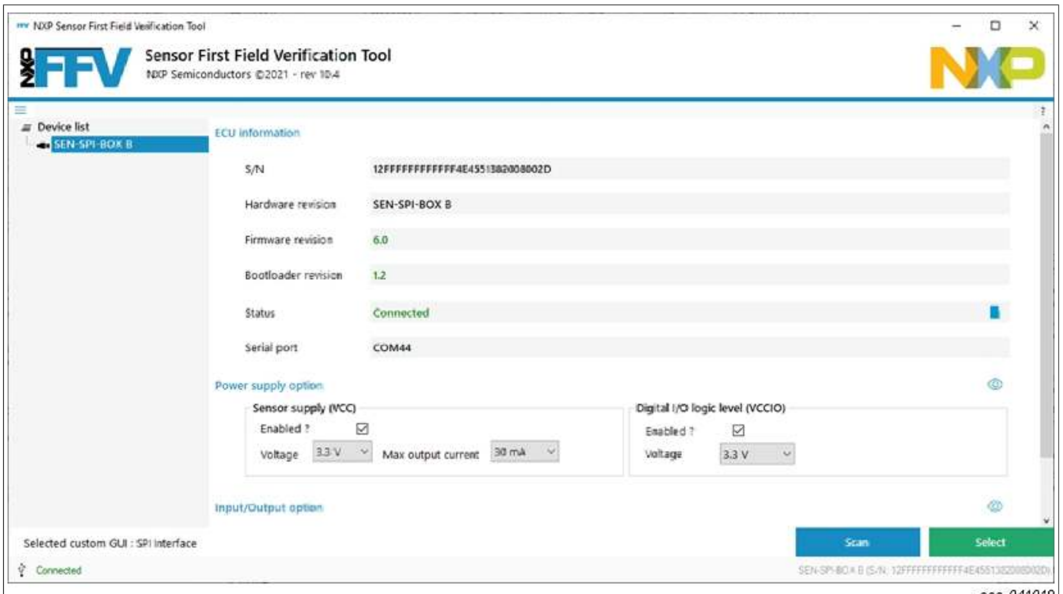

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Figure 22. Example of custom GUI selection for SPI interface

Choose the power supplies as explained Section 4.2.2.4. Select the SEN-SPI-BOX kit (green button bottom right).

Use the debug cable provided in the kit to connect the sensor with the SEN-SPI-BOX board.

Click on the "Select" button once erverything is configured. The software opens the form corresponding to the selected protocol (SPI or I²C) as detailed in Section 5.1.1 and Section 5.1.2.

5.1.1 SPI

The SPI menu offers the necessary functions to transfer data. It supports frequencies up to 10 MHz and the four different SPÏ modes. Transfer width supports 8 to 32 bits data transfers. There are two selections for Chip Select that correspond to the NXP MDI and Beagle terminals.

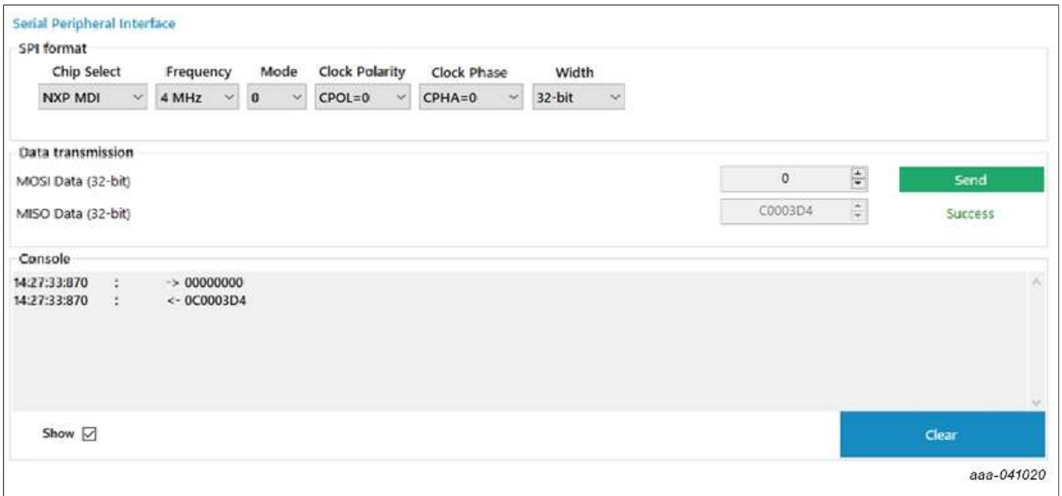


Figure 23. SPI functions for data transfer

Once the configuration set, data can be easily transferred using the “Send” button.

5.1.2 I²C

This I²C interface supports up to 64 byte data transfers.

Configure the 7-bit sensor address and the frequency of the bus (up to 1 MHz).

