FES SENSOR
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TCD CONTROLLER 3.1

Evaluation Kit for H2-TCD I2C-I Hydrogen Sensors

1. DESCRIPTION

The controller TCD-Controller 3.1 serves as evaluation kit for thermal conductivity H2-TCD I2C-I hydrogen sensors with I^2C bus. The controller contains a ±1.0°C accurate digital temperature sensor with 12-bit resolution for ambient temperature measurement and a 1K bit electrically erasable PROM. TCD-Controller 3.1 also provides SDA and SCL junctions to the internal I^2C bus of the H2-TCD I2C-I sensor to access the sensor´s internal key components.

The evaluation kit is operated through a 1-wire bus connector with a personal computer, an installed LabVIEW® runtime and the SensorControl software.

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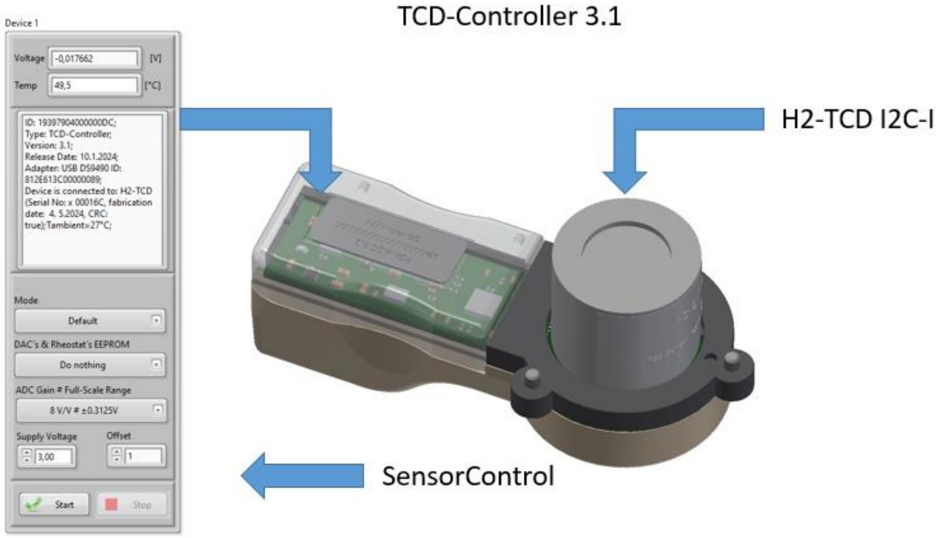
2. APPLICATION



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3. REVISION HISTORY

Date	Rev.	
July 4, 2024	1.0	Initial Version
July 15, 2024	1.1	Auto Correction Mode added

4. PIN CONFIGURATION OF SENSOR CONNECTOR

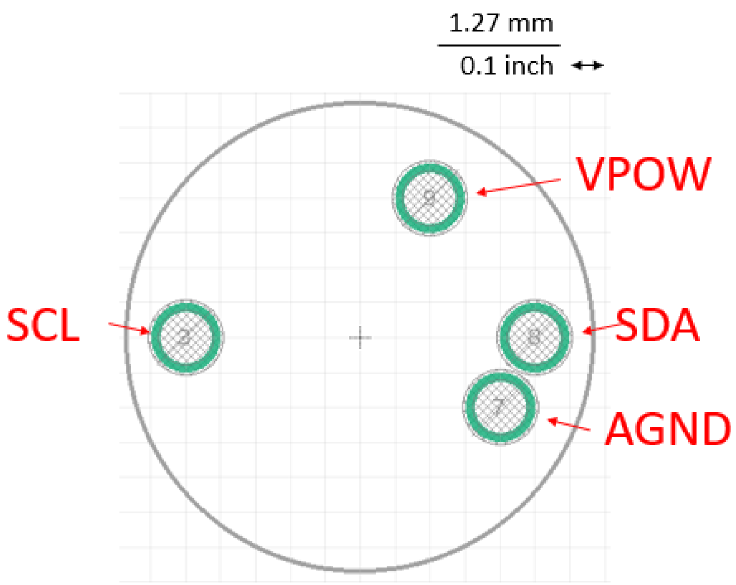


Figure 1: Top view of connections

Table 1

PIN NO.	SIGNAL NAME	DESCRIPTION
3	SCL	SCL line of I2C bus.*
7	AGND	Ground of the heaters, Wheatstone bridge and I2C bus.*
8	SDA	SDA line of I^2C bus.*
9	VPOW	Supply voltage of internal electronics. *

5. PIN CONFIGURATION OF 1-WIRE CONNECTOR

Do not connect the evaluation kit to other 1-wire components as the pins 4, 5 and 6 have a different function in common 1-wire networks. Connect the evaluation kit only to our special USB bipolar power source SBPS-eFuse-LDO. This power source also contains a socket for a jack plug which is connected to the +Vpower line.

