# ZSSC3286KIT

## Introduction

This document provides a comprehensive guide to the ZSSC3286 Evaluation Kit, explaining its hardware and software design, the required setup procedures and the steps for configurating and evaluating the ZSSC3286 sensor signal conditioning IC.

Target device: ZSSC3286 IO-Link Ready Dual Channel Sensor Signal Conditioner IC.

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# 1. Evaluation Kit Contents

Find the ZSSC3286KIT on www.renesas.com/ZSSC3286KIT.

Find the ZSSC3286 on www.renesas.com/ZSSC3286.

**Table 1. Kit Contents**

| Position | Kit Item | Item Number | Quantity |
|---|---|---|---|
| 1 | ZSSC3286 Evaluation Board | ZSSC3286 EVB V4 | 1 |
| 2 | ZSSC3286 40-QFN samples | ZSSC3286CI3R | 5 |
| 3 | SSC Communication Board | SSCCOMMBOARDV4P1C | 1 |
| 4 | SRB Sensor Replacement Board | SSCSRBV3 | 1 |
| 5 | RH4Z2501-PMOD | RH4Z2501-PMOD | 1 |
| 6 | Renesas CCE4510 2-Channel IO-Link Master | CCE4510-2CH-DB-V2.1 | 1 |
| 7 | IO-Link cable (5 Pin M12 plug to receptacle) | n.a. | 1 |
| 8 | USB cable (USB A to USB B) | n.a. | 1 |
| 9 | USB cable (USB A to USB C) | n.a. | 1 |
| 10 | ESD Tweezers | n.a. | 1 |

# 2. Evaluation Kit Setup

The ZSSC3286 Evaluation Software (GUI) is intended for demonstration purposes, configuration and calibration of single units.

A Windows®-based computer is required for interfacing with the kit and configuring the ZSSC3286.

*Note*: Upon request, Renesas provides the user with algorithms and assistance in developing their full production calibration software.

## 2.1 User Computer

### 2.1.1. Computer Requirements

*Note*: The user must have administrative rights on the computer to download and install the ZSSC3286 Evaluation Software for the kit.

The computer must meet the following requirements:

- Windows® 7, 8, 8.1, 10
- Microsoft® .NET Framework 4.0 or higher
- Supported architecture: x86 and x64
- 2x USB 2.0 port
- Internet access to download the installation setup

### 2.1.2. Software Installation and Setup

The latest version of ZSSC3286 Evaluation Software (ZSSC3286 Application v1.3.0), which is required for the kit, is available for download from the Renesas website.

*Note*: FTDI USB drivers are needed only for backwards compatibility with older Renesas communication hardware. If these drivers are not already installed on the user's computer, the software automatically installs the correct drivers after user confirmation.

Follow these steps to install the Evaluation Software:

1. Download and extract the contents of the *zssc3286-application-setup.zip* file to the user's computer.
2. Double click on the extracted *ZSSC3286 Application Setup.exe* file.

   Follow the installation instructions displayed on the screen, changing the installation path if needed. If the default path setting is used, the software automatically completes the installation and creates an access link on the user's computer under Start > All Programs > Renesas > ZSSC3286 Application. The installation dialog offers the option to create a desktop short-cut icon for the software if selected.
3. Configure and connect the Kit hardware as described in section 2.2 and 2.3.
4. Start the ZSSC3286 Application.

   On first start, the software asks for network permission for setting up the IO-Link communication server. For operating the ZSSC3286 Evaluation Software, see section 3.

## 2.2 Board Configuration and Connection

The default jumper and switch settings of the relevant kit items are shown in Figure 1, Figure 2 and Figure 3.

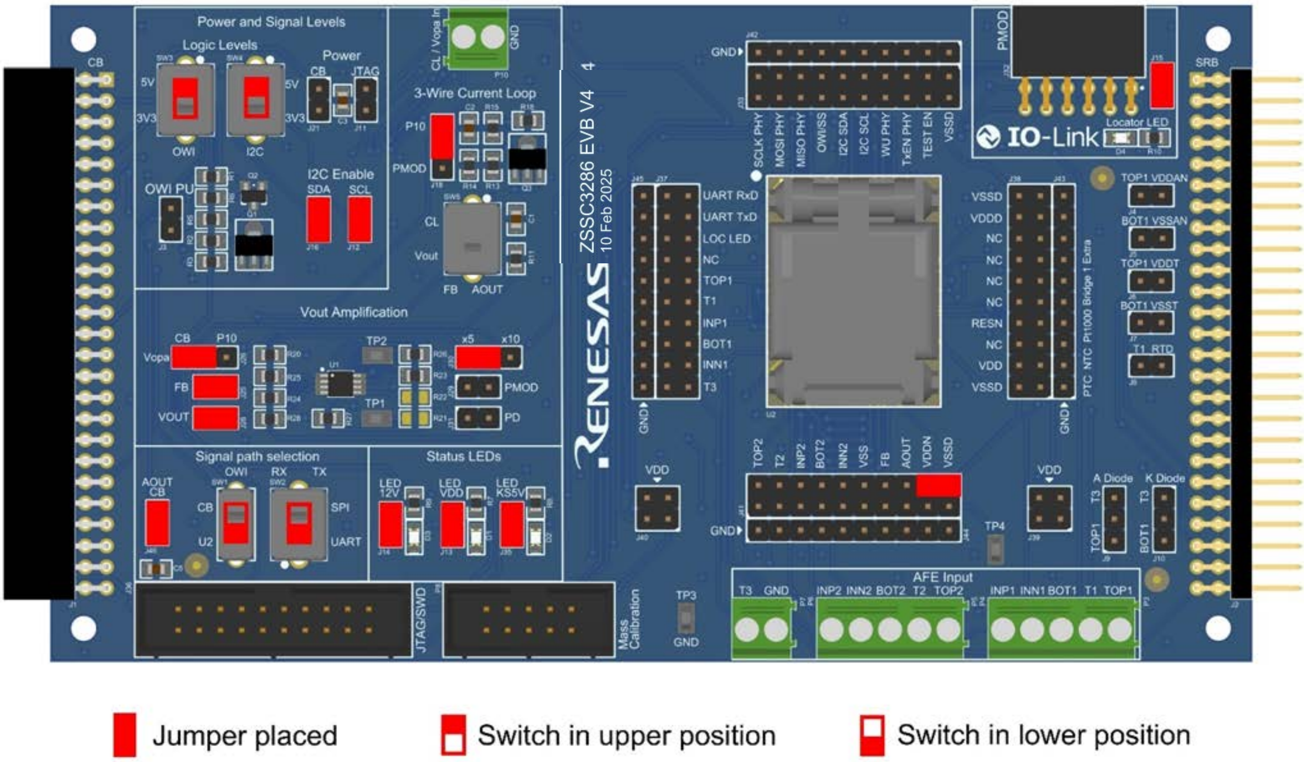



**Figure 1. ZSSC3286 EVB V4 Default Configuration**

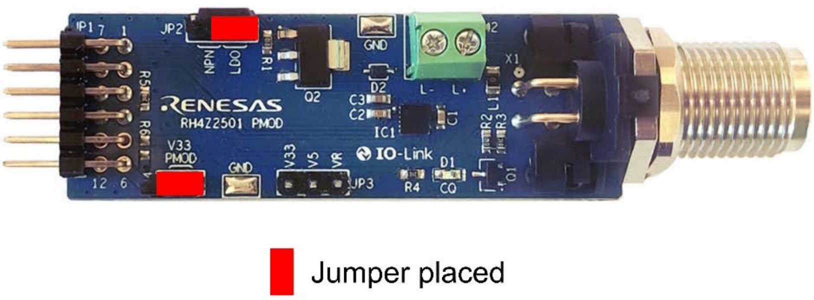



**Figure 2. RH4Z2501 PMOD Default Configuration**

For a complete description of the RH4Z2501-PMOD, refer to References item 2.

***Important:*** On RH4Z2501-PMOD, some AOUT options require R6 (0Ω) to be placed to directly route Pin 2 (I/Q) of the IO-Link M12 connector (X1) (see section 3.3.5 for details). Using a different master than the Renesas CCE4510 2-Channel IO-Link Master included in the kit may destroy the ZSSC3286 EVB and/or the sample, especially if a Class B Master is used (24V supply on Pin 2).

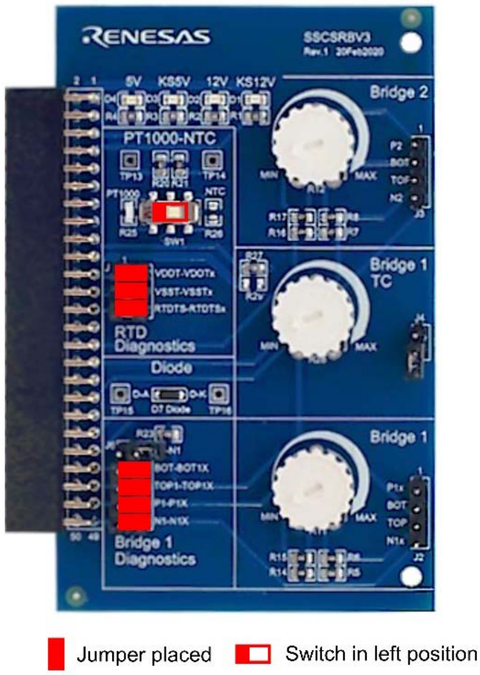



Figure 3. SSCSRBV3 Default Configuration

For a complete description of the SSC Communication Board V4.1 (CB), see References item 1. Ensure to have the CB with firmware revision 4.21 or greater, to have all the GUI functionalities operational. The CB datasheet and the firmware update package are available in References item 1.

### 2.2.1. Capacitive Replacement Board

For capacitive measurements, the Capacitive Replacement Board (SSCCRBV2) can be used.

*Note*: The SSCCRBV2 is not part of the Evaluation Kit and needs to be purchased additionally.

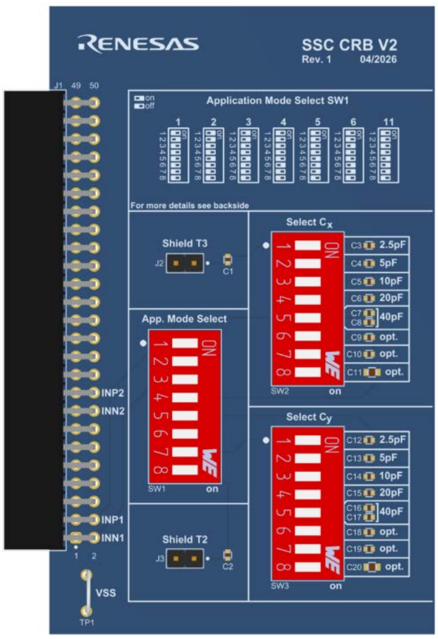



Figure 4. SSCCRBV2 Default Configuration

## 2.3 Evaluation Kit Hardware Connections

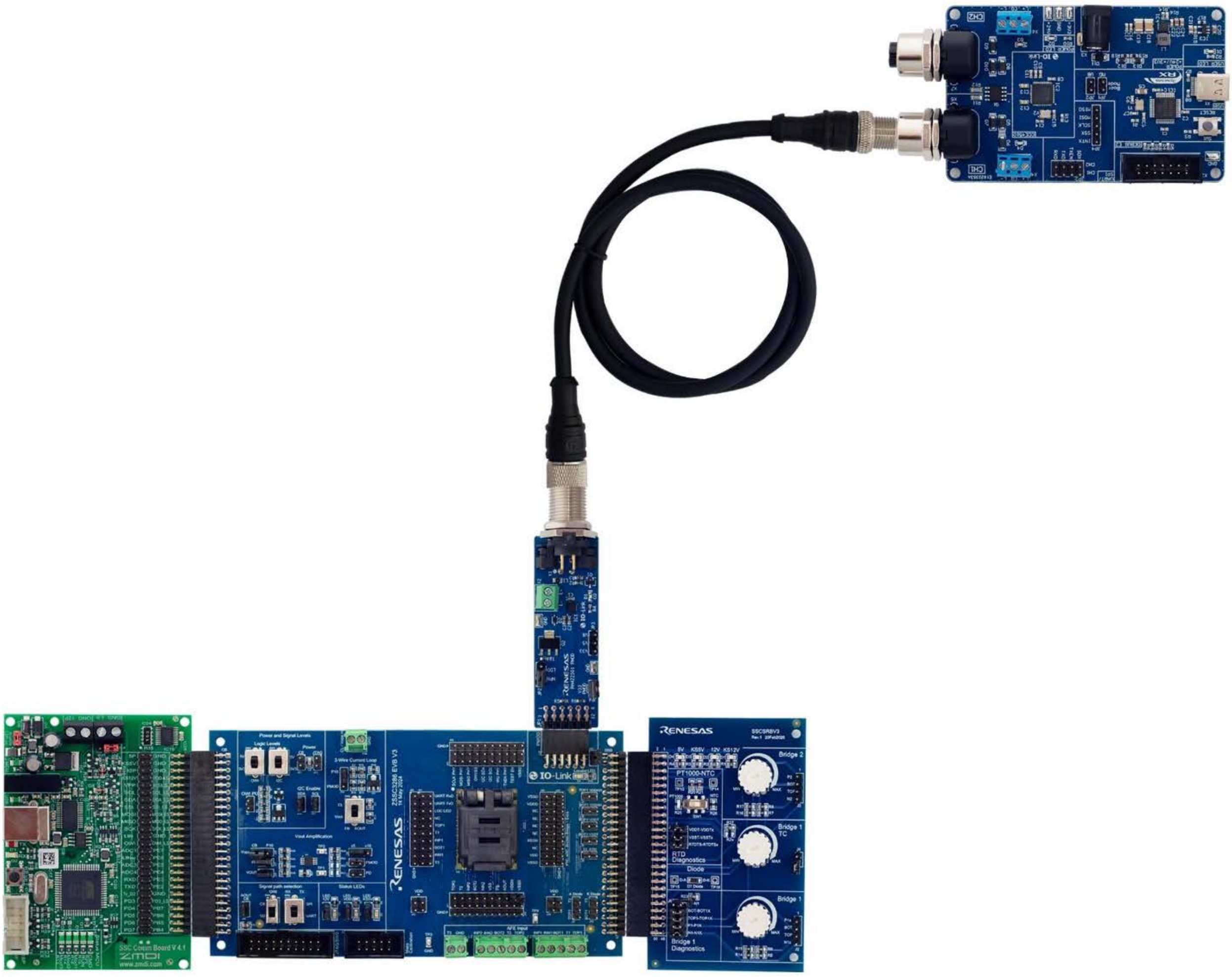


**Figure 5. ZSSC3286KIT – Overview**

Follow these steps to assemble the PCBs as shown in Figure 5 to start the kit with default settings:

1. Replace the dummy IC in the socket with a ZSSC3286 sample. Use the enclosed ESD safe tweezers for correct handling of the IC. Align Pin 1 with the dot on the opened socket U2 or with the dot on the silkscreen next to the upper left corner of socket U2.
2. Connect the ZSSC3286 Evaluation Board (J1) to the CB (K6).
3. Connect the ZSSC3286 Evaluation Board (J2) to the Sensor Replacement Board V3 (J1) or the Capacitive Replacement Board V2 (J1).
4. Connect the ZSSC3286 Evaluation Board (J32) to the RH4Z2501-PMOD (JP1).
5. Connect the RH4Z2501-PMOD with the IO-Link cable to the IO-Link Master (Channel 1).
6. For using the Renesas Master, connect via USB to the PC. Supplying the Master with 24V directly via the DC jack is not mandatory for ZSSC3286KIT operation.

*Note*: Bad electrical contact between the QFN socket and the sample can cause random connection loss or unstable output signal. Oxidation and contamination on the QFN pads and socket pins can be mitigated by carefully cleaning the contacts with compressed air and removing and installing the IC again.

***Important***: The Evaluation Kit is designed for operation at room temperature. Use of the Kit in a thermal chamber may cause damage to the boards.

## 2.4 Communication Interfaces and Logic Levels

The ZSSC3286 and the Evaluation Board support UART (IO-Link), I2C, and OWI as communication interfaces. Only UART or I2C can be active at a time and OWI is only used to control the IO-Link PHY. Sections 3.1.3 and 3.2 provide details about the corresponding Graphical User Interface (GUI) settings.

The ZSSC3286 EVB supports 5V and 3.3V logic levels for both I2C and OWI. The logic level can be adjusted via SW4 and SW3 on the Evaluation Board. When the Evaluation Board is powered via IO-Link (3.3V), use 3.3V logic level for I2C. When the Evaluation Board is powered via CB (5V), use 5V logic levels for I2C.

*Note*: Write Memory and Firmware Update do not work via I2C in 3.3V logic level with the ZSSC3286KIT.

The ZSSC3286 Evaluation Board uses the CB to translate I2C and OWI to USB. Only one CB can be connected to the user's computer at a time to operate GUI normally. Via OWI, the CB can only configure the IO-Link PHY, not the ZSSC3286. To use OWI via CB, connection via I2C to the ZSSC3286 is mandatory.

The Renesas Master is used to translate UART (via IO-Link) to USB.

**Table 2. Communication Interfaces and Logic Levels**

| Jumper/Switch | UART (IO-Link) 3.3V | UART (IO-Link) 5V | I2C 3.3V | I2C 5V | OWI 3.3V (via CB to RH4Z2501-PMOD) | OWI 5V (via CB to RH4Z2501-PMOD) |
|---|---|---|---|---|---|---|
| J21 | removed | removed | removed | set | removed | removed |
| J12 | n.a. | n.a. | set | set | set | set |
| J16 | n.a. | n.a. | set | set | set | set |
| J46 | n.a. | n.a. | set | set | removed | removed |
| JP3 (on RH4Z2501-PMOD) | removed | set (V33 - V5) | removed | n.a. | removed | set (V33 - V5) |
| JP4 (on RH4Z2501-PMOD) | set | set | set | removed | set | set |
| SW1 | U2 | U2 | U2 | U2 | CB | CB |
| SW3 | n.a. | n.a. | n.a. | n.a. | 3V3 | 5V |
| SW4 | n.a. | n.a. | 3V3 | 5V | 3V3 | 5V |

## 2.5 Power-Up Procedure

Follow these steps for powering up the EVB:

1. Connect and configure the Kit as described in sections 2.2, 2.3 and 2.4.
2. Launch the GUI.
3. Select one of the two interface options in the drop-down list at the "Connection" section on the left side of the GUI.
4. Click "Connect": The Kit will power up the EVB.

Consistency check: The GUI, at connection to the device, reads the memory of the device and automatically assesses if its configuration is consistent with the expected ones.

***Important***: The configuration of the ZSSC3286 must be performed through the GUI. Manual modification of the configuration file (section 3.1.1.1), not followed by a consistency check of the configuration performed through the GUI, may lead to unhandled device status.

# 3. ZSSC3286 Application GUI

## 3.1 Body

The Body of the GUI is visible and accessible from any tab of the GUI and provides basic control of the ZSSC3286 Application, the interconnect boards and the ZSSC3286 IC.

### 3.1.1. Menu Bar

The Menu Bar (Figure 6) provides access to files operation, serial bus settings, the CB log file, and software versioning information.


**Figure 6. Top Menu**

#### 3.1.1.1. File Menu

File Menu (Figure 7) allows to load and save the GUI configuration. It also provides the functionality to save the device configuration NVM to a file or to load an NVM configuration to a device from an already existing file. Default NVM configuration can be loaded to the GUI to save a misconfigured device.

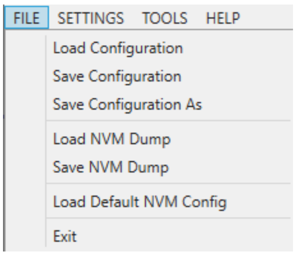



**Figure 7. File Menu**

#### 3.1.1.2. Settings Menu

Settings menu (Figure 8) allows to enter the CCP and the FW Password set on the currently used ZSSC3286 sample. This allows the GUI to perform "Write Memory" action and perform a firmware update.

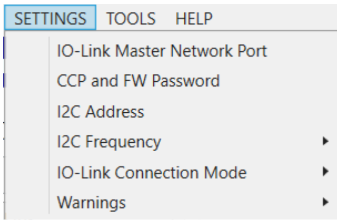



**Figure 8. Settings Menu**

The setting "IO-Link Master Network Port" allows to change the port number in a pop-up window (Figure 9). The GUI automatically recognizes the port number of a connected IO-Link master.

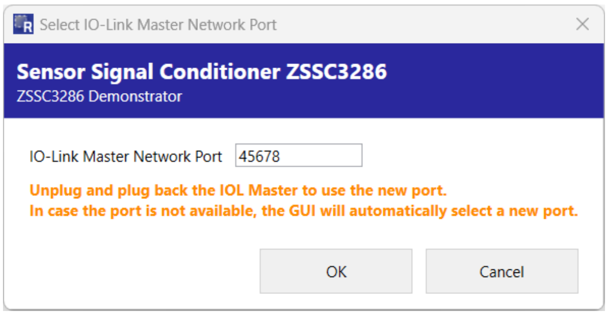



**Figure 9. IO-Link Master Network Port Pop-Up**

Clicking on “CCP and FW Password” opens a pop-up window with entry fields for CCP Password and Firmware Password (Figure 10). CCP Password can be displayed in hex or decimal format by clicking on the button on the left side on the CCP Password entry field.

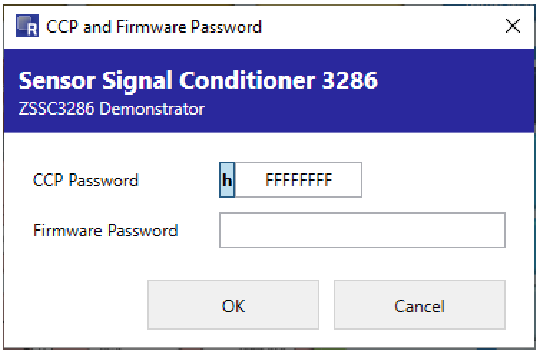



**Figure 10. CCP and Firmware Password Pop-Up**

The following options relevant to the digital serial buses can be modified via this menu. When connected to the ZSSC3286, the options for the currently used interface are not accessible.

- I2C: Address and Frequency
- IO-Link: Connection Mode
  - Autostart: Normal Port Mode of the IO-Link Master. Use this for configuration and calibration of ZSSC3286
  - Restore: Allows to overwrite parameters of a connected device with parameters previously stored in the Data Storage of the IO-Link Master.
  - Backup/Restore: Allows to store parameters from a connected device in the Data Storage of the IO-Link Master. Allows to overwrite parameters of a connected device with parameters previously stored in the Data Storage of the IO-Link Master.

Clicking on “Warnings” allows the user to enable or disable GUI warning messages (Figure 11).

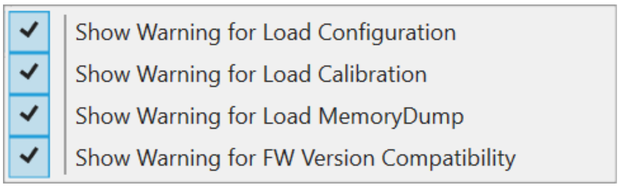



**Figure 11. Settings Menu – Warnings**

#### 3.1.1.3. Tools Menu

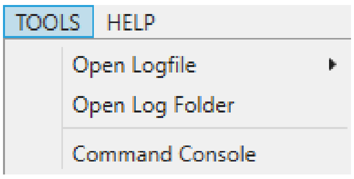



**Figure 12. Tools Menu**

The Tools menu (Figure 12) provides the following options:

- Open Logfile: the available Error, Communication, or Calibration log files can be opened (Figure 13).

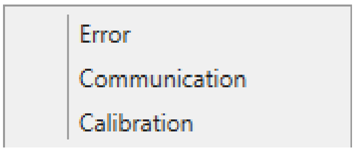



**Figure 13. Tools Menu – Open Logfile**

- Open Log Folder: opens the folder where the Logfile is located.

- Command Console: launches the Command Console (Figure 14), for detailed description of the available options see section 3.9.

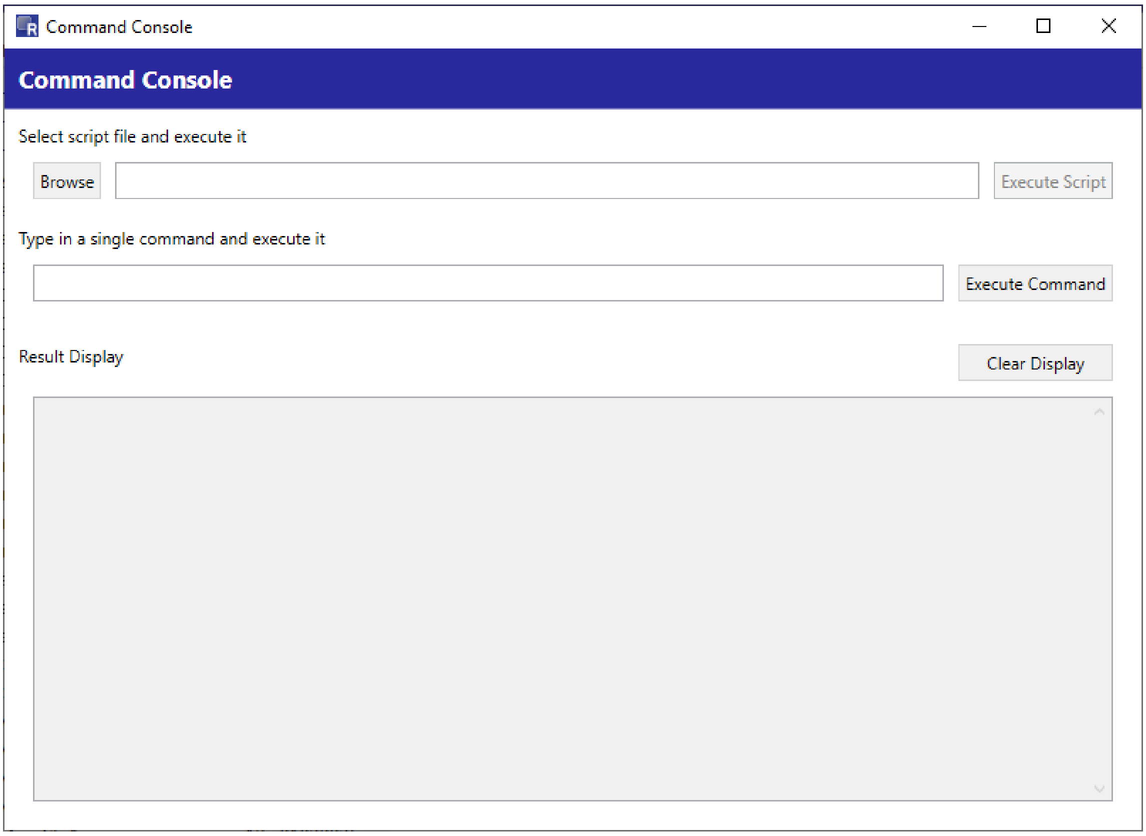



**Figure 14. Tools Menu – Command Console**

#### 3.1.1.4. Help Menu

The Help menu (Figure 15) contains relevant information about the GUI. The "About" option displays the GUI version, the USB driver version, and the Communication Board firmware version (Figure 16).

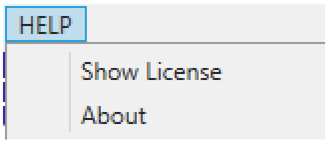
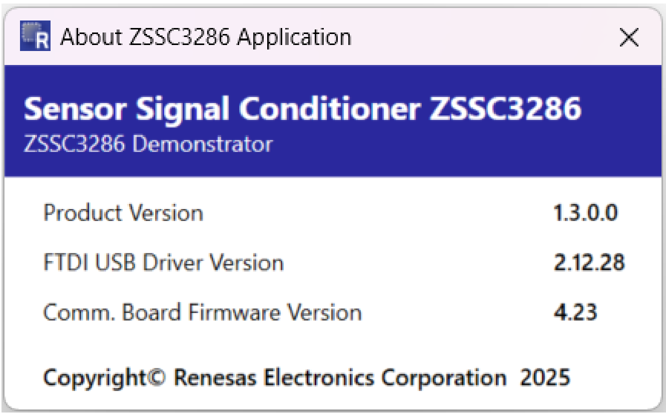



**Figure 15. Help Menu**




*Note*: Shown GUI version may not be latest; for illustration only.

**Figure 16. About Pop-Up**

### 3.1.2. Active Boards

This area displays information about the CB and the IO-Link Master currently connected to the host PC (Figure 17). Tooltip information is available for the devices (Figure 18). A click on "Refresh" button checks the CB and IO-Link Master status.

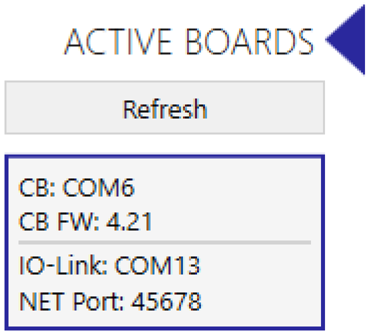



Figure 17. Active Boards

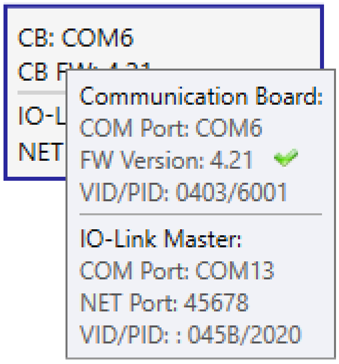



Figure 18. Active Boards – Tooltip

### 3.1.3. Connection

The connection area allows the user to control communication between the GUI, the CB / IO-Link Master and the ZSSC3286 (Figure 19) by selecting it from the drop-down menu.

**Note:** For I2C, ensure that the correct device address is set in the GUI, see section 3.1.1.2.

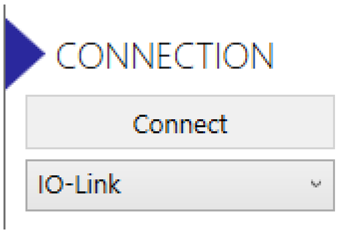



Figure 19. Connection Area

### 3.1.4. IC Status

When the ZSSC3286 is connected via I2C, the IC Status information is highlighted with yellow status buttons (Figure 20). The IC Status is based on the device status byte described in References item 3.

Clicking the "Read Status" button retrieves the most recent status byte. Its value in hexadecimal format is displayed above the button.

*Note*: IC Status is not available for connection via IO-Link.

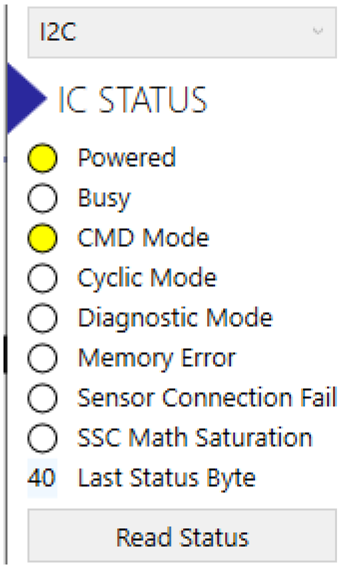



**Figure 20. IC Status**

### 3.1.5. I/O Functions

The I/O Functions area lists a set of buttons to perform the basic functions with the ZSSC3286 (Figure 21). The available selection of buttons depends on the connection mode (3.1.3). Table 3 explains the button functions.

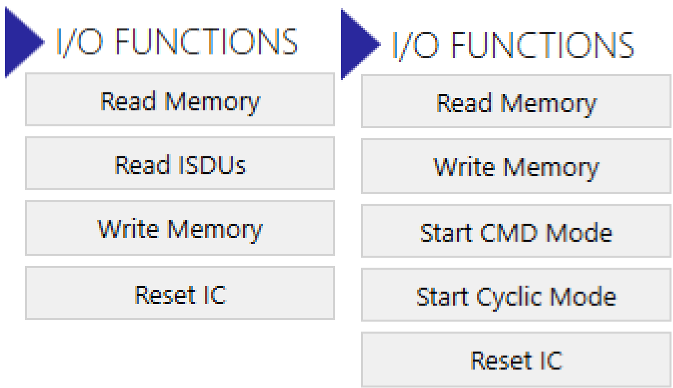



**Figure 21. I/O Functions for IO-Link (left) and I2C Connection (right)**

**Table 3. Availability of I/O Functions**

| Function | I2C | IO-Link | Function |
|---|---|---|---|
| Read Memory | Yes | Yes | Reads Memory from device and sets GUI accordingly. Implicitly performs ISDU read when connected via IO-Link |
| Read ISDUs | No | Yes | Reads ISDUs from device and sets GUI accordingly. |
| Write Memory | Yes | Yes | Performs CCP update. NVM changes are fully operational at this point. |
| Start Command Mode | Yes | No | Starts Command Mode of the device. |
| Start Cyclic Mode | Yes | No | Starts Cyclic Mode of the device. |
| Reset IC | Yes | Yes | Performs a reset of the device. |

### 3.1.6. System Status Bar

The system status bar is located at the bottom of the GUI. It displays information about connection and memory status as well as the firmware version of the IC.


*Note*: Shown FW version may not be latest; for illustration only.

