
Contents

1. Kit Contents	8
2. Evaluation Kit Setup	8
2.1 User Equipment.....	8
2.2 User Computer Requirements and Setup.....	8
2.2.1 Computer Requirements.....	8
2.2.2 Software Installation and Setup	8
2.3 Board Configuration and Connection	9
2.4 Kit Hardware Connections	10
2.5 Communication Interfaces	11
2.5.1 I2C	11
2.5.2 SPI	11
2.5.3 OWI.....	12
2.6 Figure 7. OWI Bus JumpersPower Supply Options	12
2.7 Power-Up Procedure	12
3. GUI Top.....	13
3.1 Menu Bar	13
3.1.1 File Menu	13
3.1.2 Settings Menu	14
3.1.3 Tools Menu	14
3.1.4 Help Menu.....	15
3.2 Connection.....	15
3.3 IC Status	16
3.4 I/O Functions.....	16
3.5 Write Memory and Reset IC.....	16
3.6 Active Boards	17
3.7 System Status Bar.....	17
4. Main Tab	18
5. Configure Tab.....	18
5.1 Power Supply and Oscillator.....	18
5.1.1 Power supply.....	19
5.1.2 Oscillator	19
5.2 Serial Interfaces Tab	20
5.2.1 I2C/I3C.....	20
5.2.2 SPI.....	21
5.2.3 OWI.....	21
5.3 AFE Tab.....	25
5.3.1 Sequencer.....	25
5.3.2 Temperature Selection	32
5.3.3 Bridge.....	35
5.3.4 Temperature.....	45
5.4 Third Logic Channel	56

5.4.1	Output Scaling.....	56
5.5	Output Preprocessing.....	59
5.6	FOUT	59
5.6.1	Output Type	60
5.6.2	GPIOs	60
5.6.3	Frequency	60
5.6.4	Output Stimulus.....	60
5.7	AOUT.....	61
5.7.1	Output Operation Mode	61
5.7.2	AOUT Pin Mapping.....	72
5.7.3	AOUT Output Stimulus	73
5.8	Filter.....	73
5.9	EOC/Alarm.....	74
5.9.1	EOC	75
5.9.2	Alarm	75
5.10	System Control.....	78
5.11	Customer ID.....	78
6.	Measure	78
6.1	Measure Options Selection.....	79
6.1.1	Output Type	79
6.1.2	Measure	80
6.1.3	Sensor As.....	81
6.1.4	Temperature As.....	81
6.2	Selection for Displaying	81
6.3	Save Measured Data to File	82
6.4	Save Screen Displayed Data to File.....	82
6.5	Graphs Area.....	83
7.	Calibration	84
7.1	Sensor Selection, Acquisition Type.....	84
7.2	Calibration Type Settings.....	85
7.2.1	Type.....	85
7.2.2	Curve	86
7.3	Temperature Range	86
7.4	Calibration Points	86
7.5	Calculate Coefficients, Coefficient Results and Set in GUI	87
7.6	Dual Speed Mode Calibration	88
8.	Diagnostics	89
8.1	General Tab	89
8.2	Sensor/AFE Tab.....	89
8.2.1	User Selectable Input Fields	89
8.2.2	Diagnostics Operation	91
8.2.3	AFE Diagnostic Status.....	91
8.3	AFE Diagnostic Operation Example.....	92
9.	FW Update	93
10.	Memory.....	95
10.1	Overview.....	95
10.2	View Register	95

11. Command Console	97
11.1 Select Script and Execute.....	97
11.2 Type Single Command and Execute.....	97
11.3 Result Display	98
11.4 Clear Display	98
12. Glossary	99
13. SW and FW Release References	99
14. Revision History.....	99

Figures

Figure 1. ZSSC3281 SSC Evaluation Kit – Overview.....	9
Figure 2. ZSSC3281 EVB – Overview.....	9
Figure 3. ZSSC3281 Evaluation Board V4 – Top View with Jumpers.....	10
Figure 4. Sensor Replacement Board V3.1	10
Figure 5. I2C Bus Jumpers.....	11
Figure 6. SPI Bus Jumpers	11
Figure 7. OWI Bus JumpersPower Supply Options.....	12
Figure 8. GUI Main	13
Figure 9. Top Menu	13
Figure 10. File Menu.....	13
Figure 11. Settings Menu	14
Figure 12. Settings Menu – Warnings	14
Figure 13. Tools Menu	14
Figure 14. Tools Menu – Open Logfile.....	14
Figure 15. Tools Menu – Command Console	15
Figure 16. Help Menu	15
Figure 17. Connection.....	15
Figure 18. IC Status.....	16
Figure 19. I/O Functions.....	16
Figure 20. Active Boards.....	17
Figure 21. Active Boards – Info	17
Figure 22. System Status Bar	17
Figure 23. Block Diagram on Main Tab	18
Figure 24. Power Supply and Oscillator.....	18
Figure 25. Power Supply Selection.....	19
Figure 26. Oscillator Output	19
Figure 27. Serial Interfaces	20
Figure 28. Serial Interfaces - I2C/I3C	20
Figure 29. Configure – Serial Interfaces – SPI.....	21
Figure 30. Serial Interfaces - OWI	21
Figure 31. OWI Window	22
Figure 32. OWI Window Selection.....	22
Figure 33. OWI Digital.....	23
Figure 34. OWI Analog Voltage Mode 5V VOUT	23
Figure 35. OWI Analog Voltage Mode 10V VOUT	24
Figure 36. OWI over Analog Current Loop 2-Wire	24

Figure 37. Configuration for Communication OWI over 2WCL	24
Figure 38. Connecting with OWI over 2WCL	25
Figure 39. AFE Selection and Configurability	25
Figure 40. Dual Speed Resistive Bridge Input Configuration.....	26
Figure 41. Sequencer Error Message	26
Figure 42. Sequencer Main Mode	26
Figure 43. SM+/SM- Exchange	26
Figure 44. Auto-Zero Sensor Measurement.....	27
Figure 45. Accelerated Measurements	27
Figure 46. Advanced Options.....	27
Figure 47. Advanced Options – Aux Slots	28
Figure 48. Main Mode Set to Deterministic Sensor Step Response – SM/AUX	28
Figure 49. Auxiliary Measurements	28
Figure 50. Auxiliary Measurements Enabled Displayed in GUI	29
Figure 51. Sequencer – Idle Time	29
Figure 52. Accelerated Main Measurement: SM Combinations.....	29
Figure 53. Auxiliary Insertion Rate	30
Figure 54. Auxiliary Insertion Rate: SM+AUX_AZ after the Eights Measurement	30
Figure 55. Sequence Execution	31
Figure 56. Sequence Execution Example.....	31
Figure 57. Dual Speed Settings.....	32
Figure 58. Temperature Selection Overview.....	32
Figure 59. Temperature Selection – Dual Speed	33
Figure 60. Acquired Data Stream Overview.....	33
Figure 61. AFE Status.....	34
Figure 62. Temperature Sensor Activation	34
Figure 63. Sensor to Channel Assignment	35
Figure 64. Voltage Mode.....	36
Figure 65. Resistor Mode	37
Figure 66. Current Mode	38
Figure 67. Thermopile Mode	39
Figure 68. Configure Register	39
Figure 69. Meas Config Menu	39
Figure 70. Meas Config: Single	40
Figure 71. Meas Config: Single AZ	40
Figure 72. Bridge – Sensor Values.....	40
Figure 73. Bridge – Parameters	41
Figure 74. Mode Voltage Schematic.....	41
Figure 75. Internals Example	42
Figure 76. Internals Out of Range	42
Figure 77. Schematic and Graphs Selection.....	43
Figure 78. Combined Graphs	43
Figure 79. Dual Speed Mode for Bridge 1	44
Figure 80. Dual Speed Mode for Bridge 2	45
Figure 81. Temp – Mode Sink Internal Bias	46
Figure 82. Temp – Mode Source Internal Bias	47
Figure 83. Mode Source External Bias Low	48
Figure 84. Mode Source External Bias High	49

Figure 85. External RH, RL	49
Figure 86. Mode Bridge Internal Bias	50
Figure 87. Mode Bridge External Bias	51
Figure 88. Mode Bridge Differential	52
Figure 89. Configure Register	52
Figure 90. Copy to Temp	52
Figure 91. Temp – Sensor Values	53
Figure 92. Parameters	53
Figure 93. Temp – Schematic	54
Figure 94. Internals	54
Figure 95. Internals Out of Range	55
Figure 96. Schematic and Graphs Selection	55
Figure 97. Combined Graphs	55
Figure 98. Third Logic Channel Operations	56
Figure 99. Third Logic Channel – Channel Order	56
Figure 100. Output Scaling	56
Figure 101. Back to Defaults	57
Figure 102. 50% to 100% Output	57
Figure 103. Coefficients for 0% to 100% Output	58
Figure 104. 0% to 100% Output	58
Figure 105. Output Pre-Processing Defaults	59
Figure 106. Clipping Limits	59
Figure 107. FOUT	59
Figure 108. Configure – FOUT – Output Type	60
Figure 109. FOUT - GPIOs	60
Figure 110. Configure – FOUT – Frequency Range	60
Figure 111. Configure – FOUT- Direct Setting	60
Figure 112. AOUT mapping	61
Figure 113. AOUT – Operation Mode	61
Figure 114. AOUT Power Supply	61
Figure 115. Absolute Voltage 0V-10V - Jumpers	62
Figure 116. AOUT — Measure	62
Figure 117. Absolute Voltage 0V - 10V Configuration	62
Figure 118. Absolute Voltage 0V-5V - Jumpers	63
Figure 119. Absolute Voltage 0V-5V Configuration	63
Figure 120. Absolute Voltage 0V-1V - Jumpers	64
Figure 121. Absolute Voltage 0V to 1V Configuration	64
Figure 122. Ratiometric Voltage Jumpers	65
Figure 123. Ratiometric Voltage Configuration	66
Figure 124. 2-Wire Current Loop Jumpers	67
Figure 125. 2-Wire Current Loop SRBV3 Specific Configuration	67
Figure 126. 2-Wire Current Loop Single AFE Active	68
Figure 127. 2-Wire Current Loop Power Supply and Oscillator	68
Figure 128. Default Calibration Coefficients	68
Figure 129. 2-Wire Current Loop Calibration	69
Figure 130. 2-Wire Current Loop Calibration Measured Coefficients	70
Figure 131. 3-Wire-Current-Loop Jumper Setting	71
Figure 132. 3-Wire Current Loop Calibration	71

Figure 133. 3-Wire Current Loop calibration Measured Coefficients	72
Figure 134. AOUT Pin Mapping	72
Figure 135. AOUT Direct Setting	73
Figure 136. Filter Tab	73
Figure 137. Filter Time Constant Setting	73
Figure 138. Filter Response (Digital Domain)	74
Figure 139. EOC/Alarm Signals	74
Figure 140. EOC Polarity	75
Figure 141. EOC Generation	75
Figure 142. Alarm Configuration Options	76
Figure 143. Alarm Threshold Mode, Range and Hysteresis	77
Figure 144. System Control	78
Figure 145. Customer ID	78
Figure 146. Measure Tab	78
Figure 147. Resolution from Device to GUI	79
Figure 148. Measure Selection	79
Figure 149. Output Type	79
Figure 150. Analog AOUT Read-back	80
Figure 151. Measure	80
Figure 152. Measurement Acquisition	81
Figure 153. Sensor As	81
Figure 154. Temperature As	81
Figure 155. Display Selection	81
Figure 156. Save Measured Data	82
Figure 157. Selected Display Resolution	82
Figure 158. Save Screen Displayed Data	82
Figure 159. Graphs Area	83
Figure 160. Calibration Tab	84
Figure 161. Sensor, Acquisition	84
Figure 162. Acquisition Type	84
Figure 163. Calibration Type	85
Figure 164. Curve	86
Figure 165. Temperature Range and Sample Settings	86
Figure 166. Calibration Points Input	86
Figure 167. Calculate Coefficients, Set in GUI	87
Figure 168. Coefficient Result	87
Figure 169. Dual Speed Channel Calibration	88
Figure 170. Dual Speed Channel Calibration – New Coefficients Ready	88
Figure 171. Diagnostic State Signalization Enable	89
Figure 172. Diagnostic Tab	89
Figure 173. Cbr and Cts Capacitors	90
Figure 174. UDR/LDR Selection	90
Figure 175. Input for AFE Gain Check	90
Figure 176. AFE Reference Gain	91
Figure 177. AFE Gain Tolerance	91
Figure 178. AFE Offset Reference and Tolerance	91
Figure 179. Diagnostic Check and Reset	91
Figure 180. AFE Diagnostic Status	91

Figure 181. Activation of Diagnostic Check	92
Figure 182. Diagnostic Check Pass.....	92
Figure 183. Diagnostic Check Fail.....	92
Figure 184. IC Status Sensor Connection Fail	92
Figure 185. FW Update Tab.....	93
Figure 186. FW update file not valid	93
Figure 187. Valid FW update file identified	93
Figure 188. FW Update Operation	94
Figure 189. FW Update Finished.....	94
Figure 190. Memory Overview	95
Figure 191. Register	95
Figure 192. Memory – View Register	95
Figure 193. Register Content	96
Figure 194. Changes not Written to NVM	96
Figure 195. Modified Bits in a Register –Changes not Written to NVM	97
Figure 196. Script Execution	97
Figure 197. Single Command execution.....	97
Figure 198. Command Execution Result	98
Figure 199. Clear Display.....	98

1. Kit Contents

Find the KIT on www.renesas.com/ZSSC3281KIT

- ZSSC3281 Evaluation Board – ZSSC328XEVB
- SSC Communication Board - SSCCOMMBOARDV4P1C
- SRB Sensor Replacement Board - SSCSRBV3
- ZSSC3281 40-PQFN – 5 pcs
- USB cable

2. Evaluation Kit Setup

2.1 User Equipment

A Windows®-based computer is required for interfacing with the kit and configuring the ZSSC3281.

2.2 User Computer Requirements and Setup

2.2.1 Computer Requirements

Note: The user must have administrative rights on the computer to download and install the ZSSC3281 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
- USB port
- Internet access to download the install setup

2.2.2 Software Installation and Setup

The latest version of ZSSC3281 Evaluation Software, 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 procedures to install the Evaluation Kit Software on the user's computer:

1. Downloading and extract the contents of the zip file to the user's computer.
2. Double click on the extracted ZSSC328x Application Setup.exe file.
Follow the resulting standard 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>ZSSC328x Application> ZSSC328x Application.
The installation dialog offers the option to create a desktop short-cut icon for the software if selected.
3. Connect the kit hardware as described in section 2.3.
4. Start the software program.

2.3 Board Configuration and Connection

Sections 2.4 to 0 describe information about features of the evaluation kit HW.

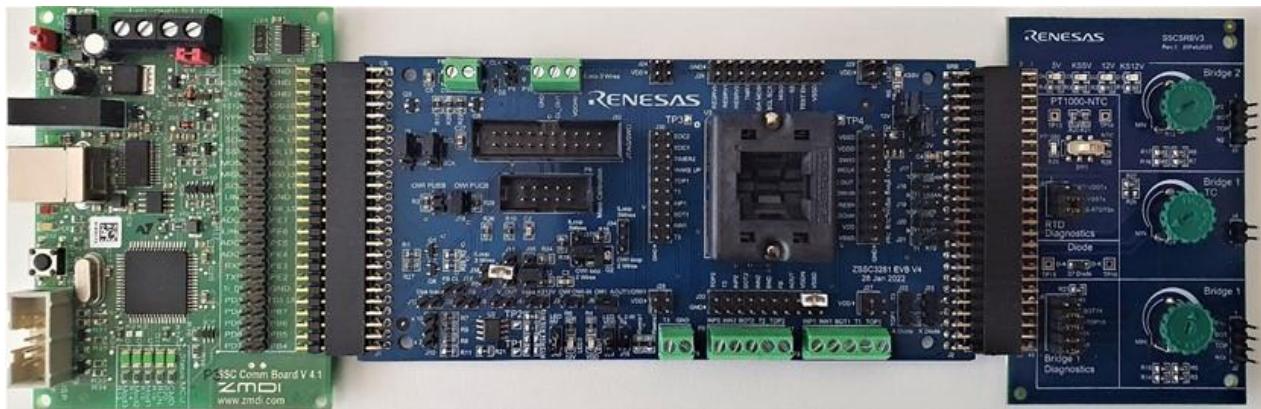


Figure 1. ZSSC3281 SSC Evaluation Kit – Overview

For a complete description of the SSC Communication Board V4.1 (CB), refer to the relevant datasheet available at the following link:

<https://www.renesas.com/eu/en/products/sensor-products/sensor-signal-conditioners-ssc-afe/ssc-cb-ssc-communication-board> .

Ensure to have the CB with Firmware revision 4.20.4 (see Figure 20) or greater, to have all the GUI functionalities operational. The CB Firmware update package is available at the following link:

<https://www.renesas.com/eu/en/products/sensor-products/sensor-signal-conditioners-ssc-afe/ssc-cb-ssc-communication-board>

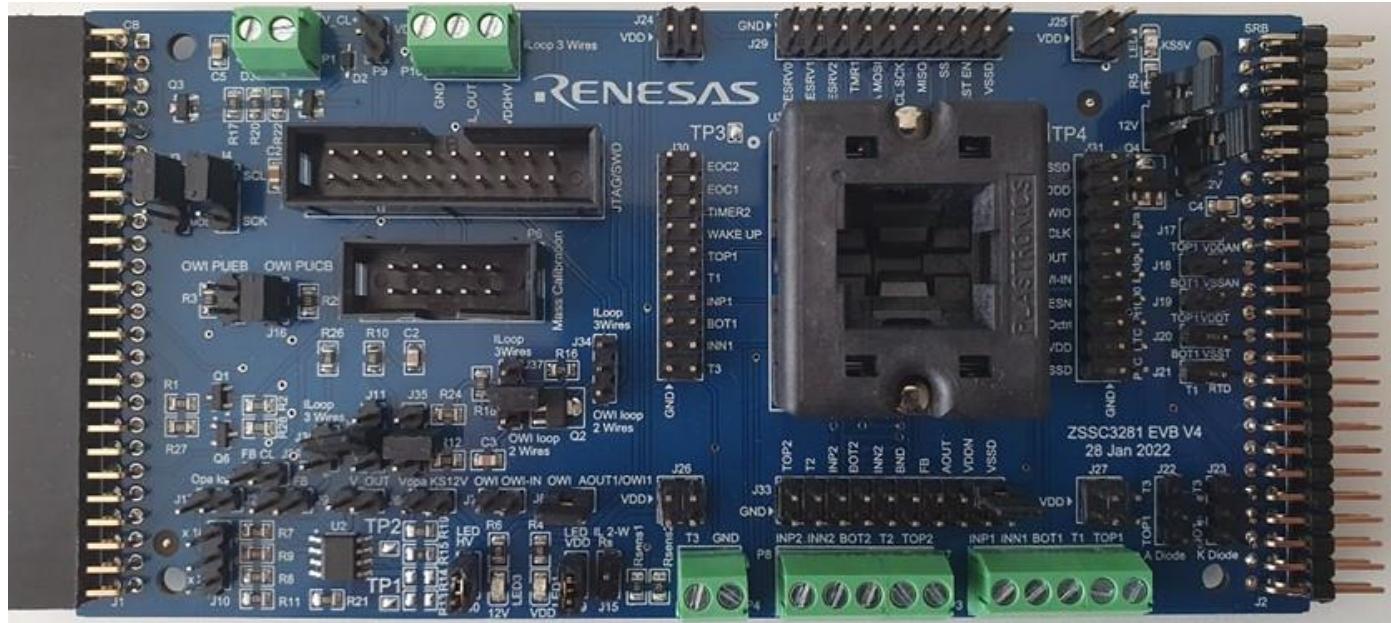


Figure 2. ZSSC3281 EVB – Overview

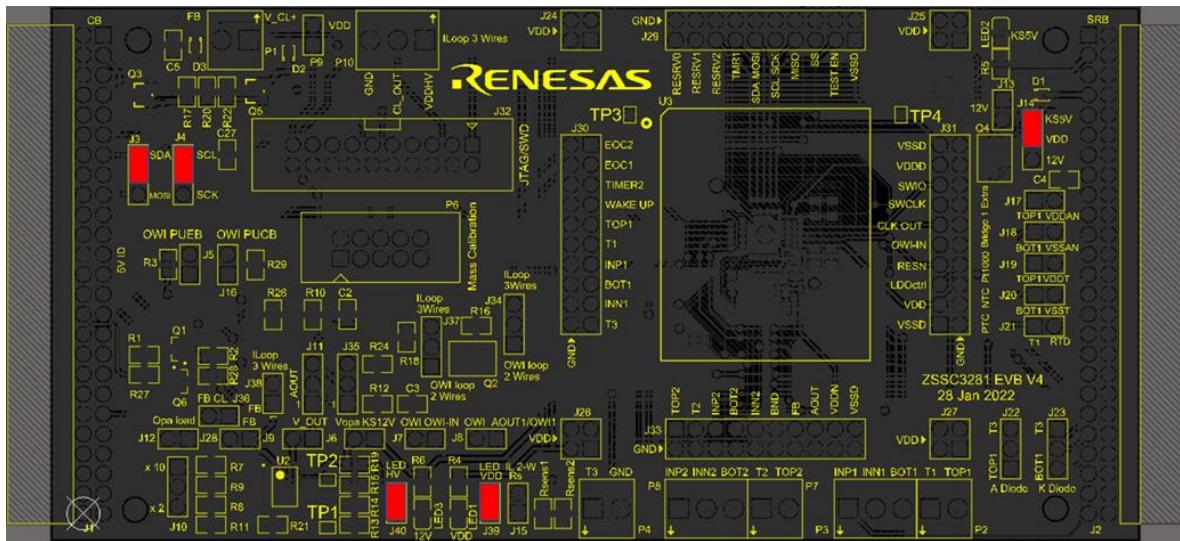


Figure 3. ZSSC3281 Evaluation Board V4 – Top View with Jumpers

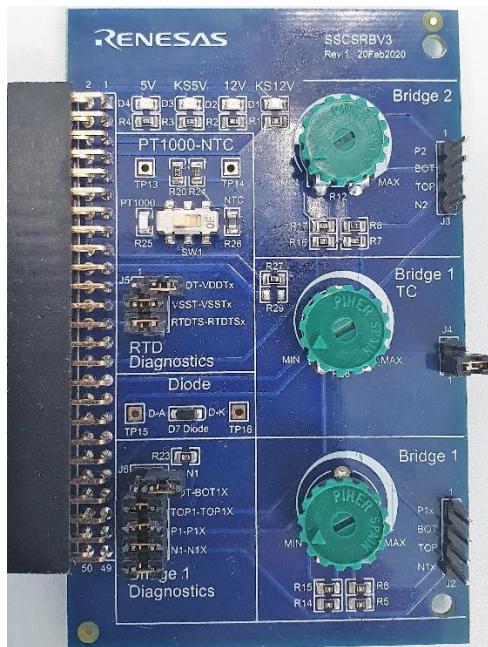


Figure 4. Sensor Replacement Board V3.1

2.4 Kit Hardware Connections

Follow these steps to assemble the three PCBs as shown in Figure 1 to start-up of the kit with default settings:

1. Connect the ZSSC3281 Evaluation Board (J1) to the SSC CB V4.1 (K6).
2. Connect the ZSSC3281 Evaluation Board (J2) to the Sensor Replacement Board V3.1.
3. Replace the dummy IC in the socket with a ZSSC3281 device under test (DUT). Take care to place the pin 1 as shown on Figure 3 (dot on the silkscreen close to TP3).
Default jumpers positions on EVB and SRB are visible in Figure 3 (J3-J4-J8-J14) and Figure 4 (J5-J6-SW1) respectively.
Use an ESD safe vacuum suction pen for correct handling of the ICs. The smallest suction cup is best suited for the ZSSC3281 samples.

The Evaluation kit is designed for operation at room temperature; use of the EVK in a thermal chamber may cause damage to the boards.

2.5 Communication Interfaces

The ZSSC3281 device supports SPI, I2C, and OWI as communication interfaces. The Evaluation Board supports all three of them, while only one can be active at a time. Sections 3.1.2 and 3.2 provide details about the corresponding Graphical User Interface (GUI) settings.

The ZSSC3281 Evaluation Board is using the SSC CB to translate these interfaces to USB. Only one SSC CB can be connected to the user's computer to operate GUI normally.

2.5.1 I2C

JP3 and JP4: short between pins 1 and 2 to use I2C.

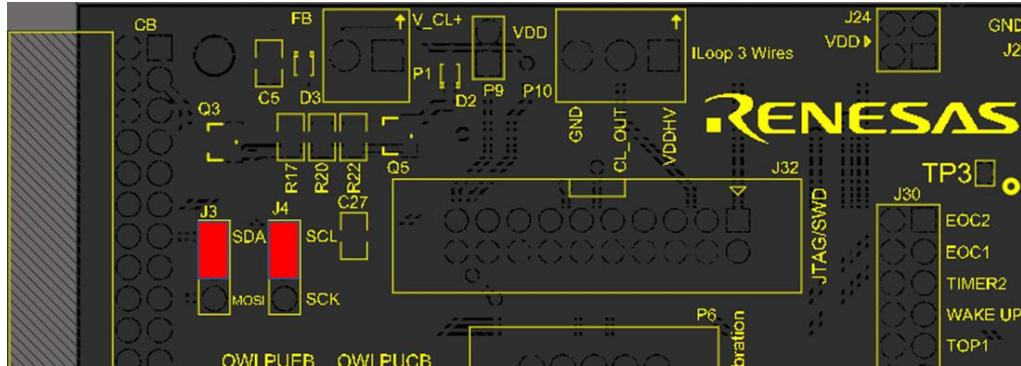


Figure 5. I2C Bus Jumpers

2.5.2 SPI

JP3 and JP4: short between pins 2 and 3 to use SPI.

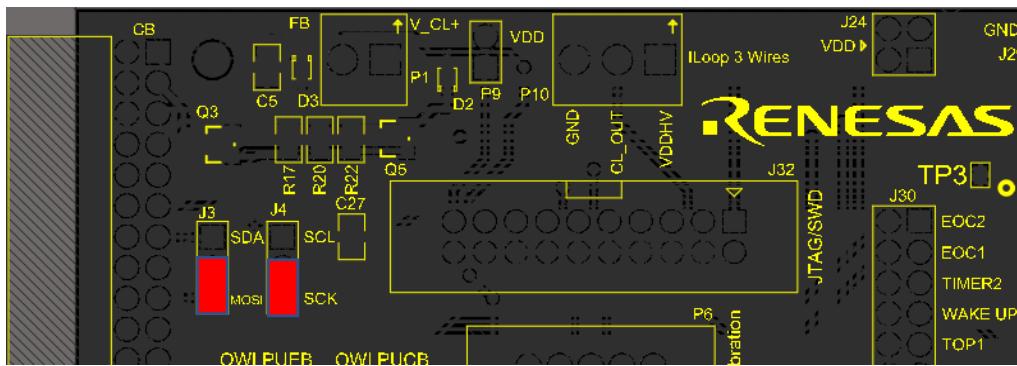


Figure 6. SPI Bus Jumpers

2.5.3 OWI

J8 and J16: short to use OWI.

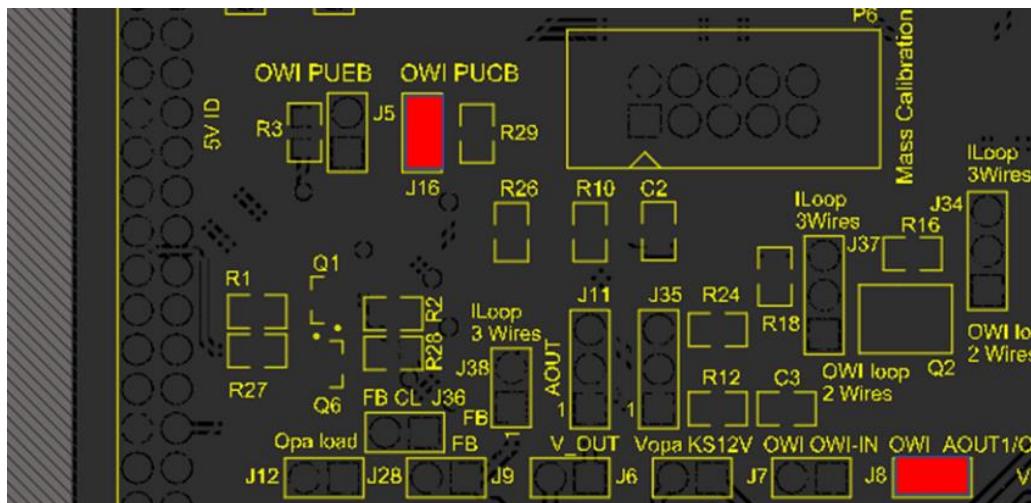


Figure 7. OWI Bus Jumpers Power Supply Options

ZSSC3281 has the following power supply options:

- 5V provided by the CB: J14 1-2 shorted (default)
- 12V is provided by the CB, regulated by the MOS and controlled by the LDOctrl line from the ZSSC3281: J13 short, J14 2-3 shorted.

Note: for this option relevant NVM configuration must be in place, otherwise damage may occur to the ZSSC3281 and/or the EVB. Refer to section 5.1.1.

2.6 Power-Up Procedure

The ZSSC3281 Evaluation Software is intended for demonstration purposes and calibration of single units. Upon request, Renesas provides the user with algorithms and assistance in developing their full production calibration software.

Follow these steps for powering up the EVB by the CB:

1. Connect the kit as described in Figure 1 and connect the USB cable to the host PC
2. Launch the GUI.
3. Select one of the three serial buses options.
4. Click “Connect”: the CB will power up the EVB.

IMPORTANT NOTE: The configuration of the ZSSC3281 must be performed through the GUI. Manual modification of the configuration file (see section 3.1.1) not followed by a consistency check of the configuration performed through the GUI, may lead to unhandled device status.

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

3. GUI Top

The main screen of the GUI is shown in Figure 8.

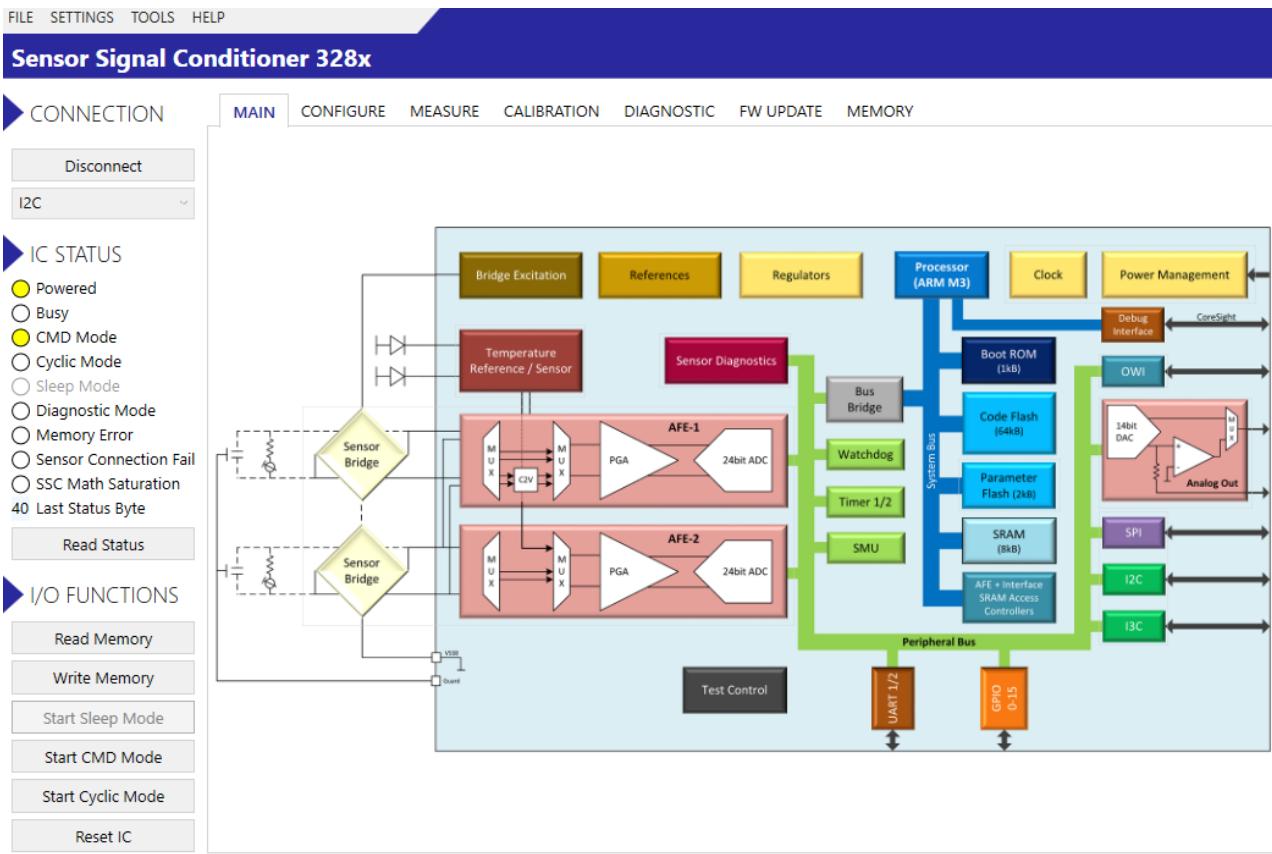


Figure 8. GUI Main

3.1 Menu Bar

The Menu bar (see Figure 9) provides access to files operation, serial bus settings, the CB log file, and software versioning information.



Figure 9. Top Menu

3.1.1 File Menu

File menu (see Figure 10) allows to load, save, or save the GUI configuration with a different name. 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.

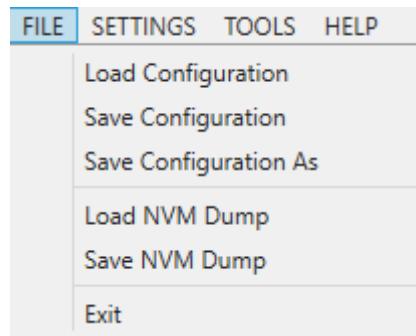


Figure 10. File Menu

3.1.2 Settings Menu

Settings menu (see Figure 11) allows configuring the following parameters relevant to the digital serial buses:

- I2C: device address, and SCL frequency
- SPI: SCK frequency, Slave Select polarity, SCK polarity and phase
- OWI:
 - Address
 - Window (first or second)
 - Frequency of bus
 - Frequency of bus for in case of OWI over-current loop

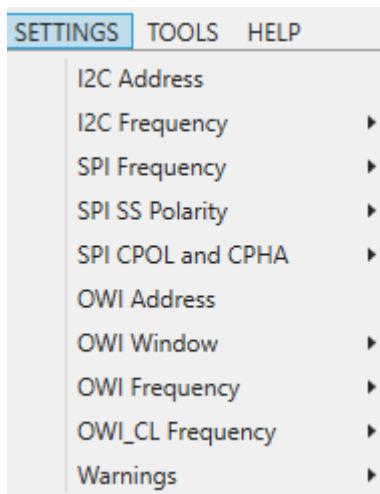


Figure 11. Settings Menu

The Settings menu allows the user to enable or disable GUI warning messages (see Figure 12).

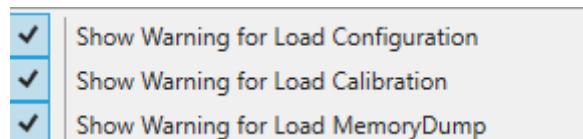


Figure 12. Settings Menu – Warnings

3.1.3 Tools Menu

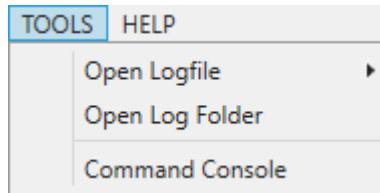


Figure 13. Tools Menu

The Tools menu (see Figure 13) provides the following options:

- Open Logfile: the available Error, Communication, or Calibration log files can be opened for here (see Figure 14).

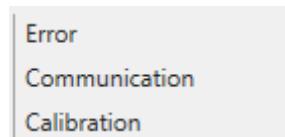


Figure 14. Tools Menu – Open Logfile

- Open Log Folder
- Command Console: the command console can be launched in here (see Figure 15), for detailed description of the available options see section 11.

