# Simulyzer-RT
# DIO-2 Card

| | |
|---|---|
| Hardware version | V1.0 |
| Documentation version: | 1.0 |
| Created: | (1.0) 06.12.2021 |
| Order no.: | 20.3004 |

# Safety instructions

To avoid damages to persons and devices the following safety instructions have to be noticed!

- Only qualified personnel are allowed to handle this device!
- Before any handling within the device the current supply has to be switched off!
- During operation the device have to be positioned, that enough air condition is supplied and no small parts can get into the ventilation slots.
- In case of any trouble the system has to be switched de-energized!
- The declared environmental conditions and max. voltage ranges have to be observed!
- To warranty the device remove all dust and dirt in periodically intervals.
- Make sure that the ventilation slots are unobstructed!

# Intended use:

**The Simulyzer RT DIO-2 card is engineered for measurement and analysis of sensors of a RT proofing system. The field of function of the DIO-2 card is the digital data transfer within the test system (see applications).**

- The device is only permitted to use for the intended use.
  Any other use results the deletion of the guarantee!

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## Table of contents

The Simulyzer-RT DIO-2 board is a further development of the Simulyzer-RT DIO-1 board in the areas:

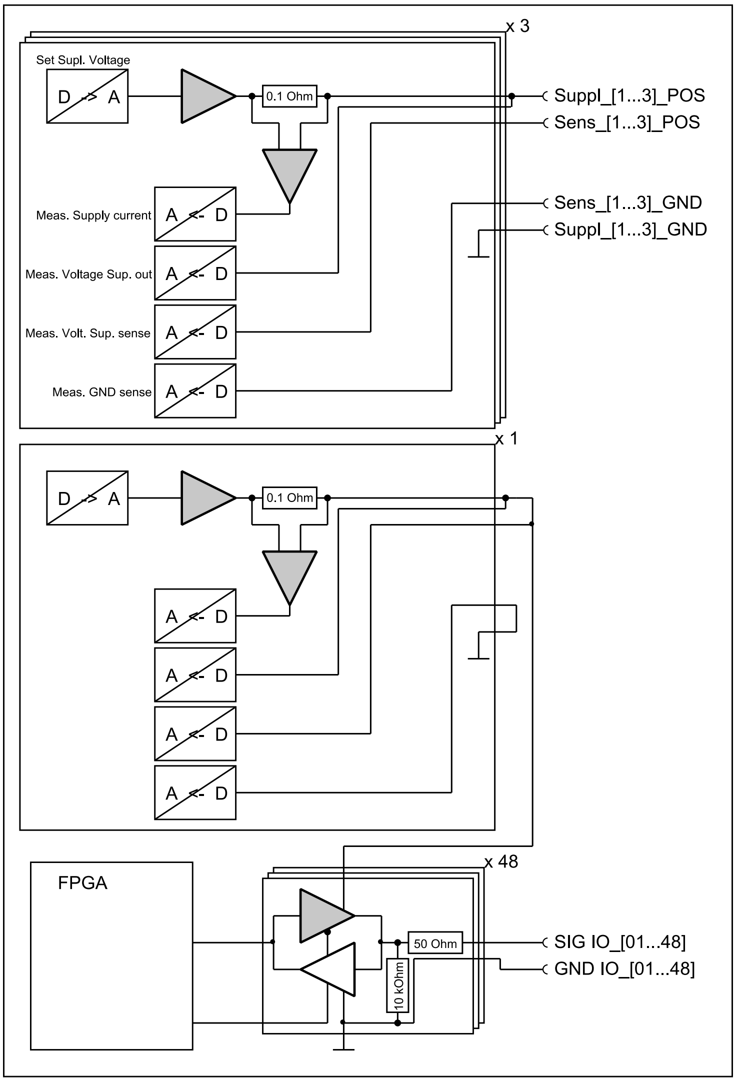
- Significantly higher FPGA size for the implementation of more complex processes.
- Significantly higher computing power for measured value preprocessing;
  DIO-1: 100,000 signal values/s
  DIO-2: 4.000.000 signal values/s

## 1. Technical data

- Current consumption: 12V / 0,8 A (without external consumers)
- Operating temperature: 0°C … 40°C
- Rel. Humidity: Max. 85% not condensed
- Weight: 190g
- Dimensions: Single Eurocard, 4 U

