

SPI-Simulyzer



Single-ended version



LVDS version

Hardware version	Up to 2.0
Software version	1.16.2
Technical data sheet version:	1.5
Order number	1.0106
Created:	(1.0) 03.05.2013
	(1.1) 04.08.2014 aux sample rates
	(1.2) 20.09.2015 correction supply voltage external sensors
	(1.3) 04.08.2018 Added HIL test
	(1.4) 18.11.2018 order number/operatingsystem added
	(1.5) 10.10.2021 Company information edited
	(1.6) 07.11.2022 CAN-Interface added

Table of contents:

1. General.....	3
2. <i>Simulyzer</i> versions	3
2.1 Single ended.....	3
2.2 LVDS.....	3
3. Working modes.....	3
3.1 ECU mode	3
3.2 Sensor mode.....	3
3.3 Passive mode	3
4. SPI-Bus parameter	4
5. Generating of the ECU data at the working mode ECU	4
6. Measurement data recording.....	4
6.1 FPGA-Version	4
6.2 Sample Rates	5
7. Presentation of the measurement data.....	5
7.1 Graphical presentation	5
7.2 Presentation in table form	5
8. Stop of the measurement data recording	5
9. Trigger of the measurement data - trigger events	5
10. Export of the measurement data	6
11. Overview of the measurement data.....	6
12. Connections.....	7
12.1 Interface and digital input/output.....	8
12.2 Pin assignment of interface 1 und 2.....	9
12.3 Pin assignment ribbon cable adaption to 25 pol-Sub-D-female connector -single ended-.....	9
12.4 Pin assignment 25-pol. digital/analog I/O -female connector-.....	9
12.5 Pin assignment LVDS version.....	10
13. Wiring	11
13.1 Wiring passive mode.....	11
13.2 Wiring ECU mode	11
13.3 Wiring sensor mode	11
13.4 Wiring HIL test	12
14. SPI VDDD, VDDA, Usensor Output voltage response	13
15. Technical data	15
16. Electrical data.....	15
17. Environment conditions	15
18. Software system prerequisites	15
19. More information and tutorials	15

1. General

Sensors of automotive technique communicate via SPI-Bus with the control unit. With the *SPI-Simulyzer* data can be read quickly and easy and is able to react to the situation using simulated data.

The *SPI-Simulyzer* is connected via USB cable with a Windows-based software.

2. Simulyzer-Versions

2.1. Single ended:

SPI-Simulyzer with **2 Interface connections**

(included in delivery a ribbon cable adaption to 25-pol. SUB-D- male connector)

and a **25-pol. SUB-D-female connector** (included in delivery an empty SUB-D mating connector).

2.2. LVDS version:

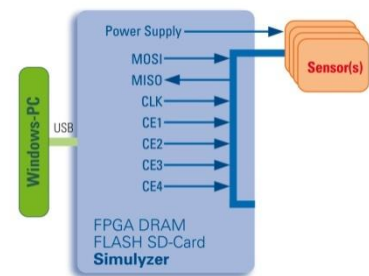
Differential signal transmission adaption

(adaption with POD to 25-pol. SUB-D-female connector available).

3. Working modes

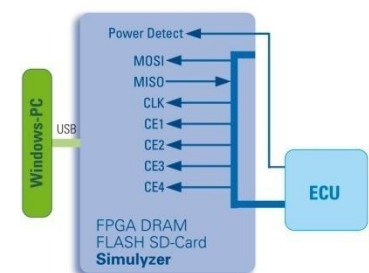
3.1. ECU mode

The *SPI-Simulyzer* supplies the sensors with voltage and generates defined master data. Parallel the data which are sent will be recorded. The data communication between the simulated ECU (SPI master) and the up to 4 sensors (SPI slaves) are displayed and recorded.



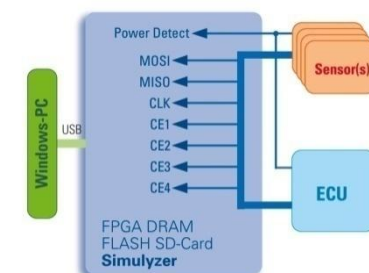
3.2. Sensor mode

The *SPI-Simulyzer* simulates up to 4 sensors by generating according data. The data communication between the ECU (SPI master) and simulated sensors (SPI slaves) are displayed and recorded.