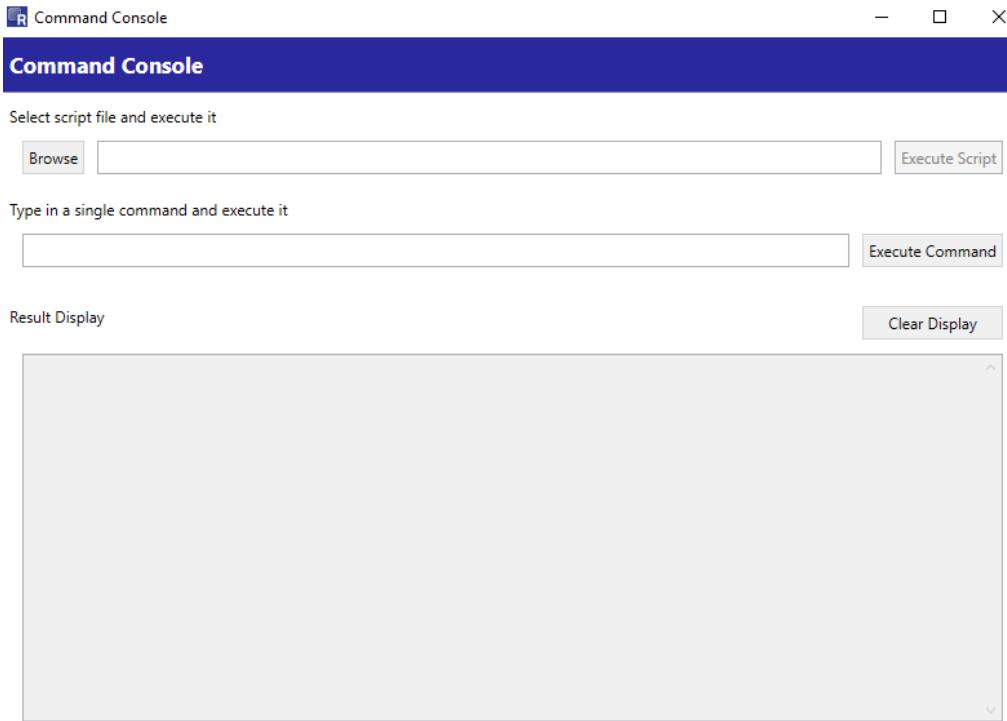


Figure 15. Tools Menu – Command Console

3.1.4 Help Menu

The Help menu (see Figure 16) has relevant information of the GUI. The 'About' option displays the GUI version, the USB driver version, and the Communication Board firmware version.



Figure 16. Help Menu

3.2 Connection

The connection area (Figure 17) allows the user to establish communication between the GUI, the Communication board, and the ZSSC3281 EVB.

Select the type of digital serial bus from a list of options (see Figure 17). For the serial buses requiring a device address, ensure that the same one is set in the device through the GUI, see section 3.1.2 for details.

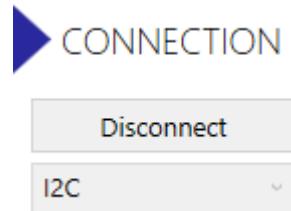


Figure 17. Connection

3.3 IC Status

The device status byte is described in the *ZSSC3281 Datasheet* document. When connection to the device is operational, the applicable status information is highlighted with the yellow status button (see Figure 18).

Pressing the “Read Status” button (see Figure 18) the most recent status byte is retrieved and the value (Hexadecimal) is displayed above the button. Refer to the *ZSSC3281 Datasheet* document for full information on the Status Byte.

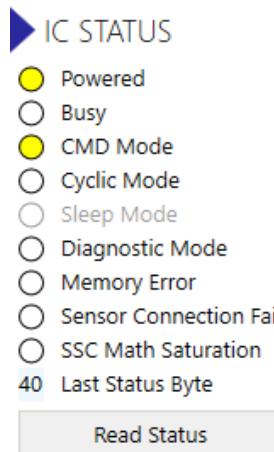


Figure 18. IC Status

3.4 I/O Functions

The I/O Function area (Figure 19) allows, through a set of pushbuttons, to perform the most basic functions with the ZSSC3281: read and write memory, enter in Command or Cyclic Mode, or Reset IC (HW line from CB connected to the reset pin of the IC).

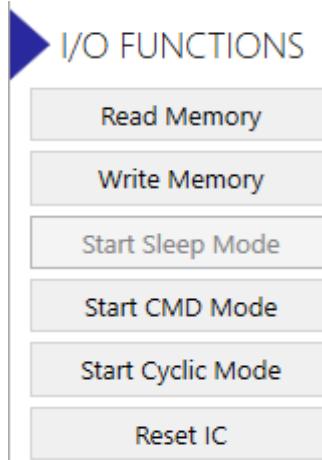


Figure 19. I/O Functions

3.5 Write Memory and Reset IC

The Write Memory button allows to write the device memory with updated values by performing an IC memory update and immediately resetting the device. All NVM memory changes are at this point fully operational. A separate IC reset is available through the Reset IC button.

3.6 Active Boards

This area (Figure 20) displays information about the boards currently connected to the host PC.

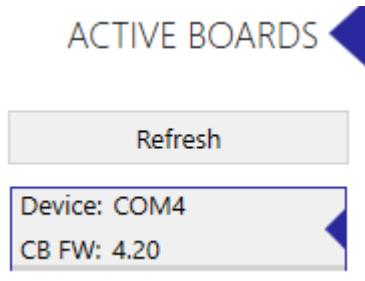


Figure 20. Active Boards

Tooltip information is available for the devices in the information area (Figure 20). Additional details are available to the user (Figure 21).

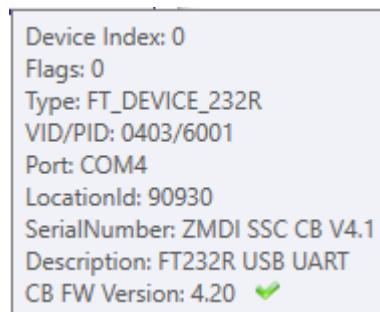


Figure 21. Active Boards – Info

3.7 System Status Bar

The system status bar is located in the bottom part of the GUI and is visible from any tab. It displays a set of information relevant to the EVB and the ZSSC3281 (see Figure 22).



Figure 22. System Status Bar

The following information is provided to the user in the system status bar:

- Digital bus currently in use
- Bus clock speed
- Device address (when applicable)
- FW version in the ZSSC3281
- ZSSC3281 system clock frequency
- Status on NVM (Memory Sync)
- Green status button: NVM is updated with last changes in GUI

4. Main Tab

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

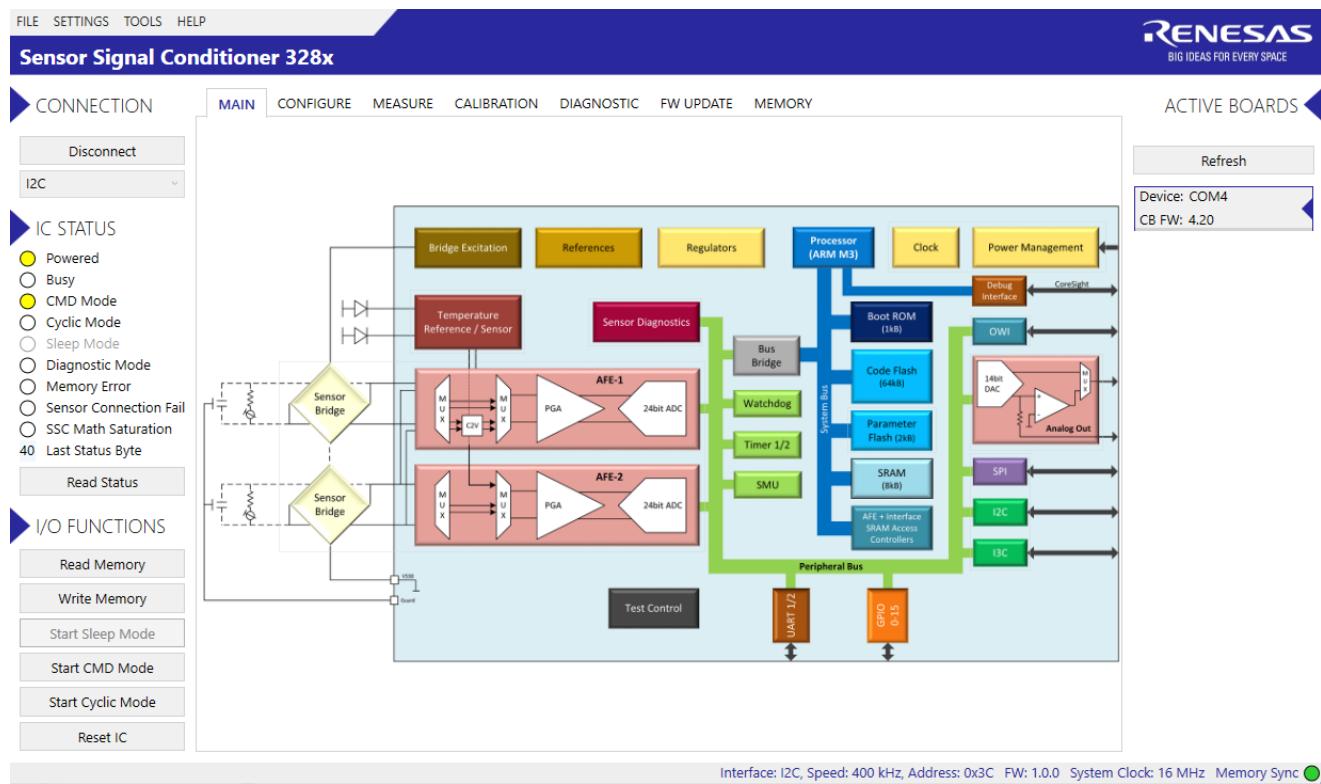


Figure 23. Block Diagram on Main Tab

5. Configure Tab

5.1 Power Supply and Oscillator

This tab (Figure 24) allows the configuration of the power supply rail of the ZSSC3281, and the output clock that is available on the GPIO14 (pin 26).

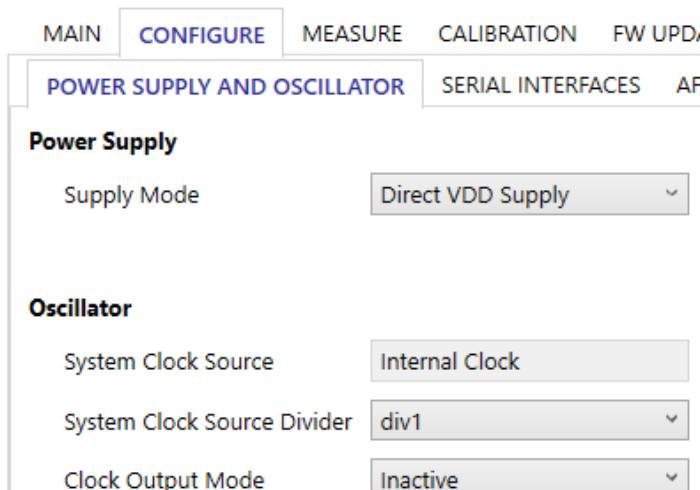


Figure 24. Power Supply and Oscillator

5.1.1 Power supply

The power supply selection (Figure 25) allows to configure the following options:

- Supply Mode
- Regulated VDD

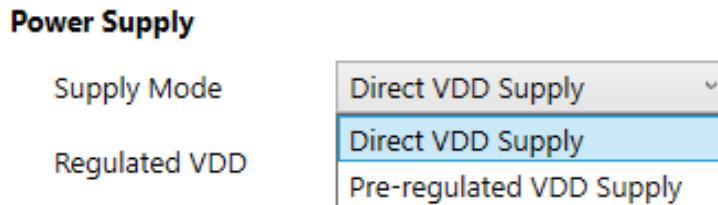


Figure 25. Power Supply Selection

'Direct VDD Supply' option makes the device ready to be supplied directly from the 5V rail provided by the CB. The 'Pre-regulated VDD Supply' option uses a 12V rail from the CB, stepped down by the EVB on board JFET controlled by the ZSSC3281 itself. For EVB power supply jumper settings see section 0.

5.1.2 Oscillator

The oscillator selection (Figure 26) allows to configure the following options:

- System Clock Source
- System Clock Source Divider
- Clock Output Mode

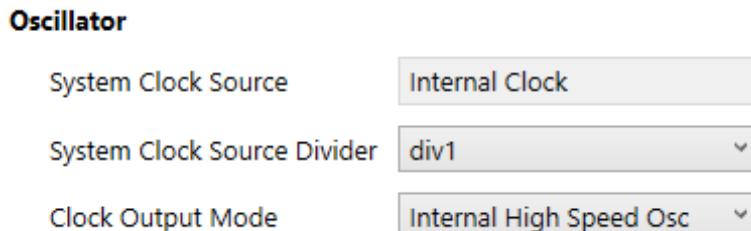


Figure 26. Oscillator Output

When selecting any value different from "div1" for the 'System Clock Source Divider', the actual system clock for the device ARM core is divided accordingly from the 16MHz internal clock source.

The 'System Clock Source Divider' options applies only when 'System Clock' value is selected for the 'Clock Output Mode'.

5.2 Serial Interfaces Tab

This tab (see Figure 27) allows to configure the three serial buses available for communication with the ZSSC3281. The settings selected in this tab need to match the selections made through the options available in section 3.1.2.

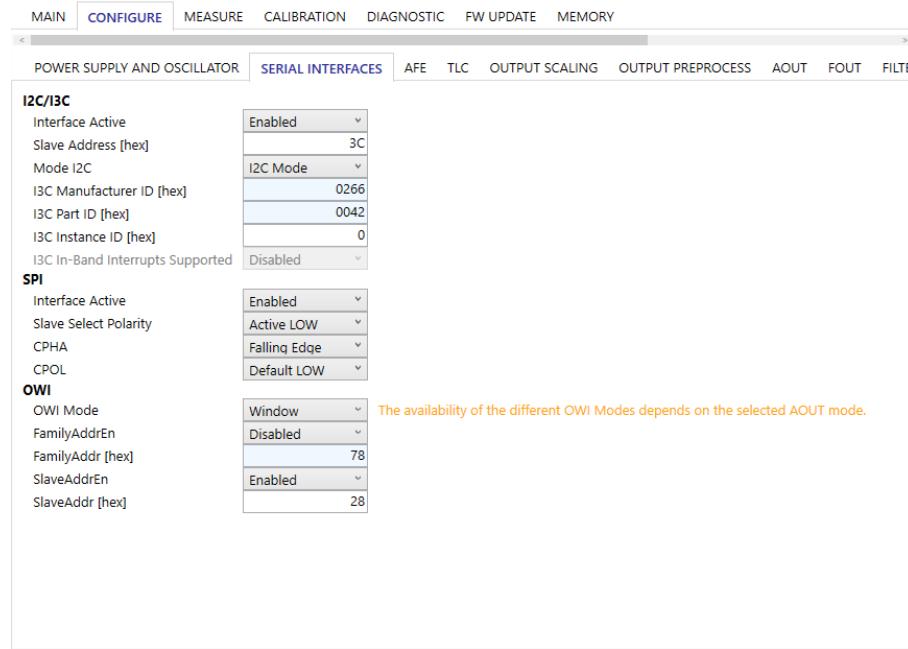


Figure 27. Serial Interfaces

5.2.1 I2C/I3C

The I2C/I3C selection (Figure 28) allows to configure the following options for the serial bus:

- Interface Active: enables or disables the bus interface
- Slave Address [hex]: user configurable slave address (Default: 0x3C)
- Mode I2C:
 - I2C default mode: all I3C functionality disabled
 - I3C: only partially supported by the EVK (limited speed, no I3C 3C in-band interrupts)
- I3C Manufacturer ID [hex]: read only – Renesas reserved
- I3C Part ID [hex]: read only - Renesas reserved
- I3C Instance ID [hex]: identifies the device
- I3C In-Band Interrupts Supported: for I3C only, not supported by the EVK

When the field “Interface Active” is “Enabled” the serial communication through the I2/3C bus is possible, see sections 2.5 and 3.1.2.

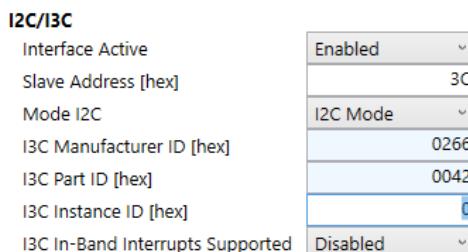


Figure 28. Serial Interfaces - I2C/I3C

5.2.2 SPI

The SPI selection (Figure 29) allows to configure the following options for the serial bus:

- Interface Active: enables or disables the bus interface
- Slave Select Polarity: active LOW or HIGH
- CPHA: data sampling edge
- CPOL: SCK LOW or HIGH

When the field “Interface Active” is “Enabled”, the serial communication through the SPI bus is possible, see sections 2.5 and 3.1.2.

SPI	
Interface Active	Enabled
Slave Select Polarity	Active LOW
CPHA	Falling Edge
CPOL	Default LOW

Figure 29. Configure – Serial Interfaces – SPI

5.2.3 OWI

The OWI tab (Figure 30) allows to configure the following options for the serial bus:

- OWI Mode:
 - Off: OWI interface is disabled.
 - Window
 - Digital Mode
 - Analog Voltage 5V
 - Analog Voltage 10V
 - Analog Current loop 2W
 - Analog Current loop 3W
- FamilyAddrEn: family addressing not supported (default)
- FamilyAddr [hex]: read only – Renesas reserved
- SlaveAddrEn: slave addressing, the default is ‘Disabled’
- SlaveAddr [hex]: user configurable slave address (default 0x28)

OWI	
OWI Mode	Off
FamilyAddrEn	Disabled
FamilyAddr [hex]	78
SlaveAddrEn	Enabled
SlaveAddr [hex]	28

Figure 30. Serial Interfaces - OWI

5.2.3.1 OWI Window

The OWI startup command must be received at either AOUT/OWI1 or OWI-IN pins, during the window time (200ms per channel).

Figure 31 shows the status of the OWI interface according to the time window and command received.

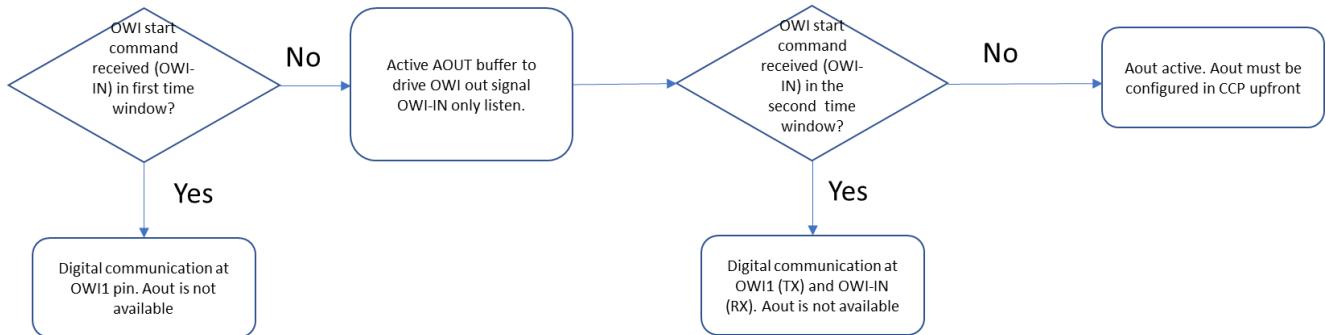


Figure 31. OWI Window

Supported AOUT Modes for OWI Window Mode:

- Absolute Voltage: 0V to 10V
- Absolute Voltage: 0V to 5V
- Ratiometric Voltage
- 2-wire-current-loop
- 3-wire-current-loop

The GUI provides the option to select to connect with the OWI bus in the first or in the second time window, see Figure 32 (refer to *ZSSC3281 Datasheet* document for a comprehensive description of the OWI Window functionality). The default is 'First', jumper to be in place is J8. If 'Second' is selected, jumper J7 must be in place.

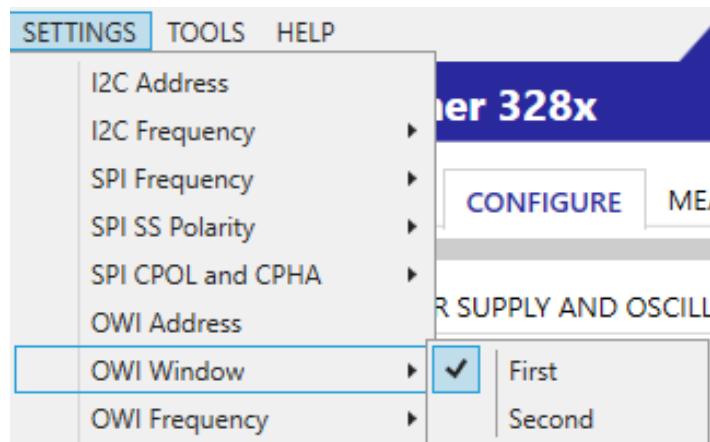


Figure 32. OWI Window Selection

5.2.3.2 OWI Digital

In the OWI Digital mode the OWI interface is in listening mode at OWI1 pin only.

Figure 33 shows the status of the OWI interface according to the time window and command received.

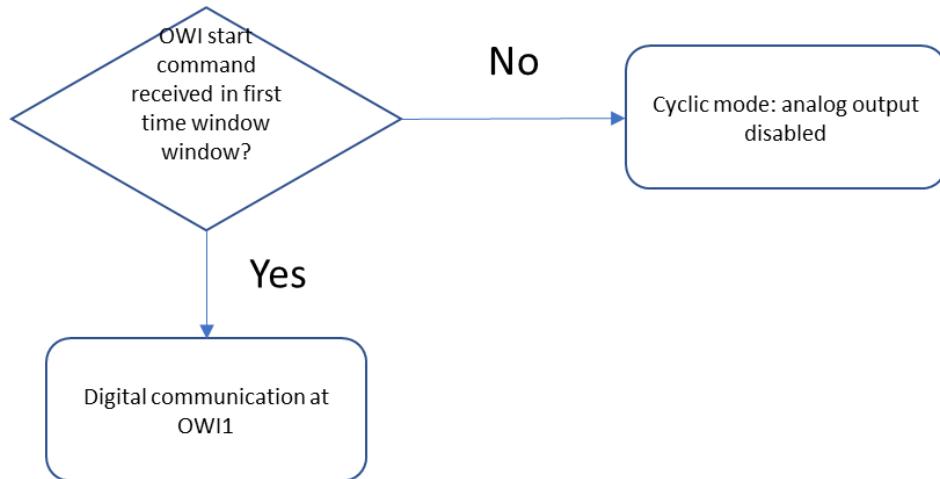


Figure 33. OWI Digital

5.2.3.3 OWI Analog Voltage Mode 5V VOUT

In the OWI Analog Voltage Mode 5V VOUT, the OWI interface is in listening mode at OWI IN pin only.

Figure 34 shows the status of the OWI interface according to the time window and the command received.

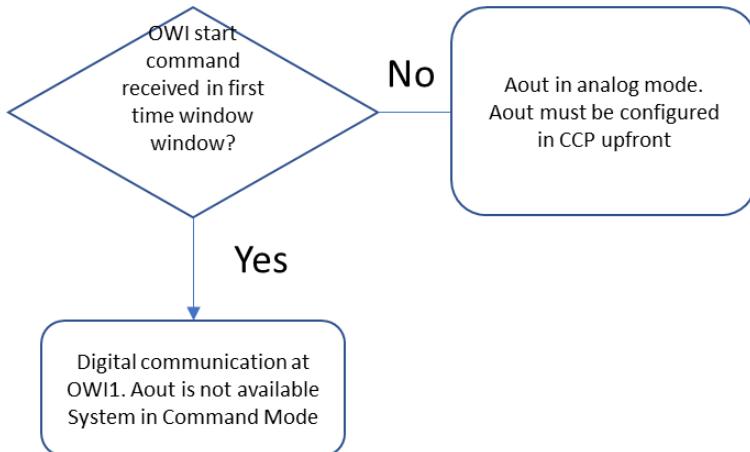


Figure 34. OWI Analog Voltage Mode 5V VOUT

Supported AOUT Modes:

- Absolute Voltage: 0V to 5V
- Ratiometric Voltage

5.2.3.4 OWI Analog Voltage Mode 10V VOUT

Note: this option requires to setup the additional 10V OWI master board that is described in a dedicated document (ask the Renesas representative).

In the OWI Analog Voltage Mode 10V VOUT, the OWI interface is in listening mode at OWI-IN pin only.

Figure 35 shows the status of the OWI interface according to the time window and the command received.

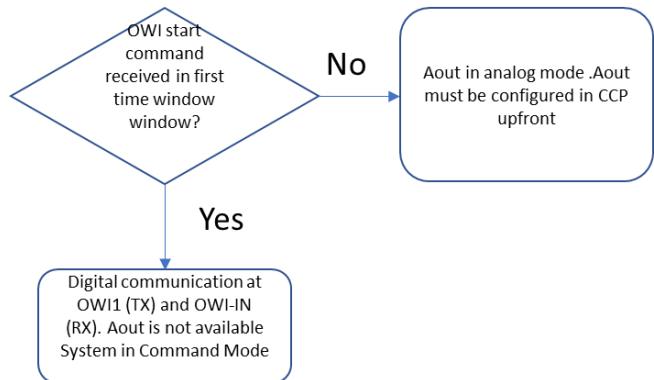


Figure 35. OWI Analog Voltage Mode 10V VOUT

Supported AOUT Modes:

- Absolute Voltage: 0V to 10V

5.2.3.5 OWI Analog Current Loop 2-Wire

Additional HW is required for OWI communication over 2-wire current loop; refer to the documentation available at the following link: [ZSSC32XX-CLOWI-PCB - One-Wire Current Loop Add-on Board for ZSSC32xx | Renesas](#)

In the OWI analog current loop 2-wire, the OWI interface is in listening mode at OWI-IN pin only.

Figure 36 shows the status of the OWI interface according to the time window and the command received.

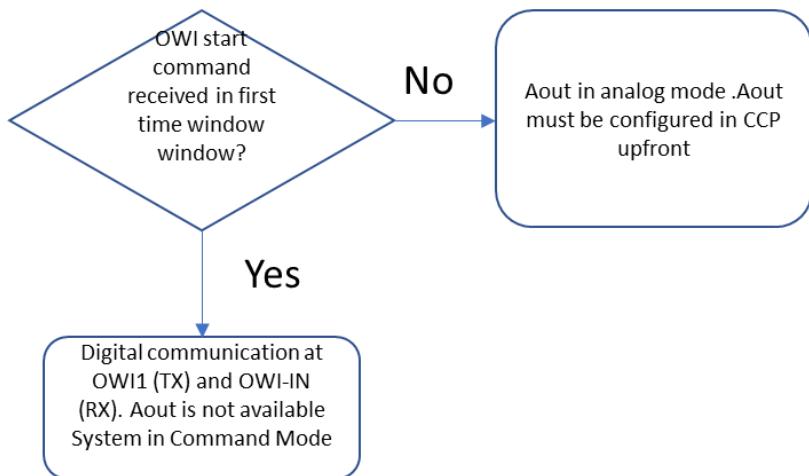


Figure 36. OWI over Analog Current Loop 2-Wire

The OWI serial interface must be configured as displayed in Figure 37.



Figure 37. Configuration for Communication OWI over 2WCL

OWI over 2WCL can be initiated from the GUI through the option displayed in Figure 38:

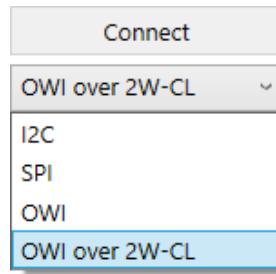


Figure 38. Connecting with OWI over 2WCL

Refer to the *ZSSC3281 OWI Master Guide* document for instructions for setting up OWI over 2-wire current loop communication.

5.3 AFE Tab

5.3.1 Sequencer

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 *ZSSC3281 Datasheet* document.

5.3.1.1 AFE Selection and Configurability

The AFE Selection and Configurability option (Figure 39) 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 value that is 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.), i.e., AFE2 is configurable for those parameters.
- Dual Speed AFE with AOUT: both AFEs are used, one sensor bridge is connected to both front ends. AFE1 is setup for fast conversion, allowing fast response at lower accuracy. AFE2 is setup for slow conversion, generating a slower response at higher/typical accuracy, see Figure 40 for the needed connections of the bridge to the device. Description of operation of dual speed with the EVK is provided in section 5.3.1.6. Refer to the *ZSSC3281 Datasheet* document for a detailed description of this AFE operation mode.

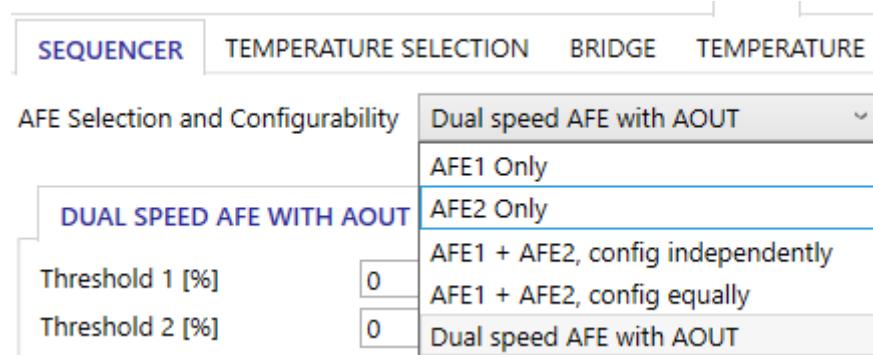


Figure 39. AFE Selection and Configurability

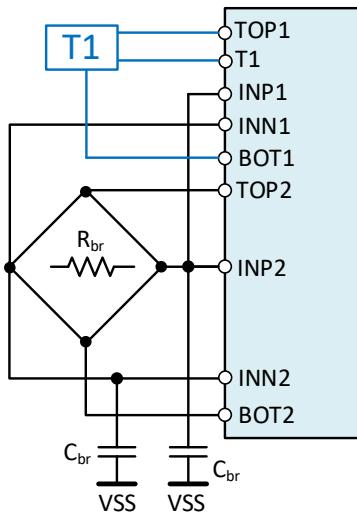


Figure 40. Dual Speed Resistive Bridge Input Configuration

Every combo must have a value for the GUI to start updating and storing the internal shadow image of the configuration file, otherwise the GUI considers the scheduler configuration. If values are missing, an error message pops-up (see Figure 41).

Not all fields for this configuration have values

Figure 41. Sequencer Error Message

When the configuration is completed, the scheduler configuration needs to be saved in the flash memory (NVM) before starting any measurement or saving the configuration on a file.

5.3.1.2 Sequencer Main Mode



Figure 42. Sequencer Main Mode

The Sequencer Main Mode option (see Figure 42) allows to configure the following options:

- Deterministic sensor step response: for an application with fast and deterministic step response, the minimum predefined measurement flow consists of three phases:
 - sensor measurement (non-inverted)
 - sensor measurement (inverted)
 - auxiliary measurement

Note: SM+ and SM- sequence could be exchanged yielding to the same result (see Figure 43).



Figure 43. SM+/SM- Exchange

Within the auxiliary measurement vector, one auto-zero sensor measurement (AZS) can be configured (see Figure 44).



Figure 44. Auto-Zero Sensor Measurement

- Accelerated main measurement (see Figure 45): this measurement scheme is faster than the 'Deterministic sensor step response' which can lead to noticeable timing overhead due to analog frontend settling times. 'Accelerated main measurement' returns a measurement with 1 bit less effective resolution (setting the same physical resolution in both scenarios).

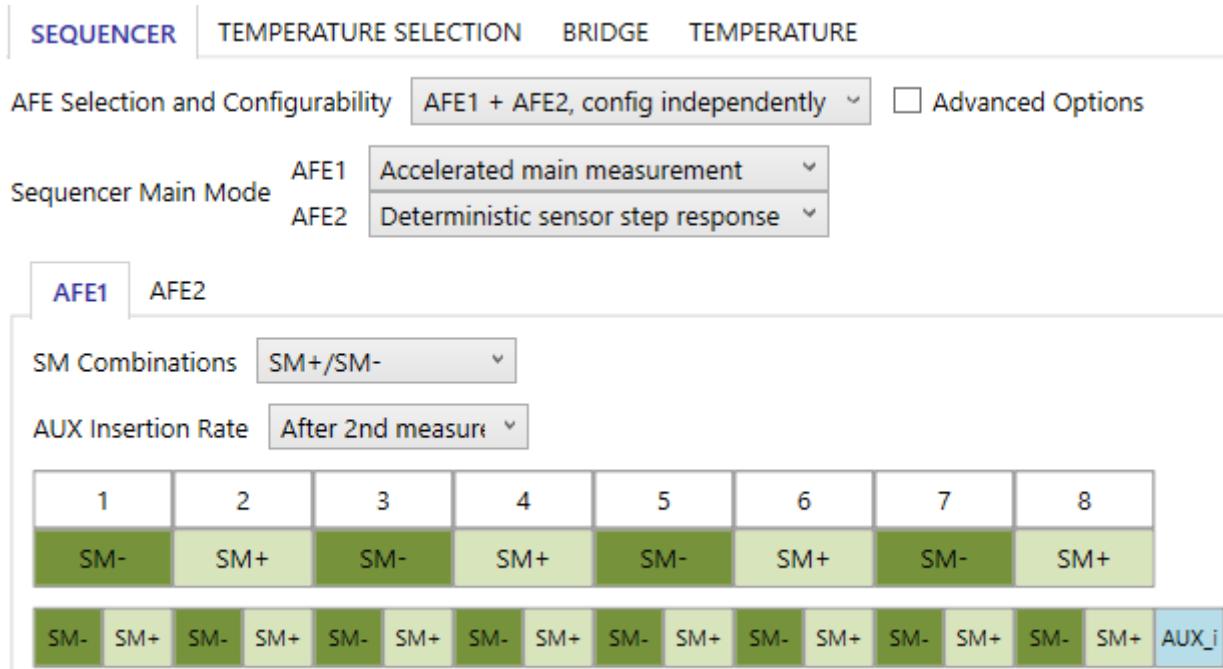


Figure 45. Accelerated Measurements

- AUX only: it can only be selected for one of the AFEs and if the Advanced Options (see 5.3.1.3) are enabled.

5.3.1.3 Advanced Options

Enabling the "Advanced Options" (see Figure 46) box sets the "Aux only" option in the Sequencer Main Mode. It also enables the insertion of a selectable number of AUX measurements.

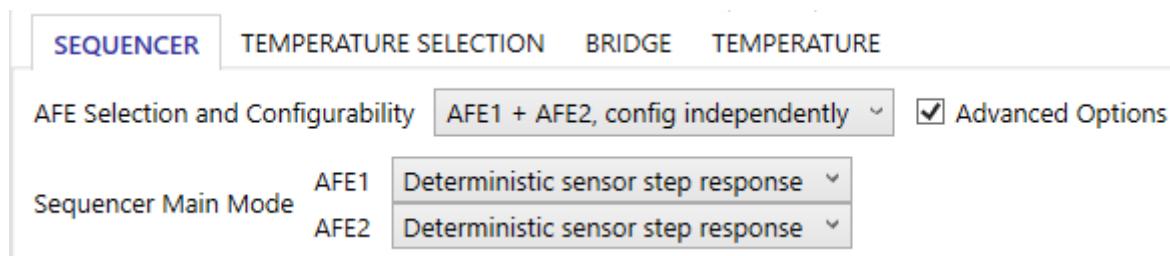


Figure 46. Advanced Options

With the advanced options enabled, the user can also insert a set of Auxiliary Measurements slots (see Figure 47).

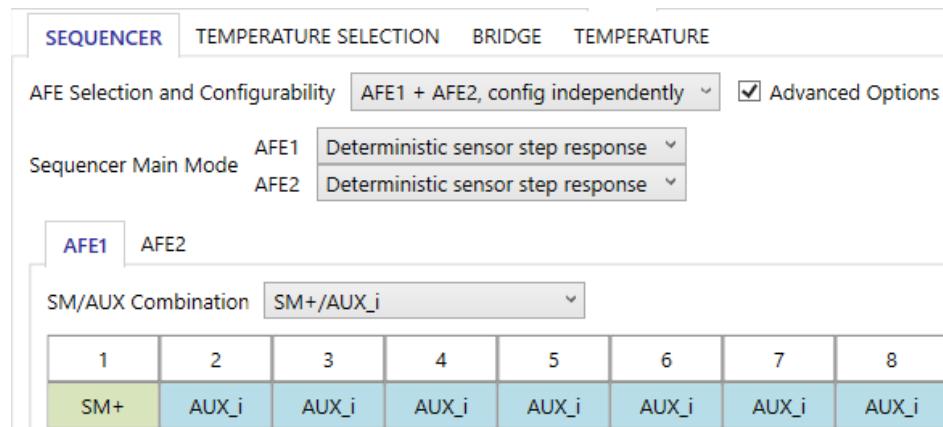


Figure 47. Advanced Options – Aux Slots

5.3.1.4 Sequencer Main Mode Set to Deterministic Sensor Step Response

When the Sequencer Main Mode is set to “Deterministic Sensor Step Response”, the SM/AUX allowed combinations are displayed in Figure 48.