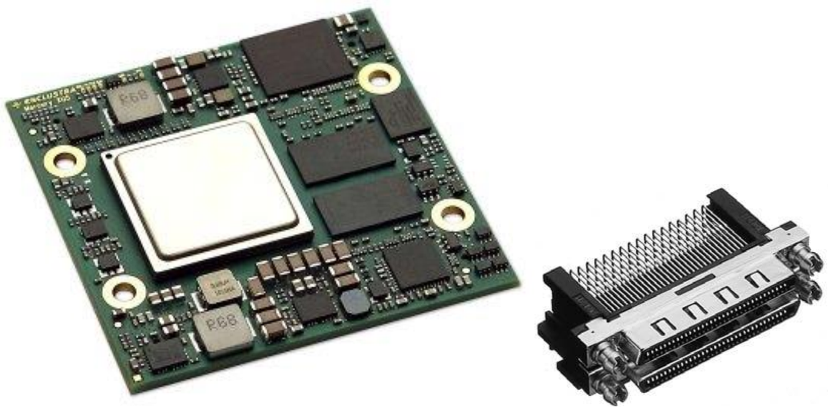
| Test conditions: Environmental temperature 20°C to 26°C | | | | | | |
|---|---|---|---|---|---|---|
| **Num** | **Evaluation** | **Symbol** | **typ.** | **min.** | **max.** | **description** |
| 1 | Permitted voltage range | $U_{supp}$ | 12V | 11.4V | 12.6V | |
| 2 | Current consumption | $I_{supp}$ | 650mA | - | 800mA | Without sensor supply |

## 2. Block diagram



## 3. Connectors:

- For SPI, FAST-SO
- Connectors to bus: 1 PCIe Lane to CPU-1
  Power supply I2C
  Parallel to all cards for synchronization
- Connectors frontside: HDRA-E68W1LFDTC „Dual Stacking Connectors“ with dig IO + Sensor Power

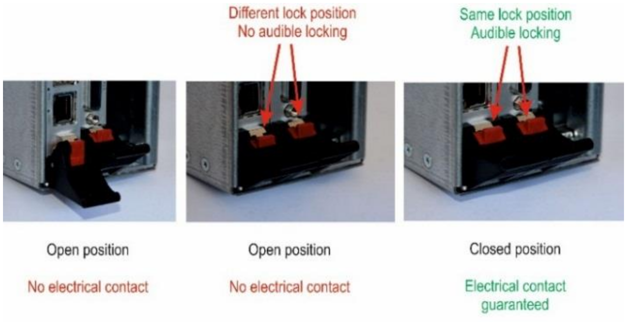


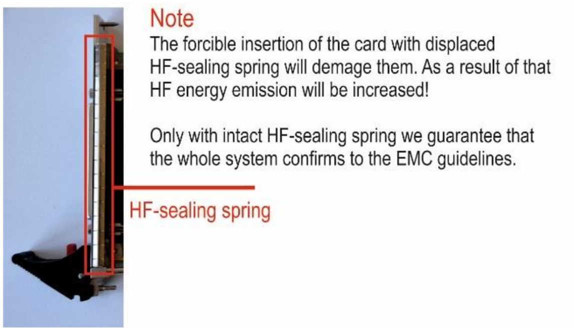
## 4. Interfaces and FPGA:

- Xilinx® Zynq® UltraScale+ MPSoC Modules for the realization of protocols. ARM® dual-/quad-core Cortex™-A53 (64 bit, up to 1500 MHz)
- 8 x SPI (MISO, MOSI, CS, CLK) + 16 Reserve DIG IO => 48 Pins
- 16xSPI (16xMISO, 16xMOSI, 8xCS, 8xCLK)/ 48 Pins
- With the 16 reserve IO, 4 x Fast-SO can be realized, among other things.
- All DIG IOs bidirectional, level adjustable from 1.2V to 5.5V operation; max. 20MHz
- 3x adjustable PU outputs,
  0.5V to 6.0V, +/- 0.1% of full scale for external supply of the sensors,
  current limitation 0..1000mA, +/- 0.1%.
  1x adjustable PU output, 0.5V to 6.0V, +/- 0.1% of full scale,
  current limitation 0..1000mA +/- 0.1%.
- for internal drivers (+ external)50 Ohm or 100 Ohm Impedanz Adaptation for coaxial or twisted pair lines
- Back measurement of the 4 PU voltages and the 4 currents. Accuracy: +/- 0.1% of the full scale value

## 5. Handling card/chassis

Pay attention that the ejection lever of the plug-in card is arrested correctly.
Only the correct position guarantees a justly connection of the bus system and the power supply!

