Contents

1   Introduction

This document describes step by step the testing, configuration and calibration procedure for the SPI_ADC Extention Module (SPI_ADC). NOTE!!: Before starting the test, please pay attention to the Electrostatic Discharge Protection (ESD) equipment. If a test was failed, please stop the test and report the fail with the dedicated fail description form.

• Be sure that your Device Under Test (DUT) lays always over a dissipative work surface.

• Don't forget to connect yourself to ground through the wrist-strap device.

Your testing area should look like the picture below.
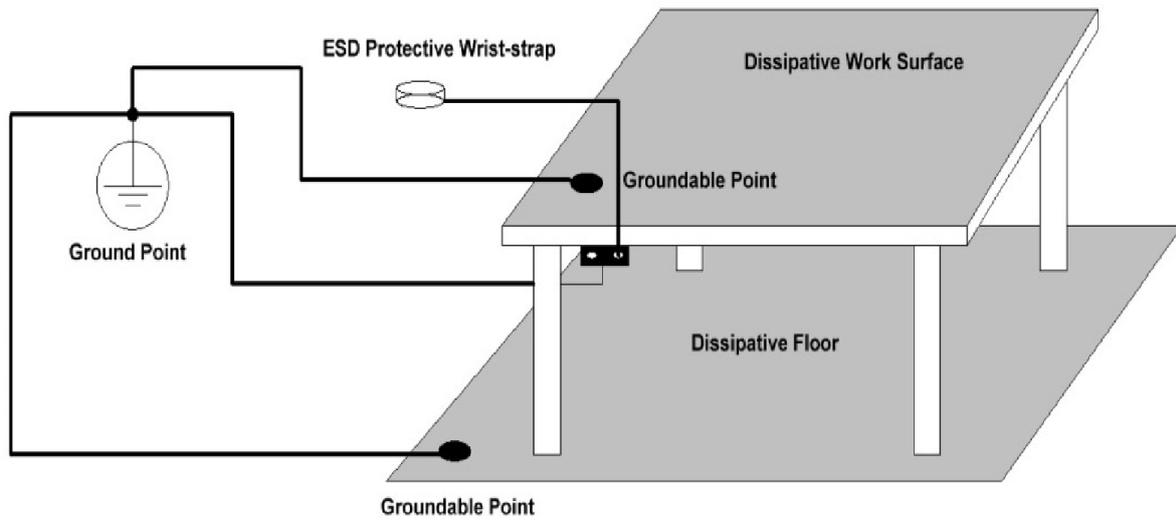
Figure 1: Test setup with ESD protection equipment

2   Equipment for testing

- ACU frame with power supply and MFU
- ICM (Firmware 7.5 or higher) with SPI hub
- Accurate reference voltage source
- 50 Ω resistor
- Accurate Digital Voltmeter
- Amperemeter
- 24 V power supply
- Connecting cables

3 Electric Tests

3.1 Supply
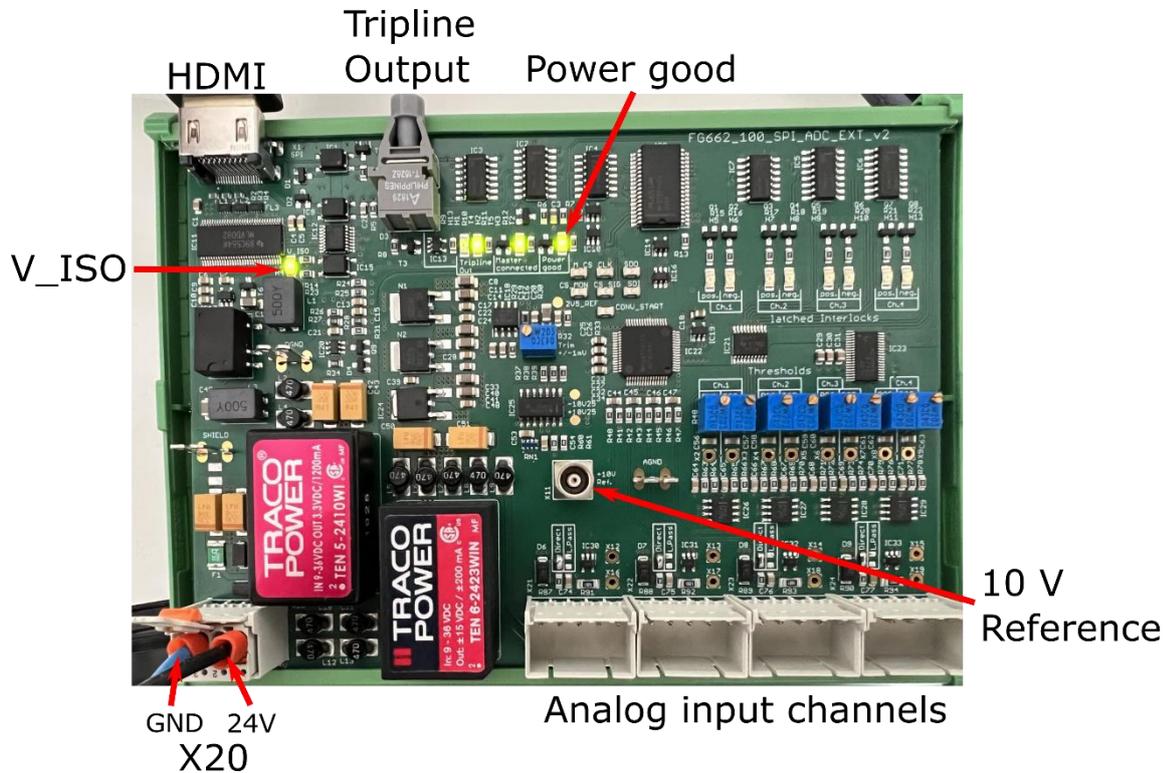
Figure 2: Overview of the SPI_ADC Extension card

Connect the SPI_ADC card to the 24 V power supply. For that connect pin 1 of X20 to 24 V and pin 2 to ground. The connection is shown in Figure 2. Power up the module and execute a visual check of the supply voltages looking at the "Power Good" and "V_ISO" LED as shown in Figure 2. They all have to be on. Measure the current drawn by the SPI ADC card (X20) with an ampere meter with the setup shown in Figure 3. Make sure that the drawn current is not too high (should be about 100 mA).
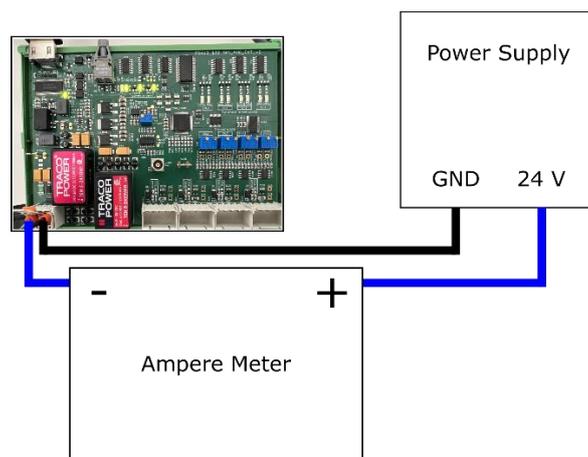
Figure 3: Setup for the measurement of the supply current

With the visual test it is not possible to be sure that the power supply voltages are correct (the LED can be on also with a different value from the expected). For that reason, it is necessary to double check the power supply values with a digital voltmeter.
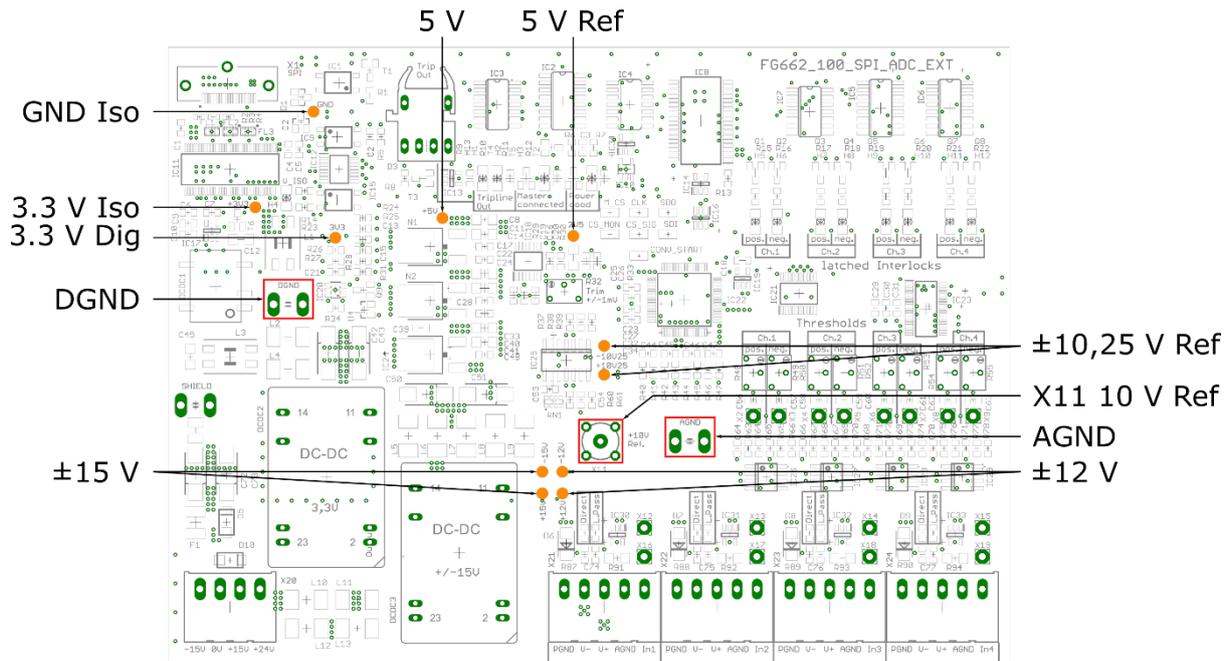
Figure 4: Measurement points for supply and reference voltages

