Manual
Software SPECTRO-M-2-DOCAL- Scope V1.1

(PC software for Microsoft® Windows® 7, 8, 10)

for sensors of SPECTRO-M-2 Series

This operating manual is intended for the installation and commissioning of the PC software SPECTRO-M-2-DOCAL-Scope V1.1 for sensors of the SPECTRO-M-2 series. To support the commissioning of the sensors, the individual functional elements of the Windows® graphical user interface are explained in this operating manual.

The SPECTRO-M-2-DOCAL-Scope V1.1 is mainly limited to the calibration of the sensors and the documentation of the measurement data.

To use the full functionality of the sensor, the SPECTRO-M-2-DOCAL-Scope V1.1 software is available.

Parameters and measured values can be exchanged between PC and sensor either via RS232 or Ethernet (using an Ethernet converter).

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1. Installation of the SPECTRO-M-2-DOCAL-Scope software

The following requirements must be fulfilled for successful installation of the software:

* Microsoft® Windows® 7, 8, 10
* IBM PC AT or compatible
* VGA graphics
* Microsoft-compatible mouse
* Serial RS232 interface at the PC or USB slot or RJ45 connector
* Cable *cab-las4/PC* for the RS232 interface or *cab-4/USB* USB converter or *cab-4/ETH* Ethernet converter

Please install the software as described below:

|	
1.	You can download the software via a provided download link or, if applicable, install it via the provided software DVD. To install the software, start the 'SETUP' program in the 'SOFTWARE' folder.
2.	The installation program displays a dialog and suggests to install the software in the C:\"FILENAME" directory on the hard disk. You may accept this suggestion with OK or [ENTER], or you may change the path as desired. Installation is then performed automatically.
3.	During the installation process a new program group for the software is created in the Windows Program Manager. In the program group an icon for starting the software is created automatically. When installation is successfully completed the installation program displays "Setup OK".
4.	After successful installation the software can be started with a left mouse button double-click on the icon.

Windows^{TM} is a registered trademark of Microsoft Corp.
VGA^{TM} is a trademark of International Business Machines Corp.

2.   Operation of the SPECTRO-M-2-DOCAL-Scope software

Please read this chapter first before you start to adjust and parameterise the sensor system.

When the SPECTRO-M-2-DOCAL-Scope software is started, the following window appears on the Windows interface:

TIP! To avoid problems with the handling of the file path, it is advisable to run the software as administrator. You can either set this in the **Properties** under **Compatibility** or you start the software with a right click and choose **"Run as administrator"**.
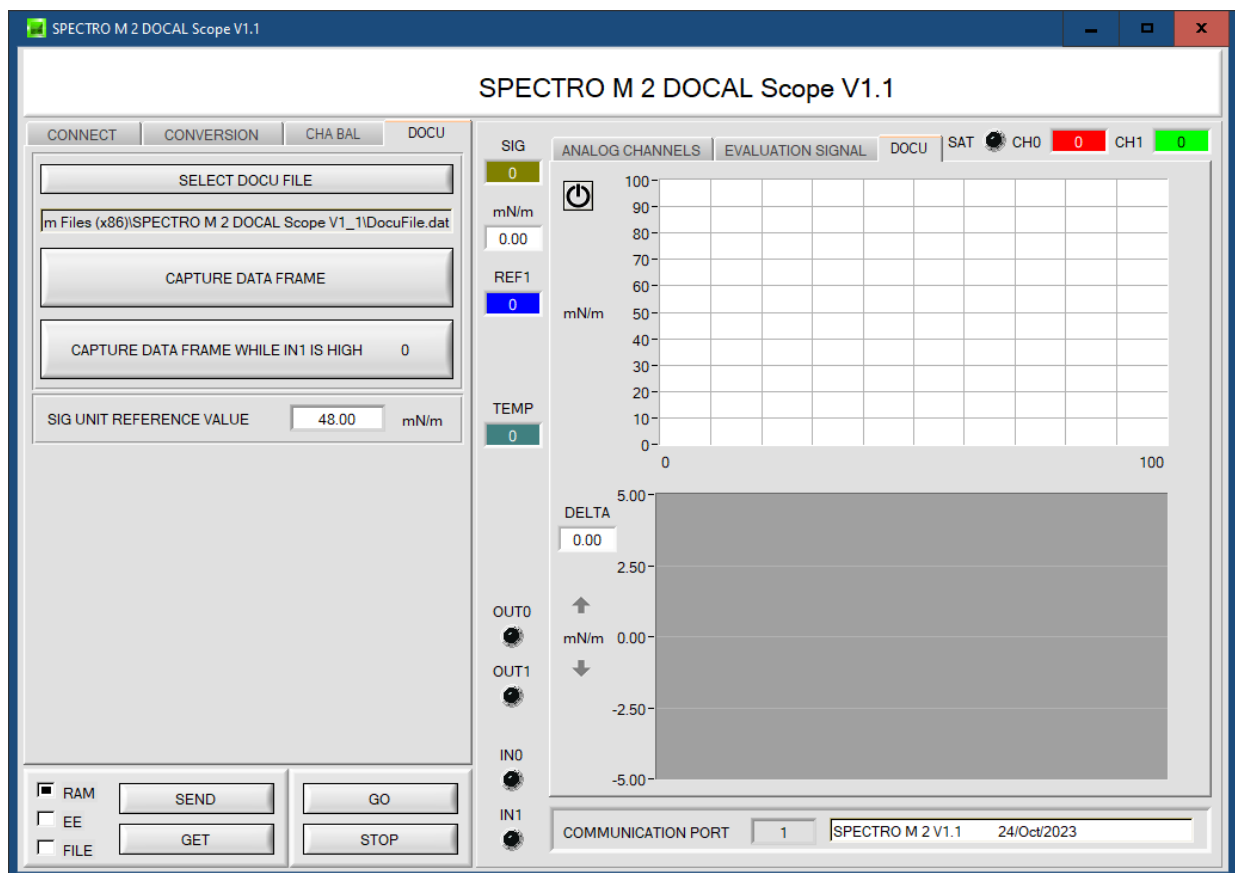
The window size and position will be the same as when the software was last closed. A double-click with the right mouse button e.g. under the minimise symbol places the window centrally in its original size.