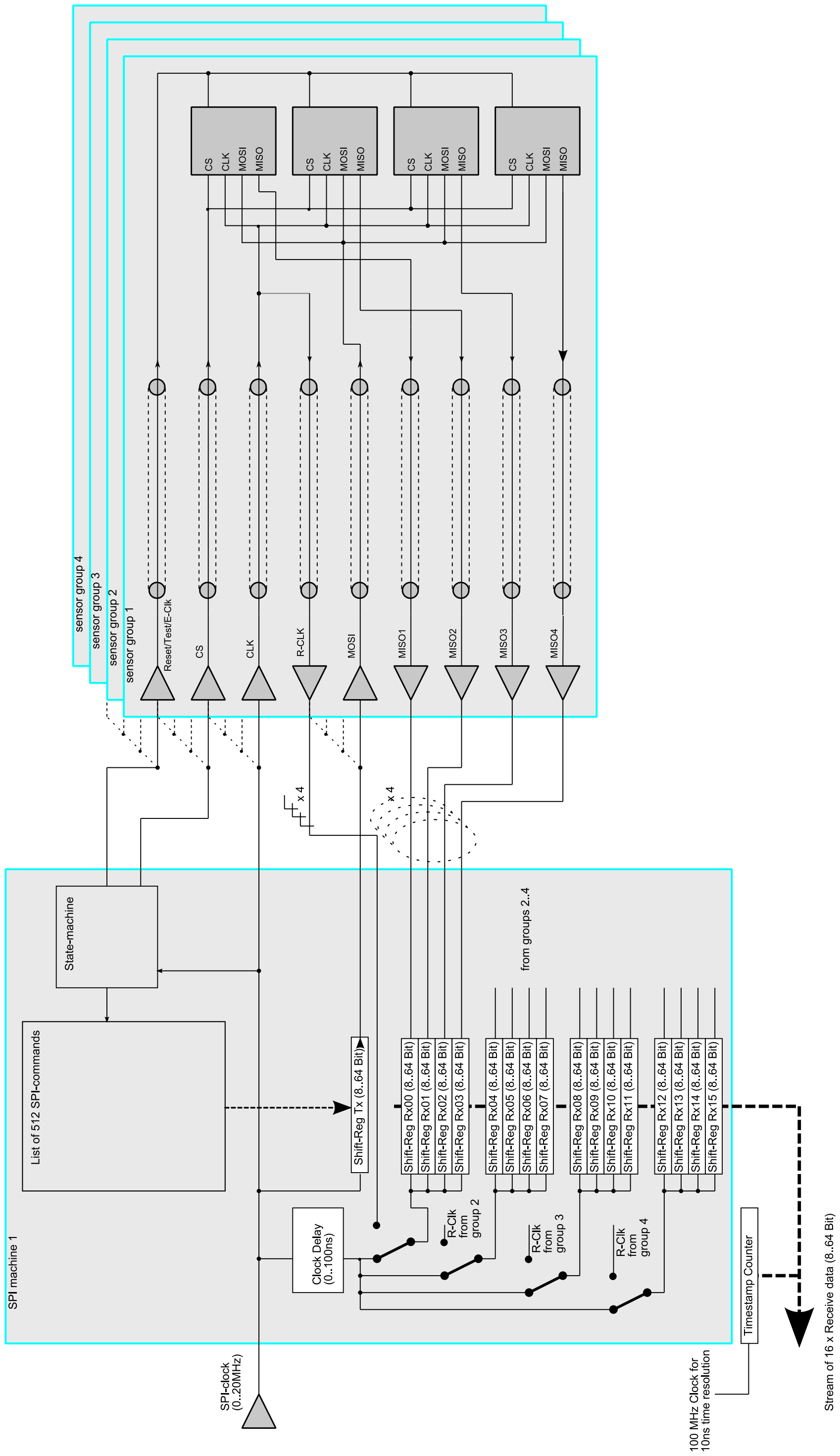


# 6. Applications – Working modes

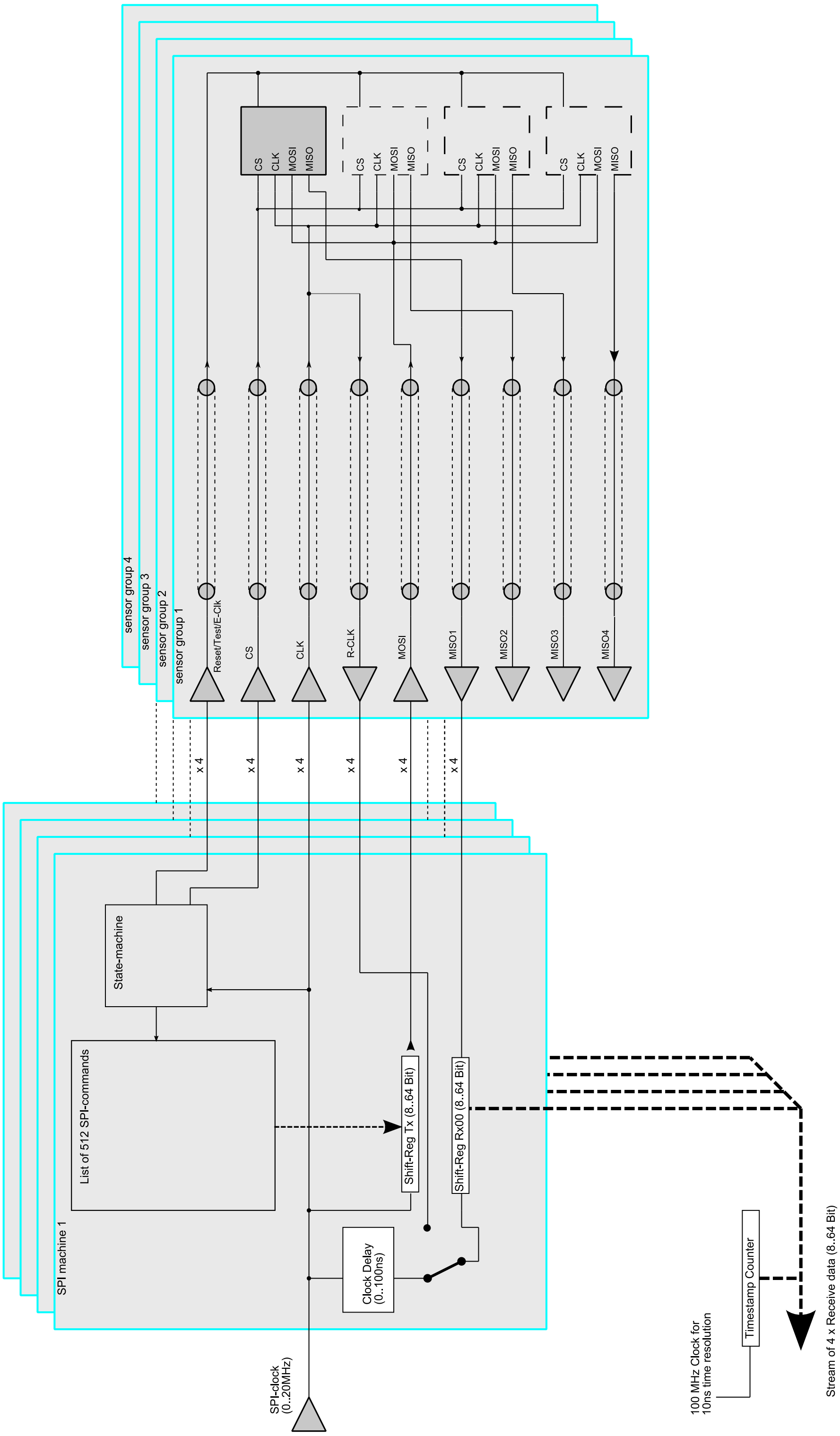
## 6.1. 16-times highspeed measurement application

For the application of a 16-fold-parall measurement technique a SPI machine is implemented in the FPGA, which controls the slave-in of 16 sensors together from a transmit shift register.
Chip select, clock and possibly reset/test are also controlled together.
Individually implemented are the 16 slave-out lines, which go to 16 receive shift registers.
The commands go absolutely synchronously to all 16 sensors, the answers are received individually.