Measure the following supply voltages with the measurement points shown in Figure 4:

- 3.3 V Iso to GND Iso
- 3.3 V Dig to DGND
- 5 V, ±12 V, ±15 V to AGND

If all supply voltages are measured correctly with 2.5% tolerance the test is passed.

3.2 Calibrate reference voltage

Keep the ADC card running for 2-3 hours to reach stable operating temperature. After that, measure the reference voltage on the LEMO connector X11 "+10V Ref.". Adjust the reference voltage with the potentiometer R32 "Trim +/-2mV" until it shows exactly 10 V. DO NOT adjust the potentiometer setting afterwards! Also measure ±10.25 V and 5 V Ref to AGND. The measurement points are shown in Figure 4. The test is passed when the voltages only differ slightly.
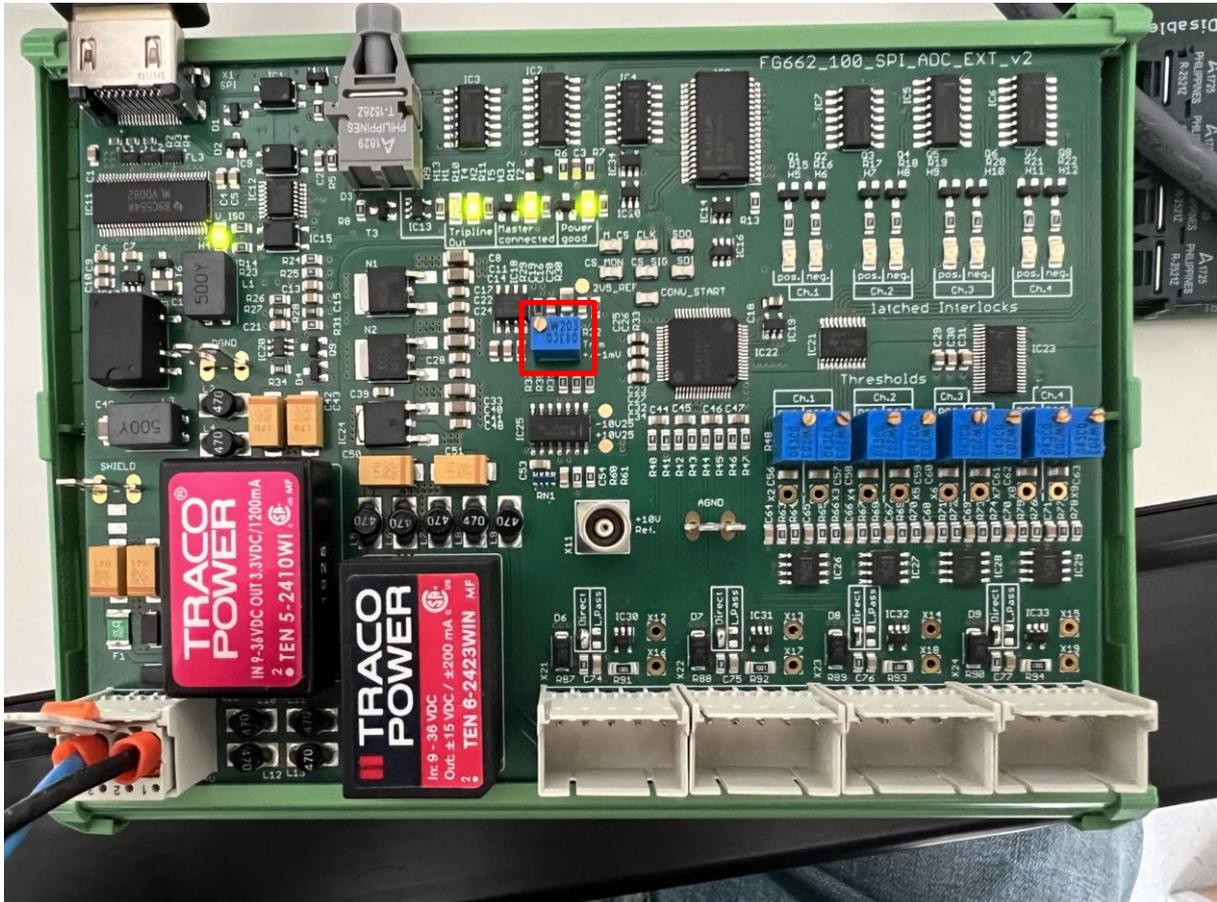
Figure 5: Potentiometer to adjust the reference voltage

4   Configuration

To configure the SPI_ADC card, connect it to channel 3 on the SPI Hub on the ICM as shown in Figure 6. Also, connect the HDMI cable to X1 on the SPI_ADC as shown in Figure 2.
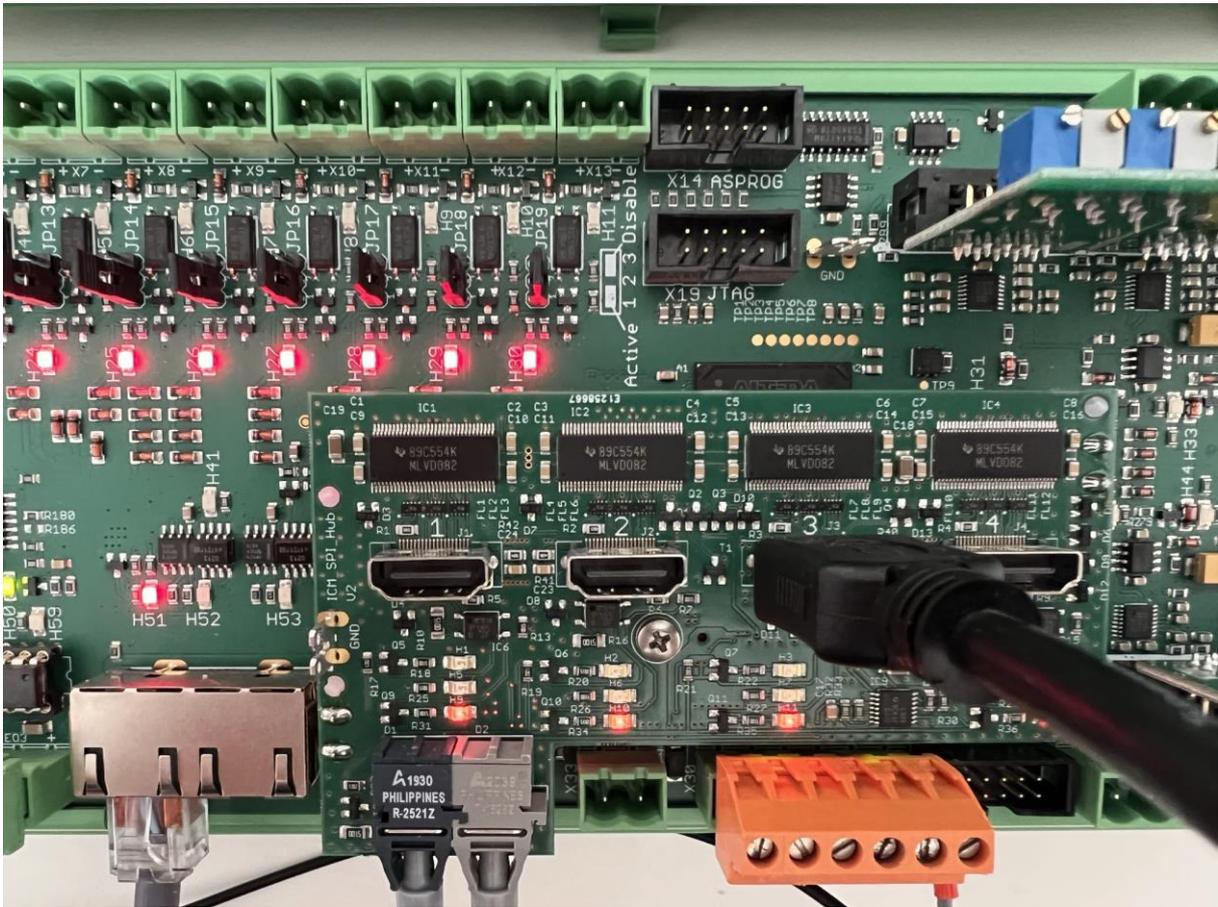
Figure 6: Connection of the SPI_ADC card to the ICM

