Bridge operations for Strain gauges

DEWESoft®

USER MANUAL

Bridge operations for Strain gauges V21-1

1. Table of contents

2. About this document

This is an application note for bridge operations - strain gauges.

Legend

The following symbols and formats will be used throughout the document.

Important
It gives you important information about the subject.
Please read carefully!

Hint
It gives you a hint or provides additional information about a subject.

Example
Gives you an example of a specific subject.

3. Introduction

Scope of this document is to explain how the bridge operations like "Balance", "Reset", "Short", "Shunt", "Shunt cal check", "Compensate" ... work in DewesoftX®. It also covers using bridge sensors with TEDS interface.

4. Set up the sensor (with TEDS)

When a sensor equipped with a TEDS chip is connected to a Dewesoft device it is automatically detected in the software (automatic reading of scaling, serial number, ...).

In DewesoftX® the sensor with TEDS is recognized and the channel is modified accordingly (a tuning fork with strain gauge applied + TEDS chip inside sensor connector).

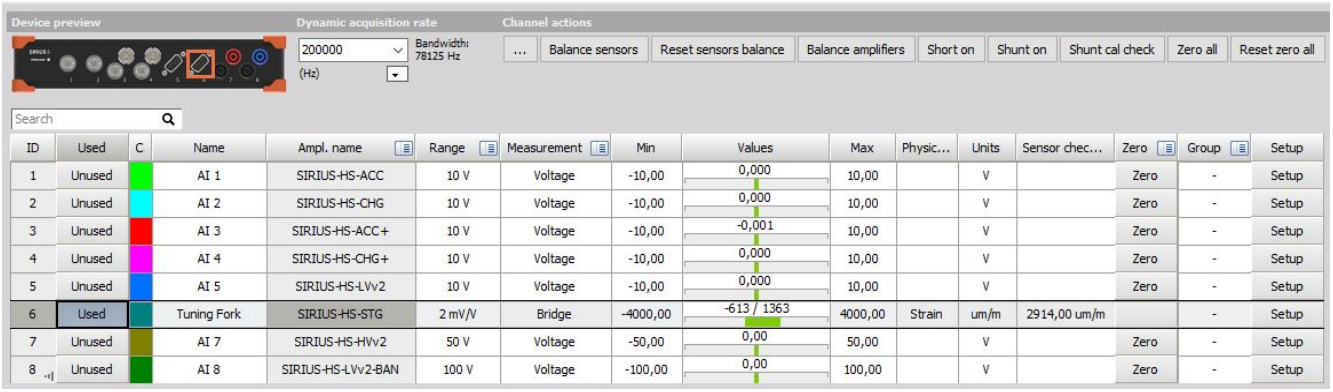


Image 1: Channel preview

All the settings like "Measurement Type", "Bridge mode", "Excitation" and "Scaling" are read out and set automatically. Note the greyed, locked fields, which cannot be changed (at first):

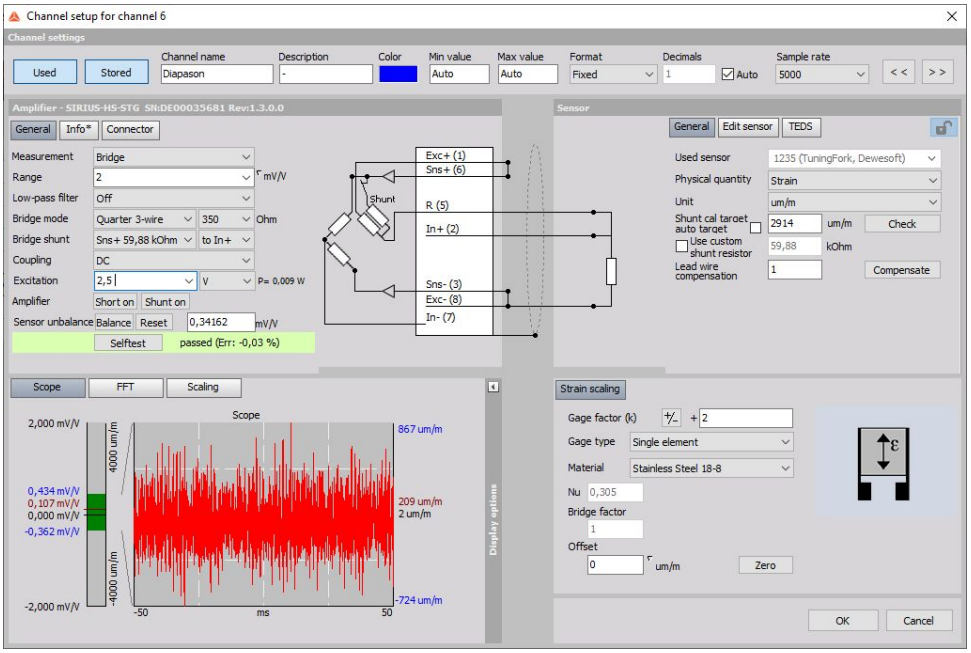


Image 2: Channel setup

4.1. Balance the bridge

From the screenshot above you see that the current sensor offset (stored in the TEDS) is 0 %. In the scope screen above the scaled value currently read (right side) is -11,3 um/m. That is because the strain gauge does not have exactly 350 ohms, which is normal, due to mechanical tolerances. Click on "Balance" to zero the bridge.

Image 3: Balance

The unbalance will be measured and shown. If it is out of limit, the field will get red. Check the strain gauge. Wrong resistance value?

Image 4: Balancing result

The input signal is now 0 mV/V.

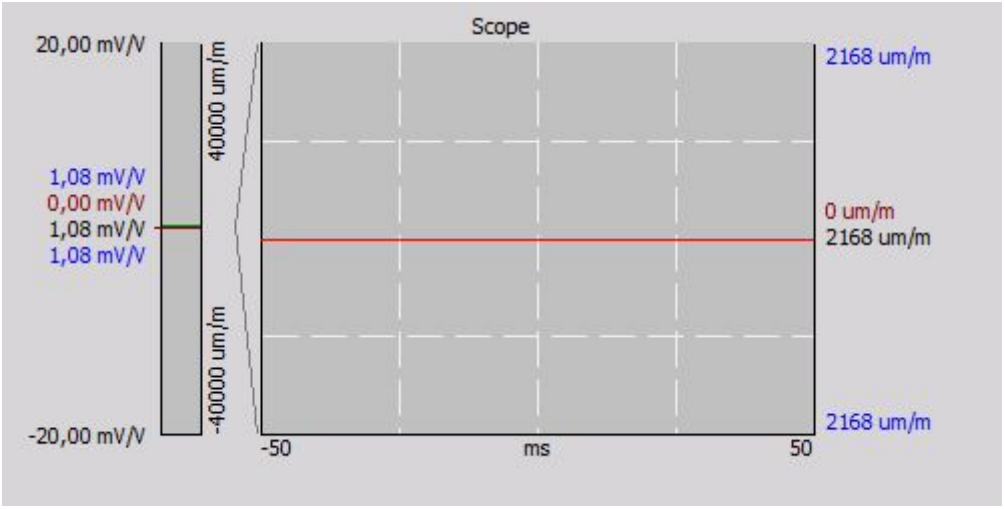


Image 5: Balanced input signal

Balance is done. That's all! Now you can start your measurement .To perform it on a number of channels at the same time, use the Group operations option in DS-GRID. You can look into more details in chapter 6.1. Group – Bridge balance.

4.2. Reset the balancing

Click on the "Reset" button. The sensor offset is removed, initial state...

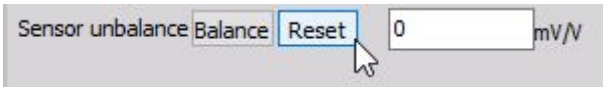


Image 6: Resetting the balance

... and you see the unbalance of the sensor again.

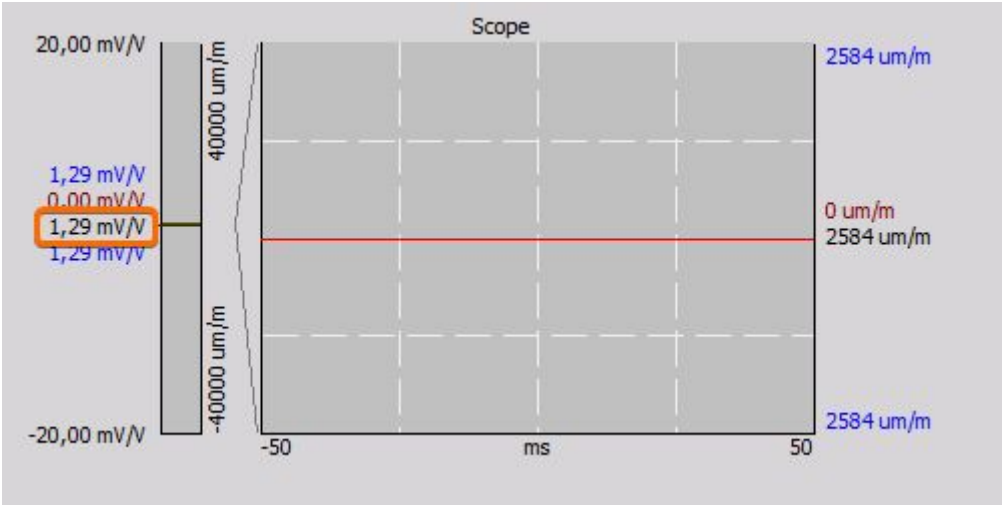


Image 7: Unbalanced input signal

"Balance" and "Reset" are opposite operations.