If a connection is not established automatically, e.g. if no sensor is connected, the software can be run in OFFLINE mode. In offline mode it only is possible to exchange parameters with a file on a storage medium, which often is helpful for the purpose of analysing parameter files.

If a sensor is connected and a connection still cannot be established, either the SCOPE version (program at the PC) and the firmware version (program in the sensor) do not match, or the interface to the sensor must be correctly configured.
If different Scope and firmware versions should be the problem, please get the Scope version that matches the firmware from your supplier.
The interface configuration is described in the CONNECT tab chapter.

Pressing the right mouse button on an individual element will call up a short help text.

Due to a better overview, parameters that are not required, displays, graphs, etc., are greyed out or invisible depending on the parameterization.

2.1 Tab CONNECT

CONNECT:
Pressing the **CONNECT** tab opens a window for selecting and configuring the interface.

The **COMMUNICATION PROTOCOL** function field is used for selecting either an **RS232** or a **TCP/IP** protocol.

If **RS232** is selected, a port from 1 to 256 can be selected with **SELECT COM PORT**, depending on which port the sensor is connected to. The sensor operates with a set baudrate that can be modified with **CHANGE BAUDRATE** (see below). The sensor and the user interface both must operate with the same baudrate.

At the user interface the baudrate is set with **SELECT BAUDRATE**. If after starting the software should not automatically establish a connection, the correct baudrate can be found with **SELECT BAUDRATE**.

If an converter is used, the **COM PORT** number can be determined by way of the hardware manager in the system control panel.
A click on the magnifier symbol opens a list with all the possible COM ports in the display.

An RS232 to Ethernet converter **(cab-4/ETH)** is needed if the sensor should communicate through a local network. With this converter a connection to the sensor can be established using the **TCP/IP** protocol.
Parameterisation of the **cab-4/ETH** converter (assigning of IP address, baudrate setting, ...) can be done with the **SensorFinder software** that is available free of charge on the internet.

In order to establish a connection to the converter, its IP address or HOST name must be entered in the field **IP ADDRESS (xxx.xxx.xxx.xxx) OR HOST NAME**. The DROP DOWN menu (down arrow) shows the last 10 IP addresses that were used. An address from this list can be directly selected by clicking on the respective item. The DROP DOWN list is saved and is thus always available when the software is closed.
The **PORT NUMBER** for the cab-4/ETH converter is set to 5000 and must not be changed.
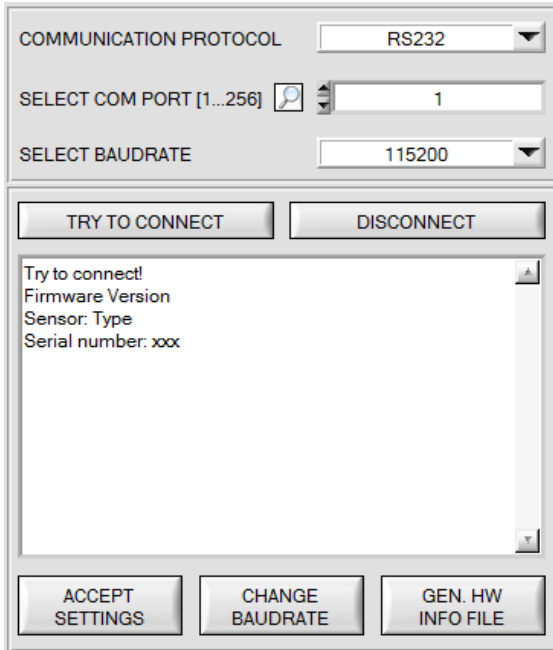When you press the **TRY TO CONNECT** button, the software tries to establish a connection with the set parameters. The communication status is shown in the display field. If the sensor answers with its FIRMWARE ID, the set connection type can be accepted by pressing **ACCEPT SETTINGS**. You will then be returned to the **PARA** tab. If you get a **TIMEOUT** message, the software could not establish a connection to the sensor. In this case please check if the interface cable is correctly connected, if the sensor is supplied with power, and if the set parameters are correct.
If a connection has been accepted by pressing **ACCEPT SETTINGS**, the software starts automatically with these settings when called the next time.
DISCONNECT disconnects the connection between sensor and PC. The software then switches to OFFLINE mode, where it is only possible to exchange parameters with a file on a storage medium.

Under **PANEL ID** a designation can be entered that will be displayed at various positions in the program window and will be saved in various files (e.g. record file).

The **LANGUAGE** selection field can be used to set the language in which the individual control elements on the user interface are represented. The language also applies to the help function that can be called up with the right mouse button.

| Please note:	The stable function of the interface is a basic prerequisite for measured value transfer from the PC to the sensor.
ATTENTION !	Due to the limited data transfer rate through the serial RS232 interface only slow changes of the raw signals at the sensor front end can be observed in the graphic output window of the PC. For maintaining maximum switching frequency at the sensor data communication with the PC must be stopped (press the STOP button).

The baudrate for data transfer through the RS232 interface can be set by means of the **SELECT BAUDRATE** drop down menu and **CHANGE BAUDRATE** function field.

If the baudrate should be changed, a connection must first be established by clicking on **TRY TO CONNECT**.
The **CHANGE BAUDRATE** button will then be active.

Now a new baudrate can be selected under **SELECT BAUDRATE**.
A click on **CHANGE BAUDRATE** sends the new baudrate information to the sensor.
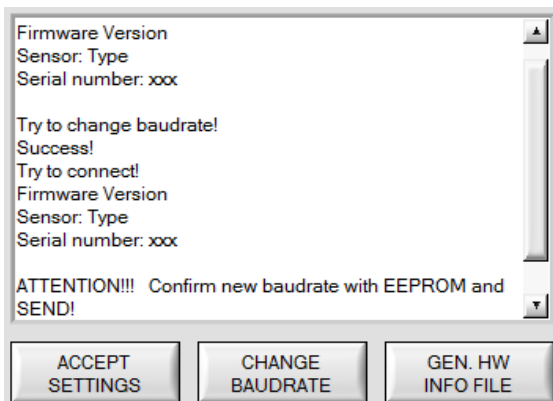

When the new baudrate information has been successfully sent, the sensor operates with the new baudrate. A window will pop up, prompting you to select **EEPROM** and then to press **SEND**. After a hardware reset the new baudrate only will be used when **EEPROM** and **SEND** have been pressed.