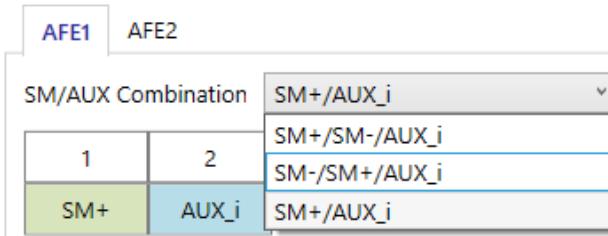


Figure 48. Main Mode Set to Deterministic Sensor Step Response – SM/AUX

Description of the options:

- 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

5.3.1.4.1 Auxiliary Option

When the “Advanced Options” are enabled, it is possible to activate a predefined amount of auxiliary measurement slots (see Figure 49).

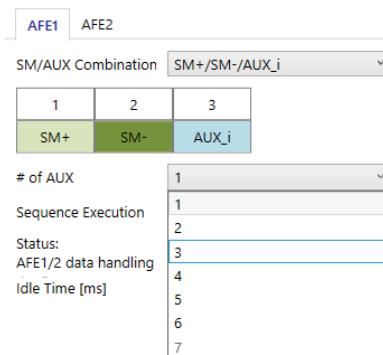


Figure 49. Auxiliary Measurements

5.3.1.4.2 Auxiliary Amount Selection

Activating more than one auxiliary measurement triggers a trading off sensor measurement interval with auxiliary cycle period: a maximum of 6 or 7 (depending on the selected SM/AUX combination) auxiliary measurements to be executed for each sensor measurement.

With the selection of the number of auxiliary measurements, the GUI appears as in Figure 50.

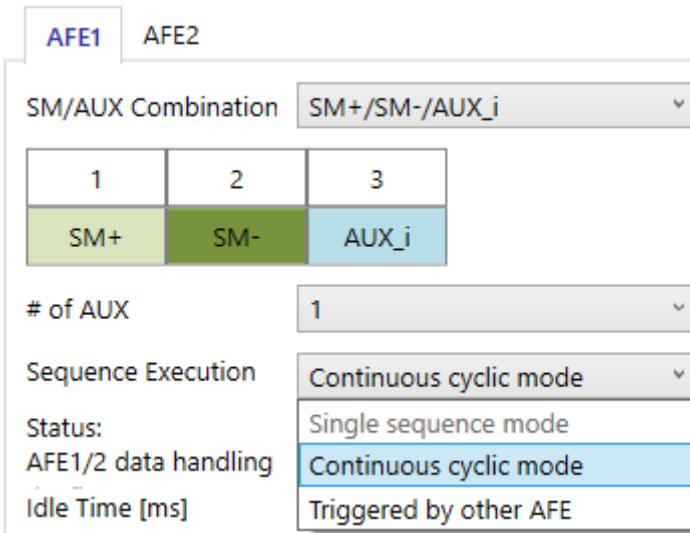


Figure 50. Auxiliary Measurements Enabled Displayed in GUI

The selection of the value in the 'Sequence Execution' field implies the following:

- Single sequence mode: one time execution of the sequence. This option is currently not available, it is reserved for future developments.
- Continuous cyclic mode: the sequence displayed is executed cyclically in a continuous way.
- Triggered by other AFE: the sequence displayed is executed after triggering by another AFE (for example, a master IC AFE triggers the sequence execution of a slave IC AFE). This option is currently not available, it is reserved for future developments.

5.3.1.4.3 Idle Time

This input field is available in 'Continuous cyclic mode' only. Idle time up to 10ms can be inserted between two sequences (see Figure 51).



Figure 51. Sequencer – Idle Time

5.3.1.5 Sequencer Main Mode Set to Accelerated Main Measurement

When the Sequencer Main Mode is set to 'Accelerated main measurement', the possible sensor measurement combinations are displayed in Figure 52.

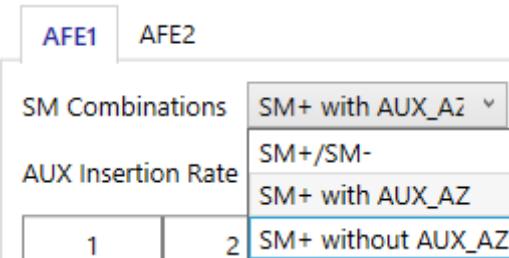


Figure 52. Accelerated Main Measurement: SM Combinations

The selection “SM combinations” chooses the baseline measurement configuration to form one sequence.

- 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.
- SM+ without AUX_AZ: SM+ only without internal offset compensation, AUX_AZ is not active.

5.3.1.5.1 AUX Insertion Rate

The AUX Insertion Rate (Advanced Options enabled) 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 53.

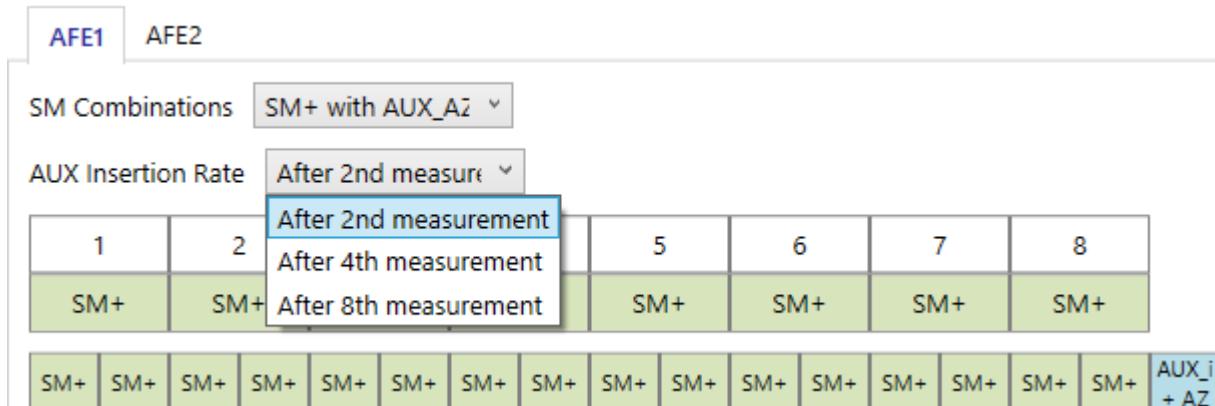


Figure 53. Auxiliary Insertion Rate

According to the selection done in the SM combination, the auxiliary measurement can also be after sequence of 16/32/64 SM+ measurements and with or without an additional AZ measurement, see Figure 54.

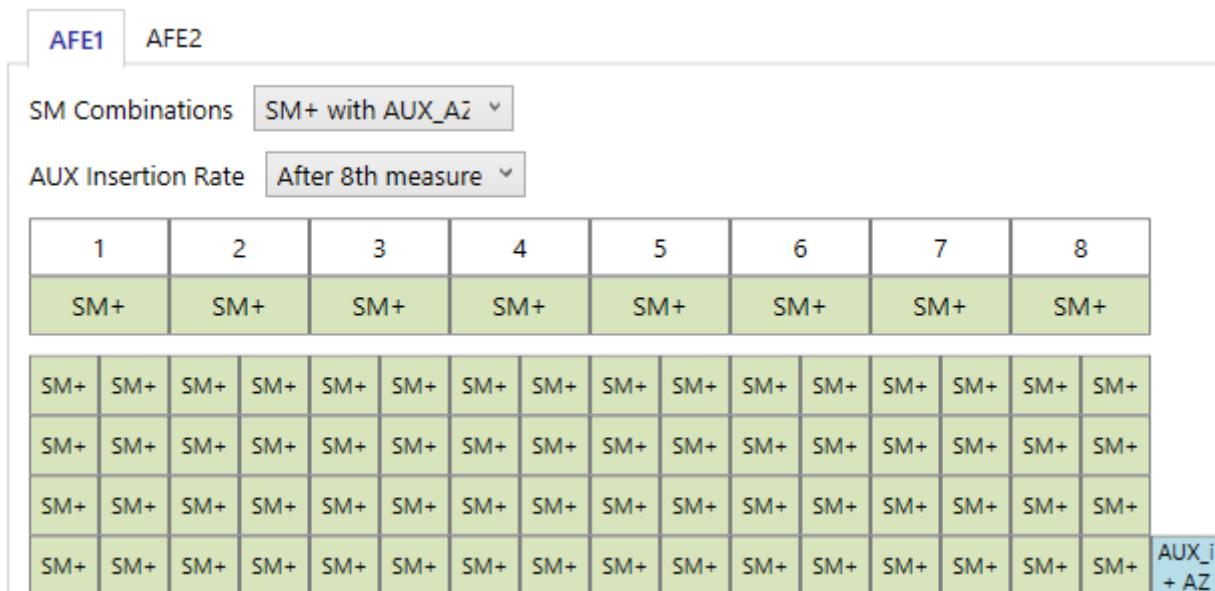


Figure 54. Auxiliary Insertion Rate: SM+AUX_AZ after the Eights Measurement

5.3.1.5.2 Sequence Execution

The selection of “Sequence Execution” (see Figure 55) allows the following options:

- Continuous cyclic mode: a continuous cyclic acquisition of the sequence defined through the “SM Combinations” and the “AUX insertion rate”.
- Triggered by the other AFE: displays a single sequence defined through the “SM Combinations” and the “AUX insertion rate” acquisition triggered by the other AFE. This option is currently not available, it is reserved for future developments.

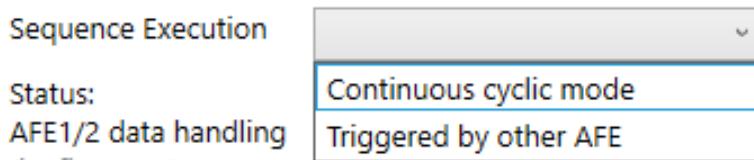


Figure 55. Sequence Execution

The example displayed in Figure 56 shows the slot order when the Sequence Execution is set to “Continuous cyclic mode”, the “AUX insertion Rate” is set after the second measurement:

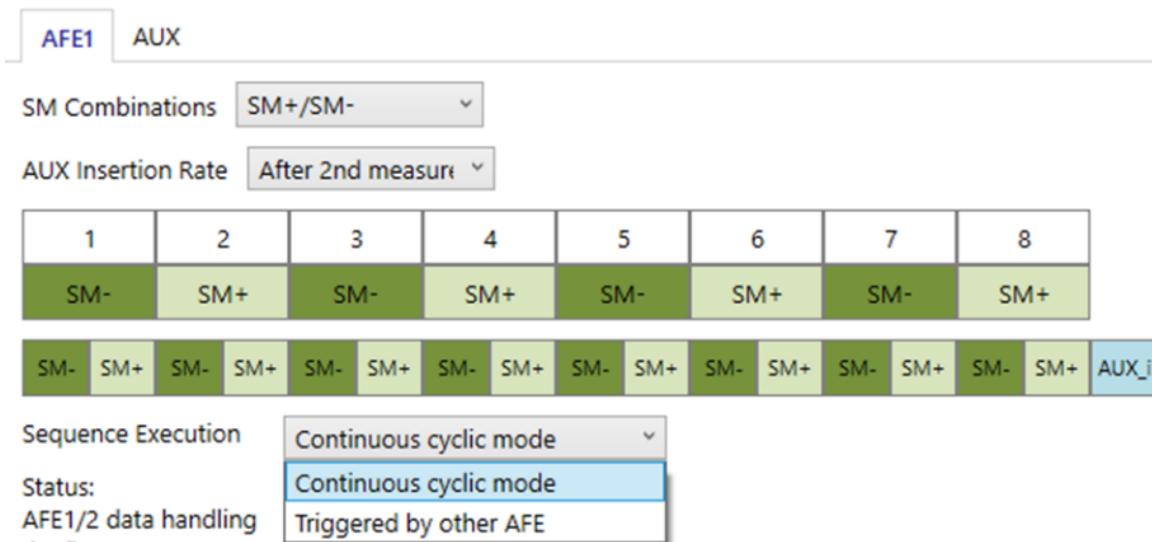


Figure 56. Sequence Execution Example

Eight SM+ and eight SM- readings are performed and finally one auxiliary measurement is taken.

5.3.1.6 AFE Selection: Dual Speed Mode

The dual speed software algorithm combines results of the acquisition from the two AFEs into one conditioned output (digital and analog) at a time. The bridge must be biased by AFE2 to ensure a ratiometric setup for AFE2 to generate precise and low noise results in this channel. The bridge bias must be active continuously to not disturb the simultaneous conversions in AFE1. Thus, AFE1 has a non-ratiometric bridge connection.

For operating the Dual Speed mode, the EVK can be used with a specific setup of the SRB3 board: remove all jumpers from J6 and connect J3-1 with J6-4, and J3-4 with J6-2. With this setup the second bridge on the SRB is connected as in Figure 40 (temperature sensor can be external, or internal PTAT).

For dual speed operation select the relevant value in the list as displayed in Figure 57.

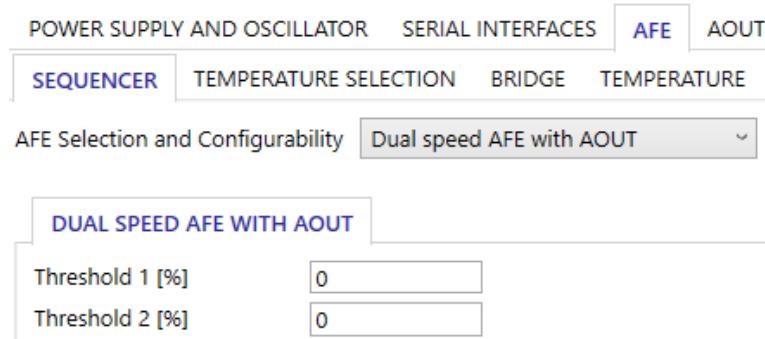


Figure 57. Dual Speed Settings

'Thresholds 1 [%]' and 'Thresholds 2 [%]' are configuration parameters used by the algorithm to switch the signal acquisition from one AFE to the other.

Transition from AFE2 to AFE1 occurs when significant signal change (larger than Threshold 1) is detected by AFE1.

Transition from AFE1 to AFE2 occurs when no further signal changes (larger than Threshold 2) are detected by AFE1 over the course of approximately two AFE2 conversion times.

Values of Thresholds are expressed in % to the full dynamic range of the signal. Their default value is 10% for 'Thresholds 1 [%]' and 2% for 'Thresholds 2 [%]'.

The selection of dual speed operation impacts several parameter values, selection and configuration options availability. Details are provided in the relevant tabs description.

5.3.2 Temperature Selection

Four physical temperature sensors are available:

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

Each of four physical temperature sensors can be assigned to each of the 3 logical temperature channels (Temp Ch1/2/3). An overview of this tab is provided in Figure 58.

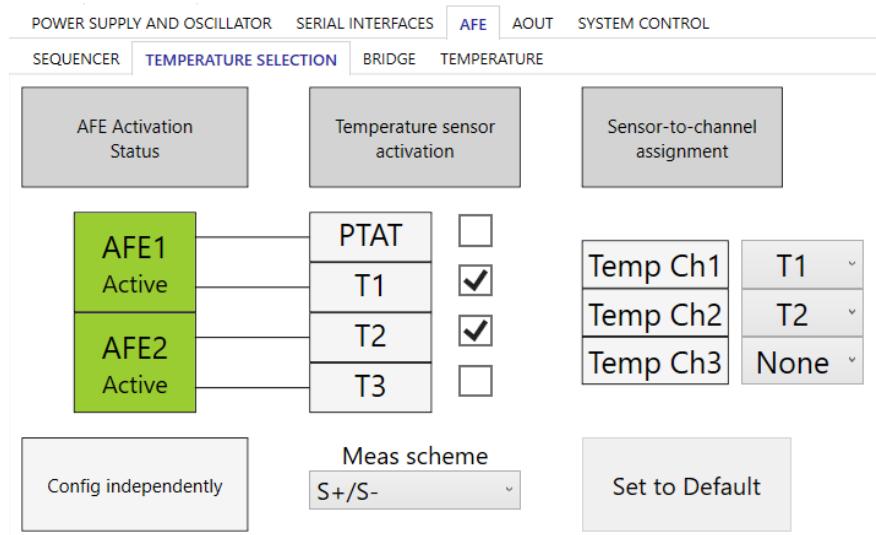


Figure 58. Temperature Selection Overview

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.

When Dual Speed Mode is selected the Temperature sensor activation is possible for AFE1, see Figure 59.

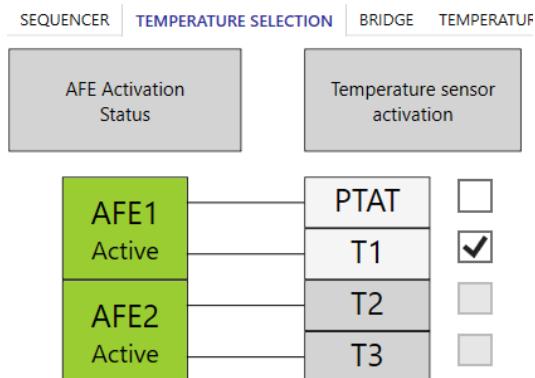


Figure 59. Temperature Selection – Dual Speed

5.3.2.1 Channels Data Paths

A simplified high-level description of the data paths for the Main sensor channels 1/2/3 and Temperature channels 1/2/3 is provided in Figure 60.

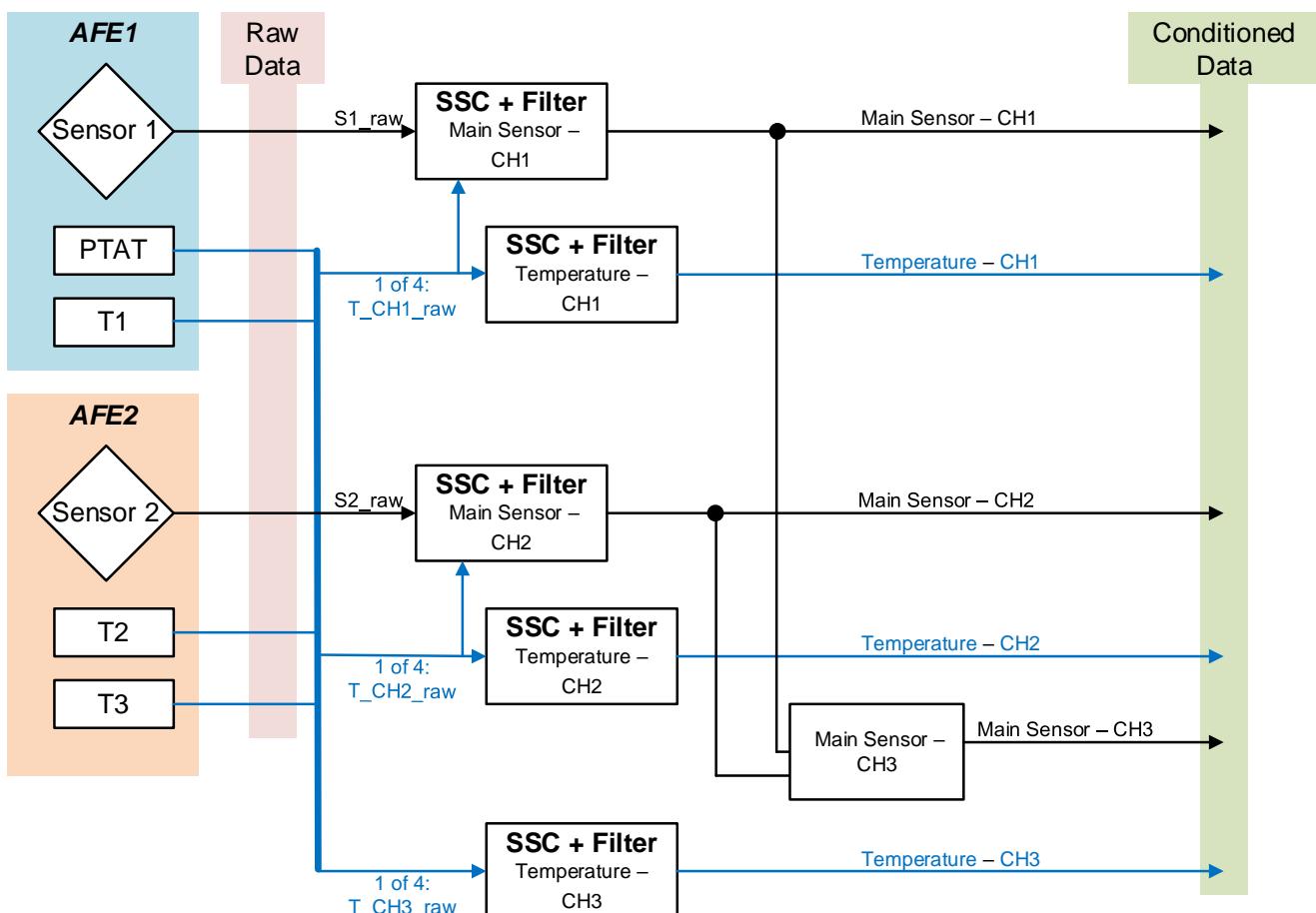


Figure 60. Acquired Data Stream Overview

Figure 60 demonstrates how the conditioned measured values are determined either for the main input transducers (CH1/2) and the derived CH3, or for the temperature transducers (PTAT, T1/2/3) that can be returned and conditioned on T_CH1/2/3.

Sensor 1 acquired data are processed through the main sensor CH1. When the calibration process requires it (refer to Figure 163), the temperature CH1 is used for the main sensor CH1 calibration over temperature.

Sensor 2 acquired data are processed through the main sensor CH2. When the calibration process requires it (refer to Figure 163), the temperature CH2 is used for the main sensor CH2 calibration over temperature.

5.3.2.2 AFE Status

Figure 61 displays the status of each AFE of the device, green color indicate 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 39. If both AFEs are active, GUI displays if they are configured equally or independently (see section 5.3.1.1 for details on dual AFE configuration).

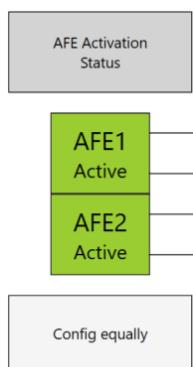


Figure 61. AFE Status

5.3.2.3 Temperature Sensor

Enable the relevant selection box to make one or more input temperature transducers active, see Figure 62.

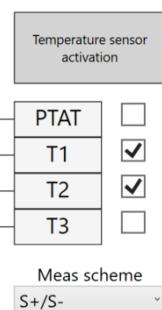


Figure 62. Temperature Sensor Activation

AFE1 processes, when activated, the PTAT and/or T1. AFE2 processes, when activated, the T2 and/or T3. The 'Meas scheme' selection list allows to choose between the acquisitions of S+/S- and S+ only.

Note: the selected activations are automatically changed in the GUI if the configuration chosen in the sequencer are modified. (refer to Figure 39). This allows to keep consistency in the device configuration.

5.3.2.4 Channel Assignment

Assign the activated temperature sensor to the Temperature channels (1/2/3) by the drop-down lists, see Figure 63. “Set to Default” button returns channel assignment to factory default values.

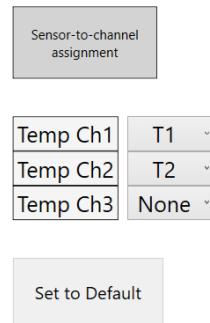


Figure 63. Sensor to Channel Assignment

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 39). This allows to keep consistency in the device configuration.

5.3.3 Bridge

The Bridge tab is structured according to the following scheme:

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

5.3.3.1 Bridge Configurations

Through the ‘Mode’ drop-down list in the Parameters section, the GUI offers 4 different options for supplying the transducer wired to the ZSSC3281, allowing the resistive bridge to be supplied by/through:

- Voltage: internal voltage supply (VDDA, refer to the ZSSC3281 *Datasheet* document), see Figure 64.
Note: this mode is used in this document for description/example purposes for the Bridge tab, selecting other modes returns different schematic, graphs, and parameters enabling/disabling options.

Configure

Calculation and Visualization

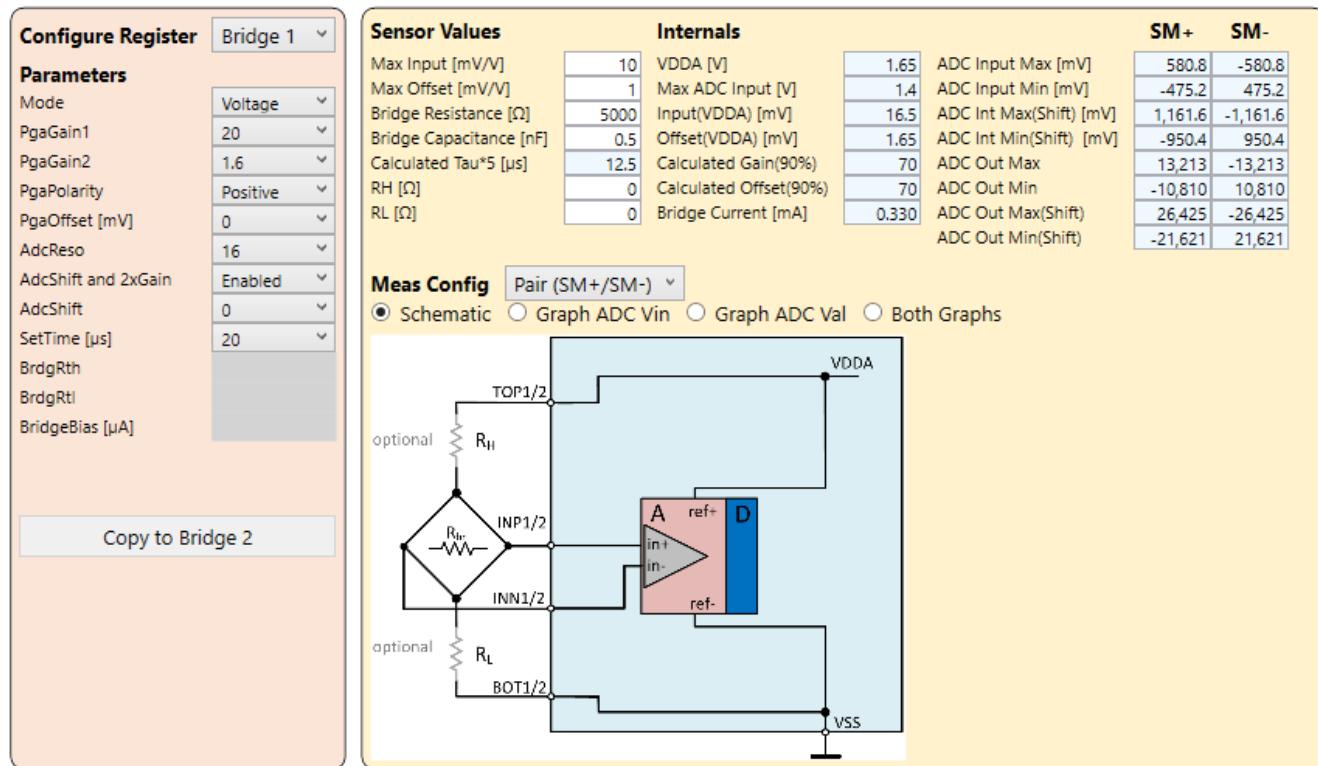


Figure 64. Voltage Mode

- Resistor: internal voltage supply (VDDA, refer to *ZSSC3281 Datasheet* document) with configurable internal series resistors, see Figure 65.

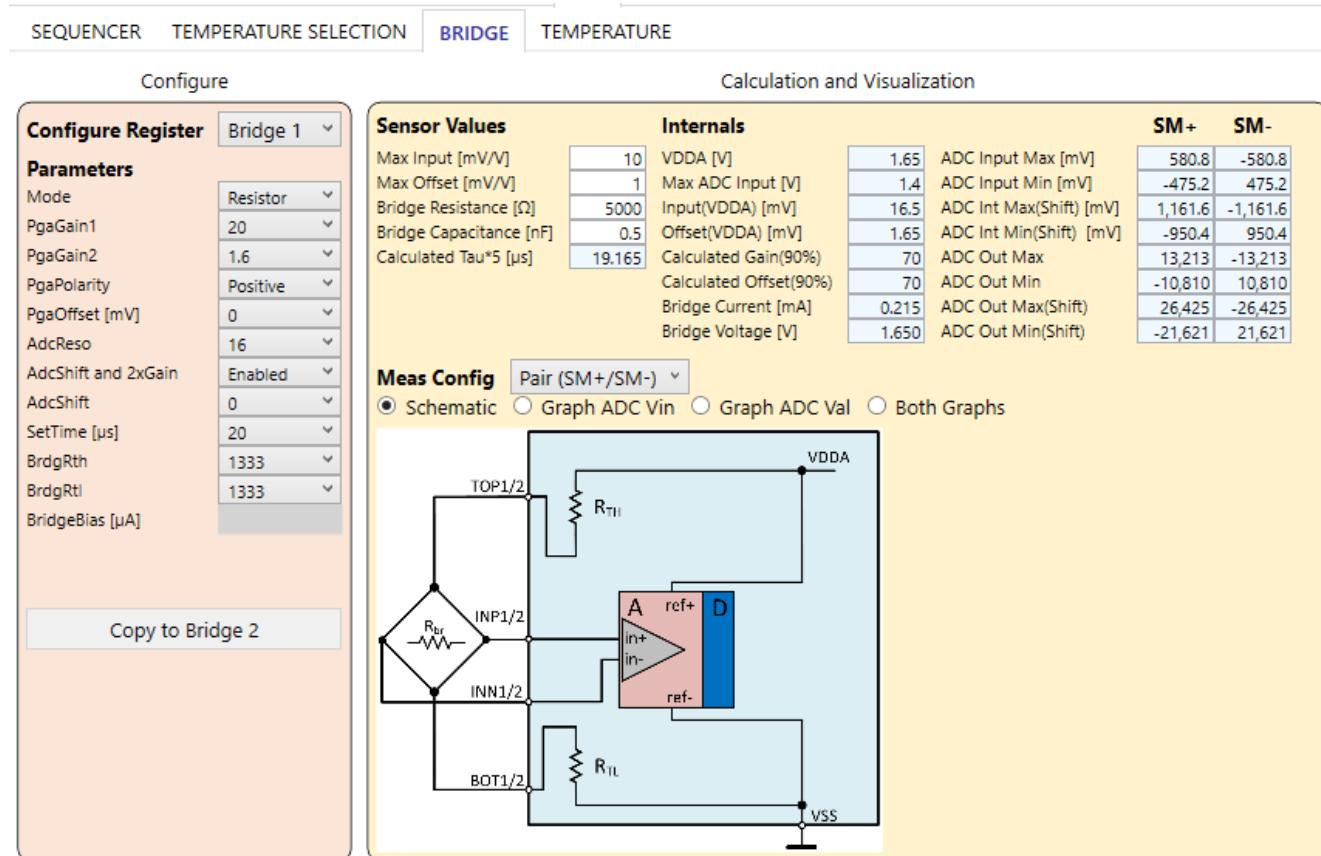


Figure 65. Resistor Mode

- Current: configurable internal current source with configurable internal series resistor, see Figure 66.

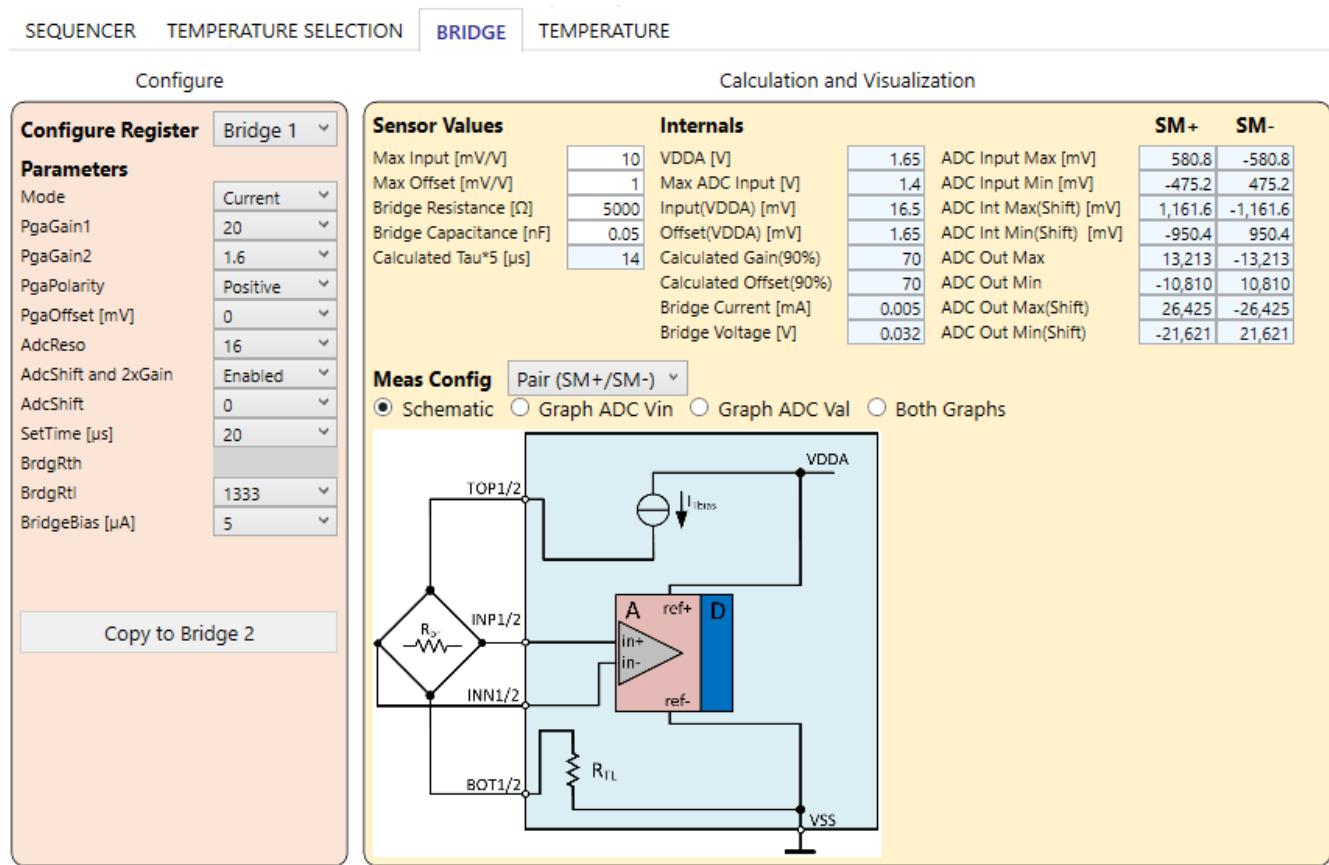


Figure 66. Current Mode

- Thermopile: the device acquires the voltage signal generated by a thermopile, see Figure 67.

