

Evaluation Kit for H2-CNI I2C-I FWB A

Hydrogen Sensors

1. DESCRIPTION

The controller I2C-USB 2.1 serves as evaluation kit for calorimetric, non-isothermally operated H2-CNI I2C-I FWB-A hydrogen sensors with I²C bus. I2C-USB 2.1 provides SDA and SCL junctions to the internal I²C bus of the H2-CNI I2C-FWB-I A sensor. The supply voltage of 9V for the sensor is generated on-board from the USB voltage by

means of a step-up converter. The controller contains a $\pm 1.0^{\circ}\text{C}$ accurate digital temperature sensor with 12-bit resolution for ambient temperature measurement and a 1K bit electrically erasable PROM.

The evaluation kit is operated through an USB port of a personal computer, an installed LabVIEW[®] runtime and the SensorControl software.

2. APPLICATION

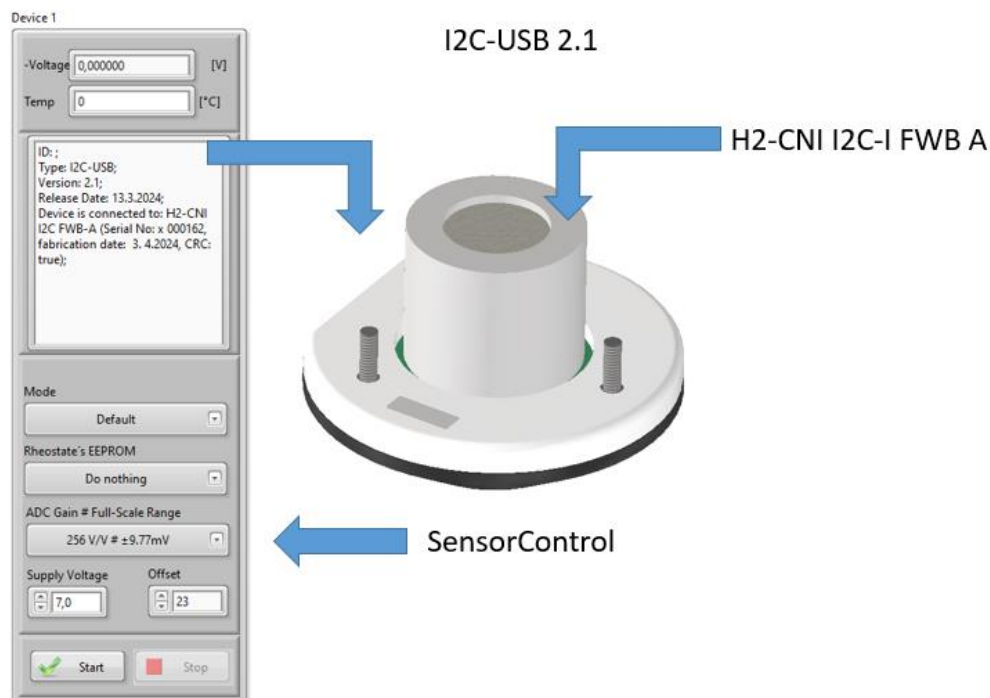


TABLE OF CONTENTS

1. Description.....	1	6. Theory of operation	4
2. Application	1	7. Operation with SensorControl	5
3. Revision History	2	8. Ordering information	15
4. Pin configuration of sensor connector	2	9. Packaging/Shipping information.....	15
5. Specifications	3	10. Notes.....	16
5.1. Absolute Maximum Ratings	3	11. Worldwide Sales and Customer Support	17
5.2. ESD CAUTION.....	3		
5.3. List of required additional Components..	3		
5.4. Mechanical	3		