A click on **ACCEPT SETTINGS** saves the current interface settings, which will then be automatically set when the software is restarted.
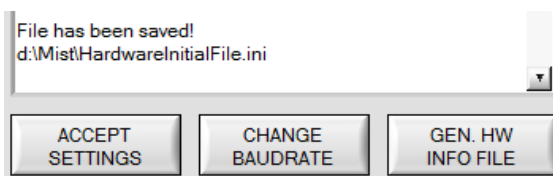
A click on the **GEN. HW INFO FILE** generates a file in which all the important sensor data are stored in encrypted form.
This file can be sent to the manufacturer for diagnostic purposes.

2.2 Button SEND, GET, GO, STOP
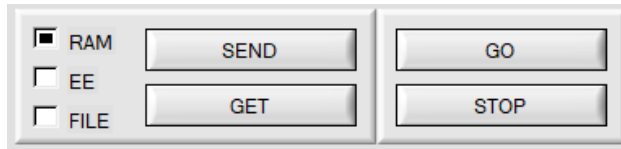
SEND [F9]:
When the **SEND** button is clicked (or shortcut key button F9 is pressed), all the currently set parameters are transferred between PC and sensor. The target of the respective parameter transfer is determined by the selected button (**RAM, EEPROM,** or **FILE**).

GET [F10]:
The currently set values can be interrogated from the sensor by clicking on the **GET** button (or with shortcut key button F10). The source of data exchange is determined by the selected button (**RAM**, **EEPROM**, or **FILE**).

RAM:
The **RAM** is a **volatile** memory in the sensor's micro-controller, i.e. when the power at the sensor is turned off, these parameters will be lost again.
The sensor always operates with the parameters in its RAM.
If the **RAM** option is selected, a click on **SEND** writes the current parameters to the sensor's **RAM** memory, and a click on **GET** reads the parameters from the sensor's **RAM** memory

EEPROM:
The **EEPROM** is a **non-volatile** memory in the sensor's micro-controller. When the power at the sensor is turned off the parameters in the **EEPROM** will not be lost. When power is turned on again, the parameters are loaded from the **EEPROM** to the **RAM** memory. Figuratively speaking the **EEPROM** thus is a level lower than the **RAM**. Data exchange between **PC** and **EEPROM** automatically is performed through the **RAM** memory, which means that parameters that are written to the **EEPROM** automatically are also written to the **RAM,** and data that are read from the **EEPROM** automatically are also read to the **RAM**.
If the **EEPROM** option is selected, a click on **SEND** writes the current parameters to the sensor's non-volatile **EEPROM** memory, and a click on **GET** reads the parameters from the sensor's **EEPROM**.
The **RAM** memory should always be used for parameterising the sensor. When suitable parameters have been found for the respective application, these parameters must be written to the sensor's **EEPROM** so that after restarting the sensor these parameters can be loaded from the **EEPROM** into the **RAM** memory.

FILE:
After pressing **SEND**, the current parameters can be written to a selectable file on the hard disk. With **GET** parameters can be read from such a file. When the **SEND** or **GET** button is pressed, a dialog box opens for selecting the desired file.
TIP! Once suitable parameters have been found for a certain application, these should always be saved in a file on the PC.

GO [F11]:
A click on this button starts data transfer from the sensor to the PC through the serial RS232 interface.

STOP [F12]:
A click on this button stops data transfer from the sensor to the PC through the serial RS232 interface

PLEASE NOTE!
Since the tabs for parameter setting and for teaching-in switching thresholds are not activated in SPECTRO-M-2-DOCAL-Scope V1.1, the parameters and switching thresholds can only be changed via the SPECTRO-M-2-Scope V1.1 software.
However, you can load a parameter file in the background via FILE and GET and then send it to the sensor via th SEND button.

2.3 Graphic display elements

The software provides various display elements and a graphic window for the visualisation of all the data that are important for parameterisation. The individual display elements and the graph are explained in the chapter below.

CH0 and **CH1:**
These displays show the analog signals of the individual cannels.
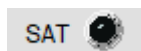The graph under the **ANALOG CHANNELS** tab shows the values as lines.

SIG:
This display shows the measurement value that is determined from **CH0 and CH1**. The graph under the **EVALUATION SIGNAL** tab visualises **SIG** as a line.

The **EVALUATION SIGNAL SIG** can be assigned a specific conversion value in a table. This value is displayed here.
See **CONVERSION** tab

SAT:
The LED **SAT** illuminates if one of the channels **CH0** or **CH1** is satiated (overmodulated).

It is necessary to ensure that the sensor is parametrized in such a way that the saturation LED **SAT** is off.

REF1:
This display shows the current REF1erence value. This value is the basis for the calculation of switching threshold and hysteresis threshold.
If **THRESHOLD TRACING** and **EXERN TEACH** are set to **OFF**, the **TEACH VALUE** is the REF1erence value.
If **THRESHOLD TRACING** is set to **ON**, automatic threshold tracing is activated. The current REF1erence value **REF1** is cyclically adapted to compensate a lowering of the current **SIG** value, e.g. due to increasing dirt accumulation.
Depending on the setting of **EXERN TEACH** the REF1erence **REF1** can also be taught through input IN0 with various methods.
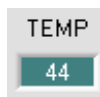In the graph the REF1erence value **REF1** is represented as a blue line.

MAX and MIN:
If with **EXTERN TEACH** or **ANALOG RANGE** a search for a minimum and/or maximum **SIG** value is necessary, these values are shown in these displays.
The two displays only are active when they are needed.