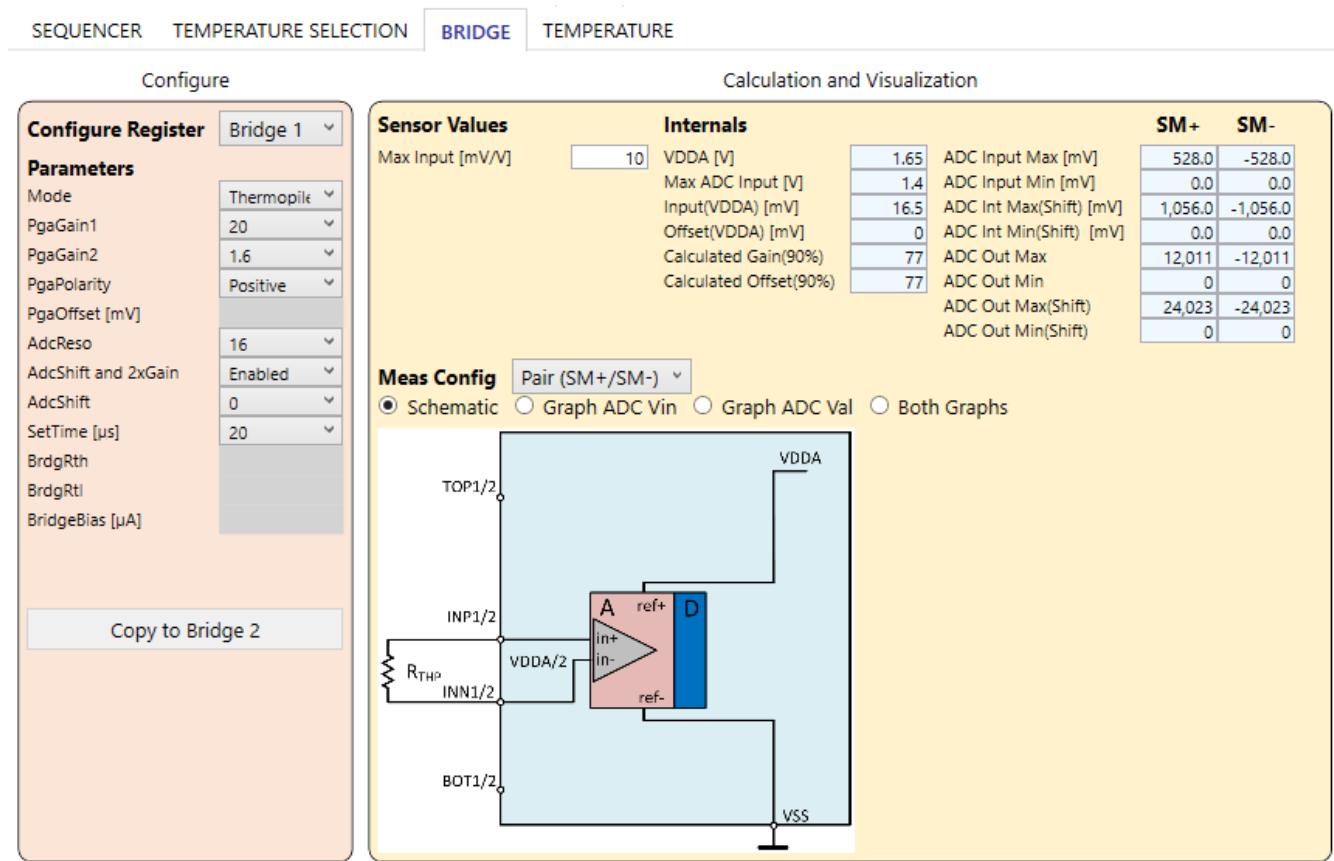


Figure 67. Thermopile Mode

5.3.3.2 Configure Register

To configure an Analog Front End, select it from the “Configure Register” drop-down list and set the relevant values in the Parameters section.

To duplicate an already defined configuration, click “Copy to Bridge“ button (see Figure 68).

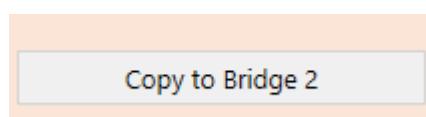


Figure 68. Configure Register

5.3.3.3 Meas Config

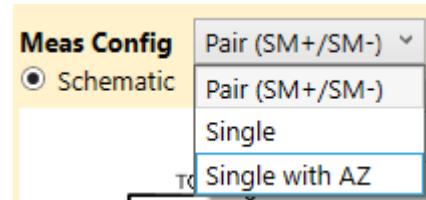


Figure 69. Meas Config Menu

The Meas Config menu (see Figure 69) affects the internal calculations and Graphs only and it allows to select from the following options:

- Pair (SM+/SM-): a pair of measurements i.e., the SM+ AND SM- readings (see Figure 69)
- Single: single measurement (see Figure 70)
 - SM+
 - SM-
 - AZ

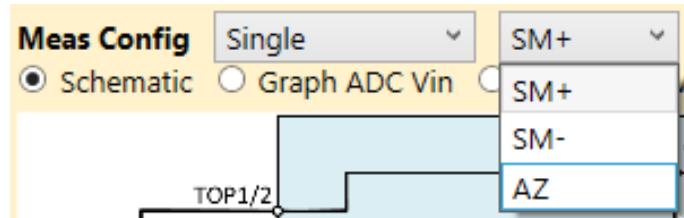


Figure 70. Meas Config: Single

- Single with AZ: single measurement with AZ (see Figure 71)
 - SM+
 - SM-
 - AZ

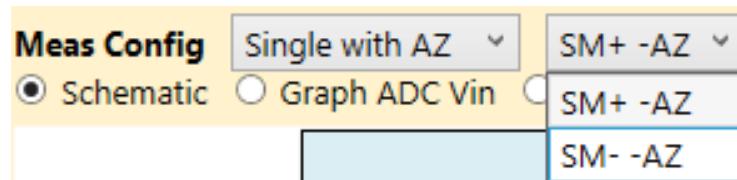


Figure 71. Meas Config: Single AZ

5.3.3.4 Sensor Values

The Sensor Values section (see Figure 72) allows the user to enter the input transducer characteristics for performing the calculations displayed in Figure 75.

Sensor Values	
Max Input [mV/V]	10
Max Offset [mV/V]	1
Bridge Resistance [Ω]	10000
Bridge Capacitance [nF]	0
Calculated Tau*5 [μs]	0
RH [Ω]	0
RL [Ω]	0

Figure 72. Bridge – Sensor Values

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

5.3.3.5 Parameters

The Parameters section (see Figure 73) 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 74 is dynamically updated according to the ‘Mode’ selection, see section 5.3.3.1 for details on different modes.

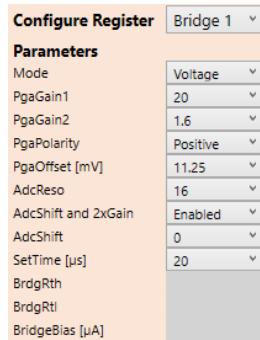


Figure 73. Bridge – Parameters

The following parameters can be set:

- Mode: defines the type of supply scheme of the connected transducer, see section 5.3.3.1.
- 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: enable of the internal ADC 2x gain and internal ADC offset shift.
- AdcShift: ADC offset shift value
- SetTime [μs]: Bridge settling time (μs)

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 (I_{Tbias})

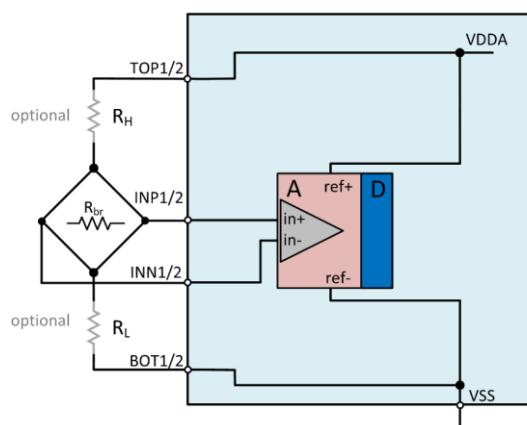


Figure 74. Mode Voltage Schematic

5.3.3.6 Internals

The Internals section (see Figure 75) displays values of specific electrical parameters that are built in the device and calculated parameters after the values set as per sections 5.3.3.3, 5.3.3.4, and 5.3.3.5.

Internals		SM+	SM-
VDDA [V]	1.65	ADC Input Max [mV]	676.8
Max ADC Input [V]	1.4	ADC Input Min [mV]	-676.8
Input(VDDA) [mV]	8.25	ADC Int Max(Shift) [mV]	148.8
Offset(VDDA) [mV]	1.65	ADC Int Min(Shift) [mV]	-148.8
Calculated Gain(90%)	129	ADC Out Max	1,353.6
Calculated Offset(90%)	60	ADC Out Min	-1,353.6
Bridge Current [mA]	0.330	ADC Out Max(Shift)	297.6
		ADC Out Min(Shift)	-297.6
			15,397
			-15,397
			3,385
			-3,385
			30,793
			-30,793
			6,770
			-6,770

Figure 75. Internals Example

The following values are displayed:

- VDDA: analog supply typical level (silicon defined)
- Max ADC Input [V]: the maximum ADC input level (silicon defined)
- Input(VDDA) [mV]: input pin level (VDDA supply) in mV
- Offset(VDDA) [mV]: offset input pin level (VDDA supply) in mV
- Calculated Gain(90%): suggested Gain setting to reach 90% FS
- Calculated Offset(90%): suggested offset setting to reach 90% 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, see Figure 76.

Internals		SM+	SM-
VDDA [V]	1.65	ADC Input Max [mV]	1,468.8
Max ADC Input [V]	1.4	ADC Input Min [mV]	-643.2
Input(VDDA) [mV]	33	ADC Int Max(Shift) [mV]	643.2
Offset(VDDA) [mV]	1.65	ADC Int Min(Shift) [mV]	2,937.6
Calculated Gain(90%)	37	ADC Out Max	-2,937.6
Calculated Offset(90%)	28	ADC Out Min	-1,286.4
Bridge Current [mA]	0.165	ADC Out Max(Shift)	1,286.4
		ADC Out Min(Shift)	33,414
			-33,414
			-14,632
			14,632
			66,827
			-66,827
			-29,264
			29,264

Figure 76. Internals Out of Range

5.3.3.7 Schematic and Graphs

Select Schematic, Graph ADC Von, Graph ADC Val, or Graph Combined (Figure 77) 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 (see Figure 78).

Schematic Graph ADC Vin Graph ADC Val Graph Combined

Figure 77. Schematic and Graphs Selection

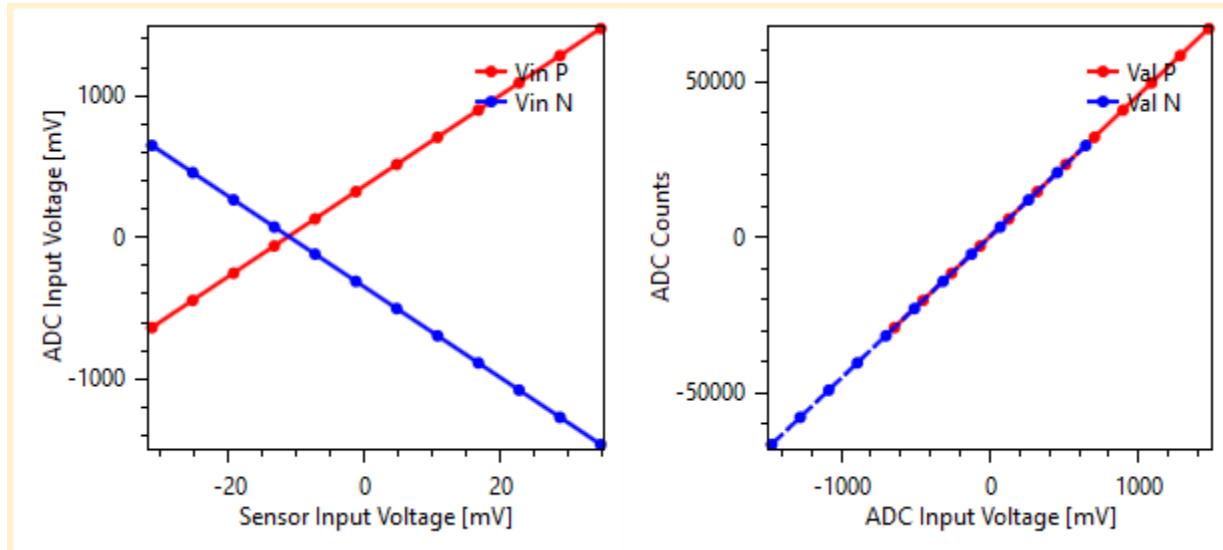


Figure 78. Combined Graphs

5.3.3.8 Bridge in Dual Speed Mode

If Dual speed mode configuration is selected (see section 5.3.1.6), parameters of Bridge 1 are fixed and they are dependant from the parameter settings of Bridge 2 as shown in Figure 79.

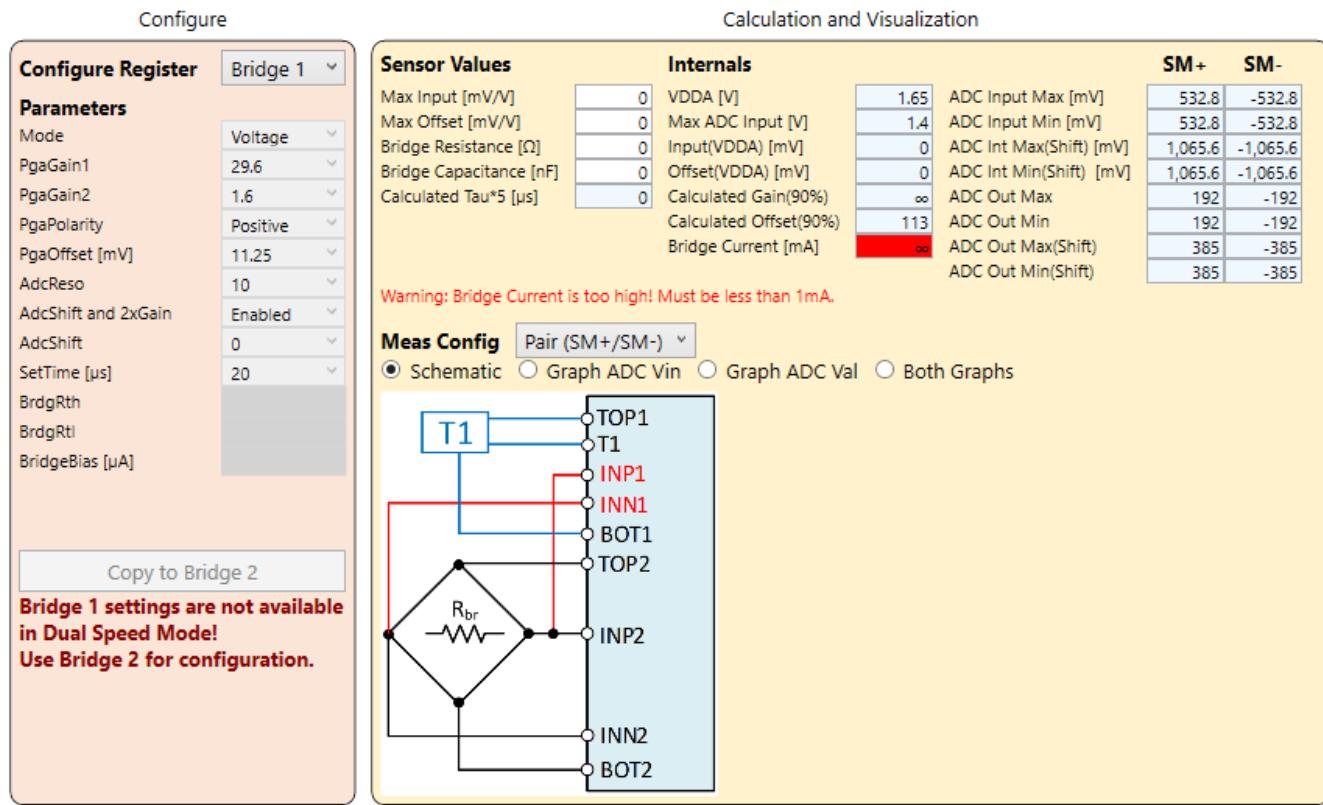


Figure 79. Dual Speed Mode for Bridge 1

Figure 80 displays the user configurable parameters for Bridge 2.

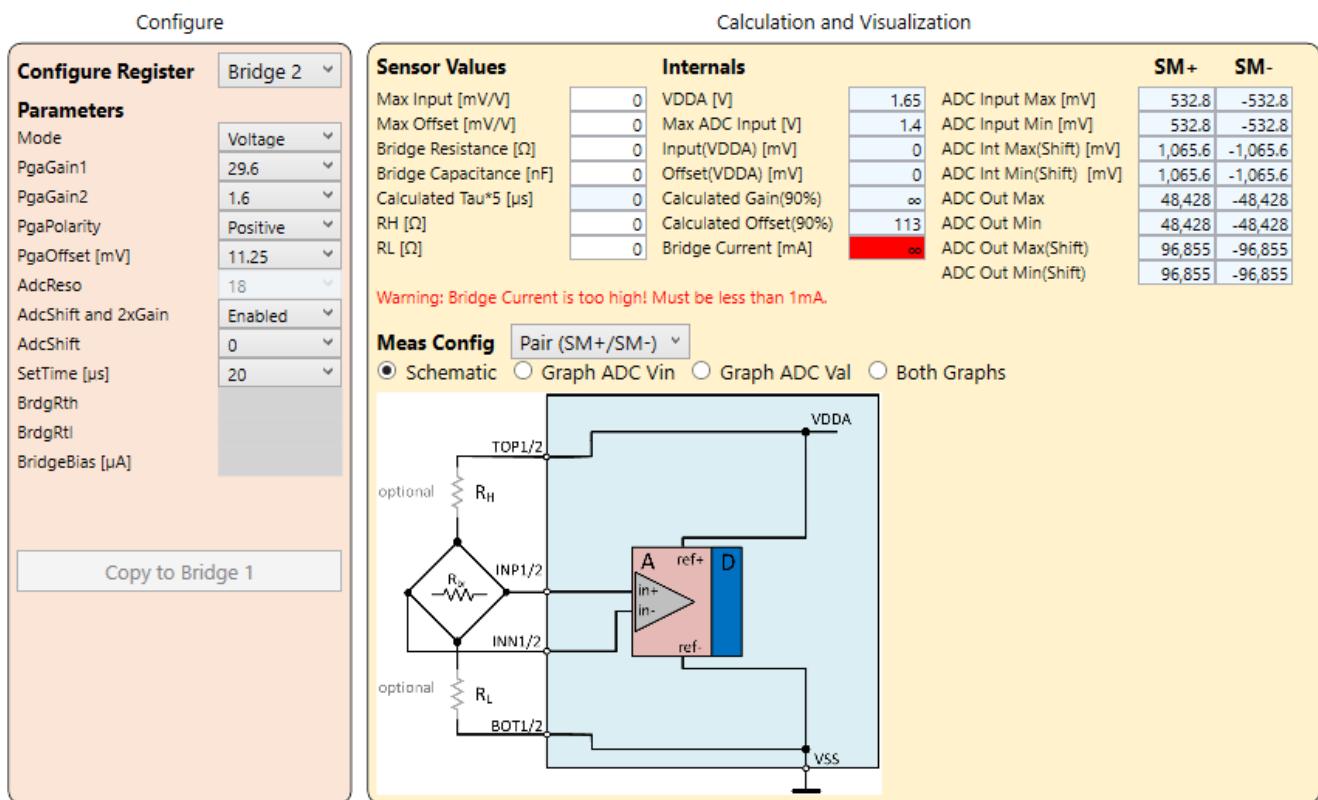


Figure 80. Dual Speed Mode for Bridge 2

Note that the resolution in the ‘AdcReso’ parameter is fixed, the values of other parameters are assigned to Bridge 1 through the Bridge 2 tab. Configuration must be saved to the NVM.

5.3.4 Temperature

The Temperature tab is structured according to the following scheme:

- The settings in the “Parameters” section are the only ones that will be saved in the device configuration NVM.
- Data input in the “Sensor Values” section are used for the “Internals” values calculations along with the “Parameters” selected.
- “Internals” calculation
- the graphs display.

5.3.4.1 Temp Configurations

Through the 'Mode' drop-down list in the Parameters section, the GUI offers 6 different options for supplying the temperature transducer wired to the ZSSC3281 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).

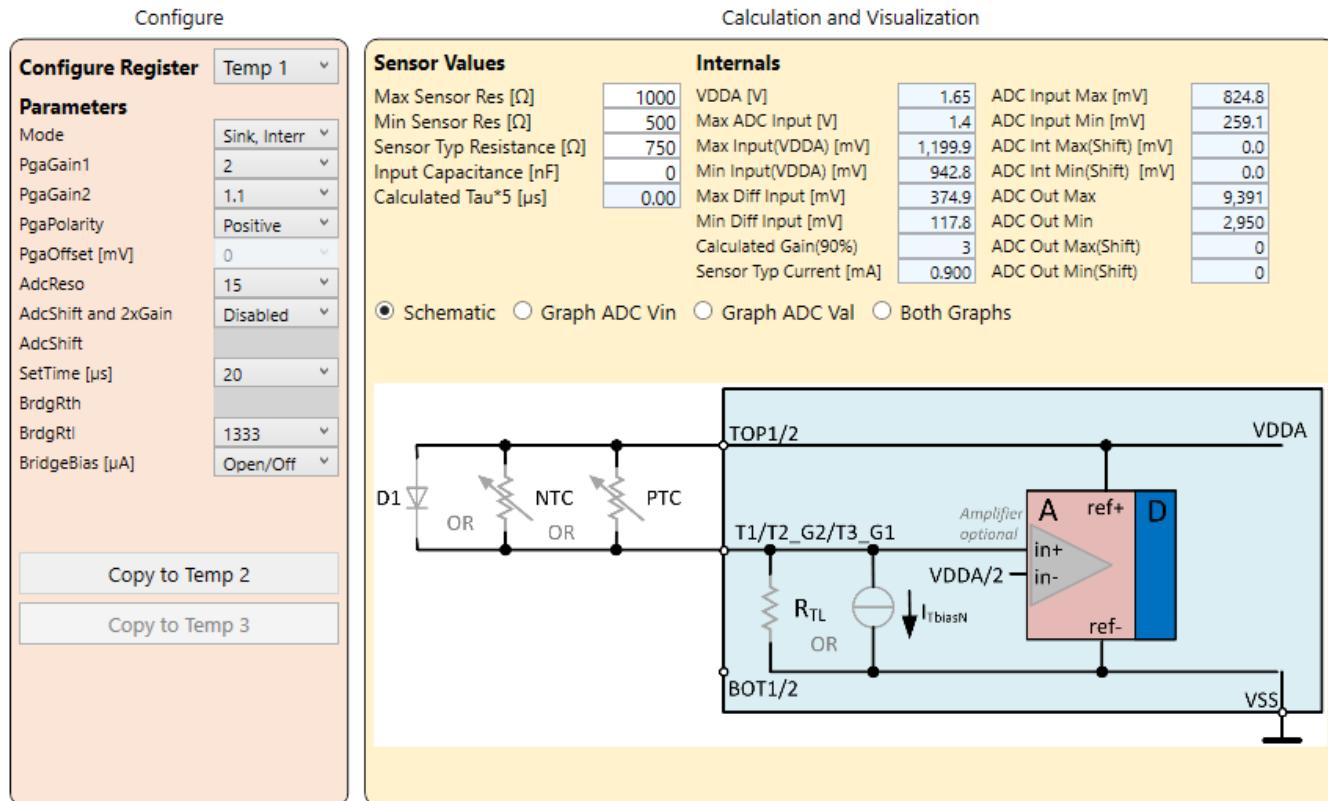


Figure 81. Temp – Mode Sink Internal Bias

- 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 (see the ZSSC3281 Datasheet document).

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.

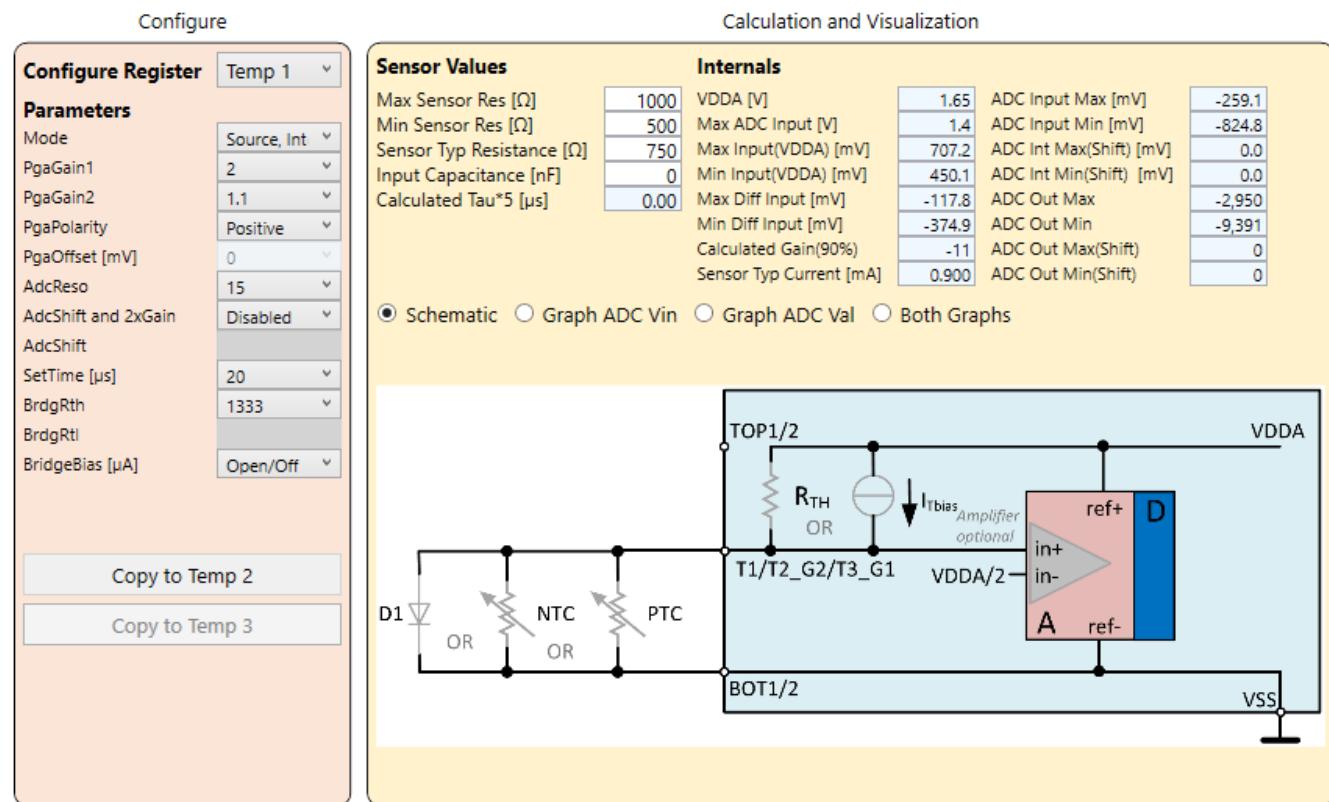


Figure 82. Temp – Mode Source Internal Bias

- 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 the VDDA rail (see the ZSSC3281 Datasheet document). This is active when the 'External RL' (selectable in the Sensor Values section) is not set to 'open' or '0'.

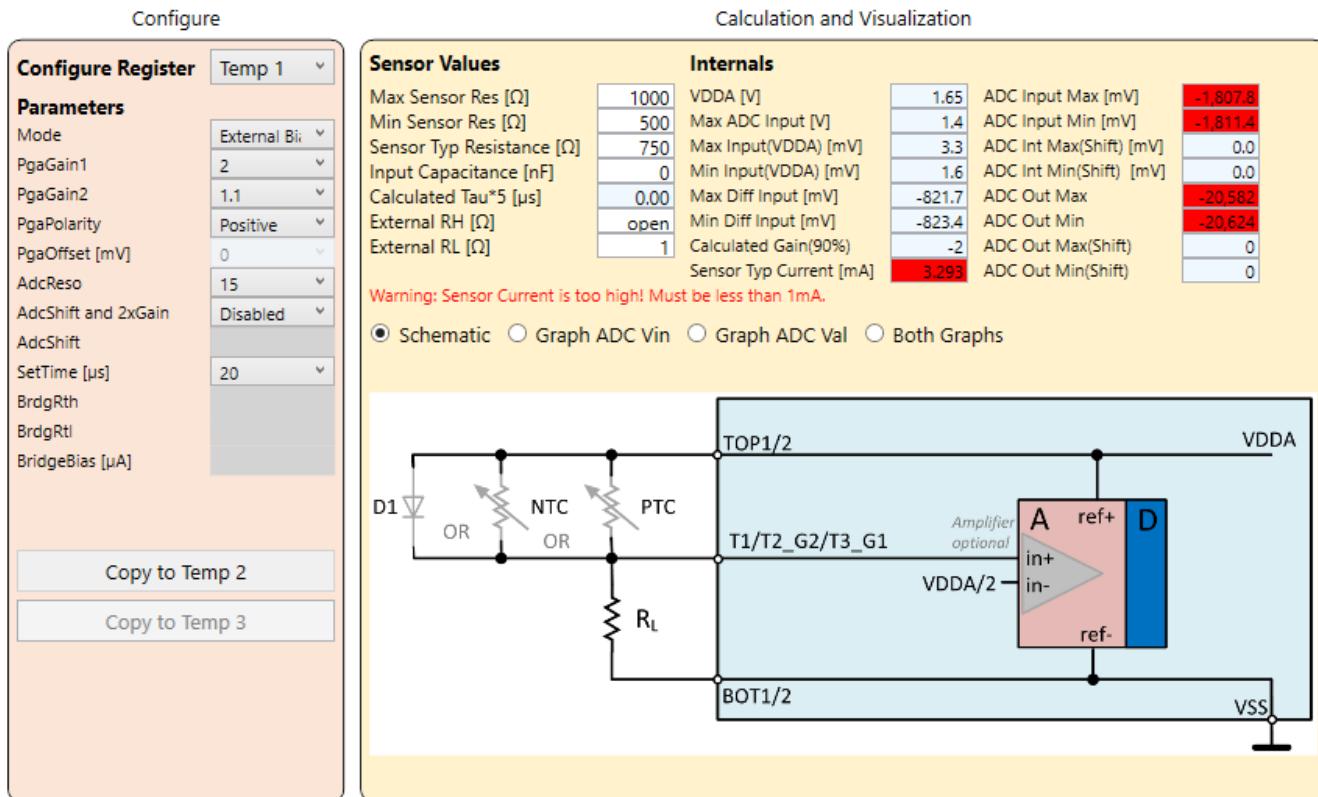


Figure 83. Mode Source External Bias Low

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

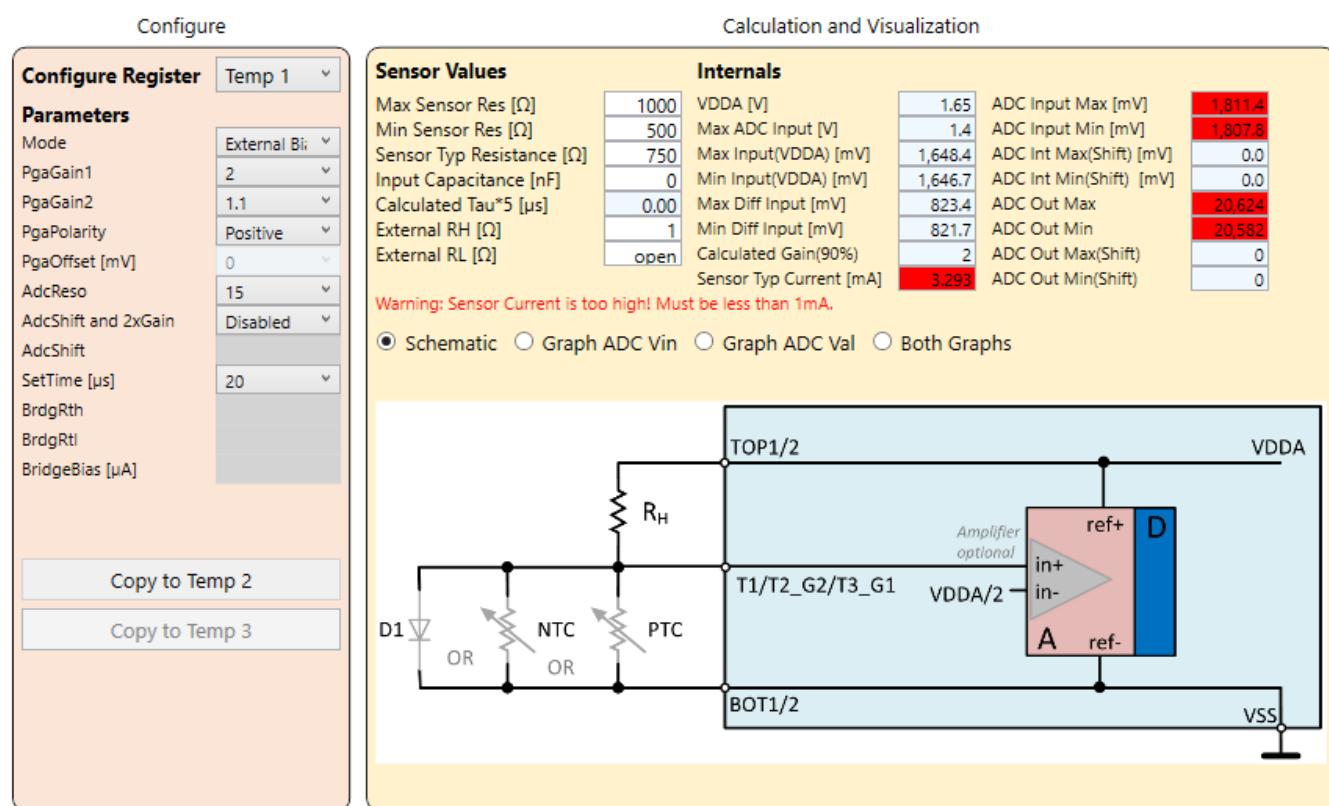


Figure 84. Mode Source External Bias High

To select between the options, put a non-zero value in the 'External RH' or 'External RL' (see Figure 85).

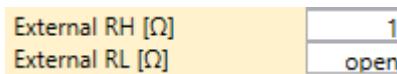


Figure 85. External RH, RL

- 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 the VDDA rail (see the *ZSSC3281 Datasheet* document).

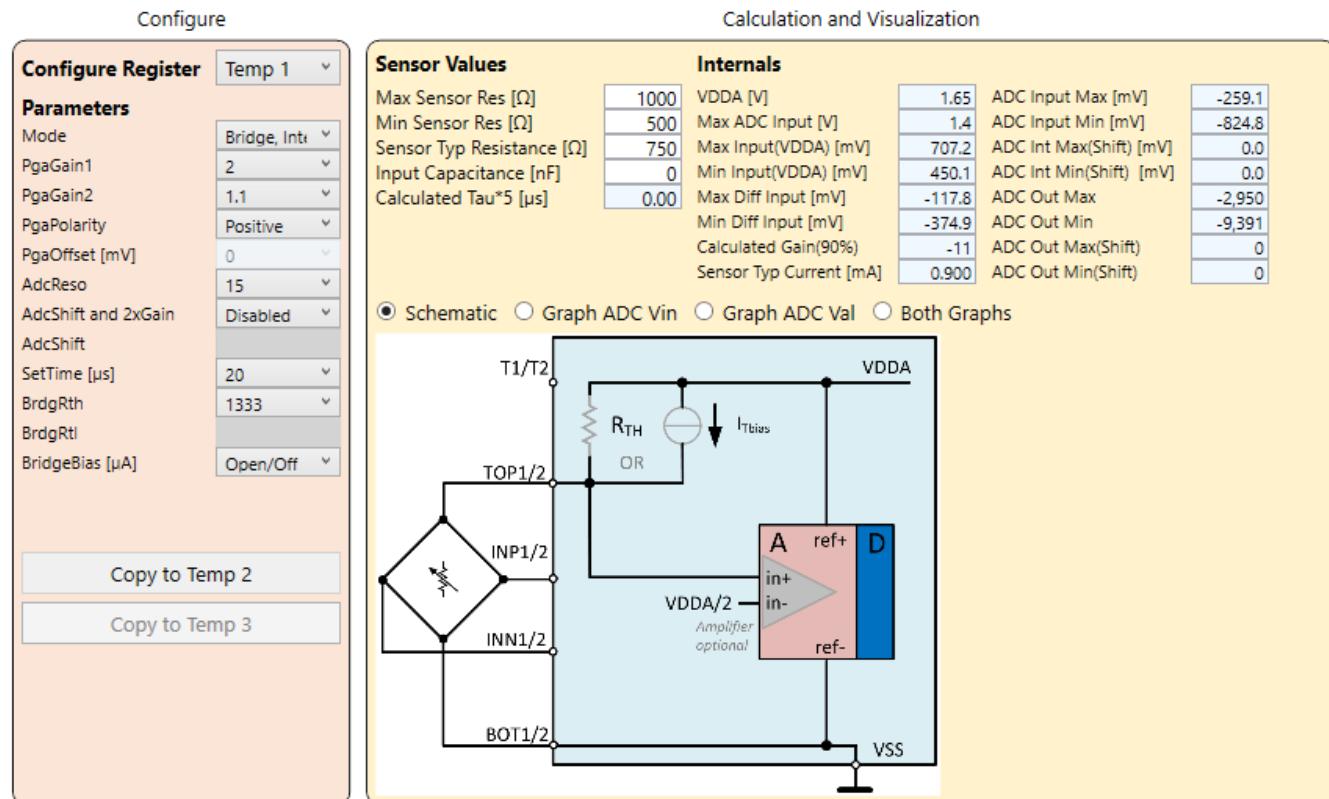


Figure 86. Mode Bridge Internal Bias

- 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').