3. REVISION HISTORY

Date	Rev.	
May 8, 2024	1.0	Initial Version

4. PIN CONFIGURATION OF SENSOR CONNECTOR

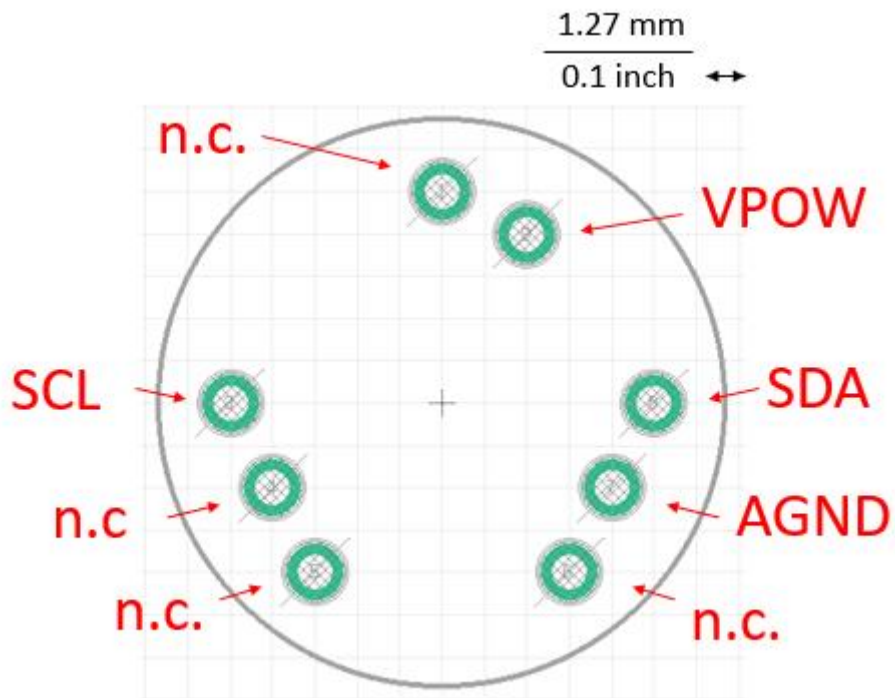


Figure 1: Top view of connections

PIN NO.	SIGNAL NAME	DESCRIPTION
1	INN	Not connected
3	SCL	SCL line of I2C bus
4	VBRIDGE	Not connected
5	INP	Not connected
6	IN-CURR	Not connected
7	AGND	I2C ground
8	SDA	SDA line of I ² C bus
9	VPOW	+Vpower Output

5. SPECIFICATIONS

5.1. ABSOLUTE MAXIMUM RATINGS

At ambient temperature $T_a = 20\text{ }^\circ\text{C}$.

Storage temperature	-40°C to 100 °C
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5.2. ESD CAUTION



ESD (electrostatic discharge) sensitive device. Although this product features protection circuitry, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

5.3. LIST OF REQUIRED ADDITIONAL COMPONENTS

PART	DESCRIPTION	QUANTITY
H2-CNI I2C-FWB A	Calorimetric hydrogen sensor for non-isothermal operation with I ² C bus	1
USB-A to micro USB 0,5	Cable 0,5 m	1
Optional:		
TC-1/4	Gas flow test chamber with ¼" tubes and Swagelok®	1

5.4. MECHANICAL

Length	42 mm
Height	12 mm
Width	39 mm

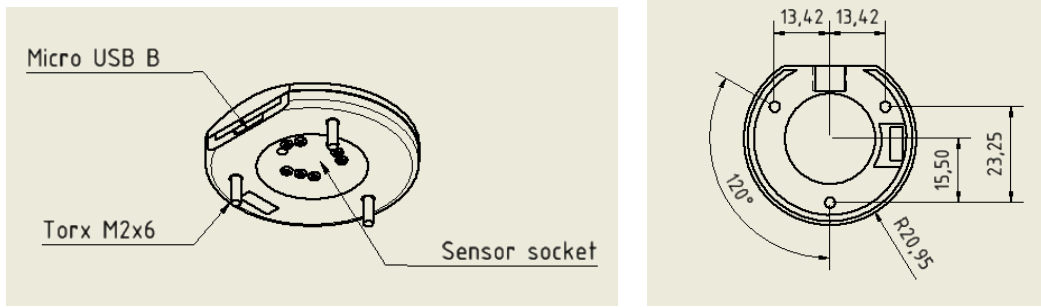


Figure 2: Drawing of I2C-USB 2.1 (left). Flange with three Torx M2x6 screws (right). All dimensions are in mm.