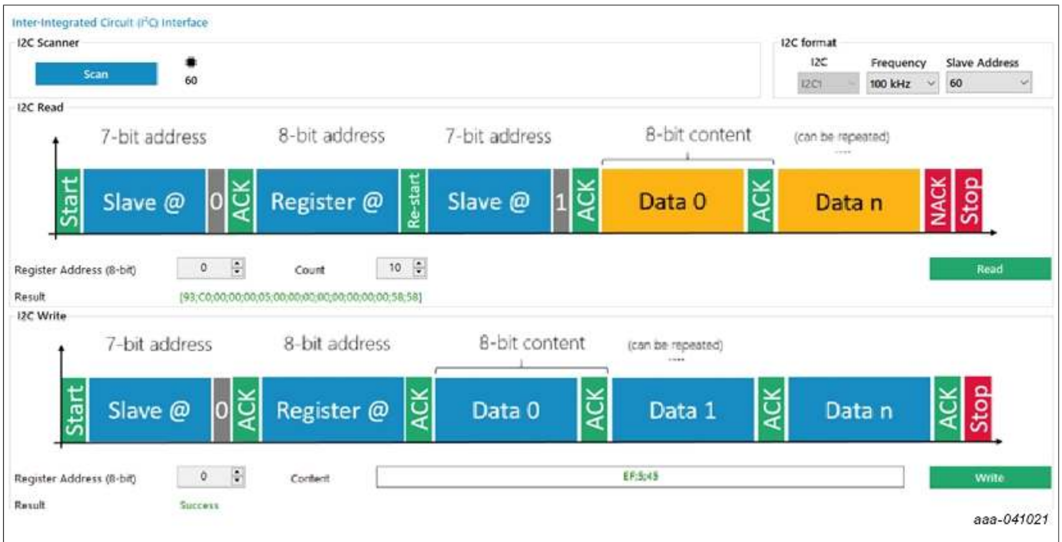


Figure 24. I²C Interface

5.1.2.1 I²C scanner

The SEN-SPI-BOX is able to scan for I²C sensor addresses. To see all compatible connected sensors, click the “Scan” button.

5.1.2.2 Read

Select a register start address and the number of data to read. The result is shown as an array of 8-bit data.

5.1.2.3 Write

Select a start register and write the value in hexadecimal. Separate multiple values using a semicolon (;).

5.2 Optional protocols

The selection of DSI3 or PSI5 protocol in the “Standard communication protocol” block necessitates a special adapter board (SEN-PSI5-ADAPTER or SEN-DSI3-ADAPTER) for each protocol.

1. Check and set the compatible power supply. Always refer to and set the power settings using the value printed on the bottom of the board.Table 3 provides a summary for convenience.

Table 3. DSI3/PSI5 adapter power settings summary

	SEN-DSI3-ADAPTER	SEN-PSI5-ADAPTER
VCC, VCCIO	5 V	3.3 V
VPP	13.5 V	10.5 V

2. Connect the adapter board on the SEN-SPI-BOX using the NXP MDI terminal. Components are on the top. Check the connector coding to avoid mistakes.
3. Click the Scan button.
4. Select the PSI5/DSI3 transceiver listed.

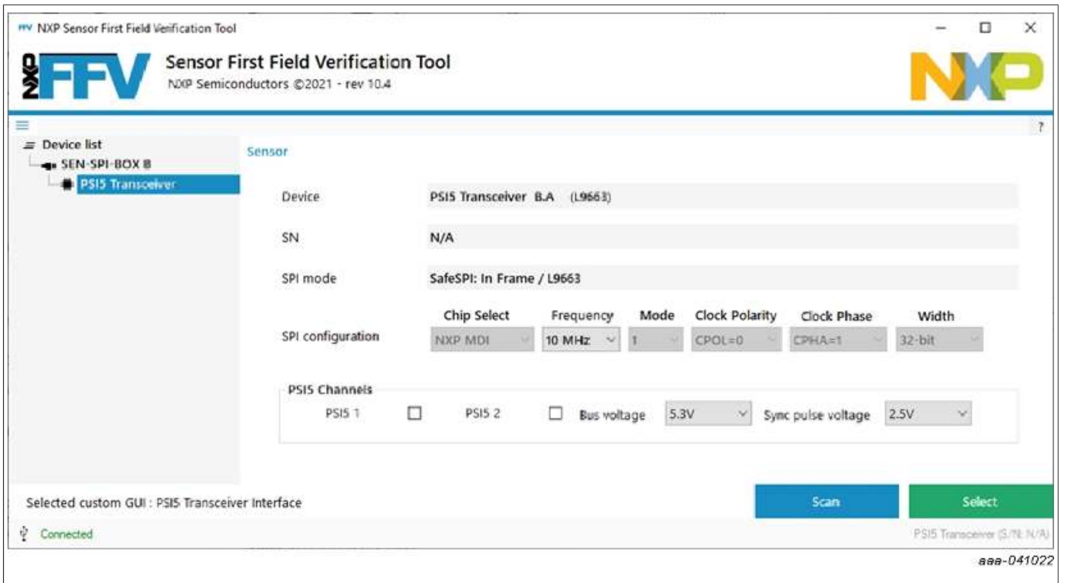


Figure 25. Transceiver selection

5.2.1 DSI3

Two DSI3 interfaces are available on the SEN-DSI3-ADAPTER board: DSI3 channel 0 and DSI3 channel 1.

To enable or disable the interface for each channel, use the “DSI3 channel enable” checkbox.

Enabling a channel automatically sends discovery pulses. Every compatible device present on the bus is assigned a unique physical address.

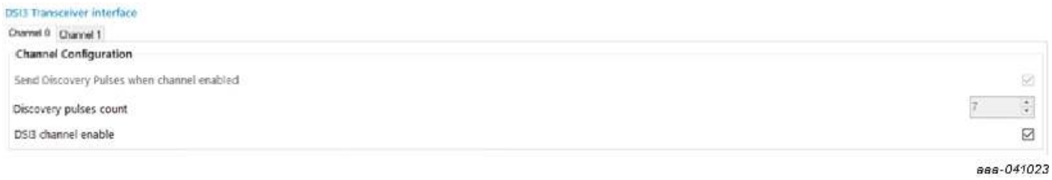


Figure 26. Enable or disable the DSI3 channel

To exit PDCM mode, the corresponding DSI3 channel must be disabled.