Open PCA. Make sure the ICM is connected on USI 3 and runs at least the firmware 7.5 as shown in Figure 7.
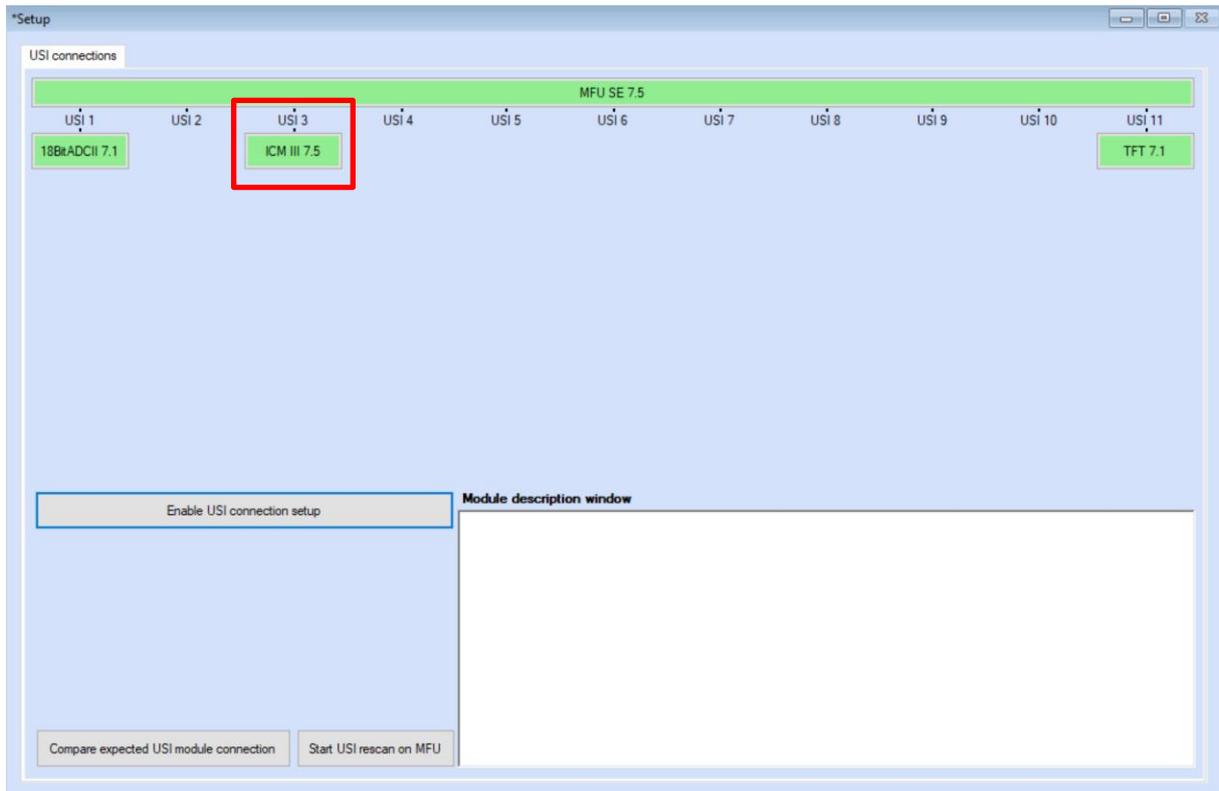
Figure 7: USI connection and Firmware of the ICM .

From the menu bar, select "Tools > Excite SPI Modules".
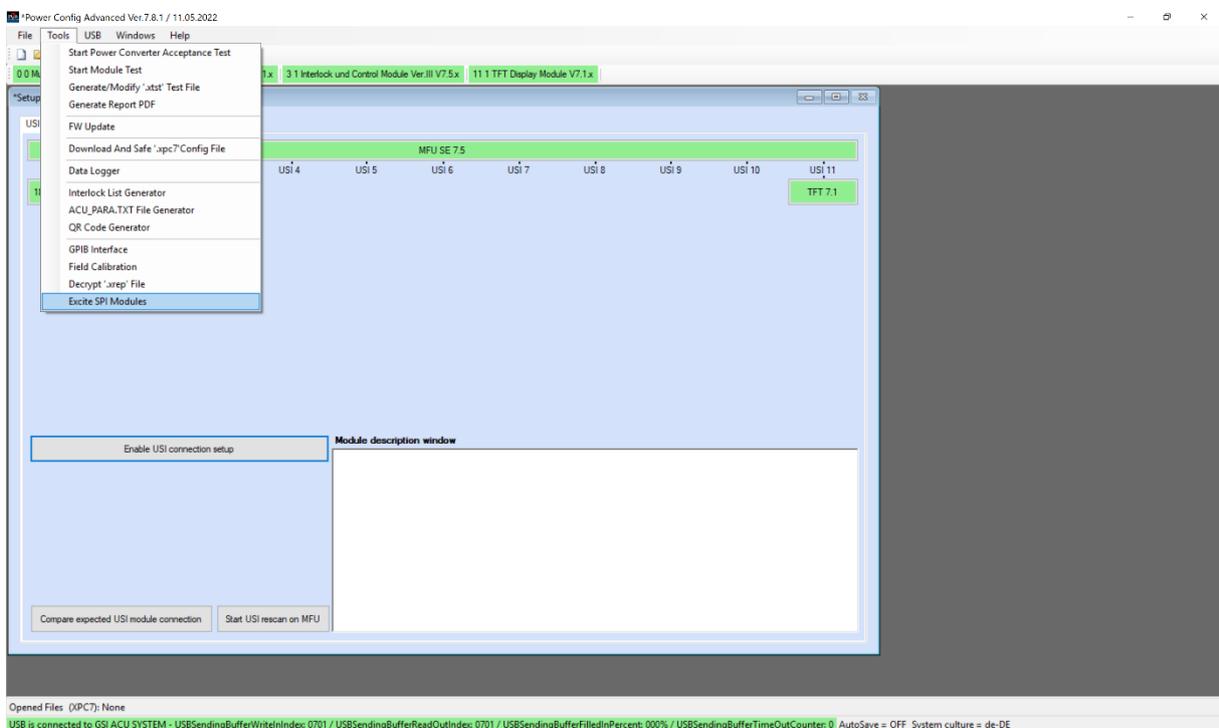
Figure 8: Menu "Tools > Excite SPI Modules"

Select "USI Nr. 3, Module Nr. 1, SPI Port 3", and click "Read". The expected "Current Module ID" and "Current Module Version" should be 0xFF.
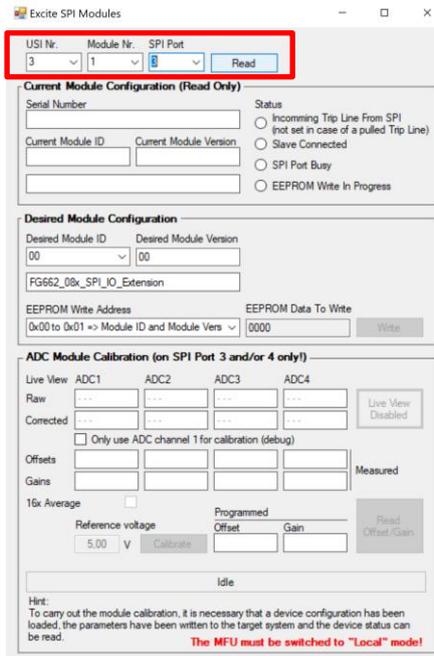
Figure 9: Read current module configuration

In the section "Desired Module Configuration" select "Desired Module ID: 03" and "Desired Module Version: 00". Click "Write".
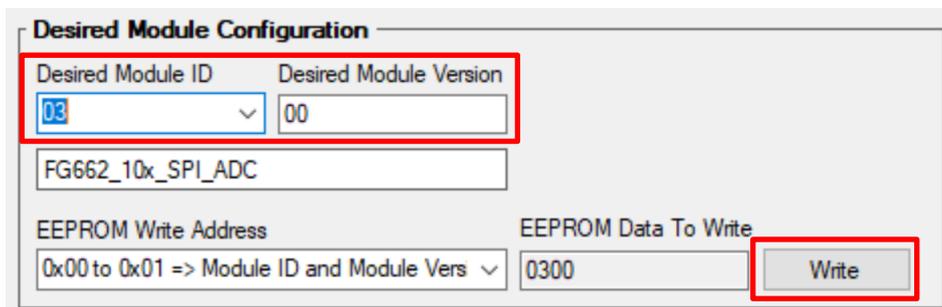
Figure 10: Configure the SPI module as ADC card

After the progress bar turns grey again and says "Idle" the card is configured successfully. The form should look like Figure 11. The serial number has to be displayed correctly in the field "Serial Number". "Current Module ID" has to be "03" and "Current Module Version" has to be "00".