TEMP:
This display shows the temperature prevailing in the sensor housing.
The display **DOES NOT** show degrees Centigrade or Fahrenheit.

OUT0 and OUT1:
These LEDs visualise the physical status of outputs OUT0 and OUT1.
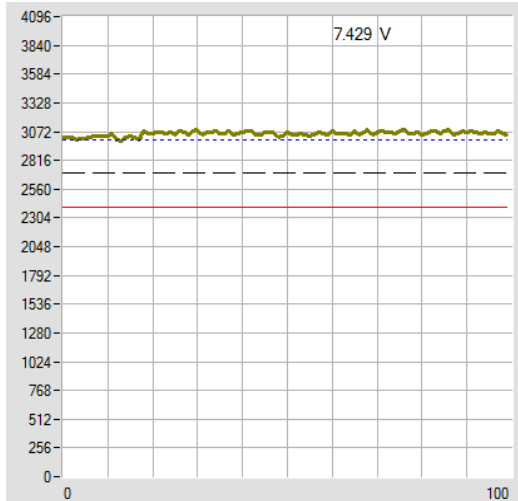When the LED is black, the output value is 0V.
When the LED is orange, the output value is +24V.

IN0 and IN1:
These LEDs visualise the physical status of inputs IN0 and IN1.
When the LED is black, the input value is 0V.
When the LED is green, the input value is +24V.

GRAPH:

The graphic display window shows the switching threshold (red line), the hysteresis threshold (black dashed line), the REF1erence value **REF1** (blue dotted line), and the current analog signal **SIG** (green line) depending on the set parameters.

In the graph of this example the parameter settings are as follows:

THRESHOLD MODE = LOW, THRESHOLD TRACING = OFF
EXTERN TEACH = OFF
TEACH VALUE = 3000 (→ REF1=3000)
THRESHOLD CALC = RELATIVE (%)
**TOLERANCE = 20**
HYSTERESIS = 10

This results in a switching threshold of **TEACH VALUE** minus **TOLERANCE** (red line), and in a hysteresis threshold of **TEACH VALUE** minus **HYSTERESIS** (black dashed line).

2.4 Tab DOCU

Pressing **DOCU** opens a view in which, after pressing **CAPTURE DATA FRAME**, the value of **SIG UNIT** is displayed in its unit in the upper graph. In the lower graph, the **delta** value of **SIG UNIT** to the reference value **SIG UNIT REFERENCE VALUE** is shown graphically as well as in a display.
With the arrow keys you can scale the Y-axis of the graph.
Use the **RESET** button to set the graph to 0.
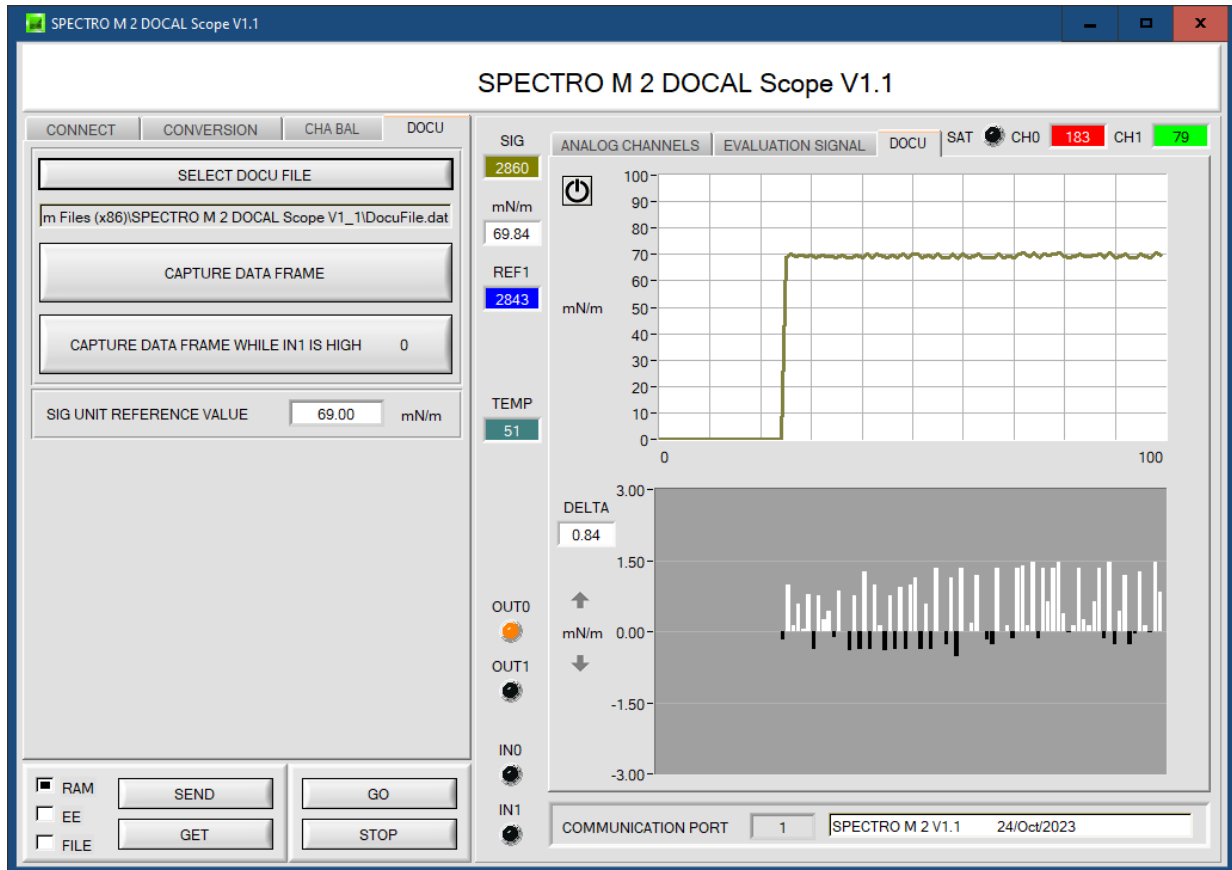
With the button **SELECT DOCU FILE** you select a file in which the values **CH0**, **CH1**, **TEMP**, **SIG**, **SIG UNIT** and **delta SIG UNIT** are stored with a time stamp.