5.2.1.1 Command and response mode (CRM)

By default the transceiver boots in CRM mode. If a sensor is connected to the bus and owns a physical address, users may be able to send a CRM command.

The sensor manufacturer specifies the commands and the data to send.

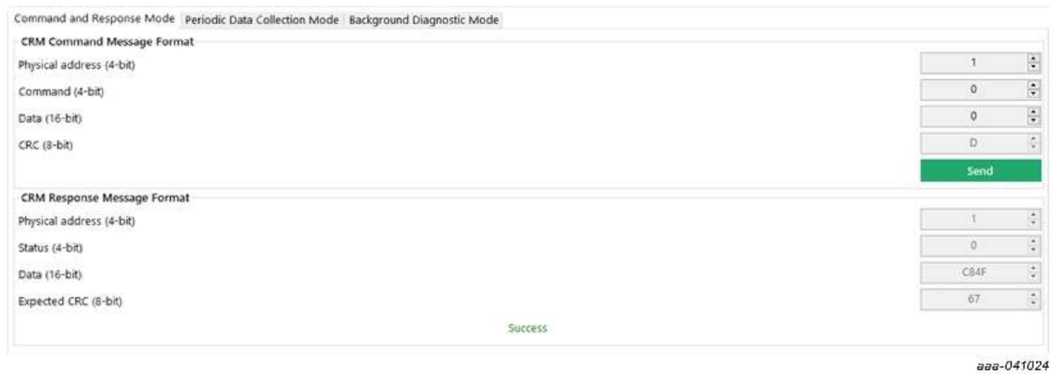


Figure 27. CRM settings

5.2.1.2 Periodic data collection mode (PDCM)

Once the sensor is configured using CRM commands, the user must set the DSI3 receiver correctly for PDCM operations.

1. Selected chip time (transceiver chip time must be identical to the chip time of the DSI3 sensor).
2. Associate source ID to timeslot. If a mismatch occurs between the frame source ID and the slot number, the mismatch raises an error.
3. Choose whether Broad Read Command (BRC) is sent every 500 µs or manually (when the user clicks the "Update" button.

The user can then switch the DSI3 transceiver to PDCM mode by clicking the “Enter” button. The transceiver stays in PCDM mode while the bus is powered.

To return to CRM mode, the user must power off, then power on, the associated channel to return to CRM mode.

Figure 28. PDCM settings

5.2.1.3 Background diagnostic mode (BDM)

Background diagnostic mode is not supported.

5.2.2 PSI5

Two PSI5 interfaces are available on the SEN-PSI5-ADAPTER board: PSI5 channel 0 and PSI5 channel 1.

The interfaces are enabled/disabled using the “PSI5 channel enable” checkbox.

The interface only works for “Sensor to ECU” communication (ECU to Sensor communication is not supported yet).

Figure 29. PSI5 transceiver interface

The operation mode must be selected according to the PSI5 sensor capability.

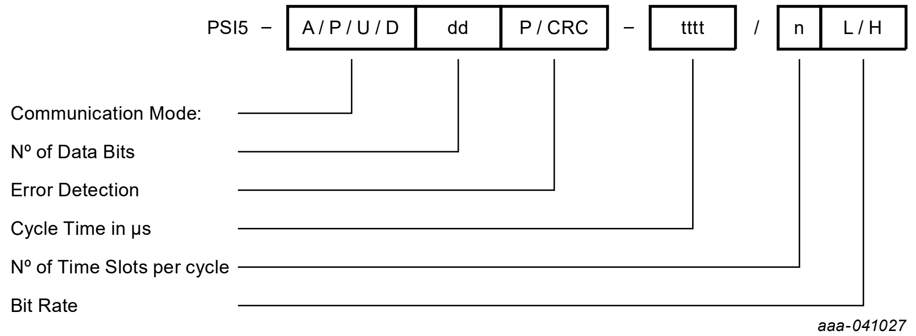


Figure 30. Denomination of PSI5 operation modes

PSI5 supports both synchronous (P) and asynchronous (A) modes. Figure 30 provides a visual summary of the PSI5 operation modes and Table 4 provides details for each field.

Table 4. PSI5 operation mode details

Field	Possible values
Communication mode	Synchronous: **P**
	Asynchronous: **A**
Number of data bits	16-bit: **16**
	10-bit: **10**
Error detection	CRC: **C**
	Parity: **P**
Cycling time	**200** µs to **8360** µs (32 µs step)
Number of slots per cycle	**1** to **6**
Bit rate	125 kbit/s: **L**
	189 kbit/s: **H**

6 Using .ffvpkg or predefined sensor packages

6.1 Connect the sensor to the FFV kit

Plug the sensor to the Sensor FFV kit. If provided by NXP, use the NXP socket board, or connect your own board. The pinout is described in Section 3.2.

6.2 Scan for sensor

In the software, press the “Scan” button.