**Figure 22. System Status Bar for I2C Connection**

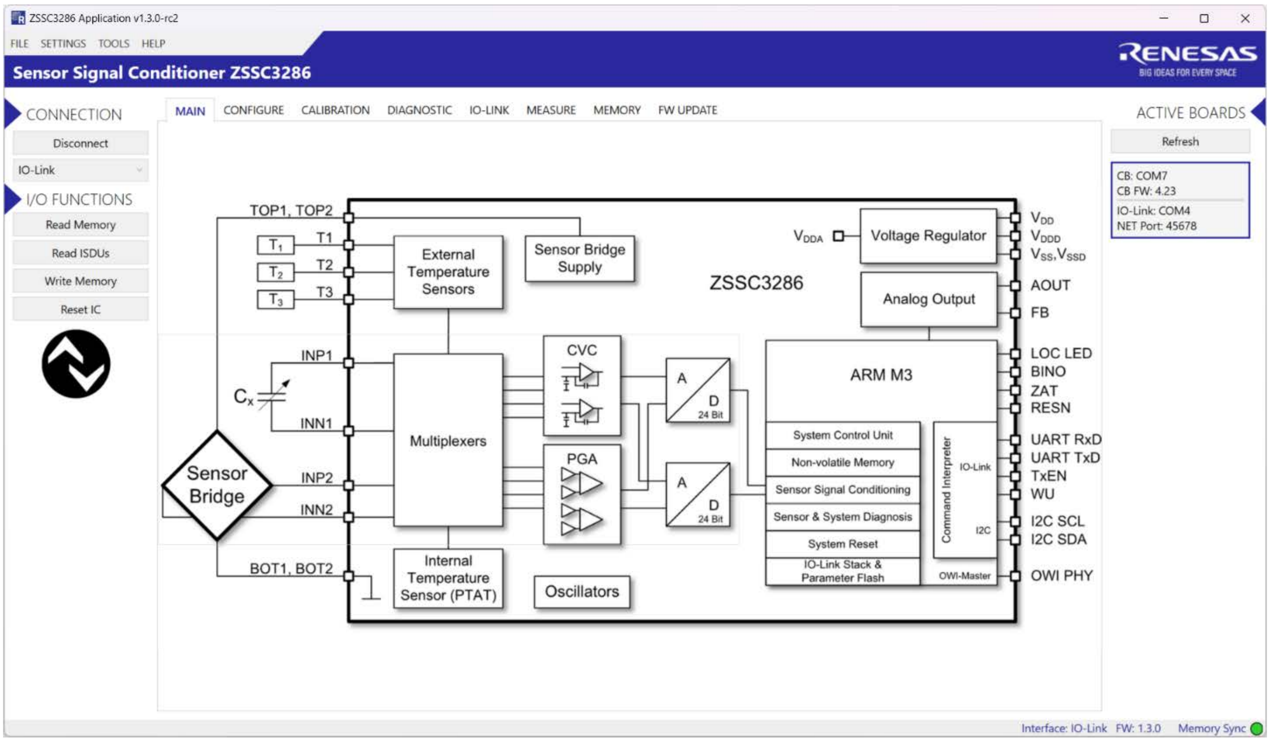
Table 4 shows the information provided to the user in the system status bar for I2C and IO-Link connection. A green status button means that NVM and GUI are synchronized.

**Table 4. System Status Bar Information Availability**

| Information | I2C | IO-Link |
|---|---|---|
| (Current) Interface | Yes | Yes |
| (Connection) Speed | Yes | No |
| (Device) Address | Yes | No |
| FW (RCA version) | Yes | Yes |
| (Status on NMV) Memory Sync | Yes | Yes |

## 3.2 Main Tab

The Main tab provides a block diagram overview of the device functionalities (Figure 23). Hovering on the block diagram highlights active areas; clicking on selected items opens the relevant configuration tab.




*Note*: GUI version may not be latest; for illustration only.

**Figure 23. Block Diagram on Main Tab**

## 3.3 Configure Tab

### 3.3.1. AFE Tab

#### 3.3.1.1. Sequencer Tab

The measurement flow is configurable by software. The Analog Front End (AFE) controls the measurement timing for Cyclic Mode. The SSC calculation is executed in parallel (pipelined). Once started, the measurement flow runs autonomously controlled by the AFE sequencer. Depending on configuration, it either runs continuously (Cyclic Mode) or stops after one defined measurement sequence.

Description of the operation of the sequencer is detailed in the *ZSSC3286 Datasheet* document (References item 3).

##### 3.3.1.1.1. Sensor Type

Depending on the chosen sensor type in Configure tab, sub tab “AFE”, sub tab “SENSOR” the displayed sensor type will switch between “Resistive” and “Capacitive”, enabling different configuration options for the sequencer tab.

##### 3.3.1.1.2. AFE Selection and Configurability (Resistive)

“The AFE Selection and Configurability” option (Figure 24) allows to configure the following options:

- AFE1 Only: AFE1 is used, only the selected AFE starts to acquire data.
- AFE2 Only: AFE2 is used, only the selected AFE starts to acquire data.
- AFE1 + AFE2, config independently: both AFEs are used, relevant configurations are set independently, no restrictions are applied.
- AFE1 + AFE2, config equally: both AFEs are used, relevant configurations are set equally, the AFE2 controls become inactive (read-only) and get assigned the same values that are selected in the corresponding AFE1 controls. This option applies for the settings that influence measurement timing (sequencer, auxiliary measurement selection, AFE resolution, etc.). This option does not apply for analog data path settings (gain, etc.), in other words, AFE2 is configurable for those parameters.
- Step Response: This option affects multiple configurations with the goal to achieve an AOUT step response time of less than 1ms and an IO-Link Step Response Time of less than 2ms. Refer to the ZSSC3286 Datasheet document for details on timings with SM+/SM- configuration (References item 3). Only one AFE is used and starts to acquire data (selectable via drop-down list “Selected AFE”). The following restrictions for the used AFE are applied:
  - Sequencer set to “SM+ AUX_i”
  - in Configure tab, sub tab “AFE”, sub tab “SENSOR”: “AdcReso” limited to 15bit, “SetTime” limited to 20µs, “SetTimeMultiplier” not selectable
  - in Diagnostic tab: Temperature Channel open measurements are limited to >100kΩ, Cbr and Cts are limited to 1nF
  - in tab “Configure”, sub tab “Filter”: Filter is disabled on all channels since it directly delays step response.

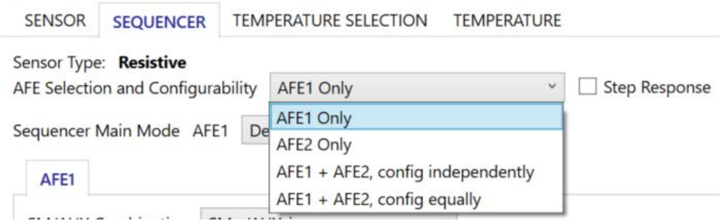



**Figure 24. AFE Selection and Configurability (Resistive)**

Every configuration field in the Sequencer tab of the GUI must have a value to be able to update NVM. If values are missing, a warning message is displayed (Figure 25) and if another tab is selected, incomplete settings will be lost.

Not all fields for this configuration have values

**Figure 25. Sequencer Error Message**

#### 3.3.1.1.3. AFE Selection and Configurability (Capacitive)

"The AFE Selection and Configurability" (Figure 24) is restricted depending on the chosen application mode in Configure tab, sub tab "AFE", sub tab "SENSOR"

- Application Mode 1, 2, 3, 4, 6: AFE1 Only: AFE1 is used, only the selected AFE starts to acquire data.
- Application Mode 5,11: AFE1 + AFE2, config equally: both AFEs are used, relevant configurations are set equally, the AFE2 controls become inactive (read-only) and get assigned the same values that are selected in the corresponding AFE1 controls. This option applies for the settings that influence measurement timing (sequencer, auxiliary measurement selection, AFE resolution, etc.).
- Activate AFE2 for temp T3: This option is only available in Application Mode 1, 2, 3, 4, 6 and enables AFE2 for temperature measurements with T3. The sequencer main mode of AFE2 is limited to "AUX only" with an adjustable idle time.

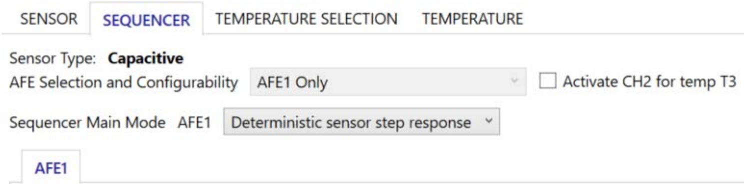



**Figure 26. AFE Selection and Configurability (Capacitive)**

Every configuration field in the Sequencer tab of the GUI must have a value to be able to update NVM. If values are missing, a warning message is displayed (Figure 25) and if another tab is selected, incomplete settings will be lost.

Not all fields for this configuration have values

**Figure 27. Sequencer Error Message**

#### 3.3.1.1.4. Sequencer Main Mode

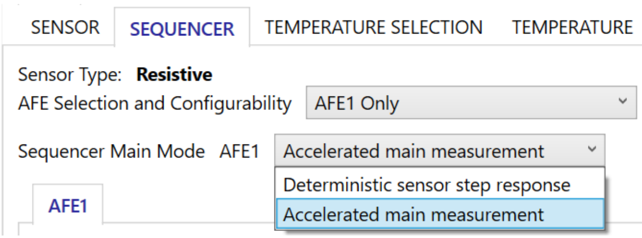



**Figure 28. Sequencer Main Mode**

The Sequencer Main Mode option (Figure 28) allows to configure the following options:

**Deterministic sensor step response**

For an application with fast, deterministic step response, the SM/AUX allowed the following combinations (Figure 29)

- SM+/SM-/AUX_i: Sensor measurement, inverted measurement, and auxiliary measurement
- SM-/SM+/AUX_i: Inverted sensor measurement, sensor measurement and auxiliary measurement
- SM+/AUX_i: Sensor measurement and auxiliary measurement (Auto-Zero)

*Note*: With sensor type selected as "Capacitive", only "SM+/SM-/AUX_i" is available.

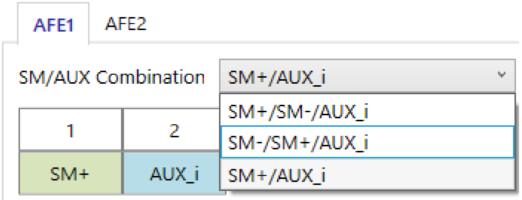



**Figure 29. SM/AUX Combinations for Deterministic Sensor Step Response**

*Note*: SM+ and SM- sequence can be exchanged yielding to the same result (Figure 30).

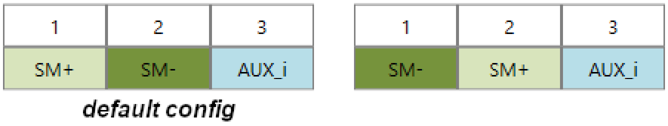



**Figure 30. SM+/SM- Exchange**

Within the auxiliary measurement vector, one auto-zero sensor measurement (AZS) can be configured (Figure 31). Thus, the inverted sensor measurement is not needed.

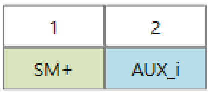



**Figure 31. SM+ with Auto-Zero Sensor Measurement**

The number of AUX measurements executed in one measurement sequence can be set to values between 1 and 7 for resistive sensor types and between 1 and 6 for capacitive sensor types. Between two sequences, an Idle Time of up to 10ms can be configured (Figure 32).

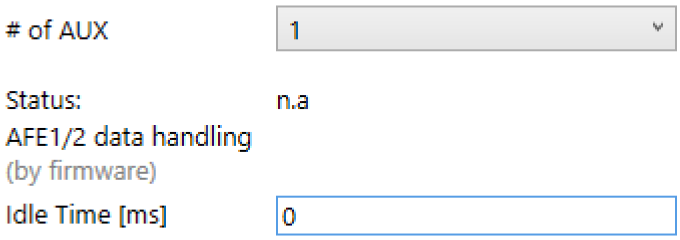



**Figure 32. Number of AUX Measurements and Idle Time**

### Accelerated main measurement

This measurement scheme (Figure 33) is faster than the “Deterministic sensor step response” by significantly reducing the number auf AUX measurements per SM measurement.

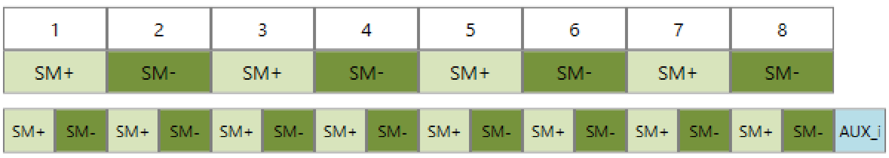



**Figure 33. Accelerated Main Measurement**

The possible sensor measurement combinations in the following (Figure 34):

- SM+/SM-: SM+ and SM- are processed to carry out internal offset compensation, AUX_AZ is not active.
- SM+ with AUX_AZ: SM+ and AUX_AZ are processed to carry out internal offset compensation, AUX_AZ is active. (not available for sensor type “Capacitive”)
- SM+ without AUX_AZ: SM+ only without internal offset compensation, AUX_AZ is not active. (not available for sensor type “Capacitive”)

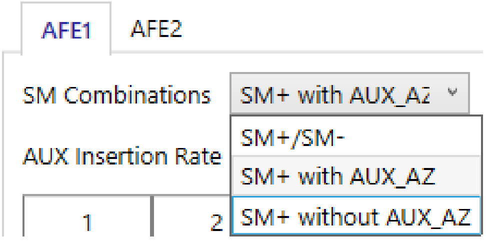



**Figure 34. SM/AUX Combinations for Accelerated Main Measurement**

The AUX Insertion Rate defines at which point of the measurement sequence an auxiliary measurement is performed. The auxiliary measurement can be placed after 2, 4, or 8 measurements (each consisting of 4 pairs of SM+/-), see Figure 35.

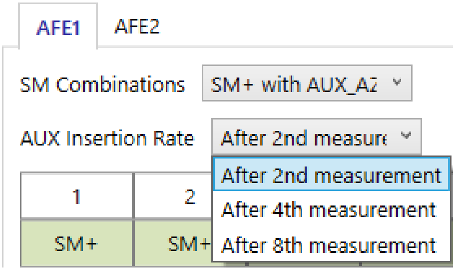



**Figure 35. Auxiliary Insertion Rate**

According to the selection done in the SM combination, the auxiliary measurement can also happen after a sequence of 16/32/64 SM+ measurements and with or without an additional AZ measurement (Figure 36).

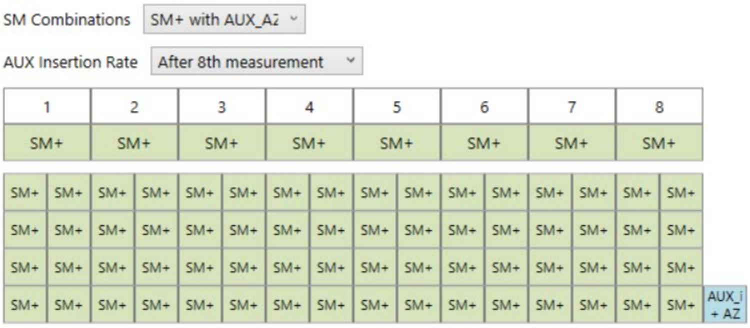



**Figure 36. Auxiliary Insertion Rate: SM+AUX_AZ after the Eighth Measurement**

### 3.3.1.2. Temperature Selection Tab

Four physical temperature sensors are available:

- 1 internal temperature sensor: PTAT
- 3 external temperature sensors: T1, T2, T3

Each physical temperature sensor can be assigned to each of the 3 logical temperature channels (Temp Ch1/2/3). An overview of this tab is provided in Figure 37.

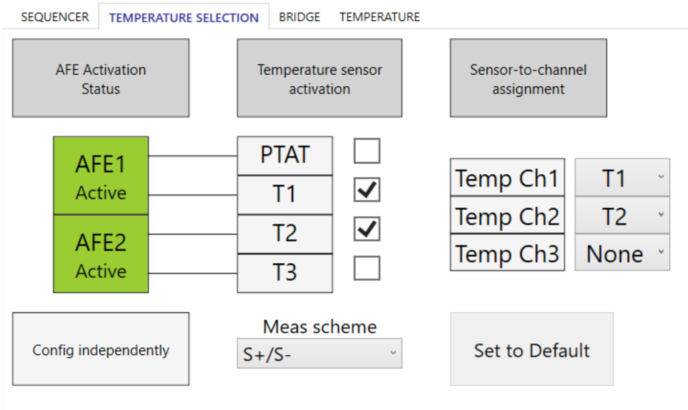



**Figure 37. Temperature Selection Overview**

This tab provides an overall view of the status of the Analog Front Ends, of the selectable temperature transducer(s), and of the association of the active temperature transducer(s) to one or more of the 3 logical temperature channels available.

### 3.3.1.2.1. Channel Data Paths

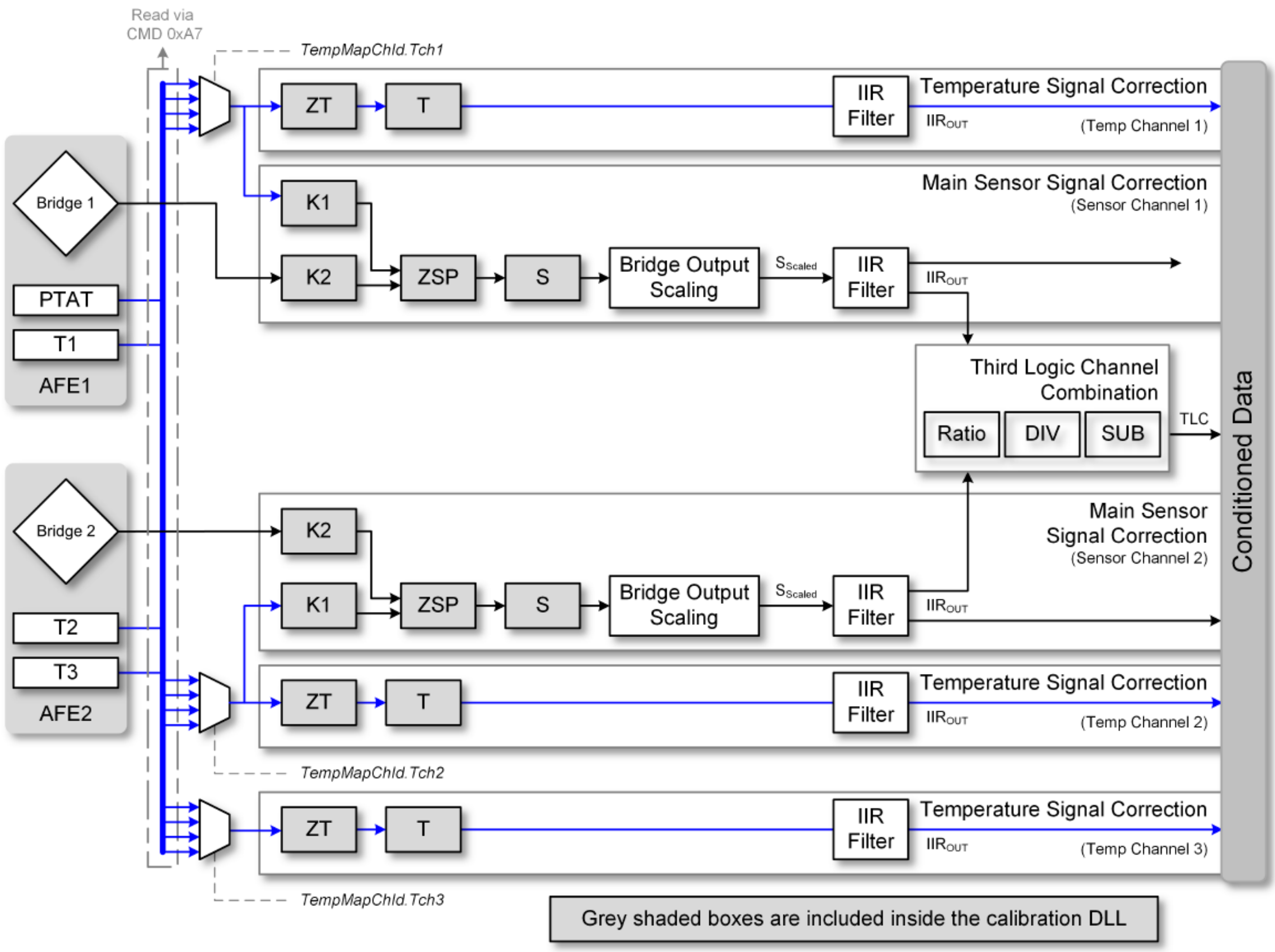



Figure 38 illustrates the sensor signal conditioning flow that is applied for AFE output data to compensate for offset, gain, non-linearity, and temperature effects and to calculate the conditioned data for further output processing. For more details, see References item 3.

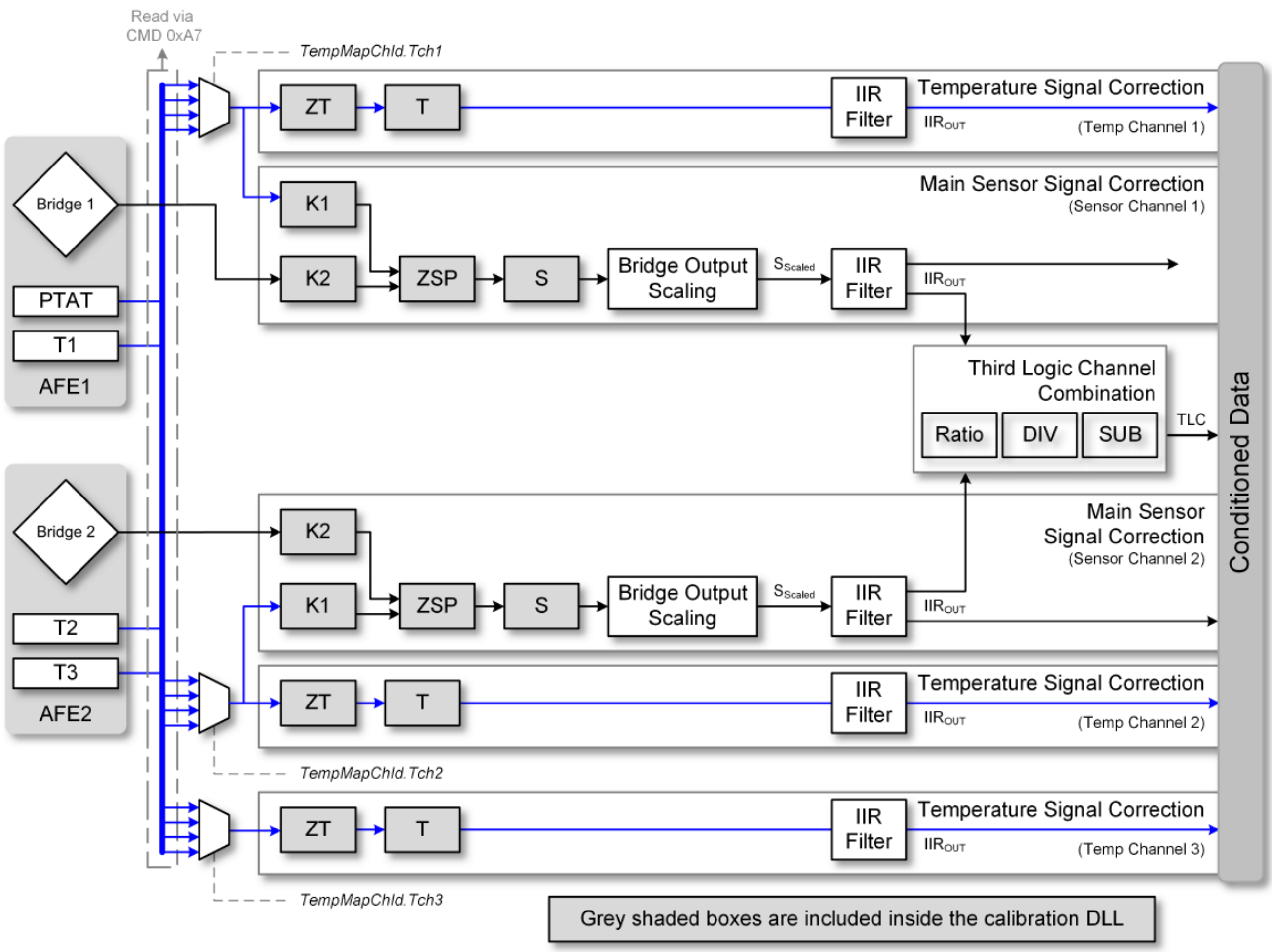



**Figure 38. Acquired Data Stream Overview**

### 3.3.1.2.2. AFE Status

Figure 39 displays the status of each AFE. A green color indicates that the AFE is active.

The AFE activation control is handled by the “Sequencer” tab, through the selection of the preferred option as displayed in Figure 24 and Figure 26. If both AFEs are active, the GUI displays if they are configured equally or independently.


**Figure 39. AFE Status**

### 3.3.1.2.3. Temperature Sensor Activation and Channel Assignment

AFE1 processes, when activated, the PTAT and/or T1. AFE2 processes, when activated, the T2 and/or T3. Sensor activation automatically changes depending on channel assignment. The “Meas scheme” drop-down list allows to choose between the acquisitions of S+/S- or S+ only (Figure 40).

*Note*: The selected activations are automatically changed in the GUI if the configuration chosen in the sequencer is modified (refer to Figure 24 and Figure 26). This allows to keep consistency in the device configuration.

Assign the activated temperature sensor to the Temperature channels (1/2/3) by the drop-down lists, see Figure 40. "Set to Default" button returns channel assignment to factory default values.

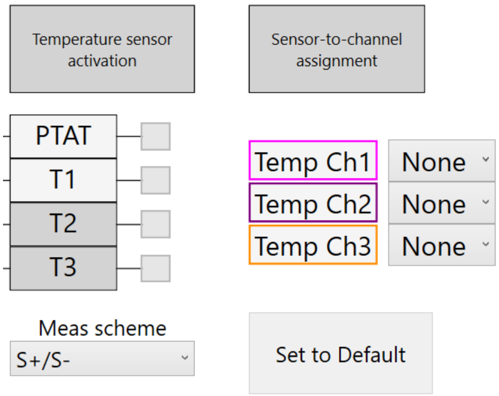



**Figure 40. Sensor to Channel Assignment**

*Note*: The channel assignments selected by the user may be automatically changed in the GUI in case the user afterwards modifies the configuration chosen in the sequencer (refer to Figure 24 and Figure 26). This allows to keep consistency in the device configuration.

### 3.3.1.3. Sensor Tab

The Sensor tab is structured according to the following:

- The "Configure Sensor" section is used to switch between resistive and capacitive sensor types and the corresponding channels or application modes.
- The settings in the "Parameters" section are the only ones that are saved in the device configuration NVM.
- Data input in the "Calculation and Visualization" section is used for calculations along with the selected values in the "Parameters" section to quickly find a suitable configuration setup.

#### 3.3.1.3.1. Configure Sensor Section

In this section, the sensor type can be switched between "Resistive" and "Capacitive". For resistive sensors, each AFE can be selected separately (Ch1, Ch2) for configuration with the "Parameters" section. For capacitive sensors, the application mode can be selected from the respective drop-down menu (see Figure 41).

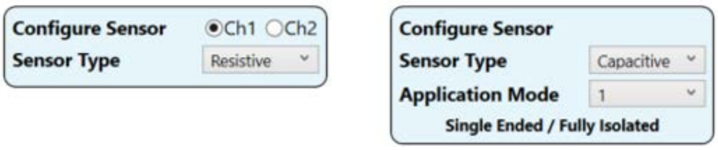



**Figure 41. Configure Sensor**

#### 3.3.1.3.2. Parameters Section (Resistive)

The Parameters section defines the type of the transducer supply, the behavior of the analog signal path, and the ADC configuration. Specific parameters values enable or disable the availability of a set of additional parameters and the relevant list of available values.

Through the "Mode" drop-down list, the GUI offers 4 options for supplying the transducer wired to the ZSSC3286, allowing the resistive bridge to be supplied by/through:

- Voltage: internal voltage supply (VDDA, References item 3)
- Current: configurable internal current source with configurable internal series resistor
- Resistor: internal voltage supply (VDDA, References item 3) with configurable internal series resistors

- Thermopile: the device acquires the voltage signal generated by a thermopile

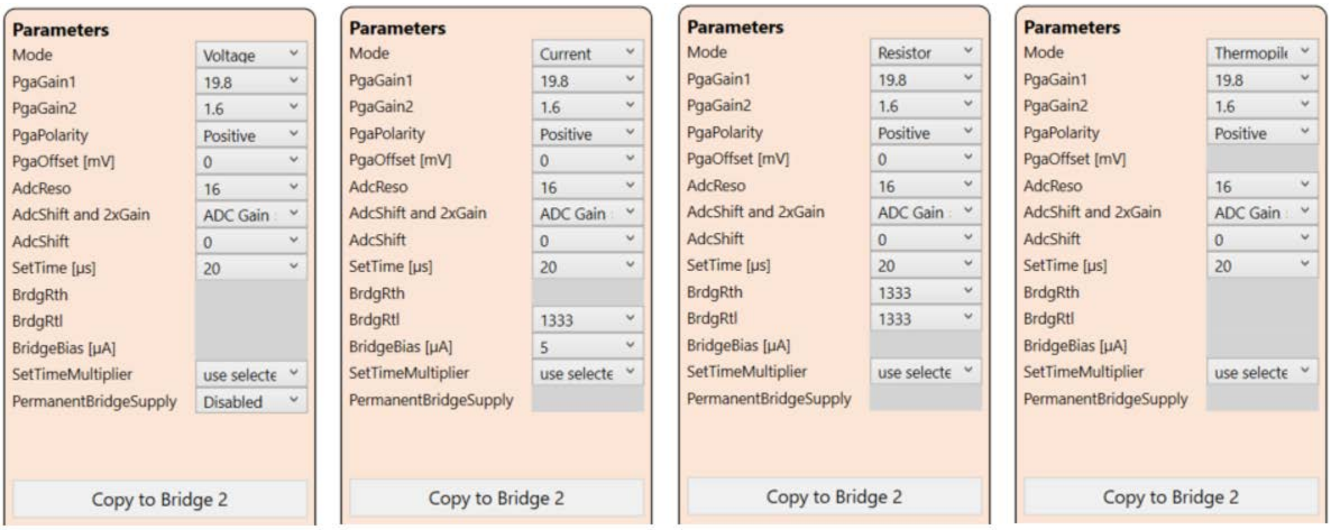



**Figure 42. Parameters Section (Resistive)**

To duplicate an already defined configuration, click the “Copy to Bridge” button (Figure 42).

The following parameters can be set:

- Mode: defines the type of supply scheme of the connected transducer
- PgaGain1: PGA gain stage 1 value
- PgaGain2: PGA gain stage 2 value
- PgaPolarity: Polarity inversion of the PGA input signal
- PgaOffset [mv]: PGA offset value (in mV)
- AdcReso: ADC resolution
- AdcShift and 2xGain: enables/disables the internal ADC 2x gain and internal ADC offset shift
- AdcShift: ADC offset shift value
- SetTime [µs]: Bridge settling time (µs)
- SetTimeMultiplier: multiplication factor for the set Bridge settling time

The following parameters are available if “Current” or “Resistor” modes are selected:

- BrdgRth: internal bridge resistor value (Ohm) upper side (RTH)
- BrdgRtl: internal bridge resistor value (Ohm) lower side (RTL)
- BridgeBias [µA]: current level of transducer current driver (ITbias)
- The following parameter is available if “Voltage” mode is selected:
- PermanentBridgeSupply: constantly powers the bridge via TOP and BOT

#### 3.3.1.3.3. Calculation and Visualization section (Resistive)

The Calculation and Visualization section is a supportive tool to find a suitable configuration for the used sensor setup. For resistive sensors it consists of the following sub-sections (see Figure 43):

- Sensor Values
- Internals
- Meas Config
- Schematics and Graphs

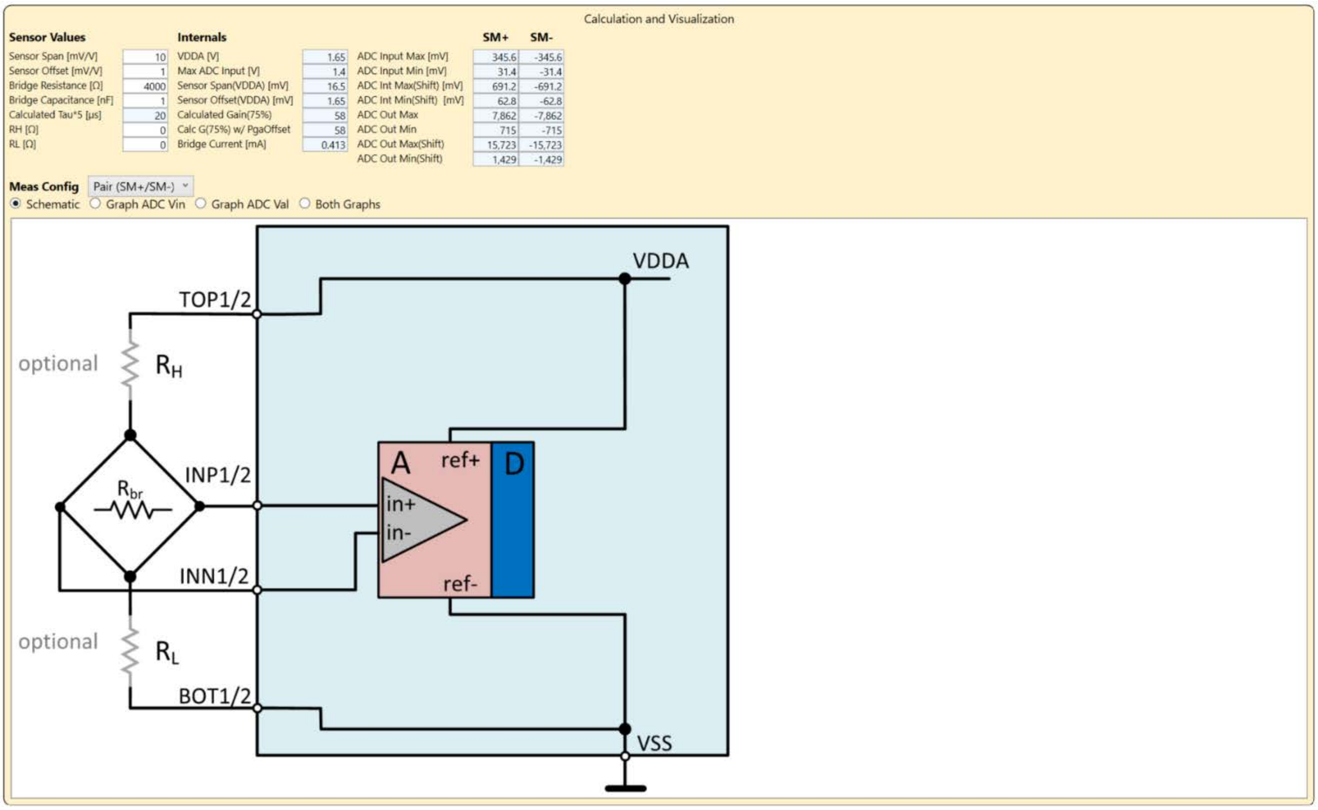



**Figure 43. Calculation and Visualization section (Resistive)**

### Meas Config

The “Meas Config” menu affects only the internal calculations and graphs, the drop-down list has the following options:

- Pair (SM+/SM-): a pair of measurements, in other words, the SM+ and SM- readings
- Single: Single measurement
  - SM+
  - SM-
  - AZ
- Single with AZ: single measurement with AZ
  - SM+ -AZ
  - SM- -AZ

### Sensor Values

The “Sensor Values” sub-section allows the user to enter the input transducer characteristics for performing the calculations and displaying the graphs.