Figure 11: Configured SPI_ADC card

5   Calibration

1. Connect the reference voltage to all channels of the SPI_ADC and set it to 9.5 V.
2. In the section "ADC Module Calibration (on SPI Port 3 and/or 4 only!)" tick the box "16x Average". Set the field "Reference voltage" to 9.5 V.

Figure 12: ADC calibration

3. Click "Calibrate" to start the calibration process. PCA will lead through the calibration procedure. The steps are still listed here.
4. Disconnect the reference voltage and connect a 50 Ω resistor and click "Continue"
5. Disconnect the 50 Ω resistor, connect the 9.5 V reference voltage again, and click "Continue".
6. After the calibration is done click "Read Offset/Gain". If the gain (around 1) and offset (around 0) are in an acceptable range the ADC card is calibrated successfully.
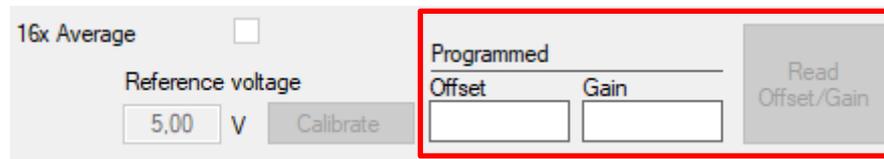
Figure 13: Offset and gain of the calibrated ADC chip

6 Functional Checks

6.1 Thresholds

Thresholds generate an interlock when the measured signal for the specific channel is smaller than the negative or higher than the positive threshold. Set the desired positive and negative thresholds for the first channel with the potentiometers. Check the set thresholds with a digital voltmeter from the measurement points in the figure below to the "AGND" terminal.
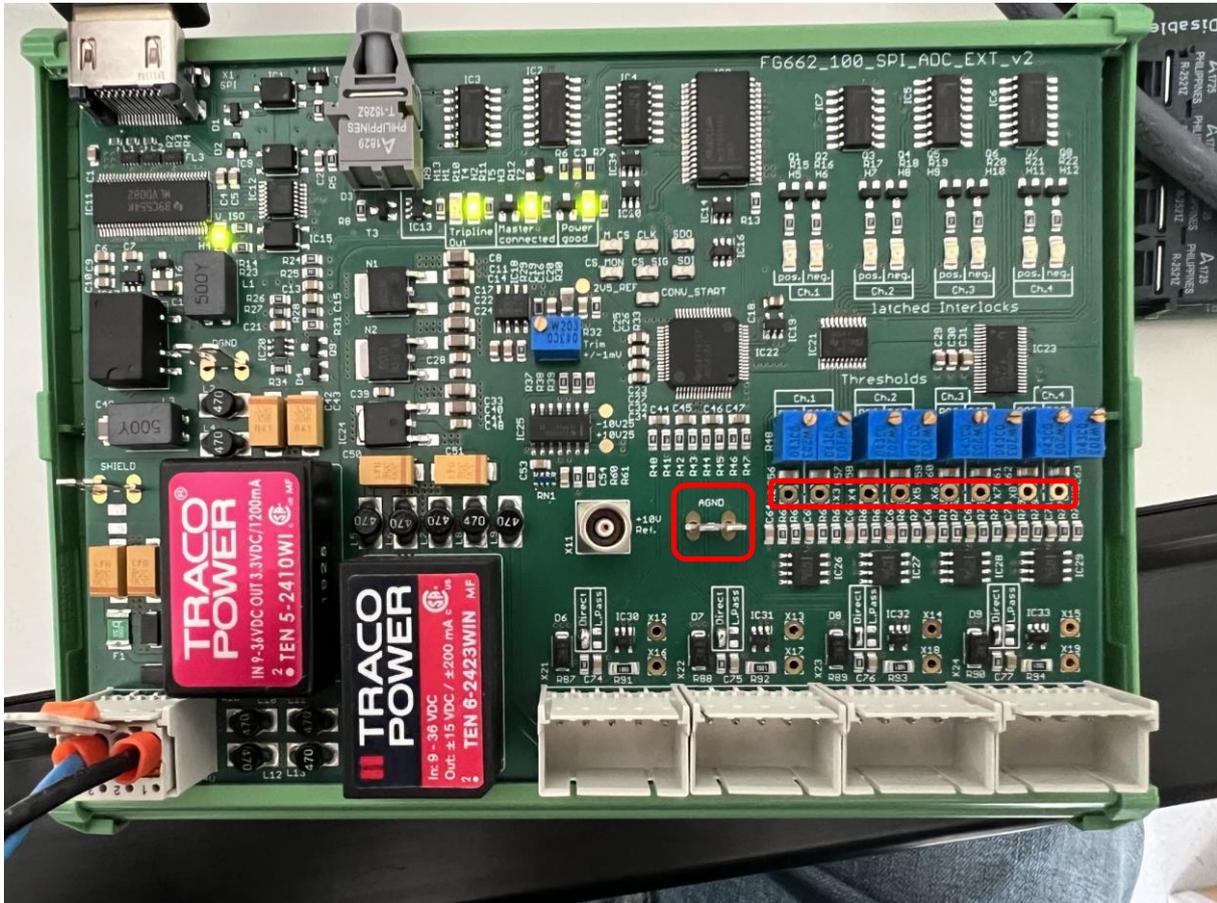
Figure 14: Measurement points (from left to right): AGND; Channel 1 positive, negative; Channel 2 positive, negative; Channel 3 positive, negative; Channel 4 positive, negative

Open the ICM tab with a right click on the ICM module in the module overview.

1. Navigate to the "SPI CH3" tab in the ICM III form.
2. Select "SPI ADC Extension" in the "Select connected module on SPI CH3" field.
3. Read the thresholds measured by the SPI ADC card. You might need to disable and enable "Live View Enabled" to refresh the measure thresholds.
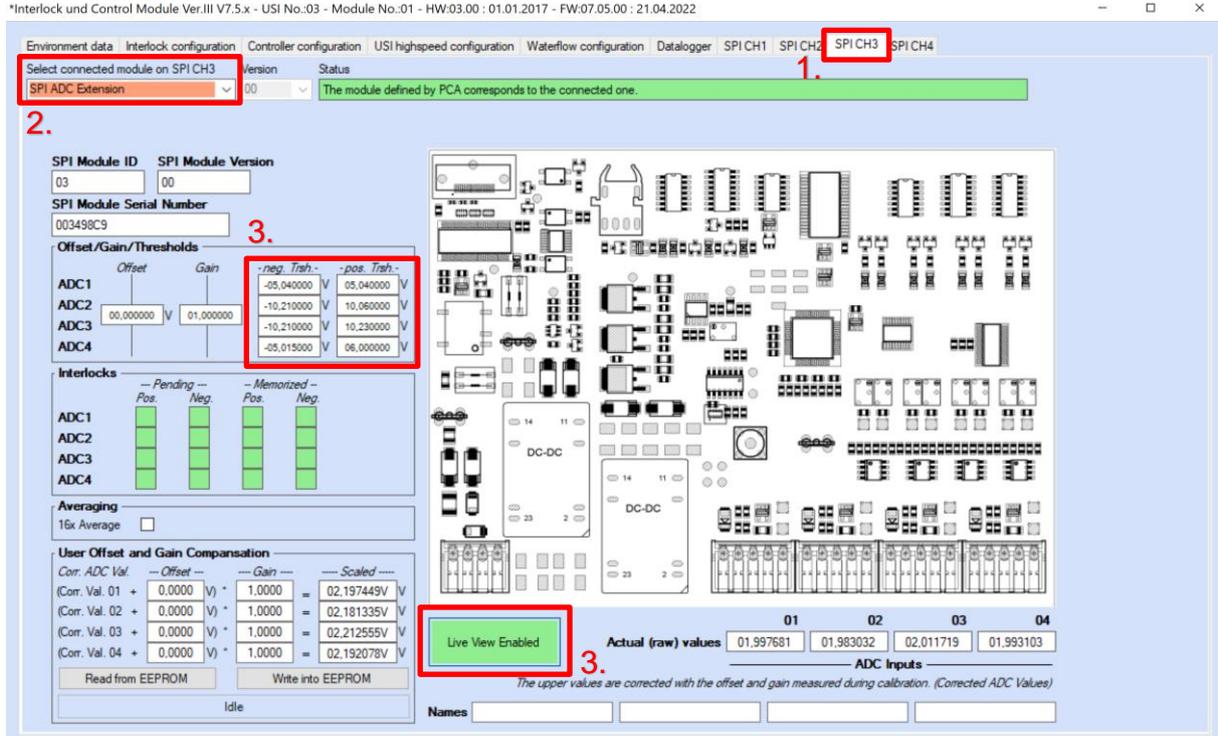
Figure 15: Reading of thresholds in the "SPI ADC" form