4.3. Short

The Short and Shunt operations are mainly thought for checking if the connected strain gage and the measurement amplifier are OK. When using the Short operation, the pins 2 and 7 (the input pins of the amplifier) are internally shorted and you see the offset of the amplifier.

First perform a "Reset" to cancel the stored offset.

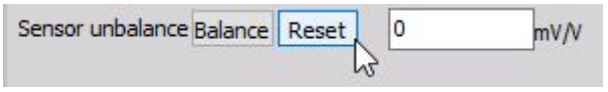


Image 8: Resetting the balance

Then click "Short on".

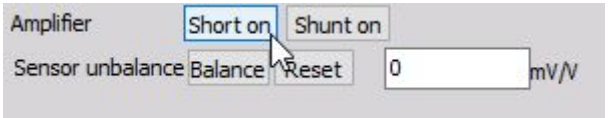


Image 9: Shorting the input pins

If the output (see left side) is close to 0, the amplifier is OK.

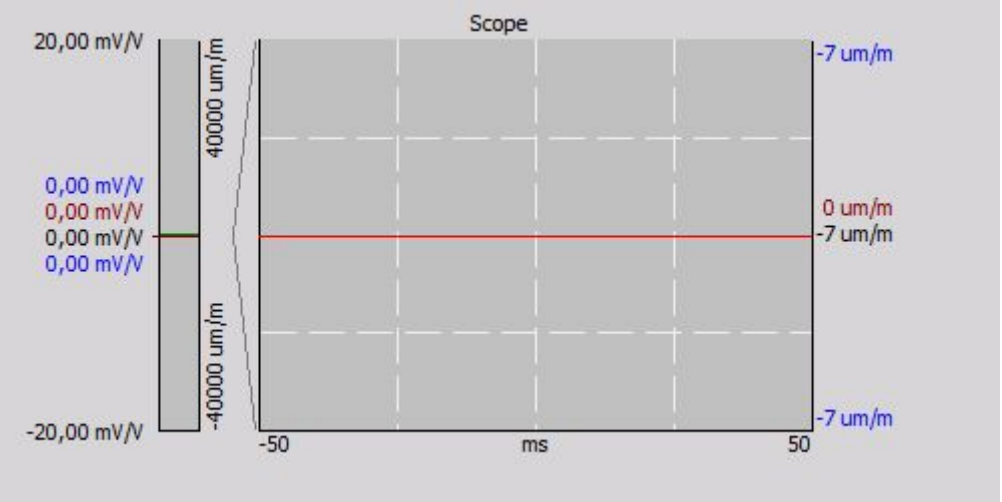


Image 10: Signal close to zero

Disable the short again by clicking "Short off".

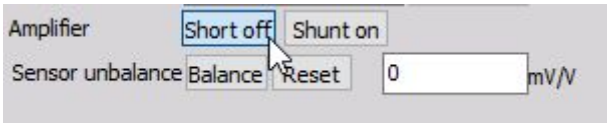


Image 11: Disabling the short

4.4. Shunt

The Shunt operation is thought for checking if the connected strain gauge is OK. From the wiring schematic in DewesoftX® you see that the amplifier already comes with the integrated shunt resistor.

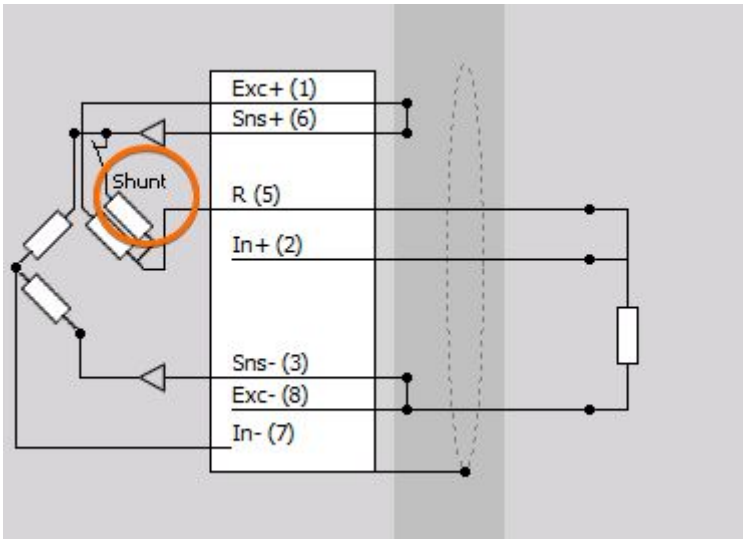


Image 12: Shunt resistor

The idea behind is to "shunt" a resistor of known value parallel to one resistor of the bridge to achieve a known, calculable unbalance. With the "Shunt calibration" we can automatically check the measured value against a predefined one (from sensor database or TEDS).

For the measurement, this internal resistor is disconnected again, of course.

Let's check out the formulas:

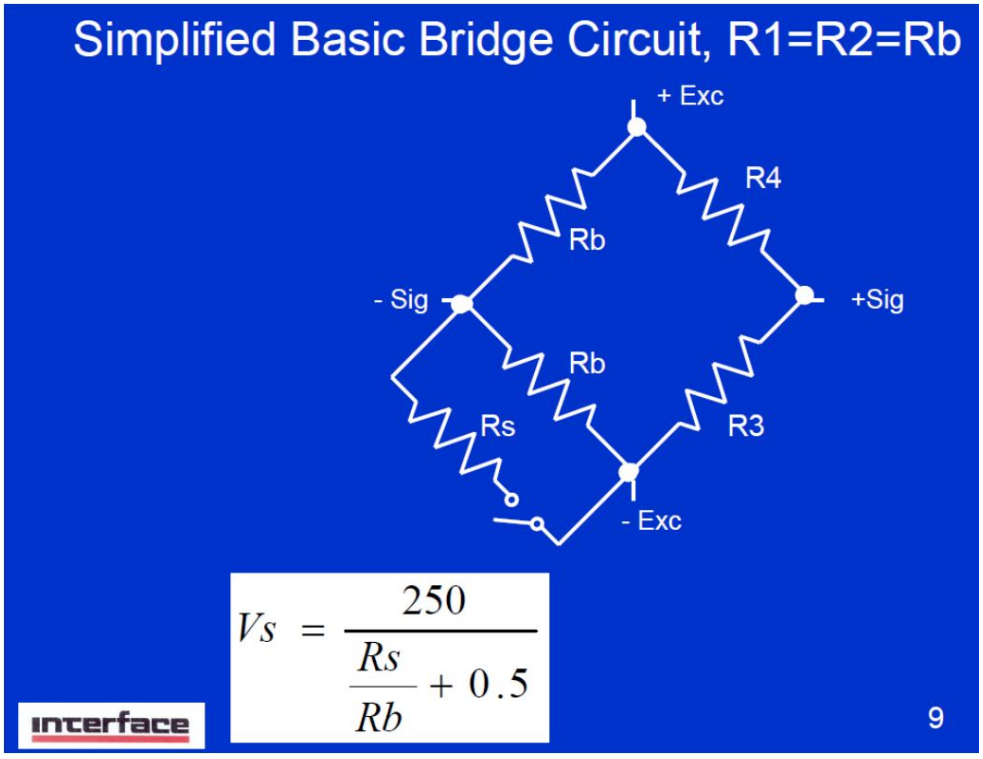


Image 13: Shunt calibration for Dummies; a reference guide" by LaVar Clegg, Interface Inc.

R3 and R4 are part of the bridge completion, internally of the amplifier. The upper Rb is the connected strain gauge, the lower Rb is also internally of the amplifier together with the shunt Rs.

With a 350 ohms quarter bridge and an internal shunt resistor of 59k88 (SIRIUS STG module) the expected unbalance should be:

Vs = 250 / (59880/350 + 0,5) = 1,45699775 mV/V

First click on "Balance", because the formula is only valid on a balanced bridge (both Rb = 350 ohms).

Image 14: Balancing the bridge

Then click "Shunt on".

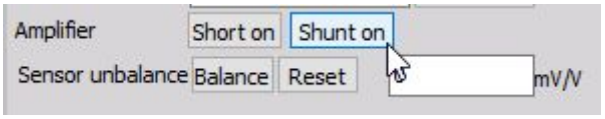


Image 15: Enabling the Shunt on

The output value comes very close to the expected value (1,4566 mV/V).