The following values are displayed / can be entered:

- Sensor Span [mV/V]: Full-scale output of the sensor relative to the input voltage
- Sensor Offset [mV/V]: Sensor output at the reference condition relative to the input voltage.
- Bridge Resistance [Ω]: Equivalent resistance of the connected bridge
- Bridge Capacitance [nF]: Equivalent capacitance of the connected bridge
- Calculated Tau*5 [µs]: Calculated value of five times the RC time constant (Resistance x Capacitance x 5). This Value is automatically calculated by the GUI.
- RH [Ω]: Resistance value for optional resistor $R_H$

- RL [Ω]: Resistance value for optional resistor $R_L$

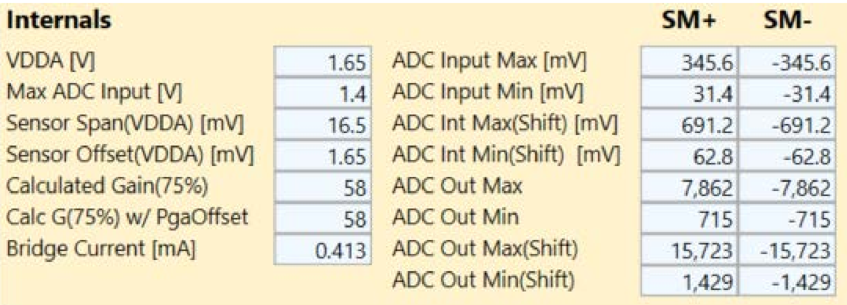
### Internals

The “Internals” sub-section displays values of specific electrical parameters that are built into the device and shows the calculated parameters depending on the values set in Meas Config, Sensor Values and Parameters (see 3.3.1.3.2).

The following values are displayed:

- VDDA: analog supply typical level (silicon defined)
- Max ADC Input [V]: the maximum ADC input level (defined by silicon)
- Sensor Span(VDDA) [mV]: input pin level (VDDA supply) in mV
- Sensor Offset(VDDA) [mV]: offset input pin level (VDDA supply) in mV
- Calculated Gain(75%): suggested Gain setting to reach 75% FS
- Calculated G(75%) w/ PgaOffset: suggested offset setting to reach 75% FS
- Bridge Current [mA]: current on the resistive transducer
- ADC Input Max [mV]: ADC maximum input (input multiplied by Gain)
- ADC Input Min [mV]: ADC minimum input (input multiplied by Gain)
- ADC Input Max(Shift) [mV]: ADC maximum input (input multiplied by Gain and including shift)
- ADC Input Min(Shift) [mV]: ADC minimum input (input multiplied by Gain and including shift)
- ADC Out Max: ADC maximum output (counts)
- ADC Out Min: ADC minimum output (counts)
- ADC Out Max(Shift): ADC maximum output with ADC internal shift and 2x gain (counts)
- ADC Out Min(Shift): ADC minimum output with ADC internal shift and 2x gain (counts)

Out of range parameters or input values are highlighted in red.



| Internals | | | SM+ | SM- |
|---|---|---|---|---|
| VDDA [V] | 1.65 | ADC Input Max [mV] | 345.6 | -345.6 |
| Max ADC Input [V] | 1.4 | ADC Input Min [mV] | 31.4 | -31.4 |
| Sensor Span(VDDA) [mV] | 16.5 | ADC Int Max(Shift) [mV] | 691.2 | -691.2 |
| Sensor Offset(VDDA) [mV] | 1.65 | ADC Int Min(Shift) [mV] | 62.8 | -62.8 |
| Calculated Gain(75%) | 58 | ADC Out Max | 7,862 | -7,862 |
| Calc G(75%) w/ PgaOffset | 58 | ADC Out Min | 715 | -715 |
| Bridge Current [mA] | 0.413 | ADC Out Max(Shift) | 15,723 | -15,723 |
| | | ADC Out Min(Shift) | 1,429 | -1,429 |

**Figure 44. Internals Out of Range**

### Schematics and Graphs

The reference schematic in Figure 43 is dynamically updated according to the “Mode” selection in the “Parameters” section (see 3.3.1.3.2).

Select Schematic, Graph ADC Vin, Graph ADC Val, or Both Graphs to switch view between the reference circuit schematic, the input to ADC input voltage to sensor input voltage transfer characteristics graph, the ADC input voltage to ADC counts transfer characteristics graph, and a combined view of both graphs (Figure 45).

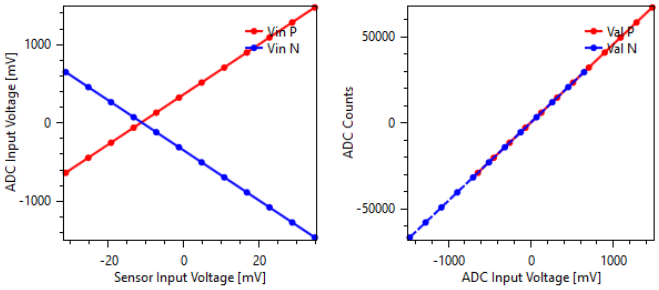



**Figure 45. Both Graphs**

### 3.3.1.3.4. AFE in Step Response Configuration

If “Step Response” configuration is selected (section 3.3.1.1.2), parameters of the chosen AFE are fixed as shown in Figure 46. Parameters of the other AFE stay configurable.

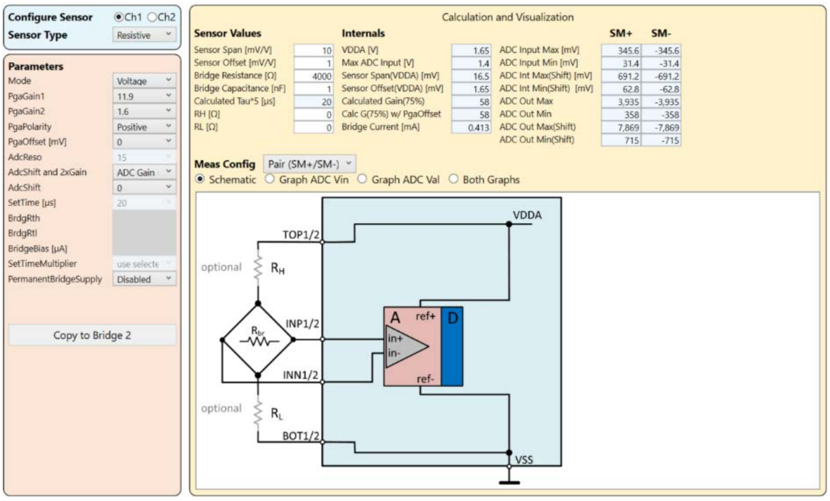



**Figure 46. Step Response Configuration for AFE1**

### 3.3.1.3.5. Parameter Section (Capacitive)

The Parameters section defines the behavior of the analog signal path, the ADC configuration and the linearization. Specific parameter values or the selected mode enables or disables the availability of additional parameters.

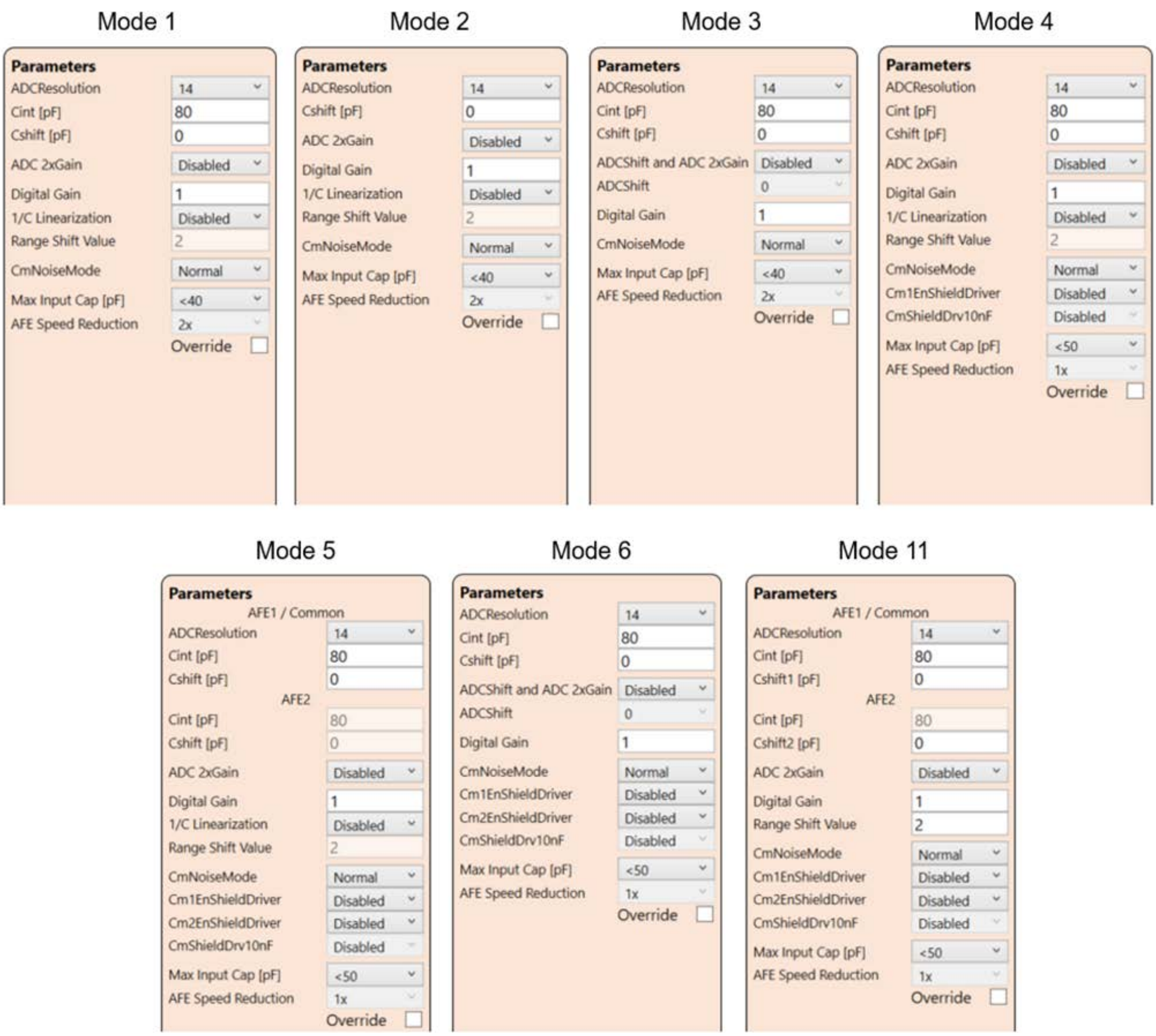



**Figure 47. Parameters Section (Resistive)**

The following parameters can be set:

- ADCResolution: ADC Resolution
- Cint [pF]: Internal reference capacitance value
- Cshift [pF]: Internal shift capacitance value
- ADC 2xGain: Enables/disables the internal ADC 2x gain
- ADCShift and ADC 2xGain: Enables/disables the internal ADC 2x gain and internal ADC offset shift
- ADCShift: ADC offset shift value
- Digital Gain: Digital Gain value
- 1/C Linearization: Enables/disables the 1/C linearization calculation
- Range Shift Value: Range shift value when using 1/C linearization
- CmNoiseMode: Switch between normal and low noise mode
- Cm1EnShieldDriver: Enables/disables the active shield driver for CVC1
- Cm2EnShieldDriver: Enables/disables the active shield driver for CVC2
- CmShieldDrv10nF: Enables/disables the 10nF shield driver mode

- Max Input Cap [pF]: Maximum input capacitance value ($C_x$ and $C_y$)
- AFE Speed Reduction: AFE speed reduction value
- Override: Enables/Disables the manual adjustment of the AFE speed reduction

#### 3.3.1.3.6. Calculation and Visualization section (Capacitive)

The Calculation and Visualization section is a supportive tool to find a suitable configuration for the used sensor setup. For capacitive sensors it consists of two tabs:

- AFE/SENSOR
- RANGE SHIFT

The AFE/SENSOR tab has the following sub-sections:

- Configuration Support
- Measurement
- Recommended Configuration Settings
- Schematics and Graph
- Expected Results (with recommended settings)

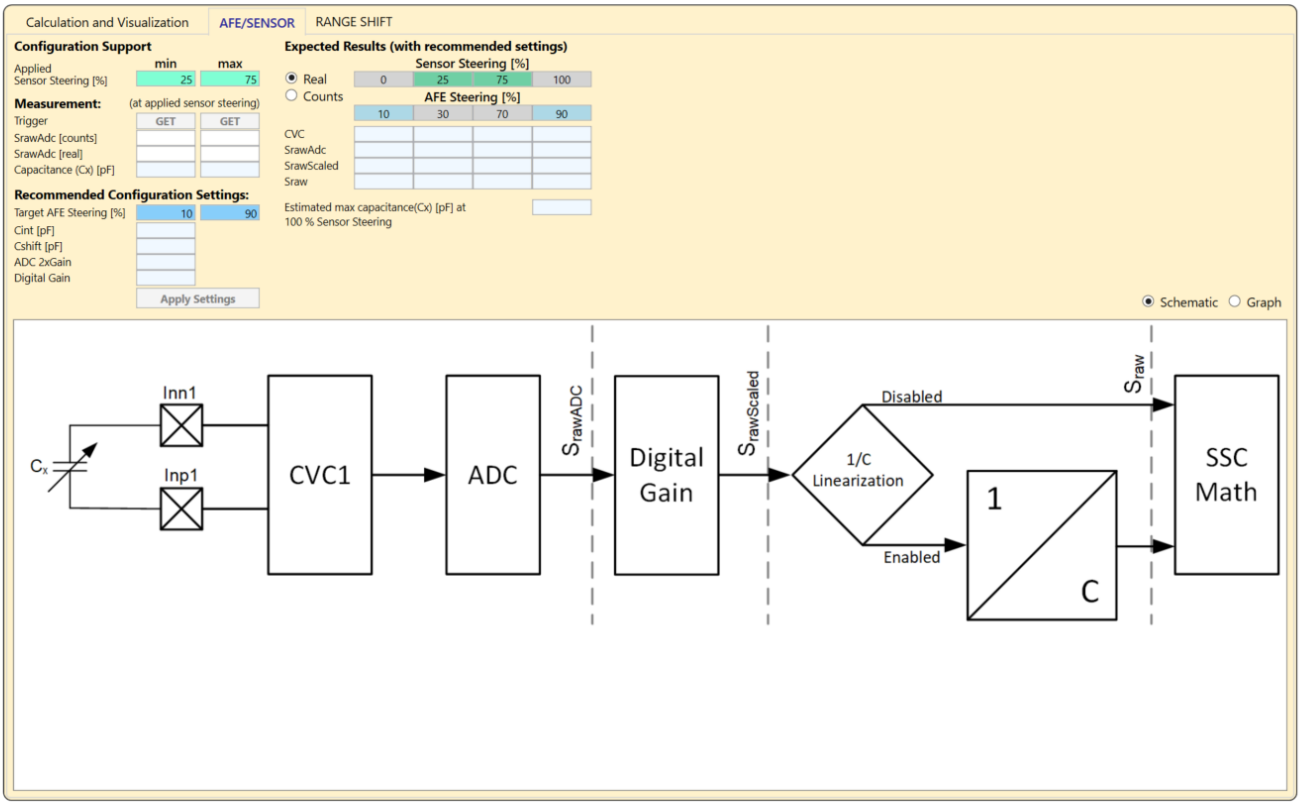



**Figure 48. Calculation and Visualization Section (Capacitive) AFE SENSOR Tab**

### Configuration Support

In the Configuration Support section, the applied sensor steering can be adjusted for performing the calculations and displaying the graphs. This section is the same for all application modes.

**Measurement**

The Measurement section will adjust depending on the selected application mode. It will display the following parameters:

- Trigger: Triggers a measurement to receive a raw measurement value from the device
- SrawAdc [counts]: Raw ADC measurement value in ADC counts
- SrawAdc [real]: Raw ADC measurement value as real number (relative, +/-1)
- SrawAdc1 [counts]: Raw ADC measurement value for CVC1 in ADC counts
- SrawAdc1 [real]: Raw ADC measurement value for CVC1 as real number (relative, +/-1)
- SrawAdc2 [counts]: Raw ADC measurement value for CVC2 in ADC counts
- SrawAdc2 [real]: Raw ADC measurement value for CVC2 as real number (relative, +/-1)
- Capacitance (Cx) [pF]: Calculated capacitance for Cx in pF
- Cap Ratio (CVCout): Calculated capacitance ratio
- Capacitance (Cx - Cy) [pF]: Calculated capacitance for Cx - Cy in pF
- Capacitance (Cr) [pF]: Calculated capacitance for Cx in pF
- Capacitance (Cy) [pF]: Calculated capacitance for Cy in pF

All SrawAdc values can be entered manually or will be entered by the GUI when clicking the respective “GET” button.

**Recommended Configuration Settings**

Based on the inputs from the Parameters section and the Configuration Support and Measurement sections, the Recommended Configuration Settings section will provide a set of recommended settings to adjust the Parameters section.

In addition to the inputs listed above, the Target AFE Steering can be adjusted in this section and affects the recommended settings.

All fields will be filled automatically when the parameters of the Measurement section are complete

The recommended configuration can be applied by clicking the “Apply Settings” button.

Depending on the selected application mode, the following settings are displayed:

- Target AFE Steering [%]: Sets the target AFE steering at full sensor steering
- Cint [pF]: Proposed optimal integration capacitance in pF
- Cshift [pF]: Proposed optimal shift capacitance in pF
- ADC 2xGain: Proposed optimal ADC gain
- Digital Gain: Proposed optimal digital gain
- Schematics and Graph

The reference schematic in Figure 48 is dynamically updated according to the Application Mode selection in the Configure Sensor section (see 3.3.1.3.1).

Select Schematic or Graph to switch the view between the reference circuit schematic or the graph (Figure 49). The Graph displays the AFE steering unipolar and bipolar over the sensor steering for target, expected and measured values.

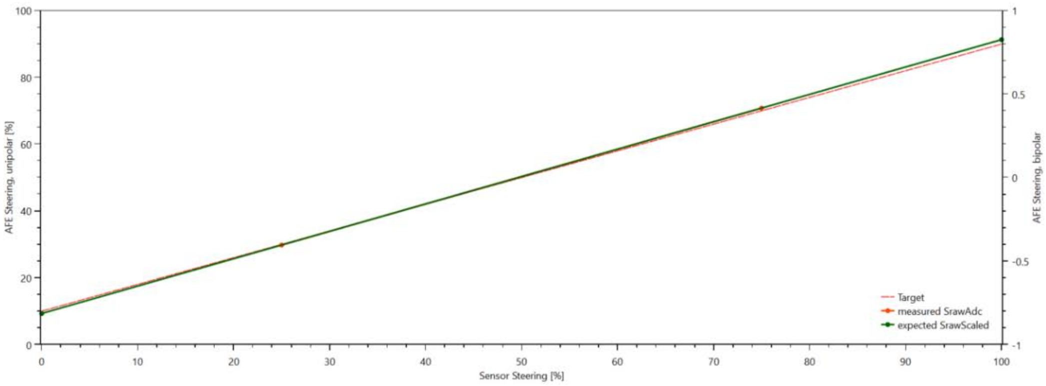



**Figure 49. Capacitive Graph Example**

### Expected Results (with recommended settings)

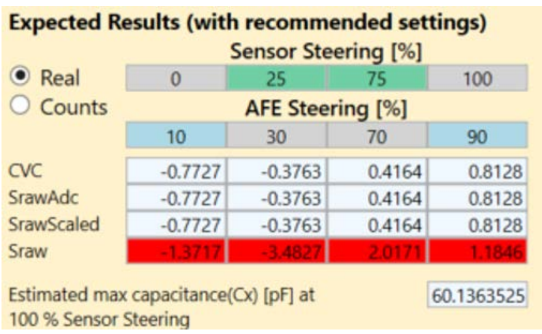
In this section, the expected results when using the recommended settings are displayed. The results can be switched between Real and Counts view.

The following values will be displayed over the chosen sensor and AFE steering:

- CVC: Expected Capacitance-to-Voltage converter output
- CVC1: Expected Capacitance-to-Voltage converter 1 output
- CVC2: Expected Capacitance-to-Voltage converter 2 output
- SrawAdc: Expected raw ADC measurement value
- SrawAdc1: Expected raw ADC measurement value for CVC1
- SrawAdc2: Expected raw ADC measurement value for CVC 2
- SrawScaled: Expected raw ADC measurement value after digital gain is applied
- Sraw: Expected raw ADC measurement value after digital gain and 1/C linearization (optional) is applied
- Estimated max. capacitance [pF] at 100% Sensor Steering

If any of the expected results are out of range, the respective values will be marked in red.

- Real values range: +/- 1.1
- Counts values range: +/- $2^{(\text{ADC Resolution-1})}$

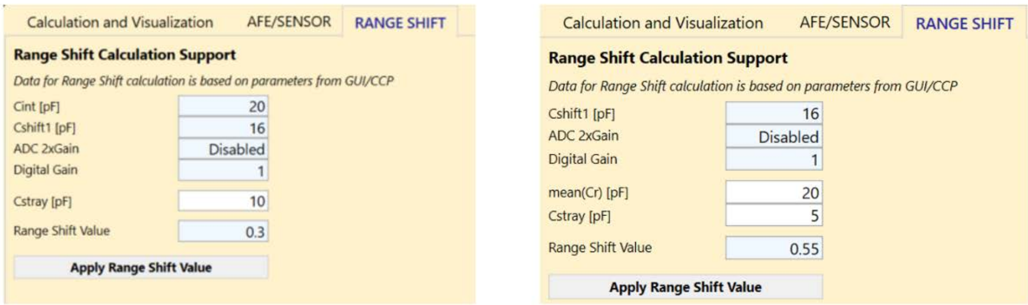


Expected Results (with recommended settings)

| | Sensor Steering [%] | | | |
|---|---|---|---|---|
| ◉ Real | 0 | 25 | 75 | 100 |
| ○ Counts | AFE Steering [%] | | | |
| | 10 | 30 | 70 | 90 |
| CVC | -0.7727 | -0.3763 | 0.4164 | 0.8128 |
| SrawAdc | -0.7727 | -0.3763 | 0.4164 | 0.8128 |
| SrawScaled | -0.7727 | -0.3763 | 0.4164 | 0.8128 |
| Sraw | -1.3717 | -3.4827 | 2.0171 | 1.1846 |
| Estimated max capacitance(Cx) [pF] at 100 % Sensor Steering | | | | 60.1363525 |

**Figure 50. Expected Results Out of Range Values**

The RANGE SHIFT tab (see Figure 51) is a supportive calculation tool to determine the range shift value that should be applied to the configuration when using the 1/C linearization or using Application Mode 11. For correct calculation it is necessary to determine the stray capacitance value (Cstray) of the sensor setup. When using Application Mode 2 or 5, also the mean value of the external reference capacitance (mean(Cr)) needs to be entered.




Application Mode 1 Application Mode 2

**Figure 51. Calculation and Visualization section (Capacitive) RANGE SHIFT tab**

The calculated Range Shift Value can be taken over into the Parameters section by clicking the Apply Range Shift Value button.

### 3.3.1.4. Temperature Tab

The Temperature tab is structured according to the following scheme:

- Only the settings in the “Parameters” section are saved in the device configuration NVM.
- Data input in the “Sensor Values” section is used for the “Internals” values calculations along with the selected “Parameters”.
- The “Meas Config” selection affects only the “Internals” calculations and the graphs display.

#### 3.3.1.4.1. Temp Configurations

Through the “Mode” drop-down list in the Parameters section, the GUI offers the following options for supplying the temperature transducer connected to the ZSSC3286 pins:

- Sink, Internal Bias: The transducer (Diode/NTC/PTC) is supplied by an internal voltage source or by an internal configurable current source tied to the VSS rail (GND) (Figure 52).

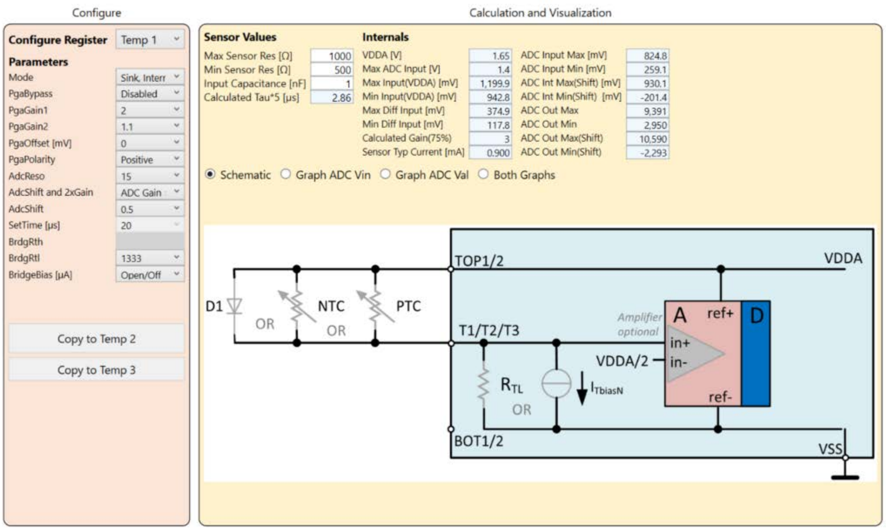



**Figure 52. Temp – Mode Sink Internal Bias**

- Source, Internal Bias: The transducer (Diode/NTC/PTC) is supplied by an internal voltage source or by an internal configurable current source tied to the VDDA rail (References item 3).

  *Note*: This mode is used in this document for description/example purposes for the Temp tab, selecting other modes returns different schematic, graphs, and parameters enabling/disabling options (Figure 53).

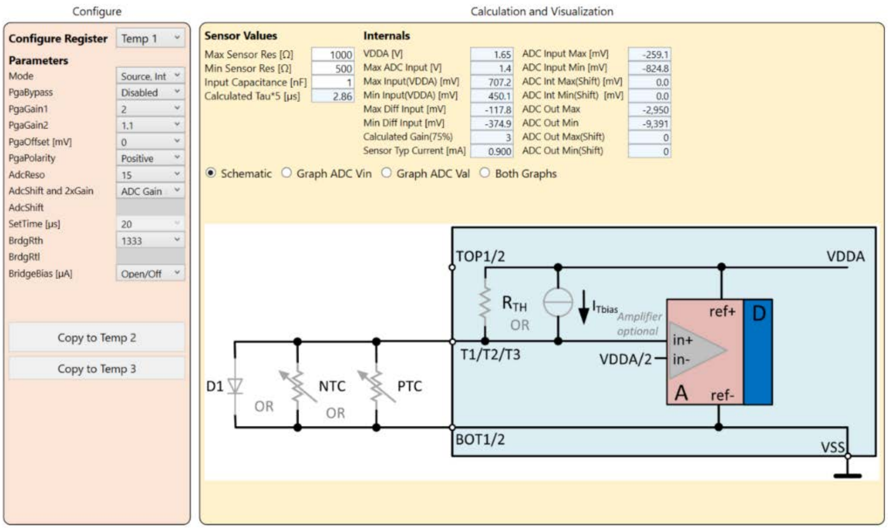



**Figure 53. Temp – Mode Source Internal Bias**

- External Bias: The transducer is supplied with a voltage source from the following possible configuration:
  - The diode/NTC/PTC transducer is supplied through an external resistor tied to VDDA (References item 3). This is active when the “External RL” (selectable in the Sensor Values section) is not set to “open” or “0” (Figure 54).

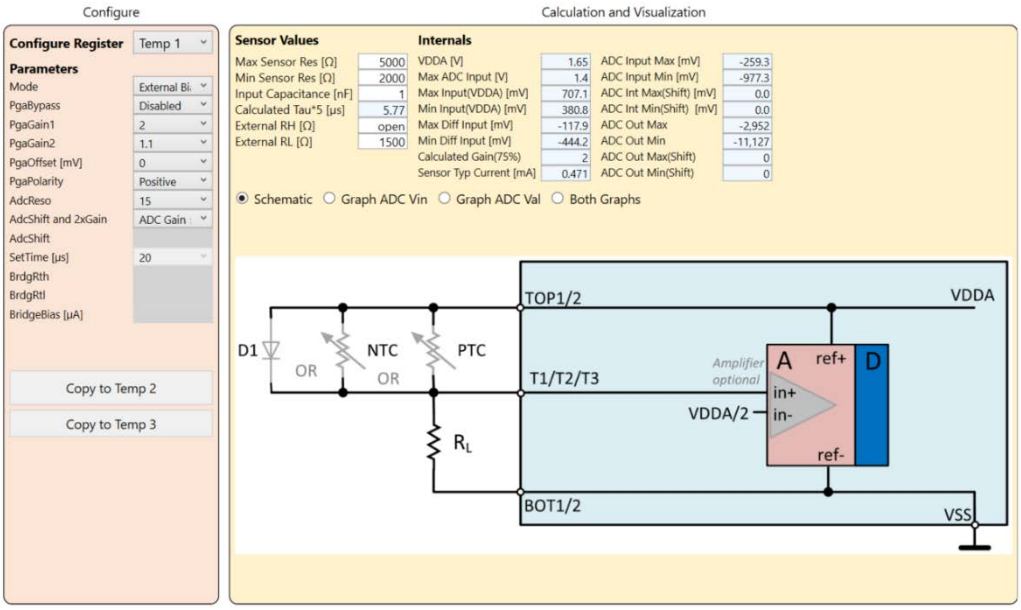



**Figure 54. Mode Source External Bias Low**

  - The diode/NTC/PTC transducer is supplied through an external resistor tied to VSS (GND) when the “External RH” (selectable in the Sensor Values section) is not set to “open” or “0” (Figure 55).

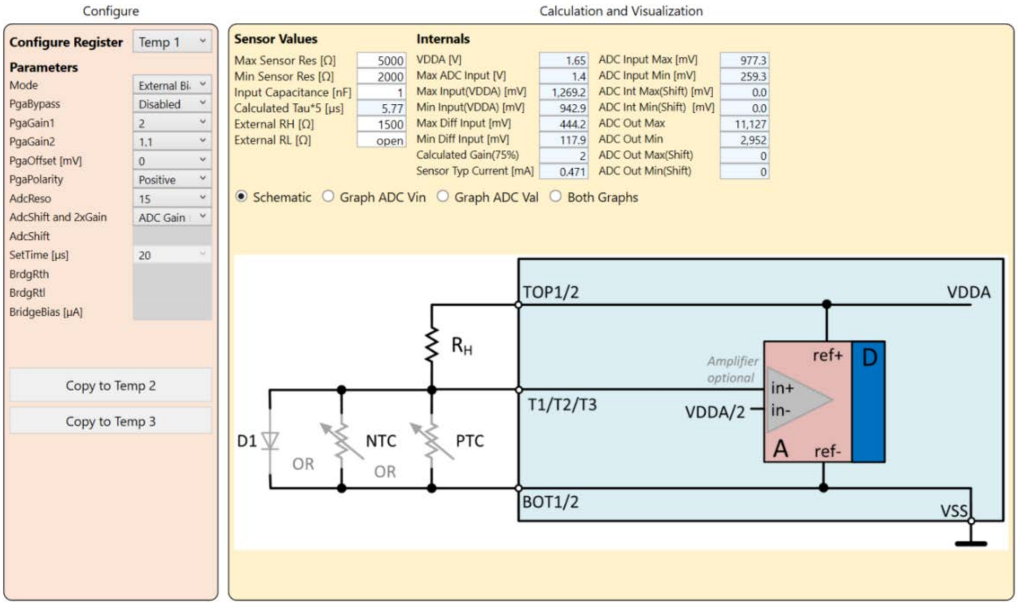



**Figure 55. Mode Source External Bias High**

To select between the options, put a non-zero value in the “External RH” or “External RL” (see Figure 56).

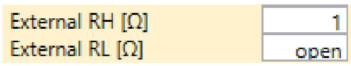



**Figure 56. External RH, RL**

- Bridge, Internal Bias: The resistive bridge (used for the main measurement) is supplied by an internal voltage source or by an internal configurable current source tied to VDDA (References item 3) (Figure 57).