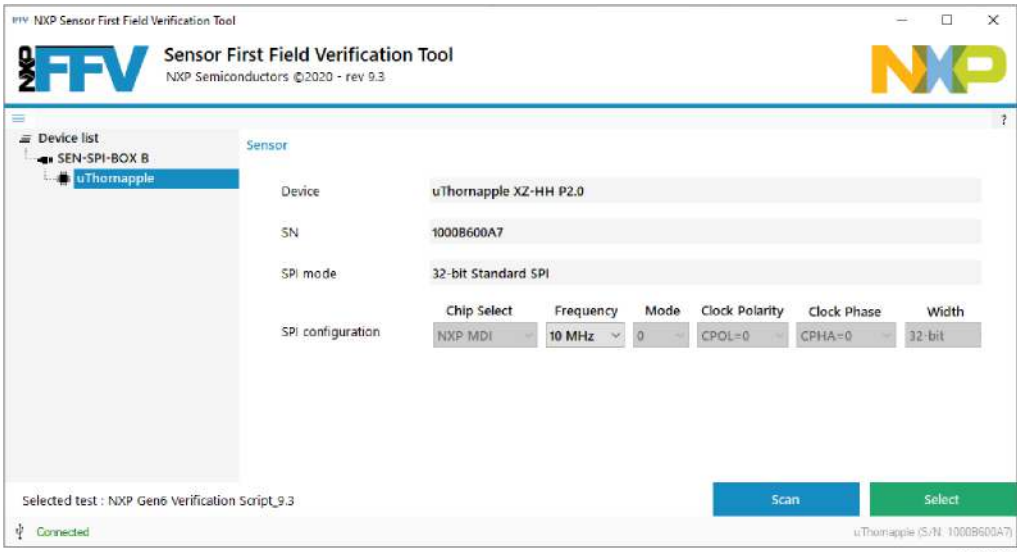


Figure 31. Sensor selection page

A list of the compatible sensors appears.

6.3 Configure the sensor

Select the sensor from the list and if available, configure the SPI/I²C settings.

Note: *The new configuration is applied only when the "Select" button is activated.*

6.3.1 Advanced window for advanced features

To open the advanced windows, right-click any compatible sensor.

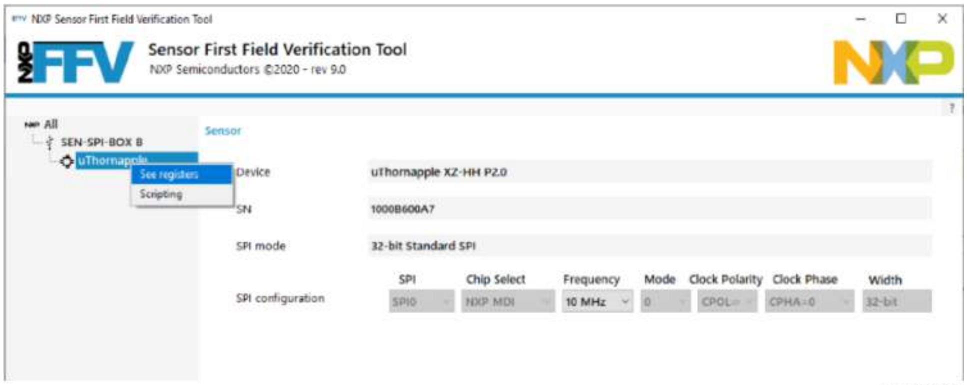


Figure 32. Advanced features

Note: *This feature should be used with special care and is not synchronized with standard functions.*

This capability means that users can overwrite the sensor register without seeing it in the other window if it is not updated.

Currently, there are two advanced forms:

- Register table: Quick and easy way to read and modify the sensor memory.
- Scripting: To configure the sensor, automate actions with a command list.

6.3.1.1 Register table

Figure 33 presents the values found in the registers of the sensor.

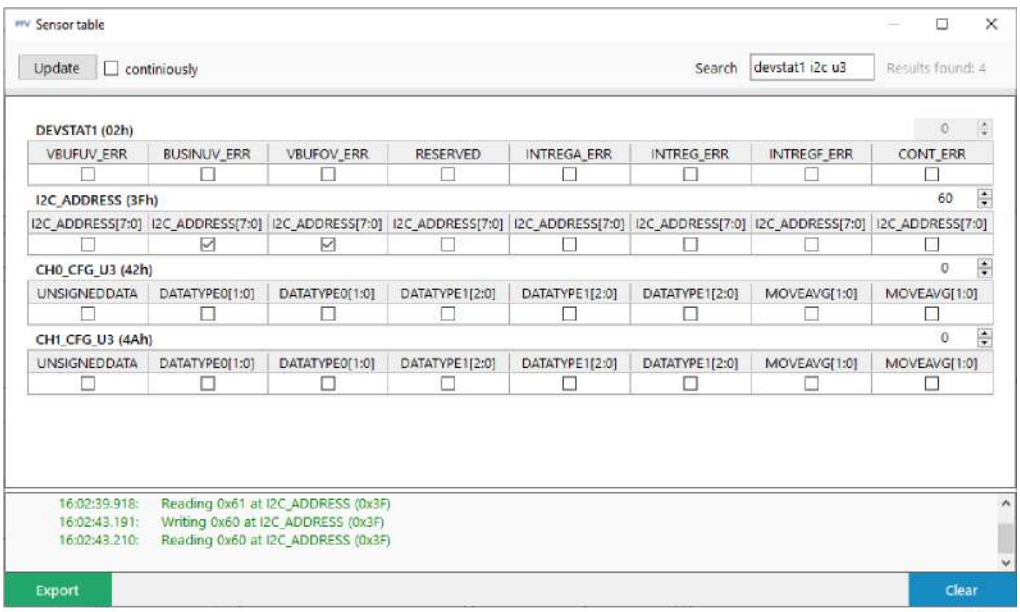


Figure 33. Register sensor content

The data presented in the sensor table, shown in Figure 33, is not real time and a mismatch could exist between the value in the table and the actual register value. The value is displayed in hexadecimal format.