The thresholds should only have a small deviation (<0.1 V) to pass the test. Repeat this step for the other three channels.

6.2 Voltage

Connect generic positive and negative voltages (e.g. 1V, -5V) to pin 1 (positive) and pin 2 (ground) to all ADC channels individually. Measure the voltage on the PCB at the measurement points. The point closer to the connector is connected to the signal and the other one is connected to the analog ground.
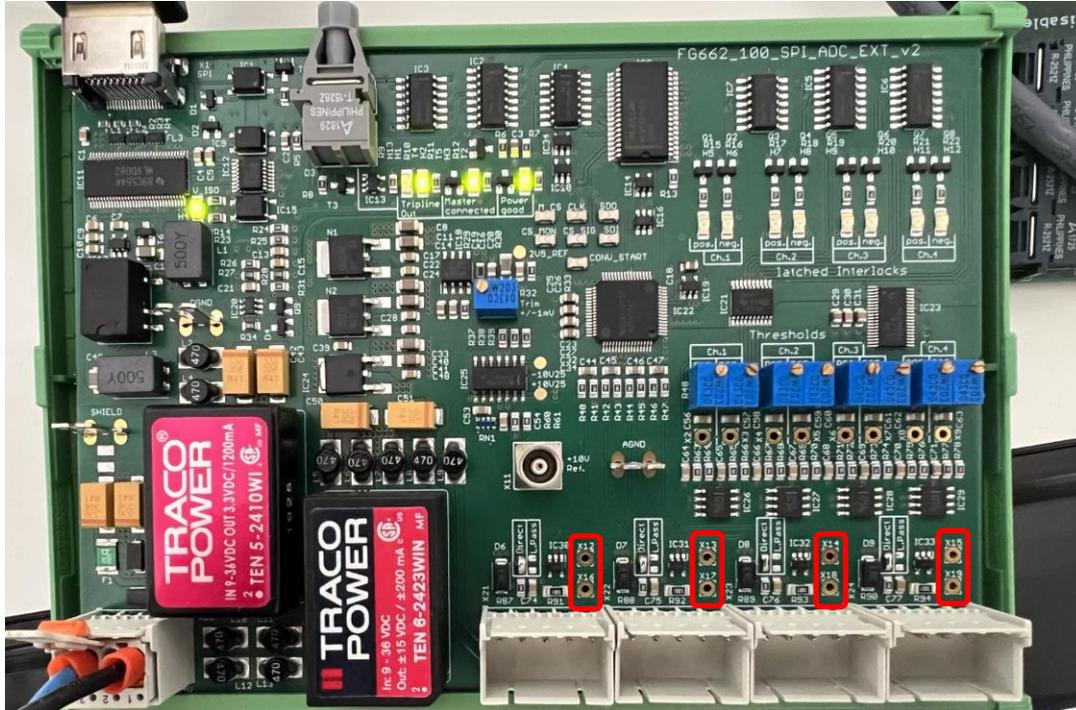
Figure 16: Measurement points for the measured analog voltage. The bottom one is the signal, the top one is the signal ground. From left to right: Channel 1, channel 2, channel 3, channel 4.

Also measure the voltage with PCA in the "SPI CH3" tab.

Figure 17:Display of the ADC measured value

The measurement results have to only slightly differ from the reference voltage to pass the test.

6.3 Interlock Tests

With the reference voltage source apply a voltage to pin 1 (positive) and pin 2 (ground) of channel one of the SPI_ADC card that is higher than its positive threshold. In the SPI 3 tab in PCA the interlock has to be displayed as pending and as memorized.
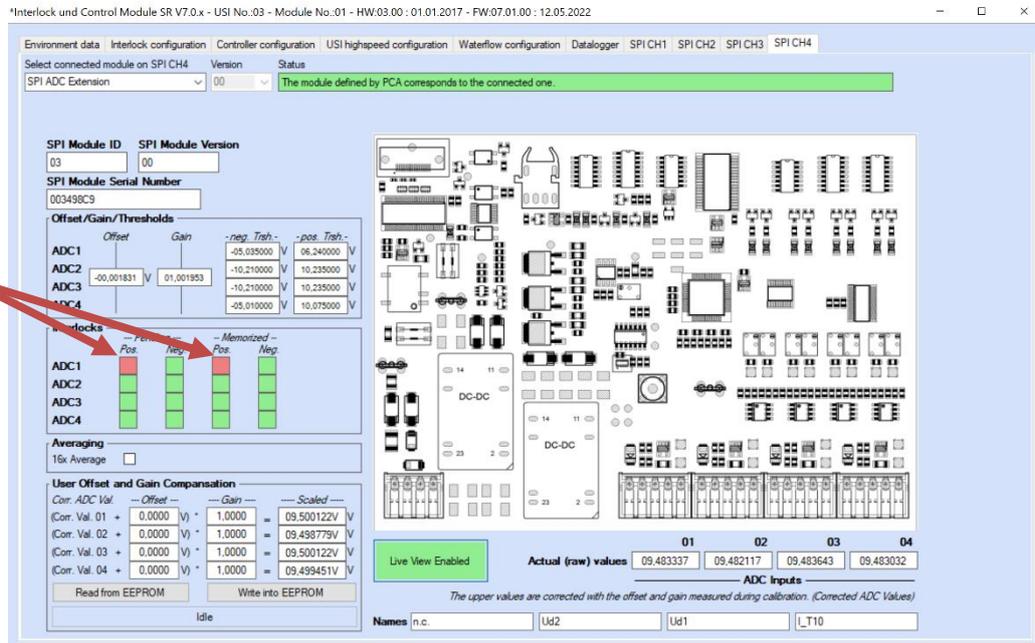
Figure 18: Example for a trigger of the ADC positive threshold

The LED for the positive threshold has to glow red. The optical transmitter has to have no light. The LED for the latched interlock has to glow red.
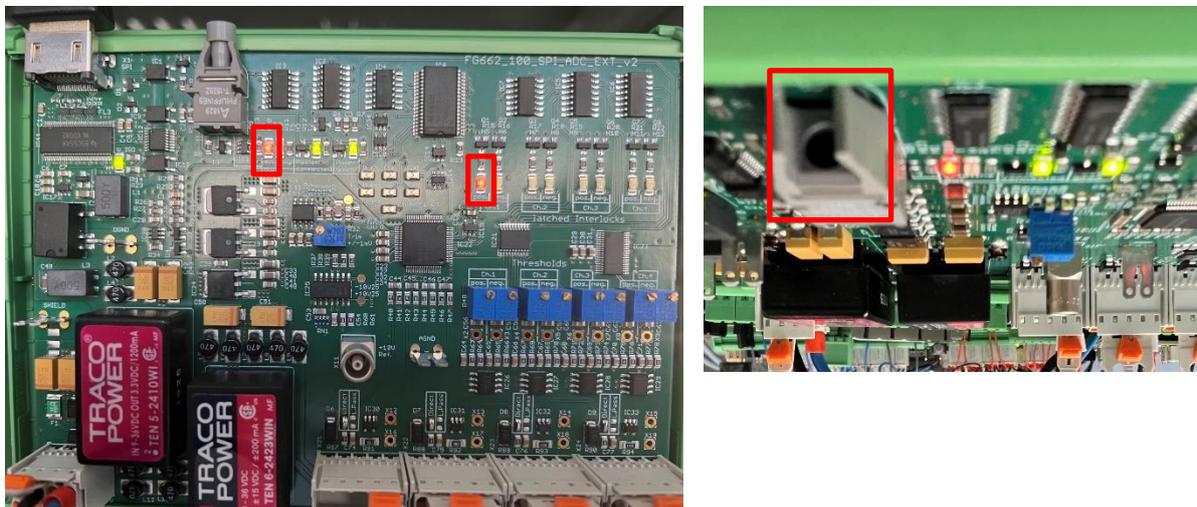
Figure 19: Tripline out LED and Ch.1 pos. LED (left) have to glow red in case of an interlock. The optical transmitter (right) has to be off (no light).