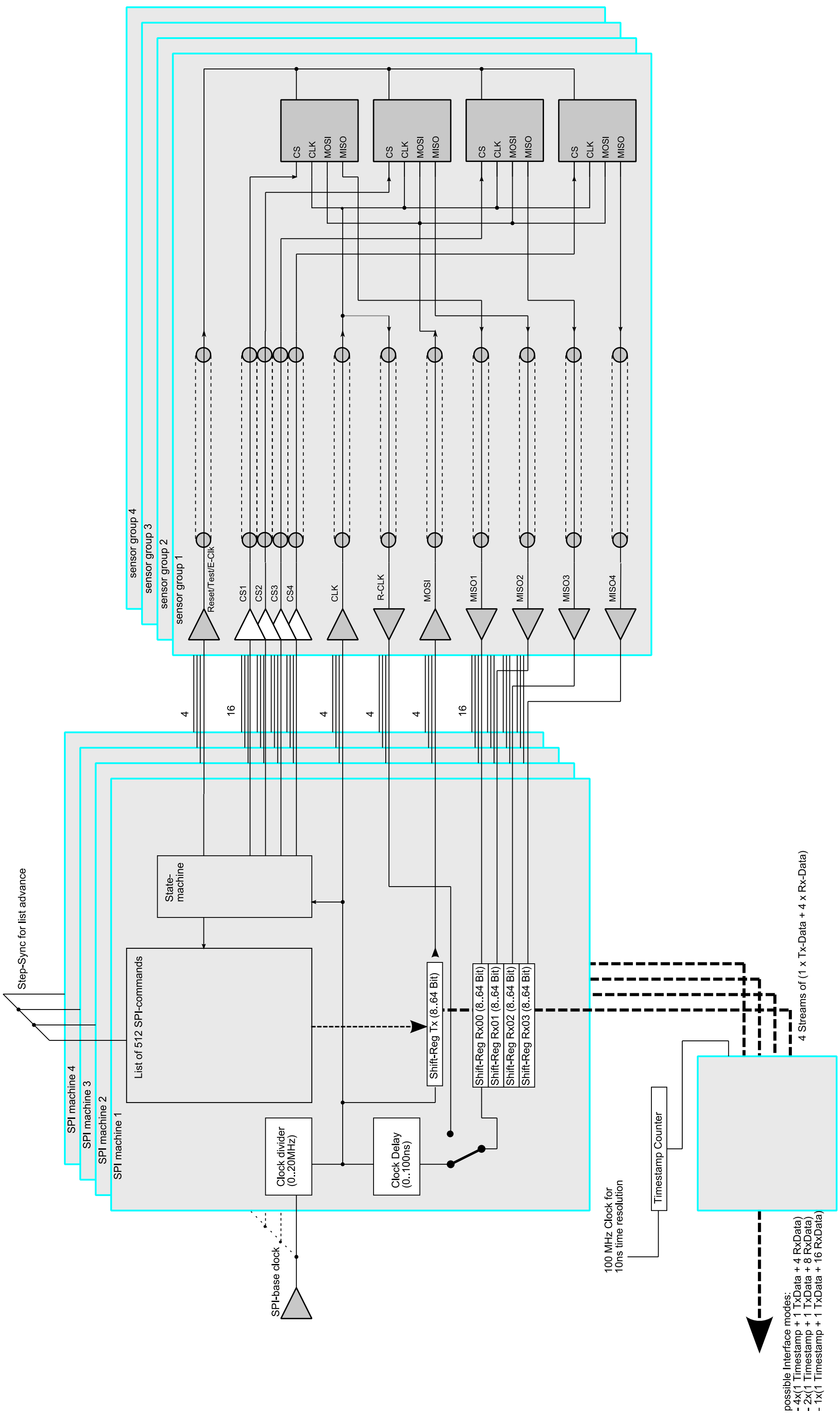
## 6.2. 4-times comparison application

4 SPI machines each with one own sending- and receiveing shift register.
Each SPI machine serves the first sensor of each 4 times group.
The rest of the three sensors of each group stay unpopulated.



### 6.3. 16-times high-speed measurement application with different sensors

At the FPGA four SPI machines are implemented, which each controls the *Slave-In* of 4 sensors of a group in common out of its 4 sending shift register. *Clock* and optionally *Reset/Test* are also controlled in common. Individually executed are the 16 *Slave-Out* lines, which are connected to the 4 receiving shift register of the 4 groups.