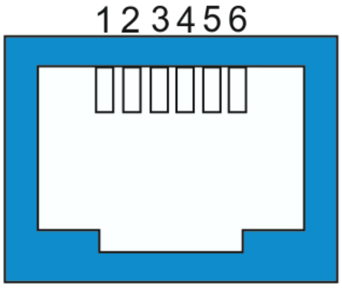


Figure 2: Pinout 6P6C-RJ12 socket

PIN NO.	SIGNAL NAME	DESCRIPTION
1	VDC	+6 V Input
2	AGND	Power Ground
3	OW	1-Wire Data
4	VPOW	+Vpower Input
5	VPOS	+12V Input
6	VNEG	-12V Input

6. SPECIFICATIONS

6.1. ABSOLUTE MAXIMUM RATINGS

At ambient temperature T_a = 20 °C.

Input supply voltage at pin 4 of the 6P6C-RJ12 socket	+9 V
Storage temperature	-40°C to 100 °C

6.2. 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.

6.3. LIST OF REQUIRED ADDITIONAL COMPONENTS

PART	DESCRIPTION	QUANTITY
H2-TCD I2C-I	Thermal conductivity hydrogen sensor for non-isothermal operation with I^2C bus	1
SBPS-eFuse-LDO 3.12	Bipolar power source, version 3.12	1
PS 6 Volt	Power supply 6 Volt	1
DS9490R	1-Wire USB Adapter (Maxim Integrated)	1
6p6c RJ12 0,3	Cable 6p6c RJ12 0,3 m	2
	Optional:	
TC-1/4	Gas flow test chamber with ¼“ tubes and Swagelok®	1

6.4. RECOMMENDED OPERATING CONDITIONS

At ambient temperature T_a = 20 °C (unless otherwise noted).