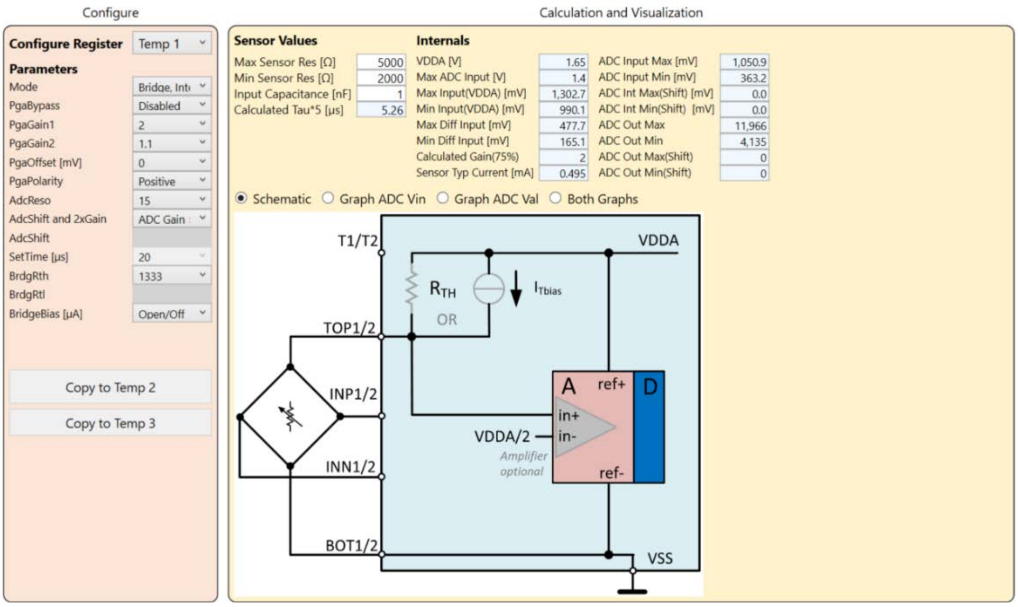



**Figure 57. Mode Bridge Internal Bias**

- Bridge, External Bias: The resistive bridge (used for the main measurement), is supplied by an internal voltage source through an external resistor (selectable by the “External RH”) (Figure 58).

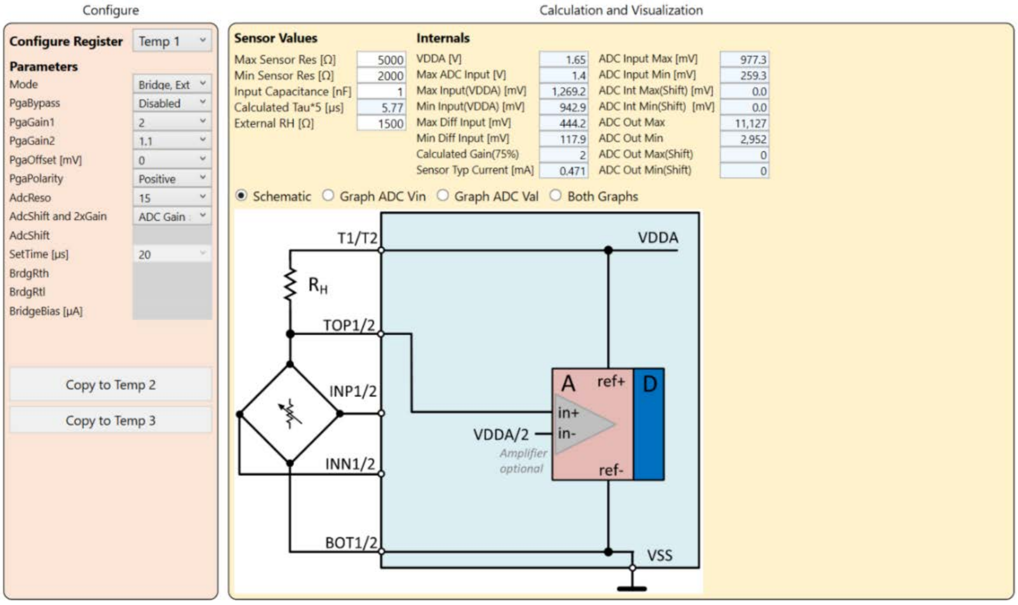



**Figure 58. Mode Bridge External Bias**

- Bridge, Differential: The resistive bridge (used for the main measurement) is supplied through an internal configurable resistor tied to VDDA (RTH) and to VSS (RTL) (Figure 59).

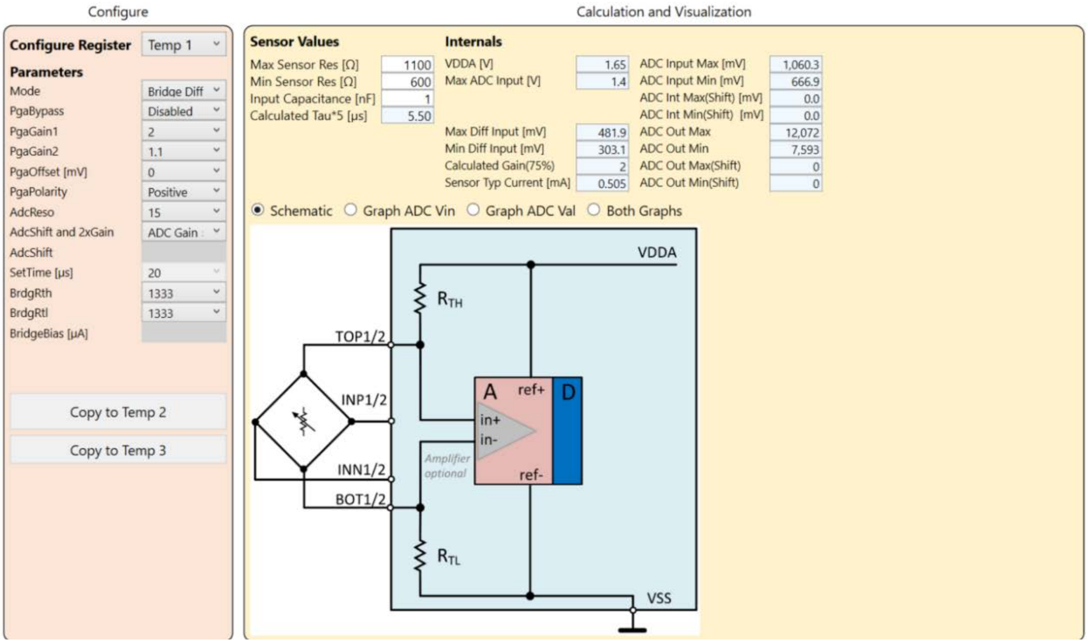



**Figure 59. Mode Bridge Differential**

### 3.3.1.4.2. Configure Register

To configure an external transducer input or the device internal temperature transducer input, select Temp1, Temp 2, Temp 3, or PTAT from the "Configure Register" drop-down list and set the relevant values in the Parameters section (Figure 60).

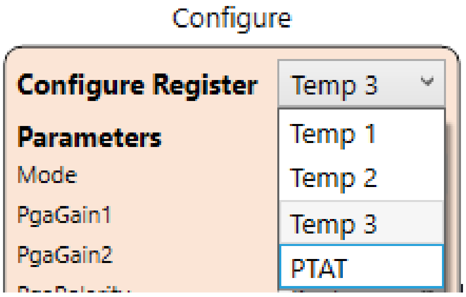



**Figure 60. Configure Register**

To duplicate an already defined configuration to another temperature sensor, click the “Copy to Temp 1/2/3“ button (Figure 61).

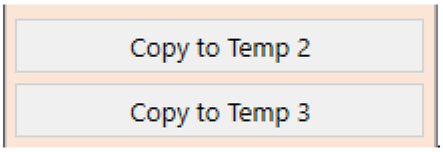



**Figure 61. Copy to Temp**

### 3.3.1.4.3. Sensor Values

This section (Figure 62) allows the user to enter the input transducer characteristics for performing the calculations displayed in Figure 65.

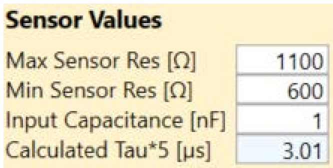



**Figure 62. Temp– Sensor Values**

The GUI calculates the Tau (Resistance x Capacitance) according to the inputs provided.

### 3.3.1.4.4. Parameters

The “Parameters” section (see Figure 63) defines the type of the transducer supply, the behavior of the analog signal path, and the ADC configuration. Specific parameters values enable or disable the availability of a set of additional parameters and the relevant list of available values.

The reference schematic in Figure 64 is dynamically updated according to the “Mode” selection, see section 3.3.1.4.1 for details on different modes.

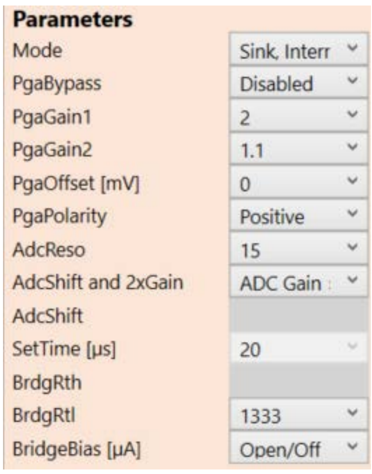



**Figure 63. Parameters**

The following parameters can be set:

- Mode: defines the type of supply scheme of the connected transducer (section 3.3.1.4.1)
- PgaBypass: defines if the external temperature sensor is connected to the PGA (disabled) or ADC (enabled)
- PgaGain1: PGA gain stage 1 value
- PgaGain2: PGA gain stage 2 value
- PgaPolarity: Polarity inversion of the PGA input signal
- PgaOffset [mv]: PGA offset value (in mV)
- AdcReso: ADC resolution
- AdcShift and 2xGain: enables/disables the internal ADC 2x gain and internal ADC offset shift
- AdcShift: ADC offset shift value
- SetTime [µs]: Bridge settling time (µs)
- BrdgRth: internal bridge resistor value (Ohm) upper side (RTH), this field is greyed out in the example configuration)
- BrdgRtl: internal bridge resistor value (Ohm) lower side (RTL)
- BridgeBias [µA]: current level of transducer current driver (ITbias)

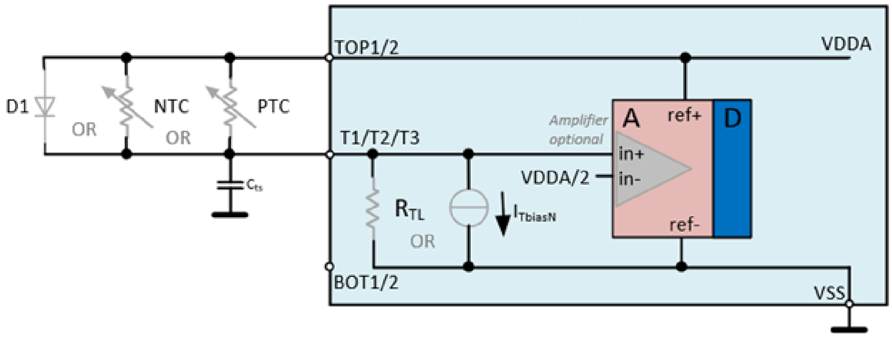



**Figure 64. Temp – Schematic**

### 3.3.1.4.5. Internals

The Internals section (Figure 65) displays values of specific electrical parameters that are built into the device and shows the calculated parameters depending on the values set as per sections 3.3.1.4.1, 3.3.1.4.2, 3.3.1.4.3 and 3.3.1.4.4.

**Internals**

| | | | |
|---|---|---|---|
| VDDA [V] | 1.65 | ADC Input Max [mV] | 688.3 |
| Max ADC Input [V] | 1.4 | ADC Input Min [mV] | 173.8 |
| Max Input(VDDA) [mV] | 1,137.8 | ADC Int Max(Shift) [mV] | 0.0 |
| Min Input(VDDA) [mV] | 904.0 | ADC Int Min(Shift) [mV] | 0.0 |
| Max Diff Input [mV] | 312.8 | ADC Out Max | 7,836 |
| Min Diff Input [mV] | 79.0 | ADC Out Min | 1,979 |
| Calculated Gain(75%) | 3 | ADC Out Max(Shift) | 0 |
| Sensor Typ Current [mA] | 0.854 | ADC Out Min(Shift) | 0 |

**Figure 65. Internals**

The following values are displayed:

- VDDA: analog supply typical level (silicon defined)
- Max ADC Input [V]: the maximum ADC input level (silicon defined)
- Max Input(VDDA) [mV]: maximum input pin level (referred to VDDA) in mV
- Min Input(VDDA) [mV]: minimum input pin level (referred to VDDA) in mV
- Max Diff Input [mV]: maximum differential input (in mV) at input pins

- Min Diff Input [mV]: minimum differential input (in mV) at input pins
- Calculated Gain(75%): suggested Gain setting to reach 75% FS
- Sensor Typ Current [mA]: typical current on transducer element (mA)
- ADC Input Max [mV]: ADC maximum input (input multiplied by Gain)
- ADC Input Min [mV]: ADC minimum input (input multiplied by Gain)
- ADC Int Max(Shift) [mV]: ADC maximum input (input multiplied by Gain and including shift)
- ADC Int Min(Shift) [mV]: ADC minimum input (input multiplied by Gain and including shift)
- ADC Out Max: ADC maximum output (counts)
- ADC Out Min: ADC minimum output (counts)
- ADC Out Max(Shift): ADC maximum output with ADC internal shift and 2x gain (counts)
- ADC Out Min(Shift): ADC minimum output with ADC internal shift and 2x gain (counts)

Out of range parameters or input values are highlighted in red (Figure 66).

**Internals**

| | | | |
|---|---|---|---|
| VDDA [V] | 1.65 | ADC Input Max [mV] | 1,683.8 |
| Max ADC Input [V] | 1.4 | ADC Input Min [mV] | 173.8 |
| Max Input(VDDA) [mV] | 1,590.3 | ADC Int Max(Shift) [mV] | 0.0 |
| Min Input(VDDA) [mV] | 904.0 | ADC Int Min(Shift) [mV] | 0.0 |
| Max Diff Input [mV] | 765.3 | ADC Out Max | 19,171 |
| Min Diff Input [mV] | 79.0 | ADC Out Min | 1,979 |
| Calculated Gain(75%) | 1 | ADC Out Max(Shift) | 0 |
| Sensor Typ Current [mA] | 1.193 | ADC Out Min(Shift) | 0 |

**Figure 66. Internals Out of Range**

#### 3.3.1.4.6. Schematic and Graphs

Select Schematic, Graph ADC Vin, Graph ADC Val, or Both Graphs (Figure 67) to switch view among the reference circuit schematic, the input to ADC Voltage transfer characteristic graph, the ADC input voltage to ADC counts transfer characteristic, and a combined view of both graphs (Figure 68).

○ Schematic ○ Graph ADC Vin ○ Graph ADC Val ◉ Both Graphs

**Figure 67. Schematic and Graphs Selection**

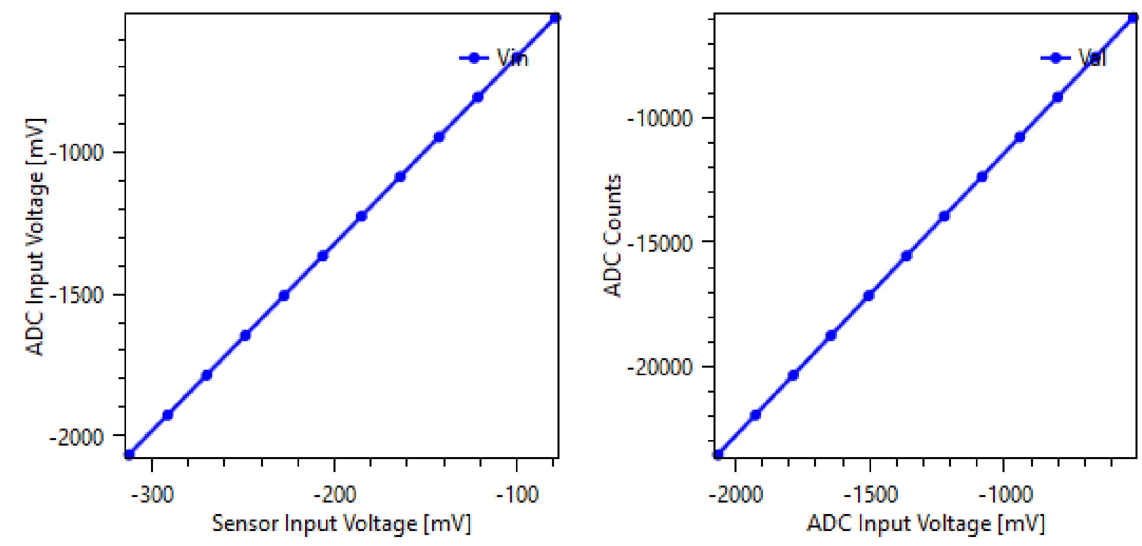



**Figure 68. Combined Graphs**

#### 3.3.1.4.7. Configuration of the Kit for SRB Pt1000 reading

TCh1 is preconfigured to allow the use of the Pt1000 present on the SRB as temperature transducer (Figure 69).

Ensure the following hardware settings are in place: ZSSC3286 EVB J7 and J8 placed; SRB SW1 in the left position.

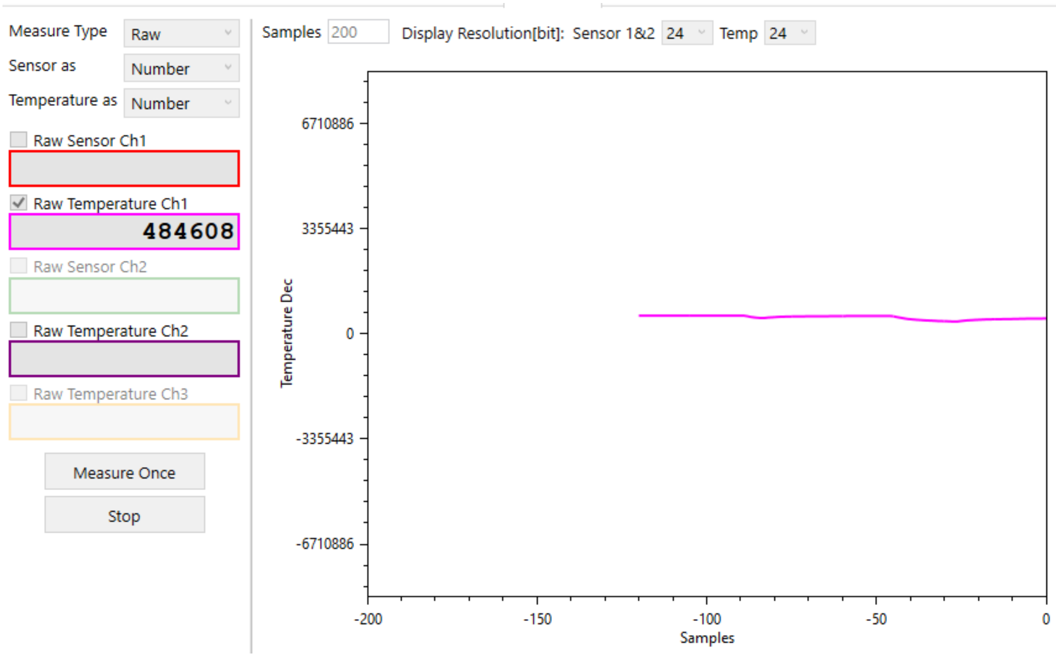



**Figure 69. Pt1000 Measurements**

For actual temperature measurement, Tch1 requires calibration (the default calibration coefficients are set to “0”, except for “TGain” being set to “1”).

### 3.3.2. TLC Tab

The Third Logic Channel (Figure 38) allows the processing of conditioned data from Sensor Channel 1 and Sensor Channel 2 according to the operation displayed in Figure 70.

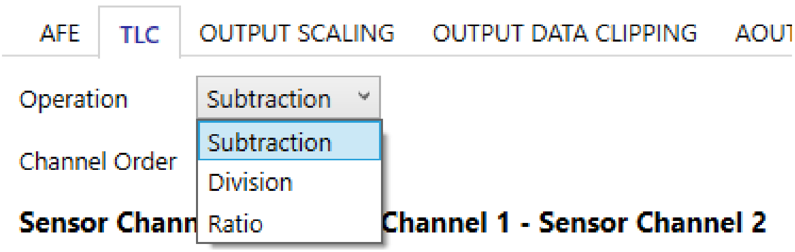



**Figure 70. Third Logic Channel Operations**

Select “Subtraction” or “Division” from the “Operation” drop-down list (Figure 70), and “CH1 op CH2” or “CH2 op CH1” from the “Channel Order” drop-down list (Figure 71).

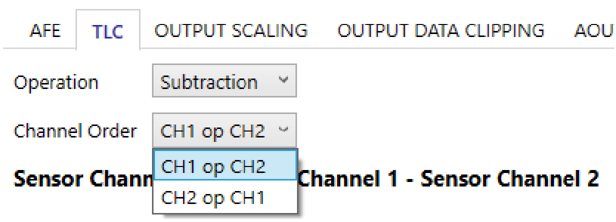



**Figure 71. Third Logic Channel – Channel Order**

The Third logic channel provides the user conditioned data only as there is no physical AFE associated with it. The relevant measurements are displayed in the Measure tab described in section 3.7.

Data provided by the ZSSC3286 is 4 bytes long so that the result of the division between the 2 sensor channels can be properly displayed.

The Third logic channel supports the following mathematical operations:

- Subtraction

  The TLC supports *subtraction* operation ch3 = ch1 – ch2.

  The TLC supports *subtraction* operation ch3 = ch2 – ch1.

- Division

  The TLC supports *division* operation ch3 = ch1 / ch2.

  The TLC supports *division* operation ch3 = ch2 / ch1.

  A division by zero or small number is handled as a math saturation.

- Ratio

  The TLC supports *ratio* operation, which is defined as following (pseudo code):

```
IF ch1 == ch2 THEN
      ch3 = 1
ELSE IF ch1 < ch2 THEN
      ch3 = ch1 / ch2
ELSE
     ch3 = 2 – (ch2 / ch1)
```

### 3.3.3. Output Scaling Tab

The output scaling functionality allows the linear re-scaling of a reduced input range to the full input range. The functionality is useful when the input range is reduced but changing the AFE settings or performing a new calibration to reach the full output range is not an option.

The functionality is available for the 2 main sensor channels (1 and 2) but not for the remaining channels (T1/2/3 and CH3).

The output scaling functionality acts downstream when the input is conditioned by the SSC math (section 3.3.1.2.1) and upstream when the application of the (IIR) has filtering function (section 3.3.6).

The Output scaling tab is displayed in Figure 72.

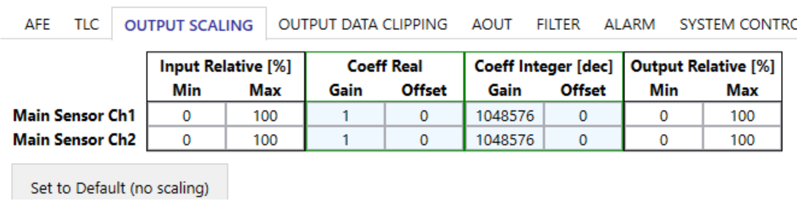



**Figure 72. Output Scaling**

The “Input Relative [%]” and “Output Relative [%]” fields are editable. The GUI calculates the “Offset” and “Gain” coefficients.

Click the “Set to Default (no scaling)” button to have the default input/output values (see Figure 73).

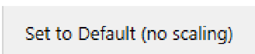



**Figure 73. Back to Defaults**

### Output Scaling Example

For this example, it is assumed that the actual input is returning an output swing from 50% to 100% of the full scale (Figure 74).

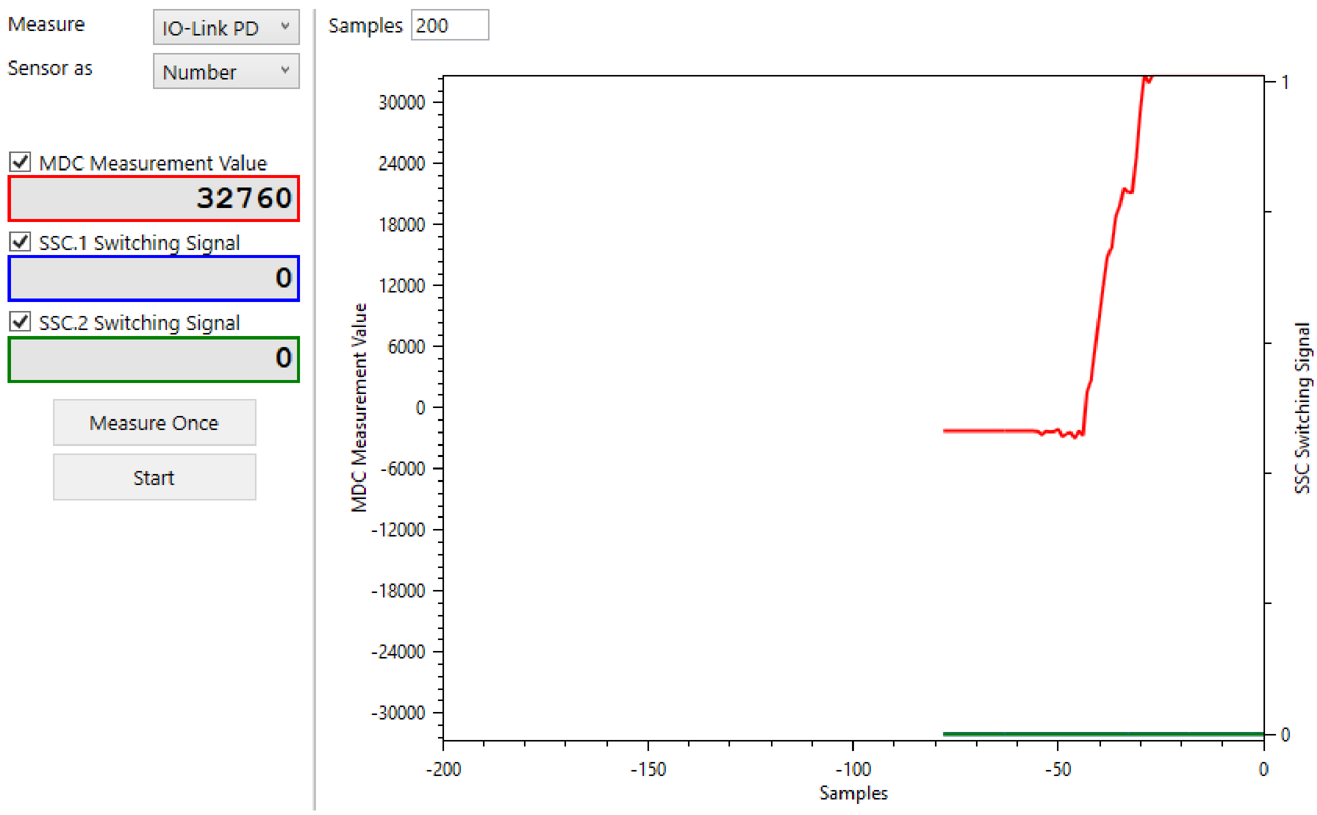



**Figure 74. 50% to 100% Output**

In the example, main sensor Ch1 must return as full-scale output without changing calibration, AFE setup or SSP Scaling, only using the Output scaling. The current full-scale signal (%) and the output desired full-scale signal (%) input is set (Figure 75).

| | Input Relative [%] | | Coeff Real | | Coeff Integer [dec] | | Output Relative [%] | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Gain | Offset | Gain | Offset | Min | Max |
| Main Sensor Ch1 | 50 | 100 | 2 | -1 | 2097152 | -1048576 | 0 | 100 |
| Main Sensor Ch2 | 0 | 100 | 1 | 0 | 1048576 | 0 | 0 | 100 |

Set to Default (no scaling)

**Figure 75. Coefficients for 0% to 100% Output**

The GUI automatically calculates the scaling coefficients to be applied and displays them in the “Coeff Real” and “Coeff Integer [dec]” fields of Figure 75. To have the Output to operate from 0% to 100% full-scale, a memory write needs to be performed so that scaling coefficients are saved in NVM.

The measurements after applying the coefficients in Figure 75 return the expected swing as displayed in Figure 76.

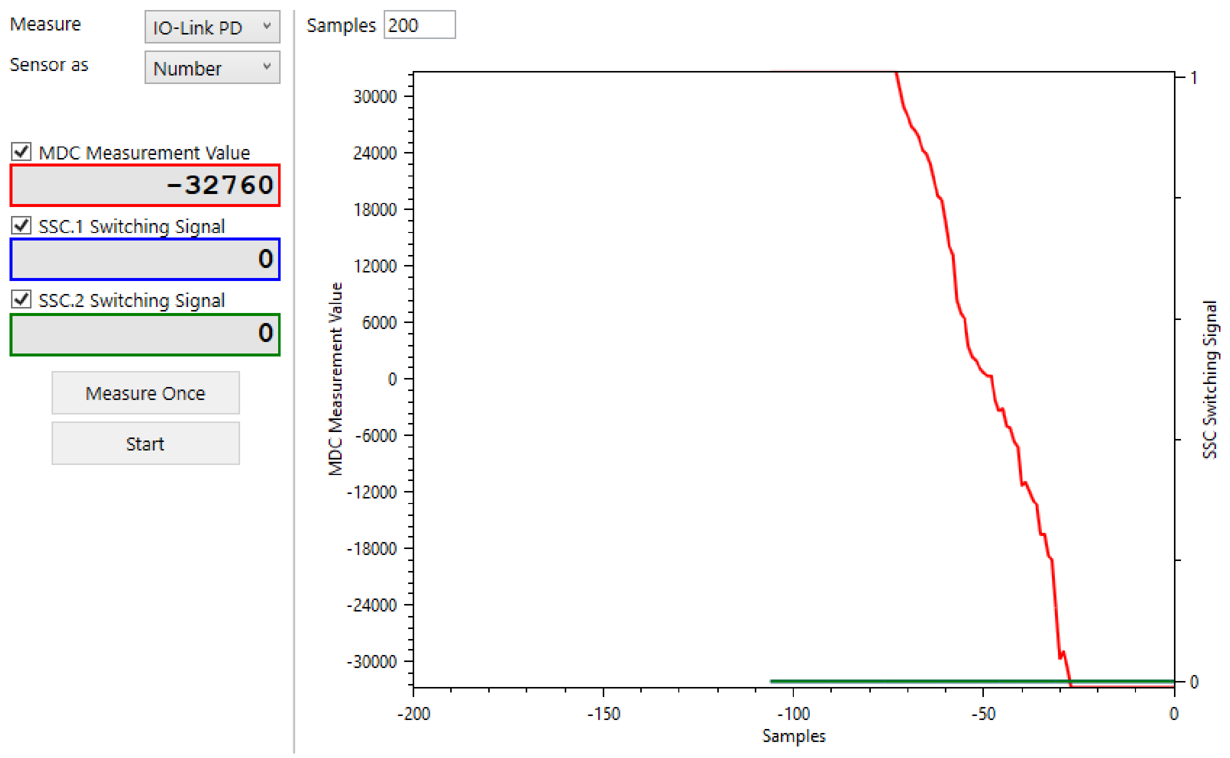



Figure 76. 0% to 100% Output (via Output Scaling)

## 3.3.4. Output Data Clipping Tab

The Output Data Clipping allows to apply a two-thresholds clipping function on the AOUT signal.

The clipping function is applied after the measured signal is corrected and not visible on the digital value for IO-Link.

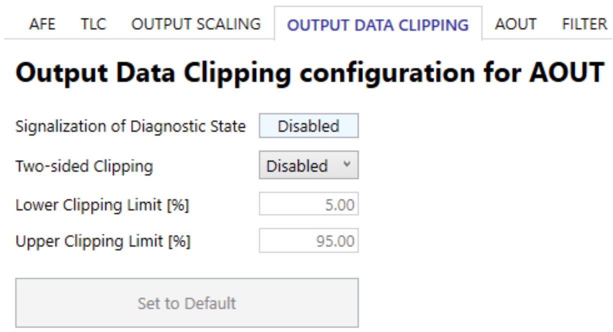



Figure 77. Output Data Clipping Default Settings

The signalization of the diagnostic state reflects the settings defined in the Diagnostic tab (section 3.5).

When the clipping is enabled, the “Lower Clipping Limit [%]” and “Upper Clipping Limit [%]” fields are editable (Figure 78).

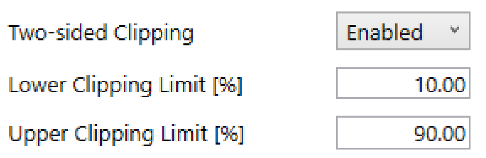



Figure 78. Clipping Limits

Store the settings in NVM via “Write Memory” to have the clipping functionality operational on measured input.

## 3.3.5. AOUT Tab

### 3.3.5.1. Output Operation Modes

Figure 79 displays the analog output options. The available options require specific ZSSC3286 EVB settings shown in Table 5. Figure 80 shows the relevant jumpers and switches on the EVB.

*Note*: If Operation Mode is other than “Disabled”, in IO-Link COM Mode, AOUT pin output is always fixed to 0V. In Bootloader Mode, AOUT pin output is floating.