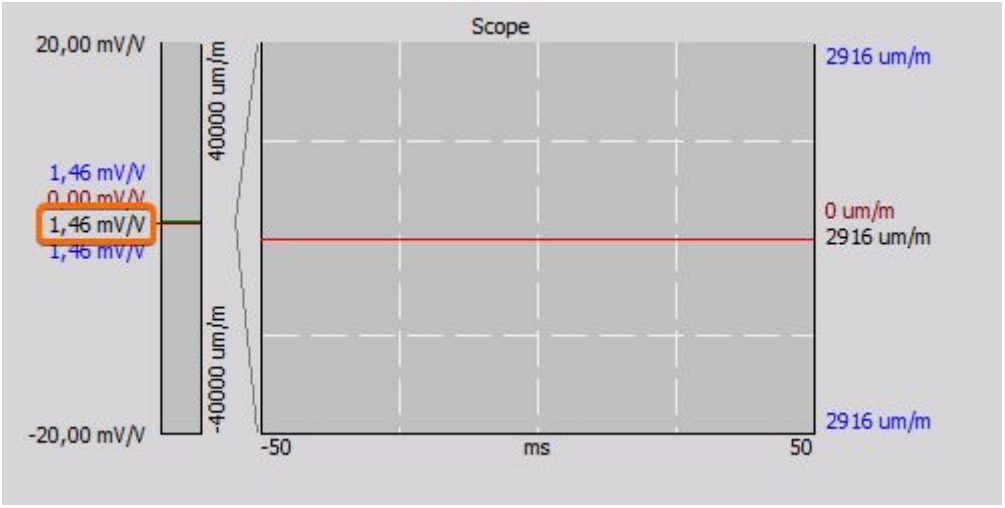


Image 16: Expected output value

But how big exactly is the error?

4.5. Shunt cal check – preparation

Shunt cal check is done on scaled values, therefore we take a look at the strain scaling. The max input from the graph above is 10 mV/V; the max scaled output signal is 20 000 um/m. So, the scaling factor is 2000.

Our target value of 1,45699775 mV/V would equal (x 2000) = 2913,9955 um/m.

In the right upper section of the channel setup window, unlock the TEDS settings (or settings of the sensor database if you don't have TEDS).

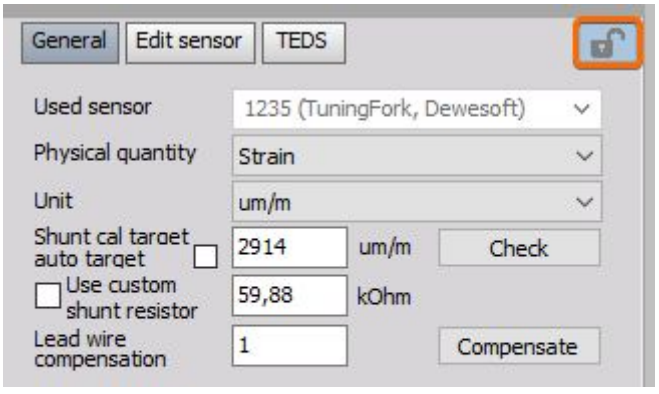


Image 17: Unlocking the TEDS settings

Enter the calculated 2913,9955 um/m in the field "Shunt cal target" and press the Enter key. The resistor is OK with 59,88k.

Then switch to the "Edit sensor" tab and click "Write to TEDS" (or "Save Sensor" if you don't have TEDS). Of course this procedure has only to be done the first time.

4.6. Shunt cal check

Now perform the "Shunt cal check":

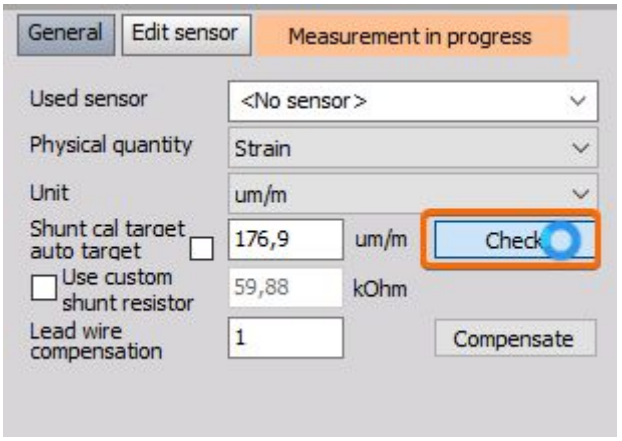


Image 18: Performing te shunt cal check

The result is shown, and looks very promising in this case (0,0 %). Strain gauge is OK.

Image 19: Shunt cal check result

If the value is bigger than 2%, it will become red.

Adjusting the 2% limit is now possible in DewesoftX®: go to Options -> Settings -> Advanced settings -> Hardware -> Amplifiers -> ShuntCal error limit [%]

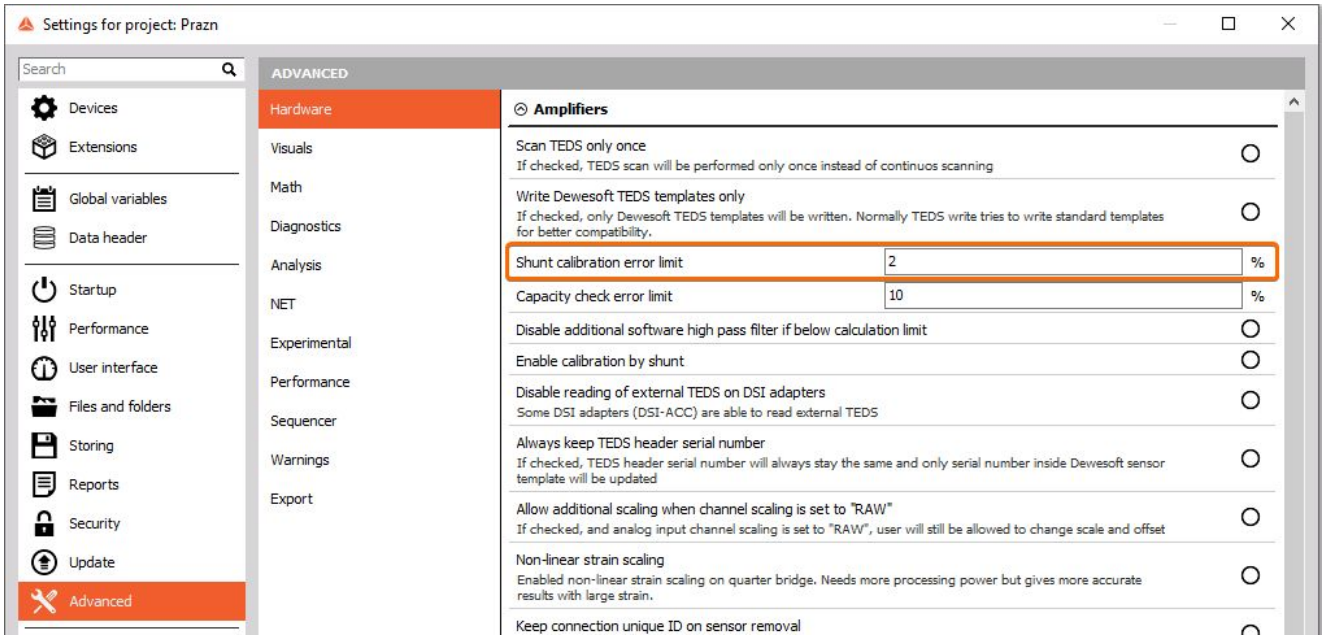


Image 20: Adjusting the error limit

4.7. Shunt cal check – with custom shunt

What do you do if the expected shunt cal result is already calculated in the datasheet / calibration sheet of the sensor, but for a different shunt resistance, e.g. 100 k?

You can just use it!

For this example, we take the well known formula from the "Shunt" chapter, and calculate the shunt result with 100k shunt resistor.
Vs = 250 / (100000/350 + 0,5) = 0,873 mV/V, with scaling of 2000 -> 1746,943 um/m

Enter the values as shown below. When entering the resistor value, the field gets yellow. Please confirm the value with pressing the Enter key.

Image 21: Custom shunt resistor

Then perform the "Check":

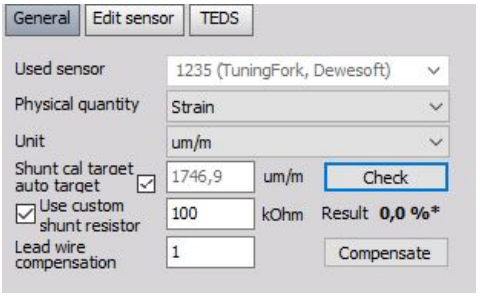


Image 22: The check has been performed with a different resistor

As you see, the software automatically takes care about different resistor values. The asterisk (*) symbol after the result indicates that the check has been performed with a different resistor value than physically available.

5. Lead wire compensation

If you have a long cable to the sensor and "quarter bridge 3 wire mode", DEWESoft can also cancel out the wire resistance. (In the other modes the wire loss is cancelled already because Sense and Excitation lines are connected directly at the sensor).

Here you see a quarter bridge strain gage with 3-wire connection. In each of the 3 lines we have built in a resistor of 11 ohms for showing the principle.
Click the "Compensate" button.