The file is saved after pressing **CAPTURE DATA FRAME.**
It should be noted that the file is created only after pressing **SELECT DOCU FILE.**
In any other case, the data is simply appended to the file displayed in the file path.
Even if the software has been restarted.

After the button **CAPTURE DATA FRAME WHILE IN1 IS HIGH** has been pressed, the software reads out data in the background. As soon as it is recognized that the input IN1 is set, this data is recorded and displayed. If the input (IN1) drops again, then an average value is formed over the recorded data and shown in the corresponding displays. Finally, the average value is appended to the selected recorder file.
ATTENTION! This mode can only be used if the IN1 input is activated in the sensor via **ANALOG OUT** or **DIGITAL OUTMODE**.
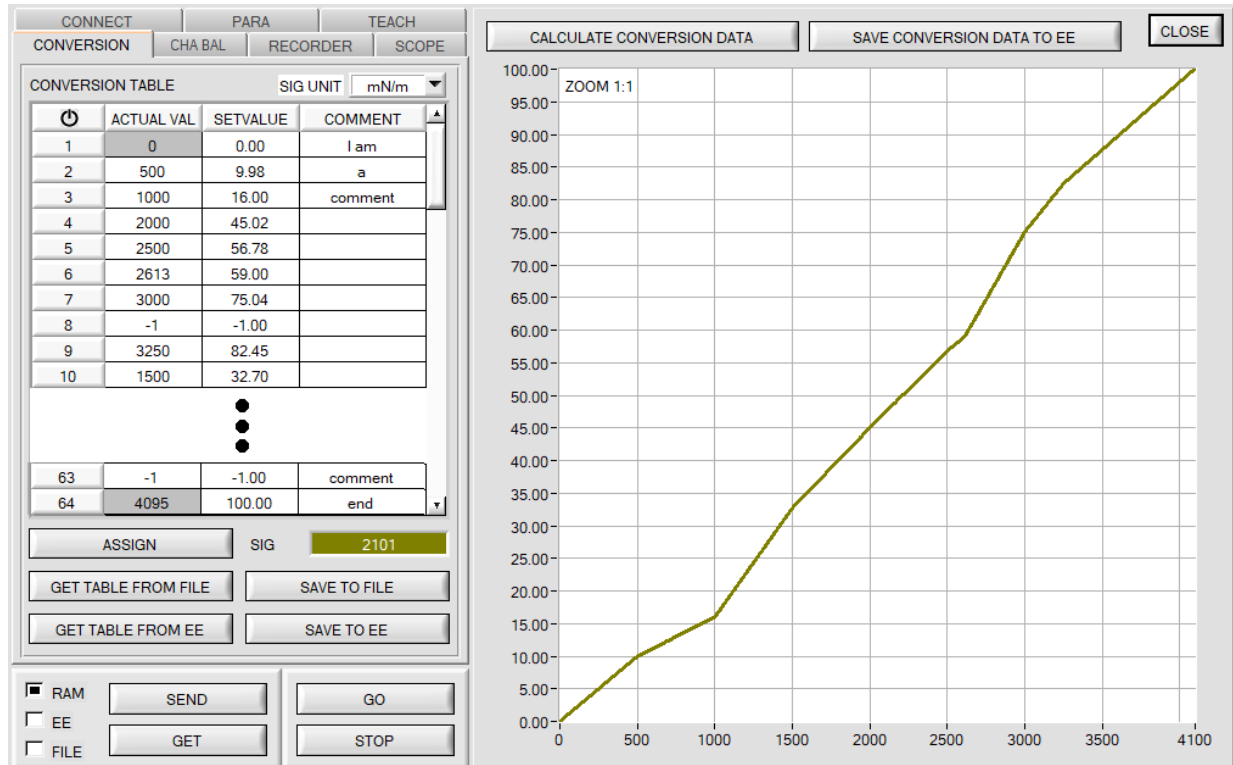
2.5 Tab CONVERSION

In the **CONVERSION** tab a certain conversion value can be assigned to the **SIG** signal.
SIG is the measured value calculated from CH0 and CH1. It is a measure for the condition of the surface that is presented to the sensor and is displayed digitally from 0 to 4095 digits.
In order to characterise the surface in a more comprehensible way, a specific physical value can be assigned to the value **SIG** in the **CONVERSION TABLE**. The unit of measurement of this value is selected in the parameter **SIG UNIT**. It can take values between 0.00 and 100.00 to two decimal places.
If **ANALOG RANGE = CONV TABLE** is set the corresponding conversion value in the range from 0.00 to 100.00 is output instead of **SIG**.

When the **GO** button is pressed the current **SIG** value is shown in the **SIG** display.
Use the mouse to select a cell in the **ACTUAL VALUE** column and press **ASSIGN.** This value is then written to the cell in the table. Then enter the physical value to which the current **SIG** value corresponds in the **SETVALUE** column. It can have values between 0.00 and 100.00.
A total of 64 conversion values can be entered this way.
NOTE: Instead of the comma, a dot must be entered as a separator.

The first and the last row must be filled in (see **CONVERSION TABLE** row 1 and 64).
Rows that are not used must be disabled with **-1** (see **CONVERSION TABLE** row 8 or 63).
The **ACTUAL VALUE** column has a value range of 0 to 4095.
The **SETVALUE** column has a value range of 0.00 to 100.00.

With a click on **CALCULATE CONVERSION DATA**, a corresponding conversion value for each **SIG** value from 0-4095 is calculated from the interpolation points of the conversion table and displayed graphically. The X-axis is the value of **SIG (ACTUAL VAL)**. The Y-axis shows the corresponding set value (**SETVALUE**).
The graph can be zoomed by holding down the control key and drawing a window with the left mouse button. Click on **ZOOM 1:1** to display the graph in normal size again.