6. THEORY OF OPERATION

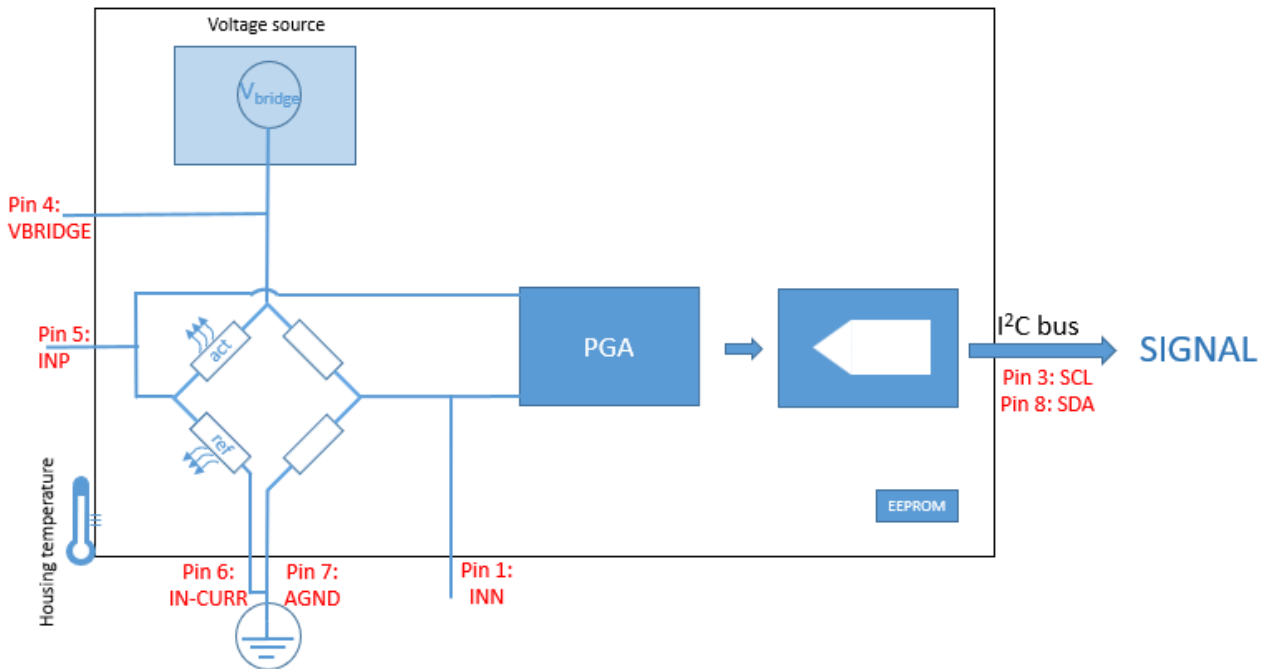


Figure 3: Sketch of sensor and main components of H2-CNI I2C-I FWB A (black frame and d)

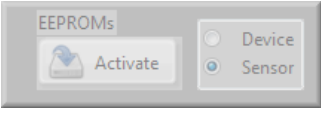
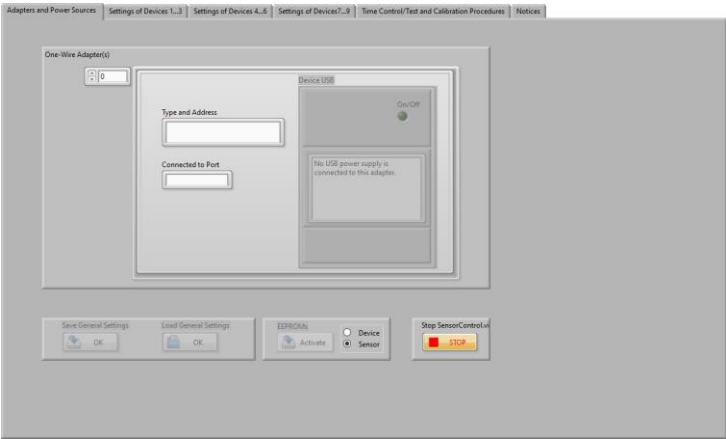
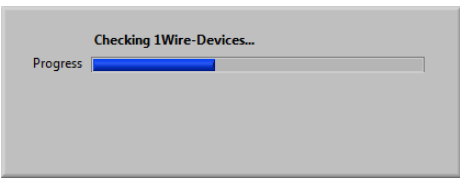
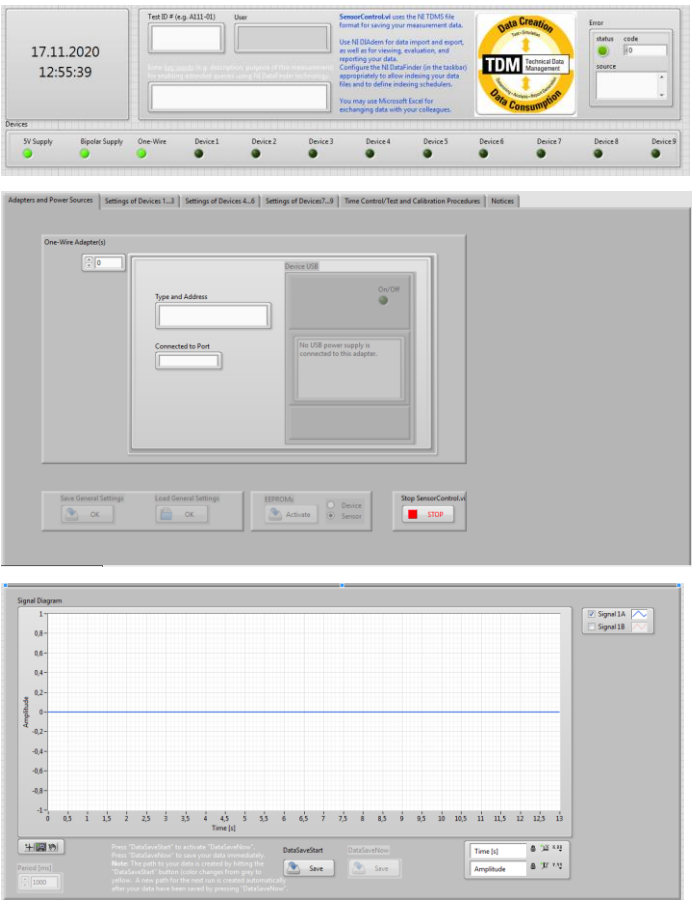
The active and reference element of the sensor forms one branch of a Wheatstone bridge configuration and are heated by the current that flows from the adjustable 256-step voltage source V_{bridge} through a precision resistor to ground. The Wheatstone bridge is zeroed by means of a 64-position digital rheostat. The balance voltage is measured with a precision, zero-drift 16 bit ADC with a built-in programmable gain amplifier. The ambient temperature is determined using a $\pm 1.0^{\circ}\text{C}$ accurate digital temperature sensor with 12 bit resolution. Sensor parameters are stored in a 1k EEPROM.