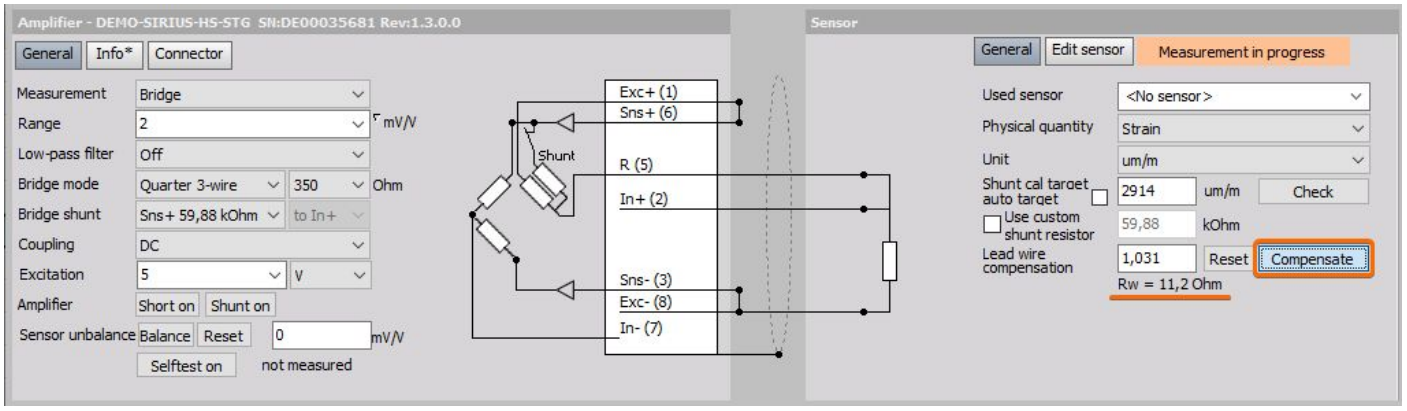


Image 23: Lead wire compensation

The correction factor is calculated (1,031 in our case) and the measured resistance (10,8 ohms) displayed. (Please take into account that this function is only available, if the Shunt resistor inside the module is connected to the Exc+ line, which is the default).

5.1. Zero

There is also a function called "Zero", let's look at the difference to "Balance".

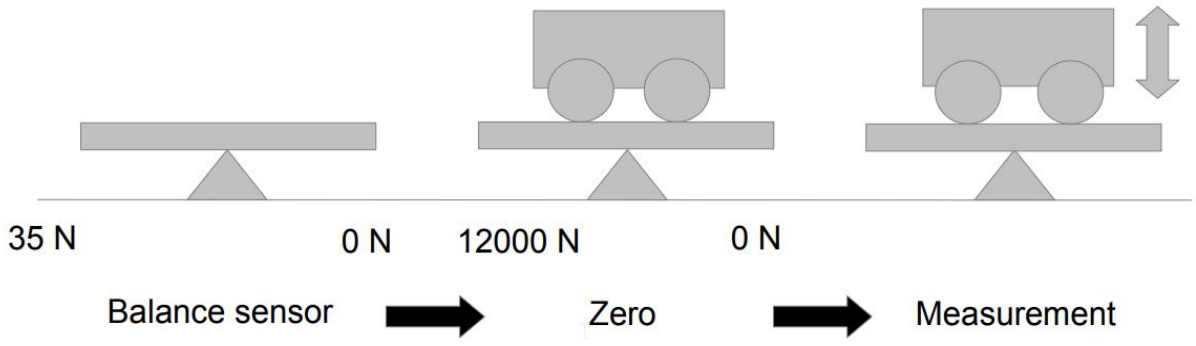


Image 24: Visual presentation of "Zero" function

Imagine, we have a force transducer with strain full bridge output. It will measure the weight in our experiment. In the first picture, we measure just the unbalance of the bridge sensor, e.g. 35 N. Let's do a "Balance". The output is now 0 N.

A vehicle is put on the test bed. We measure the weight, it is 12 000 N. For our measurement only the changing of the weight is of interest (e.g. vibrations of the vehicle), so we cancel out the fix offset with the Zero function.

Measurement	Min	Values	Max	Physical quantity	Units	Zero	Setup
Voltage	-10,00	-4,630 / 4,854	10,00		V	Zero	Setup
Voltage	-10,00	-0,464 / 0,714	10,00		V	Zero	Setup
Voltage	-52000,00	0	28000,00	Force	N	Zero	Setup
Voltage	-10,00	-8,823 / 9,074	10,00		V	Zero	Setup
Voltage	-10,00	-3,776 / 3,991	10,00		V	Zero	Setup

Image 25: Enabling the zero function

Click the "Zero" button in Channel Setup (can be reset by right mouse-click). The output is now zero again. Note, that this is a pure software subtraction. If the range was set to "Automatic", the range is automatically adapted to -52000...+28000.

The range can be set to "Automatic" in the channel setup window of the appropriate channel (right mouse-click).

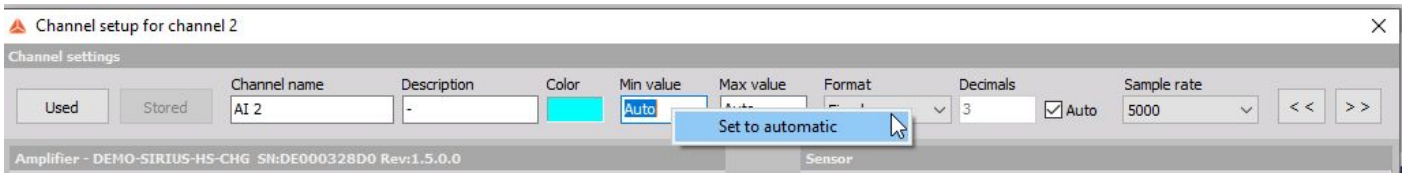


Image 26: Changing the range

Now all offsets are cancelled and we start the measurement. After the measurement you can go back to channel setup and remove the Zero. If it still shows the same weight, you can be sure, the sensor is still OK. This function can also be accessed in the Measure mode (but NOT while storing!), please see the ''Group operations''.

6. Group operations

On top of the Channel setup there is a bar with channel actions.

Image 27: Channel actions

Depending on which amplifiers are used, more or less buttons are visible. Clicking on a button performs an action on ALL the channels.

For the following steps, please activate some more columns on the channel setup table. Click on one of the small icons, and select "Edit columns":

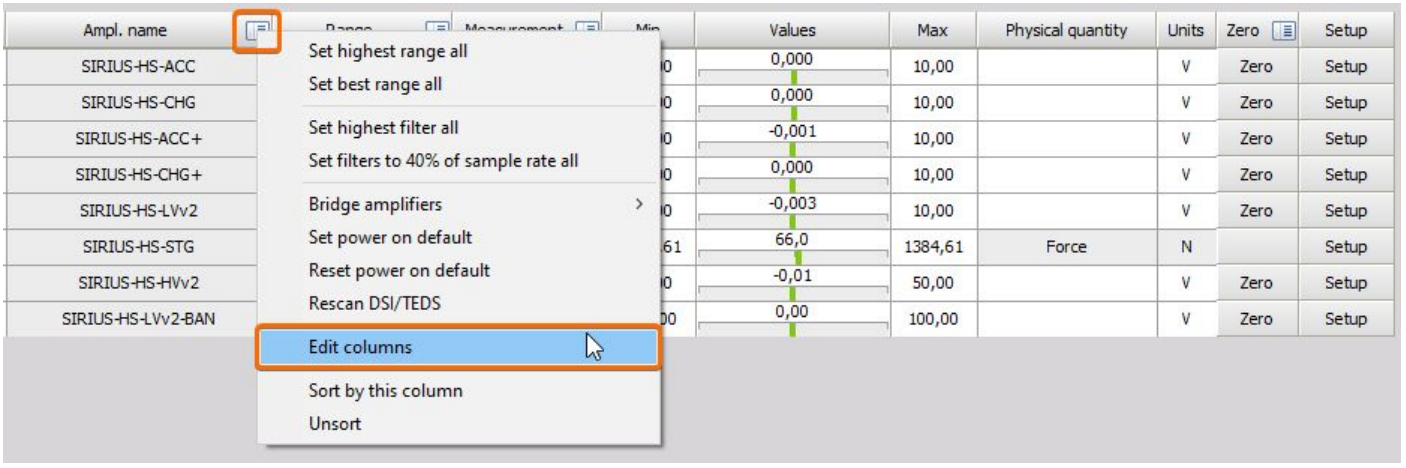


Image 28: Editing the columns

Select the fields "ShCal target", "ShCal result", "ShCal error" and "Group":

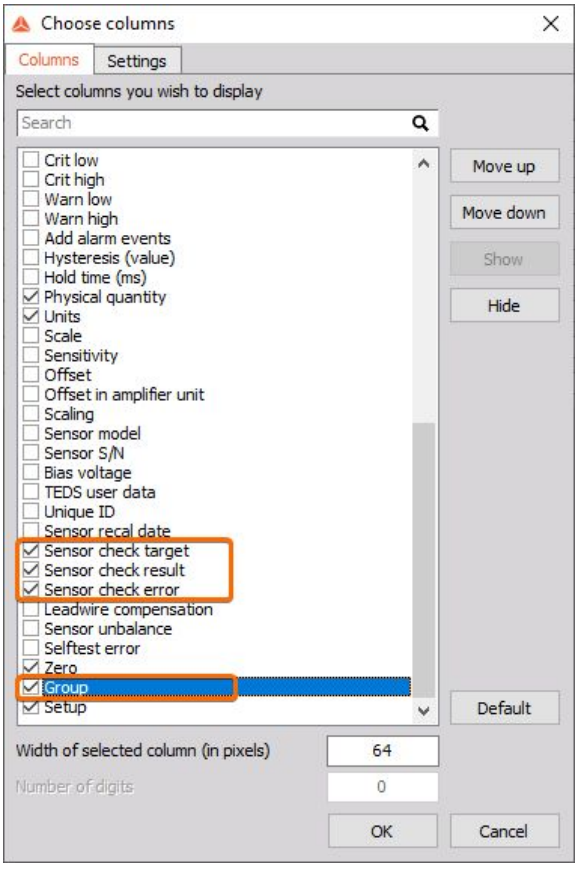


Image 29: Enabling different columns

6.1. Group – Bridge balance

In the custom SIRIUS slice below is a STG module, with a sensor connected. Click on the "Balance sensors" button.