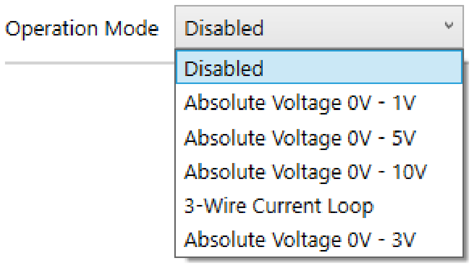



**Figure 79. AOUT – Operation Mode**

**Table 5. ZSSC3286 EVB Settings for AOUT Operation Modes**

| Jumper/ Switch | Disabled | Absolute Voltage 0V - 1V | Absolute Voltage 0V - 5V | Absolute Voltage 0V - 10V | 3-Wire Current Loop | Absolute Voltage 0V - 3V |
|---|---|---|---|---|---|---|
| J26 | open | open | CB / P10 | CB / P10 | open | open |
| J25 | n.a. | open | closed | closed | n.a. | open |
| J28 | n.a. | open | closed | closed | n.a. | open |
| J30 | n.a. | n.a. | x5 | x10 | n.a. | n.a. |
| J29 | open | open | optional | optional | open | open |
| J31 | n.a. | n.a. | optional<br>*Note*: If closed, ensure R6 (0Ω) on RH4Z2501-PMOD is set. | optional<br>*Note*: If closed, ensure R6 (0Ω) on RH4Z2501-PMOD is set. | n.a. | n.a. |
| J18 | n.a. | n.a. | open/P10 | open/P10 | PMOD / P10<br>*Note*: If closed, ensure R6 (0Ω) on RH4Z2501-PMOD is set. | n.a. |
| SW5 | n.a. | Vout | Vout | Vout | CL | Vout |
| J41: VDDN-VSSD | n.a. | as configured in GUI | as configured in GUI | as configured in GUI | closed | as configured in GUI |
| J41: AOUT-FB | n.a. | as configured in GUI | open | open | open | as configured in GUI |
| J46 | n.a. | closed | optional (if closed, GUI displays 0V - 1V output) | optional (if placed, GUI displays 0V - 1V output) | optional (if placed, GUI displays 0V - 1V output) | closed |

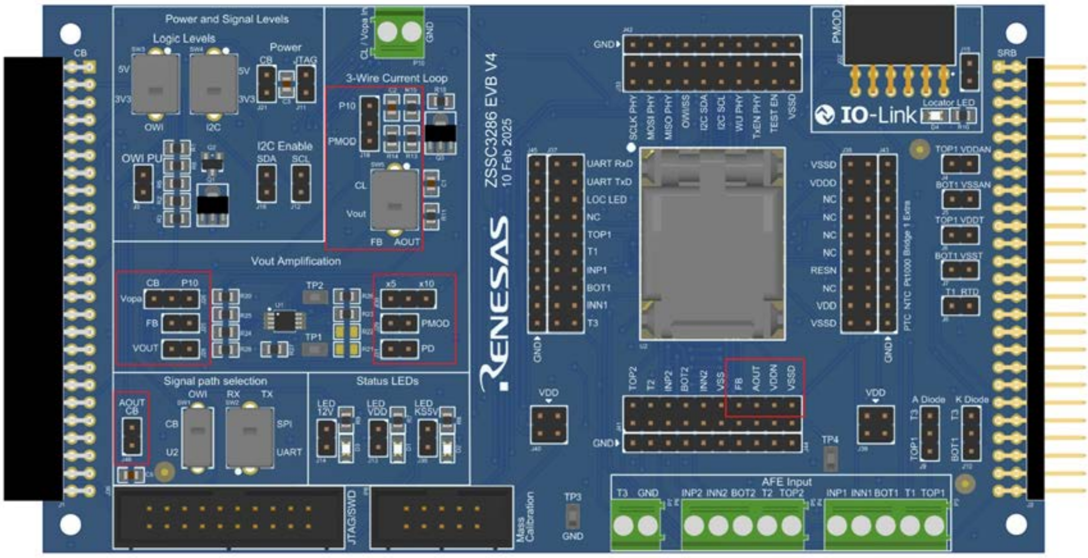


**Figure 80. Jumpers and Switches for AOUT on ZSSC3286 EVB**

### 3.3.5.1.1. Operation Mode: Disabled

In this mode, the DAC is disabled and the AOUT pin is floating.

### 3.3.5.1.2. Operation Mode: Absolute Voltage 0V–1V

See Figure 81 for the Absolute Voltage 0V–1V parameters configuration tab.

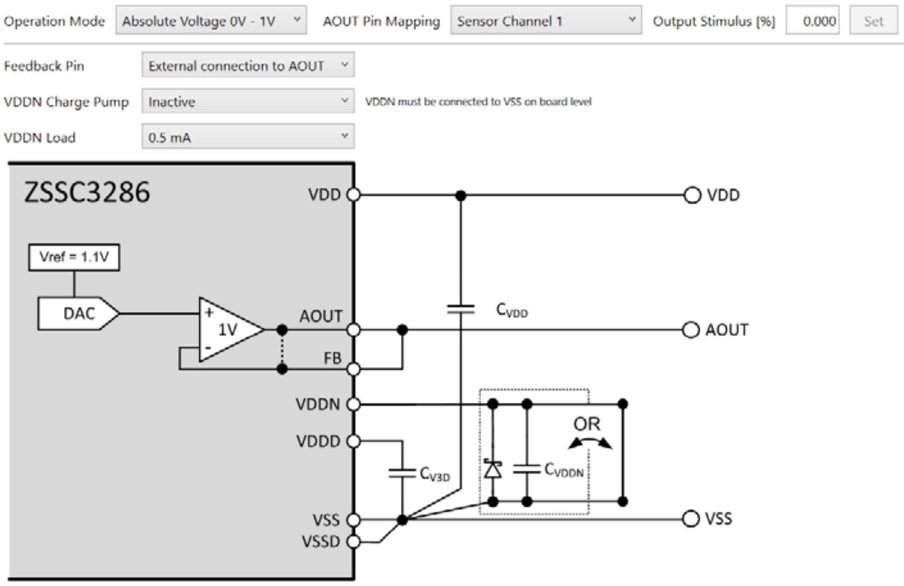



**Figure 81. Absolute Voltage 0V–1V Configuration**

**Parameters description**:

- Feedback Pin: Defines if the FB pin needs to be connected to AOUT externally, or if it is connected to AOUT internally.
- VDDN Charge Pump: To support the driving of true 0V at AOUT, an internal charge pump can be activated which generates a negative voltage of approximately -0.6V at the VDDN pin. In this application scenario the connection between VDDN and VSSD must be opened and the external capacitor CVDDN must be connected between VDDN and VSSD. Otherwise, an external short is required between VDDN and VSSD.
- VDDN Load: the maximum output drive current of the VDDN charge pump can be configured. The higher the set output drive current, the higher the quiescent current of the ZSSC3286.

AOUT output voltage can be measured by the CB in Measure tab when J16 is set.

*Note*: Before starting the measurement with the "Start" button in Measure tab, it is necessary to save configuration in NVM (by clicking the "Write Memory" button in the GUI).

#### 3.3.5.1.3. Operation Mode: Absolute Voltage 0V–5V / Absolute Voltage 0V–10V

For these modes, U1 (Operational Amplifier) is used to amplify the 0V–1V analog voltage output of the ZSSC3286 externally to either 0V–5V (x5) or to 0V–10V (x10), selectable via J30. For voltage supply of U1, either 12V from CB or an external voltage via P10 can be used, selectable via J26. If using external voltage via P10 a sufficiently high voltage level must be ensured.

The FB (Feedback) pin of the ZSSC3286 is connected to the inverting input of U1 through J25 for higher gain factor accuracy.

By closing J31, the absolute voltage output can be mapped to pin 2 (I/Q) of the IO-Link M12 connector (X1) on the RH4Z2501-PMOD board.

*Note*: When setting J31, R6 (0Ω) must be set on RH4Z2501-PMOD board.

A 10kΩ absolute voltage output load to GND can be enabled by setting J31.

See Figure 82 exemplary for the Absolute Voltage 0V–5V parameters configuration tab. Parameters are the same for Absolute Voltage 0V–10V.

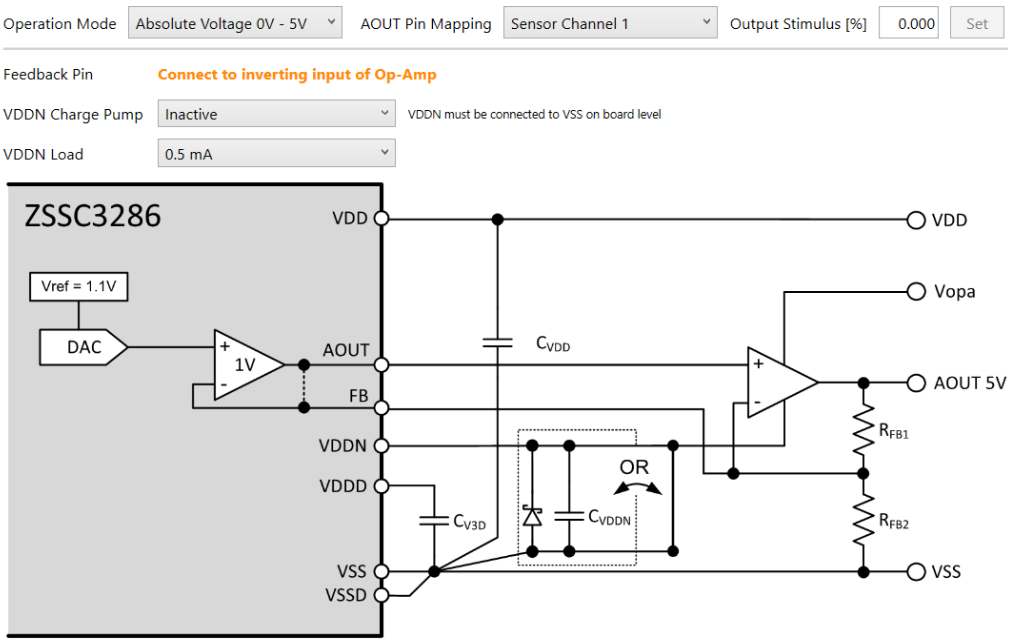



**Figure 82. Absolute Voltage 0V–5V Configuration**

**Parameters description**:

- VDDN Charge Pump: To support the driving of true 0V at AOUT, an internal charge pump can be activated which generates a negative voltage of approximately -0.6V at the VDDN pin. In this application scenario the connection between VDDN and VSSD must be opened and the external capacitor CVDDN must be connected between VDDN and VSSD. Otherwise, an external short is required between VDDN and VSSD.
- VDDN Load: the maximum output drive current of the VDDN charge pump can be configured. The higher the set output drive current, the higher the quiescent current of the ZSSC3286.

AOUT output voltage (0V–1V, before amplification) can be measured by the CB in Measure tab when J16 is set.

*Note*: Before starting the measurement with the "Start" button in Measure tab, it is necessary to save configuration in NVM by clicking the "Write Memory" button in the GUI.

### 3.3.5.1.4. Operation Mode: 3-Wire Current Loop

In 3-Wire Current Loop, AOUT is used to control an external NPN transistor as a current regulator for an externally applied voltage source (Figure 83). The ZSSC3286 EVB therefore serves as a current sink. FB pin is connected to a low side resistor in the current loop for current sensing (R18 on ZSSC3286 EVB, 43Ω).

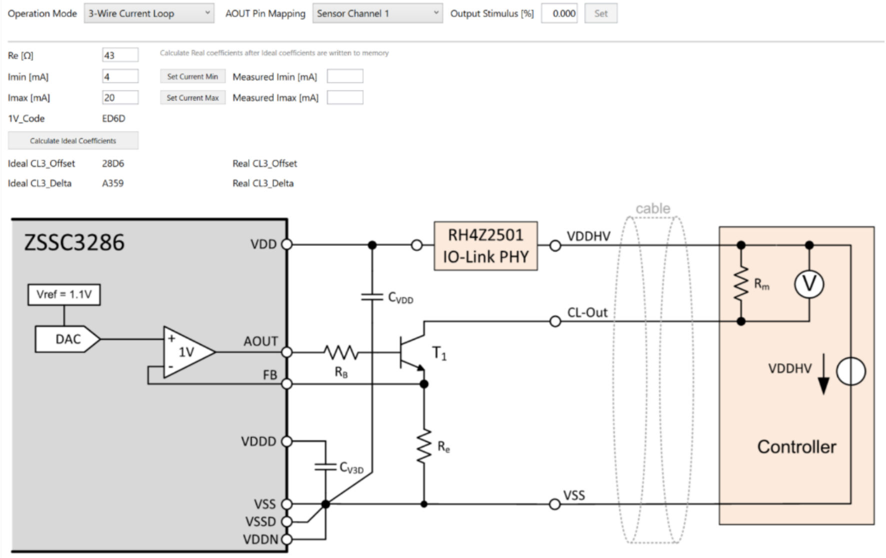



**Figure 83. 3-Wire Current Loop Configuration**

External voltage supply for the current loop can be sourced either via pin 2 (I/Q) of the IO-Link M12 connector (X1) on the RH4Z2501-PMOD board, or via P10, selectable via J18.

*Note*: R6 (0Ω) must be set on RH4Z2501-PMOD board if PMOD is used as voltage supply.

A current meter for measuring purposes can be connected between pin 2 on J18 and pin 1 (voltage supply via P10) or pin 3 (voltage supply via RH4Z2501-PMOD), thus replacing the jumper set on J18. A current limiting resistor (for example 390Ω) can optionally be used in series with the current meter.

*Note*: Before the current loop is ready to be calibrated, it is necessary to save configuration in NVM (by clicking the “Write Memory” button in the GUI main tab).

For sensor signal calibration refer to section 3.4. Follow these steps to calibrate the 3-wire current loop:

1. Set the “Re [Ω]”, “Imin [mA]”, and “Imax [mA]” values for the current loop input. “Re [Ω]” resistor on ZSSC3286 EVB is always 43Ω (R18).
2. Click the “Calculate Ideal Coefficients” button (see Figure 84).

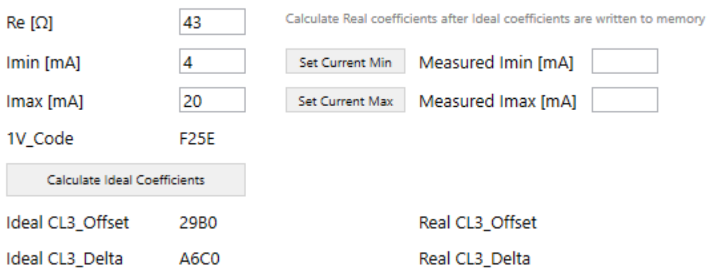



**Figure 84. 3-Wire Current Loop Calibration**

3. Click on “Write Memory”.

*Note*: “Set Current Min/Max” is not available in IO-Link COM mode.

4. Click on the “Set Current Min” button and measure the current in the loop with a current meter.
5. Input the measured value in the “Measured Imin [mA]” input field.
6. Click on the “Set Current Max” button and measure the current in the loop with a current meter.

7. Input the measured value in the "Measured Imax [mA]" input field.
   The GUI appears as displayed in Figure 85 (values are for reference only).

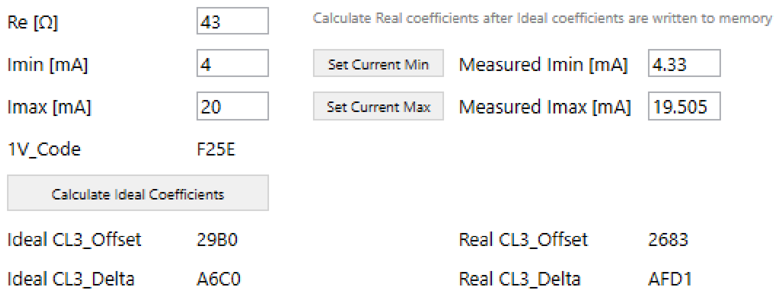



**Figure 85. 3-Wire Current Loop Calibration Measured Coefficients**

8. Click on "Write Memory".
   The current loop is calibrated and ready for measurements.

#### 3.3.5.1.5. Operation Mode: Absolute Voltage 0V–V

See Figure 86 for the Absolute Voltage 0V–3V parameters configuration tab.

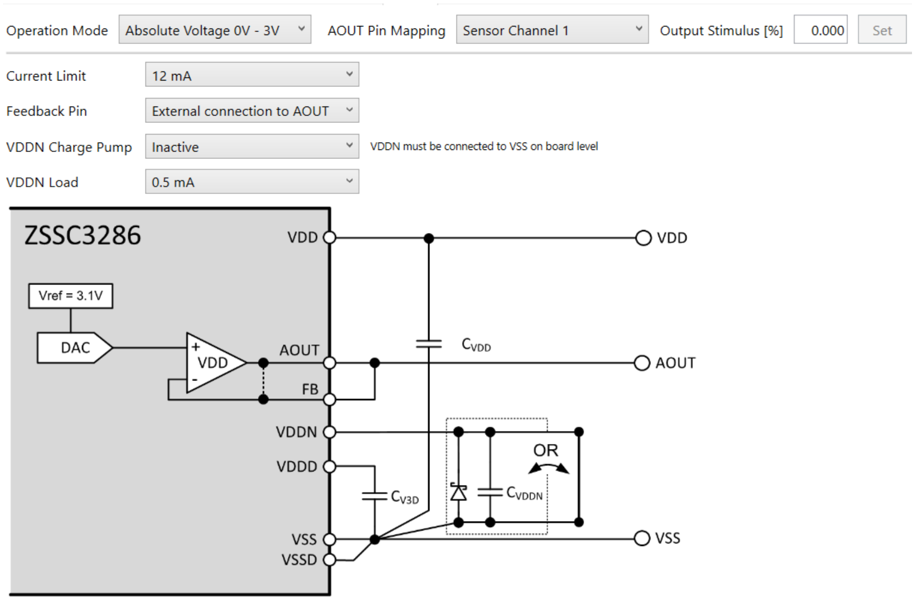



**Figure 86. Absolute Voltage 0V–3V Configuration**

**Parameters description**:

- Current Limit: Defines short circuit output current limitation of AOUT buffer. Typical current limit is selectable.
- Feedback Pin: Defines if the FB pin needs to be connected to AOUT externally or internally.
- VDDN Charge Pump: To support the driving of true 0V at AOUT, an internal charge pump can be activated which generates a negative voltage of approximately -0.6V at the VDDN pin. In this application scenario the connection between VDDN and VSSD must be opened and the external capacitor CVDDN must be connected between VDDN and VSSD. Otherwise, an external short is required between VDDN and VSSD.
- VDDN Load: the maximum output drive current of the VDDN charge pump can be configured. The higher the set output drive current, the higher the quiescent current of the ZSSC3286.

AOUT output voltage can be measured by the CB in Measure tab when J16 is set.

*Note*: Before starting the measurement with the "Start" button in Measure tab, it is necessary to save configuration in NVM (by clicking the "Write Memory" button in the GUI).

#### 3.3.5.2. Channel Mapping

The AOUT pin can provide the analog output from different channels, select it from the AOUT Pin Mapping drop-down list (see Figure 87).

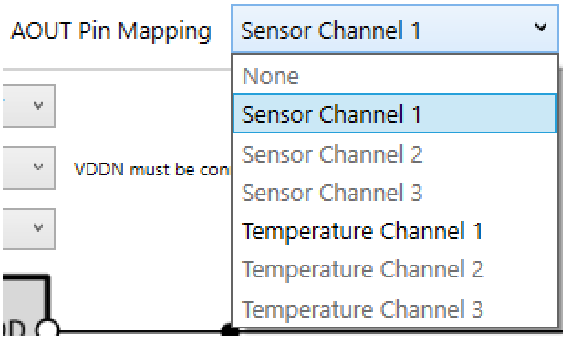



**Figure 87. AOUT Pin Mapping**

#### 3.3.5.3. AOUT Output Stimulus

The AOUT can be directly driven with a fixed output level by entering the value to the Output Stimulus [%] field and clicking the ‘Set’ button (see Figure 88).

*Note*: Output Stimulus is not functional in IO-Link COM mode.

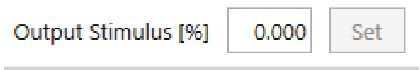



**Figure 88. AOUT Output Stimulus**

### 3.3.6. Filter Tab

The filter can be employed for each conditioned sensor signal in Cyclic Mode only. The location of the filter function in the processing path is highlighted in Figure 38. The purpose of the filter is noise reduction (low pass filter). The main capability of the IIR filter is to allow a compromise between noise reduction and response time.

*Note*: The step response gradually approaches the actual step value following an exponential like behavior.

The Filter tab is displayed in Figure 89.

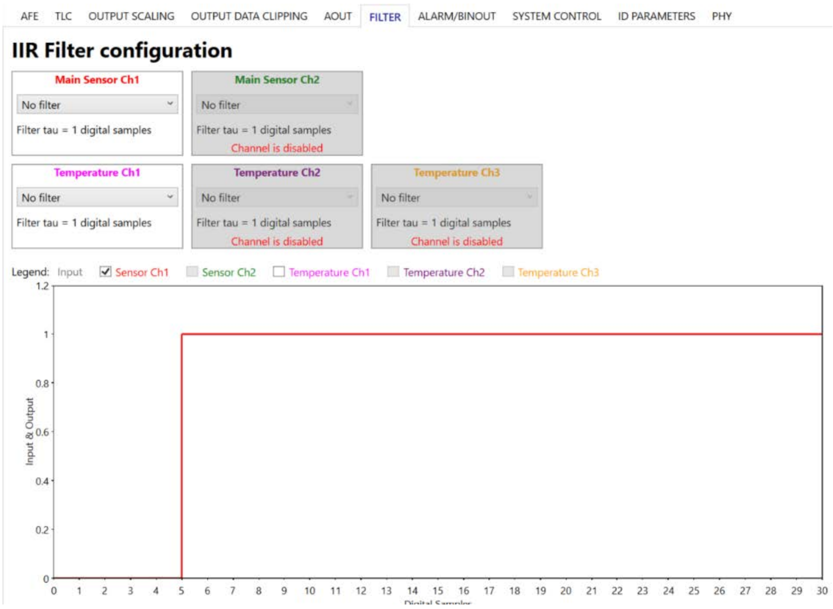



**Figure 89. Filter Tab**

The filter function applied to each of the channels displayed in Figure 89 is identical. The list of values displayed in Figure 90 allows the selection of the time constant (tau) of the filter, expressed in units of digital samples.

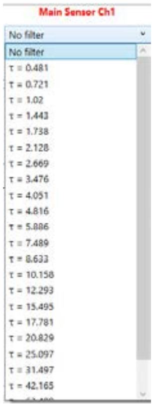



**Figure 90. Filter Time Constant Setting**

Filter behavior at the event of an input step is displayed in Figure 91 with a filter tau value of 4.051 (abscissa represents time in terms of digital samples).

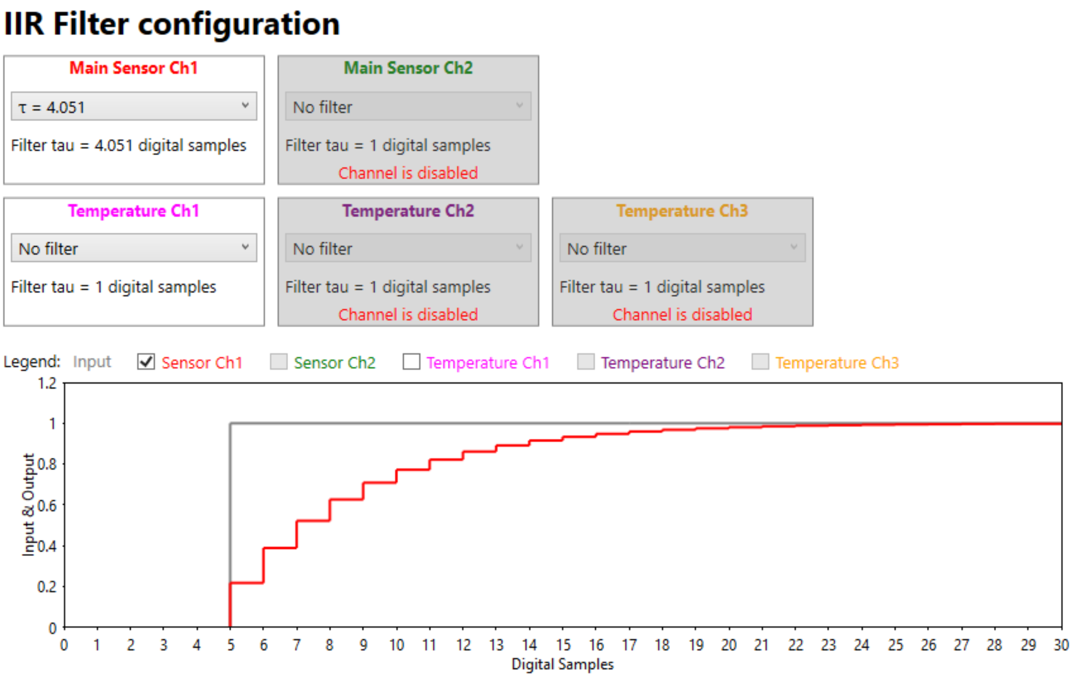



**Figure 91. Filter Response (Digital Domain)**

To calculate the actual time needed for filter settling, measure the data rate of the output first (that is dependent on the selected resolution and the sequencer configuration). At 5 times the filter constant “tau”, 99.3% of steady step response signal are reached. Dividing the number of samples corresponding to 5 times “tau” by the data rate gives the result for the filter settling time.

*Note*: Before the filter function becomes operational, it is necessary to execute a “Write Memory” command to save the time constant in NVM.

*Note*: The filter configuration functionality is not available when operating the Step Response Mode (section 3.3.1.1.2).

### 3.3.7. Alarm/Binout Tab

When Alarm function is enabled, ZSSC3286 outputs a binary signal on UART TxD pin which propagates to the C/Q line of the IO-Link interface in SIO Mode. Any Sensor Switching Signal from IO-Link COM Mode can be mapped as a signal source for Alarm function.

When Binary Output function is enabled, ZSSC3286 outputs a binary signal on GPIO15 pin in IO-Link communication mode and in SIO Mode. Any Sensor Switching Signal from IO-Link COM Mode can be mapped as a signal source for Alarm function.

Sensor Switching Signal configuration is described in section 3.6.3.

Figure 92 shows the options for signal selection for Alarm and Binary Output function.


**Figure 92. Alarm / Binary Output Configuration Options**

- Alarm in SIO mode / Binary Output: Enables/Disables the respective feature.
- Binary Output Mode: Allows to choose in which mode the binary output is used (IO-Link COM, SIO only or IO-Link and SIO)
- Sensor Switching Signal: Allows to choose one of the two available Sensor Switching Signals of SSP 4.1.1.
- Signal Inversion: Allows to invert the Alarm / Binary Output signal. If disabled, the Sensor Switching Signal is output directly without inversion. If enabled, inversion is done before signal output.

### 3.3.8. System Control Tab

This tab gives access to Main Operation Mode control (Figure 93).


**Figure 93. System Control Tab**

The “System Startup” drop-down list allows to define the active Operation Mode (References item 3) at system startup. The selection is active after writing to NVM, see Figure 94. When connecting to a device, the GUI always enters Command Mode for memory read.

In the “CCP Password” field, the CCP Password of the current device can be set. CCP Password can be displayed in hex or decimal format by clicking on the button on the left side on the CCP Password entry field. The “Firmware Password” can be set in the respective field, consisting of maximum 16 characters. (Figure 95)

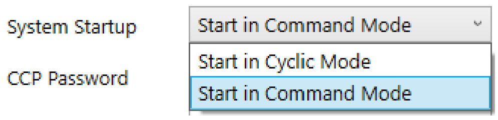



**Figure 94. System Startup**

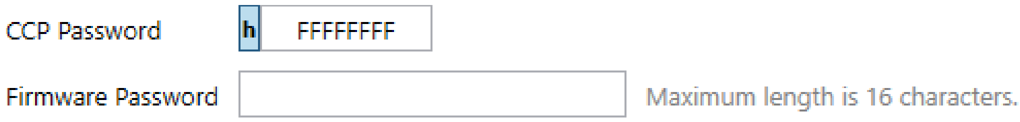



**Figure 95. CCP Password and Firmware Password**

### 3.3.9. ID Parameters Tab

Identification (ID) Parameters are used for device identification via IO-Link. The parameters are stored in NVM and are readable via IO-Link ISDUs.

In this tab, the ID parameters can be set (Figure 96). The currently used parameter length for parameters of data type String is indicated ("Length:") as well as the maximum possible Length of the parameter ("Max:") right next to the corresponding field. See References item 3 for details on ID Parameter description and implementation.

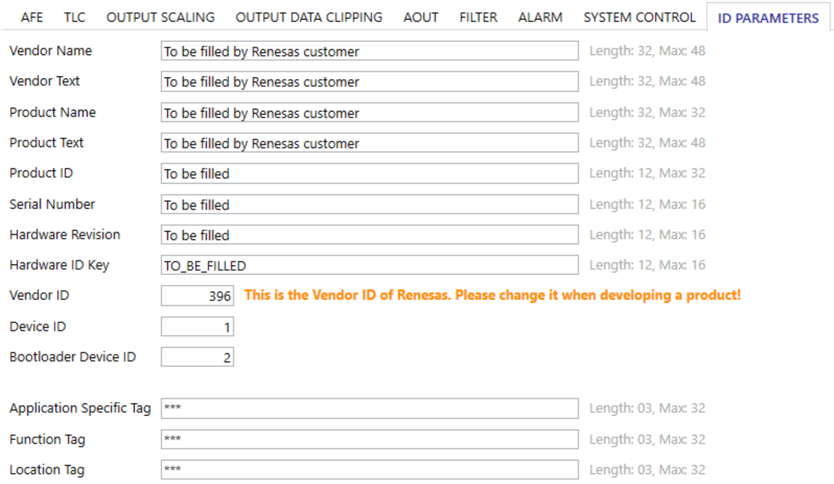



**Figure 96. Identification Parameters**

### 3.3.10. PHY Tab

This tab allows to control register settings of the RH4Z2501 IO-Link PHY placed on the RH4Z2501-PMOD board (Figure 97).

*Note*: For further information on RH4Z2501 registers, see References item 4.

In the "PHY Select" combo box, the RH4Z2501 can be selected to write the registers of a connected RH4Z2501 PHY from Renesas. If no PHY configuration is needed, for example when using a different PHY, the option "OWI Disabled" can be selected, which disables OWI output.

The individual registers whose control is supported by ZSSC3286 can be selected in "PHY Register" combo box. The respective bit field functions for the selected register are shown in the area below the "PHY Register" combo box. Each function has a dedicated combo box that lists all available options for the bit field. The default option of each bit field is bold.

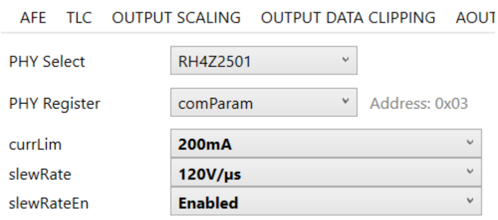



**Figure 97. PHY Configuration Tab**

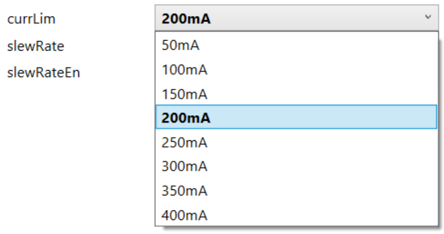



**Figure 98. Bit Field Options**

## 3.4 Calibration Tab

The Calibration tab (Figure 99) allows acquiring raw data and calculating the coefficients needed for signal linearization and temperature compensation.

Refer to the information provided in section 3.3.1.2 for mapping a Temperature transducer to a specific main sensor and its relevant signal processing.

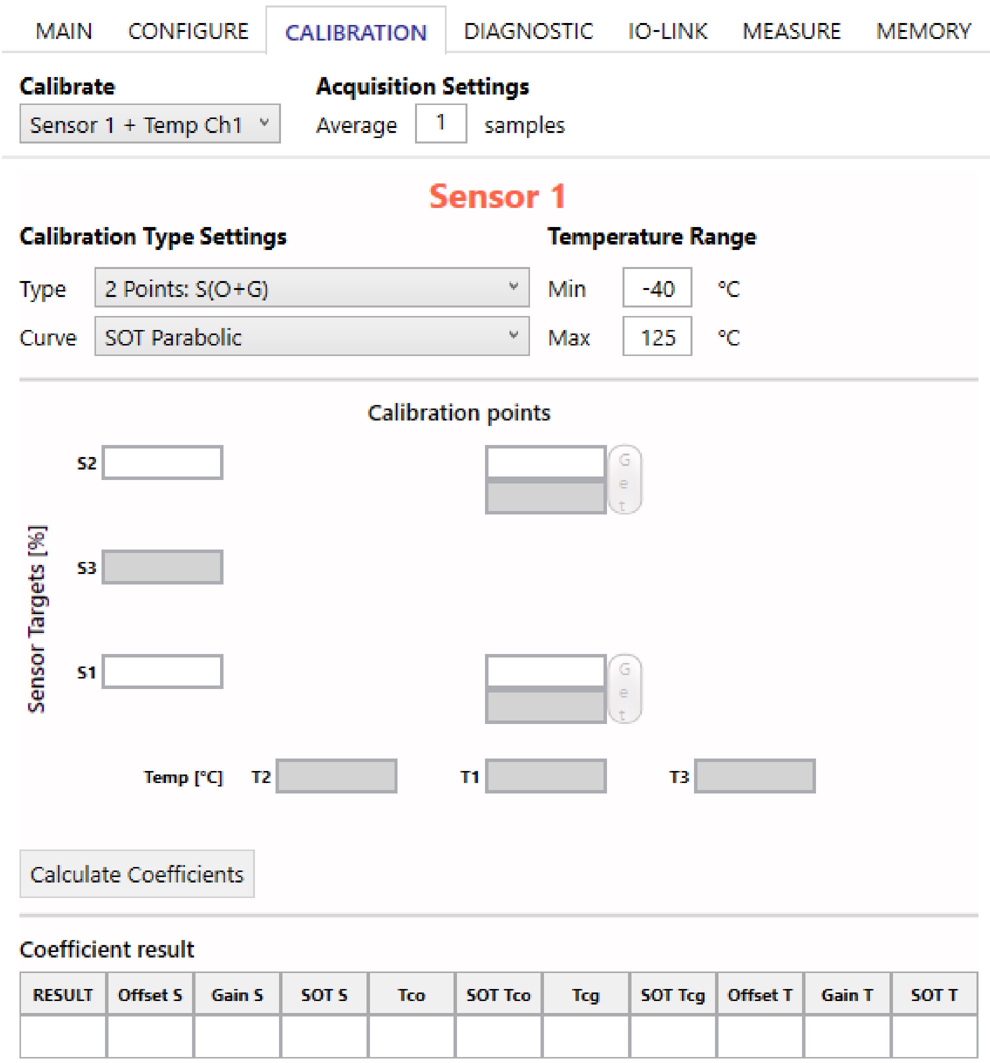



**Figure 99. Calibration Tab**

### 3.4.1. Sensor Selection and Acquisition Settings

Select Sensor 1/2 (and relevant Temperature Ch1/2) or Temperature Ch3 from the “Calibrate” drop-down menu. For each calibration point, the specified number of samples is averaged to remove ripple, selectable in the “Acquisition Settings” field (Figure 100).

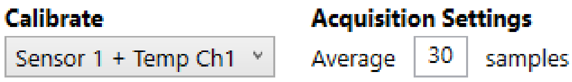



**Figure 100. Sensor, Acquisition**

## 3.4.2. Calibration Type Settings

The settings available in this area of the Calibration tab define the features of the calibration that are finalized with the data collection at the chosen calibration points.