# 7. Measurement accuracy

## 7.1. Time base

| Test conditions: Environmental temperature 20°C to 26°C | | | | | | |
|---|---|---|---|---|---|---|
| **Num** | **Evaluation** | **Symbol** | **Type** | **Max** | **Unit** | **Comment** |
| 1 | Accuracy time base | $\Delta f/f$ | ±30 | ±50 | ppm | - |
| 2 | Aging of time base | $\Delta f/f_A$ | ±5 | | ppm/year | - |
| 3 | Temperature drift of time base | $\Delta f/f_T$ | ±0.3 | ±0.7 | ppm/°C | - |

## 7.2. Measurement of the supply voltage

| Test conditions: Environmental temperature 20°C to 26°C | | | | | | |
|---|---|---|---|---|---|---|
| **Num** | **Evaluation** | **Symbol** | **Type** | **Max** | **Unit** | **Comment** |
| 4 | Accuracy of the measured voltage | $U_{mea}$ | ±0.3 | ±0.4 | % of scfin. 7.5V | Range 0.5V .. 6.0V |
| 5 | Aging of the measured voltage | $U_{A\text{-}mea}$ | | ±0.1 | %/year | Range 0.5V .. 6.0V |
| 6 | Resolution of the measured voltages | | 16 | | Bit | 0.. 65535 |
| | | | 0.1144409 | | mV/LSB | |

## 7.3. Measurement of the supply currents

| Test conditions: Environmental temperature 20°C to 26°C | | | | | | |
|---|---|---|---|---|---|---|
| **Num** | **Evaluation** | **Symbol** | **Type** | **Max** | **Unit** | **Comment** |
| 7 | Accuracy of the measured current | $I_{mea}$ | ±0.3 | ±0.4 | % of scfin. 1000mA | Range 2mA .. 900mA |
| 8 | Aging of the measured current | $I_{A\text{-}mea}$ | | ±0.1 | % of scfin. 1000mA / year | Range 2mA .. 900mA |
| 9 | Resolution of the measured current | | 16 | | Bit | 0.. 65535 |
| | | | 15,2587891 | | µA/LSB | |

## 7.4. Generation of the voltages

| Test conditions: Environmental temperature 20°C to 26°C | | | | | | |
|---|---|---|---|---|---|---|
| **Num** | **Evaluation** | **Symbol** | **Type** | **Max** | **Unit** | **Comment** |
| 10 | Accuracy of the created current | $U_{mea}$ | ±0.3 | ±0.4 | % of scfin. 6.3V | Range 0.5V .. 6.0V |
| 11 | Aging of the created current | $U_{mea}$ | | ±0.1 | % of scfin 6.3V / year | Range 0.5V .. 6.0V |
| 12 | Resolution of the created current | | 16 | | Bit | 0.. 65535 |
| | | | 0,096130371 | | mV/LSB | |

# 8. Connection diagram X10/X11

| Pin | Paar | Belegung Stecker 1 (Rand) |
|---|---|---|
| 1 | 1 | GND |
| 35 | | Sig_IO 01 |
| 2 | 2 | GND |
| 36 | | Sig_IO 02 |
| 3 | 3 | GND |
| 37 | | Sig_IO 03 |
| 4 | 4 | GND |
| 38 | | Sig_IO 04 |
| 5 | 5 | GND |
| 39 | | Sig_IO 05 |
| 6 | 6 | GND |
| 40 | | Sig_IO 06 |
| 7 | 7 | GND |
| 41 | | Sig_IO 07 |
| 8 | 8 | GND |
| 42 | | Sig_IO 08 |
| 9 | 9 | GND |
| 43 | | Sig_IO 09 |
| 10 | 10 | GND |
| 44 | | Sig_IO 10 |
| 11 | 11 | GND |
| 45 | | Sig_IO 11 |
| 12 | 12 | GND |
| 46 | | Sig_IO 12 |
| 13 | 13 | GND |
| 47 | | Sig_IO 13 |
| 14 | 14 | GND |
| 48 | | Sig_IO 14 |
| 15 | 15 | GND |
| 49 | | Sig_IO 15 |
| 16 | 16 | GND |
| 50 | | Sig_IO 16 |
| 17 | 17 | GND |
| 51 | | Sig_IO 17 |
| 18 | 18 | GND |
| 52 | | Sig_IO 18 |
| 19 | 19 | GND |
| 53 | | Sig_IO 19 |
| 20 | 20 | GND |
| 54 | | Sig_IO 20 |
| 21 | 21 | GND |
| 55 | | Sig_IO 21 |
| 22 | 22 | GND |
| 56 | | Sig_IO 22 |
| 23 | 23 | GND |
| 57 | | Sig_IO 23 |
| 24 | 24 | GND |
| 58 | | Sig_IO 24 |
| 25 | 25 | GND |
| 59 | | +VCC1 |
| 26 | 26 | GND |
| 60 | | +VCC1 |
| 27 | 27 | GND |
| 61 | | +VCC1 |
| 28 | 28 | GND |
| 62 | | Sense VCC1 |
| 29 | 29 | GND |
| 63 | | Sense GND1 |
| 30 | 30 | GND |
| 64 | | +VCC2 |
| 31 | 31 | GND |
| 65 | | +VCC2 |
| 32 | 32 | GND |
| 66 | | +VCC2 |
| 33 | 33 | GND |
| 67 | | Sense VCC2 |
| 34 | 34 | GND |
| 68 | | Sense GND2 |