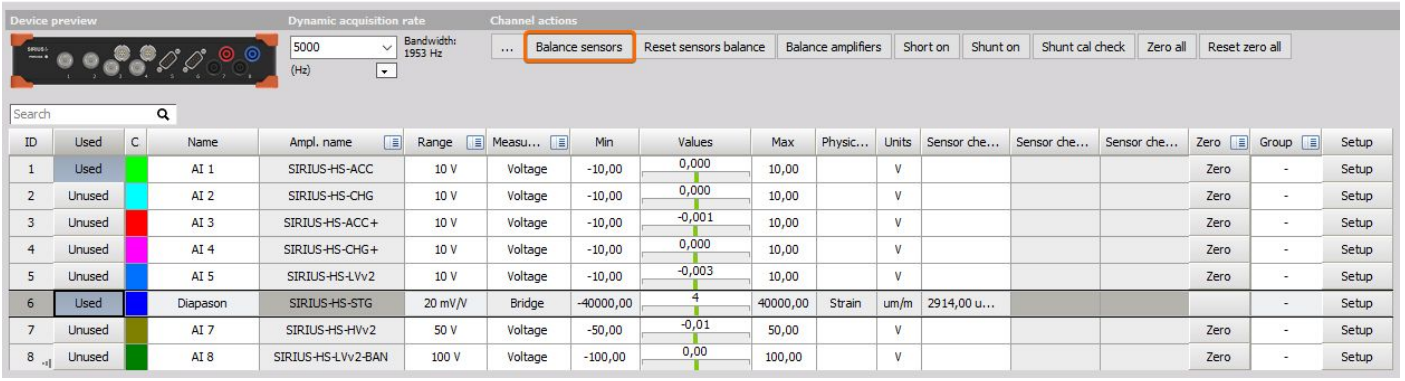


Image 30: Balancing the sensor

As you see, all bridges are balanced with one click, input values become 0.

6.2. Group – Shunt Cal Check

From the picture above, note that there has to be a ''Shunt cal target'' entered before doing the check (1,45699775 * 210 * 2 = 611,94 N/mm²; see section "Shunt"). Now click on the "Shunt cal check" button.

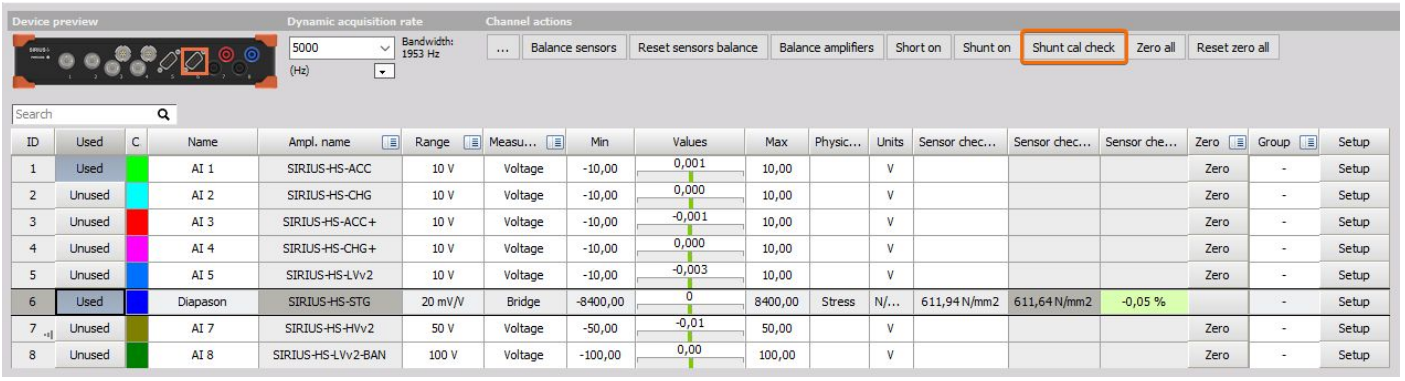


Image 31: Shunt cal check on a group

After a few seconds, you see the result in the additional columns we added.

6.3. Group – Balance amplifiers

The "Balance amplifiers" operation is applied on all channels at once. It is used to correct the amplifier offset before measurement, e.g. the drift on long-term measurements, or if the device is put to extremely different temperature conditions in short time (e.g. performing a measurement at -20°C, and immediately after that at +40°C). Depending on the usage, it does not have to be done before each test, generally only from time to time.

1. Let's assume we have a SIRIUS HS STG amplifier in bridge mode, set to the smallest range of 2mV/V. When there is nothing connected, we will see only noise, so please click the "Short on" button. The IN- and IN+ will be shorted internally to determine the amplifier offset, in this case 13 µV.

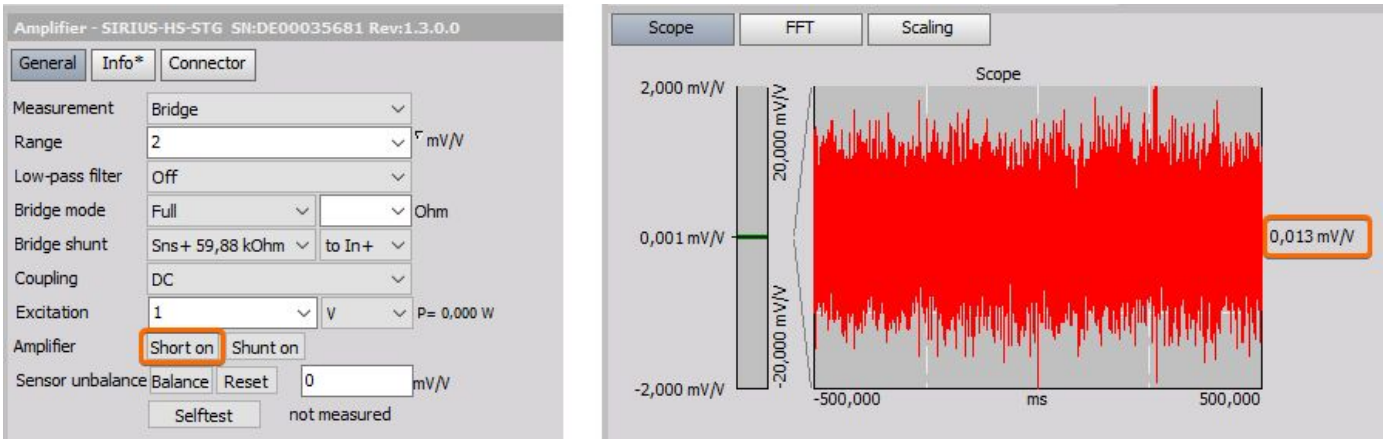
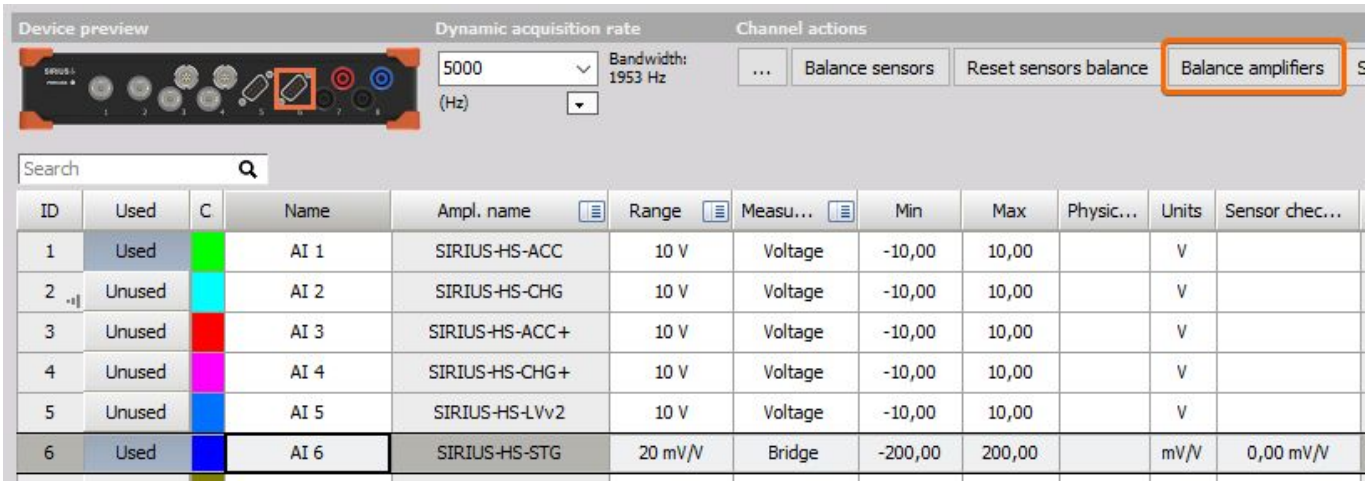