3.3. Passive mode:

The data communication between the sensors and the control unit (ECU) will be recorded and visualized.



4. SPI-BUS parameter

Data length	8 to 64 Bits per data package
SPI Clock rate	10 Hz to 20MHz
Baud rate	8 Mbit/s
Error detection	Parity/CRC
Phase and polarity of SPI data/SPI clock	All 4 variations: <u>1. variation:</u> <i>Phase Clock-Idle = 0</i> <i>SPI data with 1. edge after SS (High)</i> <u>2. variation:</u> <i>Phase Clock-Idle = 0</i> <i>SPI data with 2. edge after SS (Low)</i> <u>3. variation:</u> <i>Phase Clock-Idle = 1</i> <i>SPI data with 1. edge after SS (High)</i> <u>4. variation:</u> <i>Phase Clock-Idle = 1</i> <i>SPI data with 2. edge after SS (Low)</i>
Protocol	Inframe communication Outframe communication
Supply voltage of the external sensors (ECU-Mode)	2,5 V to 20 V
High/Low-voltage level of the digital inputs	2V
High/Low-voltage level of the digital outputs	CMOS outputs with $V_{dd}=2,5\text{ V to }6\text{ V}$

5. Generating of ECU data at the working mode ECU

The data values of the ECU (master data) are defined by entry of the single commands, separated in the once time running init phase and the multiple running data of the measurement cycle (slope definition).

The commands can be edited directly or can be imported as a text file.

The injection of single commands is possible at any time during the measurement cycle.

6. Measurement recording

The SPI data are recorded as a FPGA decoded data in common with a time stamp.

The resolution is 1 μs . The data are stored in a file up to 4 gigabyte. The file is organized as a ring buffer (first in/last out)

During this time, the data are shown as permanently changing numbers or characteristics in the presentation window.

6.1. FPGA versions

The respective FPGA version have to be accorded to the respective software version.

History of the FPGA version:

FPGA-Version	Software-Version
0x31A	1.15.1
0x31B	1.15.2
0x31C	1.15.3
0x31C	1.15.4
0x31C	1.15.5
0x31C	1.15.6
0x31E	1.16.0
0x31E	1.16.1
0x320	1.16.2

6.2. Sample rates of the Aux inputs

LVDS		Single ended	
1 signal	-	1 signal	Each signal 100 k samples/s
2 signals	1. signal with 50 k samples/s 2. signal with 50 k samples/s	2 signals	Each signal 100 k samples/s
3 signals	1. signal with 50 k samples/s 2. and 3. Signal with 25 k samples/s	3 signals	Each signal 100 k samples/s
4 signals	1. signal with 50 k samples/s 2., 3. and 4. signal with 16,67 k samples/s	4 signals	Each signal 100 k samples/s

7. Presentation of the measurement data

7.1. Graphical presentation

The data of the ECU as well as the sensors are presented as an analog-signal and as a digital signal with separate free selectable colors over a time axis. Trigger values and CRC resp. Parity error are marked up. The unit of the vertical axis is LSB, but can be changed in other units corresponding to the physical unit. The time section and the zoom of the presentation can be done individual.

7.2. Presentation in table form

The measurement data are additionally displayed as a textual table. Thereby each row represents a data frame of the SPI-Master resp. SPI-Slave. At the columns the time stamp, the number of transmitted bits, the hexadecimal value of the transmitted data frame of the ECU and the sensors as well as the extracted measurement data value are displayed. If an parity/CRC error occurs the corresponding line will be highlighted in red.

8. Stop of the measurement data recording

After starting the measurement data recording the measurement cycle can be stopped by following variations:

- Manual - by clicking on the stop button of the software
- After a defined time
- After a defined number of cycles.

9. Trigger of the measurement data - trigger events

By defining trigger values, specified events (trigger events) can be recorded and saved.

Definition of trigger values:

- Recognize a parity/CRC errors
- Data value levels: go below or beyond of a data value
- External trigger voltage:
Recognition of a voltage at the trigger input (min. 2 V- max. 5 V)

After trigger a free defined number of data will be recorded. The according trigger events can be stored in defined time sections. By triggering a voltage impulse is generated at the trigger output (CMOS output with $V_{dd}=5V$).