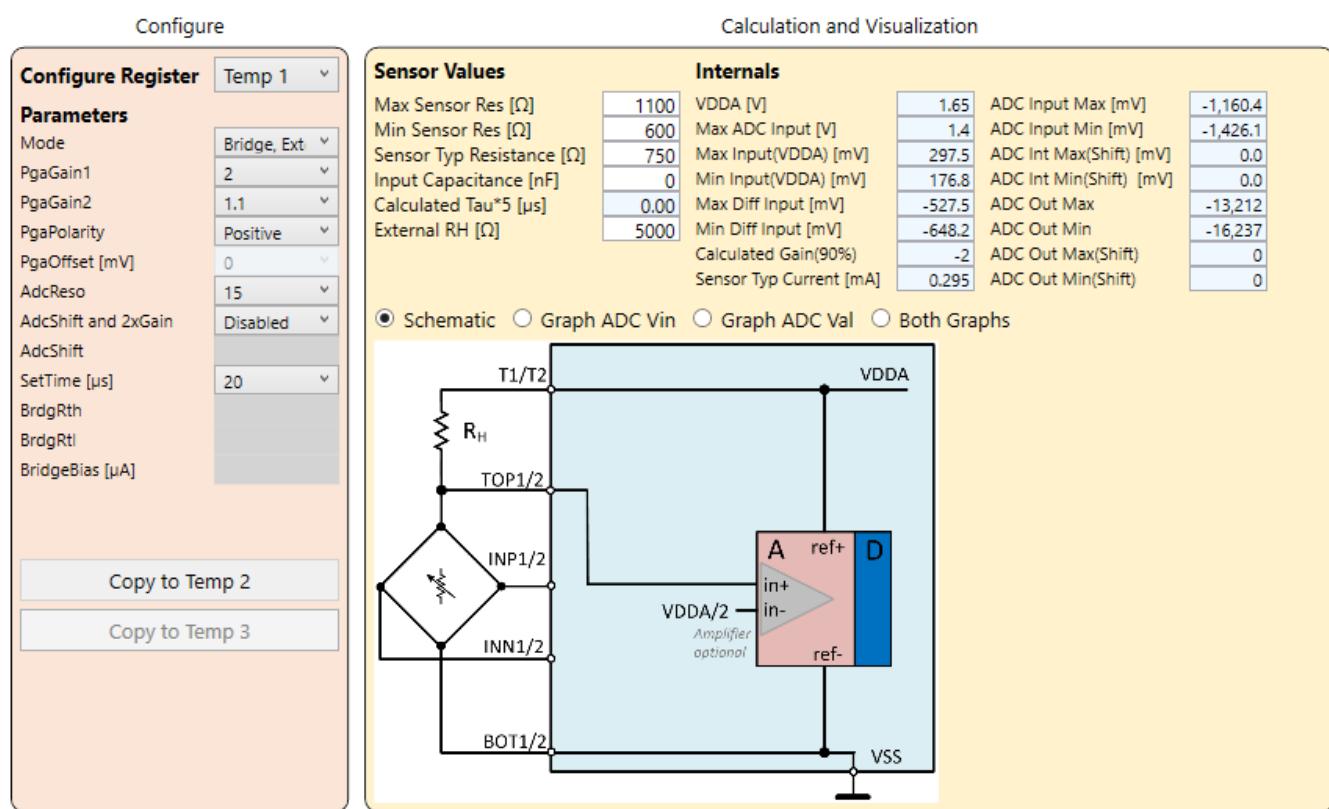


Figure 87. Mode Bridge External Bias

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

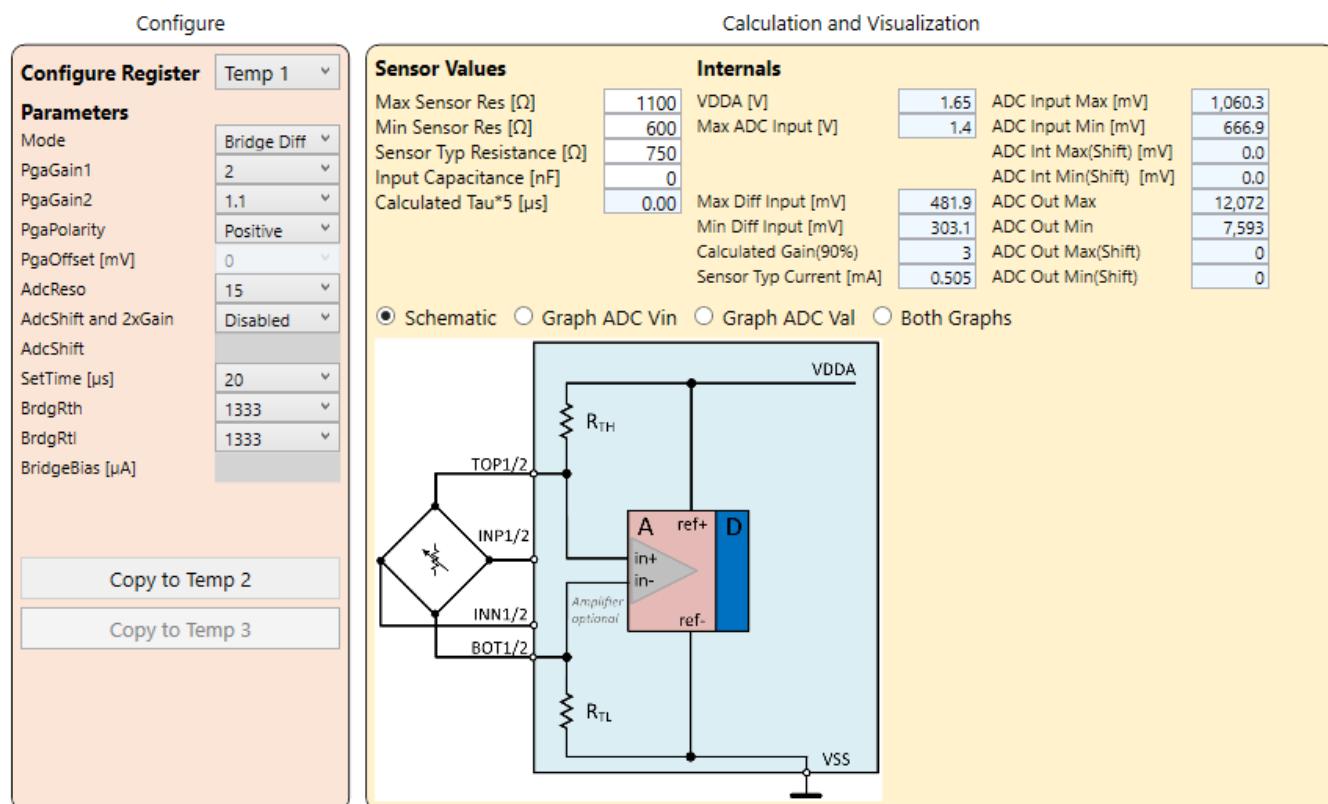


Figure 88. Mode Bridge Differential

5.3.4.2 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 (see Figure 89).

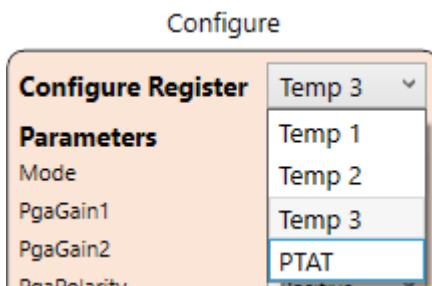


Figure 89. Configure Register

To duplicate an already defined configuration, click “Copy to Temp” button (see Figure 90).

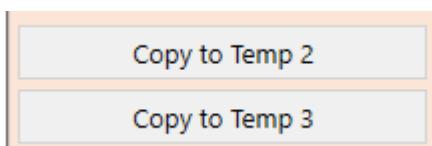


Figure 90. Copy to Temp

5.3.4.3 Sensor Values

This section (see Figure 91) allows the user to enter the input transducer characteristics for performing the calculations displayed in Figure 94.

Sensor Values	
Max Sensor Res [Ω]	1100
Min Sensor Res [Ω]	600
Sensor Typ Resistance [Ω]	750
Input Capacitance [nF]	0
Calculated Tau*5 [μs]	0.00

Figure 91. Temp- Sensor Values

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

5.3.4.4 Parameters

The Parameters section (see Figure 92) 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 93 is dynamically updated according to the 'Mode' selection, see section 5.3.4.1 for details on different modes.

Parameters	
Mode	Bridge Diff ▾
PgaGain1	2 ▾
PgaGain2	1.1 ▾
PgaPolarity	Positive ▾
PgaOffset [mV]	0 ▾
AdcReso	15 ▾
AdcShift and 2xGain	Disabled ▾
AdcShift	Disabled
SetTime [μs]	20 ▾
BrdgRth	1333 ▾
BrdgRtl	1333 ▾
BridgeBias [μA]	

Copy to Temp 2

Figure 92. Parameters

The following parameters can be set:

- Mode: defines the type of supply scheme of the connected transducer, see section 5.3.4.1.
- 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: enable of 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 (I_{Tbias})

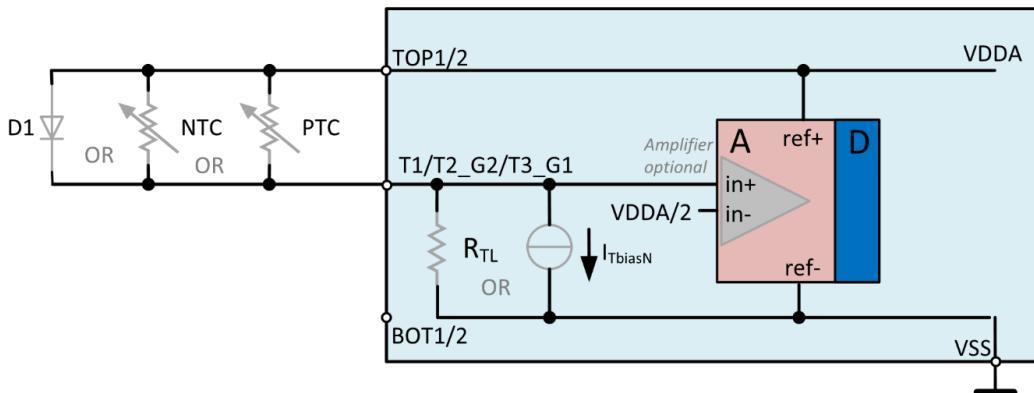


Figure 93. Temp – Schematic

5.3.4.5 Internals

The Internals section (see Figure 94) displays values of specific electrical parameters that are built in the device and calculated parameters after the values set as per sections 5.3.4.1, 5.3.4.2, 5.3.4.3, and 5.3.4.4.

Internals	
VDDA [V]	1.65
Max ADC Input [V]	1.4
Max Input(VDDA) [mV]	746.0
Min Input(VDDA) [mV]	512.2
Max Diff Input [mV]	-79.0
Min Diff Input [mV]	-312.8
Calculated Gain(90%)	-16
Sensor Typ Current [mA]	0.854
ADC Input Max [mV]	-347.6
ADC Input Min [mV]	-1,376.5
ADC Int Max(Shift) [mV]	0.0
ADC Int Min(Shift) [mV]	0.0
ADC Out Max	-3,958
ADC Out Min	-15,672
ADC Out Max(Shift)	0
ADC Out Min(Shift)	0

Figure 94. 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(90%): suggested Gain setting to reach 90% 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, see Figure 95.

Internals		
VDDA [V]	1.65	ADC Input Max [mV]
Max ADC Input [V]	1.4	ADC Input Min [mV]
Max Input(VDDA) [mV]	746.0	ADC Int Max(Shift) [mV]
Min Input(VDDA) [mV]	512.2	ADC Int Min(Shift) [mV]
Max Diff Input [mV]	-79.0	ADC Out Max
Min Diff Input [mV]	-312.8	ADC Out Min
Calculated Gain(90%)	-16	ADC Out Max(Shift)
Sensor Typ Current [mA]	0.854	ADC Out Min(Shift)

Figure 95. Internals Out of Range

5.3.4.6 Schematic and Graphs

Select Schematic, Graph ADC Vin, Graph ADC Val, or Graph Combined (Figure 96) 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 (see Figure 97).

Schematic Graph ADC Vin Graph ADC Val Graph Combined

Figure 96. Schematic and Graphs Selection

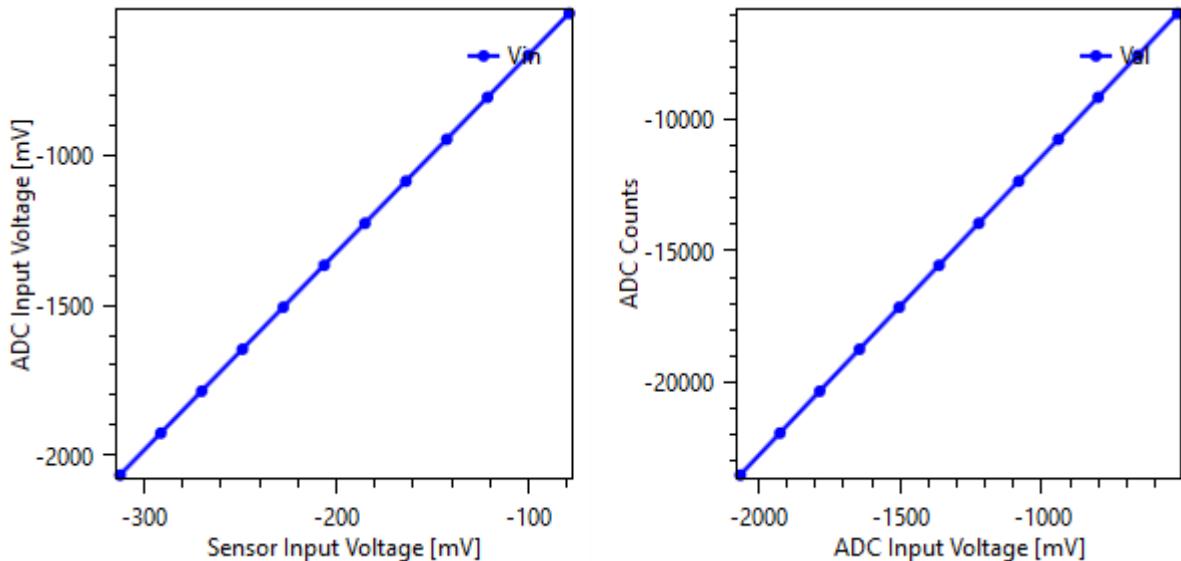


Figure 97. Combined Graphs

5.4 Third Logic Channel

The Third logic channel (see Figure 60) allows the processing of conditioned data from Sensor Channel 1 and Sensor Channel 2 according to the operation displayed in Figure 98.

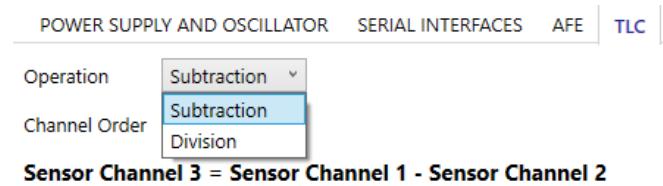


Figure 98. Third Logic Channel Operations

Select 'Subtraction' or 'Division' from the Operation drop-down list (see Figure 98), and 'CH1 op CH2' or 'CH2 op CH1' from the Channel Order drop-down list (see Figure 99).

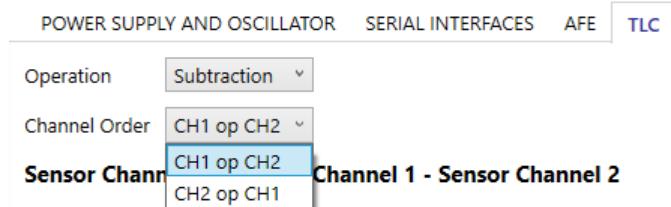


Figure 99. Third Logic Channel – Channel Order

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 6.

Data provided by the ZSSC3281 are in a 4 bytes length so that the result of the division between the 2 sensor channels can be properly displayed.

5.4.1 Output Scaling

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 7) and upstream when the application of the (IIR) has filtering function (section 5.8).

The Output scaling tab is displayed in Figure 100.

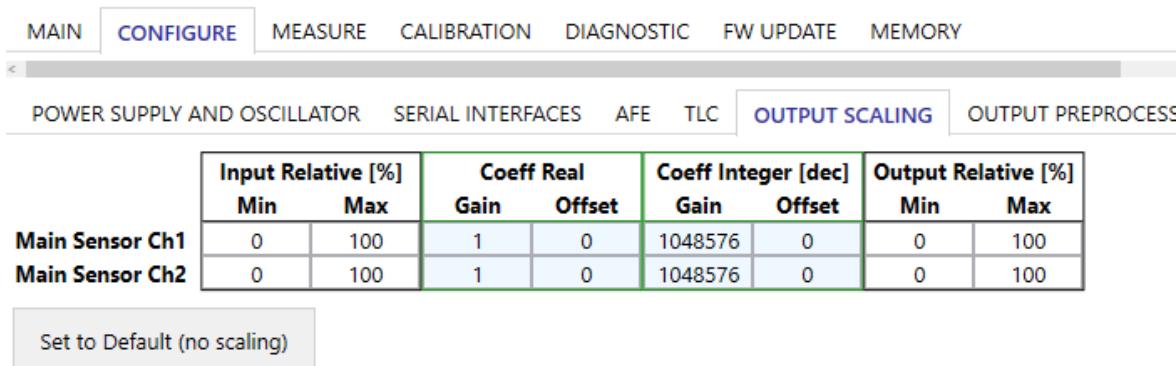


Figure 100. Output Scaling

The Input Relative [%] and Output Relative [%] fields are editable, the GUI calculates the offset and gain coefficients.

Click the 'Set to Default (no scaling)' to have the default input/output values (see Figure 101).

Set to Default (no scaling)

Figure 101. Back to Defaults

Output Scaling Example

For this example, it is assumed that the actual input returning an output swing from 50% to 100% of the full scale (see Figure 102).

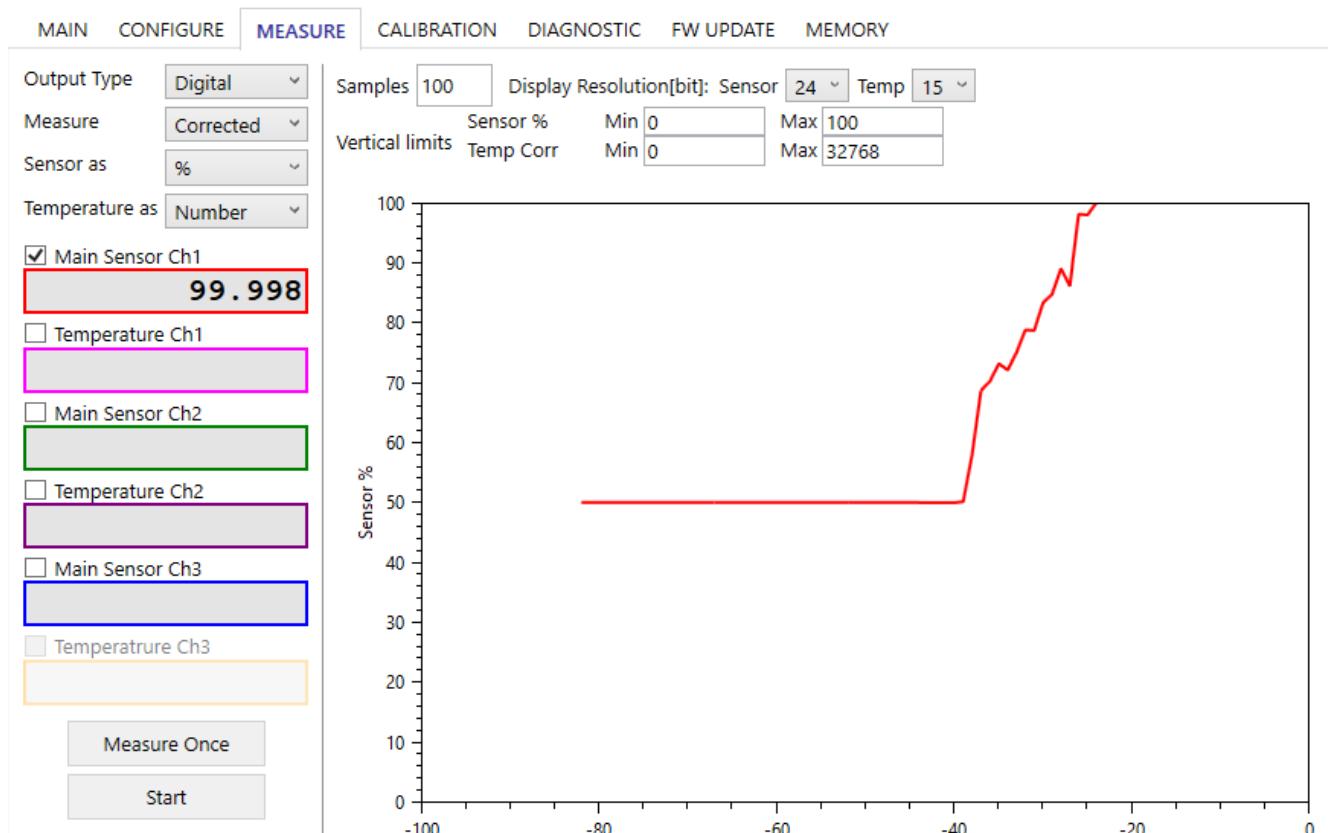


Figure 102. 50% to 100% Output

In the example, main sensor Ch1 has to return as full-scale output without changing calibration or AFE setup using the Output scaling. The current full-scale signal (%) and the output desired full scale signal (%) input is set (see Figure 103).

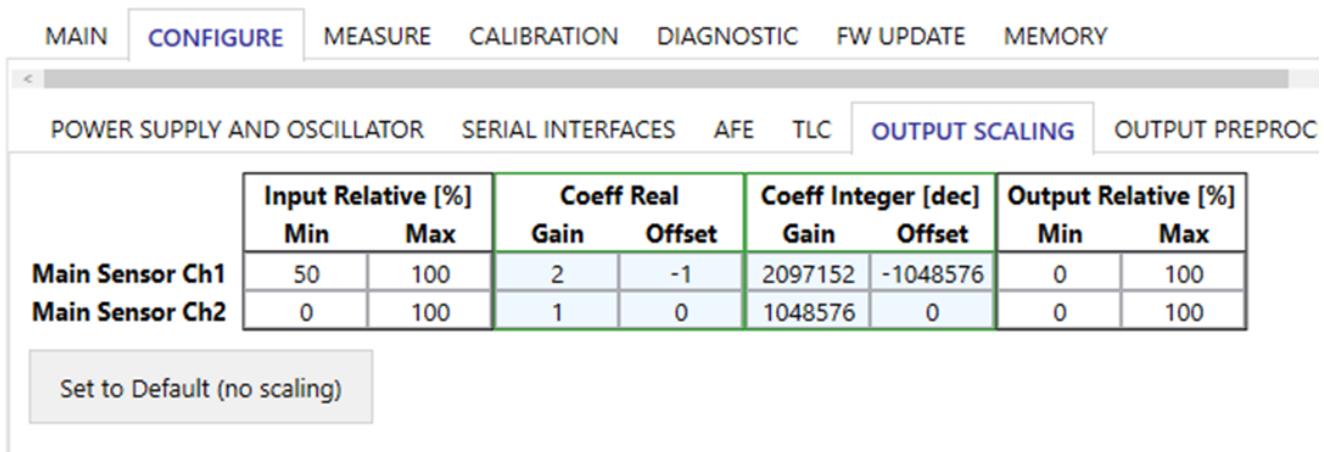


Figure 103. Coefficients for 0% to 100% Output

The GUI automatically calculates the scaling coefficients to be applied and displays them in the Coeff Real and Coeff Integer [dec] fields of Figure 103. To have the Output to operate the 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 103 return the expected swing as displayed in Figure 104

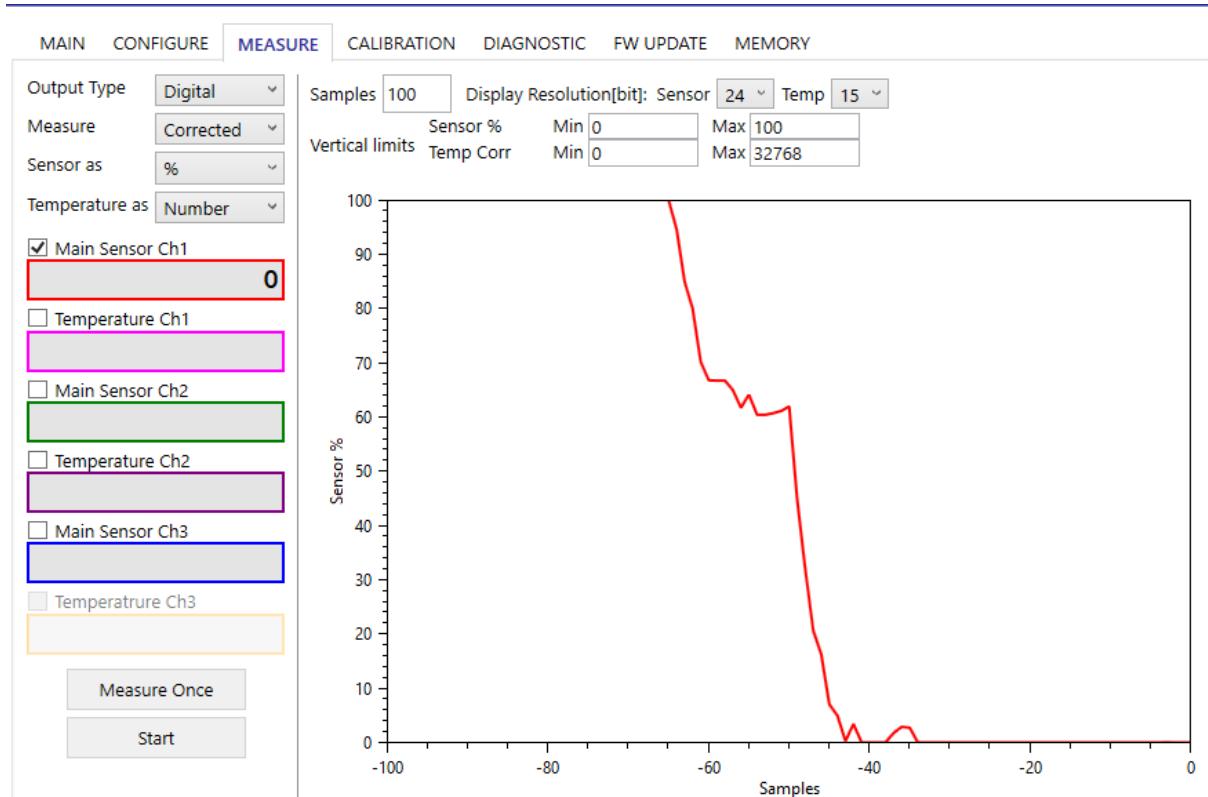


Figure 104. 0% to 100% Output

5.5 Output Preprocessing

The output preprocessing allows to apply a two thresholds clipping function on the AOUT and FOUT signals.

The clipping function is applied after the measured signal is corrected and not visible on the digital values displayed in Measure tab.

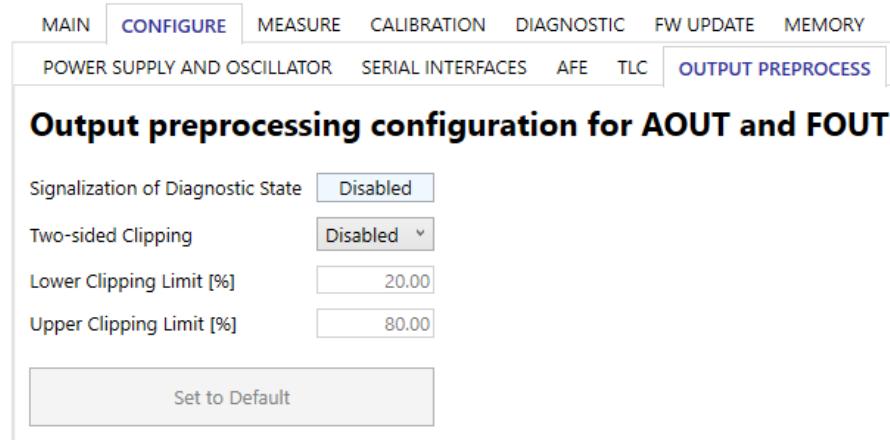


Figure 105. Output Pre-Processing Defaults

The signalization of the diagnostic state reflects the settings defined in the Diagnostic tab (refer to section 8).

When the clipping is enabled, the 'Lower Clipping Limit [%]' and 'Upper Clipping Limit [%]' fields are editable (see Figure 106).

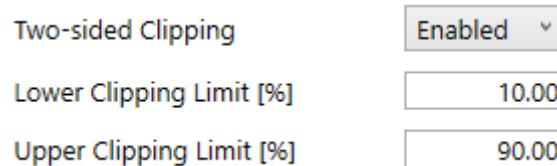


Figure 106. Clipping Limits

Store the settings in NVM to have the clipping functionality operational on measured input.

5.6 FOUT

Modulated signals can be output on the dedicated pins (refer to ZSSC3281 *Datasheet* document), options can be set in the FOUT tab, see Figure 107.

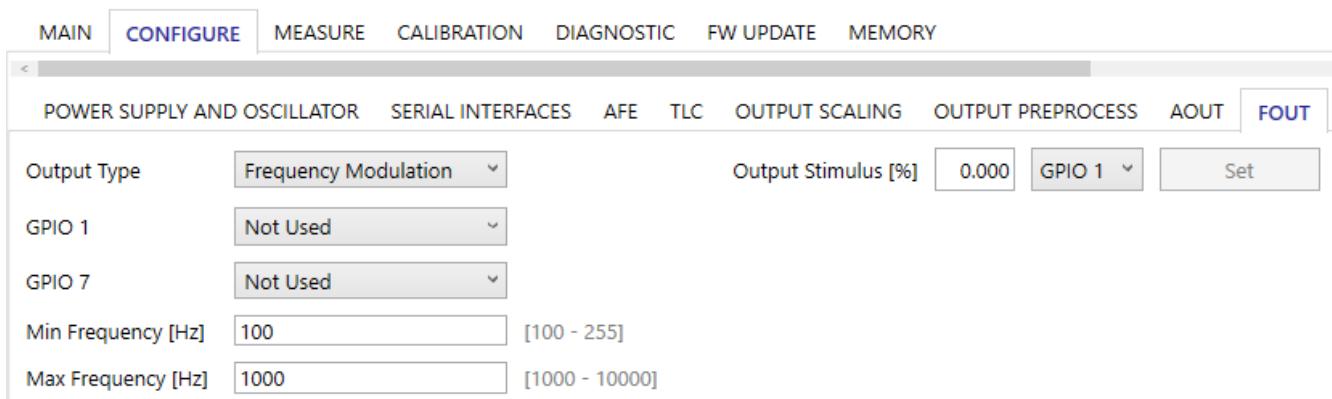


Figure 107. FOUT

5.6.1 Output Type

The following options are available for the modulation (see Figure 108):

- No Output Modulation
- Frequency Modulation
- Pulse Width Modulation option is currently not available, it is reserved for future development.

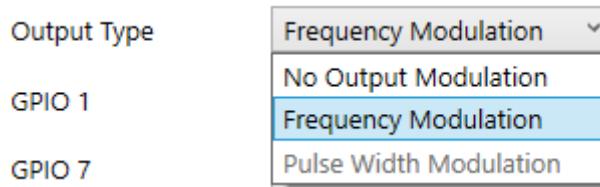


Figure 108. Configure – FOUT – Output Type

5.6.2 GPIOs

Any active channels can be associated to GPIO 1 and GPIO 7, see Figure 109.

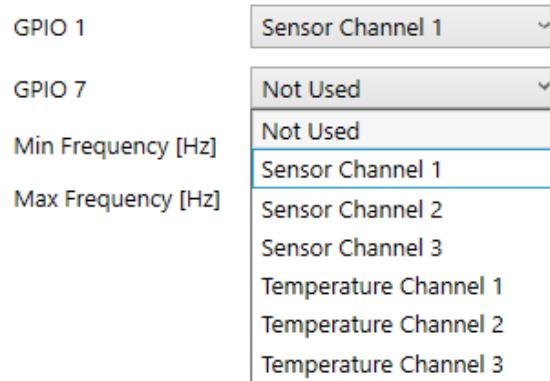


Figure 109. FOUT - GPIOs

5.6.3 Frequency

The frequency range limits are defined with the Min Frequency [Hz] and Max Frequency [Hz] fields, see Figure 110.

Min Frequency [Hz]	<input type="text" value="100"/> [100 - 255]
Max Frequency [Hz]	<input type="text" value="1000"/> [1000 - 10000]

Figure 110. Configure – FOUT – Frequency Range

5.6.4 Output Stimulus

To drive a GPIO directly, set the fixed output level in the 'Output Stimulus [%]' field and click the 'Set' button (see Figure 111).

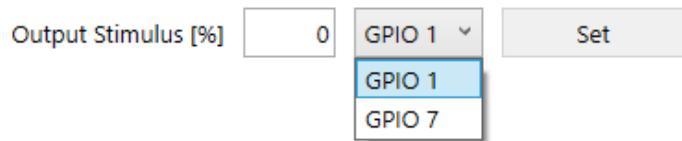


Figure 111. Configure – FOUT- Direct Setting

Store the settings in NVM to have the FOUT functionality operational on measured input.

5.7 AOUT

From the AOUT Pin Mapping menu select the channel to be output as analog output. In Figure 112 'Sensor Channel 1' is selected, refer to section 5.7.2 for additional details.

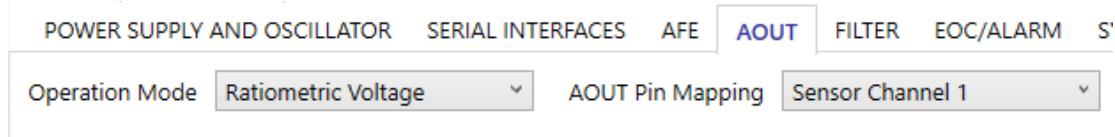


Figure 112. AOUT mapping

5.7.1 Output Operation Mode

See Figure 113 for the analog output options. The available options require specific EVB jumper configuration.

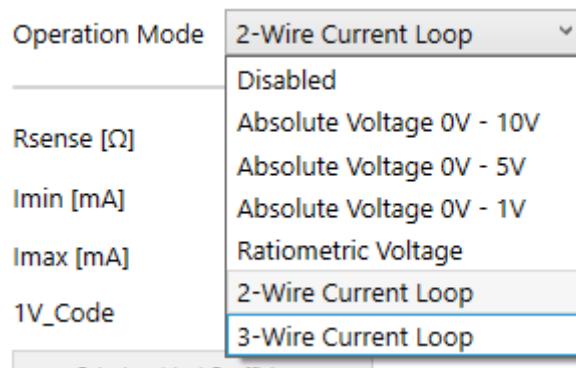


Figure 113. AOUT – Operation Mode

5.7.1.1 Operation Mode: Absolute Voltage 0V - 10V

Selecting this option automatically sets the proper device power supply configuration, see Figure 114. Note: ensure the device is supplied by the 12V rail from the CB as described in section 0

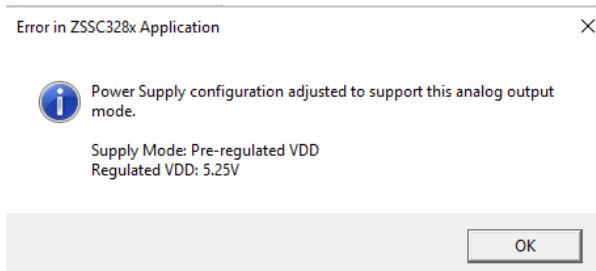


Figure 114. AOUT Power Supply

The following jumper settings are needed to operate in this configuration:

- J11: short pins 1-2
- J6: short
- J28: short
- J9: short
- J12: short
- J10: short pins 2-3 (Set the external operational amplifier U2 gain equal to 2)
- J8: short (allows the GUI to visualize the AOUT pin signal only, the 0V to 10V signal is present on J10)

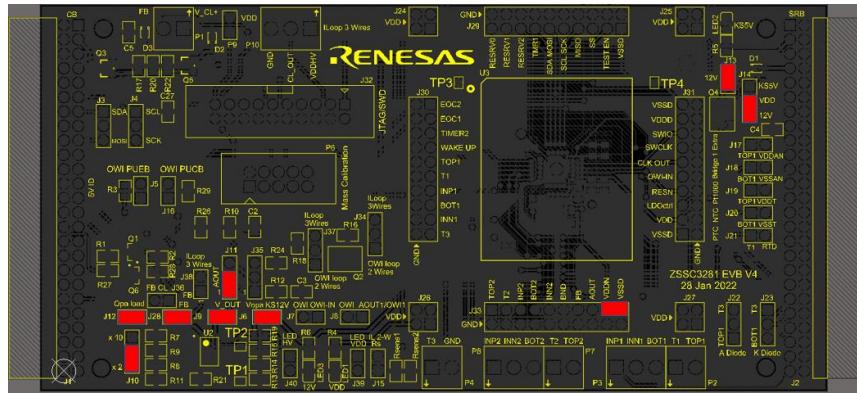


Figure 115. Absolute Voltage 0V-10V - Jumpers

Note: before starting the measurement with the “Start” button (see Figure 116), it is necessary to save configuration in NVM (by the “Write Memory” button in the GUI main tab) and to make sure the output is present on J10 pin 2-3.