Image 32: Internally shorted input pins

2. Then exit the channel setup and do the "Balance amplifiers", it takes some seconds.



ID	Used	C	Name	Ampl. name	Range	Measu...	Min	Max	Physic...	Units	Sensor chec...
1	Used		AI 1	SIRIUS-HS-ACC	10 V	Voltage	-10,00	10,00		V	
2	Unused		AI 2	SIRIUS-HS-CHG	10 V	Voltage	-10,00	10,00		V	
3	Unused		AI 3	SIRIUS-HS-ACC+	10 V	Voltage	-10,00	10,00		V	
4	Unused		AI 4	SIRIUS-HS-CHG+	10 V	Voltage	-10,00	10,00		V	
5	Unused		AI 5	SIRIUS-HS-LVv2	10 V	Voltage	-10,00	10,00		V	
6	Used		AI 6	SIRIUS-HS-STG	20 mV/V	Bridge	-200,00	200,00		mV/V	0,00 mV/V

Image 33: Balancing the amplifiers

3. Repeat step 1 and check the amplifier offset again. In our example it is only 0,03 µV.

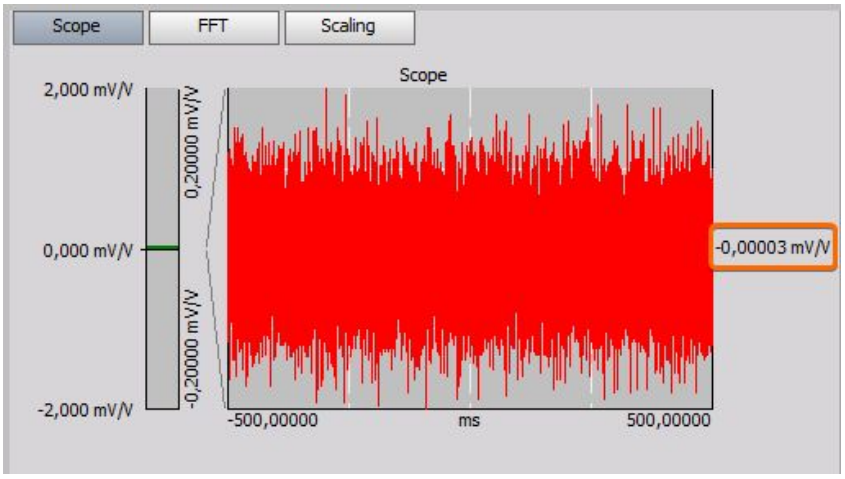


Image 34: Repeating the test

4. If you want to reset the offsets again, please go to Option -> Settings -> Select Device to Setup -> Analog Input -> and click the "Bridge amplifier offset" button on the bottom side. In the new window "Bridge amplifier offset" you see a list of all the applied offset corrections for each channel.

We used the STG module on the last channel in Range3, as expected the offset is 13µV. The HG (high-gain) and LG (low-gain) values show the offsets of both dual-core ADC stages.

The button "Reset offsets" below deletes all correction values and the whole tab disappears.

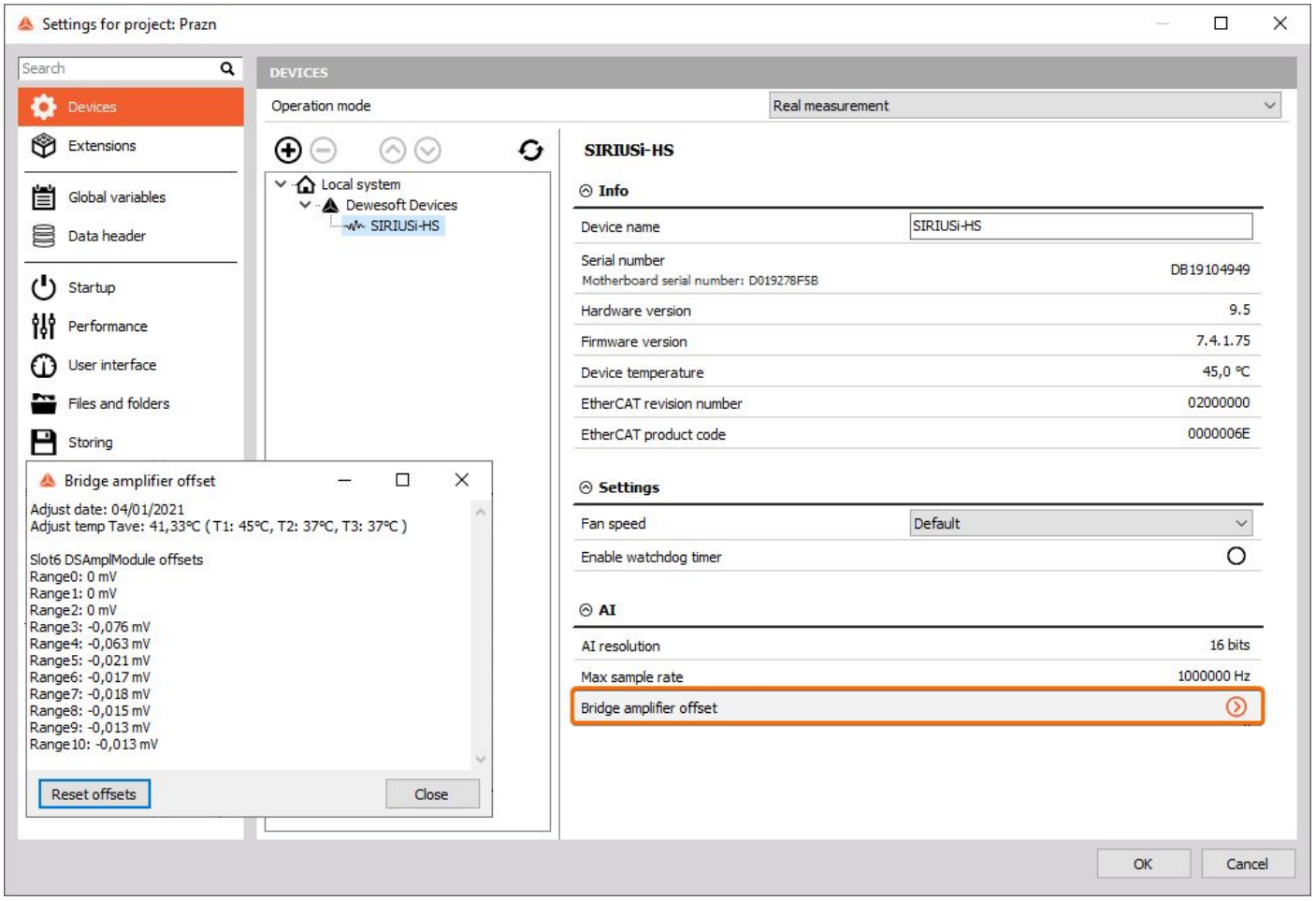


Image 35: Resetting the amplifier offset

6.4. Group operations with different groups

In the Group column assign one channel to "Group 1", the other to "Group 2".

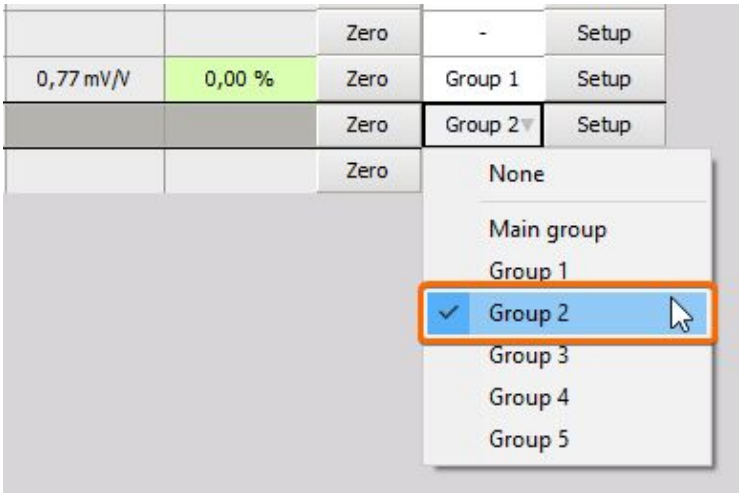


Image 36: Assigning the groups

Now you can apply (bridge) operations group-wise.

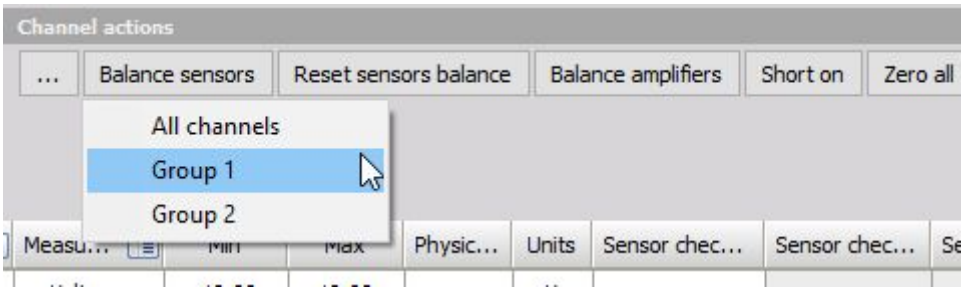


Image 37: Newly enabled options

6.5. Group operations in Measure mode

Now, with one channel assigned to Group 1, another to Group 2, let's go to the Measure mode. There are two new buttons called "Zero" and "Amplifier".