| Pin | Paar | Belegung Stecker 2 (innen) |
|---|---|---|
| 1 | 1 | GND |
| 35 | | Sig_IO 25 |
| 2 | 2 | GND |
| 36 | | Sig_IO 26 |
| 3 | 3 | GND |
| 37 | | Sig_IO 27 |
| 4 | 4 | GND |
| 38 | | Sig_IO 28 |
| 5 | 5 | GND |
| 39 | | Sig_IO 29 |
| 6 | 6 | GND |
| 40 | | Sig_IO 30 |
| 7 | 7 | GND |
| 41 | | Sig_IO 31 |
| 8 | 8 | GND |
| 42 | | Sig_IO 32 |
| 9 | 9 | GND |
| 43 | | Sig_IO 33 |
| 10 | 10 | GND |
| 44 | | Sig_IO 34 |
| 11 | 11 | GND |
| 45 | | Sig_IO 35 |
| 12 | 12 | GND |
| 46 | | Sig_IO 36 |
| 13 | 13 | GND |
| 47 | | Sig_IO 37 |
| 14 | 14 | GND |
| 48 | | Sig_IO 38 |
| 15 | 15 | GND |
| 49 | | Sig_IO 39 |
| 16 | 16 | GND |
| 50 | | Sig_IO 40 |
| 17 | 17 | GND |
| 51 | | Sig_IO 41 |
| 18 | 18 | GND |
| 52 | | Sig_IO 42 |
| 19 | 19 | GND |
| 53 | | Sig_IO 43 |
| 20 | 20 | GND |
| 54 | | Sig_IO 44 |
| 21 | 21 | GND |
| 55 | | Sig_IO 45 |
| 22 | 22 | GND |
| 56 | | Sig_IO 46 |
| 23 | 23 | GND |
| 57 | | Sig_IO 47 |
| 24 | 24 | GND |
| 58 | | Sig_IO 48 |
| 25 | 25 | GND |
| 59 | | +VCC3 |
| 26 | 26 | GND |
| 60 | | +VCC3 |
| 27 | 27 | GND |
| 61 | | +VCC3 |
| 28 | 28 | GND |
| 62 | | Sense VCC3 |
| 29 | 29 | GND |
| 63 | | Sense GND3 |
| 30 | 30 | GND |
| 64 | | +VCC4 |
| 31 | 31 | GND |
| 65 | | +VCC4 |
| 32 | 32 | GND |
| 66 | | +VCC4 |
| 33 | 33 | GND |
| 67 | | |
| 34 | 34 | GND |
| 68 | | |