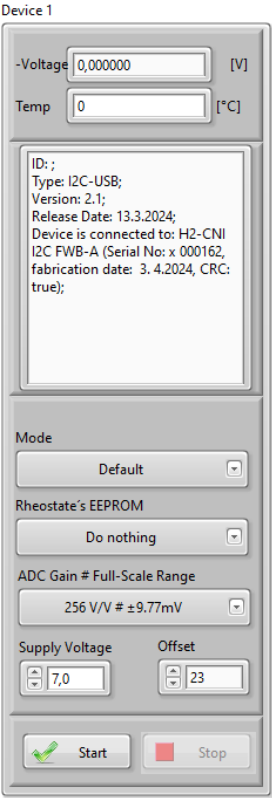
All integrated circuits of the sensor are accessible through the I2C bus with the SCL and SDA lines. They are connected to a USB to I2C master bridge device within the evaluation kit. The kit is connected to a Windows[®] PC via an micro-USB-to-USP cable and operated by the software SensorControl as described in the next section.

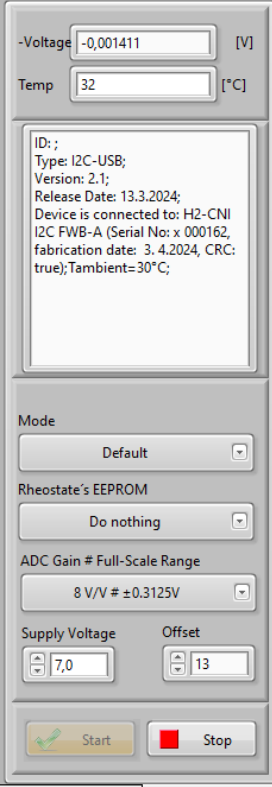
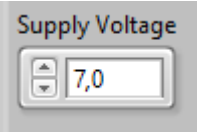
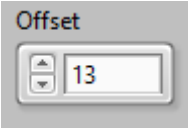
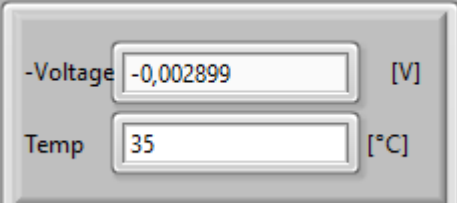
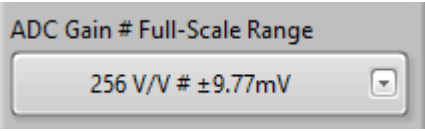
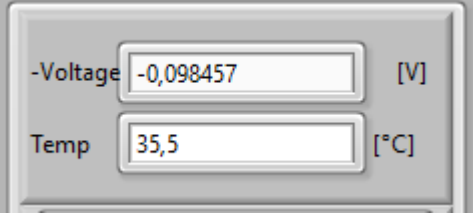
The H2-CNI I2C-I FWB A sensor contains a catalytically active element and an inactive reference element. They are heated by the power which is delivered from the voltage source. The power at the active element is approximately $P = \frac{1}{2} V_{\text{bridge}} I$ with I as current. The operation temperature is adjusted well above the temperature of the ambient oxygen-containing atmosphere. The temperature of the active element can be approximately kept constant and independent from the ambient temperature by choosing an appropriate voltage V_{bridge} . The underlying function between V_{bridge} and T_{ambient} can be stored within the sensors EEPROM, together with other parameters such as the resistances of the sensor elements. Exposure to hydrogen leads to a flameless oxidation of H₂ molecules that generates a chemical heat. It is proportional to the reaction rate, i.e. the number of H₂ molecules that undergoes oxidation towards H₂O. The chemical heat increases the electrical resistance of the active element which in turn results in a change of the balance voltage. The latter is accurately determined with a 16-bit analog-to-digital converter with input current cancellation and a bandgap reference with very high accuracy and low thermal drift of 10 ppm/°C (max).