Set the value of the reference voltage in between the positive and negative thresholds. The pending interlock marker in PCA has to disappear. The memorized interlock has to be displayed on the "latched Interlocks" LED, the tripline LED (Figure 19) as well as in PCA (Figure 20).
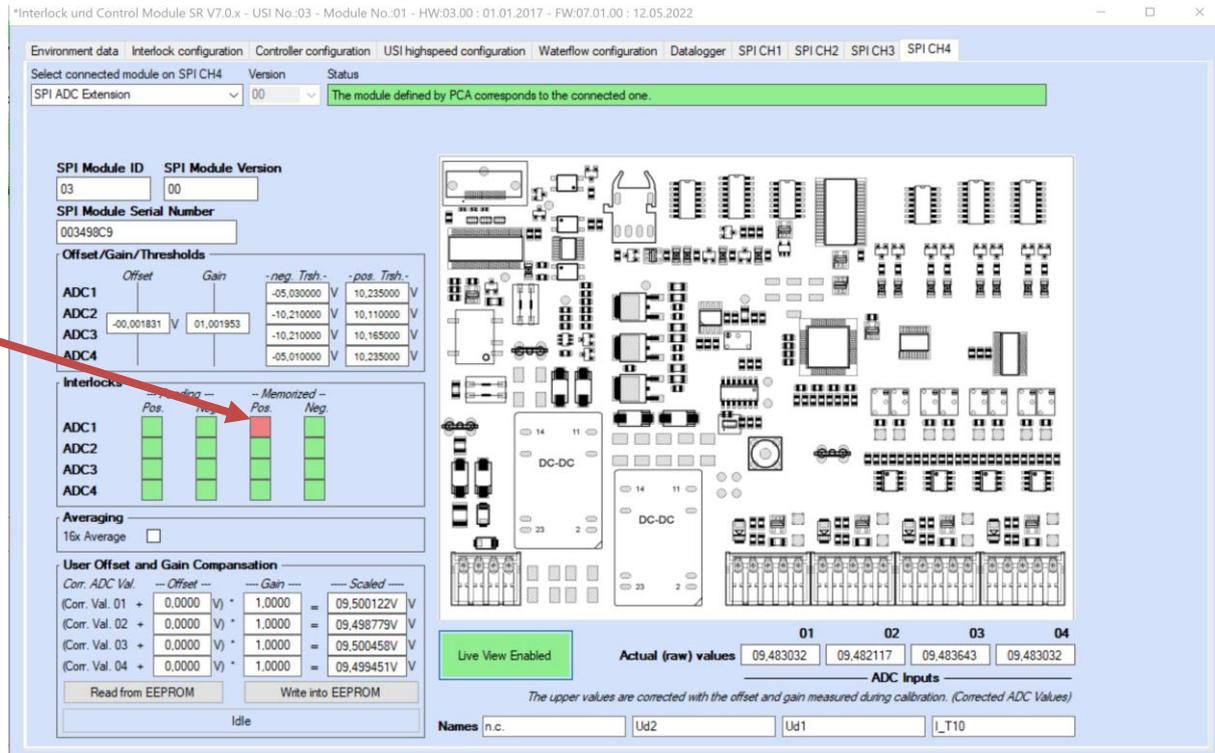
Figure 20: Memorized interlock in PCA

Press the reset button on the MFU to clear the interlock on the PCB and in PCA. The tripline LED has to glow green, the Ch.1 pos. LED has to turn off, and the optical transmitter has to be on as shown in Figure 21.
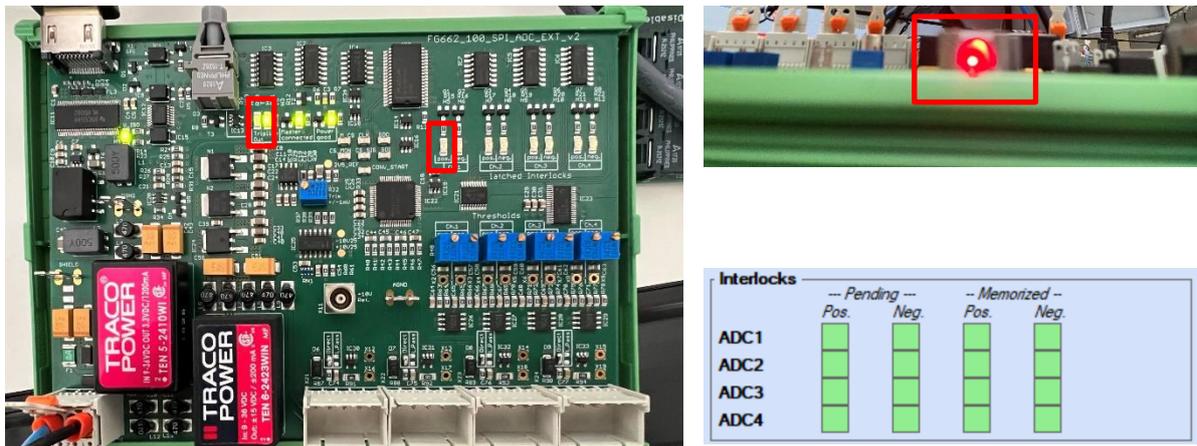
Figure 21: Tripline out LED has to glow green and Ch.1 pos. LED has to be off (left). The optical transmitter (right) has to be on (glowing). The interlocks have to disappear in PCA.

Then apply a voltage to channel 1 of the SPI_ADC card that is lower than the negative threshold. In the SPI 3 tab in PCA the interlock has to be displayed as pending and as memorized as shown in Figure 22.
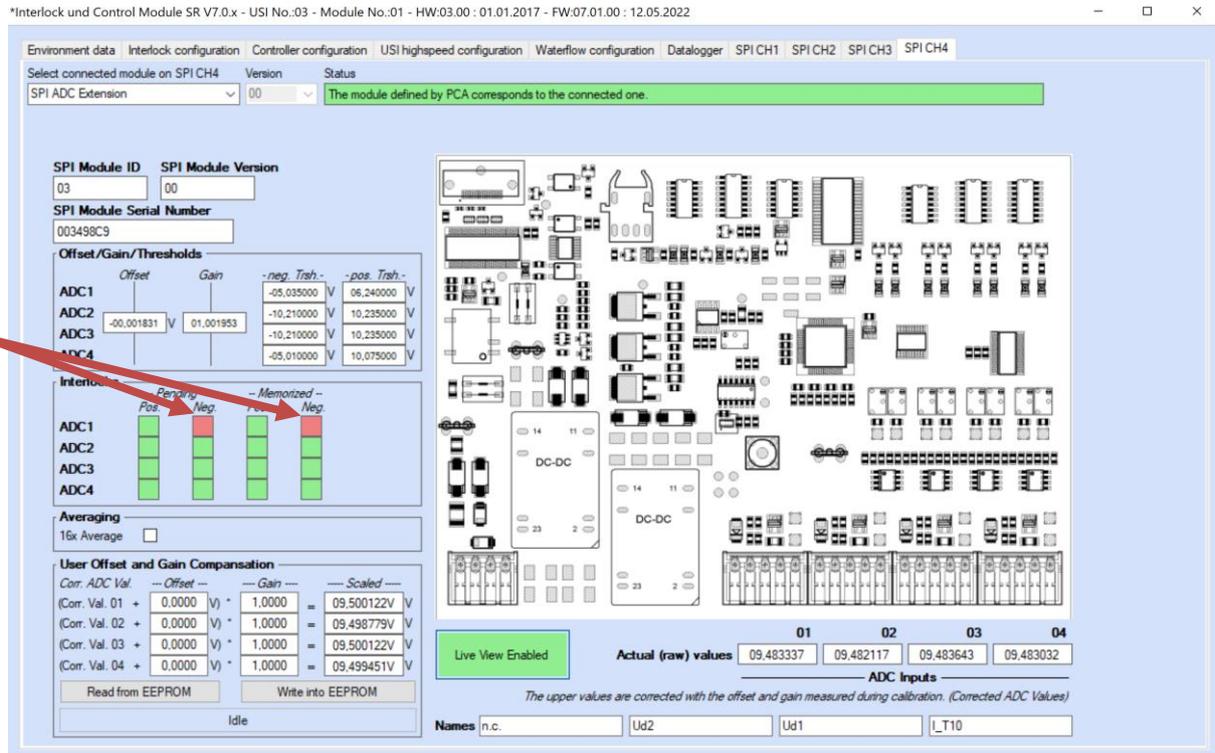
Figure 22: Pending and memorized negative interlock