Use filters to reduce the number of visible registers (address, register name, bit field name).

6.3.1.2 Custom script

In parallel, custom scripts can be executed if users want to automate some actions.

To learn how to write scripts, review Section 6.5.3.1.

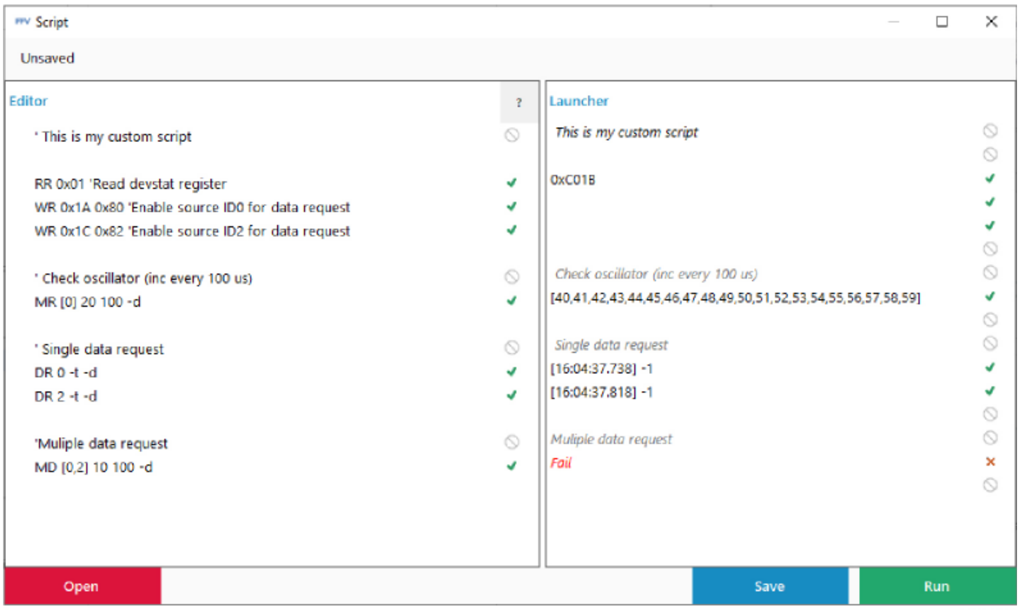


Figure 34. FFV script editor

6.4 Open the package

Press the "select" button to open the package content.

There are two types of .ffvpkg files:

- Test File (See the magnifier icon in Figure 35.)
- Datalogger File (See the graphing icon in Figure 35.)

Depending on the file, the correct form automatically opens.

Figure 35. Types of .ffvpkg files

If using .ffvscript file, jump to Section 6.5.3.

6.5 Use the package files

6.5.1 Test file

6.5.1.1 Configure the test

If available, press the wrench icon to change the test settings. Users can skip some tests by unchecking the test in the list.

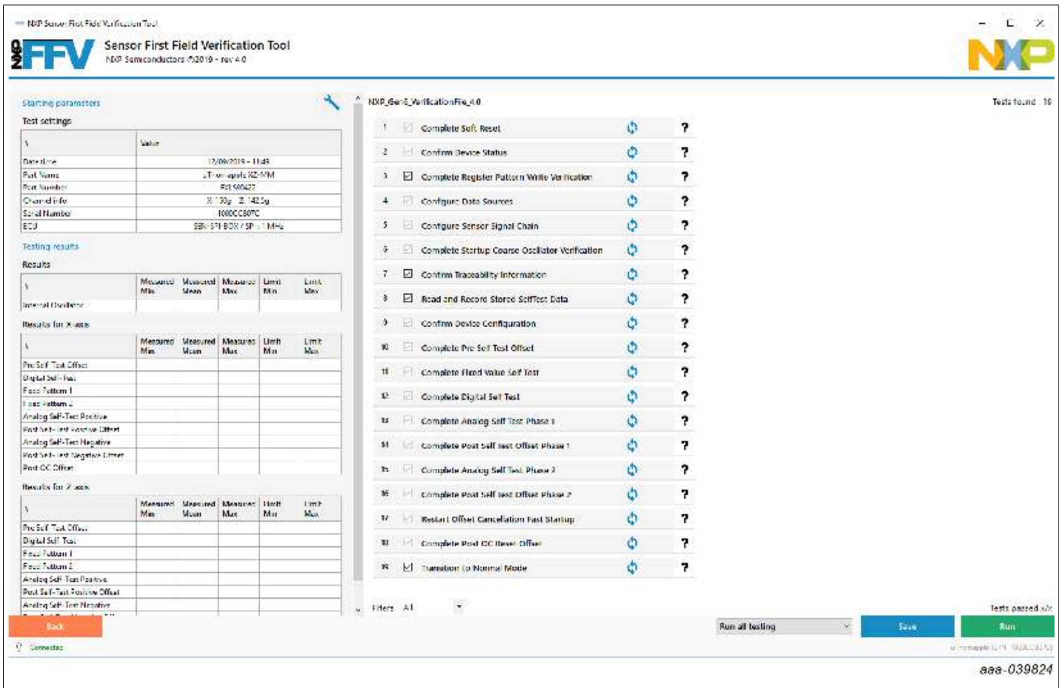


Figure 36. Test of an FXLS90422AES inertial sensor

6.5.1.2 Run the test

Once everything is configured, press the “Run” button. Wait while the sequence is being executed. To view the details of the selected test, click the folder icon.