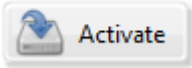
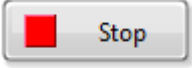
7. OPERATION WITH SENSORCONTROL

#	STEP	FIGURE
Follow "INSTALLATION GUIDE 1-WIRE DRIVER"		
Run SensorControl.vi or SensorControl.exe		
1	Connect the I2C-USB 2.1 with the USB port	

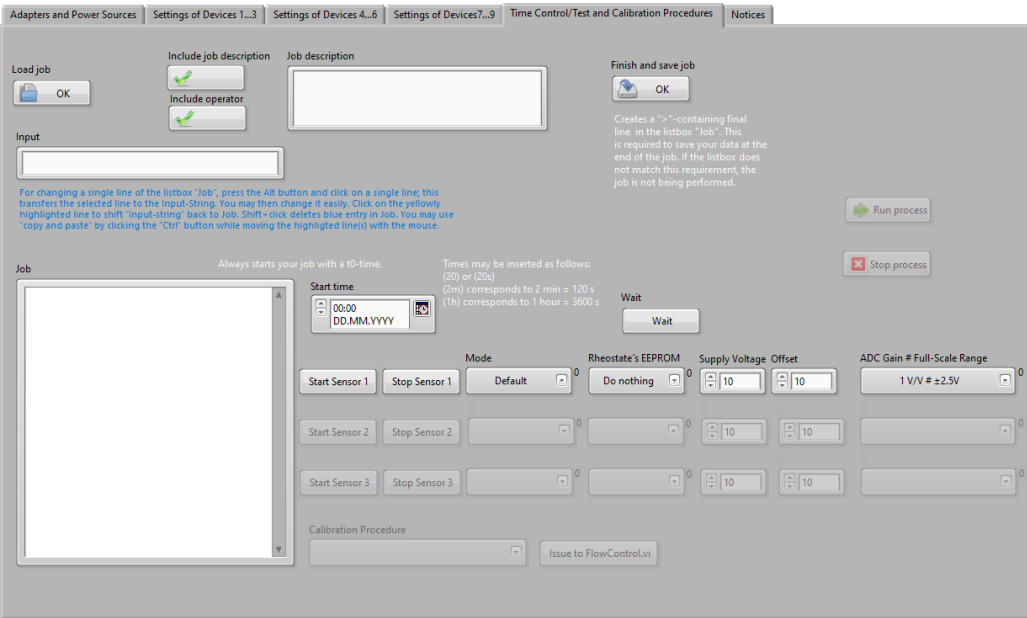
<p>2</p>	<p>Choose "Sensor" in the EEPROM selection box*</p>  <p>to ensure reading of the controller adjustments from the sensor's internal EEPROM and not from the device's internal EEPROM.</p> <p>*) see Comment on page 9</p>	
<p>3</p>	<p>Run SensorControl (see User Guide SensorControl.vi for further explanations)</p>	<p>Wait until initialization is completed</p> 
<p>4</p>		