The LED for the negative threshold has to glow red. The optical transmitter has to have no light. The LED for the latched interlock has to glow red.
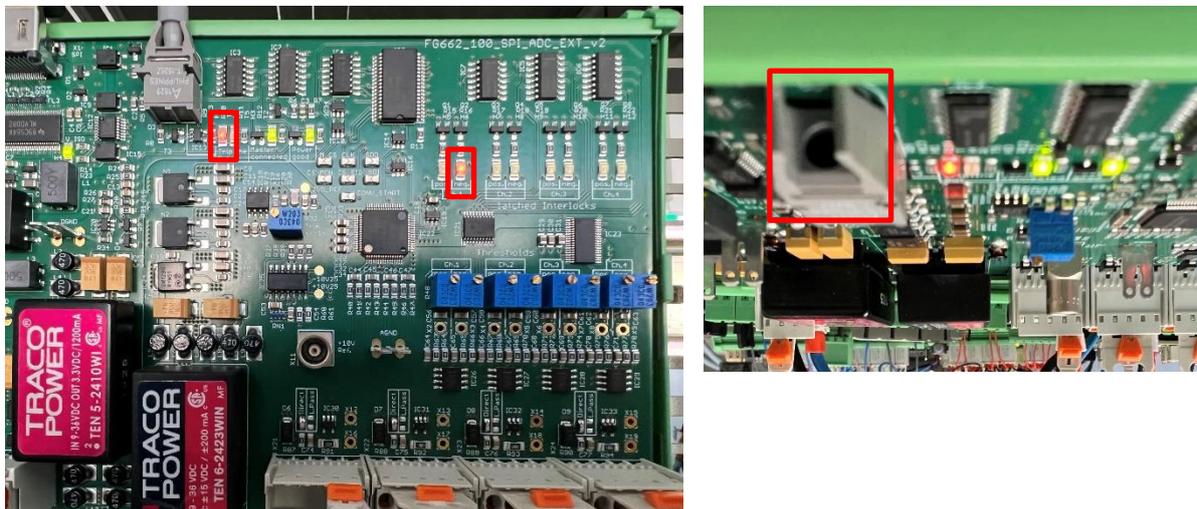
Figure 23: Tripline out LED and Ch.1 neg. LED (left) have to glow red in case of an interlock. The optical transmitter (right) has to be off (no light).

Set the value of the reference voltage in between the positive and negative thresholds. The pending interlock marker in PCA has to disappear. The memorized interlock has to be displayed on the "latched Interlocks" LED, the tripline LED (Figure 23) as well as in PCA (Figure 24).
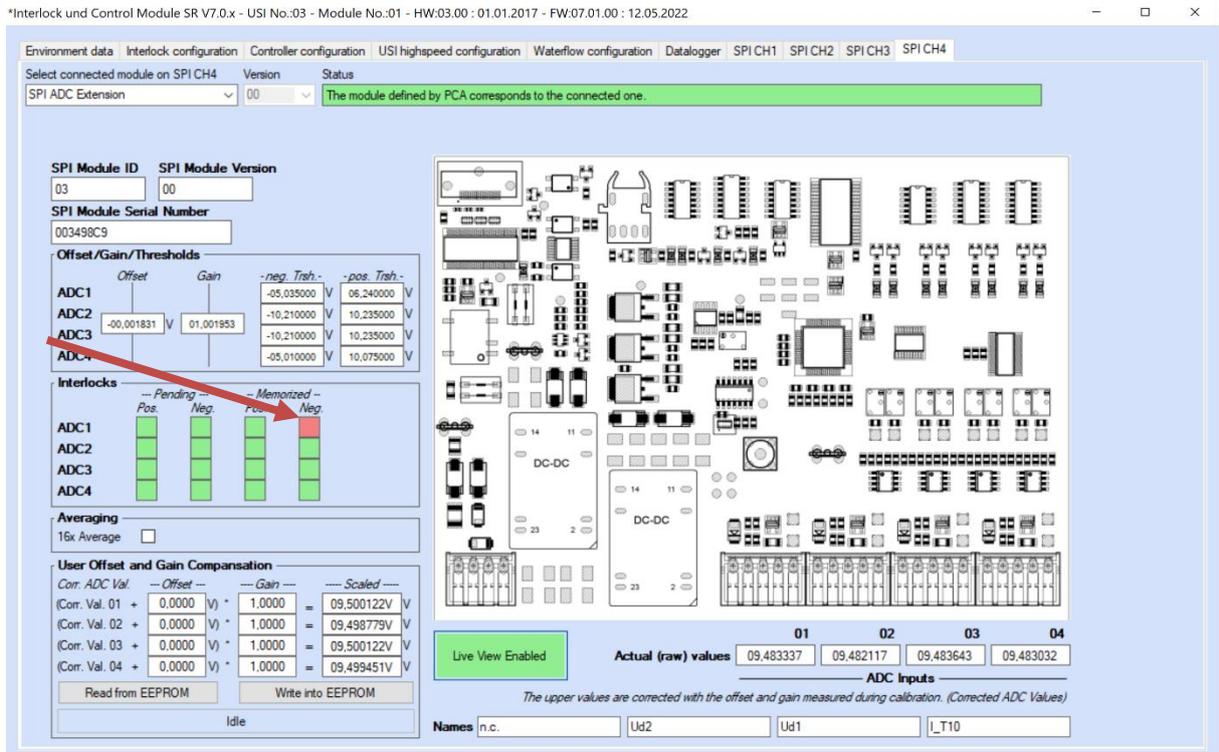
Figure 24: Memorized interlock in PCA

Press the reset button on the MFU to clear the interlock on the PCB and in PCA. The tripline LED has to glow green, the Ch.1 pos. LED has to turn off, and the optical transmitter has to be on as shown in Figure 25.
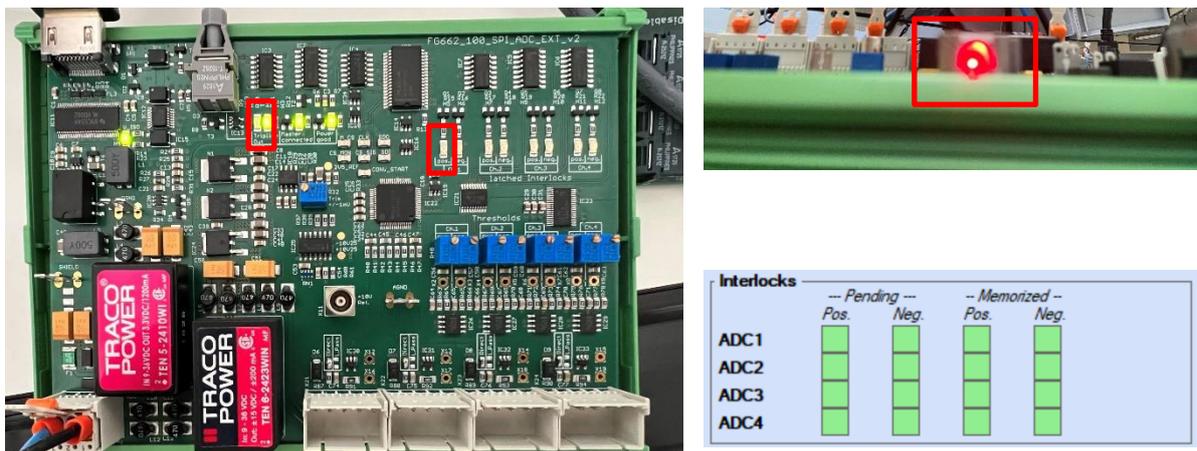
Figure 25: Tripline out LED has to glow green and Ch.1 pos. LED has to be off (left). The optical transmitter (right) has to be on (glowing). The interlocks have to disappear in PCA.

Repeat the steps for the other 3 channels. The test is successful when the interlocks are displayed correctly.