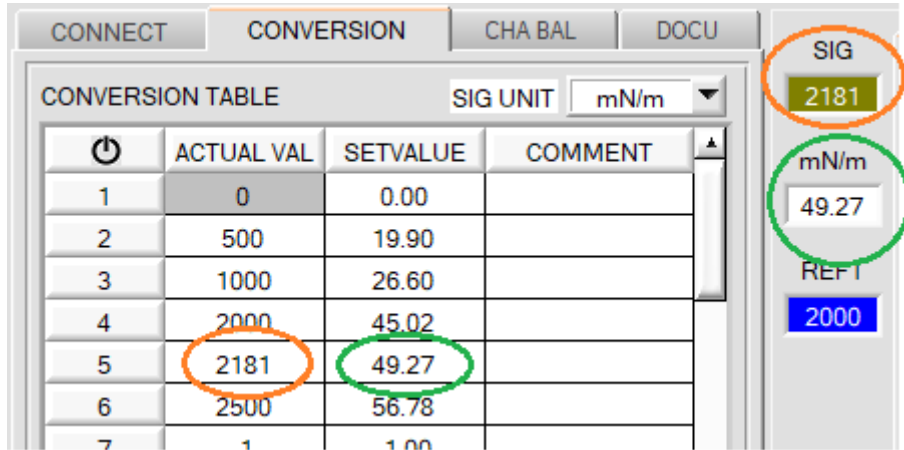With **SAVE CONVERSION DATA TO EE** the conversion data can be sent to the EEPROM of the sensor.

Moreover, **GET TABLE FROM FILE** and **SAVE TO FILE** can be used to load the conversion table from a file or to save it in a file.

With **GET TABLE FROM EE** and **SAVE TO EE** the conversion table can be loaded from the sensor's EEPROM or saved to the sensor's EEPROM.

An individual comment for every line can be entered in the **COMMENT** column.
The comment is stored in a file on the PC via **SAVE TO FILE** and in the EEPROM of the sensor with **SAVE TO EE**.
Memory space issues mean that only the first 8 characters are entered in EEPROM from the respective comment line.

A click on the ⏻ symbol resets the table.

The conversion value corresponding to the **SIG** value is shown in a display on the user interface in **GO** mode. It is also saved when recording data (see **RECORDER** tab).

NOTE: **SIG UNIT** is a parameter. It is stored in the **RAM** or **EEPROM** of the sensor together with the other parameters of the **PARA** and **TEACH** tabs.
The buttons **GET TABLE FROM FILE**, **SAVE TO FILE**, **GET TABLE FROM EE** and **SAVE TO EE** do not influence the parameter **SIG UNIT**.

2.6 Tab CHA BAL

2.6.1 Channel balancing

With the sensors of the SPECTRO-M-2 series a channel balancing can be performed. The balancing can be performed on any surface.
Channel balancing makes sense given multiple sensors which are to be taught.
If so, the same switching threshold, tolerance and hysteresis can be set for all sensors. This creates an identical starting point for multiple sensors and various applications.

After pressing **CHA BAL** the following window is displayed:
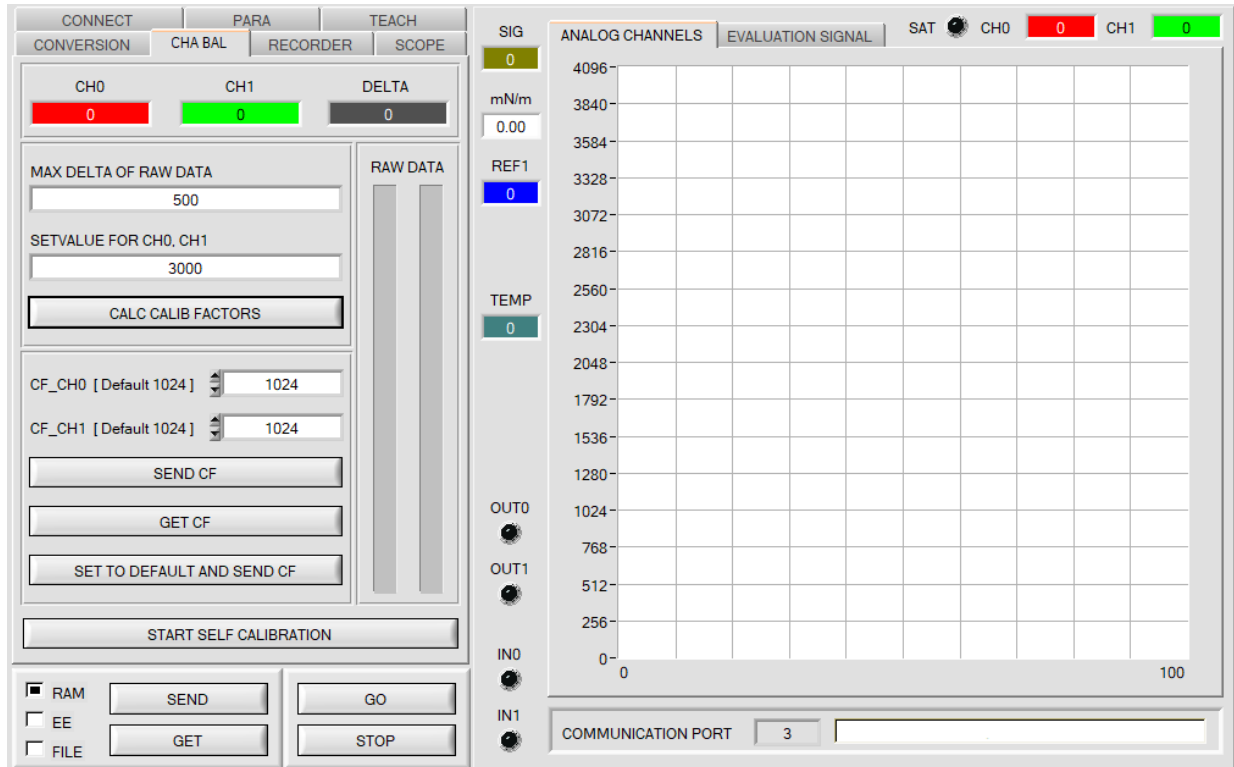
Calculation example for determining the calibration factors

In the example in the picture below, a POWER value at which the two bars of the raw signals **RAW DATA** are in the dynamic range has been set. Each of the two bars is at approx. 2300 digits. It is thus appropriate to set a setpoint value of 2300 (see **SETVALUE FOR CH0, CH1**). When calibration is now started by pressing **CALC CALIB FACTORS** the software automatically calculates the calibration factors for **CH0** and channel **CH1**. The calibration factors are normalized as integers to the value 1024.