10. Export of the measurement data

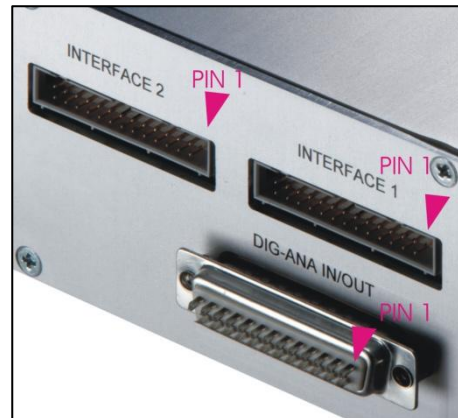
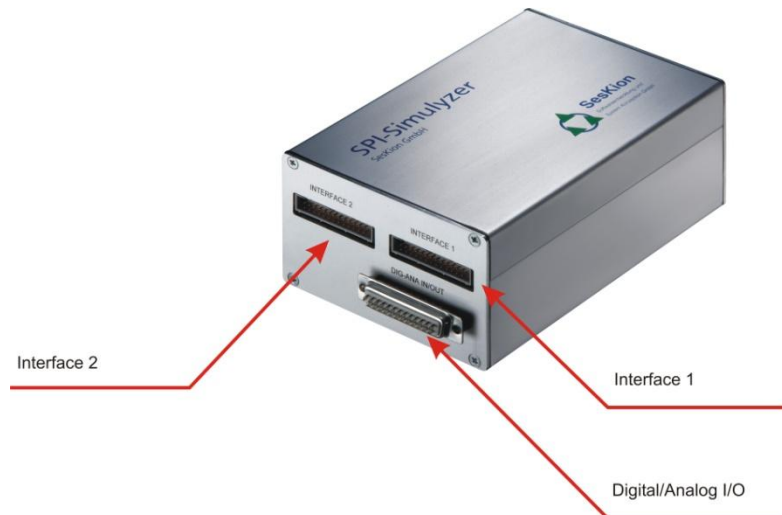
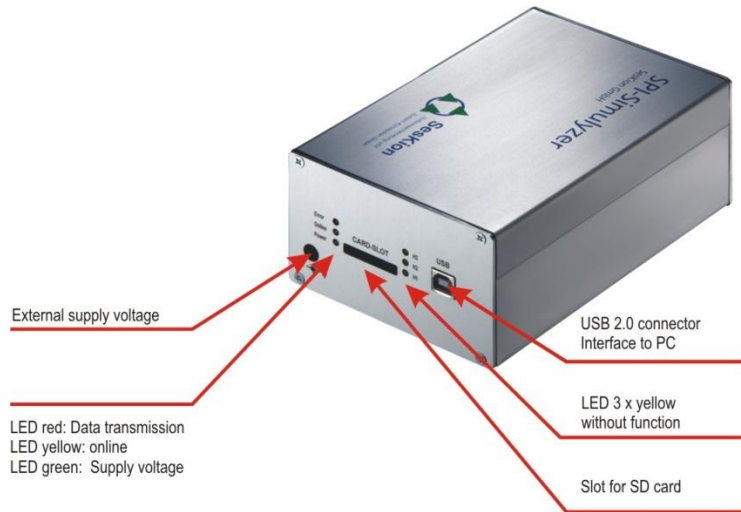
The recorded data are stored in binary form. They can be exported as a (*.txt) or (*.csv) file in different formats (TCDM, hexadecimal, decimal and as physical units. Thereby a selection of single measurement signals is possible.

11. Overview of the functions

The following functions are available:

- Visualizing the SPI-Bus communication
- Recording of the measurement data
- Stop of recording by defined values
- Simulation of the ECU (Generating of master data)
- Export/import of the master data
- Export/import of the sensor data
- Logic analyzer of the data lines
- SPI-Bus parameter editor
- Table list of the measurement data
- Single command editor
- Measurement data file inspector
- Definition of trigger values
- Analyze and saving trigger events
- Export of trigger events
- Manipulation of the inputs/outputs
- Injection of trigger and reference signals
- Definition of project files and their administration.

12. Connections



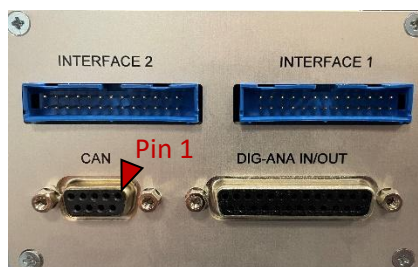
Note:

Supply voltage 12 V via external power supply (1 Ampère)
 Ground of the supply voltage is connected with the case!
 Ground of the cable signals have to be the same ground!