	MIN	NOM	MAX	UNIT
VPOW	+6	+6V	+9	V

6.5. MECHANICAL

Length	70 mm
Height	23 mm
Width	33 mm

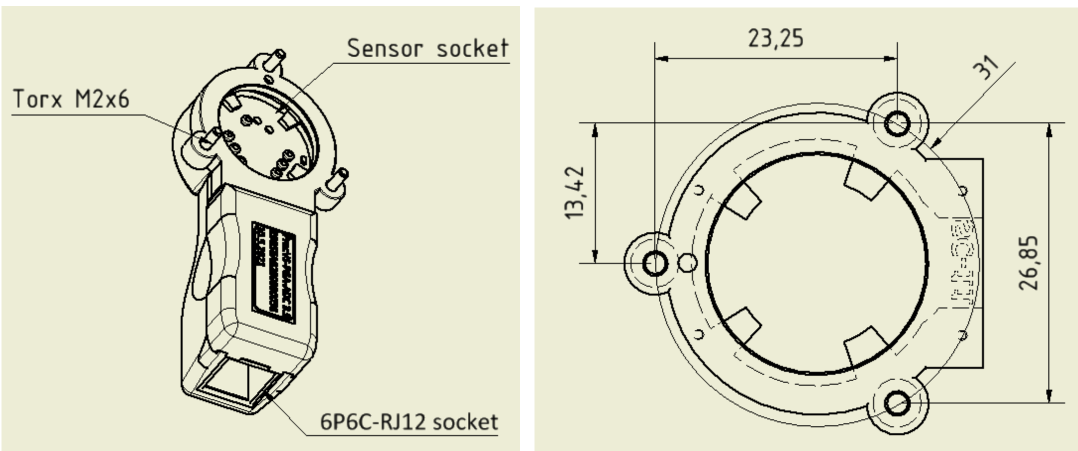


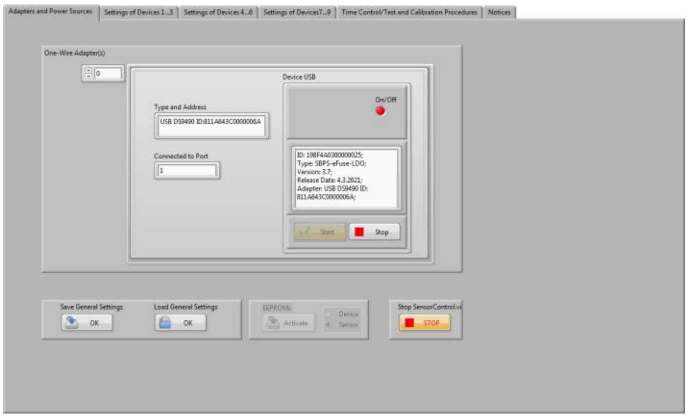
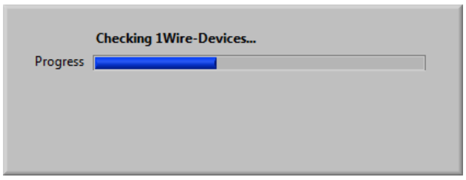
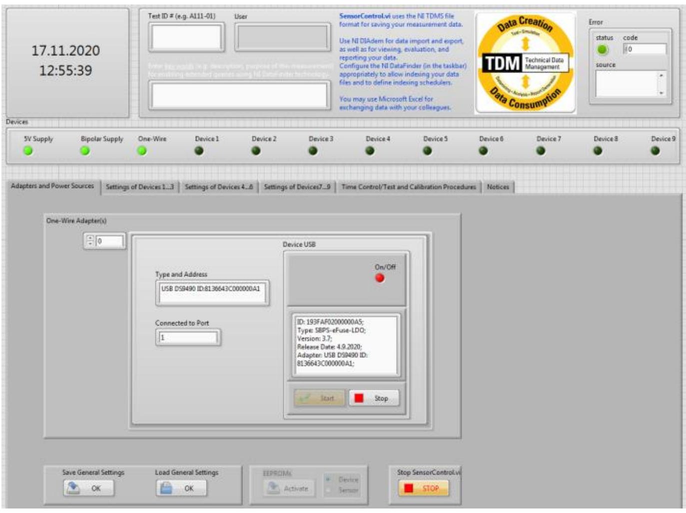
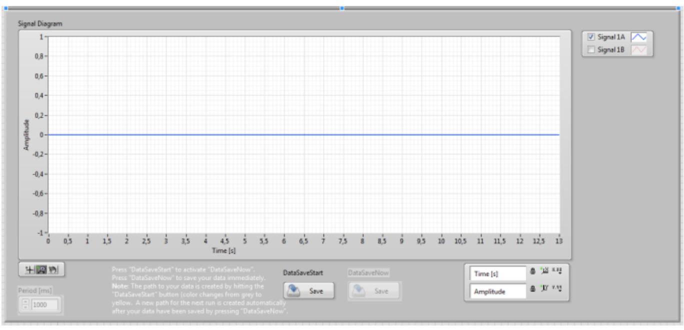
Figure 4: Drawing of TCD-Controller 3.1 (left). Flange with three Torx M2x6 screws (right). All dimensions are in mm.

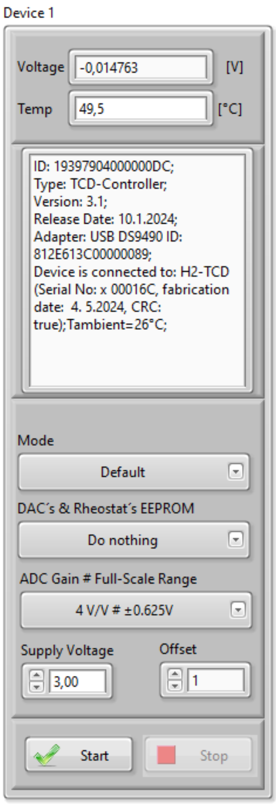
7. THEORY OF OPERATION

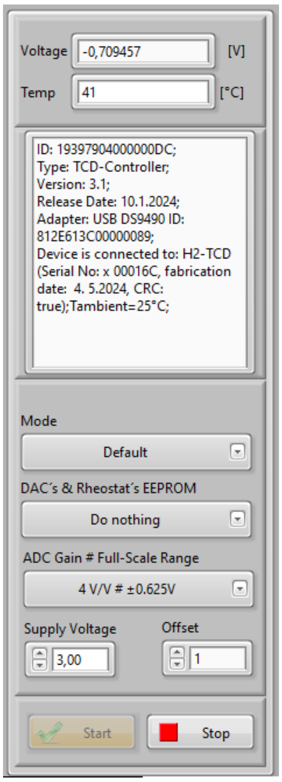
Refer to Specification Sheet H2-TCD I2C-I for detailed information.