Formula:

CF_CH0 = (SETVALUE / RAW DATA CH0) * 1024 = (3300 / 3150) * 1024 = 1073
CF_CH1 = (SETVALUE / RAW DATA CH1) * 1024 = (3300 / 3490) * 1024 = 968
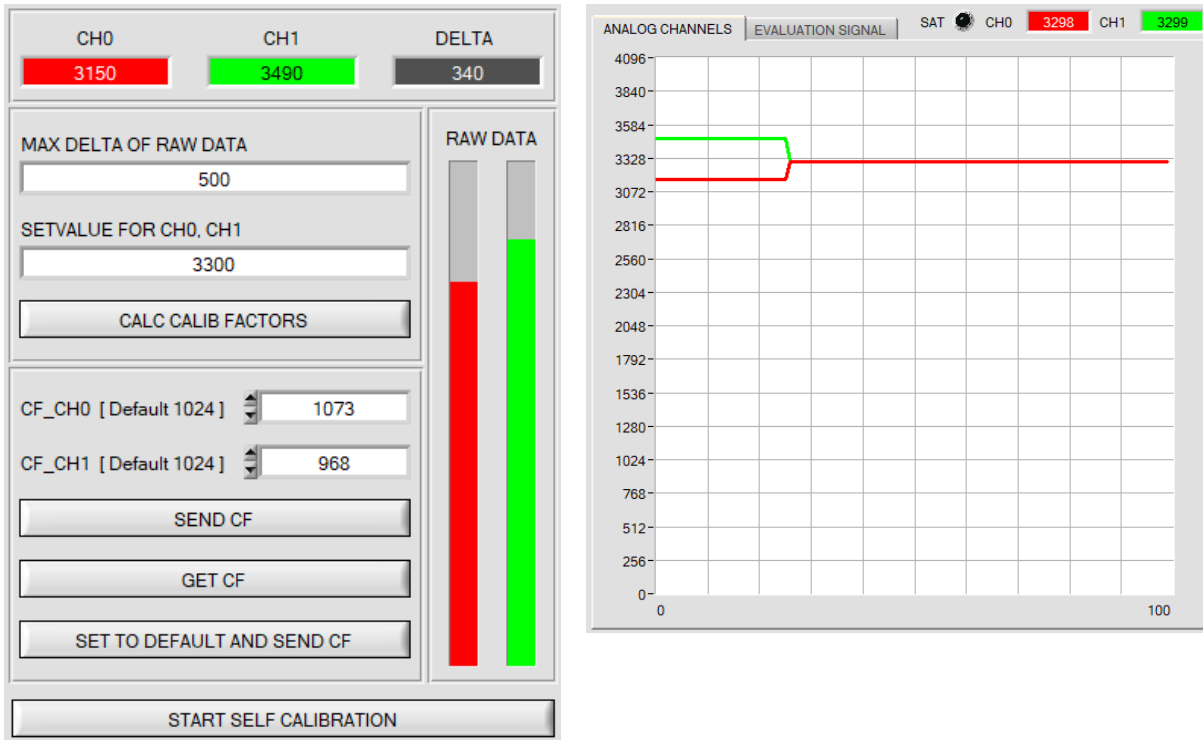
When the calibration factors have been calculated by the software on the user interface, they are automatically saved to the non-volatile **EEPROM** memory of the sensor. Calibration is then finished, work can then be continued in the main panel.

When the sensor detects a raw signal, it applies the calibration factor saved in the **EEPROM** to this raw signal, i.e. in the main panel only the calibrated data for channel **CH0** and channel **CH1** are displayed. Evaluation by the micro-controller also is exclusively done with the calibrated data.

In the following the individual steps for calibrating the sensors are described:
INFO: The individual pop-up windows are intended as a help to guide you through the calibration process.
ATTENTION: It is a prerequisite for successful calibration that the sensor front-end is calibrated to a white surface.

Step 1:
First of all a suitable **POWER** value must be found such that the **RAW DATA** for **CH0** and **CH1** lie in the dynamic range (upper third of the bar display).

Step 2:
When you have set a suitable POWER value, determine a **SETVALUE FOR CH0, CH1**. The software now calculates the calibration factors in such a way that this SETVALUE is reached for the raw data (see calculation example above).

Step 3:
Determine a **MAX DELTA OF RAW DATA** (the software suggests 500).
Calibration is only permitted, if the current **DELTA** of the **RAW DATA** is smaller than the **MAX DELTA OF RAW DATA**. **DELTA** is the maximum of **CH0** and **CH1** minus the minimum of **CH0** and **CH1**. This is necessary in order to ensure that the sensor functions properly and calibration is performed on a suitable surface.

Step 4:
Start calibration by pressing **CALC CALIB FACTORS**. The button starts to flash in red, and at the same time 100 raw data are recorded through the interface, of which the respective mean value of **CH0** and **CH1**. The individual calibration factors are formed from these mean values and from the **SETVALUES FOR CH0 and CH1** and they are then entered in the corresponding edit-boxes. The calibration software automatically saves the calculated calibration factors to the EEPROM of the sensor. Then the software changes to the GO mode and displays the **RAW DATA** and the calibrated data in the main panel. Please note that the values for **CH0** and **CH1** in the main panel approximately are equal to the value of SETVALUE

You may also change the calibration factors **CF_CH0** and **CF_CH1** manually by entering new values in the corresponding input fields. Please note that these factors are saved to the EEPROM by pressing **SEND CF**. **GET CF** reads the calibration factors that are currently saved in the EEPROM.