5	<p>Click on the register card "Settings of Sensors 1...3"</p>		<p>Voltage shows the balance voltage of the Wheatstone bridge configuration of the H2 CNI I2C sensor.</p> <p>Temp will show the sensor housing temperature.</p> <p>Display shows "Notices to Operators":</p> <ul style="list-style-type: none"> ID of device (controller); Type of device; Version of device Release date of device; Adapter to which the device is connected; Type of sensor to which the device is connected; serial number of the sensor, fabrication date and the result of the CRC check of the data integrity. <p>Mode to select the default mode.</p> <p>Rheostat's EEPROM to store and load the offset. This value is adjusted immediately after powering the sensor.</p> <p>Supply voltage V_{bridge} to excite the Wheatstone bridge.</p> <p>Offset of the 64-position rheostat.</p> <p>Start and Stop button</p>
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6	<p>Click "Start"</p>		<p>Adjust or change the supply voltage (bridge excitation voltage)</p>  <p>As the result of the applied voltage to the sensor elements and the correspondingly current flow through the sensor, the temperatures of the active and reference sensor elements and the sensor housing increase.</p> <p>Adjust the offset if necessary</p>  <p>(value depends on sensor) and observe the corresponding reduction of the bridge balance voltage</p>  <p>The voltage can be further amplified by increasing the PGA gain from 8 V/V to 256 V/V.</p>  <p>As the result, the voltage is increased by a factor of approx. $256/8=32$</p> 
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7	Click on register card "Adapters and Power Supplies" and activate EEPROM		Return to register card "Settings of Sensors 1...3". Stop button has disappeared and Start button has changed to Save. Clicking on Save stores all adjustments in the EEPROM of the sensor.
8	Click "Stop"		Data collection and sensor stop.

Systematic evaluation of sensor properties using register card "Time Control and Calibration Procedures"

9	Click on register card "Time Control/ Test and Calibration Procedures"	 <p>This card allows you to define a job which is a list of instructions that are consecutively issued to SensorControl thereby enabling a time-controlled experiment.</p> <p>The job is defined in the window "Job" and written by using the bottoms on the right-hand side of this window. Always use this method to define a job as it is strictly bond to certain format rules. Jobs are started by clicking "Run process" (Do this not now!). A job starts with defining is start value. Times in the past are considered as instruction to start immediately. Then, a sequence of commands follows; they always start with "!". Clicking on "Wait" produces a line !Wait Start(t). t must be replaced by a waiting time You can insert them as follows:</p> <p>(20) or (20s) (2m) corresponds to 2 min = 120 s (1h) corresponds to 1 hour = 3600 s</p> <p>The wait command is very important as this is the only way to define a time-dependent consecution of other instructions.</p> <p>Instead of writing in the window "Job" you can follow the blue instruction shown below the window "Input".</p>
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Thus one can organize a list of instructions in the window “Job”. You can use the mouse to shift lines in the window; modifying and deleting is also possible.

As an example, try to type the job shown above.

Clicking or selecting certain values in “Mode”, “ADC Gain”, “Supply Voltage” or “Offset” generate corresponding entries in the job.

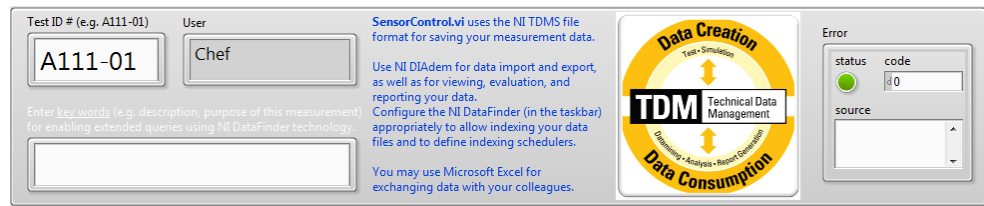
Clicking on Start Sensor 1 generates a line !Sensor: Start(1) and will be interpreted as to start sensor 1; same holds for clicking on Stop Sensor 1.

A job must be completed with a line that starts with >. This line is created by clicking on “Finish and save job”. It also allows you to save your job on the hard disk in the folder “LabView Data”. The > sign will be interpreted as to save your data and to stop the job.

You may also include a job description and/or the operator name. You can also load previous jobs by clicking on “Load job”.

Note: There must be no empty lines in the job; so if empty lines show up delete them or shift the instructions with the mouse. If you type a new entry and you do not see it scroll in the window to the bottom. If you see empty lines, delete them.

Define a Test ID# in the top box of SensorControl.vi.

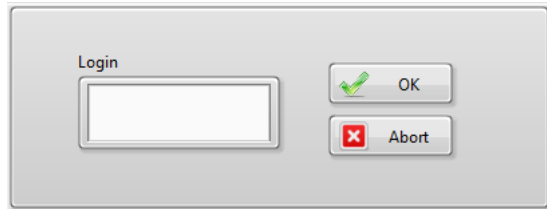
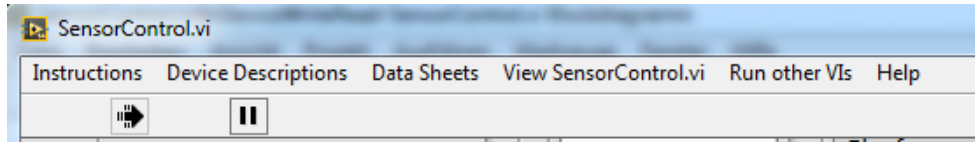


(You may also give some key words in the keywords window). The software only accepts Test ID# in the format Xnnn-nn. The “Run process” button is enabled.