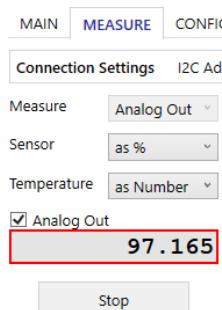


Figure 116. AOUT — Measure

See Figure 117 for the Absolute Voltage 0V - 10V parameters configuration tab.

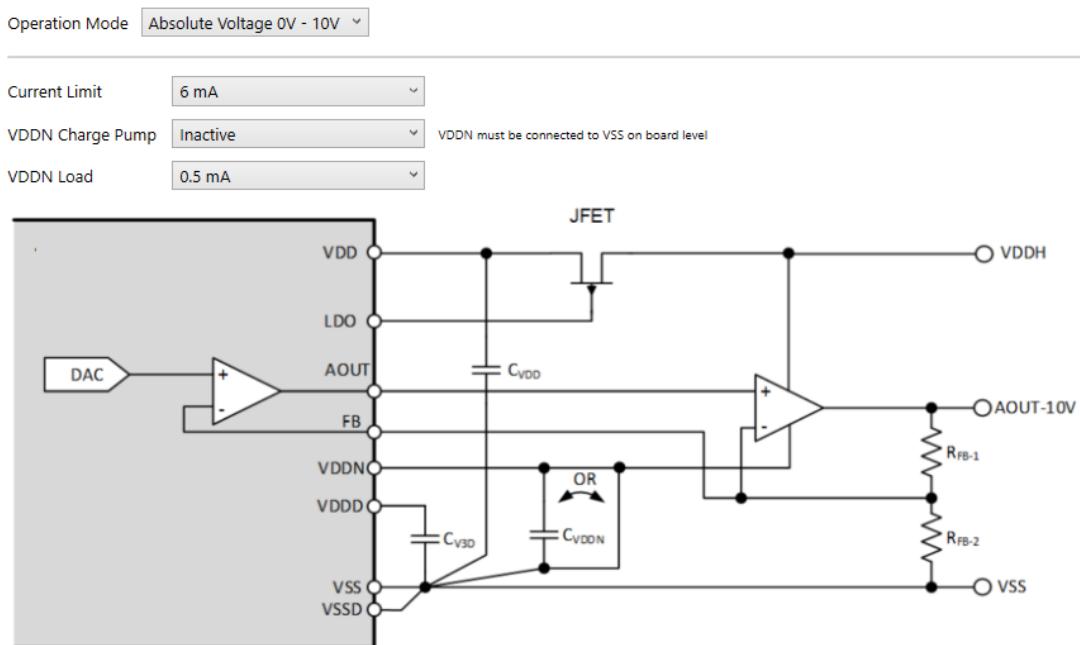


Figure 117. Absolute Voltage 0V - 10V Configuration

Parameters description:

- Current Limit: defines short circuit output current limitation of AOUT Buffer. Typical current limit is selectable.
- 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 otherwise required external short connection between VDDN and VSS must be opened and the external capacitor C_{VDDN} must be connected between VDDN and VSS.
- 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 ZSSC3281.

5.7.1.2 Operation Mode: Absolute Voltage 0V - 5V

For operating in this configuration, remove specific jumpers setup described in 5.7.1.1, no additional jumpers setting on the EVB is needed.

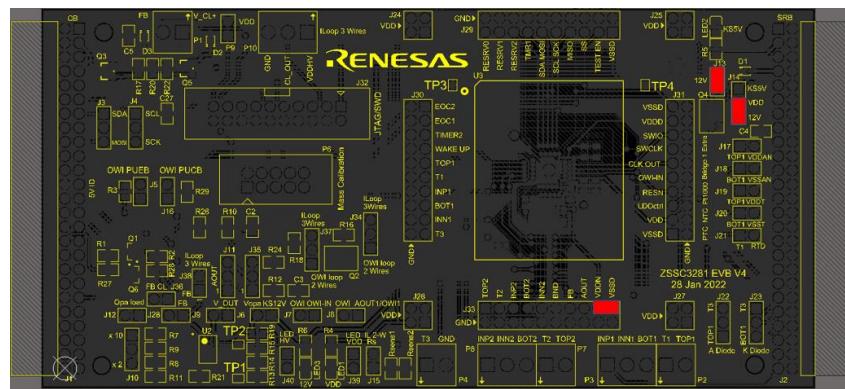


Figure 118. Absolute Voltage 0V-5V - Jumpers

See Figure 119 for the Absolute Voltage 0V - 5V parameters configuration tab.

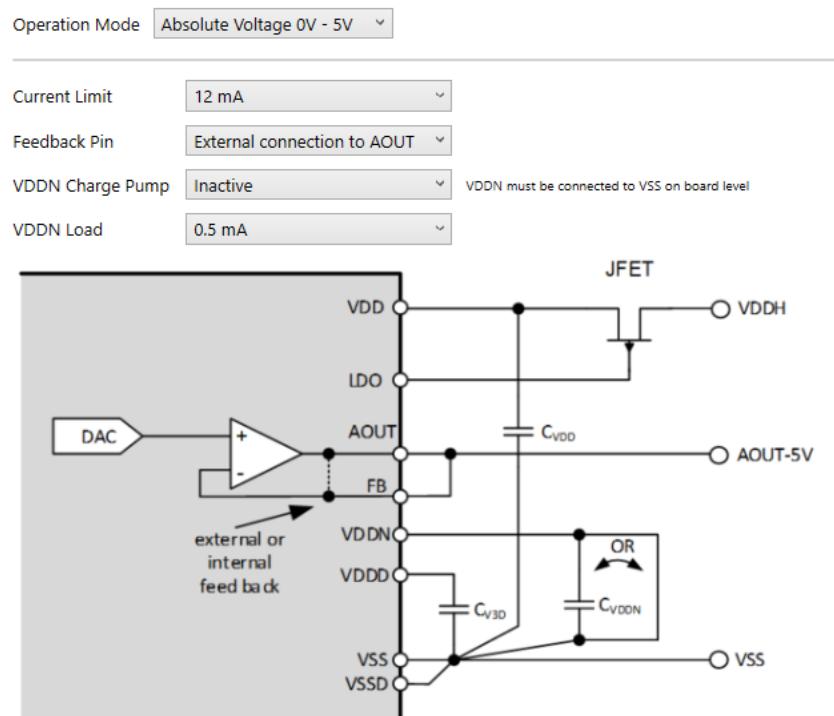


Figure 119. Absolute Voltage 0V-5V Configuration

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 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 otherwise required external short connection between VDDN and VSS must be opened and the external capacitor C_{VDDN} must be connected between VDDN and VSS.
- 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 ZSSC3281.

Note: before starting the measurement with the “Start” button, it is necessary to save configuration in NVM (by the “Write Memory” button in the GUI main tab), to reset the device, and to make sure the output is present on J8 pin 1-2 shorted.

5.7.1.3 Operation Mode: Absolute Voltage 0V - 1V

For operating in this configuration, remove specific jumpers setup described in 5.7.1.1 and 5.7.1.2, no additional jumpers setting on the EVB is needed.

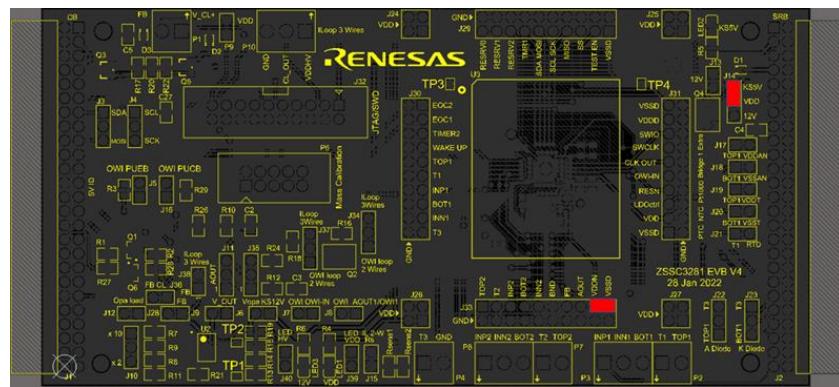


Figure 120. Absolute Voltage 0V-1V - Jumpers

See Figure 121 for the Absolute Voltage 0V - 1V parameters configuration tab.

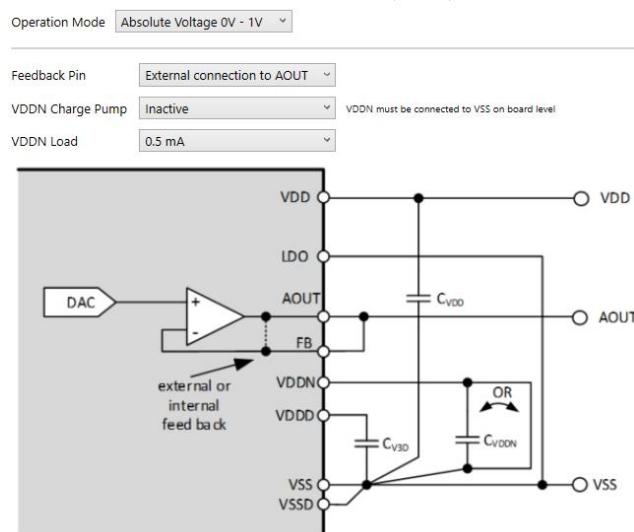


Figure 121. Absolute Voltage 0V to 1V Configuration

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 otherwise required external short connection between VDDN and VSS must be opened and the external capacitor C_{VDDN} must be connected between VDDN and VSS.
- 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 ZSSC3281.

Note: before starting the measurement with the “Start” button, it is necessary to save configuration in NVM (by the “Write Memory” button in the GUI main tab), to reset the device, and to make sure the output is present on J8 pin 1-2 shorted.

5.7.1.4 Operation Mode: Ratiometric Voltage

For operating in this configuration, remove specific jumpers setup described in 5.7.1.1 or 5.7.1.2 or 5.7.1.3, no additional jumpers setting on the EVB is needed.

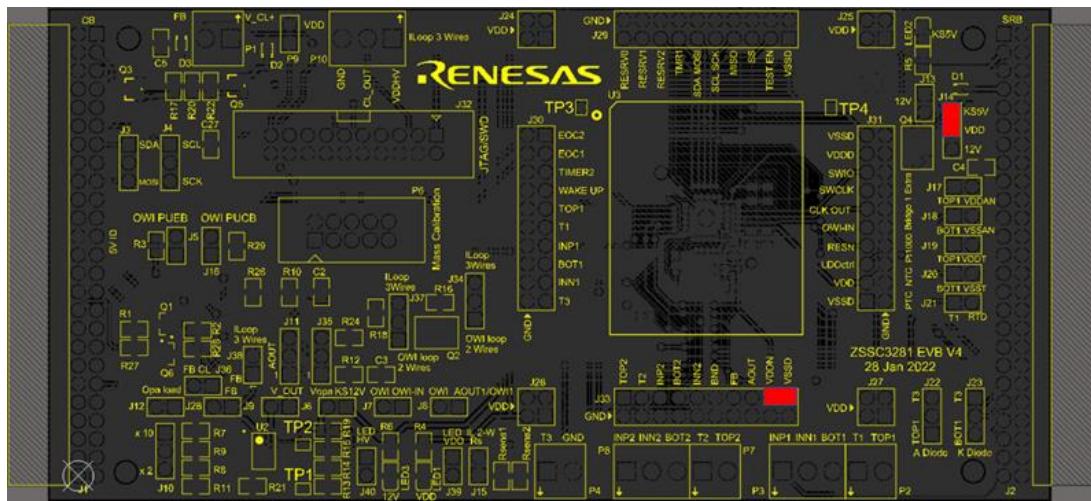


Figure 122. Ratiometric Voltage Jumpers

See Figure 123 for the Ratiometric Voltage parameters configuration tab.

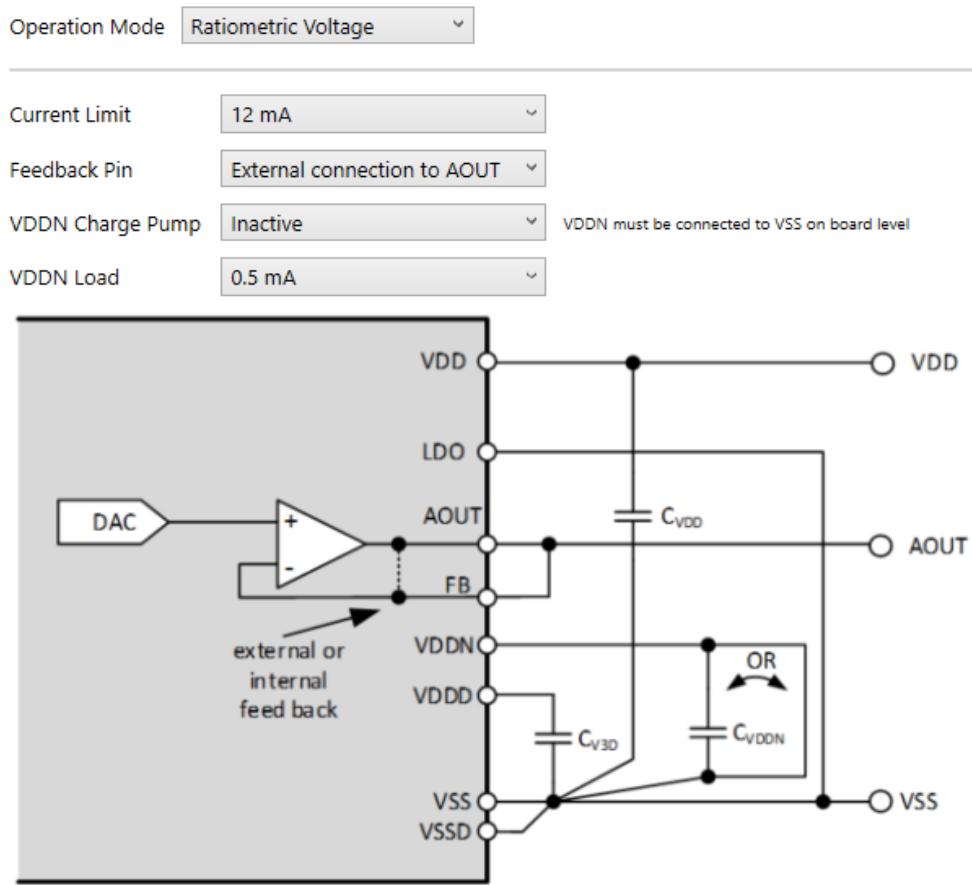


Figure 123. Ratiometric Voltage Configuration

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 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 otherwise required external short connection between VDDN and VSS must be opened and the external capacitor C_{VDDN} must be connected between VDDN and VSS.
- 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 ZSSC3281.

Note: before starting the measurement with the “Start” button, it is necessary to save configuration in NVM (by the “Write Memory” button in the GUI main tab), and to make sure the ratiometric output is present on J8 pin 1-2 shorted.

5.7.1.5 Operation Mode: 2-Wire Current Loop

For operating in this configuration, remove specific jumpers setup described in 5.7.1.1, 5.7.1.2, 5.7.1.3, or 5.7.1.7 and set the jumpers as the following:

- J11: short 2-3
- J35: short 1-2
- J37: short 1-2
- J34: short 1-2
- J15: short
- J14: short 2-3
- Ensure that VDDN is shorted to GND (J33) as displayed in Figure 124.

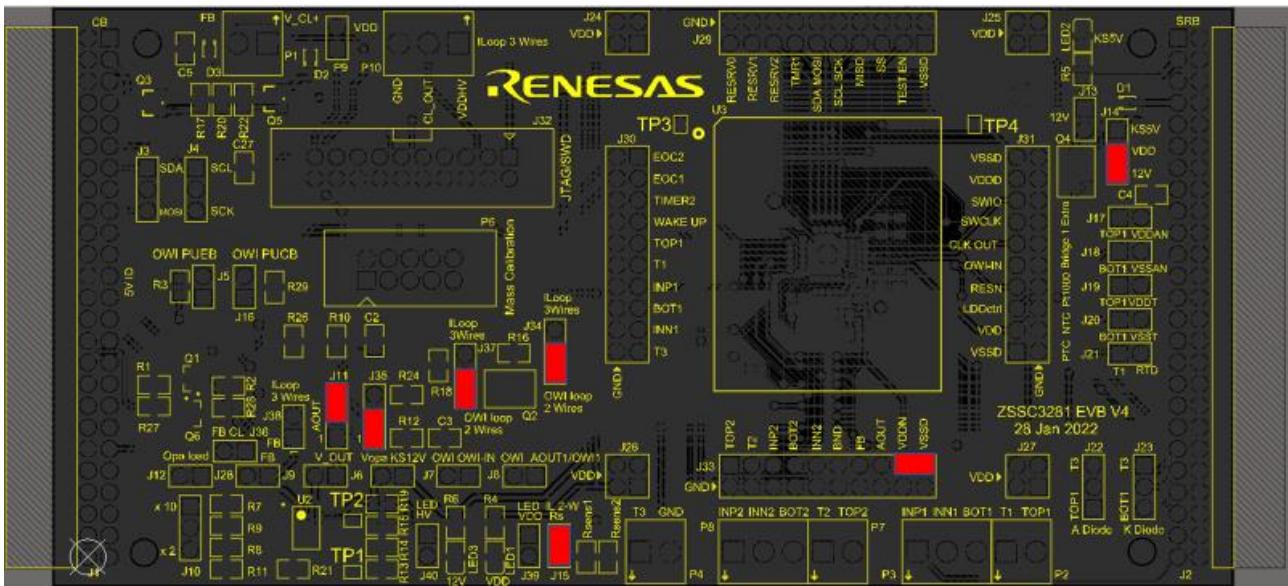


Figure 124. 2-Wire Current Loop Jumpers

For the ZSSC3281EVB version V3 or older, unsolder R4.

When using the SRB3 sensor replacement board to operate the 2-wire current loop, ensure that resistor R1 and R3 are not soldered on the board (see Figure 125).

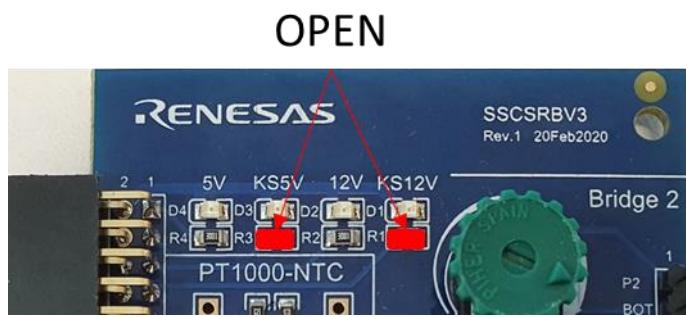


Figure 125. 2-Wire Current Loop SRB3 Specific Configuration

For testing purposes, the power supply of the current loop can be 24V applied to the connector P1. A current meter (for measuring purposes) needs to be connected between in series with the loop power supply (high side).

Selecting 2-Wire Current Loop option automatically set the proper device power supply configuration, see Figure 114.

Ensure the sequencer has one AFE enabled (for example, AFE1) as per Figure 126.

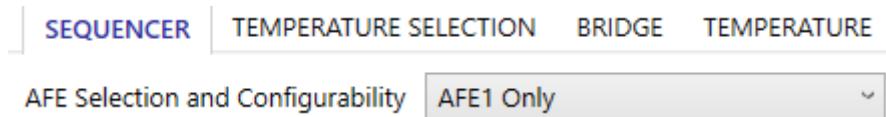


Figure 126. 2-Wire Current Loop Single AFE Active

Ensure the Power Supply and Oscillator parameters are configured as per Figure 127.

Power Supply

Supply Mode Requires different jumper settings

Regulated VDD

Oscillator

System Clock Source

System Clock Source Divider

Clock Output Mode

Some settings are not selectable due to the configured AOUT Mode.

Figure 127. 2-Wire Current Loop Power Supply and Oscillator

Ensure the calibration coefficients in NVM are configured as per Figure 128 (default values).

Afe1CfgSccCoeff.SOffset	32	00000000
Afe1CfgSccCoeff.SGain	33	00200000
Afe1CfgSccCoeff.SSot	34	00000000
Afe1CfgSccCoeff.SShift	35	00000000
Afe1CfgSccCoeff.STco	36	00000000
Afe1CfgSccCoeff.SSotTco	37	00000000
Afe1CfgSccCoeff.STcg	38	00000000
Afe1CfgSccCoeff.SSotTcg	39	00000000

Figure 128. Default Calibration Coefficients

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

5.7.1.6 2-Wire Current Loop Calibration

For sensor signal calibration refer to section 7.

Follow these step to calibrate the 2-wire current loop option:

1. Set the ‘Rsense [Ω]’, ‘Imin [mA]’, and ‘Imax [mA]’ values for the current loop input (defaults are displayed)
2. Click the ‘Calculate Ideal Coefficients’ button (see Figure 129).

Operation Mode **2-Wire Current Loop** AOUT Pin Mapping **Sensor Channel 1**

Rsense [Ω] **50** Calculate Real coefficients after Ideal coefficients are written to memory

Imin [mA] **4** Set Current Min Measured Imin [mA]

Imax [mA] **20** Set Current Max Measured Imax [mA]

1V_Code **F3D2**

Calculate Ideal Coefficients

Ideal CL2_Offset **A14C** Real CL2_Offset

Ideal CL2_Delta **4B06** Real CL2_Delta

The diagram shows a complex analog circuit for current loop calibration. It features a LDO, an operational amplifier (op-amp) with a feedback path through resistors R1 and R2, and a digital-to-analog converter (DAC). The DAC is connected to the non-inverting input of the op-amp. The output of the op-amp is connected to the non-inverting input of a second op-amp, labeled 'AOUT'. The inverting input of 'AOUT' is connected to a feedback node labeled 'FB'. A current sense resistor, Rsense, is connected between the FB node and the ground rail (VSS). The output of 'AOUT' is connected to the gate of a JFET. The drain of the JFET is connected to the positive rail (VDD) through a diode D1. The drain of the JFET is also connected to the cable, which is connected to a load resistor (Rload) and an ammeter (A). The cable is terminated with a capacitor (Cload). Various voltage and current points are labeled: Iloop, Isense, Vloop, VFB, Vp, Vref, and various LDO and op-amp supply voltages.

Figure 129. 2-Wire Current Loop Calibration

3. Execute a Memory Write.
4. Click on the 'Set Current Min' button and read the current in the loop through a current probe (a digital multi meter in series in the loop can be used as well).
5. Input the read value in the relevant input field.
6. Click on the 'Set Current Max' button and read the current in the loop through a current probe (a digital multi meter in series in the loop can be used as well).
7. Input the read value in the relevant input field.

The interface appears as displayed in Figure 130 (values are for reference only).

Operation Mode **2-Wire Current Loop** AOUT Pin Mapping **Sensor Channel 1**

Rsense [Ω]	50	Calculate Real coefficients after Ideal coefficients are written to memory
Imin [mA]	4	Set Current Min Measured Imin [mA] 4.3
Imax [mA]	20	Set Current Max Measured Imax [mA] 19.7
1V_Code	F3D2	
Calculate Ideal Coefficients		
Ideal CL2_Offset	A14C	Real CL2_Offset A2B4
Ideal CL2_Delta	4B06	Real CL2_Delta 4DF2

Figure 130. 2-Wire Current Loop Calibration Measured Coefficients

8. Execute a Memory Write.
The Current loop is calibrated and ready for measurements.
9. Click on the 'Start' button (see Figure 152) to start measurement.

5.7.1.7 Operation Mode: 3-Wire Current loop

Selecting 3-Wire Current Loop option automatically set the proper device power supply configuration, see Figure 114. Note: before the current loop is ready to be calibrated, it is necessary to save configuration in NVM (by the "Write Memory" button in the GUI main tab). For operating in this configuration, remove specific jumpers setup described in 5.7.1.1, 5.7.1.2, 5.7.1.3, or 5.7.1.5, and set the jumpers as the following:

- J11: short 2-3
- J35: short 2-3
- J37: short 2-3
- J34: short 2-3
- J14: short 2-3
- J38: short
- Ensure that VDDN is shorted to GND (J33) as displayed in Figure 131.
- Connect P10, pin 1, to the VDDHV
- Connect GND of VDDHV to P10 pin 3.

A current meter (for measuring purposes) with a current limiting resistor (for example, 390Ω) can be connected between P10 pin 1 and 2, or the current meter can be attached on J34 replacing the short 2-3.

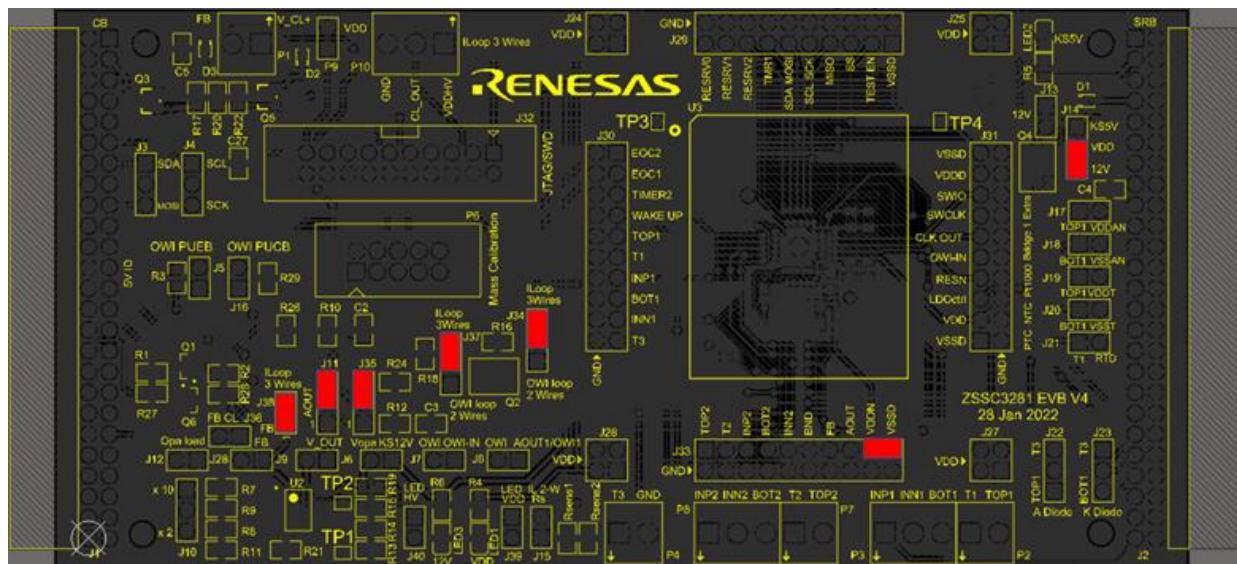


Figure 131. 3-Wire-Current-Loop Jumper Setting

5.7.1.8 3-Wire Current Loop Calibration

For sensor signal calibration refer to section 7. Follow these step to calibrate the 3-wire current loop option:

1. Set the 'Rsense [Ω]', 'Imin [mA]', and 'Imax [mA]' values for the current loop input.
2. Click the 'Calculate Ideal Coefficients' button (see Figure 132).

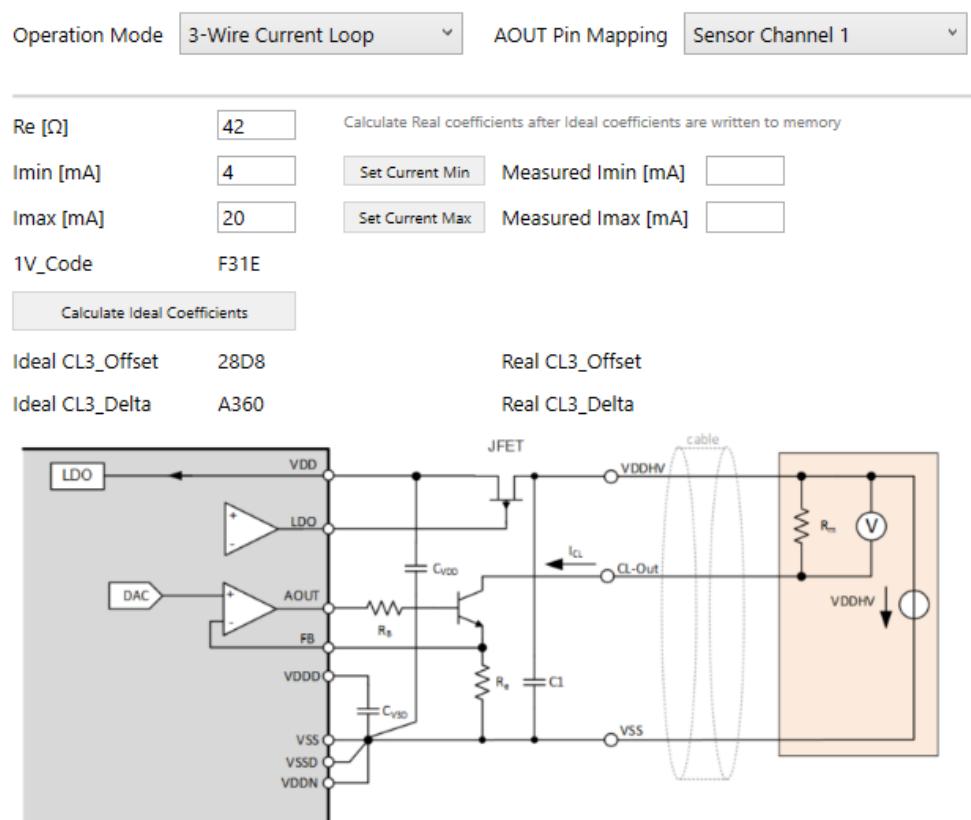


Figure 132. 3-Wire Current Loop Calibration

3. Execute a Memory Write.
4. Click on the 'Set Current Min' button and read the current in the loop through a current probe (a digital multi meter in series in the loop can be used).
5. Input the read value in the relevant input field.
6. Click on the 'Set Current Max' button and read the current in the loop through a current probe (a digital multi meter in series in the loop can be used).
7. Input the read value in the relevant input field.

The interface appears as displayed in Figure 133 (values are for reference only).

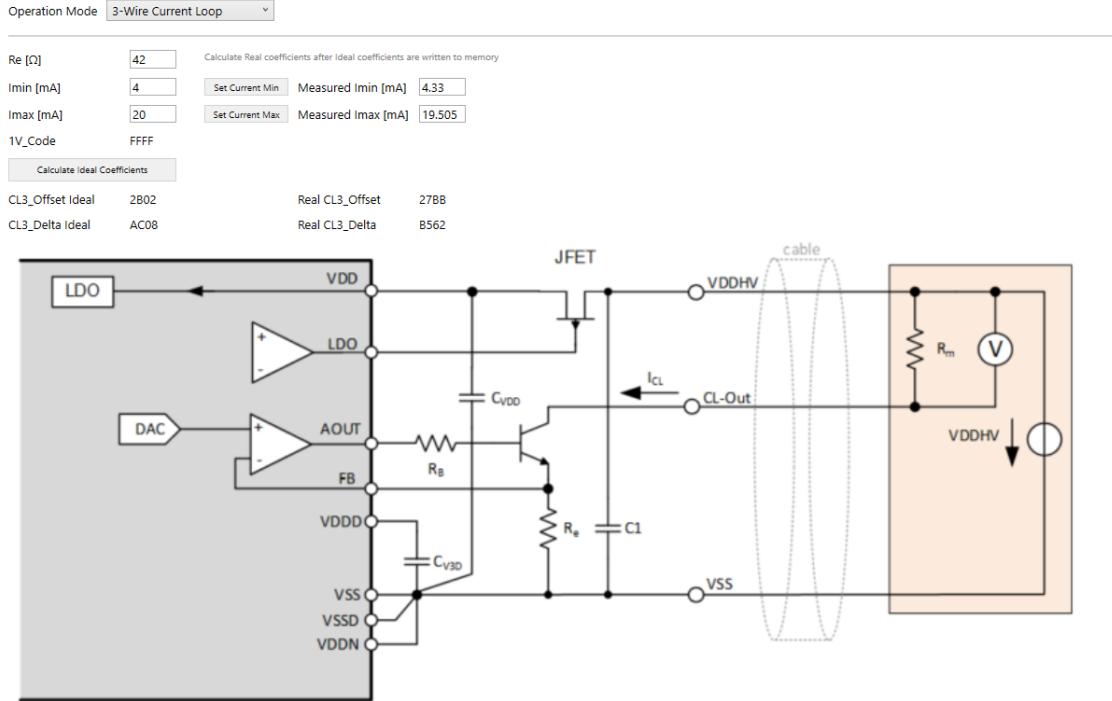


Figure 133. 3-Wire Current Loop calibration Measured Coefficients

8. Execute a Memory Write.
- The current loop is calibrated and ready for measurements.
9. Click on the 'Start' button (see Figure 152) to start measurement.

5.7.2 AOUT Pin Mapping

The AOUT pin can provide the analog output from different channels, select it from the AOUT Pin Mapping drop-down list (see Figure 134).

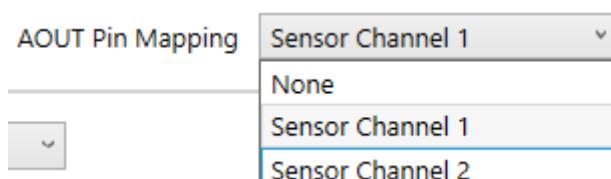


Figure 134. AOUT Pin Mapping

In Dual Speed Mode, the AOUT mapping is forced to Sensor Channel 1 (no other options are available).

5.7.3 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 135).

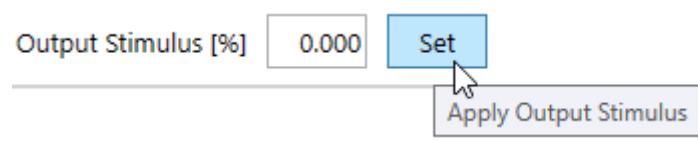


Figure 135. AOUT Direct Setting

5.8 Filter

The filter can be employed for each conditioned sensor signals in Cyclic Mode only. The location of the filter function in the processing path is highlighted in Figure 60. 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 136.

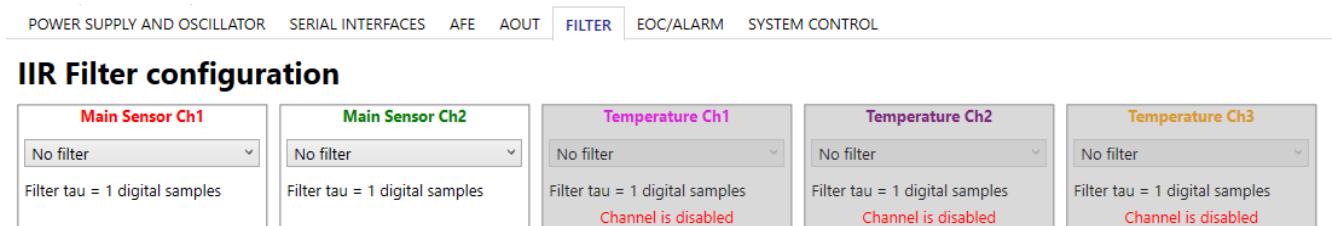


Figure 136. Filter Tab

The filter function applied to each of the channels displayed in Figure 136 is identical. The list of values displayed in Figure 137 allows the selection of the time constant (tau) of the filter, expressed in units of digital samples.