12.1. Optional CAN Interface

Optionally new devices can be served with an additional CAN-Interface (no retrofit ex post).
 Option 2.2001 "Optional CAN interface – SPI-Simulyzer built-in order no 2.1001".

Pin	Description
1	nc
2	CAN low
3	GND
4	nc
5	nc
6	GND
7	CAN high
8	nc
9	nc



Note: Terminating resistor between CAN-high and CAN-low is **not** implemented.

12.2. Interface and digital input/output

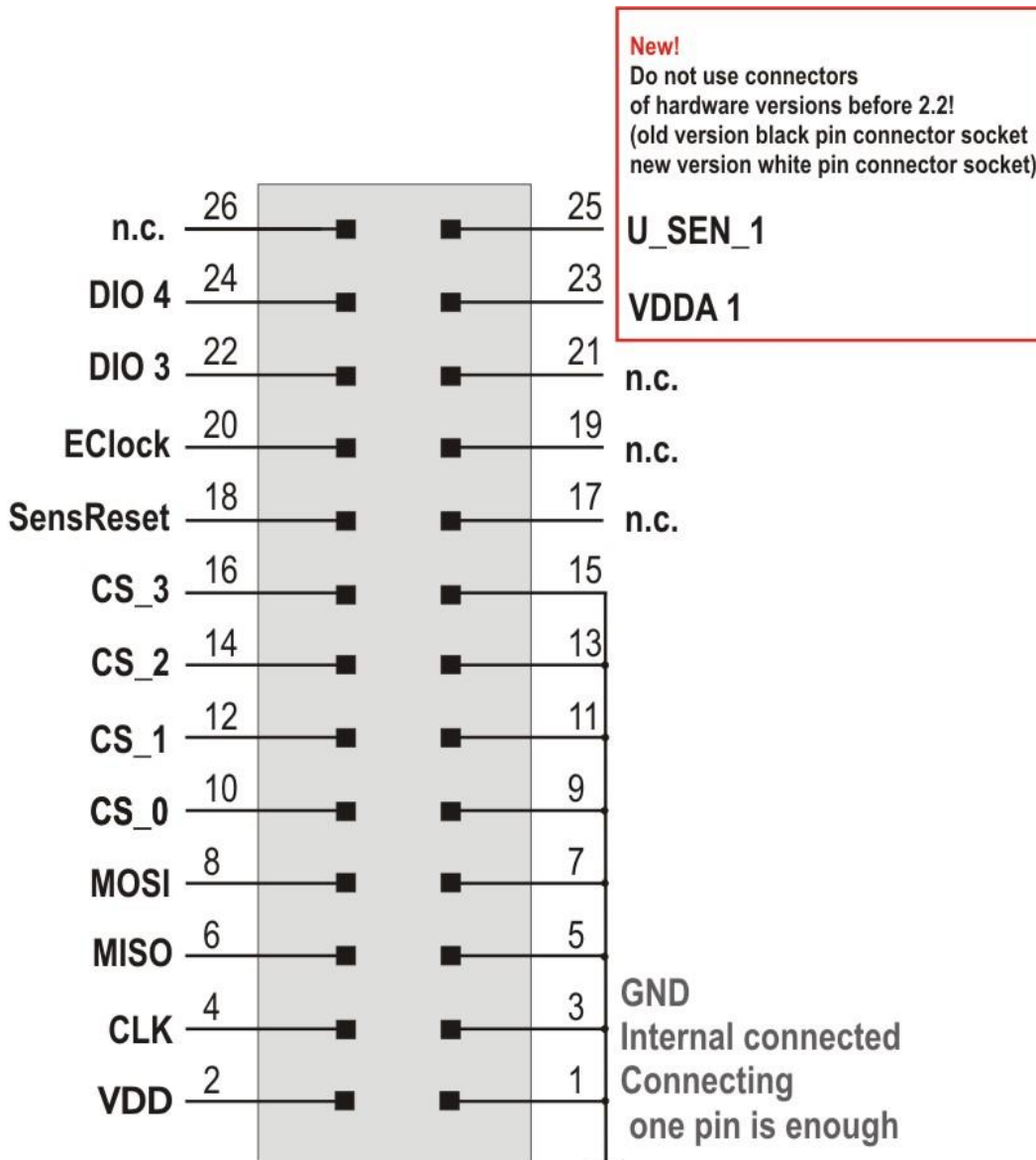
Both in common is the reference voltage supply REF193, which affords 3 Volt. In addition, in the measuring and spending analog branch, resistances with an accuracy of 0,1% are used. The used OPs are high impedance OPs. Electric capacitor with leakage currents are not used in the measuring circuit. The AD-Converter has a resolution of 12 Bit.