# 9. Connection diagram X10/X11 as a 4x4 SPI Master Machine

| Pin | Paar | Belegung Stecker 1 (Rand) |
|---|---|---|
| 1 | 1 | GND |
| 35 | | CLK_G1 |
| 2 | 2 | GND |
| 36 | | R_CLK_G1 |
| 3 | 3 | GND |
| 37 | | MOSI_G1 |
| 4 | 4 | GND |
| 38 | | RES_TEST_E_G1 |
| 5 | 5 | GND |
| 39 | | CS_G1_S1 |
| 6 | 6 | GND |
| 40 | | CS_G1_S2 |
| 7 | 7 | GND |
| 41 | | CS_G1_S3 |
| 8 | 8 | GND |
| 42 | | CS_G1_S4 |
| 9 | 9 | GND |
| 43 | | MISO_G1_S1 |
| 10 | 10 | GND |
| 44 | | MISO_G1_S2 |
| 11 | 11 | GND |
| 45 | | MISO_G1_S3 |
| 12 | 12 | GND |
| 46 | | MISO_G1_S4 |
| 13 | 13 | GND |
| 47 | | CLK_G2 |
| 14 | 14 | GND |
| 48 | | R_CLK_G2 |
| 15 | 15 | GND |
| 49 | | MOSI_G2 |
| 16 | 16 | GND |
| 50 | | RES_TEST_E_G2 |
| 17 | 17 | GND |
| 51 | | CS_G2_S1 |
| 18 | 18 | GND |
| 52 | | CS_G2_S2 |
| 19 | 19 | GND |
| 53 | | CS_G2_S3 |
| 20 | 20 | GND |
| 54 | | CS_G2_S4 |
| 21 | 21 | GND |
| 55 | | MISO_G2_S1 |
| 22 | 22 | GND |
| 56 | | MISO_G2_S2 |
| 23 | 23 | GND |
| 57 | | MISO_G2_S3 |
| 24 | 24 | GND |
| 58 | | MISO_G2_S4 |
| 25 | 25 | GND |
| 59 | | +VCC1 |
| 26 | 26 | GND |
| 60 | | +VCC1 |
| 27 | 27 | GND |
| 61 | | +VCC1 |
| 28 | 28 | GND |
| 62 | | Sense VCC1 |
| 29 | 29 | GND |
| 63 | | Sense GND1 |
| 30 | 30 | GND |
| 64 | | +VCC2 |
| 31 | 31 | GND |
| 65 | | +VCC2 |
| 32 | 32 | GND |
| 66 | | +VCC2 |
| 33 | 33 | GND |
| 67 | | Sense VCC2 |
| 34 | 34 | GND |
| 68 | | Sense GND2 |

| Pin | Paar | Belegung Stecker 2 (innen) |
|---|---|---|
| 1 | 1 | GND |
| 35 | | CLK_G3 |
| 2 | 2 | GND |
| 36 | | R_CLK_G3 |
| 3 | 3 | GND |
| 37 | | MOSI_G3 |
| 4 | 4 | GND |
| 38 | | RES_TEST_E_G3 |
| 5 | 5 | GND |
| 39 | | CS_G3_S1 |
| 6 | 6 | GND |
| 40 | | CS_G3_S2 |
| 7 | 7 | GND |
| 41 | | CS_G3_S3 |
| 8 | 8 | GND |
| 42 | | CS_G3_S4 |
| 9 | 9 | GND |
| 43 | | MISO_G3_S1 |
| 10 | 10 | GND |
| 44 | | MISO_G3_S2 |
| 11 | 11 | GND |
| 45 | | MISO_G3_S3 |
| 12 | 12 | GND |
| 46 | | MISO_G3_S4 |
| 13 | 13 | GND |
| 47 | | CLK_G4 |
| 14 | 14 | GND |
| 48 | | R_CLK_G4 |
| 15 | 15 | GND |
| 49 | | MOSI_G4 |
| 16 | 16 | GND |
| 50 | | RES_TEST_E_G4 |
| 17 | 17 | GND |
| 51 | | CS_G4_S1 |
| 18 | 18 | GND |
| 52 | | CS_G4_S2 |
| 19 | 19 | GND |
| 53 | | CS_G4_S3 |
| 20 | 20 | GND |
| 54 | | CS_G4_S4 |
| 21 | 21 | GND |
| 55 | | MISO_G4_S1 |
| 22 | 22 | GND |
| 56 | | MISO_G4_S2 |
| 23 | 23 | GND |
| 57 | | MISO_G4_S3 |
| 24 | 24 | GND |
| 58 | | MISO_G4_S4 |
| 25 | 25 | GND |
| 59 | | +VCC3 |
| 26 | 26 | GND |
| 60 | | +VCC3 |
| 27 | 27 | GND |
| 61 | | +VCC3 |
| 28 | 28 | GND |
| 62 | | Sense VCC3 |
| 29 | 29 | GND |
| 63 | | Sense GND3 |
| 30 | 30 | GND |
| 64 | | +VCC4 |
| 31 | 31 | GND |
| 65 | | +VCC4 |
| 32 | 32 | GND |
| 66 | | +VCC4 |
| 33 | 33 | GND |
| 67 | | |
| 34 | 34 | GND |
| 68 | | |