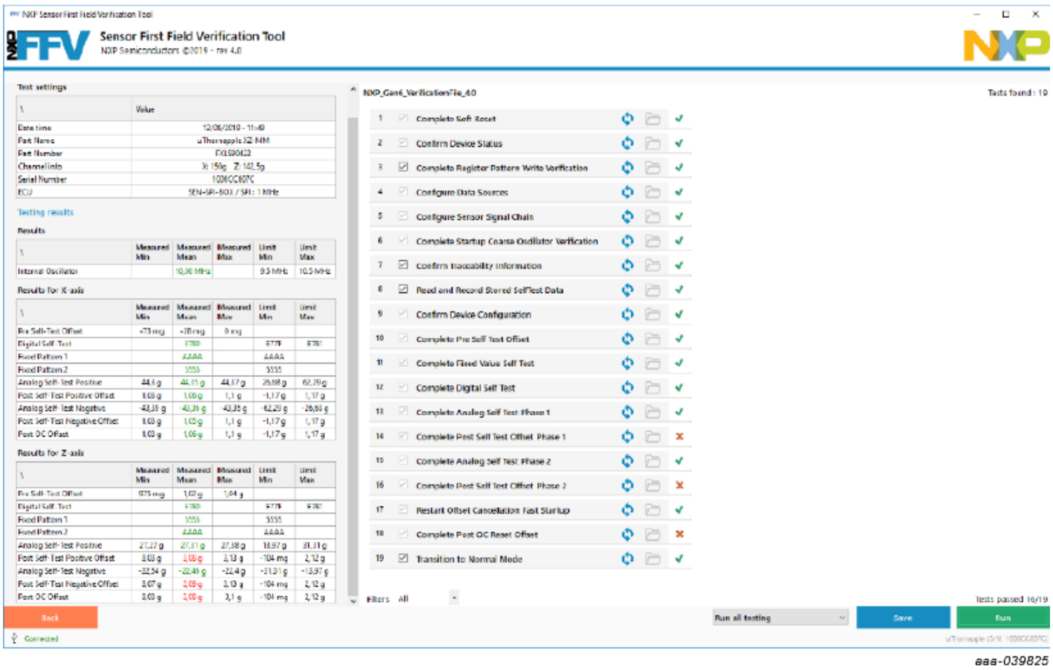


Figure 37. FFV running the test

When complete, export the test results by clicking “Save”. A “.ffvreport” file and a .pdf is generated. The results are visible later when opening the file.

Close the software.

6.5.1.3 Open a test report

Open a test report file by double-clicking a “.ffvreport” file or by launching the software and selecting the file from the window browser.

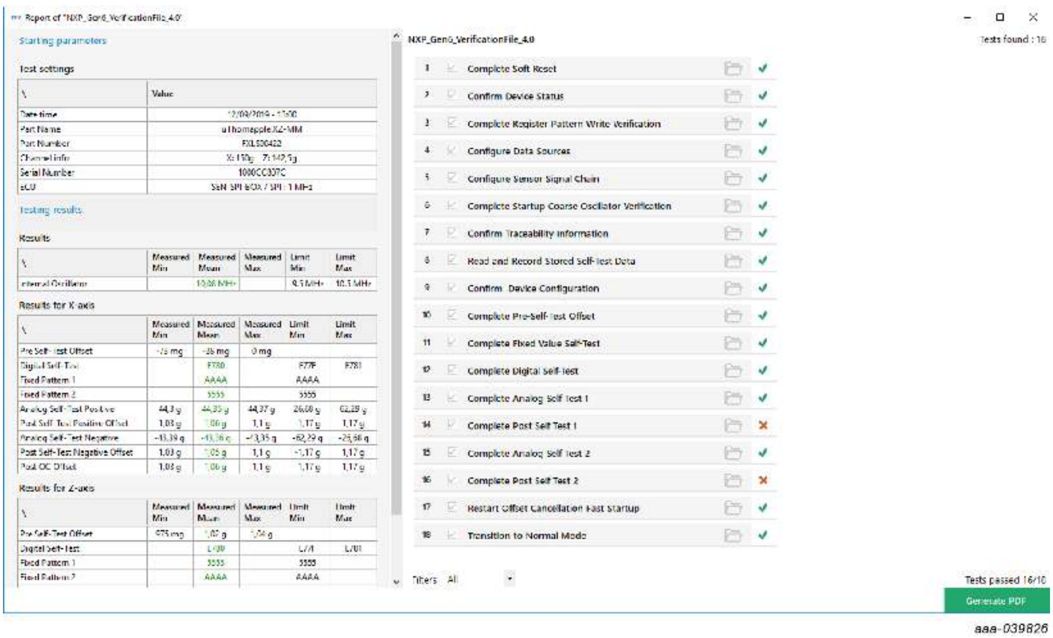


Figure 38. FFV opening the test report

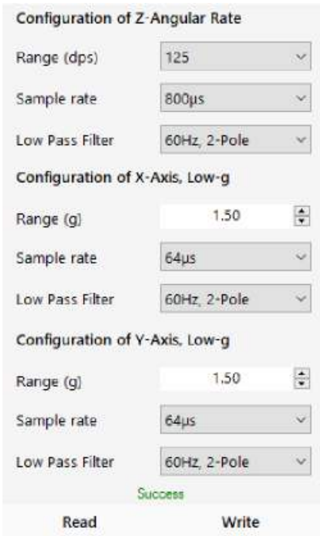
This form is read-only. Re-executing any test from here is not possible.