The measure arrangement was developed as simply as possible, to receive no addition of tolerances. The experience shows that the indicated accuracy of < 0.5% is fallen below clearly. A temperature compensation does not take place, because it is assumed that the equipment is used under laboratory conditions.

The analog outputs are used for the analog sensor data. They are logical OP outputs, which are not able to drive great charges. For example, to control a magnet valve an external boost is necessary.

Via the analog outputs the SPI measurement is transmitted. As soon as a new value appears in the SPI, the corresponding output is actualized.

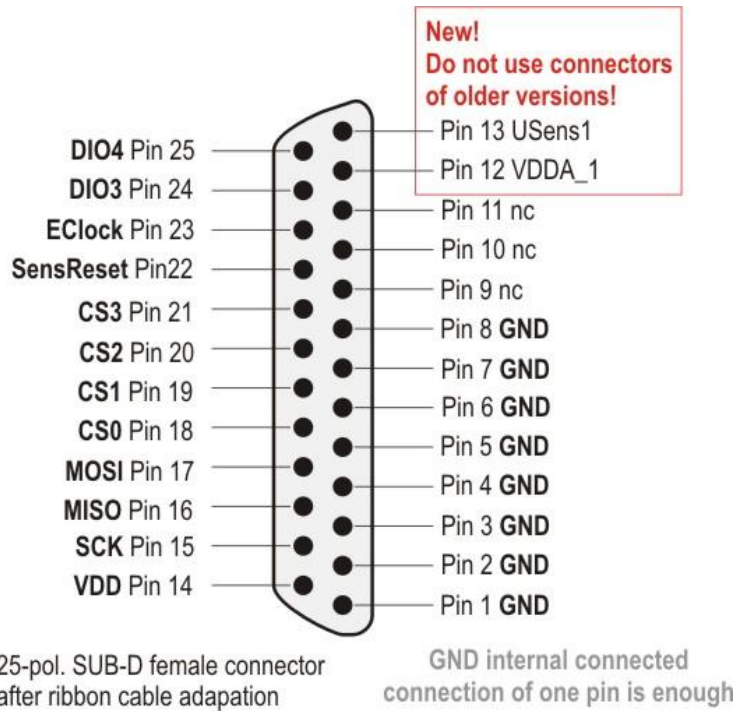
12.3. Pin assingment interface 1 and 2



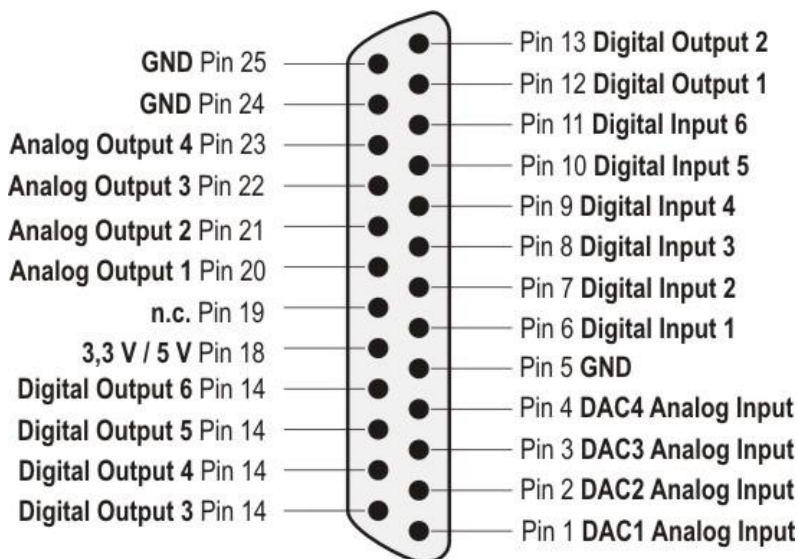
12.4. Pin assignment ribbon cable adaption to 25 pol-sub-D-female connector - single ended -

The *SPI-Simulyzer* is delivered with a ready-made ribbon cable with a 25-pol. sub-D-female connector.