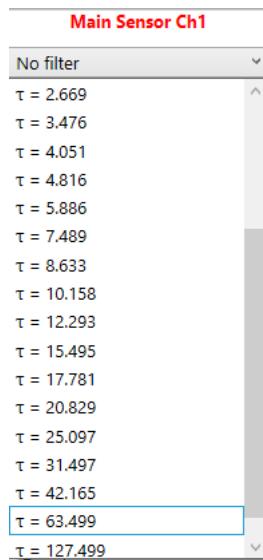


Figure 137. Filter Time Constant Setting

Filter behavior at the event of an input step is displayed in figure Figure 138, where the filter tau value 4.051 (X axis is representing time in terms of digital samples).

IIR Filter configuration

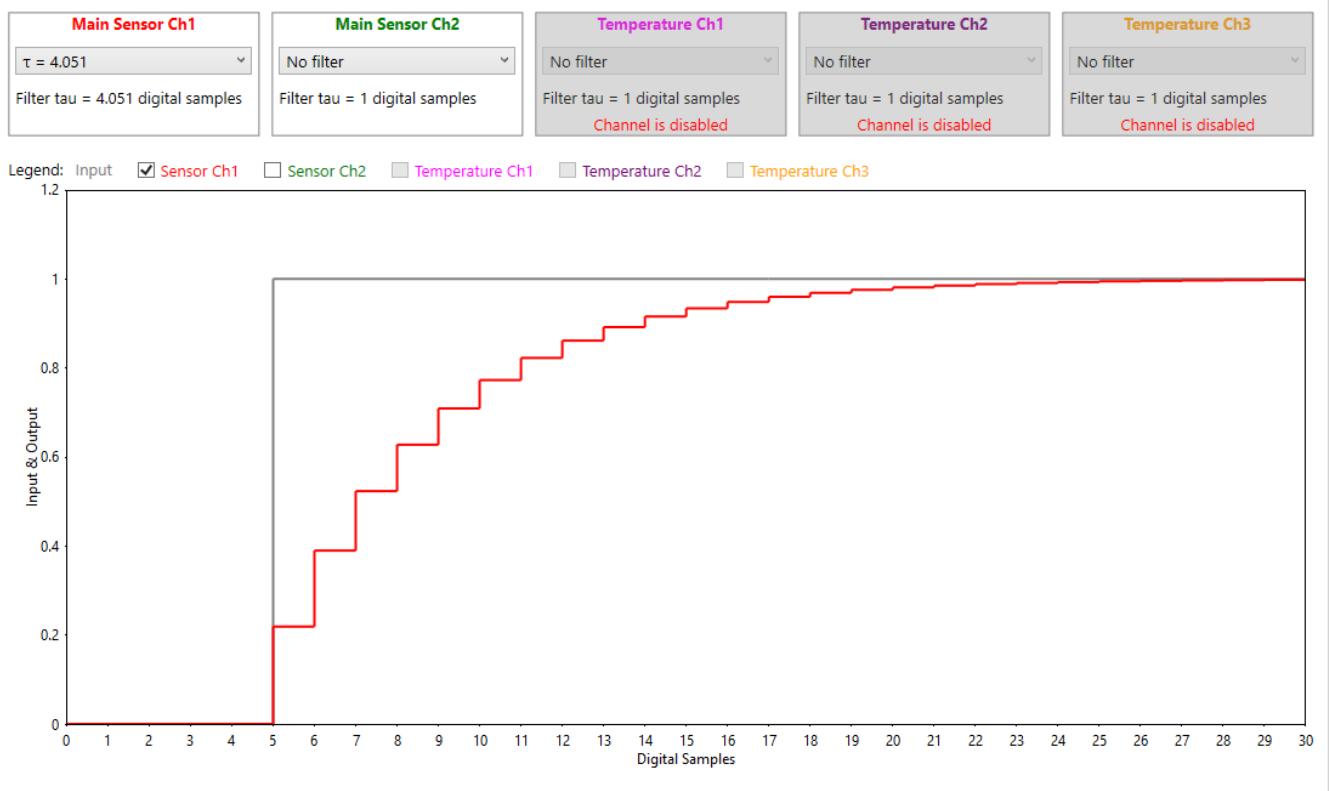


Figure 138. Filter Response (Digital Domain)

To calculate the actual time needed for filter settling, measure the data rate of the output first (that is dependant on the resolution selected and the sequencer configuration).

Note: before the filter function becomes operational, it is necessary to execute a Write Memory to save the time constant in flash memory.

The filter configuration functionality is not available when operating the Dual Speed Mode.

5.9 EOC/Alarm

The ZSSC3281 provides the option to generate two independent EOC/Alarm signals. EOC/Alarm functions are selectable as displayed in Figure 139.

Main Sensor Channel 1 (GPIO2)

Selected Mode	EOC
Output Polarity	None
	EOC
	Alarm

Main Sensor Channel 2 (GPIO3)

Selected Mode	EOC
Output Polarity	Active High

Figure 139. EOC/Alarm Signals

EOC/Alarm functions have configurable options, see sections 5.9.1 and 5.9.2 for details. These signals are generated when the corrected measurement of the main sensor is available at the digital output buffer for reading.

5.9.1 EOC

The EOC signals (one for AFE1 and one for AFE2) are activated when the SSC-corrected measurement result of the main bridge sensor is available for the host system, which means after the output data buffer is updated.

The EOC signals are independently configurable for each main sensor channel. EOC for main sensor channel 1 is assigned to pin GPIO2 and EOC for main sensor channel 2 is assigned to pin GPIO3.

The EOC signal can be configured as active high or active low by selecting an option from the Output Polarity drop-down list (see Figure 140).

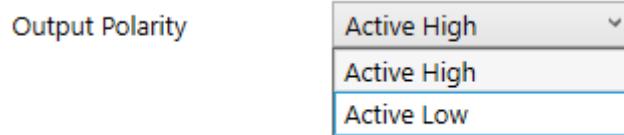


Figure 140. EOC Polarity

Behavior of the EOC signal is shown in Figure 141.

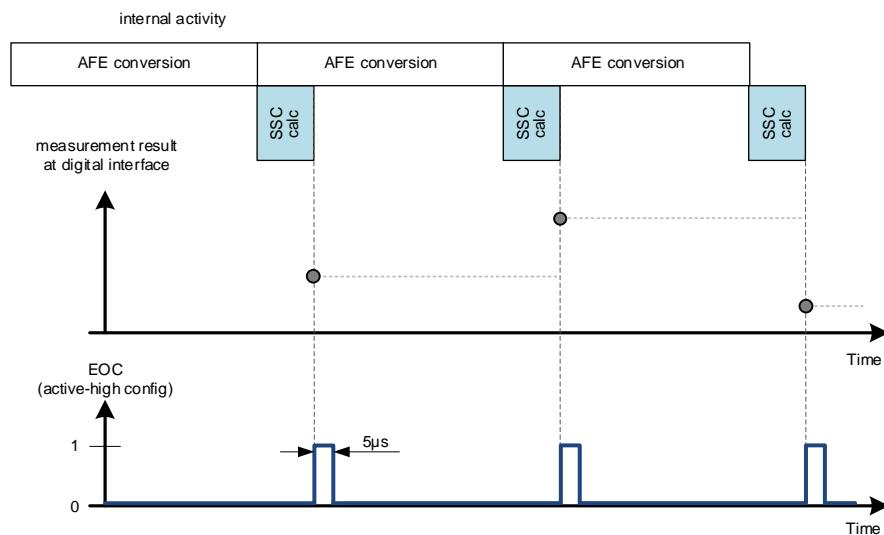


Figure 141. EOC Generation

5.9.2 Alarm

The Alarm (comparator) functionality is highly configurable and allows the user to select among the following options:

- single threshold mode or dual threshold (window) mode
- alarm region (Above/Below, Outside/Inside)
- hysteresis
- persistence
- active-high / active-low output levels for both features

The Alarm signals are one for AFE1 and one for AFE2.

The Alarm signals are independently configurable for each Main Sensor Channel. Alarm for main sensor channel 1 is assigned to pin GPIO2 and Alarm for main sensor channel 2 is assigned to pin GPIO3.

The selections are visible in the GUI as displayed in Figure 142.

Main Sensor Channel 1 (GPIO2)		Main Sensor Channel 2 (GPIO3)	
Selected Mode	Alarm	Selected Mode	Alarm
Output Polarity	Active High	Output Polarity	Active High
Threshold Mode	Single Threshold	Threshold Mode	Single Threshold
Range	Above	Range	Above
Hysteresis	0	Hysteresis	0
Persistence	0	Persistence	0
Threshold 1	0	Threshold 1	0

Figure 142. Alarm Configuration Options

Constraints on thresholds and hysteresis:

- Threshold2 must be set larger than Threshold1. The maximum value of Threshold2 is 16777215.
- Threshold 1 can be set up only to 16777214 (FS-1).
- Hysteresis cannot be set higher than Threshold1.
- Persistence: the maximum value is 255.
For example, if signal sampling rate is 1ms and Persistence is set to 225, the alarm has a persistence on the output of about 0.25s
- Hysteresis: the configured hysteresis value defines the hysteresis “offset”, i.e., the hysteresis width is effectively twice the configured hysteresis value.
For example:
 - Threshold set equal to 15194300
 - Hysteresis set equal to 10
 - Hysteresis window width is equal to 20 counts, centered on the 15194300 threshold.
 - Hysteresis and Persistence are both disabled if their relevant value is set to 0.

See Figure 143 for the behavior of the Threshold Mode, Range and Hysteresis parameters.

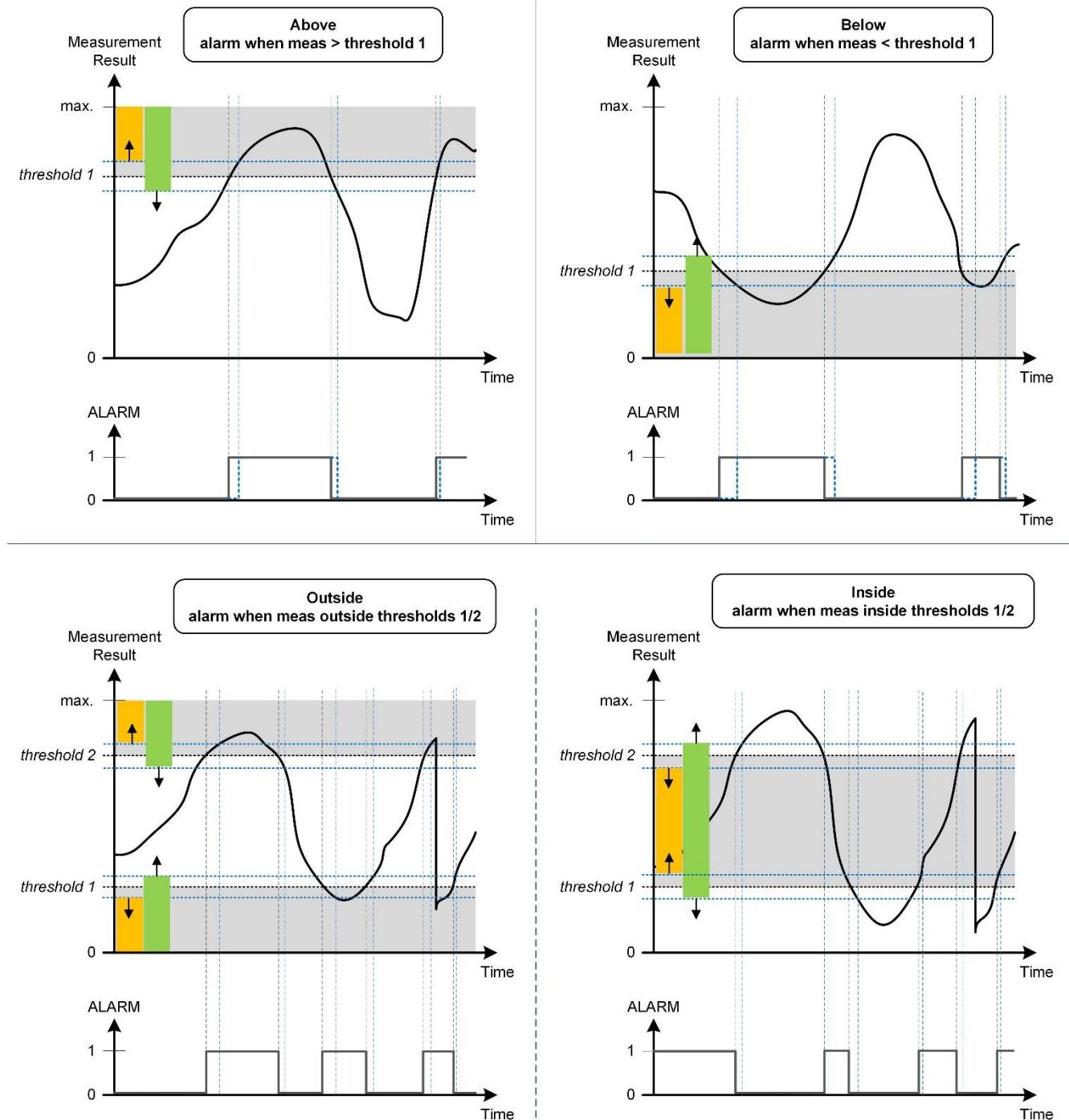


Figure 143. Alarm Threshold Mode, Range and Hysteresis

5.10 System Control

Define the active device Mode (refer to the *ZSSC3281 Datasheet* document) at system startup on the System control tab. The selection is active after writing to NVM, see Figure 144.

Select 'Enable' from the Advanced Error Response drop down list, refer to the *ZSSC3281 Datasheet* document for details on this function.

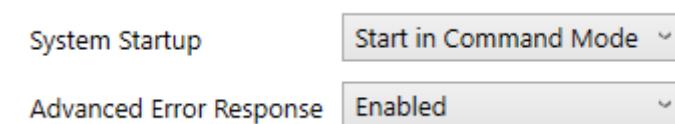


Figure 144. System Control

5.11 Customer ID

The Customer ID tab provides the capability to store two words (32 bits each) in the NVM that may contain, for example, the final product manufacturing information (see Figure 145).



Figure 145. Customer ID

6. Measure

The Measure tab (Figure 146) provides a comprehensive overview on the measurements visualization settings and the option to save the acquired data to file.

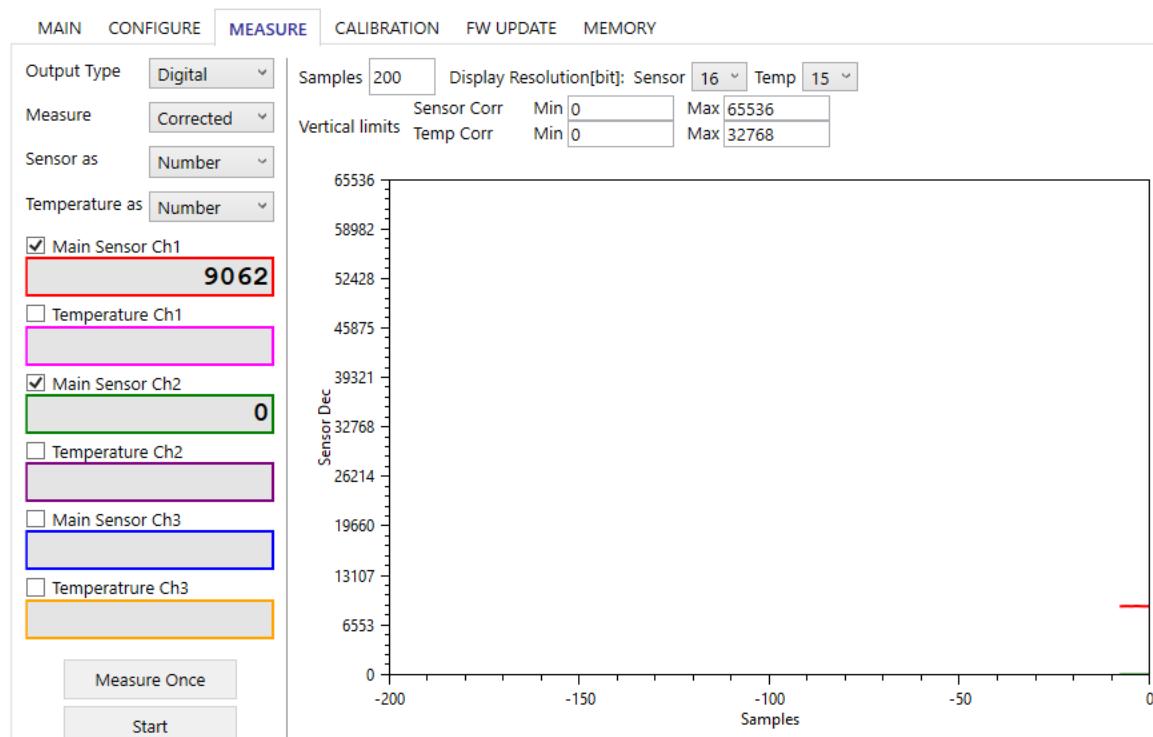


Figure 146. Measure Tab

Each measurement result coming from the ZSSC3281 is structured in 3 bytes (24-bit) or in case of CH3 in 4 bytes. The GUI limits the data display to the selected resolution via software (see the 'Display Resolution[bit]' fields of Figure 146). The original stream of bits can be viewed by logging the communication. The graph shown in Figure 147 is an example of the resolution range from the chip through the communication channel to the GUI display.

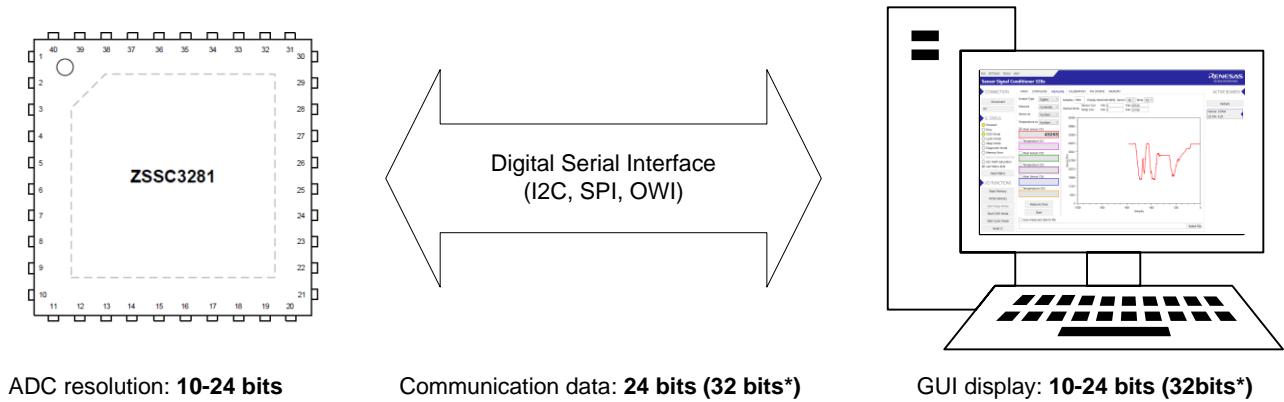


Figure 147. Resolution from Device to GUI

6.1 Measure Options Selection

The Measure menu (Figure 148) allows to select options to display the acquired data, either for the Main sensor or the Temperature sensor.

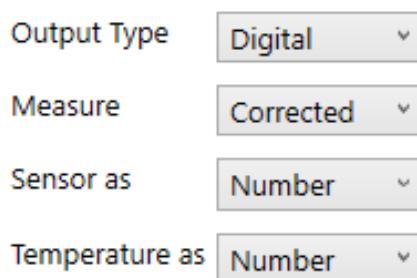


Figure 148. Measure Selection

6.1.1 Output Type

This drop-down list (Figure 149) allows to select the type of output to be displayed.

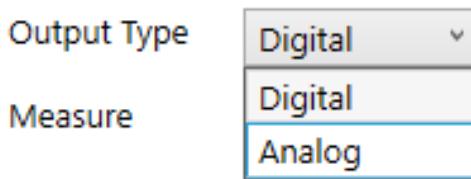


Figure 149. Output Type

If Digital is selected, data displayed is the one received on the operating serial buses.

If Analog is selected and J8 on the EVB is shorted, the analog output is connected to a 10bit ADC input available on the CB, allowing analog data to be displayed (see Figure 150).

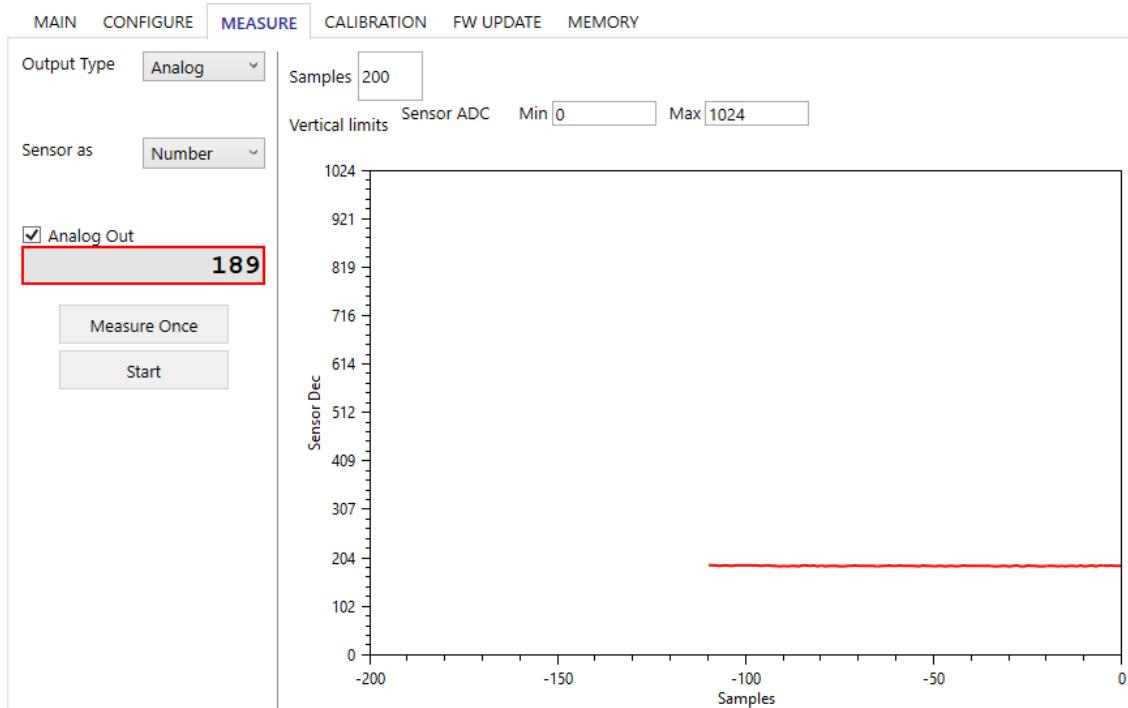


Figure 150. Analog AOUT Read-back

6.1.2 Measure

Select an option from the Measure drop-down list (see Figure 151):

- Raw Legacy: data is acquired through a legacy set of reading commands. These measurements are not mathematically conditioned by the device.
Legacy commands are implemented in the ZSC3281 to allow a direct comparison with previously released devices such as the ZSSC3240.
- Raw: data is acquired through a ZSSC3281 specific set of reading commands. These measurements are not mathematically conditioned by the device.
- Corrected: data is acquired through a specific ZSSC3281 set of reading commands. These measurements are mathematically conditioned by the device.

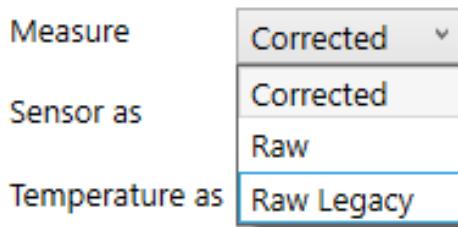


Figure 151. Measure

For information on the commands available for data acquisition, refer to the ZSSC3281 *Datasheet* document.

6.1.2.1 Measurement Acquisition

The GUI offers the following options for measurements acquisition:

- single measurement acquisition (Measure Once),
- continuous acquisition (Start).

The selection is possible by using the pushbuttons shown in Figure 152.

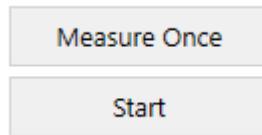


Figure 152. Measurement Acquisition

6.1.3 Sensor As

This drop-down list allows the visualization of data according to the options displayed in Figure 153.

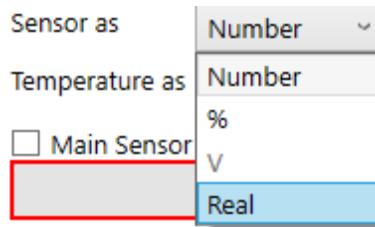


Figure 153. Sensor As

Note: the “Real” option allows visualizing the measurements as per the internal ZSSC3281 representation: in the (-1 to 1) range for Raw data, in the (0 to 2) range for conditioned data.

6.1.4 Temperature As

This drop-down list allows the visualization of data according to the options displayed in Figure 154.

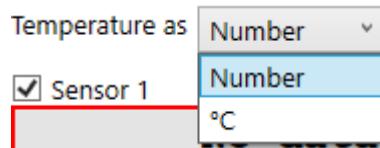


Figure 154. Temperature As

6.2 Selection for Displaying

By marking the relevant check box and clicking on the ‘Start’ button, the numerical field shows the data from the selected sources (see Figure 155), see sections 6.1.1 to 6.1.4 for details.

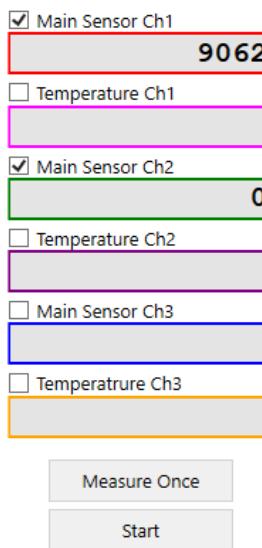


Figure 155. Display Selection

6.3 Save Measured Data to File

By marking the relevant check box and clicking on the ‘Start’ button, acquired data is stored in the selected file (Figure 156). This offers the user the possibility to perform statistical analysis on data batches.



Figure 156. Save Measured Data

Note: when “As Visualized” is active, the data saved on file are stored in decimal format taking in account the display resolution selected, see Figure 157.

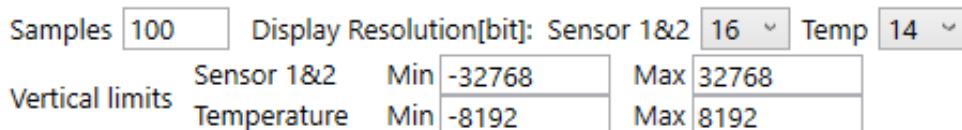


Figure 157. Selected Display Resolution

For example: if the actual ADC resolution is set at 16bit and the display resolution is set to 18bits, data stored on file are already taking in account the scaling from the fixed 24bit format data received from the ZSSC3281 to the display configured resolution (18bits). The physical data resolution is 16bits, as per setting in the Bridge Configure tab (see section 5.3.3.1). The display resolution is in most of cases set equal to the ADC resolution.

When “As Received from Device” is active, the data saved on file are stored in decimal format, without any further manipulation from the GUI.

6.4 Save Screen Displayed Data to File

To visualize the acquired data on screen and then save to file, follow these steps:

1. Select the wanted channel(s).
2. Start measurement.
3. Stop the measurements when the data displayed on the screen are needed on file.
4. Click on the ‘Export Graph Data’ button (see Figure 158).
5. Browse and save the file to a location.

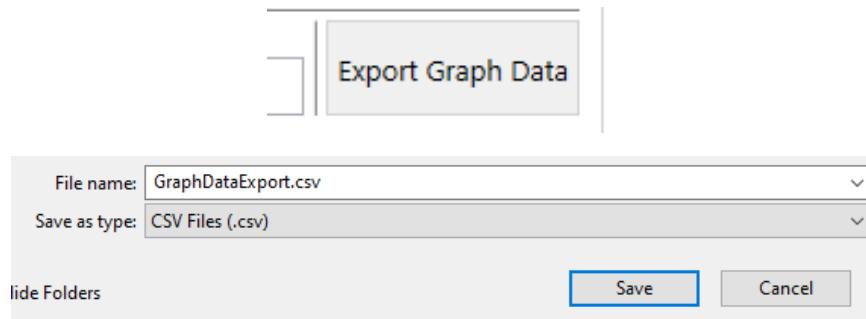


Figure 158. Save Screen Displayed Data

6.5 Graphs Area

The graphs area (Figure 159) allows visualizing, over a specific number of samples, the trend of the acquired data as selected in section 6.2.

Set the following options for display:

- the number of samples
- the resolution of the display either for the sensor or for the temperature graph
- the limits of the Y-axis

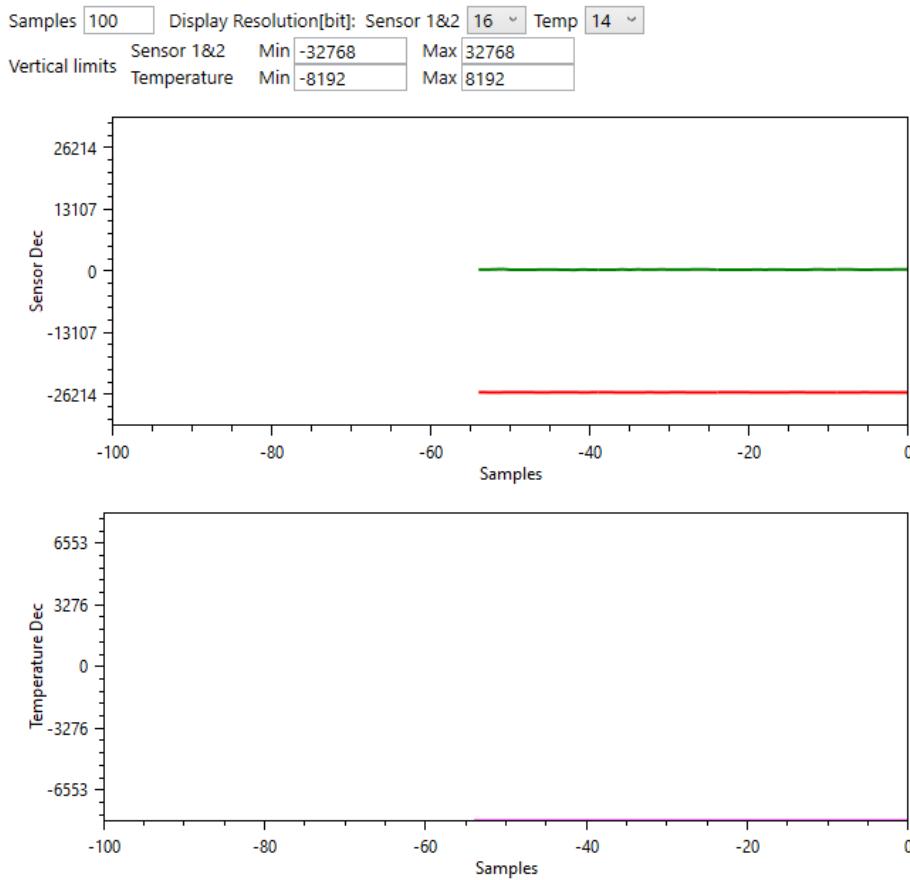


Figure 159. Graphs Area

7. Calibration

The Calibration tab (see Figure 160) allows acquiring raw data and calculating the coefficients needed for signal linearization and temperature compensation.

Refer to the information provided in section 5.3.2 for the association of a Temperature transducer to a specific main sensor and relevant signal processing.

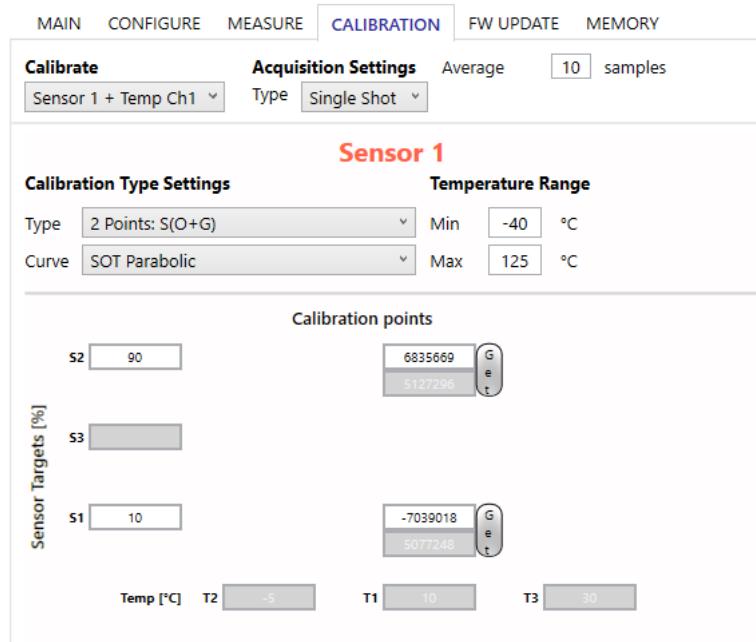


Figure 160. Calibration Tab

7.1 Sensor Selection, Acquisition Type

Select the sensor, the acquisition type, and specify the number of samples for calibration with the drop-down lists and boxes displayed in Figure 161.

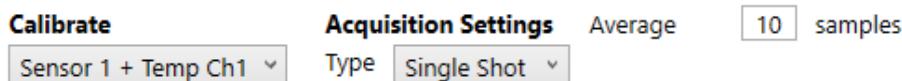


Figure 161. Sensor, Acquisition

Select Sensor 1/2 (and relevant Temperature Ch1/2) or Temperature Ch3 from the “Calibrate” drop-down.

Select either Single Shot (for using the 0xA7 command) or Legacy (for using both 0xA2 and 0xA6 commands) from the “Acquisition Type” drop-down to choose the option to adopt a specific type of data acquisition for the calibration points, see Figure 162. Refer to the ZSSC3281 *Datasheet* document for the description of the commands.



Figure 162. Acquisition Type

Set the number of samples to be averaged as input reading for the calibration point by the “Average” input field.

7.2 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.

7.2.1 Type

The number of points of the selected input (main sensor and temperature channel) is defined with the one of selectable options in the 'Type' drop-down list (see Figure 163).

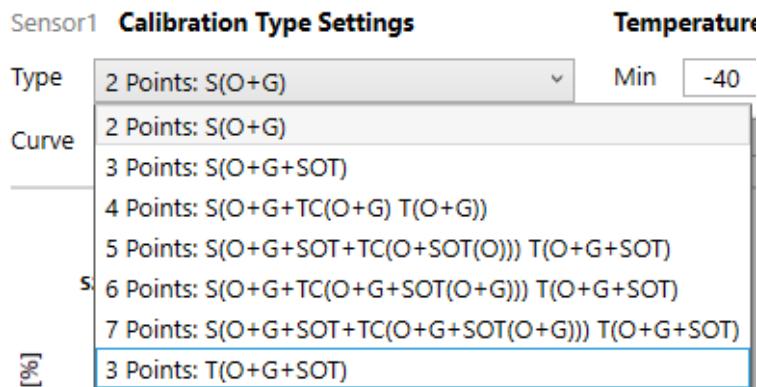


Figure 163. Calibration Type

Table 1 provides information linking 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 1. 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	Temperature
2 Point	B(O+G)	✓	✓									2	0
3 Point	B(O+G + SOT)	✓	✓			✓						3	0
4 Point	B(O+G +TC(O+G) T(O+G))	✓	✓	✓	✓				✓	✓		2	2
5 Point	B(O+G +SOT + TC(O+SOT(O))) T(O+G+SOT))	✓	✓	✓		✓	✓		✓	✓	✓	3	3
6 Point	B(O+G+TC(O+G+SOT(O+G))) T(O+G+SOT))	✓	✓	✓	✓		✓	✓	✓	✓	✓	2	3
7 Point	B(O+G+SOT+TC(O+G+SOT(O+G))) T(O+G+SOT))	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3	3
2 Point	T(O+G)								✓	✓		0	2
3 Point	T(O+G+SOT)								✓	✓	✓	0	3

7.2.2 Curve

Select a second-order equation to compensate for sensor nonlinearity with a parabolic curve by choosing either of the following options from the 'Curve' drop-down list (see the *ZSSC3281 Datasheet* document for details):

- SOT Parabolic: this compensation is recommended for most of the transducers.
- SOT S-shaped

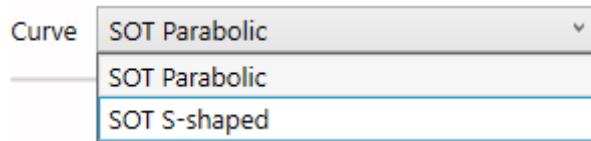


Figure 164. Curve

7.3 Temperature Range

The application temperature range must be specified by the user, entering values to the 'Min' and 'Max' fields (see Figure 165).