### 3.4.2.1. Type

The number of points of the selected input (main sensor and temperature channel) is defined by the selected option in the “Type” drop-down list (see Figure 101).

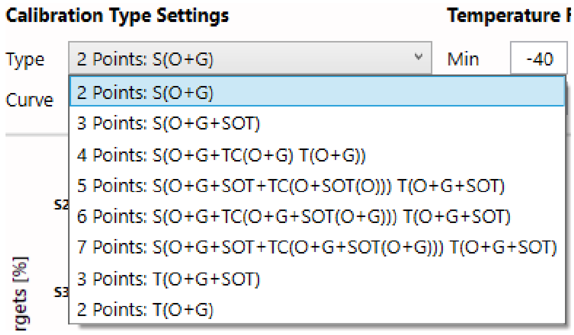



**Figure 101. Calibration Type**

Table 6 links the GUI mnemonic to the specific set of coefficients calculated and used for correcting the measurement before providing it on the chosen output. It also maps the mnemonic with a specific relevant set of measurements (Main Sensor and Temperature).

**Table 6. Calculating Coefficients**

| Type | GUI | Calculated Coefficients | | | | | | | | | | Required Set Points | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OFFSET_S | GAIN_S | TCO | TCG | SOT_S | SOT_TCO | SOT_TCG | OFFSET_T | GAIN_T | SOT_T | Main Sensor | Temp |
| 2 Point | S(O+G) | ✓ | ✓ | | | | | | | | | 2 | 0 |
| 3 Point | S(O+G + SOT) | ✓ | ✓ | | | ✓ | | | | | | 3 | 0 |
| 4 Point | S(O+G +TC(O+G) T(O+G)) | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | 2 | 2 |
| 5 Point | S(O+G +SOT + TC(O+SOT(O))) T(O+G+SOT)) | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | 3 | 3 |
| 6 Point | S(O+G+TC(O+G+SOT(O+G))) T(O+G+SOT)) | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | 2 | 3 |
| 7 Point | S(O+G+SOT+TC(O+G+SOT(O+G))) T(O+G+SOT)) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 3 | 3 |
| 3 Point | T(O+G+SOT) | | | | | | | | ✓ | ✓ | ✓ | 0 | 3 |
| 2 Point | T(O+G) | | | | | | | | ✓ | ✓ | | 0 | 2 |

#### 3.4.2.2. Curve

A second-order equation can be selected to compensate for sensor nonlinearity by choosing one of the following options from the “Curve” drop-down menu (References item 3 for mathematical details):

- SOT Parabolic (recommended for most transducers)
- SOT S-shaped

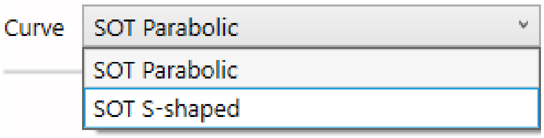



Figure 102. Curve

### 3.4.3. Temperature Range

The application temperature range must be specified by the user, entering values to the “Min” and “Max” fields (Figure 103).

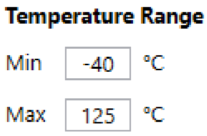



Figure 103. Temperature Range and Sample Settings

### 3.4.4. Calibration Points

Depending on the calibration type, the corresponding number of calibration points is displayed in the Calibration points matrix to illustrate the coverage of the measurement range.

When the calibration type is defined, the reference value S(x) for the Sensor Targets represents the final output data (as in sensor application) in percentage of the ADC full-scale range, after signal conditioning.

In the example in Figure 104, a raw bridge sensor value of -7039018 counts is mapped by calibration to 10% of full-scale range and a raw bridge sensor value of 6835669 counts is mapped by calibration to 90% of full-scale range.

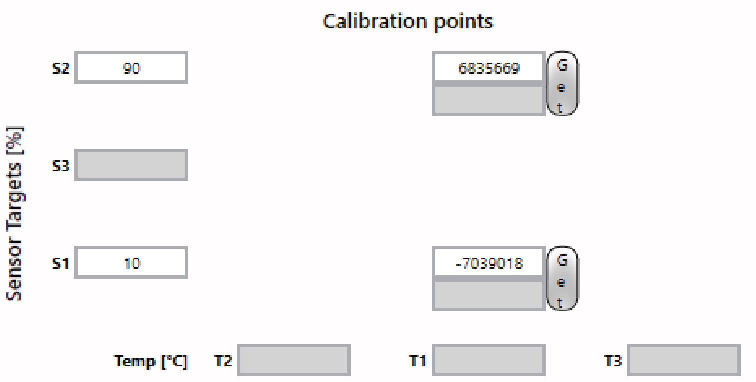



Figure 104. Calibration Points Input

**Definitions**:

- Sensor Targets [%]: External sensor measurement reference point must be entered as a percentage of the full measurement range (sensor application range).
- Temp [°C]: Temperature measurement reference point must be entered in degrees Celsius.
- S(x): Raw external sensor measurement result in counts, values can be entered manually or fetched by clicking the “Get” button.
- T(x): raw temperature measurement result in counts, values can be entered manually or fetched by clicking the “Get” button.

### 3.4.5. Calculating and Setting Coefficient Results

When the complete set of calibration data is collected, the correction coefficients can be calculated by clicking the “Calculate Coefficients” button (see Figure 105).


**Figure 105. Calculate Coefficients, Set in GUI**

The calculated coefficients are displayed in the “Coefficient result” table (see Figure 106 for an example with two calibration points).

Coefficient result

| RESULT | Offset S | Gain S | SOT S | Tco | SOT Tco | Tcg | SOT Tcg | Offset T | Gain T | SOT T |
|---|---|---|---|---|---|---|---|---|---|---|
| SUCCESSS | 25418 | 2028694 | | | | | | | | |

**Figure 106. Coefficient Result**

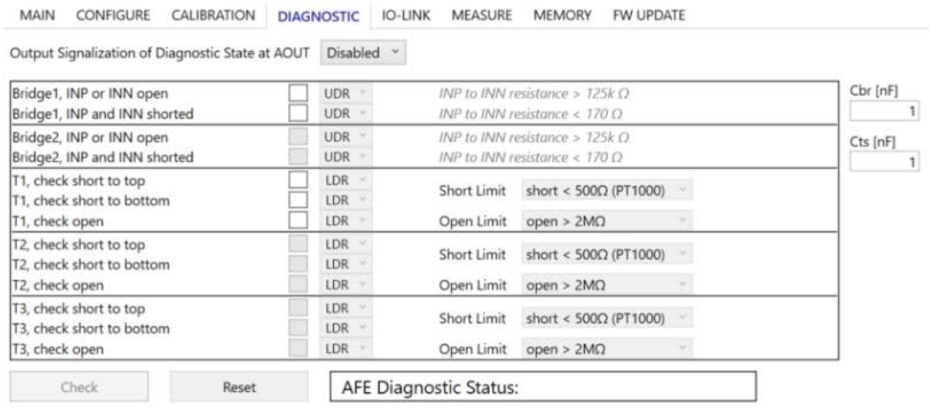
The result can be either:

- Success: Calibration coefficients can be saved in the NVM by clicking the “Set in GUI” button (Figure 106) and executing a Write Memory action.
- Failed: The calculated coefficients which are out of range are displayed in red. In this case, a new calibration shall be started.

## 3.5 Diagnostic Tab

The Diagnostic tab (Figure 107) enables controlling the diagnostic tests via the GUI. The Diagnostic functionality is limited for Step Response Mode (3.3.1.1.2). Depending on the selected sensor type (resistive or capacitive), the Diagnostic tab will display the available diagnostic tests.

Resistive




Capacitive

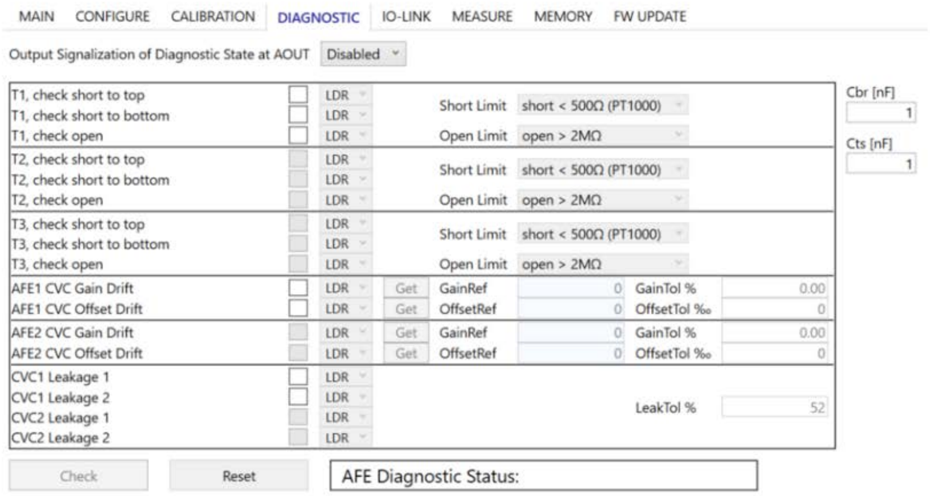



**Figure 107. Diagnostic Tab**

Diagnostic state can be enabled or disabled on AOUT pin (see section 3.3.4 and References item 3 for details) with the “Output Signalization for Diagnostic State at AOUT” drop-down list. Output Data Clipping must be enabled for this feature to take effect.

In the diagnostic test table, marking the relevant check box enables the corresponding diagnostic test. If a test requires additional user input, it must be entered in the input field available on the right side. See References item 3 for a comprehensive description of the diagnostic features.

### 3.5.1. User Selectable Input Fields

The Diagnostic tab has the following fields:

- Cbr [nF] and Cts [nF] fields: Values from 0nF to 2nF are allowed, the corresponding capacitors are displayed in Figure 108.

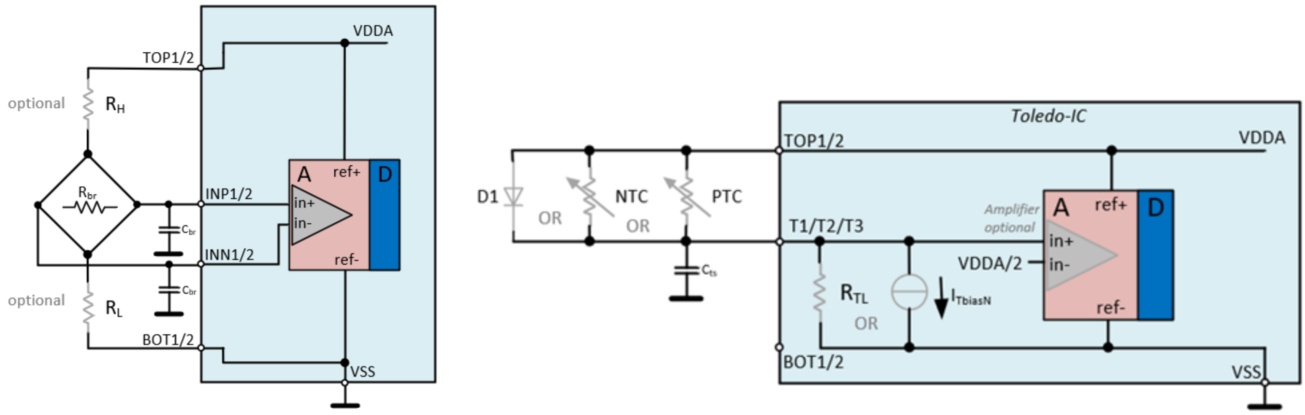



**Figure 108. Cbr and Cts Capacitors**

- UDR/LDR drop-down lists: Defines if an upper or lower diagnostic range of signalization level is used on the AOUT and/or FOUT pins for the selected check (Figure 109).


**Figure 109. UDR/LDR Selection**

- Short Limit/Open Limit options: Limits are selectable from the drop-down lists.
  Only “short < 500Ω (PT1000)” is available for the short limit (T1, T2, T3).
  The following options are available for open limits (T1, T2, T3):
  - open > 2MΩ
  - open > 500kΩ
  - open > 100kΩ
- GainTol %/OffsetTol ‰: Defines the tolerance threshold of AFE1 and AFE2 gain and offset in % / ‰, respectively. This is an internal measurement using a reference capacitance, which does not depend on the connected capacitive sensor.
- The gain tolerance absolute value is derived from the measured gain reference value and GainTol %.
- As the measured offset reference value is rather small, the offset tolerance absolute value is derived from the full-scale measurement value and OffsetTol ‰.
- The default value is 0 for GainTol and OffsetTol. It is recommended to change this to 2% for GainTol and 2‰ for OffsetTol as initial values.
- The “Get” button will read the current gain or offset reference value.
- LeakTol%: Defines the tolerance threshold for the leakage current at the sensor inputs.
  The default value is set to 52% which will result in approximately 2% main sensor deviation.

### 3.5.2. Diagnostics Operation

Diagnostic check and reset can be started with the relevant buttons.

*Note*: To have the specific set of diagnostic features operational, execute a “Write Memory” action. The “Check” and “Reset” buttons are disabled until the NVM is updated (Figure 110).

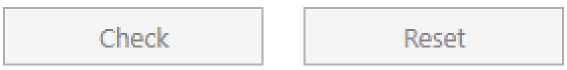



**Figure 110. Diagnostic Check and Reset**

### 3.5.3. AFE Diagnostic Status

The Diagnostic tab provides the current Diagnostic Status (Figure 111).

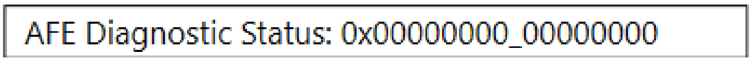



**Figure 111. AFE Diagnostic Status**

When diagnostic checks do not return a fault, Status is set to “0” (two 32 bits words). A check detecting a fault determines a change in the AFE Diagnostic Status value.

A comprehensive description of the Diagnostic Status is provided in References item 3.

### 3.5.4. AFE Diagnostic Operation Example

In this diagnostics operation example, check for shorts between INP1 and INN1 are used, AFE1 is enabled, the “Bridge1, INP and INN shorted” check box is enabled (Figure 112), and a “Write Memory” is executed.


**Figure 112. Activation of Diagnostic Check**

Performing the diagnostic check by clicking on the “Check” button returns a successful the result (Figure 113).

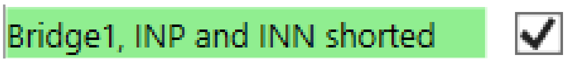



**Figure 113. Diagnostic Check Pass**

After clicking on “Reset” and placing a short between the INN1 and INP1 pins on the ZSSC3286 EVB, another performed check fails (Figure 114).


**Figure 114. Diagnostic Check Fail**

In the IC Status, the failure is reported as “Sensor Connection Fail”, displayed in Figure 115.

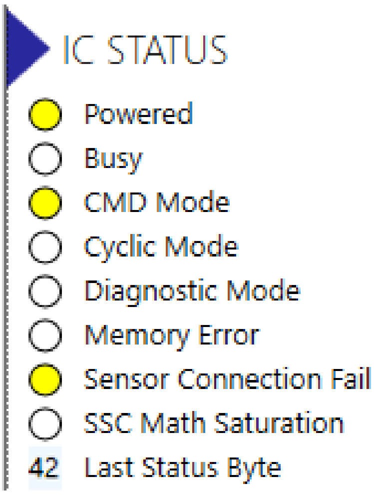



**Figure 115. IC Status Sensor Connection Fail**

## 3.6 IO-Link Tab

This tab offers setting options for the Smart Sensor Profile (SSP). It allows to execute device functions and log events specific to IO-Link and create the IO-Link Device Description (IODD). The ZSSC3286 implements SSP 4.1.1 which is structured as shown in Figure 116. All SSP specific settings and options in the GUI relate to SSP 4.1.1.

| 16 | 8 | 2 | 1 | 0 |
|---|---|---|---|---|
| IntegerT(16) | IntegerT(8) | 6 bit | BOOL | BOOL |
| Measurement value | Scale | Vendor spec. | SSCm.2 | SSCm.1 |

**Figure 116. Structure of SSP 4.1.1**

### 3.6.1. SSP Channel Mapping Tab

In this tab, the data source mapped to Measurement Data Channel 1 of SSP4.1.1 can be chosen via the drop-down list in Figure 117. Availability of data sources depends on AFE (section 3.3.1) and TLC (section 3.3.2) settings.

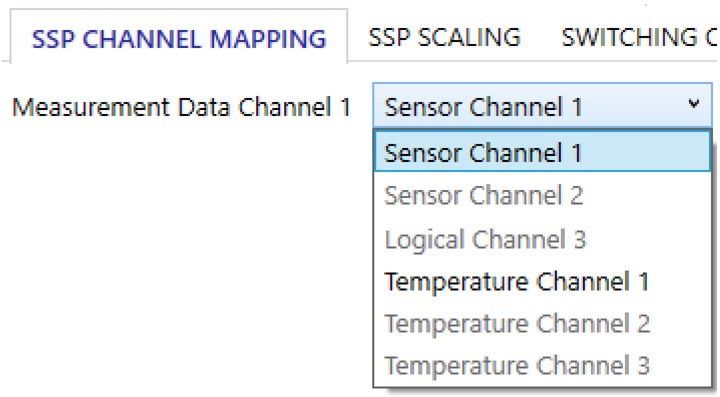



**Figure 117. SSP Channel Mapping**

### 3.6.2. SSP Scaling Tab

This tab is used to rescale the data mapped to the SSP (section 3.6.1) and apply physical units. Using the inputs in this tab, the GUI calculates the Coefficients for SSP Scaling. For reference, the structure of SSP 4.1.1 is displayed in the graphic at the top of the tab (Figure 118).

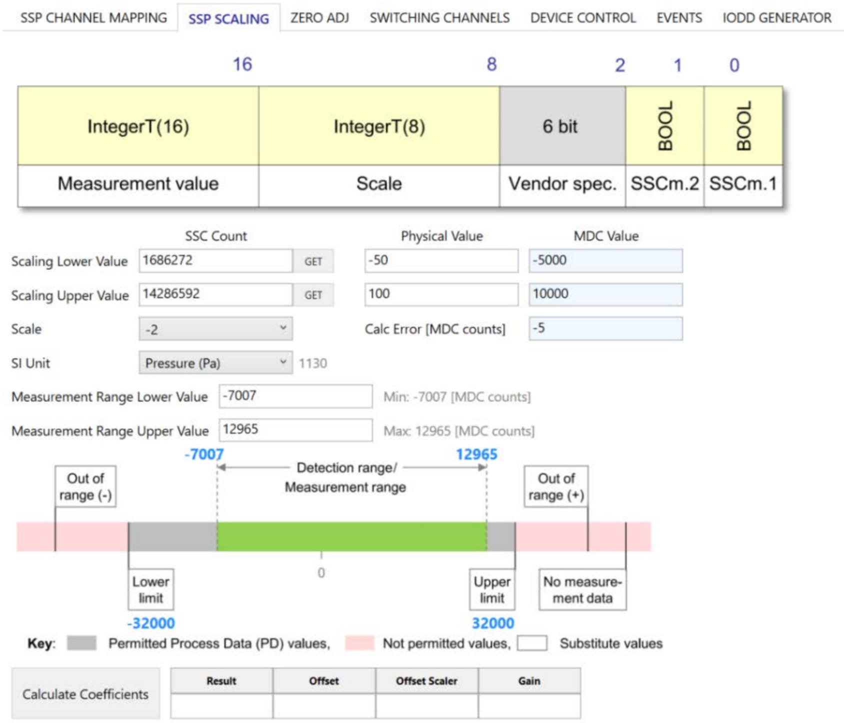



**Figure 118. SSP Scaling Tab**

#### 3.6.2.1. Assignment of Physical Values, Scale and Unit

SSP Scaling is a linear scaling process, defined by two points, the “Scaling Lower Value” and “Scaling Upper Value”. Each point assigns an “SSC Count” (24bit Conditioned Data or 32bit Conditioned Data for TLC, Figure 38) to a “Physical Value” (16bit Process Data within SSP 4.1.1 MDC, ranging from -32000 to +32000 counts). For more information about IO-Link Rescaling, see References item 3. All explanations in this section refer to Figure 119.

The “SSC Count” fields allow to enter values manually or to fetch the currently measured value by clicking the “Get” button next to the corresponding field. The desired corresponding “Physical Value” must be entered in the respective field next to “SSC Count” field.

Applying the “Scale” to the “Physical Value” results in the “MDC Value”. The “MDC Value” represents the counts within the 16bit Process Data of SSP 4.1.1. The GUI automatically chooses the “Scale” value which leads to the highest accuracy in the Process Data (in other words, the lowest value, since it leads to the highest range in the Process Data). Via the drop-down list, all possible values for “Scale” are available and can be chosen.

The GUI calculates and displays the maximum error over the entire valid Process Data range as MDC counts in the “Calc Error [MDC counts]” as the result of the scaling process.

The “SI Unit” drop-down list includes all possible units defined by IO-Link standard; the corresponding unit code (4-digit number) is displayed next to the list. The chosen unit is assigned to the SSP.

“Scale” and “SI-Unit” are updated in the GUI after a memory read of the ZSSC3286.

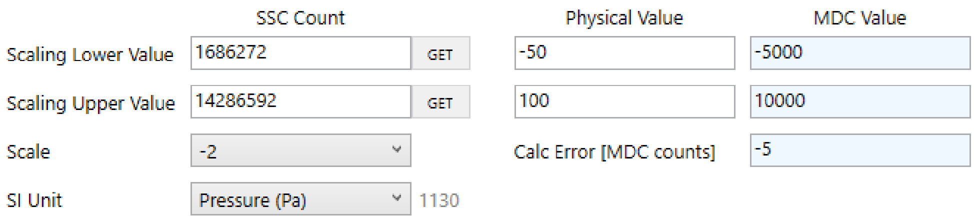



**Figure 119. Assignment of Physical Values, Scale and Unit**

#### 3.6.2.2. Range Definition

The IO-Link standard defines a valid Process Data range and an out-of-range event where replacement values are the substitute output for the Process Data. The ZSSC3286 does not differentiate between “Detection range/Measurement range” as valid Process Data range (see Figure 120), it can reach beyond the specified lower or upper scaling points defined in section 3.6.2.1. The Conditioned Data range, defined by the calibration process (section 3.4), is used as input for Rescaling and normally reaches further than the lower or upper scaling points and allows MDC values to be outside the lower or upper Scaling Value.

Via the fields “Measurement Range Lower/Upper Value” the “Detection range / Measurement range” can be defined within the limits of Conditioned Data range. Based on calibration range, the GUI automatically calculates the limits for “Measurement Range Lower/Upper Value” and displays them next to the corresponding fields.

“Measurement Range Lower/Upper Value” fields are updated in the GUI after memory read of the ZSSC3286.

For easier understanding, the set range values are added to the graphic at the bottom of the GUI as blue numbers.

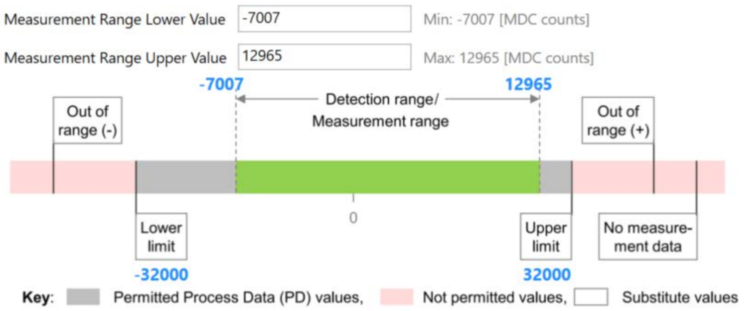



**Figure 120. Process Data Range Definition**

#### 3.6.2.3. Scaling Coefficients

By clicking on the “Calculate Coefficients” button, the SSP Scaling Coefficients are calculated from the settings in this tab and are set in Memory tab. “Offset” and “Gain” define the linear scaling between SSC Counts and MDC Counts. The “Offset Scaler” is an additional scale factor for “Offset” and stays at 1 for SSP 4.1.1.

A “Write Memory” command needs to be executed for the changes to become effective.

Calculate Coefficients

| Result | Offset | Offset Scaler | Gain |
|---|---|---|---|
| SUCCESS | -7007 | 1 | 1248 |

**Figure 121. SSP Scaling Coefficients**

### 3.6.3. Zero Adjustment Tab

The Zero Adjustment feature allows the user to define a reference point for the sensor output to compensate for offsets caused by installation conditions, environmental influences, or signal drift.

When executed, an offset is applied so that the currently measured value corresponds to a defined Reference Point. A typical example is a tare function in weighing applications, where the output is set to zero under unloaded conditions.

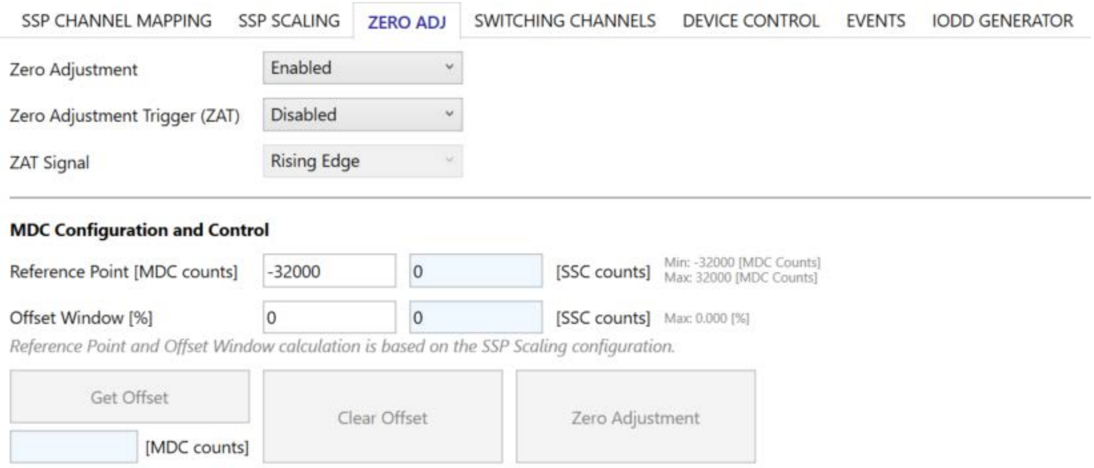



**Figure 122. Zero Adjustment Tab**

**Zero Adjustment:** Enables or disables the feature.

**Zero Adjustment Trigger (ZAT):** Defines in which communication mode the zero adjustment hardware trigger is enabled and can be triggered by the dedicated trigger signal at GPIO14. This parameter is only available if Zero Adjustment is enabled. Possible options are:

- Disabled
- SIO Only
- IO-Link COM Only
- SIO and IO-Link COM

**ZAT Signal:** Defines which signal edge triggers the zero adjustment hardware trigger. This parameter is only available if the trigger is not set to Disabled and can be defined as rising edge or falling edge.

### 3.6.3.1. MDC Configuration and Control

In this section, the reference point and the offset window can be defined and the offset value can be read, cleared or set.

**Reference Point:** Defines the value to which the sensor output is adjusted when performing a zero adjustment.

**Offset Window:** Defines the permissible range for the calculated offset. The absolute maximum limit (shown in grey at the right side) depends on:

- Minimum and maximum MDC counts
- Minimum and maximum SSC counts
- Configured reference point

These values are derived from sensor characteristics, calibration, and SSP scaling.

*Note*: When setting the reference point or offset window, make sure to write memory before using the control button to apply zero adjustment.

The control buttons have the following functionality:

**Get Offset:** Reads and displays the current offset value in the designated output field.

**Clear Offset:** Resets the current offset value to zero.

**Zero Adjustment:** Calculates and applies a new offset based on the current configuration. If the calculated value is within the allowed offset window, it is applied and displayed. If the value exceeds the limits, an error message is generated and no change is applied.

To determine if the offset is within the allowed offset window the following calculation is used:

$$Allowed\ offset\ in\ MDC\ counts = Maximum\ configured\ MDC\ count\ range\ \times\ offset\ window$$

Example:

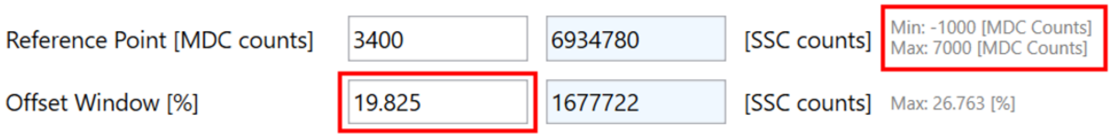



**Figure 123. Example Allowed Offset Calculation**

$$Allowed\ offset\ in\ MDC\ counts = Maximum\ configured\ MDC\ count\ range\ \times\ offset\ window$$
$$Allowed\ offset\ in\ MDC\ counts = 7000 - (-1000) \times 0.19825$$
$$Allowed\ offset\ in\ MDC\ counts = 1586$$

The allowed offset is defined symmetrically with respect to the reference point and applies in both the positive and negative direction (±1586 counts).

*Note*: When performing zero adjustment more than one time, the offset will always be calculated with respect to the defined reference point.

### 3.6.4. Switching Channels Tab

This tab enables configuration of both Sensor Switching Channels of SSP 4.1.1 in an independent side-by-side tab layout (Figure 124). This document uses SSC.1 Switching Signal 1 as an example for describing the feature.

**Note:** Configuration changes done via this tab do not require “Write Memory” action to become effective (except “Detection Mode”).

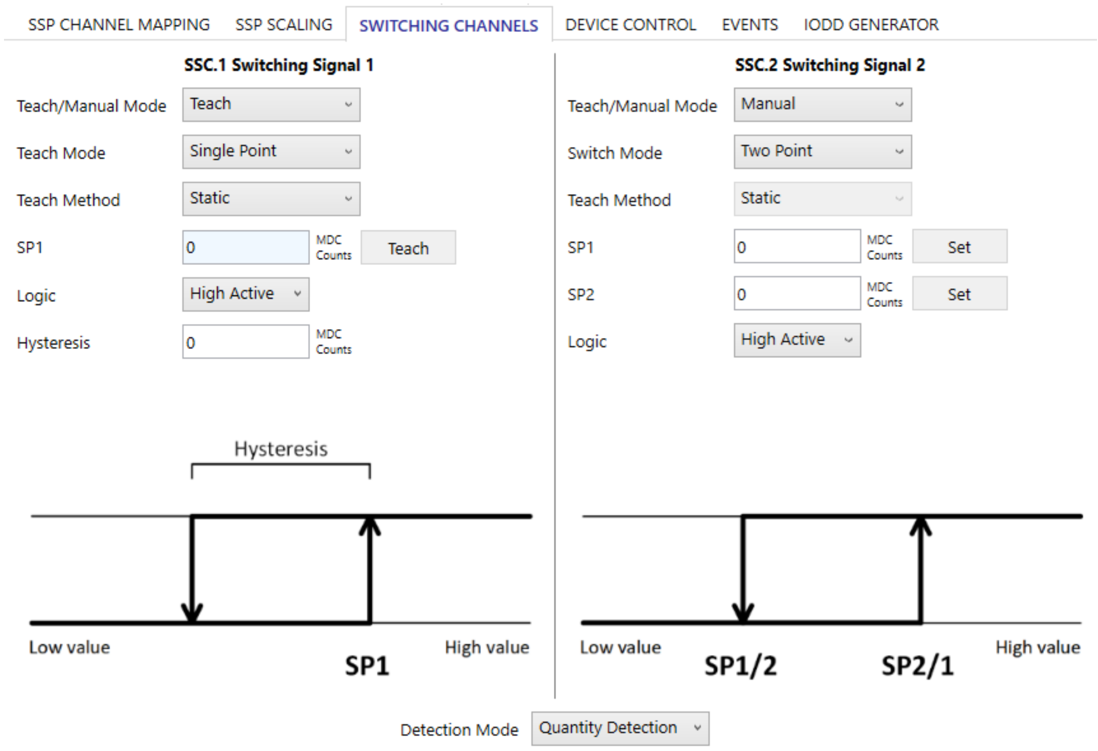



**Figure 124. Switching Channels Tab**

Use the “Teach/Manual Mode” drop-down list to define either of the following switching values (Figure 125).

- Teach: selects the IO-Link Teach functionality which uses measured values in real-time to define switching values. It enables the drop-down list “Teach Mode”.

- Manual: allows the user to manually enter switching values in input fields and clicking the “Set” button (Figure 128). It enables the drop-down list “Switch Mode”.

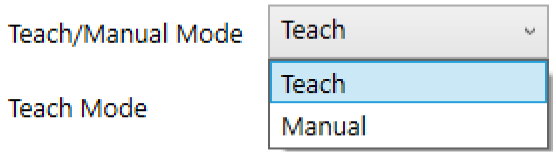



**Figure 125. Teach/Manual Mode**

Select either of the following options from the “Switch Mode” or “Teach Mode” drop-down list to define how Setpoints (SP) are interpreted in the context of switching behavior (Figure 126):

- Deactivated: No switching is performed, and Sensor Switching Channel output is kept low. All options below “Teach Method” are hidden.
- Single Point: Switching is performed based on a single SP in combination with a hysteresis value.
  With this option only the “SP1” field is available for entering Setpoints. In “Teach” mode the “SP1” field is read-only.
- Two Point: Switching is performed based on two SPs which inherently define hysteresis.
  With this option both “SP1” and “SP2” fields are available for entering Setpoints. In “Teach” mode “SP1” and “SP2” fields are read-only.
- Window: Switching is performed based on two SPs. They form a logic window via two switching points defined by the SPs in combination with a hysteresis value.
  With this option both “SP1” and “SP2” fields are available for entering Setpoints. In “Teach” mode “SP1” and “SP2” fields are read-only.