6.5.1.4 Create a custom test file using C# .Net

Custom test files can be developed using Visual Studio IDE with C# .Net framework. Special documentation is available from the FFV software by clicking “Create advanced C# script” from the launcher.

6.5.2 Datalogger file

6.5.2.1 Configure the sensor



aaa-039827

Figure 39. Example of configuration interface

The left panel offers many high-level settings the user may access to configure the sensor. Do not forget to apply the settings before starting any data steam.

This panel may display differently depending on the selected file/sensor.

6.5.2.2 Configure the streaming settings

The streaming panel is split in 3 different sub panels.

6.5.2.2.1 Stream settings

The Stream settings panel allows users to select:

- “Sampling time” between two data (make sure that the communication frequency is high enough to support the highest rate).
- “Count”: The number of samples to be collected (any non-number value is turned into infinite).
- “Acquisition time”: Not selectable. It just gives the result of “Count” x “Sampling Time”.
- “Unit in LSB”: Unchecked. Shows the plot with the standard units, else shows in LSB.
- “Start” / “Stop”: Launch/stop the stream.

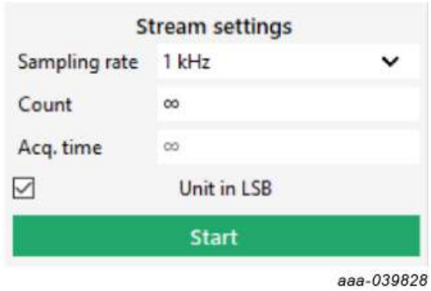


Figure 40. FFV configuring the stream settings

6.5.2.2.2 Stream info

The stream info panel displays status information about the data collection.

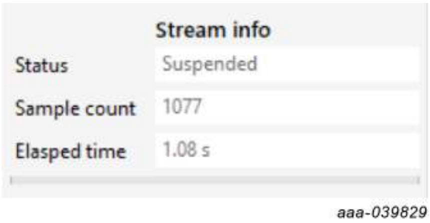


Figure 41. FFV stream information

6.5.2.2.3 Recording settings

The Recording settings panel allows the user to record the incoming data stream.

- **Output file:** The path of the record
- **Status:** Indicates whether a recording is taking place.
- **Recording time:** Displays how long the recording has been running.
- **Record / Stop:** Launches/Stops the record.

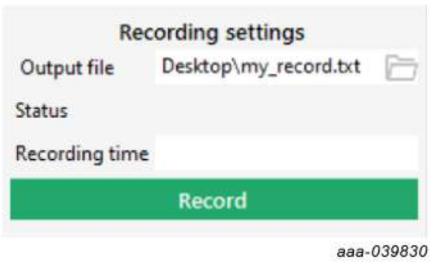


Figure 42. FFV recording the settings

6.5.2.2.4 Run the datalog

Once everything is configured, take advantage on the fast real-time data plotting.

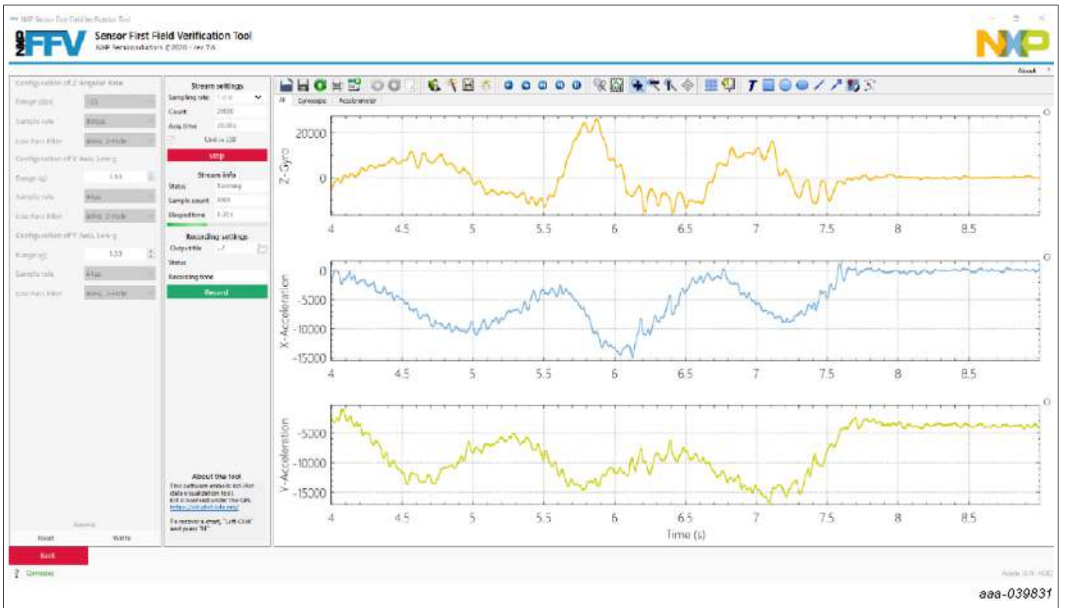


Figure 43. Real-time graphing example

6.5.3 Script file

To automatically execute a list of commands, use script files to create customized scripts. These scripts are editable using simple text keywords.