Image 38: Additional buttons

If the "Zero" button is not there, most likely sensors from the sensor database / TEDS sensors are used, and changing the offset is not allowed. Check sensor settings in Channel setup or Sensor editor.
If the "Bridge" button is not there, no bridge amplifiers are set to "Used" in channel setup.

Now you can do a selective "Balance" on the group you want or on "All channels".

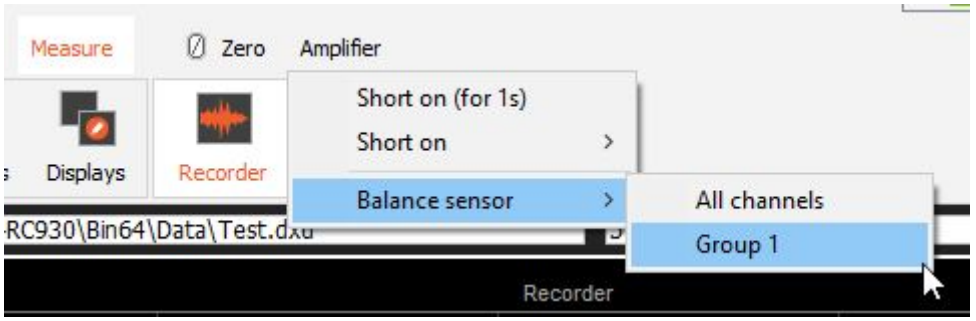


Image 39: Selective balancing

Note, that DewesoftX® is in Acquisition mode, but NOT storing! When pressing "Store", of course no balancing is possible during measurement any more.

7. Shunt/Short at beginning and end of measurement

At the end of a measurement you may want to check if the strain gage and the amplifier are still OK. Maybe you also want to see if the bridge was drifting over time due to temperature or other effects.

Start the measurement, click the Store button.

The "Zero" button will disappear, because zeroing also changes the channel min/max limits, and that is not allowed during measurement. Also balancing the bridge is not possible at this state any more.

Do a "Short on for 1s", wait a little bit, then press "Shunt on for 1s".

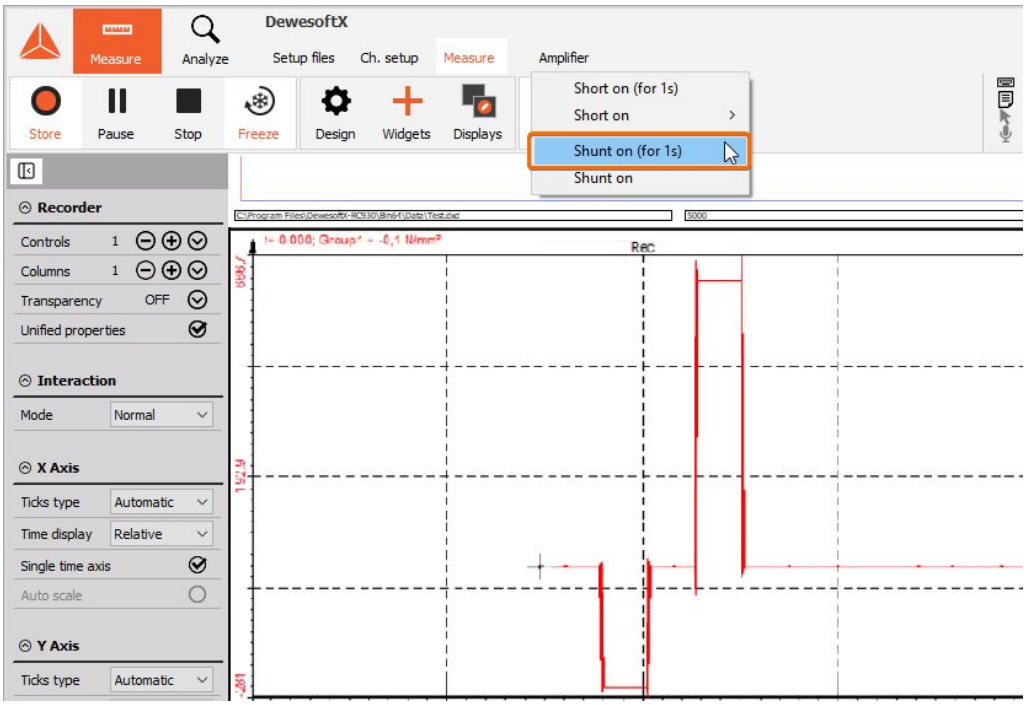


Image 40: Enabling Shunt/Short while in measurement

At the end of the measurement – when you are still storing – do again a "Short on for 1s" followed by a "Shunt on for 1s".

Stop the measurement and go to Analyze mode.

Activate the cursors table in the properties of the recorder instrument (on the left side).

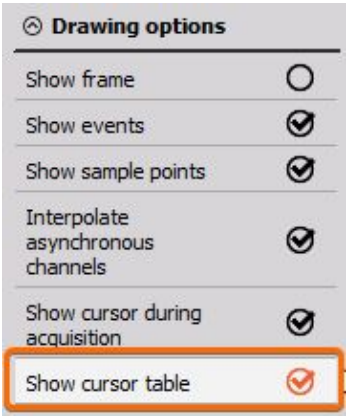


Image 41: Activate the cursors table

Move the white cursor I to the Short position on start, and cursor II to the Short position at the end (grey arrows). You can also lock the cursors to not lose them when zooming in and out of a longer measurement. On the right side the Delta will be shown. In our case it is 0,0 – measurement OK.

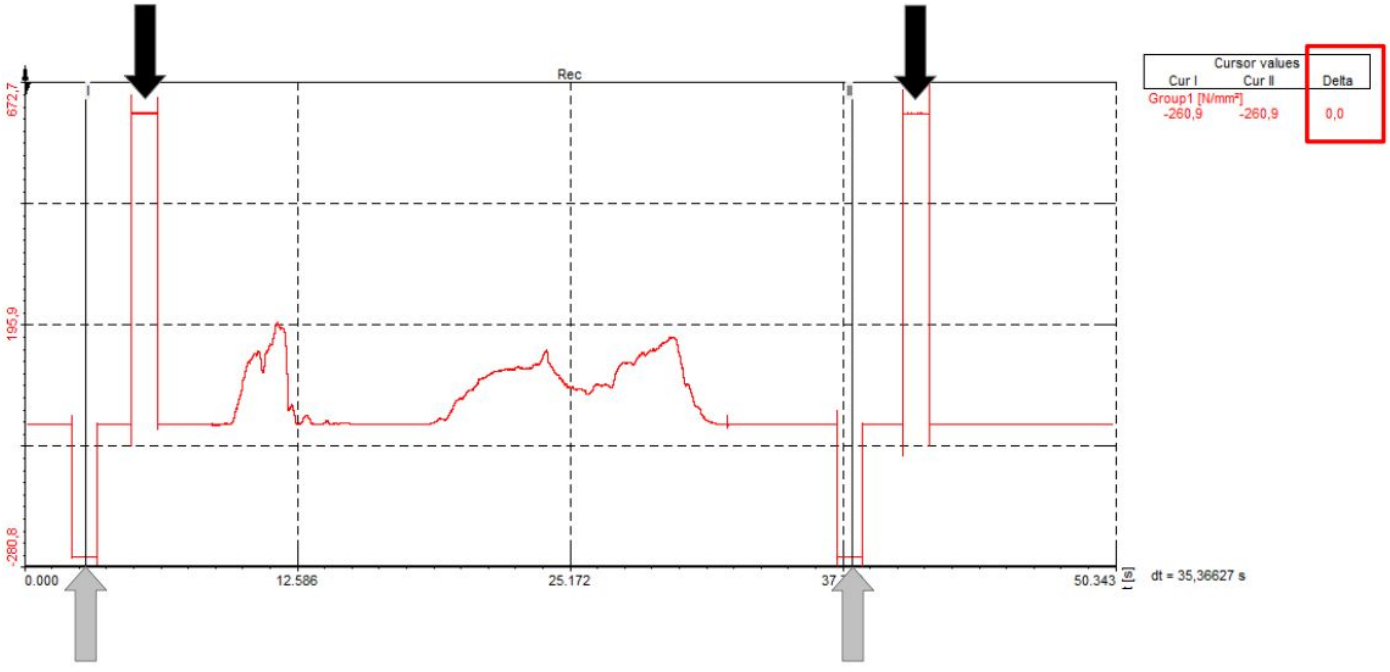


Image 42: Delta values

Then move the cursors to the Shunt positions (black arrows), repeat the procedure to also check the Delta of the Shunt measurement.

8. Hint : Strain gage configurations in DewesoftX®

Until now it was rather difficult to select the proper strain configuration. You had to find out the bridge factor in the tutorials table and look for materials coefficients.