8. OPERATION WITH SENSORCONTROL

#	STEP	FIGURE
Follow "INSTALLATION GUIDE 1-WIRE DRIVER"		
Run SensorControl.vi or SensorControl.exe		
1	Plug 1-Wire USB Adapter to an USB port of the running PC.	
2	Connect RJ12 socket (labeled USB) of the bipolar power source with the 1-wire USB adapter using a 6pc6 cable.	
3	Connect a 6 V plug-in power supply with the power line and connect it with the bipolar power source.	
4	Plug the H2-TCD I2C sensor into the controller TCD-Controller and connect one RJ12 socket of the bipolar power source with the sensor controller TCD-Controller using a low-ohmic 6p6c cable	**Note:** Many commercial 6p6c RJ12 cables are used for communication networks. We recommend for the connection between the SBPS- LDO and the TCD-Controller a low-ohmic, short cable.

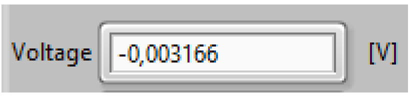
5	Choose "Sensor" in the EEPROM selection box*  to ensure reading of the controller adjustments from the sensor´s internal EEPROM and not from the device´s internal EEPROM. *) see Comment on page 9	
6	Run SensorControl (see User Guide SensorControl.vi for further explanations)	Wait until initialization is completed  and the yellow LED of the SBPS-eFuse-LDO bipolar power source stops blinking. It indicates that the software accesses the I2C bus of the sensor controller and of the sensor. Finally, you get the frontpanel  

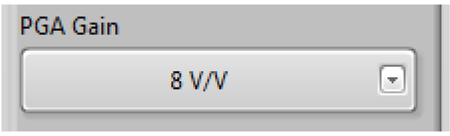
7	Click on the register card "Settings of Sensors 1…3"		**Voltage** shows the balance voltage of the Wheatstone bridge configuration of the H2 CNI I2C sensor. **Temp** will show the housing temperature of the sensor. **Display** shows "Notices to Operators": ID of device (controller); Type of device; 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. **Mode:** Default and Auto Correction **Ring to access the DAC´s and rheostat´s non-volatile memory**. **Ring to adjust the gain of 16 bit ADC´s internal PGA**. This ADC measures the voltage of a 1 Ohm resistor in series with the sensor/compensator. **Supply voltage** V_{heat} to heat the two sensing elements. **Offset** of the 64-position rheostat to adjust the zero signal **Start** and **Stop** button
Comment:			

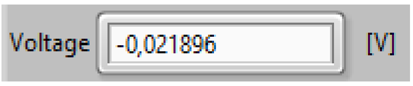
<table>
<tr>
<td>8</td>
<td>Click “Start”</td>
<td>
</td>
<td>Adjust the supply voltage (bridge excitation voltage) to

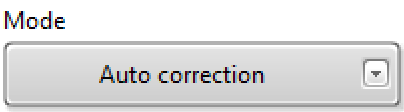

As the result of the applied voltage to the sensor elements, the correspondingly flowing current through the sensor, the temperatures of the sensor elements and the sensor housing increase, as indicated by

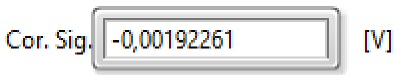

After equilibration (>30 min) adjust the offset to

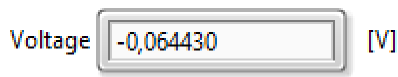

(value depends on sensor) and observe the corresponding reduction of the (bridge balance) voltage


The voltage can be further amplified by increasing the PGA gain from 1 V/V to 256 V/V.