Pin-assignment of the 25 pol sub-D-female connector:

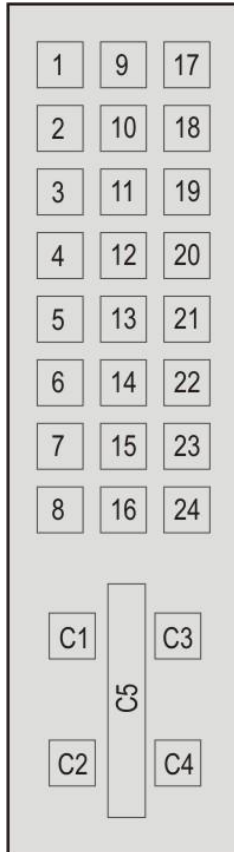


12.5. Pin assignment of the 25-pol. digital/analog I/O - female connector -



12.6. Pin assignment of the LVDS-Version

Pin assignment of the interface 1 and 2:

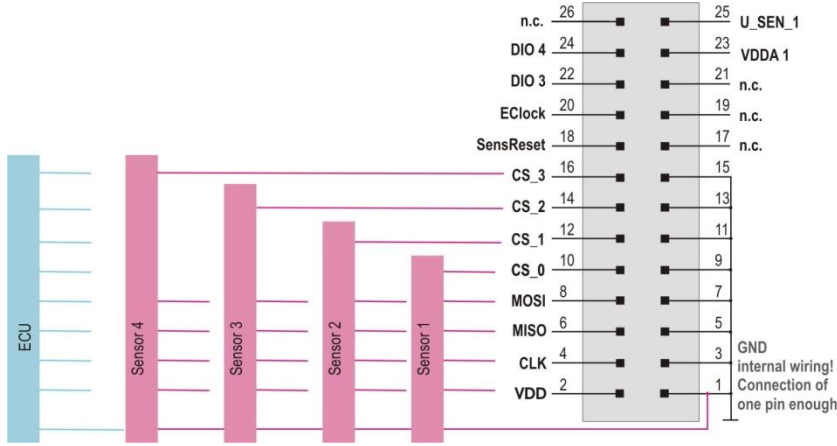


Pin	Signal
1	CS3-
2	CS3+
3	GND
4	CS2-
5	CS2+
6	!SO_MI_EXT
7	!OE_EXT
8	GND
9	CS1-
10	CS1+
11	GND
12	MOSI-
13	MOSI+
14	VDD
15	GND
16	+3,3 V
17	CS0-
18	CS0+
19	GND
20	MISO-
21	MISO+
22	GND
23	CLK+
24	CLK-
C1	SensReset
C2	EClock
C3	DAC3
C4	DAC4
C5	GND

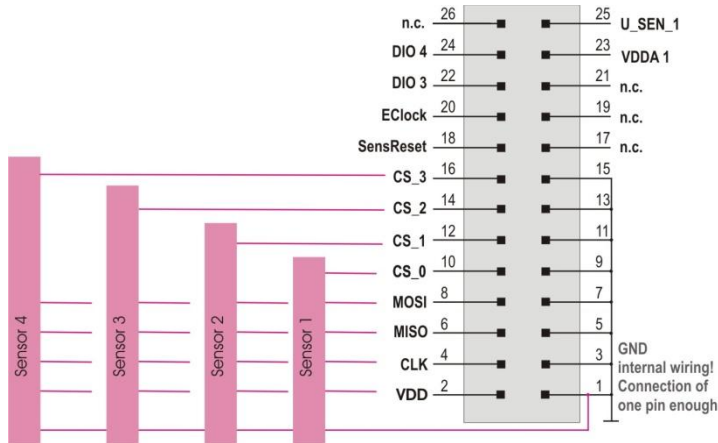
The pin assignment of the 25-pol sub-D-female connector after the POD corresponds to the pin assignment of the single-ended version!