6.4 Master Connected Test

Unplug the HDMI cable from the ADC_SPI card. The "Master connected" LED has to be off and the "Tripline out" LED has to glow red (shown in the figure below) to pass the test.
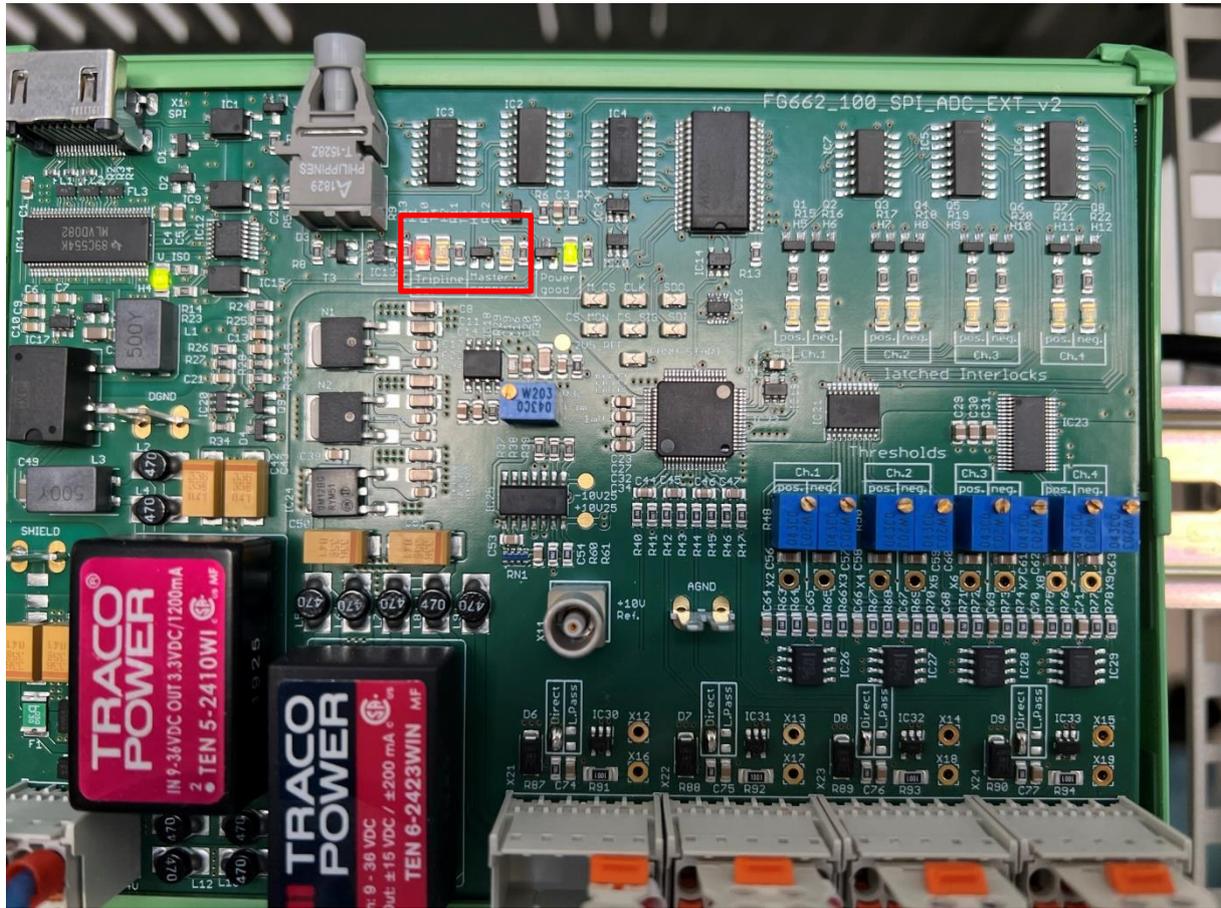
Figure 26: Master connected LED (marked) has to be off to pass the test

7 Label

To mark the SPI ADC card as tested and calibrated a label has to be added to the PCB. To generate a label open PCA. From the menu bar select "Tools > QR Code Generator".
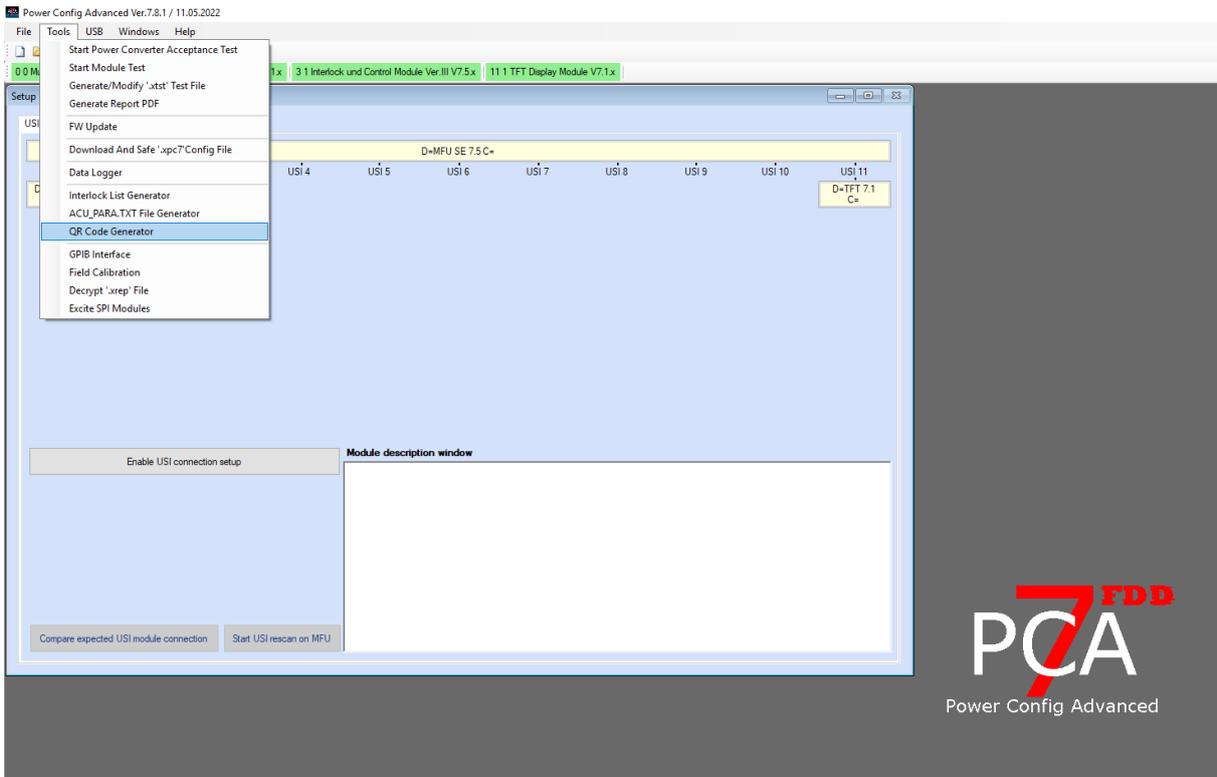
Figure 27: Open QR code generator tool

Fill out the form as shown in Figure 28. Enter the date after "Calibrated on" in the format DDMMYY. Replace the "XXXXXXXX" with the SPI ADC card serial number. After you filled out the form click on "Print".
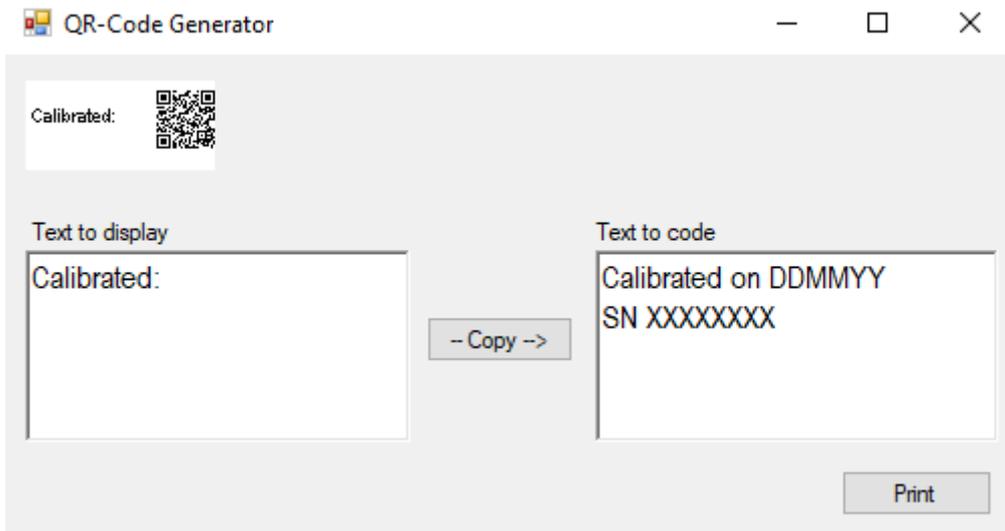
Figure 28: QR-Code Generator with added calibration information

Print the label on a label and adhere it to the surface of the SPI_ADC card.