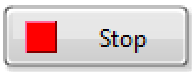
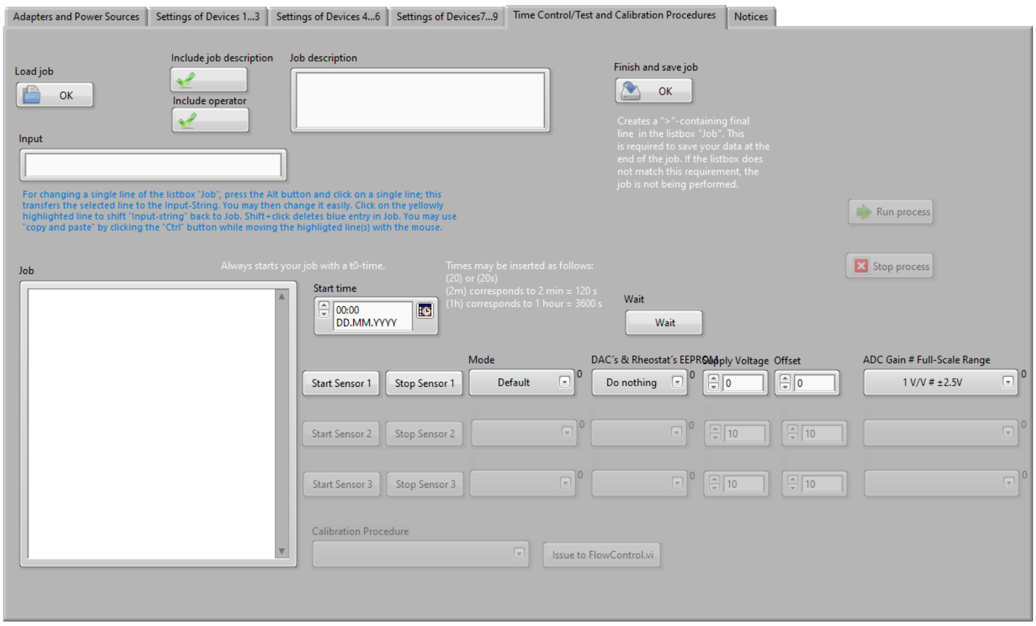
The effect is the approx. 8 times higher voltage.


when compared with the voltage at 1V/V.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>Change Mode into


Signal B is changed in


The auto correction uses the sensor´s temperature to determine the temperature-induced contribution (“background”) of the signal


by applying the following formula
$$Cor. Sig. = Voltage - [Temperature \times Gain + Offset]$$</td>
</tr>
</table>

9			Gain and Offset are stored in the sensor´s EEPROM
10	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.
11	Click “Stop”		Data collection and sensor stop.
Systematic evaluation of sensor properties using register card “Time Control and Calibration Procedures”			
12	Click on register card “Time Control/Test and Calibration Procedures”	 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. 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: Instead of writing in the window “Job” you can follow the blue instruction shown below the window “Input”.

(20) or (20s)

(2m) corresponds to 2 min = 120 s

(1h) corresponds to 1 hour = 3600 s

The wait command is very important as this is the only way to define a time-dependent consecution of other instructions.

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”, “PGA Gain”, “Supply Voltage” or “Offset” generate corresponding entries in the job.

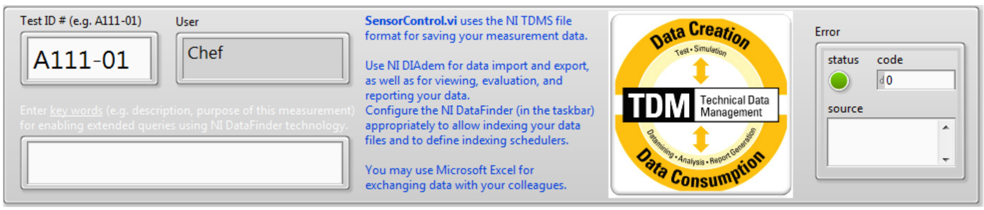
Clicking on Start Sensor 1 generates a line !Sensor: Start(1) and will be interpreted as to start sensor 1; same holds for clicking on Stop Sensor 1.

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.

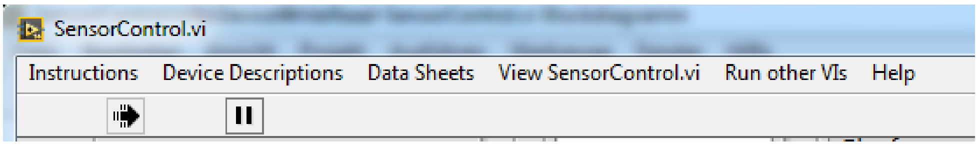
Define a Test ID# in the top box of SensorControl.vi.