The job starts and will be done by clicking on “Run process”. Then the subVI “TimeControl” will take over the control of the software until it is finished by reaching the line >... or by clicking on “Stop process”. You are not limited with the length of your job. They run very safely over long times. Note, however, that data will automatically be stored after 24 h operation. This does not affect running your job.

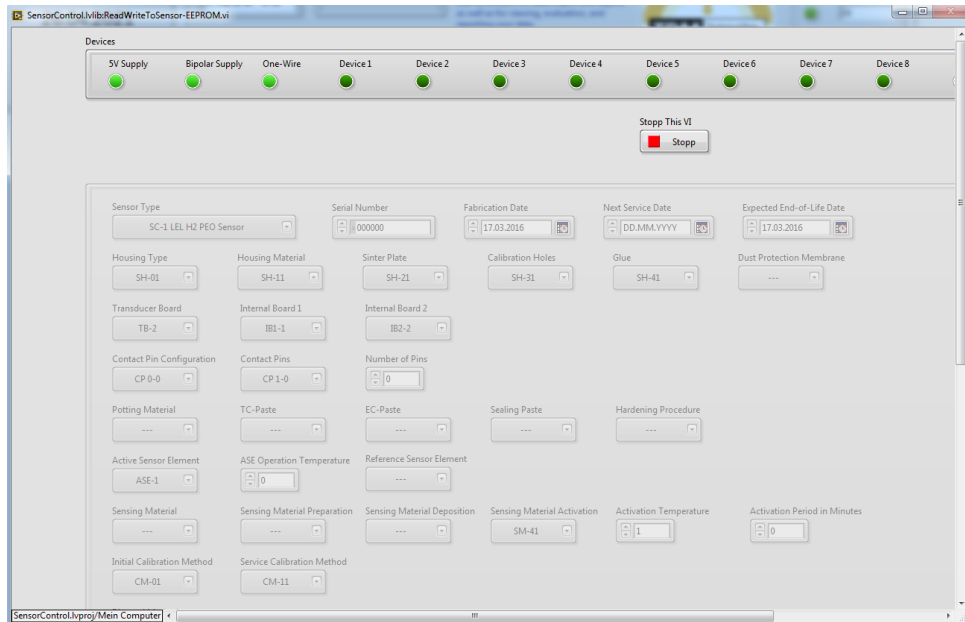
Access to the sensor's EEPROM

Open menu "Run other VIs" and select "Read and Write to Sensor's EEPROM/Login Required"



Enter "admin" and click on "OK" (The keyboard's enter button is not accepted!)
A new window appears

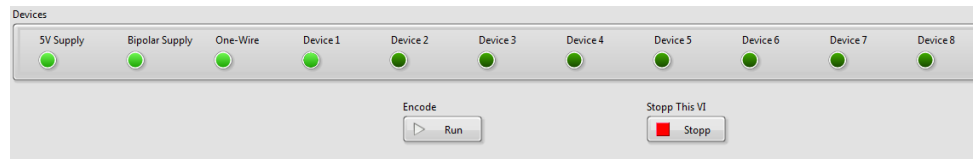
10



Click on "Device 1" to access the EEPROM of the sensor plugged in the device 1 controller.

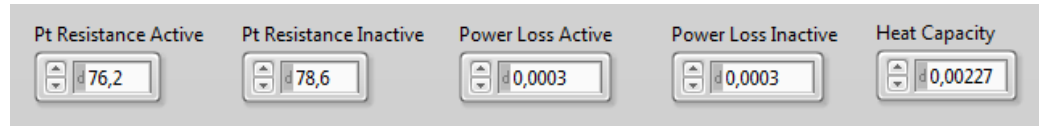


The “Read EEPROM” button is shown. Click on this button and wait a couple of seconds. The EEPROM is read, entries are filled, the “Read EEPROM” disappears and



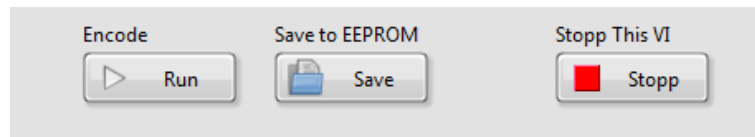
“Encode” is displayed.