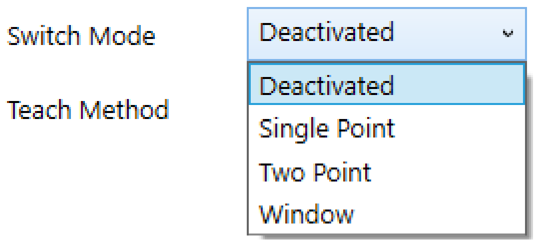



**Figure 126. Switch Mode / Teach Mode**

Select either of the following as data acquisition mode for defining Teach values from the “Teach Method” drop-down list (Figure 127):

- “Static”: The currently available Process Data value is taken as Teach value by clicking the “Teach” button (Figure 129).
- “Dynamic”: Process Data acquisition is started and must be stopped manually with the “Teach Start” and “Teach Stop” buttons. The Process Data values acquired between Teach start and stop action are arithmetically averaged and the result becomes the Teach value.
  A started Teach process can be aborted by clicking the “Cancel” button (Figure 130).

*Note*: “Teach Method” is only available if “Teach” is selected from the “Teach/Manual Mode” drop-down list.

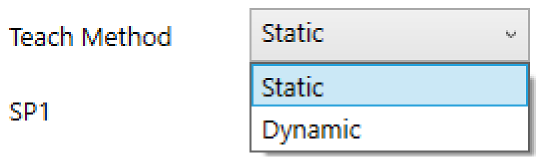



**Figure 127. Teach Method**

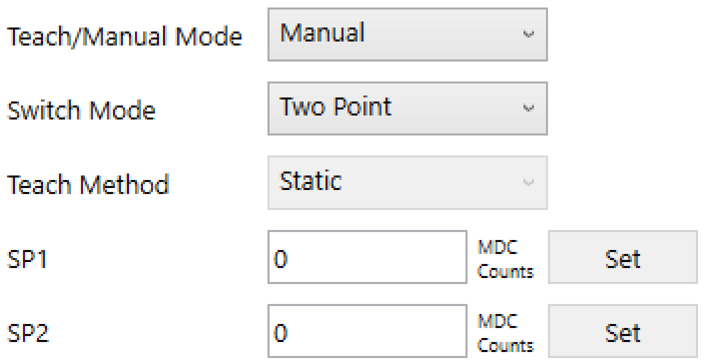



**Figure 128. Setpoint Fields in Manual Mode, Two Point Mode**

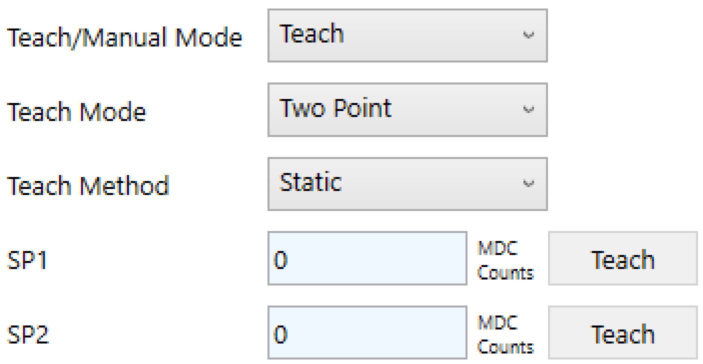



**Figure 129. Setpoint Fields in Teach Mode (Static), Two Point Mode**

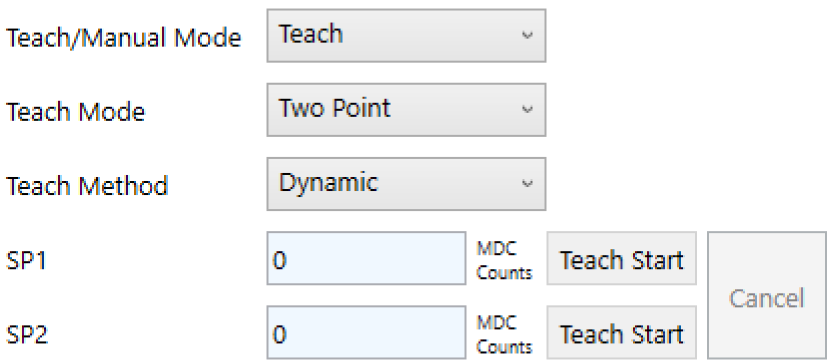



**Figure 130. Setpoint Fields in Teach Mode (Dynamic), Two Point Mode**

Via the “Logic” drop-down list (Figure 131), the switching output function can be inverted (flipped on a horizontal axis).

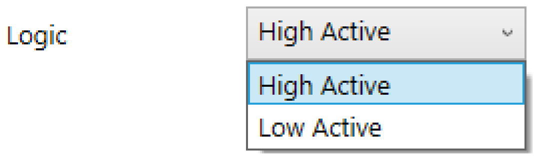



**Figure 131. Logic**

In “Single Point” or “Window” teach mode, switching hysteresis can be defined by the “Hysteresis” field (Figure 132). The alignment of hysteresis is shown in the graphic section (Figure 133).


**Figure 132. Hysteresis**

A graphic displays the switching logic and behavior depending on selection for the options of the tab. Figure 133 shows and example graphic for "Window" mode and "High Active" switching signal settings.

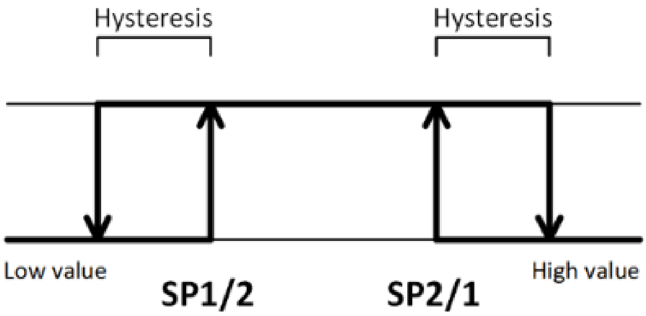



**Figure 133. Example for Switching Behavior Graphic in Window Mode**

"Detection Mode" option (Figure 134) effectively inverts the output logic (flipping the switching behavior graphic on a vertical axis) and is available in "Single Point" and "Two Point" mode. This option affects all Sensor Switching Channels within the SSP simultaneously.

According to IO-Link standard and assuming "High Active" logic, the following terms are used:

- Object Detection: A switching signal stays active for low measurement values and transitions to inactive for, for example, object distance/range measurement.
- Quantity Detection: a switching signal transitions from inactive to active with increasing values (at a certain quantity threshold).

After changing Detection Mode, "Write Memory" must be performed to become effective.

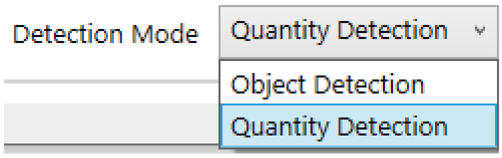



**Figure 134. Detection Mode**

### 3.6.5. Device Control Tab

The Device Control Tab offers IO-Link Device Control options and Locator feature control.

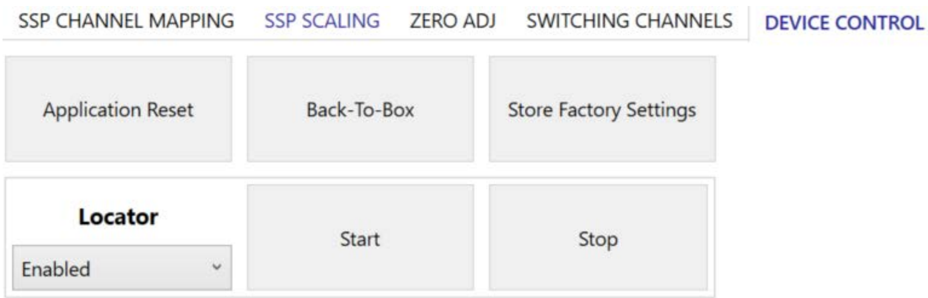



**Figure 135. Device Control Tab**

The following functions are available on the Device Control tab:

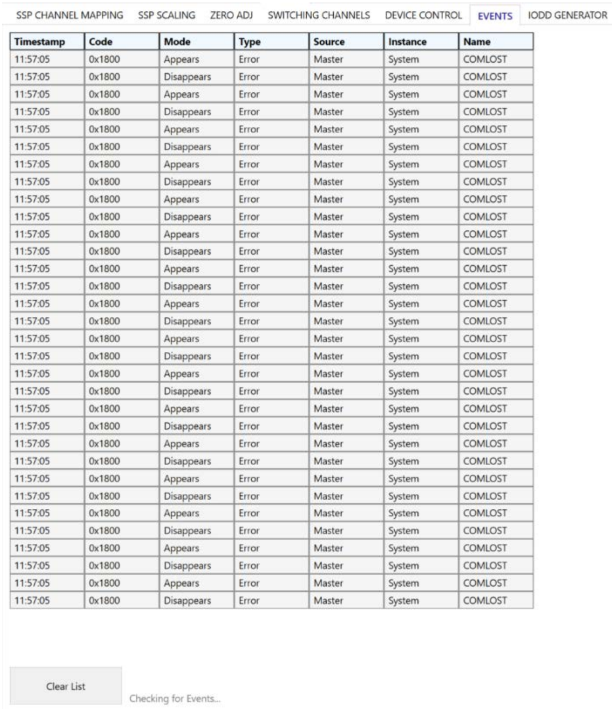
- Application Reset: Performs IO-Link device application reset. Only application-specific parameters are reset (for example, switching points). After the reset, ISDUs are reread. ID parameters stay unchanged. Master-Device connection stays uninterrupted.
- Back-To-Box: Performs IO-Link Back-to-box command. Application-specific parameters and ID parameters are reset. After executing this command, the Device stays disconnected and a new "Connect" needs to be performed.

- Store Factory Settings: The IO-Link application-specific parameters and ID-parameters are backed-up for restoring via “Application Reset” or “Back-To-Box” commands.
  *Note*: At delivery state, ZSSC3286 stores the default parameters from Renesas as a back-up. As soon as custom IO-Link parameters are applied, they should be stored via “Store Factory Settings” command.
- Locator function: It can be used to identify the EVB to which the GUI is connected by letting the Locator LED blink periodically on the EVB (D4).
  - Drop-down list: The Locator function can be enabled/disabled.
  - Start: starts the blinking pattern
  - Stop: stops the blinking pattern

### 3.6.6. Events Tab

The GUI supports receiving and displaying IO-Link events. The events are displayed chronically in a list (Figure 136). The “Time Stamp” refers to the time of fetching the event from the IO-Link Master, not the actual occurrence of the event at the Device or Master.

Events are fetched when the Event tab is selected, indicated by “Checking for Events…” message. During Event checking, the check for events and the received events are logged in the communication log. Checking for Events is done at an interval of at least 300ms. The Event list in the GUI can be cleared by clicking the “Clear List” button.




| Timestamp | Code | Mode | Type | Source | Instance | Name |
|---|---|---|---|---|---|---|
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Appears | Error | Master | System | COMLOST |
| 11:57:05 | 0x1800 | Disappears | Error | Master | System | COMLOST |

**Figure 136. Events Tab**

## 3.6.7. IODD Generator Tab

This tab gives access to the IO-Link Device Description (IODD) Generator (Figure 137) that generates an IODD based on the current configuration of the ZSSC3286 and integrates direct customer input.

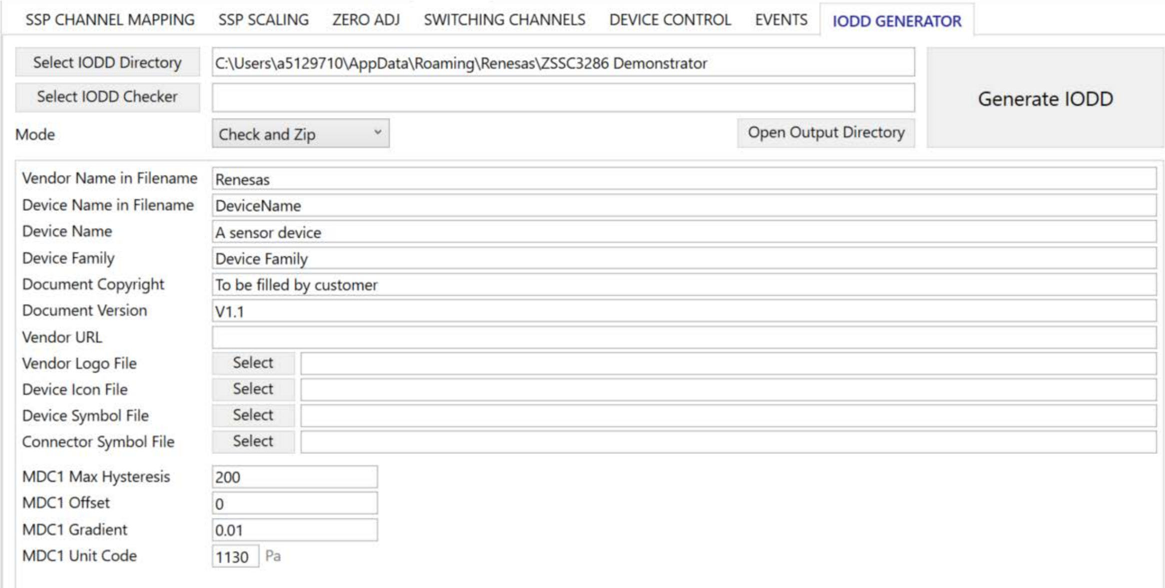



**Figure 137. IODD Generator Tab**

### 3.6.7.1. Generator Control

The top section of the tab provides file control (Figure 138). The output directory for the IODD can be defined by clicking the “Select IODD Directory” button in the file control section (Figure 138). The chosen output path is displayed in the editable field next to the button and can be opened with the “Open Output Directory” button.

The path to the IODD Checker can be defined by clicking the “Select IODD Checker” button. The GUI is compatible with IODD V1.1.5 and IODD Checker V2025.1. The chosen output path is displayed in the editable field next to the button. The IODD Checker can be downloaded from the official IO-Link website: https://io-link.com/en/

Clicking the “Generate IODD” button starts the IODD Generator to create the IODD files.

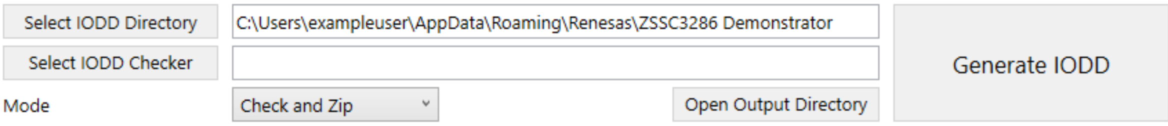



**Figure 138. IODD Generator Control**

The “Mode” drop-down list offers three output options for checking and compressing the IODD (Figure 139). Only when checking the IODD, a valid CRC stamp at the end of the IODD file is created.

- Check and Zip: The IODD is checked by the selected IODD Checker, and the output files are compressed into a ZIP file. A ZIP file is needed for most IO-Link Master control tools to import the IODD.
- Don’t check and Zip: The IODD is neither checked, nor are the output files compressed.
- Don’t Zip: The IODD is checked, but the output files are not compressed.

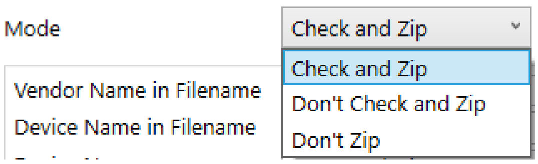



**Figure 139. IODD Generator Mode**

#### 3.6.7.2. Manufacturer and Application Specific Options

The lower section of the tab consists of input fields for manufacturer and application specific attributes or elements. The upper input fields provide vendor and device information to the customer.

The four image files, selectable via “Select” button or via the input field, are displayed in IO-Link Master control tools and are all optional. Image file format must comply with IO-Link standard as shown in Table 7:

**Table 7. IODD Image File Formats**

| Image Name | Image Size (pixel) | File Format | File Name as Output Data |
|---|---|---|---|
| Vendor Logo | 160 x 90<br>(landscape oriented) | PNG | VendorName-logo.png |
| Device Icon | 48 x 48 (square) | PNG | VendorName-DeviceName-icon.png |
| Device Symbol | min. 160 x 160<br>max. 320 x 320<br>(square) | PNG | VendorName-DeviceName-pic.png |
| Connector Symbol | min. 160 x 160<br>max. 320 x 320<br>(square) | PNG | VendorName-DeviceName-con-pic.png |

The value in “MDC1 Max Hysteresis” field limits the hysteresis of all Sensor Switching Channels (section 3.6.3) for the customer. This value does not affect possible hysteresis settings in the GUI.

The fields “MDC1 Offset” and “MDC1 Gradient” and “MDC 1 Unit Code” can be used to rescale the Process Data in the IO-Link Master interpretation, for example, to allow conversion to units outside the SI unit system. This must not be confused with SSP Scaling coefficients and the Scale value transmitted in the SSP (section 3.6.2.3): By IO-Link specification, the Offset, Gradient, and Unit Code parameters are a separate interpretation system. Since the physical values from both systems should match, the GUI presets the fields “MDC1 Offset” and “MDC1 Gradient” and “MDC 1 Unit Code” according to settings in SSP Scaling tab.

#### 3.6.7.3. Output Data

Depending on Generator Control settings, the output folder contains different output files:

**IODD: XML file**

The IODD XML file is always generated. If checking is set in the “Mode” option, this file contains a valid CRC stamp. The XML file name is structured as follows:

*VendorName-DeviceName-YYYYMMDD-IODD1.1.xml*

(example: *Renesas-ZSSC3286KIT-20241016-IODD1.1.xml*)

**IODD: Image files (PNG files)**

If specified, the image files are copied from the referenced path to the output directory. Without changing the file names of the referenced files (original files), the images are renamed according to IODD Generator input and settings.

**IODD: ZIP file**

If ZIP is set in the “Mode” option, this ZIP archive contains the IODD XML file and, if specified, the referenced image files. The XML file name is structured as follows:

*VendorName-DeviceName-YYYYMMDD-IODD1.1.zip*

(example: *Renesas-ZSSC3286KIT-20241016-IODD1.1.zip*)

**iodd_checker.log**

If checking is set in the “Mode” option, the IODD Checker creates a log file containing the tests and test results of the checked IODD and a summary of the check.

**ioddSettings.json**

This file contains the attribute values for IODD Generator for the created IODD. It can be used to run the IODD Generator directly, without the GUI.

### 3.6.7.4. Error Handling

If the IODD file generation fails, an error message is displayed reflecting either of the following sources:

- GUI
- IODD Generator
- IODD Checker

The error and additional details are saved into the GUI’s Communication log file.

#### 3.6.7.4.1. Errors from the GUI

If the GUI fails to create the JSON settings file, the most probable reason is either the lack of proper permissions to create the file in the specified directory or that the specified output directory is invalid, see Figure 140 as an example.

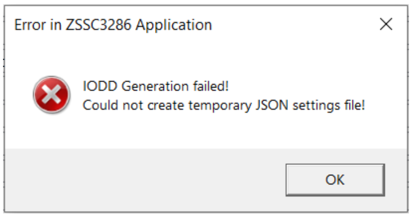
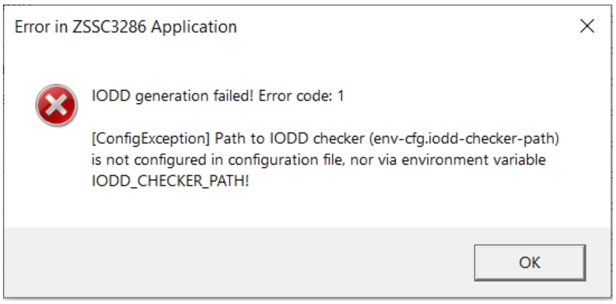


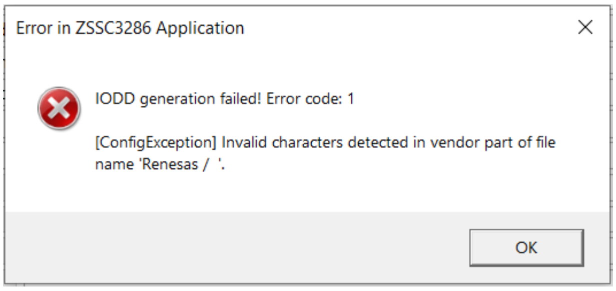

**Figure 140. Error Message from GUI**

#### 3.6.7.4.2. Errors from the IODD Generator Tool

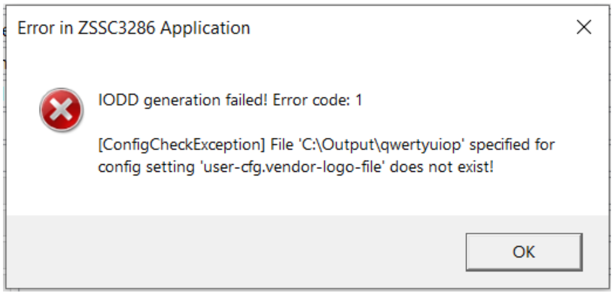
The IODD Generator tool does not proceed the IODD file generation if a validity check occurs of the received JSON configuration file.




Invalid IODD Checker path




Invalid characters in the Vendor Name parameter




Invalid path to the Vendor Logo image file

**Figure 141. Error Message Examples from IODD Generator (JSON Configuration File Errors)**

### 3.6.7.4.3. Errors from the IODD Checker

If the IODD Checker detects that the IODD file does not conform to the IODD specification, an error message is generated (see Figure 142) and the error is logged into the IODD Checker log file. Warnings in the log file can be ignored.

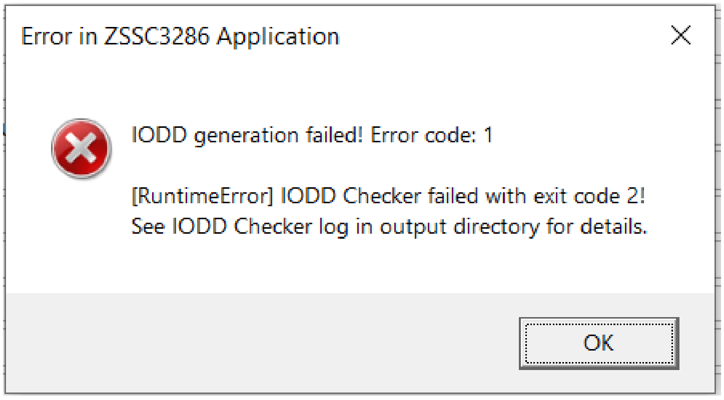



**Figure 142. Error message from IODD Checker**

The following example is from the IODD Checker log file showing error details:

```
======================================================
IO Device Description Checker V1.1.9
Checks an IODD V1.1.3 for syntax and semantic errors
Copyright (c) 2015-2022 by IO-Link Community
======================================================
Checks file : C:\Output\Renesas-DeviceName-20240930-IODD1.1.xml

XMLReader: Begin Check...........................
XMLReader Validation: no errors

Business rules: Check .........................
test case : "NewestChecker" : ok
test case : "File name convention of IODD" : ok
test case : "File name convention and format of linked files" : errors occurred
  line 692 column 76 : error : wrong size 'Renesas-DeviceName-con-pic.png' : 160
x 160 up to 320 x 320 pixel required
test case : "Read data structures" : ok
test case : "Profile header" : ok
test case : "productId" : ok
test case : "StdVariableRef" : warnings occurred
[…]
```

#### 3.6.7.4.4. IODD Generator Tool Availability Check

At startup, the GUI verifies if the IODD Generator tool is available and can be run. External factors (for example, corruption of the GUI files after installation) or interference by other applications (for example, misconfigured antivirus software) could prevent the IODD Generator tool from executing. If the IODD Generator tool is not able to run, the GUI displays a warning message at the bottom of the IODD Generator tab, see Figure 143.


**Figure 143. Warning Message: IODD Generator is not Available**

## 3.7 Measure Tab

The Measure tab (Figure 144) provides a comprehensive overview of the measurement visualization settings and the option to save acquired data to a file.

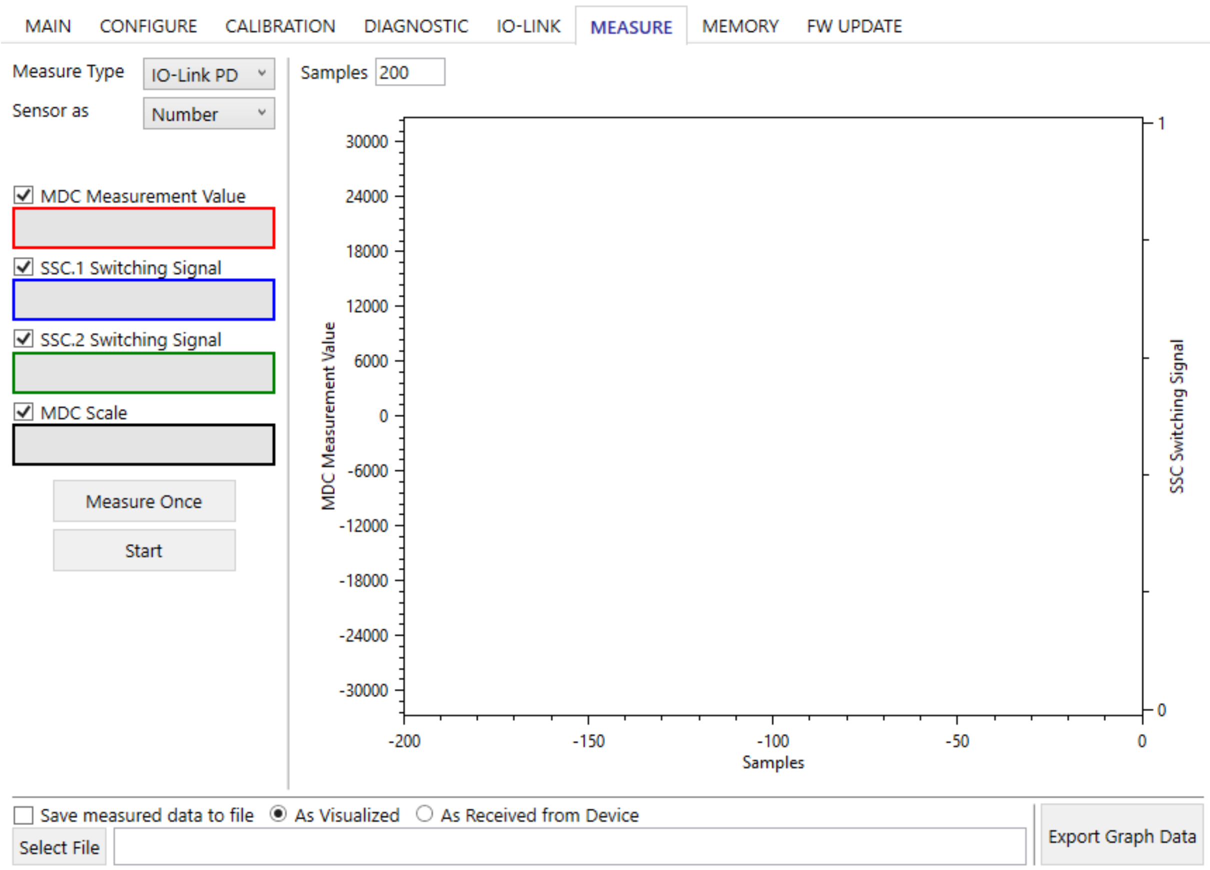



**Figure 144. Measure Tab**

### 3.7.1. Measure Options

#### 3.7.1.1. Measure Type

Select Measure Type option from the “Measure Type” drop-down list (see Figure 145):

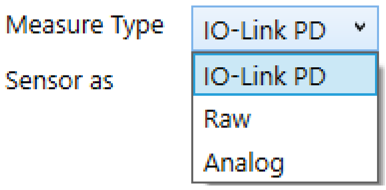



**Figure 145. Measure Type**

- IO-Link PD: Data is acquired from IO-Link Process Data (PD) within the Smart Sensor Profile (SSP). SSP 4.1.1 features a 16bit measurement value and two Sensor Switching Channels.
- Raw: Data is acquired through a specific set of reading commands. Raw data is mathematically unconditioned data.
- Analog: If Analog is selected and J46 on the ZSSC3286 EVB is shorted, the analog output is connected to a 10bit ADC input available on the CB, allowing analog data to be displayed.

Table 8 lists the availability of Measure Types depending on the interface used for connection to the EVB.

**Table 8. Measure Type Availability**

| Measure Type | IO-Link | I2C (via CB) |
|---|---|---|
| IO-Link PD | ✓ | n.a. |
| Raw | ✓ | ✓ |
| Analog | n.a. | ✓<br>J46 placed on EVB |

### 3.7.1.2. Sensor as and Temperature as

The “Sensor as” drop-down list allows the visualization of data according to the options displayed in Figure 146.

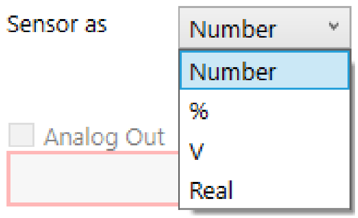



**Figure 146. “Sensor as” Options for “Analog”**

The “Temperature as” drop-down list allows the visualization of data according to the options displayed in Figure 147.

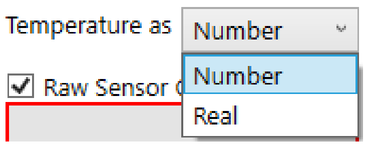



**Figure 147. “Temperature as” Options for “Raw”**

Table 9 lists the availability and data representation format of “Sensor as” and “Temperature as” options.

**Table 9. Data Representation Format: “Sensor as” / “Temperature as”**

| Sensor as/ Temperature as | Measure Type | | |
|---|---|---|---|
| | **IO-Link PD** | **Raw** | **Analog** |
| **Sensor as** | | | |
| Number | bit range according to SSP<br>SSP 4.1.1: 16bit | $-2^{x-1}\ldots+2^{x-1}$ range, with x: 10…24 bit | $0\ldots2^{10}$ range<br>(0…5V range) |
| % | n.a. | Data scaled to<br>0…100% range | Data scaled to<br>0…100% range<br>(0…1V range) |
| V | n.a. | n.a. | Data displayed in Volts<br>(0…1V range) |

| Sensor as/ Temperature as | Measure Type | | |
|---|---|---|---|
| | **IO-Link PD** | **Raw** | **Analog** |
| Real | n.a. | Data scaled to -1…+1 range | Data scaled to 0…+2 range (0…1V range) |
| **Temperature as** | | | |
| Number | n.a. | $-2^{x-1}…+2^{x-1}$ bit range, with x: 10…24 bit | n.a. |
| Real | n.a. | Data scaled to -1…+1 range | n.a. |

### 3.7.1.3. Channel Display Selection

When marking a check box and clicking on the “Start” button, the corresponding numerical field shows the data from the selected sources, and the data is displayed in the graphs area. Availability and accessibility of sources varies depending on AFE configuration and Measure Type selection, see Figure 148, Figure 149 and Figure 150.

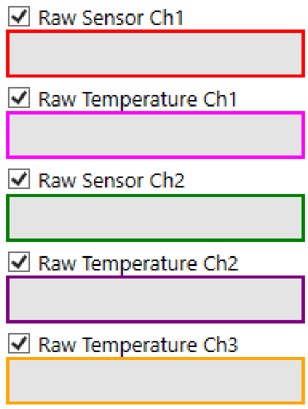



**Figure 148. Display Selection for Measure Type “Raw”**

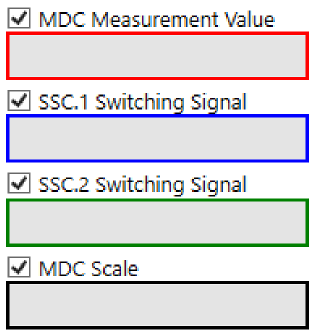



**Figure 149. Display Selection for Measure Type "IO-Link PD"**

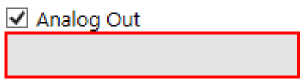



**Figure 150. Display Selection for Measure Type "Analog"**

#### 3.7.1.4. Measurement Acquisition

The GUI offers the following options for measurements acquisition (Figure 151):

- Single measurement acquisition ("Measure Once" button),
- Continuous acquisition ("Start" button).

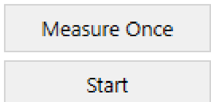



**Figure 151. Measurement Acquisition**

### 3.7.2. Graphs Area

The graphs area (Figure 152) allows visualizing the trend of the acquired data as selected. The number of samples displayed in the graph can be configured in the "Samples" field. For Measure Type "Raw", the resolution for Sensor and Temperature channels respectively can be chosen from the corresponding combo box (10bit to 24bit).

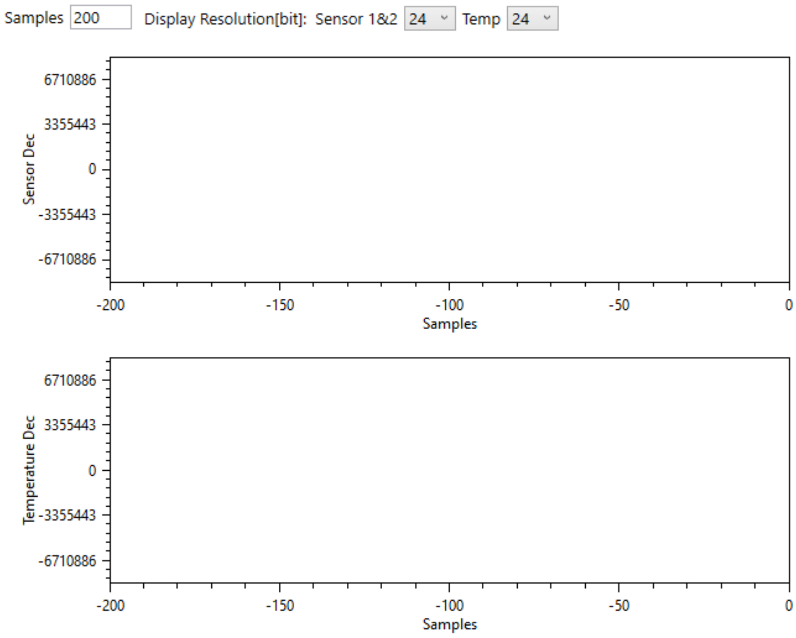



**Figure 152. Graphs Area**

### 3.7.3. Save Data

#### 3.7.3.1. Save Measured Data to File

By marking the check box "Save measured data to file" and clicking on the "Start" button, the acquired data is stored in the selected file (Figure 153). This offers the user the possibility to perform statistical analysis on data batches.