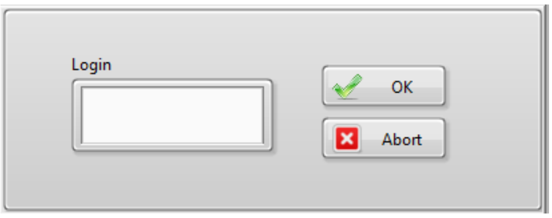


(You may also give some key words in the keywords window). The software only accepts Test ID# in the format Xnnn-nn. The “Run process” button is enabled.

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.

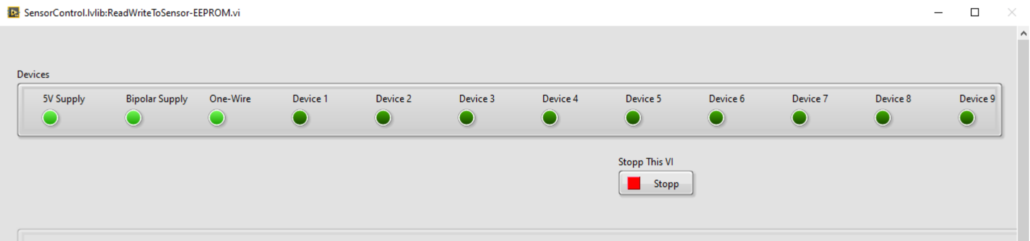
<table>
<tr><td colspan="3">Access to the sensor´s EEPROM</td></tr>
<tr><td>12</td><td>Open menu “Run other VIs” and select

“Read and Write to Sensor´s EEPROM/Login Required”</td><td>




Enter “admin” and click on “OK” (The keyboard´s enter buttom is not accepted!)

A new window appears



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

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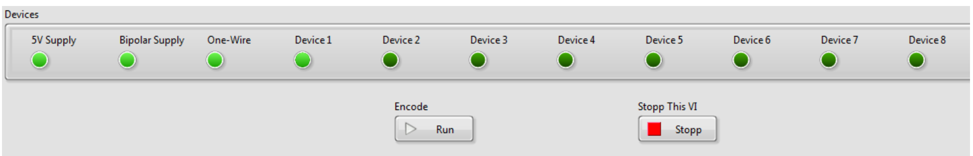
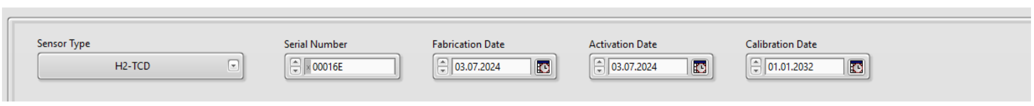
<tr><td></td><td></td><td>
The “Read EEPROM” button is shown. Click on this button and wait a couple of seconds. The EEPROM is read, entries are filled, the “Read EEPROM” disappears and



“Encode” is displayed.



</td></tr>
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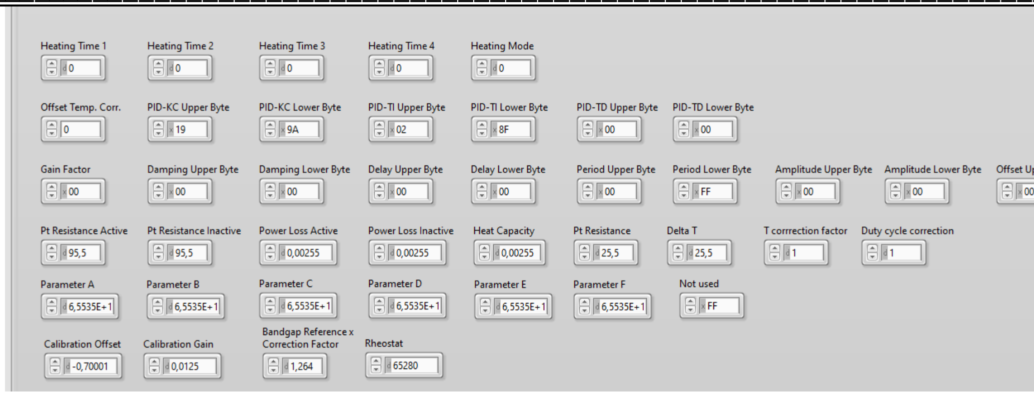
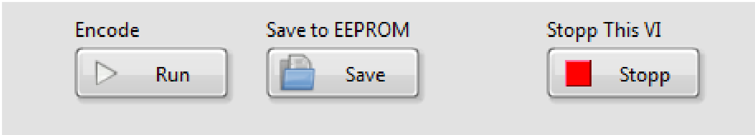
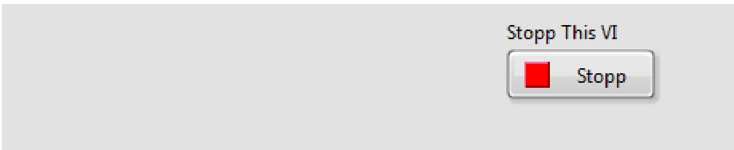