13. Wiring

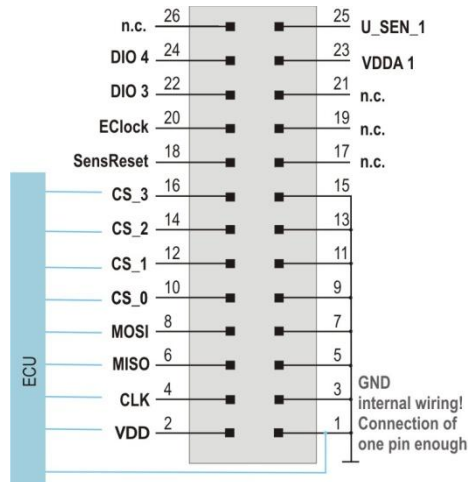
13.1. Wiring Passive Mode



13.2. Wiring ECU Mode



13.3. Wiring Sensor Mode



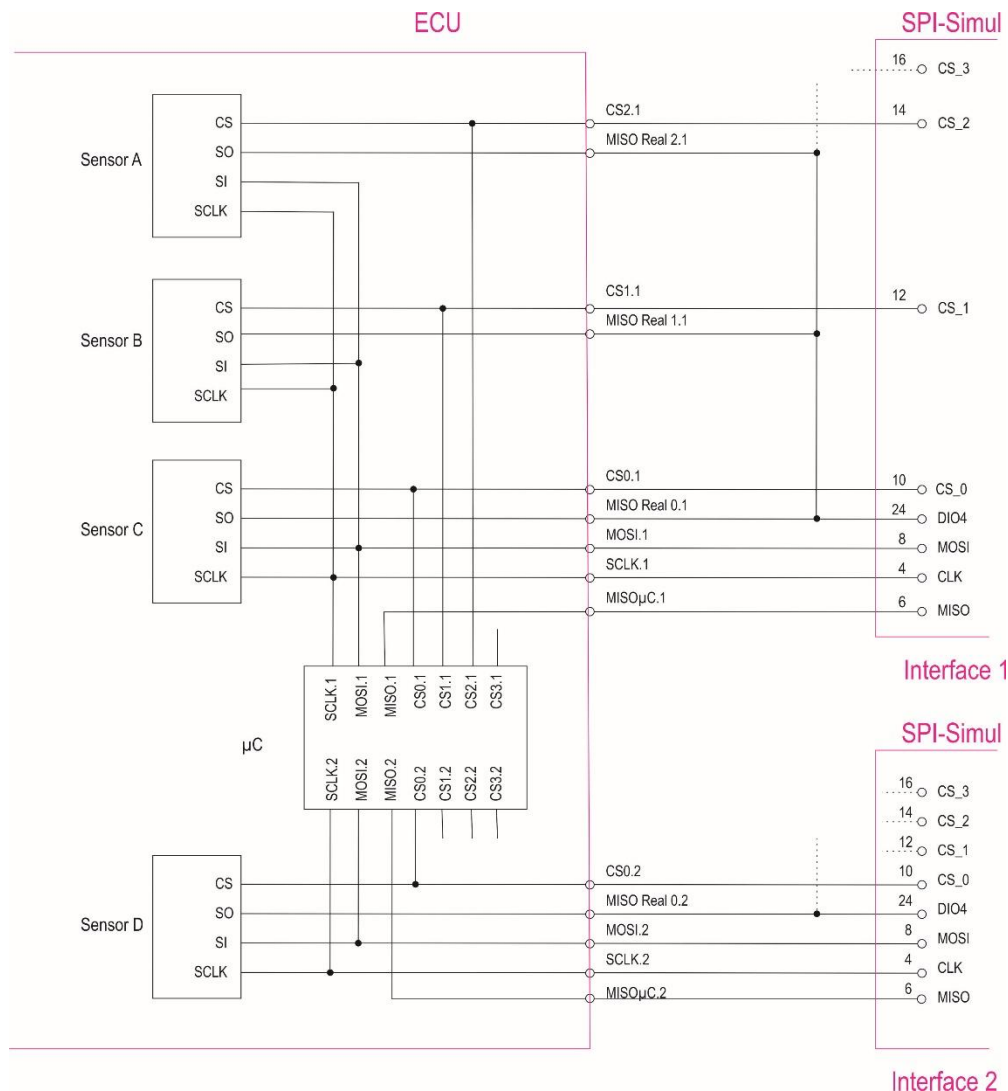
13.4. Wiring HIL test

Below there is a description of wiring the SPI signals of an ECU with the SPI-Simulyzer for using under HIL test.

Note: A SPI-Simulyzer is able to simulate 4 SPI sensors at most.
 These 4 SPI sensors can be spread to both interfaces.
 There are implementations of sensor models for different sensors.
 The sensor models have to be checked individually with SesKion GmbH and have to be created new by SesKion. Therefore the functional range have to be defined according to the sensor data sheet.
 Sensor models have to be licenced at any time!