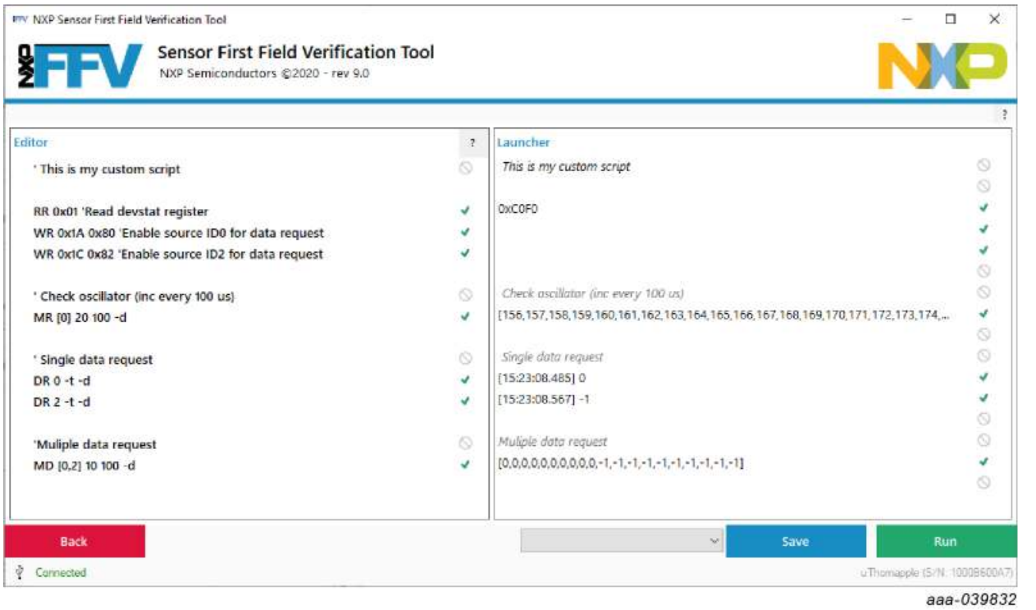


Figure 44. FFV creating customized scripts

To load the file content, drag and drop a text file into the editor area.

6.5.3.1 Create custom scripts

The available keywords are listed below and can be used to develop automatic line by line sequences.

6.5.3.1.1 Generic sensor commands (high-level)

- RR <*address*> [*options*]: Read register command.
- WR <*address*> <*data*> [*options*]: Write register command.
- DR <*source ID*> [*options*]: Sensor Data Request command (Auto-Safety sensor).

6.5.3.1.2 Generic advanced sensor commands (high-level)

- MR <*addess(es)*> <*multiplier*> <*delay*> [*options*]: Multi read register command, real time.
  - address(es): Can be [@1, @2, @3] or range as [@1 - @3] (up to 1024 bytes).
  - multiplier: Repeat the address sequence.
  - delay: Time in µs between each command. (up to 100 ms, check the bus speed compatibility).
- MD <*source Id*> <*multiplier*> <*delay*> [*options*]: Multi data-request register command, real time).
  - source Id: Can be [1, 2, 3] or range as [1 - 3].
  - multiplier: Repeat the source Id sequence.
  - delay: Time in µs between each command. (up to 100 ms, check the bus speed compatibility).

6.5.3.1.3 Generic SPI commands (low level)

- S32 <*data*> [*options*]: 32-bit SPI transfer.
- S24 <*data*> [*options*]: 24-bit SPI transfer.
- S16 <*data*> [*options*]: 16-bit SPI transfer.
- S8 <*data*> [*options*]: 8-bit SPI transfer.

6.5.3.1.4 Generic I²C commands (low level)

Not supported yet.

6.5.3.1.5 Other commands (low level)

- SETV <*channel*> <*voltage*> [*options*]: Power supply command *(Special care is required when using this command. Applying an incorrect voltage may damage a sensor.)*.
  - channel: VCC, VCCIO, or VPP.
  - voltage: (VCC, VCCIO) OFF, 3.3, 5 - (VPP) OFF, 10.5, 13.5.
- DELAY <time> [*options*]: Software delay command in milliseconds, not real time, only accurate for long timing.
- ': Comment.

6.5.3.1.6 Using [Options]

At the end of the command line, add a "-" followed by the option flag. The available flags are:

- -D: Output result in decimal rather than hex.
- -T: Print timestamp.

6.5.3.1.7 Examples

Table 5. Example script commands

Command	Command comment
rr 0x3e	'read address 3E in hexadecimal, result output is in hexadecimal.
rr 25 -t	'read register 25 (19 in hex), result output in hexadecimal, timestamp is displayed.
rr 0x12 -d	'read address 12 in hexadecimal, result output is in decimal.
wr 0x1A 0xAA	'write 0xAA in the register 0x1A.
wr 0x41 255	'write 0xFF in the register 0x41.
dr 0 -d -t	'data request channel 0 with timestamp and decimal output.
mr [0-5] 1 0	'read addresses from 0 to 5 once at the highest bus speed.
mr [0,1,2,3,4,5] 1 0	'same as above.
mr 0 20 100 -d	'read register at address 0 20 times every 100 µs with a decimal display.
md 0 5 100	'data request for channel 0, 5 times every 100 µs.
md [0,1] 10 200 -d	'data request channel 0 and 1, 20 times every 200 ms, decimal display.

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