If pressing **CALC CALIB FACTORS** should not be successful, please follow the information provided in the pop-up windows.
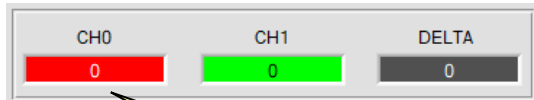Calibration only is completed successfully, if the following pop-up window is displayed:
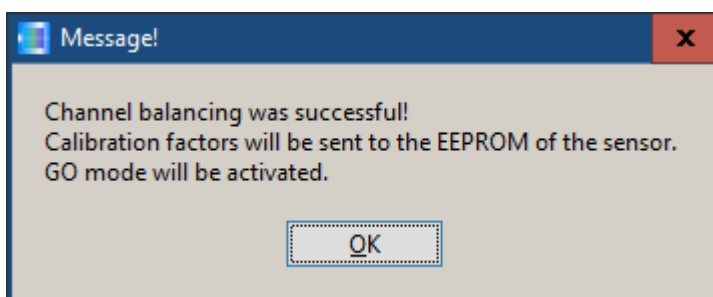
A click on **START SELF CALIBRATION** causes the sensor to calculate the calibration factors itself. It is not possible to specify a **SETVALUE FOR CH0, CH1** and a **MAX DELTA OF RAW DATA** here.
When the sensor has calculated the calibration factors, it displays these on the software user interface. In the corresponding input fields it also displays the **SETVALUE FOR CH0, CH1** that it used for calculation and the **MAX DELTA OF RAW DATA** value that resulted from calculation.

With the **SET TO DEFAULT AND SEND CF** button, **CF_CH0** and **CF_CH1** are reset and written into the EEPROM. **MAX DELTA OF RAW DATA** and **SETVALUE FOR CH0, CH1** are also reset to their default values on the software user interface.
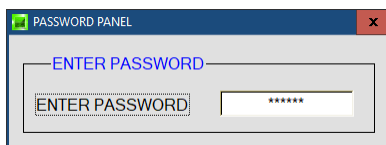
2.6.2 Offset calibration

To avoid an increase of the electronic offset when using the integral function (**INTEGRAL** parameter), this offset can be eliminated by way of offset calibration or zero-point calibration. The corresponding tab is password-protected to prevent inadvertent incorrect settings.
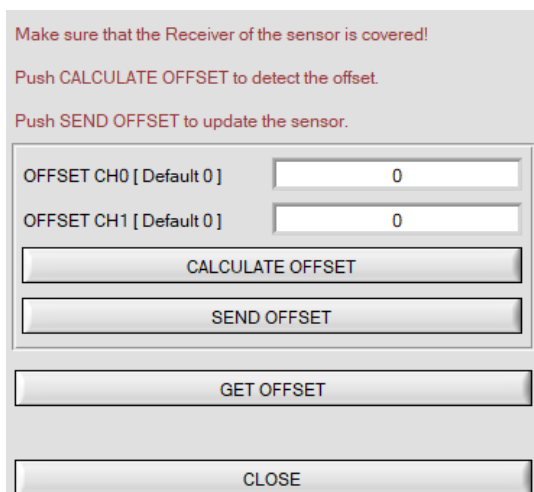
CH0	CH1	DELTA
0	0	0

Offset calibration can be accessed by double-clicking with the right mouse button exactly at the frame below **CH0** in the **CHA BAL** tab.

e.g. here:
Double-click with the right mouse button.

PASSWORD PANEL

ENTER PASSWORD

ENTER PASSWORD   ******

You will then be prompted to enter a password.
The password is: mellon

Make sure that the Receiver of the sensor is covered!

Push CALCULATE OFFSET to detect the offset.

Push SEND OFFSET to update the sensor.

OFFSET CH0 [Default 0]   0

OFFSET CH1 [Default 0]   0

CALCULATE OFFSET

SEND OFFSET

GET OFFSET

CLOSE

Then follow the instructions provided in the tab.

ATTENTION!
With offset calibration it is of utmost importance that the receiver does not see any extraneous light.
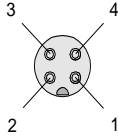TheREF1ore cover the receiver of the sensor, e.g. with a black cloth that is impermeable to light.

This is absolutely necessary for proper and perfect offset calibration.

Now press **CALCULATE OFFSET**. The offset value always should be clearly less than 100.
With **SEND OFFSET** this value is written to the sensor's EEPROM.

GET OFFSET AND SETTING TIME FACTOR can be used to check the value that is saved as the offset value.
If necessary, **SEND OFFSET** can be used to save an offset value manually. (! not recommended !)

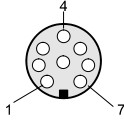# 3. Connector assignment of the SPECTRO-M-2 sensors

Connection of SPECTRO-M-2 to PC:

4-pole M5 fem. connector (type Binder 707) *SPECTRO-M-2/PC-RS232*	
Pin No.:	**Assignment:**
1	+24VDC (+Ub)
2	0V (GND)
3	Rx0
4	Tx0

Connecting cables to choose from:
cab-las4/PC-…
cab-4/USB-…
cab-4/ETH-…

Connection of SPECTRO-M-2 to PLC:

Pin No.:	Color of wire: (cab-las8/SPS)	Assignment:
	8-pole fem. connector (type Binder 712) ***SPECTRO-M-2/PLC***	
1	white	0V (GND)
2	brown	+24V (± 10 %)
3	green	IN0 (Digital 0: 0 … 1V, Digital 1: +Ub – 10%)
4	yellow	IN1 (Digital 0: 0 … 1V, Digital 1: +Ub – 10%)
5	grey	OUT0 (Digital 0: 0 … 1V, Digital 1: +Ub – 10%)
6	pink	OUT1 (Digital 0: 0 … 1V, Digital 1: +Ub – 10%)
7	blue	Not connected
8	red	ANALOG (0…10V or 4…20mA)

Connecting cable:
cab-las8/SPS-…