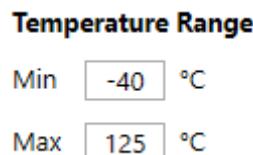


Figure 165. Temperature Range and Sample Settings

7.4 Calibration Points

Depending on the calibration type, the corresponding number of calibration points is displayed in the Calibration Points graph 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 in percentage of the ADC FS range from the ZSSC3281 output, after signal conditioning.

In the example in Figure 166, a raw bridge sensor value of -7039018 counts is mapped by calibration to 10% of FS and a raw bridge sensor value of 6835669 counts is mapped by calibration to 90% of FS.

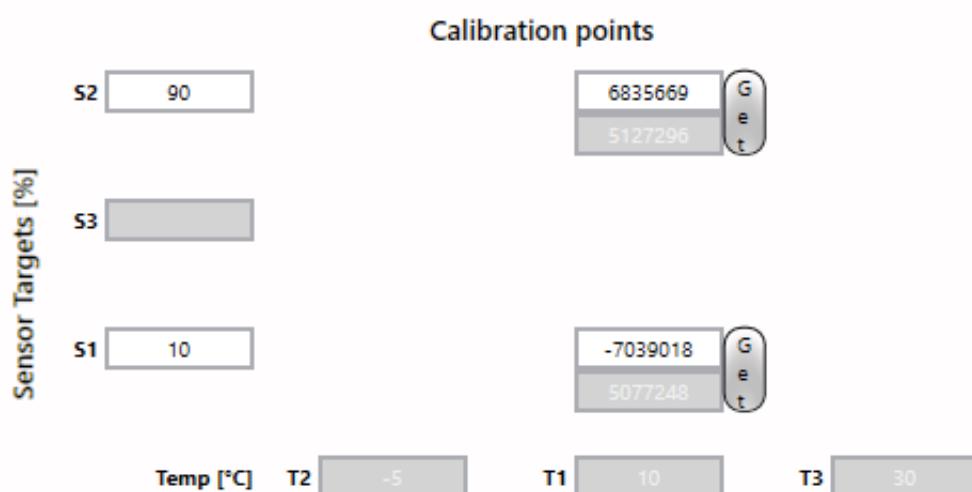


Figure 166. Calibration Points Input

Definitions:

- Sensor Targets [%]: external sensor measurement reference point, enter the point as a percent of the full measurement range.
- Temp [°C]: temperature measurement reference point, enter the point in Celsius degrees.
- S(x): raw external sensor measurement result in counts, enter values manually or get them displayed by clicking the 'Get' button.
- T(x): raw temperature measurement result in counts, enter values manually or get them displayed by clicking the 'Get' button.

7.5 Calculate Coefficients, Coefficient Results and Set in GUI

When the complete set of calibration data is collected, the correction coefficients can be calculated by clicking the 'Calculate Coefficients' button (see Figure 167).

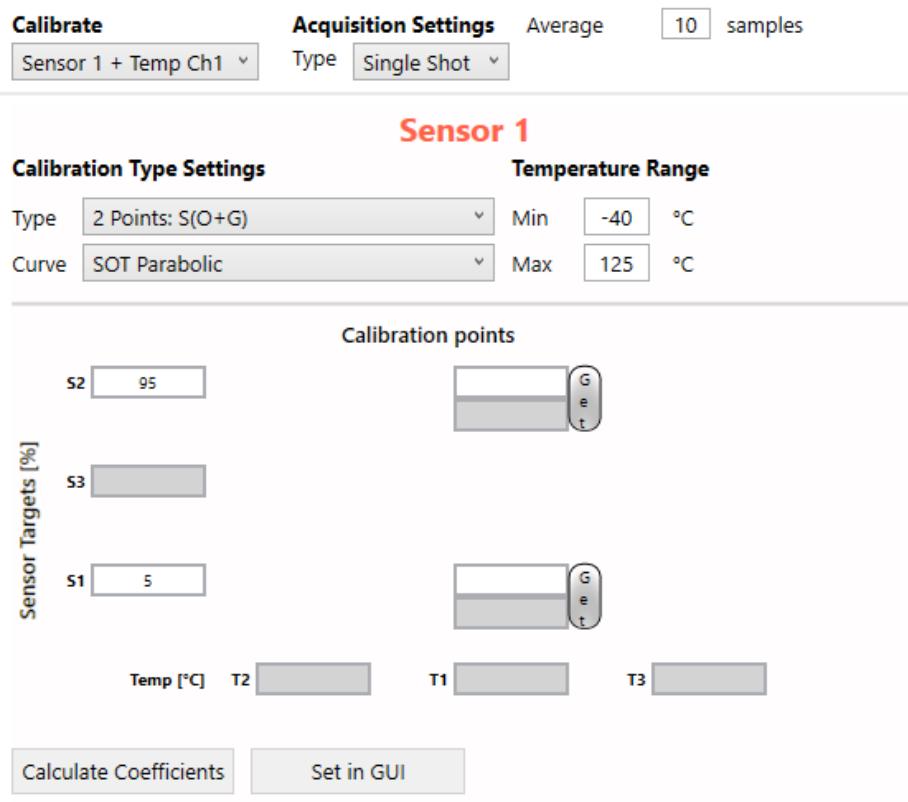


Figure 167. Calculate Coefficients, Set in GUI

The calculated coefficients are displayed in the 'Coefficient result' table (see Figure 168 for an example with 2 points calibration).

Coefficient result

RESULT	Offset S	Gain S	SOT S	T _{co}	SOT T _{co}	T _{cg}	SOT T _{cg}	Offset T	Gain T	SOT T
SUCCESS	25418	2028694								

Figure 168. Coefficient Result

The result can be either:

- Success: save the calibration coefficients in the NVM by clicking the 'Set in GUI' button (see Figure 167) and execute a Memory Write.
- Failed: the calculated coefficients out of range are displayed in red.

7.6 Dual Speed Mode Calibration

Select the “Dual Speed Ch” option from the ‘Calibrate’ drop-down list (see Figure 169) to have both sensor channels share the same calibration settings. The “Get”, “Calculate coefficients”, and “Set in GUI” buttons work simultaneously for both signal paths (CH1 and CH2).

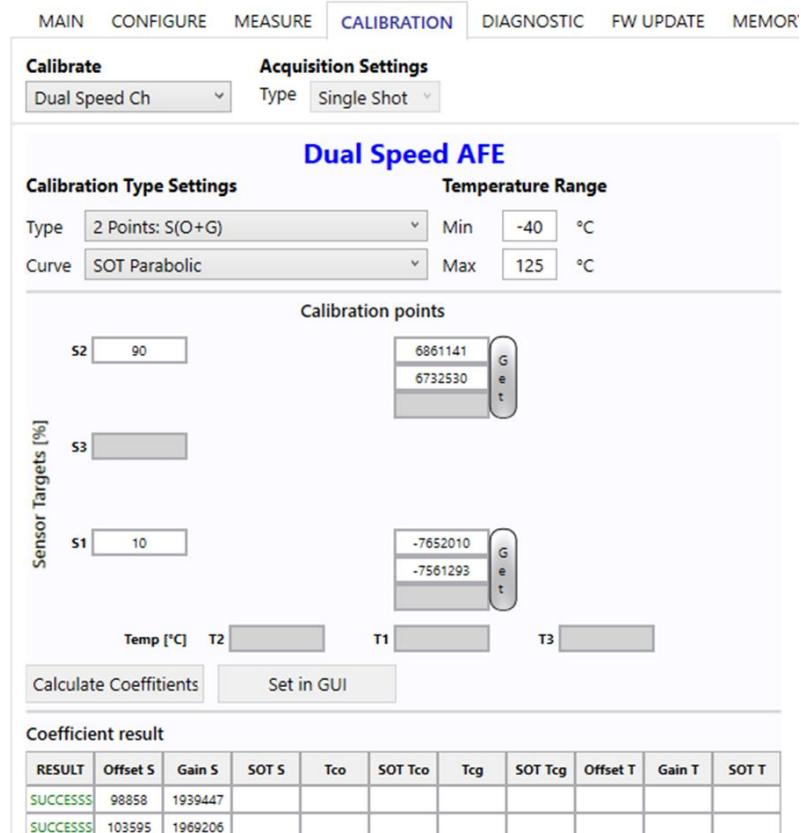


Figure 169. Dual Speed Channel Calibration

When the input measurements is acquired (see Figure 169 for a 2 points calibration example), the coefficients can be calculated by clicking the ‘Calculate Coefficients’ button.

The result can be either:

- Success: operation for both channels passed, save the newly calculated calibration coefficients (see Figure 170) in the NVM by clicking the ‘Set in GUI’ button (see Figure 170) and execute a Memory Write to finalize the operation.
- Failed: the calculated coefficients out of range are displayed in red.

Afe1CfgSccCoeff.SOffset	4D 0001822A
Afe1CfgSccCoeff.SGain	4E 001D97F7
Afe1CfgSccCoeff.SSot	4F 00000000
Afe1CfgSccCoeff.SShift	50 00000000
Afe1CfgSccCoeff.STco	51 00000000
Afe1CfgSccCoeff.SSotTco	52 00000000
Afe1CfgSccCoeff.STcg	53 00000000
Afe1CfgSccCoeff.SSotTcg	54 00000000
SscCoeffSbr[0].OutScaleGain	55 00100000
SscCoeffSbr[0].OutScaleOfst	56 00000000
Afe2CfgSccCoeff.SOffset	57 000194AB
Afe2CfgSccCoeff.SGain	58 001E0C36
Afe2CfgSccCoeff.SSot	59 00000000

Figure 170. Dual Speed Channel Calibration – New Coefficients Ready

8. Diagnostics

The Diagnostic tab enables the diagnostic test through the GUI. The Diagnostic functionality is not available in Dual Speed Mode (see 5.3.1.1).

8.1 General Tab

Enable or disable the diagnostic state (refer to the *ZSSC3281 Datasheet* document for the functional description) on the AOUT pin and the pins associated to FOUT (GPIOs) with the drop-down list as displayed in Figure 171.

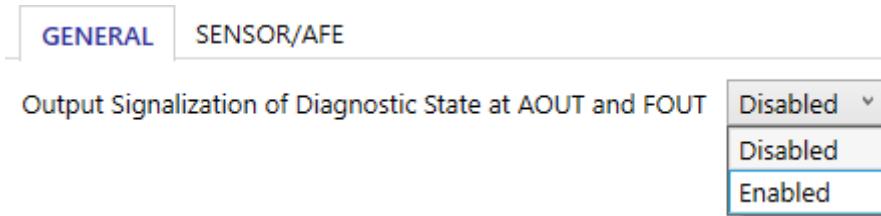


Figure 171. Diagnostic State Signalization Enable

8.2 Sensor/AFE Tab

On the Sensor/AFE tab (see Figure 172) mark the relevant check box to enable the corresponding diagnostic test. If a test requires additional user input, it must be entered in the input field available on the right side. Refer refer to the *ZSSC3281 Datasheet* document for a comprehensive description of the diagnostic features.

The screenshot shows the 'SENSOR/AFE' tab of the diagnostic interface. It lists various diagnostic tests with configuration options. The table includes columns for test descriptions, selection checkboxes, limit types (UDR, LDR), limit values, and tolerance fields. On the right side, there are input fields for 'Cbr [nF]' (0) and 'Cts [nF]' (1). At the bottom are 'Check' and 'Reset' buttons, and a 'AFE Diagnostic Status:' field.

Test Description	Selection	Limit Type	Limit Value	Open Limit	Short Limit	Input
Bridge1, INP or INN open	<input type="checkbox"/>	UDR			INP to INN resistance > 125k Ω	
Bridge1, INP and INN shorted	<input type="checkbox"/>	UDR			INP to INN resistance < 170 Ω	
Bridge2, INP or INN open	<input type="checkbox"/>	UDR			INP to INN resistance > 125k Ω	
Bridge2, INP and INN shorted	<input type="checkbox"/>	UDR			INP to INN resistance < 170 Ω	
T1, check short to top	<input type="checkbox"/>	LDR			Short Limit	short < 500 Ω (PT1000)
T1, check short to bottom	<input type="checkbox"/>	LDR			Open Limit	open > 2M Ω
T1, check open	<input type="checkbox"/>	LDR				
T2, check short to top	<input type="checkbox"/>	LDR			Short Limit	short < 500 Ω (PT1000)
T2, check short to bottom	<input type="checkbox"/>	LDR			Open Limit	open > 2M Ω
T2, check open	<input type="checkbox"/>	LDR				
T3, check short to top	<input type="checkbox"/>	LDR			Short Limit	short < 500 Ω (PT1000)
T3, check short to bottom	<input type="checkbox"/>	LDR			Open Limit	open > 2M Ω
T3, check open	<input type="checkbox"/>	LDR				
AFE1 Gain Drift	<input type="checkbox"/>	LDR	Get	GainRef	0	GainTol %
AFE1 Offset Drift	<input type="checkbox"/>	LDR	Get	OffsetRef	0	OffsetTol %
AFE2 Gain Drift	<input type="checkbox"/>	LDR	Get	GainRef	0	GainTol %
AFE2 Offset Drift	<input type="checkbox"/>	LDR	Get	OffsetRef	0	OffsetTol %

Figure 172. Diagnostic Tab

8.2.1 User Selectable Input Fields

The Sensor/AFE tab has the following fields:

- Cbr [nF] and Cts [nF] fields: enter the values to the fields within the allowed range of 0nF to 2nF, the capacitors are displayed in Figure 173.

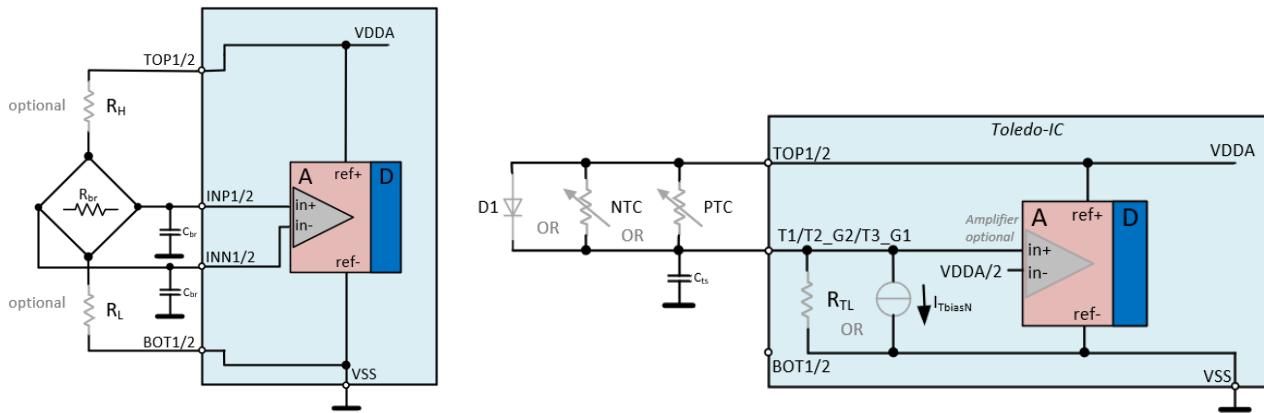


Figure 173. Cbr and Cts Capacitors

- UDR/LDR drop-downs: define if an upper or lower diagnostic range of signalization level is used on the AOUT and/or FOUT pins for the selected check (see Figure 174).
Note: the UDR signalization has higher priority on the LDR signalization. It might be convenient to assign the UDR to a check if it is of top priority in the application under design.



Figure 174. UDR/LDR Selection

- Short Limit/Open Limit options: select the limits from the drop-down lists.
'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
- AFE(x) Gain Drift: set the values to have the gain references for AFEs calculated.
Follow these steps to calibrate AFE gain drifts:
 - Enable 'AFE1 Gain Drift' or 'AFE2 Gain Drift' checkboxes.
The "Get" button is enabled.
 - Click on 'Get'.
The 'Set diagnostic DAC value for AFE(x) Gain check' window pops-up (see Figure 175).

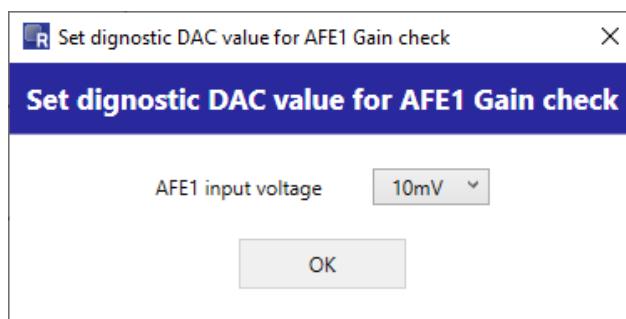


Figure 175. Input for AFE Gain Check

- Select a value from the 'AFE(x) input voltage' drop-down list.
Note: for the identification of the actual AFE gain, it is recommended to use the default value. Other values are available for testing purpose only.

4. Click on “OK”.

The GUI calculates the AFE gain reference that is displayed in the non-editable field (see Figure 176).

Afe1GainRef:

Figure 176. AFE Reference Gain

5. Enter the lifetime drift tolerance (in %) to the ‘Afe(x)GainTol %’ field (see Figure 177).

Note: the GUI rounds the input value to the closest admissible value for the calculation.

Afe1GainTol %:

Figure 177. AFE Gain Tolerance

6. Write to NVM.

- AFE(x) Offset Drift: set values to have offset for AFEs calculated properly.

Follow these steps to calibrate AFE offset drifts:

1. Enable ‘AFE1 Offset Drift’ or ‘AFE2 Offset Drift’ checkboxes.

The “Get” button is enabled.

2. Click on ‘Get’.

The GUI makes an offset measurement that is displayed in the non-editable field (see Figure 178).

Afe1OffsetRef: Afe1OffsetTol %:

Figure 178. AFE Offset Reference and Tolerance

3. Enter the lifetime drift tolerance (in %, related to the ADC full scale) to the ‘AfeOffsetTol%’ field (see Figure 178).

4. Write to NVM.

8.2.2 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 memory write. The ‘Check’ and ‘Reset’ buttons are disabled until the Memory Write is performed (see Figure 179).

Figure 179. Diagnostic Check and Reset

8.2.3 AFE Diagnostic Status

The Diagnostic tab provides the current Diagnostic Status (see Figure 180).

AFE Diagnostic Status: 0x00000000_00000000

Figure 180. AFE Diagnostic Status

When diagnostic checks do not return a fault, the 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 the *ZSSC3281 Datasheet* document.

8.3 AFE Diagnostic Operation Example

In this diagnostics operation example the default EVK configuration is used with the check for shorts between INP1 and INN1, AFE1 is enabled, the 'Bridge1, INP and INN shorted' checkbox is enabled (see Figure 181), and a write to memory is executed.

Bridge1, INP and INN shorted INP to INN resistance < 170 Ω

Figure 181. Activation of Diagnostic Check

When the diagnostic check is performed by clicking on the "Check" button, the result is successful (see Figure 182).

Bridge1, INP and INN shorted

Figure 182. Diagnostic Check Pass

After clicking on 'Reset' and placing a short between the INN1 and INP1 pins on the EVB, the new check fails (see Figure 183).

Bridge1, INP and INN shorted

Figure 183. Diagnostic Check Fail

In the IC Status the failure is reported as displayed in Figure 184 :

► IC STATUS

- Powered
- Busy
- CMD Mode
- Cyclic Mode
- Sleep Mode
- Diagnostic Mode
- Memory Error
- Sensor Connection Fail
- SSC Math Saturation

42 Last Status Byte

Figure 184. IC Status Sensor Connection Fail

9. FW Update

Update the ZSSC3281 Firmware version that is on the device memory through the FW Update tab (see Figure 185).

The FW update is normally performed using the I2C serial bus, make sure that the relevant jumper configurations (see section 2.5) on the EVB are in place to ensure to proper operation.

Before starting the procedure of FW update ensure that the device configuration saved in NVM has the System Startup option (see Figure 144) set to “Start in Command Mode”. Missing this setting in NVM can result in FW update failure.

Notes:

- It is recommended to make a copy of the NVM configuration settings (see Figure 10 for details) before performing a FW update.
- Ensure that during the FW update operation the supply is not switched off. Interruptions of the power supply during an NVM update may result in a loss of functionality of this device.

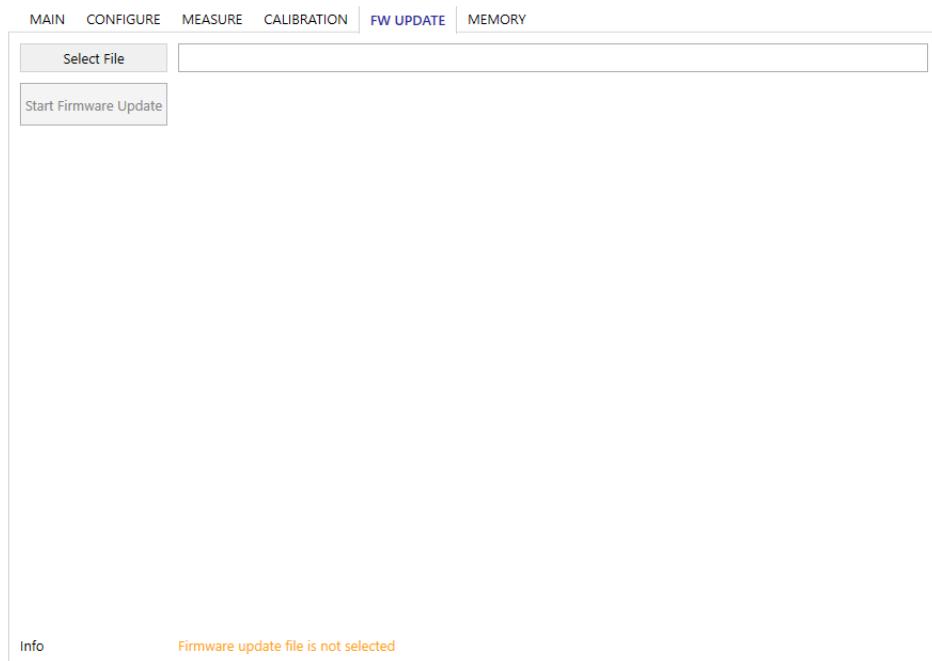


Figure 185. FW Update Tab

Follow these steps to update the FW:

1. Select and upload the FW update file.

The file extension must be either .bin or .zip; the .zip contains both the .bin and VersionInfo.txt files which is displayed on the GUI.

The file needs to contain valid firmware update data, otherwise an error message appears (see Figure 186).



Figure 186. FW update file not valid

When a valid firmware update file is selected, an acknowledgement message is displayed (see Figure 187).

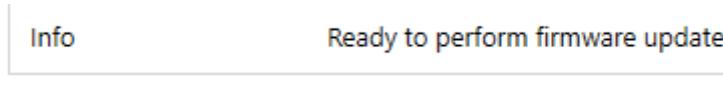


Figure 187. Valid FW update file identified

The firmware update can be performed whether the GUI is connected or not. If the GUI is connected, it goes through the following sequence:

- a. Disconnect
- b. FW update
- c. Reconnect
- d. Read all memory

2. Click the “Start Firmware Update” button. The ‘ZSSC328x Application’ window pops-up (see Figure 188). The button is enabled if all criteria to perform a FW update is met.
During the update, no other action can be performed in the GUI.

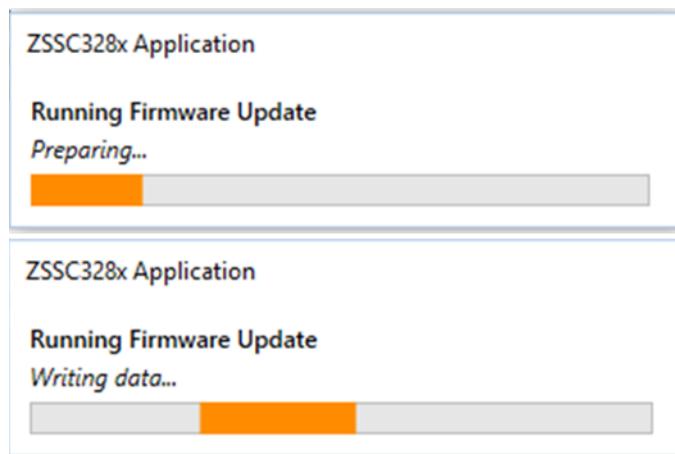


Figure 188. FW Update Operation

3. Click OK in the ‘Success’ pop-up window.

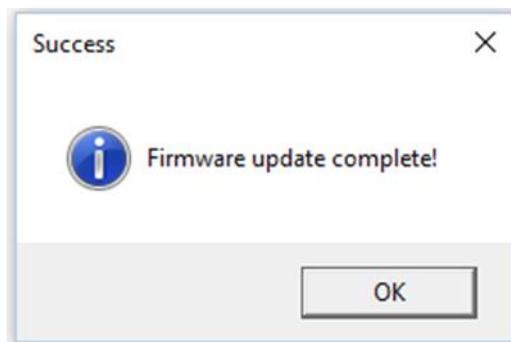


Figure 189. FW Update Finished

Additional tracking information about the FW update is available in the communication log file (see section 3.1.3).

10. Memory

10.1 Overview

The Memory tab provides the user a read only view on the device configuration memory (NVM), see Figure 190.

MAIN	MEASURE	CONFIGURE	CALIBRATION	MEMORY
IfbParamCfg	00	00000000		
I3cslvRegCtrl	01	00000000		
I3cslvRegStatAddrCtrl	02	00000000		
I3cslvInBandIrqSupport	03	00000000		
SpislvParamCfg	04	00000000		
OwislvCtrReg	05	00000000		
OwislvSlvaddrReg	06	00000000		
OwislvFixedLenReg	07	00000000		
OwiModeParam	08	00000000		
CntCommParam	09	00000000		
CommParamCrc	0A	00000000		
MiscctrParamCfg.Clkout	0B	00000000		
MiscctrParamCfg.Divafeac	0C	00000000		
MiscctrParamCfg.Divfclk	0D	00000000		
SmuParamCfg.Anacfg	0E	00000000		
SmuParamCfg.Extclkcfg	0F	00000000		
CbSelParam	10	00000000		
Bm1Cfg1	11	00000000		
Bm1Cfg2	12	00000000		
Bm2Cfg1	13	00000000		
Bm2Cfg2	14	00000000		
ExtTemp1Cfg1	15	00000000		
ExtTemp1Cfg2	16	00000000		
ExtTemp2Cfg1	17	00000000		
ExtTemp2Cfg2	18	00000000		
ExtTemp3Cfg1	19	00000000		

Figure 190. Memory Overview

The complete set of register composing the device configuration memory is listed. Each register is associated with a mnemonic, an address, and the relevant content (in hexadecimal value) as displayed in Figure 191:

Bm1Cfg1 11 00000000

Figure 191. Register

10.2 View Register

To have a detailed view of the register content, select it from the 'View Register' drop-down list (see Figure 192).

View Register	IfbParamCfg
Hex Value	SmuParamCfg.Extclkcfg
Bit Fields	CbSelParam
EnCrc	Bm1Cfg1
EnErrResp	Bm1Cfg2
BypassCmdInterp	Bm2Cfg1
	Bm2Cfg2
	ExtTemp1Cfg1
	ExtTemp1Cfg2
	ExtTemp2Cfg1
	ExtTemp2Cfg2
	ExtTemp3Cfg1
	ExtTemp3Cfg2
	Afe1MeasCfg1
	Afe1MeasCfg2
	Afe1MeasCfg3
	Afe1MeasCfg4
	Afe2MeasCfa1

Figure 192. Memory – View Register

For the selected register, the relevant values are displayed and the bit sets associated with specific functions or functionalities are listed (Figure 193 shows an example register). The value of registers is accessible in read/write through the Configure and Calibration tabs described in sections 5 and 7.

View Register		Bm1Cfg1
Hex Value	04000616	
Bit Fields		
BmPgaGain1	[3:0]	6 30
BmPgaGain2	[6:4]	1 1.2
BmPgaPolarity	[7:7]	0 1
BmAdcReso	[11:8]	6 16
BmAdcShift	[14:12]	0 0
BmBrdgType	[15:15]	0 V-source
BmSetTime	[17:16]	0 20
BmBrdgRth	[21:18]	0 0
BmBrdgRtl	[25:22]	0 0
BmAdcMux	[28:26]	1 ADC input cc
BmTest	[29:29]	0 0
BmTestDac	[30:30]	0 0
BmType	[31:31]	0 Resistive

Figure 193. Register Content

When changes to the configuration of the device are set, those are highlighted in the Memory map in red (see Figure 194). To have the changes taken an effect, execute a Write Memory operation.

MAIN	CONFIGURE	MEASURE	CALIBRATION	DIAGNOSTIC	FW UPDATE	MEMORY
ExtTemp2Cfg2		1A 00000010				
ExtTemp3Cfg1		1B 00118502				
ExtTemp3Cfg2		1C 00000010				
PtatCfg1		1D 00008413				
PtatCfg2		1E 00000000				
Afe1MeasCfg1		1F 01020036				
Afe1MeasCfg2		20 000BC813				
Afe1MeasCfg3		21 00000018				
Afe1MeasCfg4		22 00400000				
Afe2MeasCfg1		23 01020036				
Afe2MeasCfg2		24 000BC813				
Afe2MeasCfg3		25 00000300				
Afe2MeasCfg4		26 00400000				
DiagSen.DiagCfg		27 00000000				
DiagSen.Range[0].Inp		28 00000000				
DiagSen.Range[0].Inn		29 00000000				
DiagSen.Range[1].Inp		2A 00000000				
DiagSen.Range[1].Inn		2B 00000000				
DiagSen.GainChk[0]		2C 00000000				
DiagSen.GainChk[1]		2D 00000000				
DiagSen.OfstChk[0]		2E 00000000				
DiagSen.OfstChk[1]		2F 00000000				
TempMapChId		30 0000001A				
MathSbrAlgoSel		31 00000011				
Afe1CfgSccCoeff.SOffset		32 00806522				
Afe1CfgSccCoeff.SGain		33 001D46B2				
Afe1CfgSccCoeff.SSot		34 00000000				
Afe1CfgSccCoeff.SShift		35 00000000				
Afe1CfgSccCoeff.STco		36 00000000				

Figure 194. Changes not Written to NVM

Hoovering over a modified register allows the direct display of the bit fields, in the Edit Register section it is possible to check the bits of the registers that were affected by a change (see Figure 195).

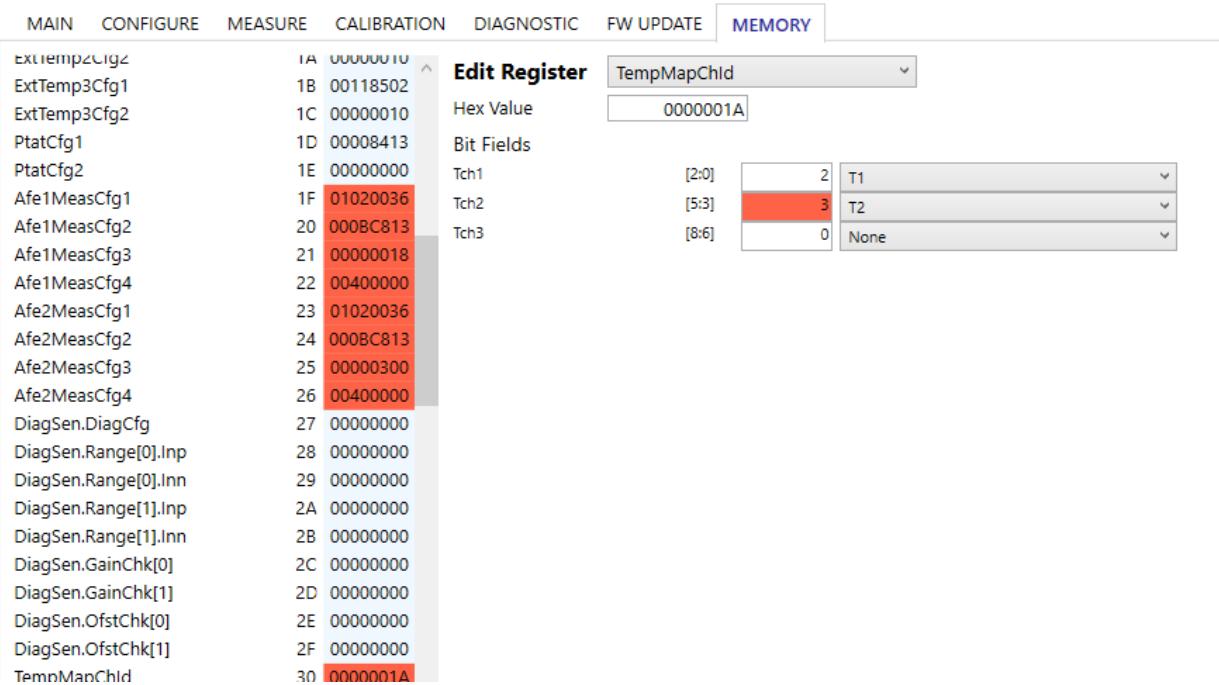


Figure 195. Modified Bits in a Register –Changes not Written to NVM

11. Command Console

The Command Console can be started as described in section 3.1.3. Commands can be written directly to the ZSSC3281 (through the CB) and the device response is received in the output window. The output data from the ZSSC3281 can be copied and saved for further analysis by right-clicking on the results in the display.

11.1 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 196.

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

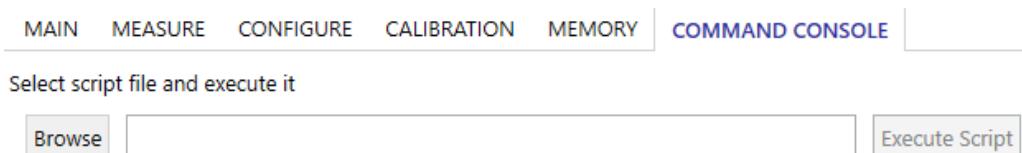


Figure 196. Script Execution

11.2 Type Single Command and Execute

A single command can be executed using the entry field displayed in Figure 197.



Figure 197. Single Command execution

The list of the commands is available upon request.

11.3 Result Display

The result of the execution of a command is returned in the area displayed in Figure 198.

Result Display

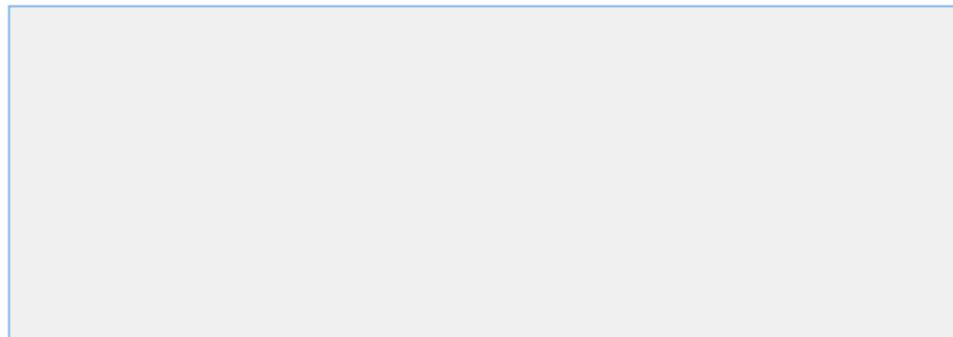


Figure 198. Command Execution Result

The output data from the ZSSC3281 can be copied and saved for further analysis by right-clicking on the results in the display.

11.4 Clear Display

Once a command is executed and the relevant result is displayed, the display area may be cleared using the “Clear Display” button (see Figure 199).

Clear Display

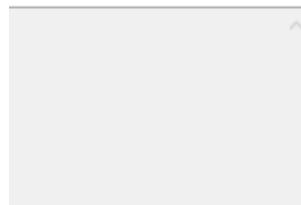


Figure 199. Clear Display

12. Glossary

Term	Description
2WCL	Two Wire Current Loop
AFE	Analog Front End
AUX	Auxiliary
CB	Communication Board
CMD	Command
DUT	Device Under Test
EOC	End of Conversion
ESD	Electro Static Discharge
EVB	Evaluation Board
EVK	Evaluation Kit
FS	Full Scale
FW	Firmware
GND	Ground
GUI	Graphical User Interface
HW	Hardware
IC	Integrated Circuit
JP	Jumper
NTC	Negative Temperature Coefficient
NVM	Non Volatile Memory
OWI	One Wire Interface
PC	Personal Computer
PCB	Printed Circuit Board
SM-	Sensor Measurement Negative
SM+	Sensor Measurement Positive
SRB	Sensor Replacement Board
SSC	Sensor Signal Conditioner

13. SW and FW Release References

GUI SW Release	FW Release
1.1.x	1.0.0

14. Revision History

Revision	Date	Description
1.00	Jun 14, 2022	Initial release.

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