Scroll, e.g. to the bottom and find

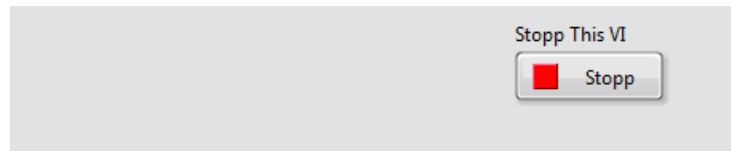


This entries are used to calculate the sensor elements’ temperatures from and the temperature-dependent platinum resistances and the thermal properties of the sensor elements.


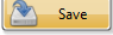
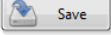
Entries can be changed (although it is not recommended) and encoded by clicking on “Encode”



The “Save to EEPROM” option appears that can be clicked to save the encoded data into various registers of the sensors’s EEPROM. After clicking “Save to EEPROM” wait a couple of seconds until this button disappears and only

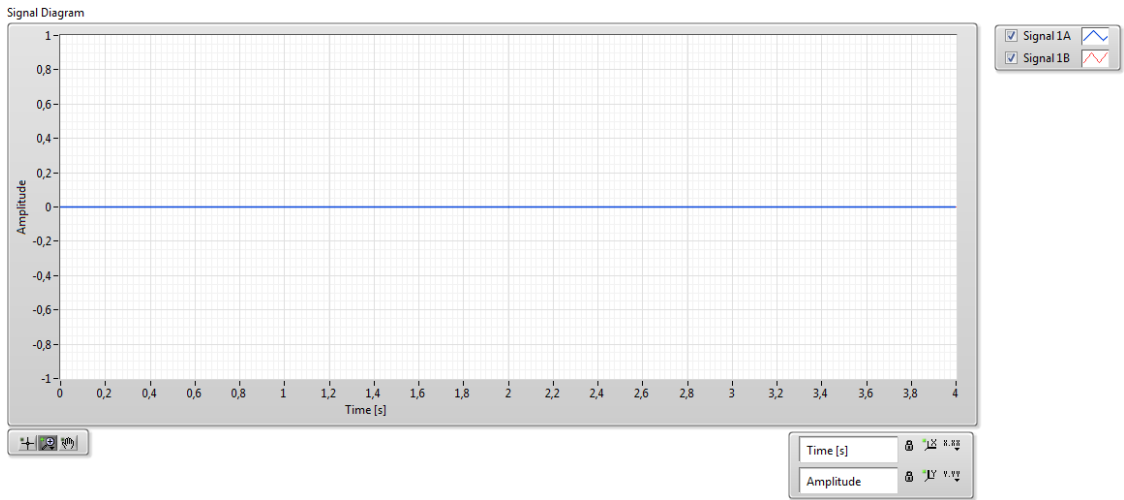


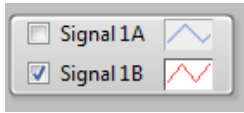
“Stopp This VI” remains. Now one can leave this SubVI by clicking on “Stopp This VI” which removes the window.

Saving data to the hard disk			
11	<p>Click on</p> <p>DataSaveStart</p> 	<p>DataSaveStart DataSaveNow</p>  	<p>Press "DataSaveStart" to activate "DataSaveNow".</p> <p>Press "DataSaveNow" to save your data immediately.</p> <p>Note: The path to your data is created by hitting the "DataSaveStart" button (color changes from grey to yellow. A new path for the next run is created automatically after your data have been saved by pressing "DataSaveNow". Data are stored in the folder C:/Measurement data</p> <p>File names are given as "A111-01_14-05-2020-04-24-03.dat" with the Test ID#, followed by "_", the date-time and the extension ".dat". Data are automatically saved 24 h after running SensorContro.vi.</p> <p>Evaluate data with DIADEM (National Instruments). Export to EXCEL is possible.</p>

Working with the signal diagram

12



Signals can be removed from or included in the diagram by setting . You may also change colors etc.

Signals are always recorded independently of whether they are displayed in the diagram.

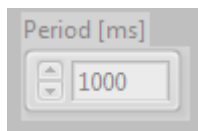
Click on the diagram to have access to further adjustments, e.g. automatic scaling for y and x.



Click on  to have more options with respect to handling the signals in the diagram.

13

All data are displayed as a function of time in the signal diagram at a rate of 1000 ms⁻¹. You may increase the period before you start SensorControl.vi



but only larger times are allowed.

8. ORDERING INFORMATION

I2C-USB 2.1

9. PACKAGING/SHIPPING INFORMATION

This item is shipped individually in an ESD box.

10.NOTES

11.WORLDWIDE SALES AND CUSTOMER SUPPORT

ALDERS electronic GmbH

Arnoldstraße 19 , 47906 Kempen (Germany)

sales@alders.de

+49 2152 8955-230