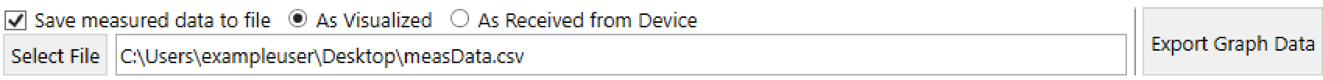



**Figure 153. Save Measured Data**

When "As Received from Device" is active, the data is saved in decimal format as received from ZSSC3286 without any further manipulation by the GUI.

When “As Visualized” is active, the data is saved in decimal format according to the display resolution selected (Figure 154), thus as displayed in Channel Display Selection field.

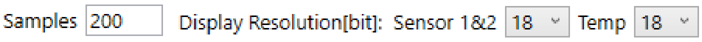



**Figure 154. Selected Display Resolution**

Table 10 lists the stored data format depending on the selected Measure type.

**Table 10. Stored Data Format**

| Save Data Option | Measure Type | | |
|---|---|---|---|
| | **IO-Link PD** | **Raw** | **Analog** |
| As Received from Device | Bit range according to SSP<br>SSP 4.1.1: 16bit value | 24bit value with accuracy according to ADC resolution | 10bit value<br>(0…5V range) |
| As Visualized | no effect:<br>Bit range according to SSP<br>SSP 4.1.1: 16bit value | 10…24bit value<br>(LSBs cropped from received 24bit value) | 10bit accuracy value according to “Sensor as” setting |

### 3.7.3.2. Save Displayed Graph Data to File

To save the visualized data from graph to file, follow these steps:

1. Select the desired channel(s)/source(s).
2. Start measurement.
3. Stop the measurement when the desired data is displayed on the screen.
4. Click on the “Export Graph Data” button (Figure 155).
5. Browse and save the file to a location (Figure 155).
6. Click the “Save” button.

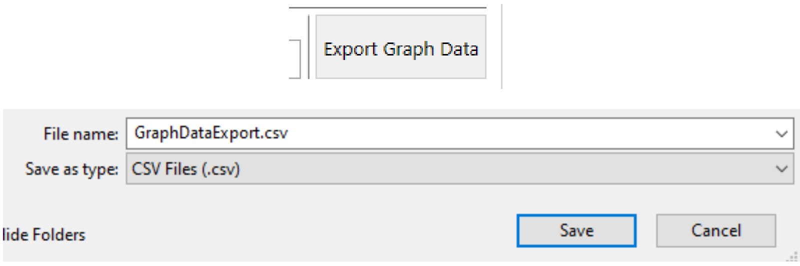



**Figure 155. Save Displayed Data**

# 3.8 Memory

## 3.8.1. Overview

The Memory tab provides the user a read-only view on the device configuration memory (NVM), see Figure 156.

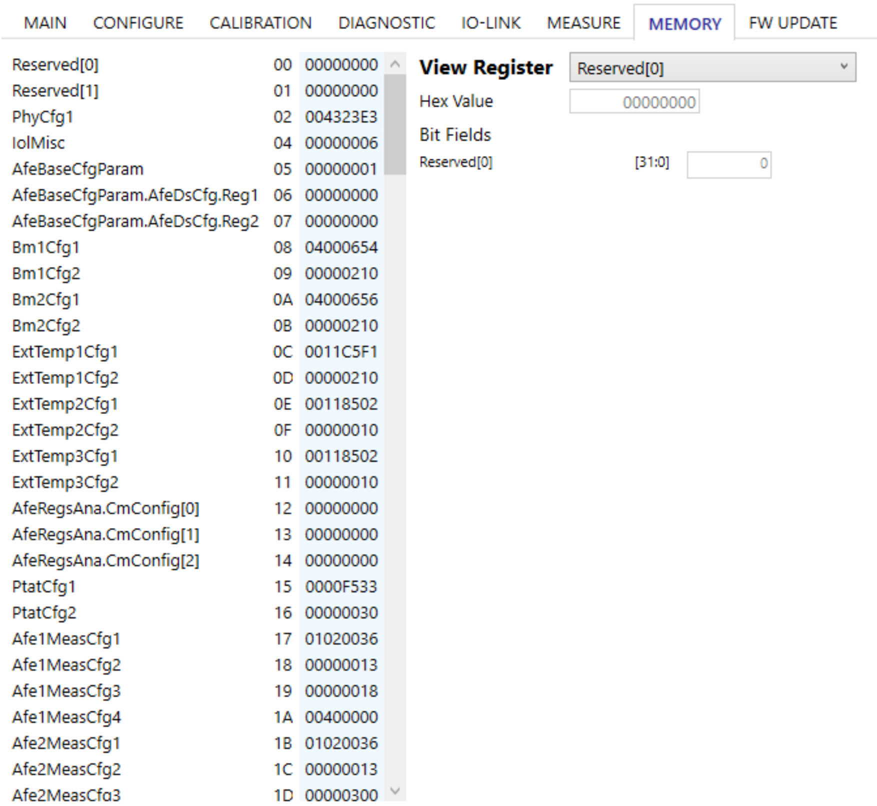



**Figure 156. Memory Overview**

The complete set of registers composing the device configuration memory is listed in a Memory map. Each register is associated with a mnemonic, an address, and the relevant content (in hexadecimal value) as displayed in Figure 157.


**Figure 157. Register**

## 3.8.2. View Register

To have a detailed view of the register content, the register can be selected via the list on the left side of the tab or via the "View Register" drop-down list (Figure 158).

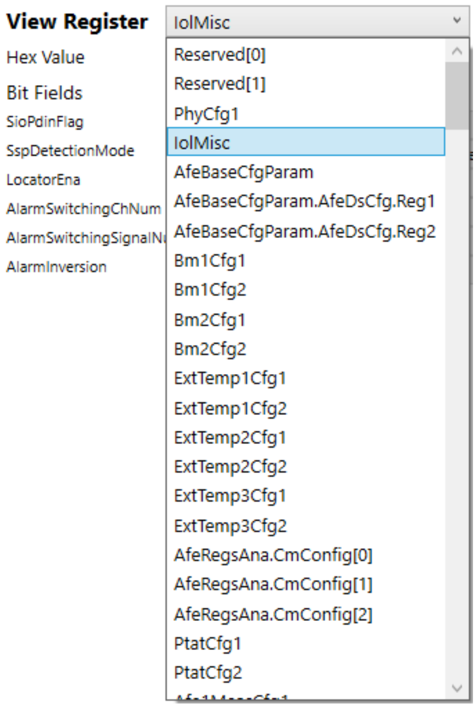



**Figure 158. Memory – View Register via Drop-Down List**

For the selected register, the relevant values are displayed and the bit fields associated with specific functions or functionalities are listed (Figure 159 shows an example register: the values are accessible in read/write through the Configure and Calibration tabs described in section 3.3.10.

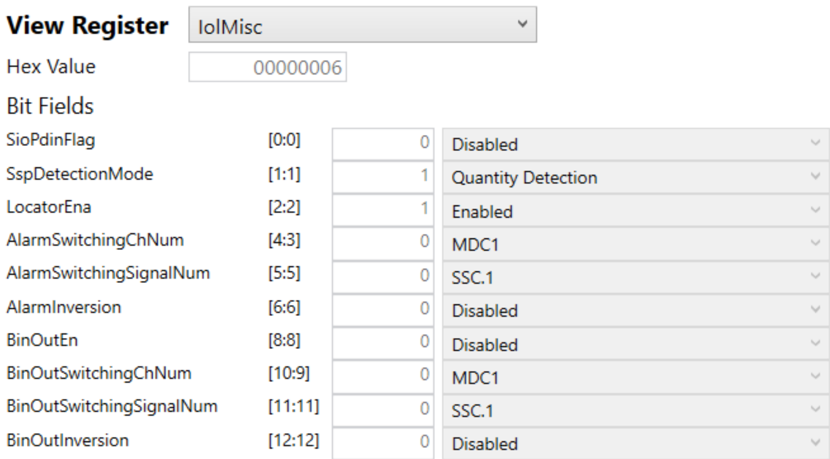



**Figure 159. Register Content**

Changes to the configuration of the device are highlighted in the Memory map in red. A Write Memory operation must be performed for the changes to take effect. In the “View Register” section, it is possible to check the bits of the registers that were affected by a change (Figure 160).

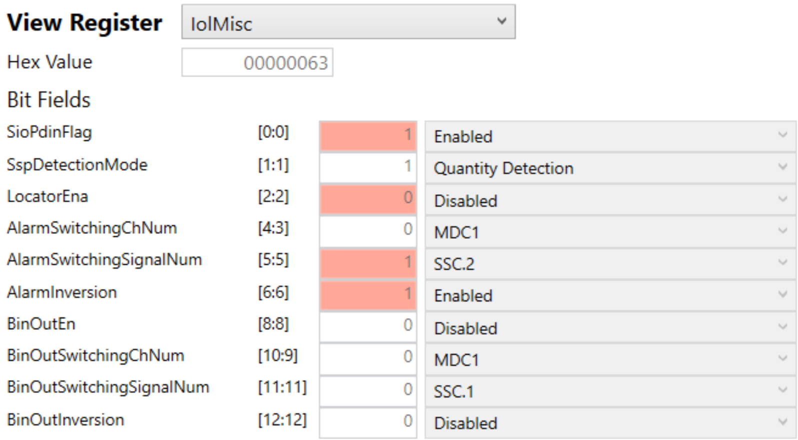



**Figure 160. Modified Bits in a Register – Changes not Written to NVM**

## 3.9 FW Update Tab

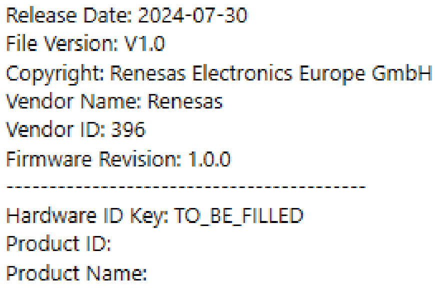
This tab allows updating the ZSSC3286 Firmware via either IO-Link or I2C.

*Note*: It is highly recommended to make a copy of the NVM configuration settings (section 3.1.1.1) before performing an FW update.

***Important***: Ensure a stable power supply during update. Power loss during update may cause corruption of the device.

Follow these steps to update the firmware:

1. Click on “Select File” and choose the correct FW Update file in IOLFW or BIN format.
   Once the file is chosen, the GUI displays its meta data (Figure 161 shows an example). If the FW Update file is valid, the GUI shows “Ready to perform firmware update” at the bottom of the tab.


Release Date: 2024-07-30
File Version: V1.0
Copyright: Renesas Electronics Europe GmbH
Vendor Name: Renesas
Vendor ID: 396
Firmware Revision: 1.0.0
----------------------------------------
Hardware ID Key: TO_BE_FILLED
Product ID:
Product Name:

Note: Shown FW version may
not be latest; for illustration only.

**Figure 161. Firmware Meta Data**

2. Click on Start Firmware Update.
   The GUI runs either of the following FW Update procedures:
   - via I2C: Figure 162 shows the progress pop-up window during FW Update.
   - via IO-Link: Figure 163 shows the progress pop-up window during FW Update.

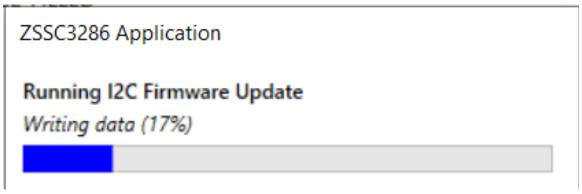



**Figure 162. I2C FW Update Progress**

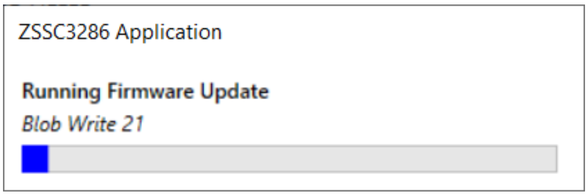



**Figure 163. IO-Link FW Update Progress**

After data is successfully written, the ZSSC3286 is restarted and either of the following messages are shown:

- update via I2C: Figure 164 shows the confirmation pop-up window for successful FW Update.
- update via IO-Link: Figure 165 shows the confirmation pop-up window for successful FW Update.

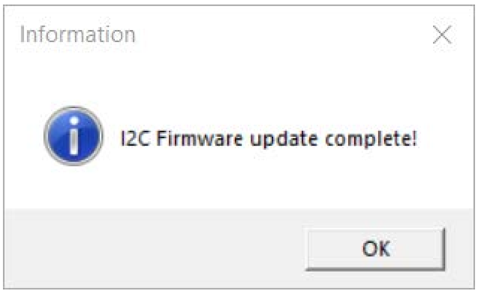



**Figure 164. I2C FW Update Success Message**

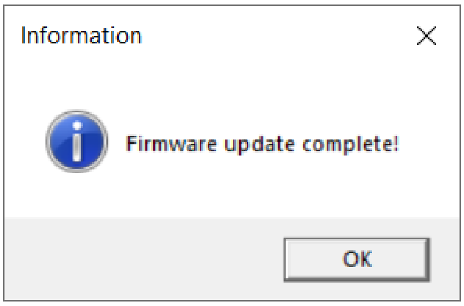



**Figure 165. IO-Link FW Update Success Message**

## 3.10 Command Console

The Command Console can be started as described in section 3.1.1.3 (Figure 166). Commands can be written directly to the CB and IO-Link master allowing direct write and read commands for the ZSSC3286 via I2C and IO-Link. The device response is received in the result display.

The list of CB commands and IO-Link command syntax is available upon request.

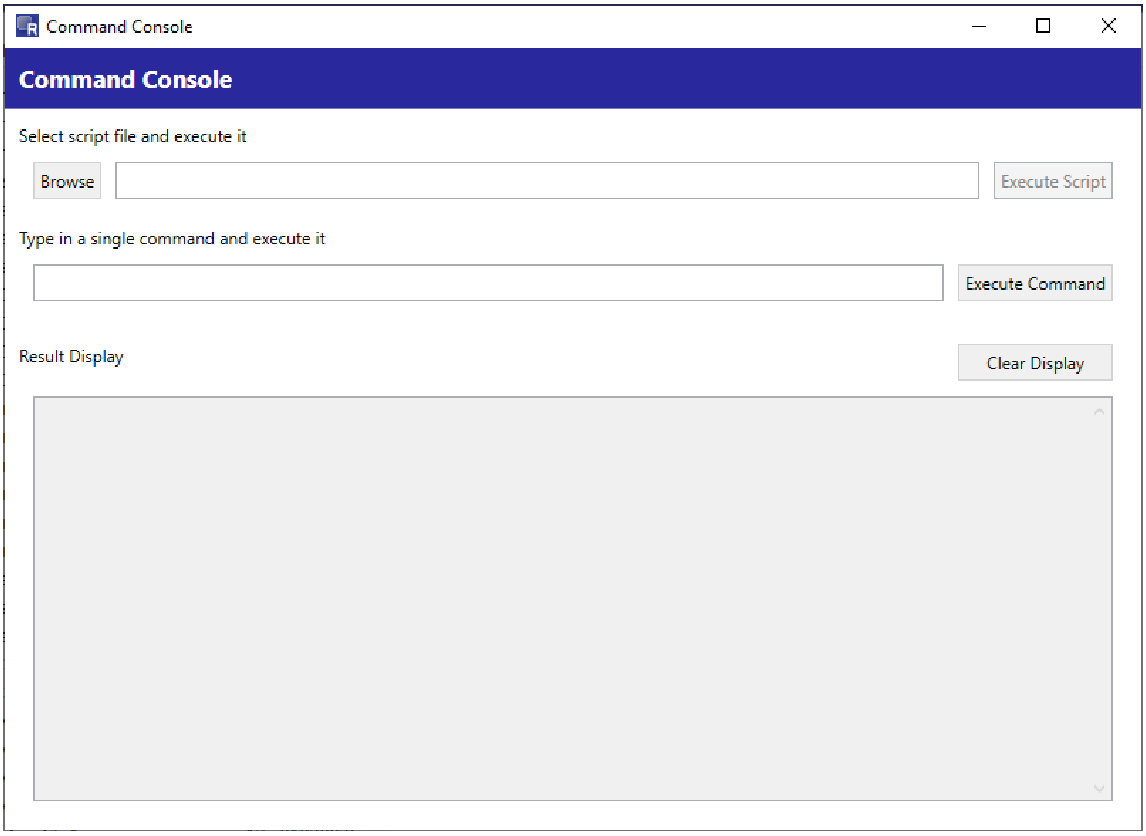



**Figure 166. Command Console Pop-Up Window**

### 3.10.1. Select Script and Execute

A previously edited script file, containing a commands sequence, can be loaded and executed directly by clicking the “Browse” button, selecting a file, and clicking the “Execute Script” button as shown in Figure 167.

The script file must be a text file with valid commands.

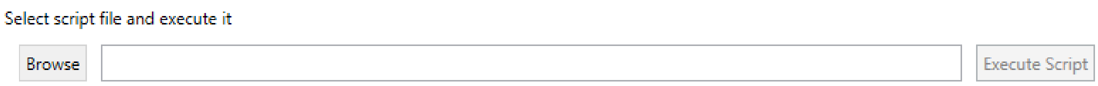



**Figure 167. Script Execution**

### 3.10.2. Type Single Command and Execute

A single command can be typed using the entry field and executed with “Execute Command” button shown in Figure 168.

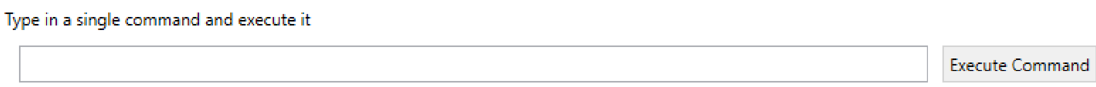



**Figure 168. Single Command Execution**

### 3.10.3. Result Display

The result of the execution of a command is returned in the area displayed in Figure 169. The output data of the ZSSC3286 can be marked and copied to the clipboard via a context menu (for example, for further analysis).

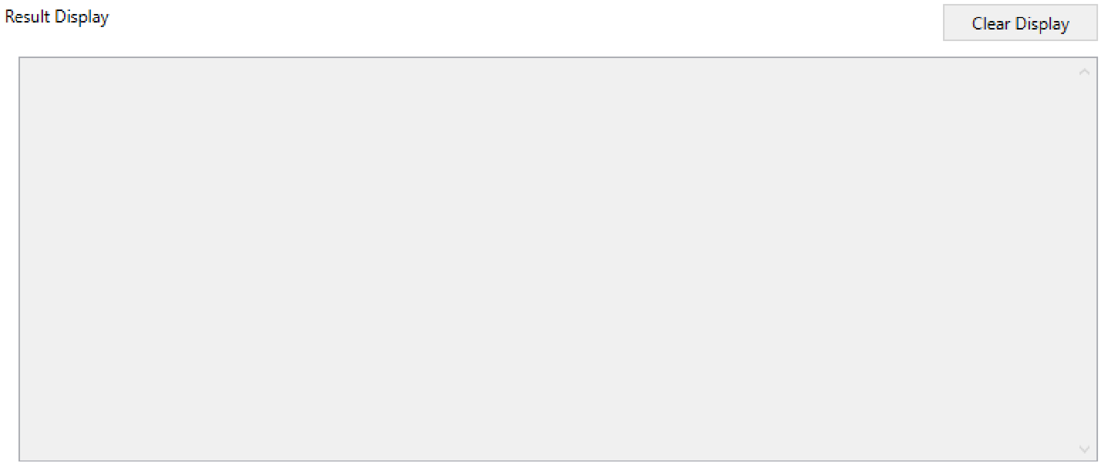



**Figure 169. Command Execution Result**

### 3.10.4. Clear Display

The Result Display area can be cleared using the “Clear Display” button (Figure 170).

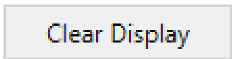



**Figure 170. Clear Display**

# 4. Example Configuration for Capacitive Measurement

This section describes how to use the Capacitive Replacement Board (SSCCRBV2) in an example configuration for capacitive measurements.

Before getting started, load the default NVM configuration.

Be aware that all measurement values may vary due to tolerance and parasitic effects.

During the configuration, calibration and IO-Link scaling, the SSCCRBV2 can be configured using the dedicated DIP-switches.

## 4.1 Target Sensor Steering and MDC counts

Table 11 shows the mapping of the target sensor steering to the actual capacitive values selected on the SSCCRBV2 and the expected MDC measurement values after the configuration and calibration process is performed.

**Table 11. Capacitive Example Value Mapping**

| Capacitive Value | Target Sensor Steering | MDC Measurement Value |
|---|---|---|
| 0 pF | 0% | -32760 |
| 5 pF | 10% | 500 |
| 45 pF | 90% | 4500 |
| 50 pF | 100% | 32760 |

## 4.2 Hardware Configuration

Refer to section 2.3 for hardware configuration. For this example, the SSCCRBV2 needs to be connected and the dip switches need to be configured to use application mode 1. Since IO-Link communication will be used, the IO-Link Master needs to be connected.

## 4.3 Configuration and Calibration

Configure the AFE:

1. Choose IO-Link in the “Connection” section and click on connect.
2. Select the “Configure Tab”, sub tab “AFE”, sub tab “Sensor”.
3. Select “Capacitive” from the “Sensor Type” drop down menu.
4. Select “1” from the “Application Mode” drop down menu.
5. Select “16” from the “ADCResolution” drop down menu.
6. Select “<80” from the “Max Input Cap” drop down menu.
7. Change the min value of the “Applied Sensor Steering” in the “Configuration Support” section to 10.
8. Change the max value of the “Applied Sensor Steering” in the “Configuration Support” section to 90.
9. Click on “Write Memory”.
10. Configure the SSCCRBV2 to have 5 pF at Cx and click on the “Get” button for the min value in the “Configuration Support” section.
11. Configure the SSCCRBV2 to have 45 pF at Cx and click on the “Get” button for the max value in the “Configuration Support” section.
12. Click on “Apply Settings”.
13. Click on “Write Memory”.

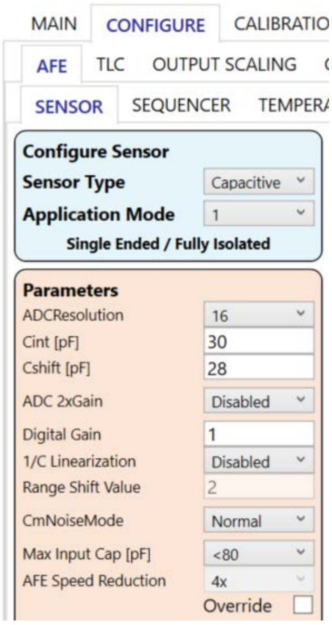



**Figure 171. Example Configuration (Capacitive)**

Calibrate the AFE:

1. Select the "Calibration" Tab.
2. Change the value of "S1" to 10.
3. Change the value of "S2" to 90.
4. Configure the SSCCRBV2 to have 5 pF at Cx and click on the "Get" button for the "S1" calibration point.
5. Configure the SSCCRBV2 to have 45 pF at Cx and click on the "Get" button for the "S2" calibration point.
6. Click on "Calculate Coefficients".
7. Click on "Write Memory".

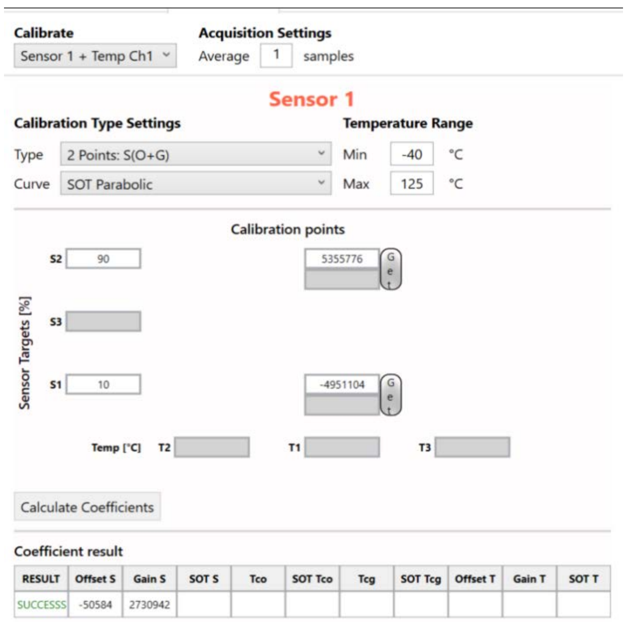



**Figure 172. Example Calibration (Capacitive)**

IO-Link SSP scaling:

1. Select the “IO-Link” tab, sub tab “SSP Scaling”.
2. Configure the SSCCRBV2 to have 5 pF at Cx and click on the “Get” button for the “Scaling Lower Value”.
3. Configure the SSCCRBV2 to have 45 pF at Cx and click on the “Get” button for the “Scaling Upper Value”.
4. Change the “Physical Value” for the lower value to 5000.
5. Change the “Physical Value” for the upper value to 45000.
6. Change the “Measurement Range Lower Value” to 100.
7. Change the “Measurement Range Lower Value” to 4900.
8. Click on “Calculate Coefficients”.
9. Click on “Write Memory”.

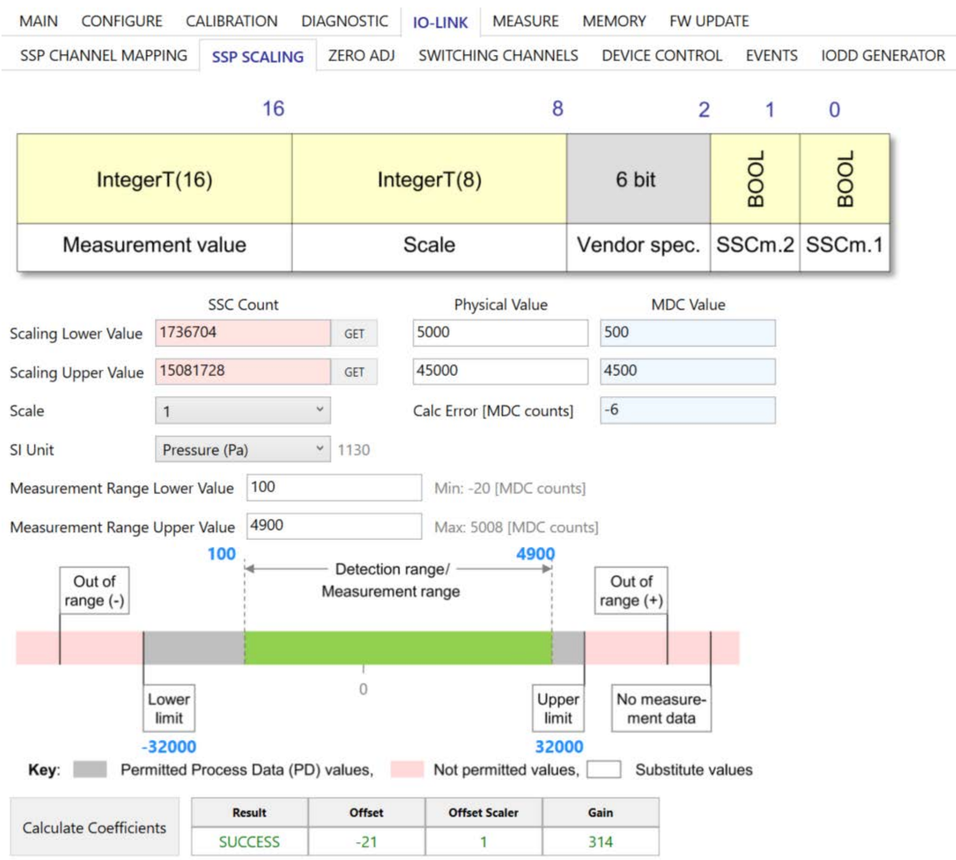



**Figure 173. Example IO-Link SSP Scaling (Capacitive)**

## 4.4 Capacitive Measurement

After configuration, calibration and IO-Link scaling, the measurements can be performed.

For 5pF, a measurement value of 500 MDC counts is expected. For 45pF, a measurement value of 4500 MDC counts is expected.

1. Select the “Measure” Tab.
2. Click on “Start”.
3. Change the value of $C_x$ to any value between 5pF and 45pF to see the measurement results.

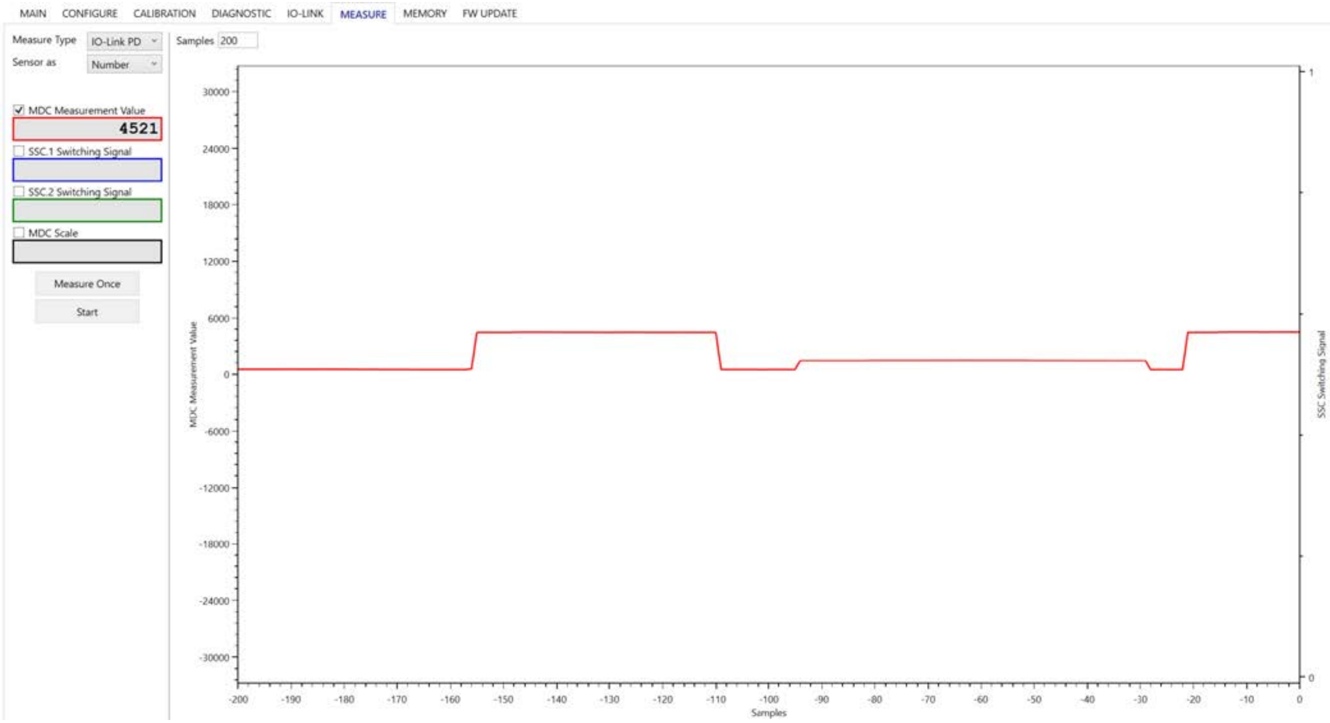



**Figure 174. Example IO-Link PD Measurement**

# 5. GUI and FW Revision References

| GUI Revision | FW Revision |
|---|---|
| 1.3.0 | 1.3.0 |

# 6. References

| Reference Number | Title |
|---|---|
| 1 | SSC-CB Datasheet available at: https://www.renesas.com/SSC-CB |
| 2 | RH4Z2501-PMOD Evaluation Board Manual available at: https://www.renesas.com/RH4Z2501-PMOD |
| 3 | ZSSC3286 Datasheet available at: https://www.renesas.com/ZSSC3286 |
| 4 | RH4Z2501 Datasheet available at: https://www.renesas.com/RH4Z2501 |

# 7. Glossary

| Term | Description |
|---|---|
| AFE | Analog Front End |
| AUX | Auxiliary |
| CB | SSC Communication Board V4.1 |
| C/Q | C/Q line of IO-Link interface. Connection for communication (C) or switching (Q) signal. |
| DC | Direct Current |
| DC-DC | Direct Current - Direct Current |
| ESD | Electrostatic Discharge |
| EVB | Evaluation Board |
| FW | Firmware |
| GND | Ground |
| GUI | Graphical User Interface (Renesas ZSSC3286 Application) |
| IC | Integrated Circuit |
| IO, I/O | Input Output |
| IODD | IO-Link Device Description |
| LDO | Low Drop Out |
| LED | Light Emitting Diode |
| MCU | Microcontroller |
| MDC | Measurement Data Channel |
| n.a. | not applicable |
| NPN | Negative-Positive-Negative |
| NTC | Negative Temperature Coefficient |
| NVM | Non-Volatile Memory |
| OWI | One Wire Interface |
| PC | Personal Computer |
| PCB | Printed Circuit Board |
| PD | Process Data |
| PHY | Physical Layer |
| PMOD | Digilent Pmod™ Connector |
| PTC | Positive Temperature Coefficient |
| QFN | Quad Flat No Leads Package |
| SM+, SM- | Sensor Measurement Positive, Sensor Measurement Negative |
| SRB | Sensor Replacement Board |
| SSC | Sensor Signal Conditioner |
| SSP | Smart Sensor Profile |
| TLC | Third Logic Channel |

# 8. Revision History

| Revision | Date | Description |
|---|---|---|
| 1.04 | Aug 10, 2026 | Evaluation Software version update; Capacitive Front End, Zero Adjustment Feature |
| 1.03 | Oct 27, 2025 | Evaluation Software version update; Hardware version and configuration, AOUT modes, Alarm/Binout Tab, PHY Tab, IODD Generator version, Command Console |
| 1.02 | Feb 28, 2025 | Evaluation Software version update; explanation of I/O Functions; Kit hardware setup picture |
| 1.01 | Jan 24, 2025 | Evaluation Software version update |
| 1.00 | Oct 9, 2024 | Initial release. |

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