In the following example 4 SPI-sensors are connected with the ECU and to the microcontroller.
 The sensors A, B and C via a common SPI interface and chip select lines as well as one SPI sensor more via a second SPI interface and a chip select line.
 The signals *SCLK.i*, *MOSI.i*, *CS0.i*, *CS1.i* and *CS2.i* are parallel lead through to a test plug for internal ECU connection. The original connection between *MISO.i* and the SO lines of the sensors have to be cut and lead through to the test plug
 Die *MISOReal.i* are linked outside and connected to the according interface of the SPI simulyzer.
 If single or all internal sensors of the ECU have to be used without simulation, their *MISOReal.i* signals have to be connected with the *MISO μ C.i* signal directly!

14.



14. SPI VDDD, VDDA, Uensor Output voltage response

The current measurements refer to the total currents, i.e. U_Sensor_1 and U_Sensor_2 together or VDDD_1, VDDD_2, VDDA_1 and VDDA_2 together. So if 100mA is drawn on one channel VDDA_1 at 3V, there is nothing left for the others.

VDD and U_Sensor are independent of each other. Both sources can therefore be loaded independently of each other. U_sensor is supplied via an SNT, so more current can be drawn here. VDDD and VDDA are generated together in a linear power OP. Here the voltage is generated by a higher voltage, the current flow generates power loss, which is higher the smaller VDD is. Therefore, only a smaller current can be supplied.

The drop in the output voltage of approx. 0.1V/100mA occurs at the current switch, which separates the internal voltage supply from the external voltages (e.g. in passive mode). If necessary, the output voltage can be increased by using the voltage measurements of the external voltages.

U_Sensor, 1,5V nominal	
Output voltage	Capacity (mA)
1,5	0
1,47	20
1,45	40
1,42	60
1,40	80
1,37	100
1,32	150
1,26	200

U_Sensor, 3V nominal	
Output voltage	Capacity (mA)
3,0	0
2,98	20
2,96	40
2,93	60
2,91	80
2,89	100
2,83	150
2,78	200

U_Sensor, 4,5V nominal	
Output voltage	Capacity (mA)
4,5	0
4,48	20
4,45	40
4,43	60
4,41	80
4,38	100
4,33	150
4,27	200

VDDD, VDDA, 1,5V nominal	
Output voltage	Capacity (mA)
1,5	0
1,46	20
1,43	40
1,40	60
1,39	70
1,38	80
1,35	100 (peak)

VDDD, VDDA, 3V nominal	
Output voltage	Capacity (mA)
3,0	0
2,99	20
2,98	40
2,93	60
2,92	80
2,92	100
2,89	150 (peak)

VDDD, VDDA, 4,5V nominal	
Output voltage	Capacity (mA)
4,5	0
4,47	20
4,45	40
4,42	60
4,40	80
4,38	100
4,36	120
4,33	150
4,30	200 (peak)

15. Technical data

Dimensions	165 x 105 x 55 mm
Case material	Alu
Wight	1 kg
Operating temperature range	32°F ... 104°F
Acceleration	Max. 3g
Rel. humidity	Max. 85% not condensed

16. Electrical data

Current consumption via USB	Typ. 500 mA
Supply voltage of the external sensors at the ECU mode	0 V ... 5,5 V
Dynam. RAM	128 MB
FPGA Soft μ C Core	32 bit Soft-Core

Note:

The application of an external voltage over 6 V can disturb the *SPI-Simulyzer!*

17. Environmental conditions

Usage sites are electronic engineering labours with corresponding ambient conditions.

18. Software system prerequisites

- Operating system: Windows 7 or 8, XP,10 (32 or 64 bit)
- Microsoft .Net 2.0 framework. Will be installed automatically.
- Memory: min. 1GB RAM
- Hard disk 100 MB to 4GB free capacity (limits of the data FIFO)
- Processor: min.1.5 GHz
- USB 2.0 High-speed interface
- Screen resolution: min.1024x768 Pixel, opt. 1280x720 Pixel

19. More information and tutorials

Seskion GmbH
Karlsruher Straße 11/1
D-70771 Leinfelden-Echterdingen
Phone: +49 (711) 990 58 14
Fax: +49 (711) 990 58 27
Email: info@seskion.de
URL: <http://www.seskion.de>