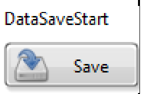
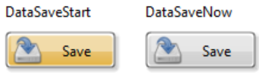
Entries can be changed (although it is not recommended) and encoded by clicking on "Encode". Note the values of "Calibration Offset" and "Calibration Gain", attributed to Offset and Gain in the auto correction formula in row 10.

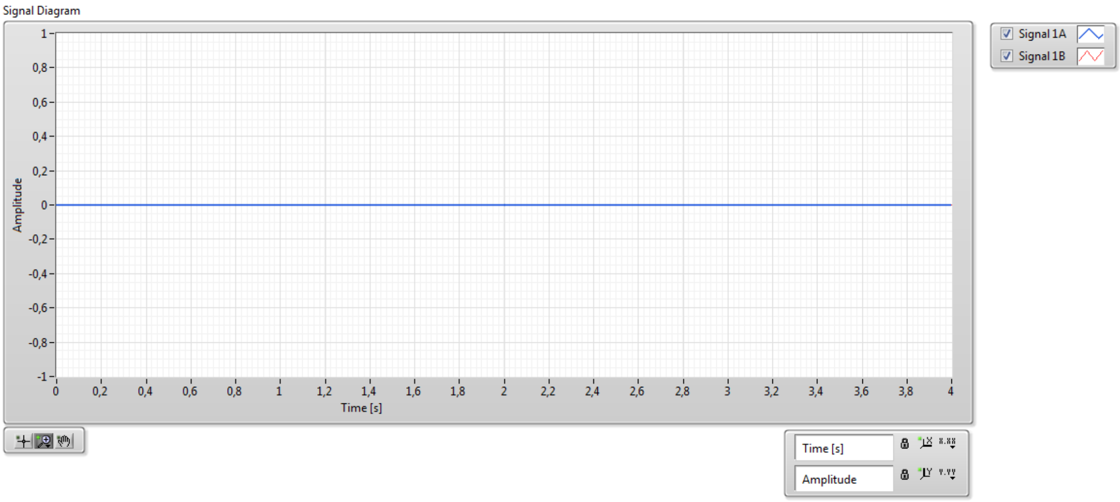


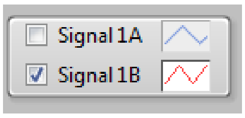
The "Save to EEPROM" option appears that can be clicked to save the encoded data into various registers of the sensors´s EEPROM. After clicking "Save to EEPROM" wait a couple of seconds until this buttom disappears and only

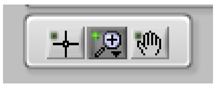
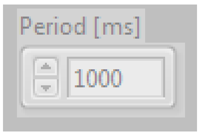


"Stopp This VI" remains. Now one can leave this SubVI by clicking on "Stopp This VI" which removes the window.

Saving data to the hard disk			
13	Click on 		Press "DataSaveStart" to activate "DataSaveNow". Press "DataSaveNow" to save your data immediately. 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 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. Evaluate data with DIADEM (National Instruments). Export to EXCEL is possible.

<table>
<tr><th colspan="2">Working with the signal diagram</th></tr>
<tr><td>14</td><td>

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.</td></tr>
<tr><td>15</td><td>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.</td></tr>
</table>

9. ORDERING INFORMATION

TCD-Controller 3.1

10.PACKAGING/SHIPPING INFORMATION

This item is shipped individually in an antistatic bag.

11.NOTES

12.WORLDWIDE SALES AND CUSTOMER SUPPORT

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