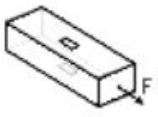
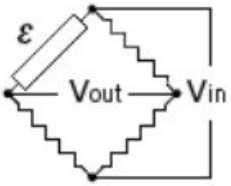
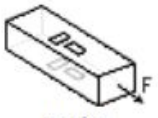
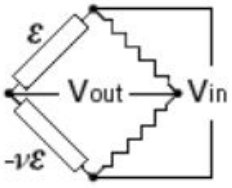
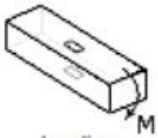
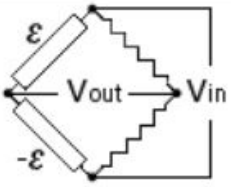
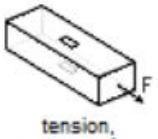
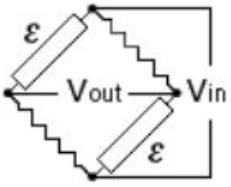
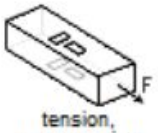
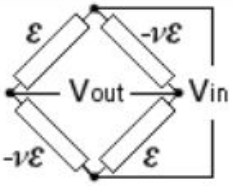
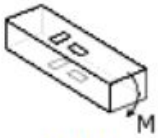
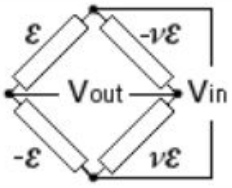
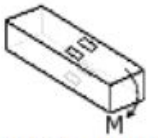
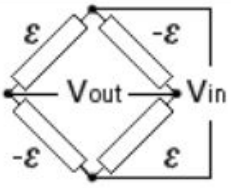
MEASURES	TYPE	BRIDGE	EQUATION Vout/Vin	BRIDGE FACTOR	LINEAR	DESCRIPTION
 tension, compression	quarter		$\frac{k\cdot\varepsilon}{4+2\cdot k\cdot\varepsilon}$	1	no	Single gage measuring tension and compression - basic configuration
 tension, compression	half		$\frac{k\cdot\varepsilon\cdot(1+\nu)}{4+2\cdot k\cdot\varepsilon\cdot(1-\nu)}$	$(1+\nu)$	no	One gage in principal direction and one in transverse direction - usually used for temperature compensation
 bending	half		$\frac{k\cdot\varepsilon}{2}$	2	yes	Two gages with opposite strain - usually used for measurement of bending
 tension, compression	half		$\frac{k\cdot\varepsilon}{2+k\cdot\varepsilon}$	2	no	Two gages with same strain - usually used for bending cancellation
 tension, compression	full		$\frac{k\cdot\varepsilon\cdot(1+\nu)}{2+k\cdot\varepsilon\cdot(1-\nu)}$	$2\cdot(1+\nu)$	no	Two pairs of gages where one is in the principal direction and the other one is in transverse direction used in temperature compensation and bending cancellation
 bending	full		$\frac{k\cdot\varepsilon\cdot(1+\nu)}{2}$	$2\cdot(1+\nu)$	yes	Two pairs of gages where one is in the principal direction and the other one is in transverse direction used in temperature compensation and tension cancellation
 bending, torsion	full		$k\cdot\varepsilon$	4	yes	Two pairs of gages in opposite strain - usually used for measurement of bending

Image 43: Strain gage configurations

Depending on the selected "Bridge mode" in the amplifier settings (Full, Half, QuarterBridge), it will now graphically show a various number of possible bridge configurations, and furthermore you can select the material for using the correct Young's modulus.
Another error source is eliminated.

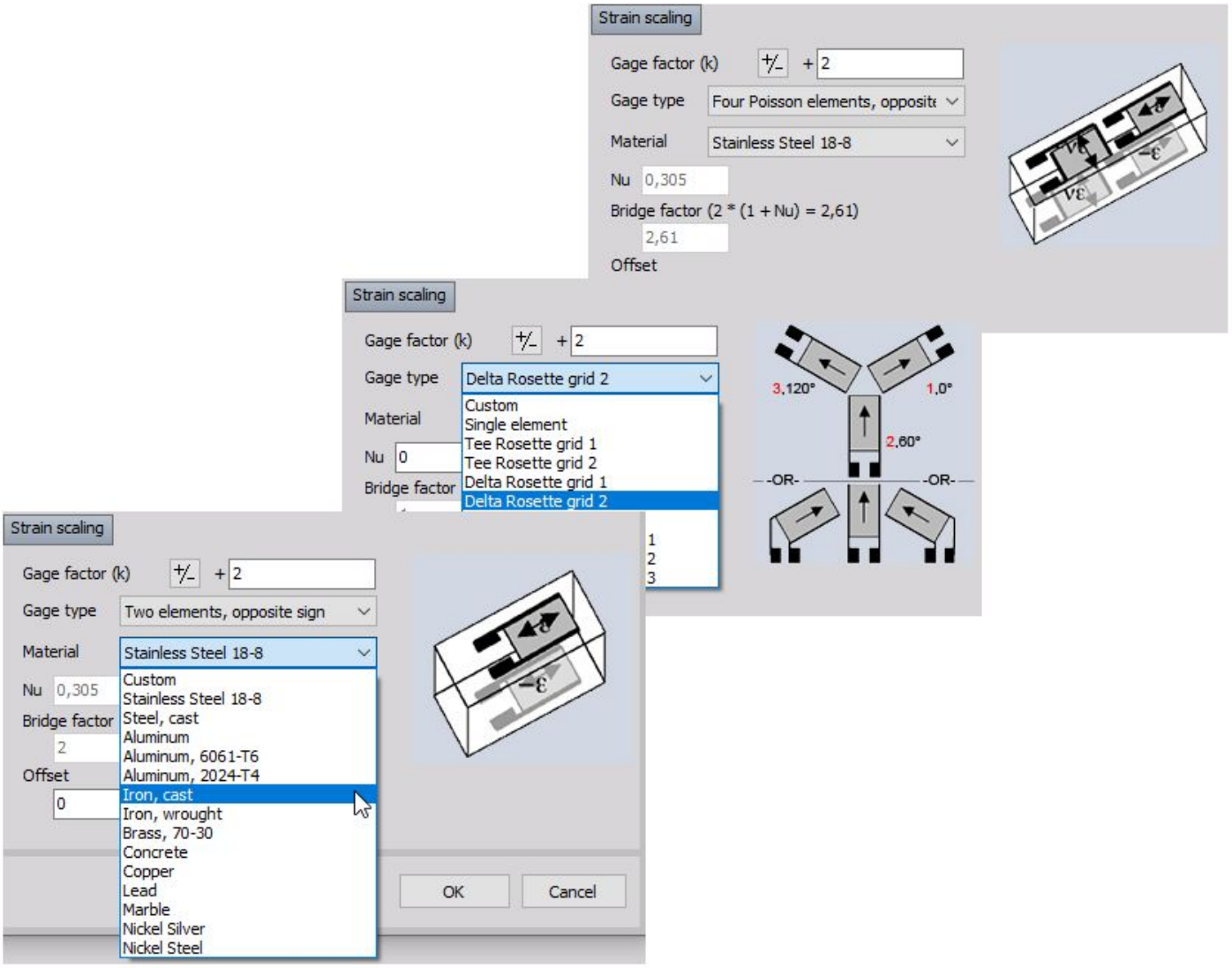


Image 44: Various number of possibilities of the bridge configurations

9. Hint : Rosette Math

Included in the standard math function is the rosette math plugin.

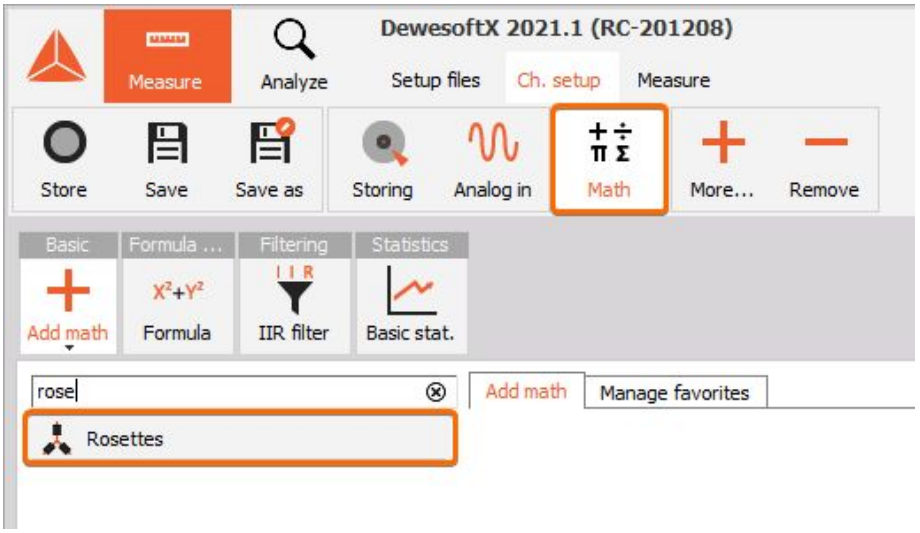


Image 45: Adding the rosette math

Simply select the 3 strain or stress input channels and the orientation of the elements.

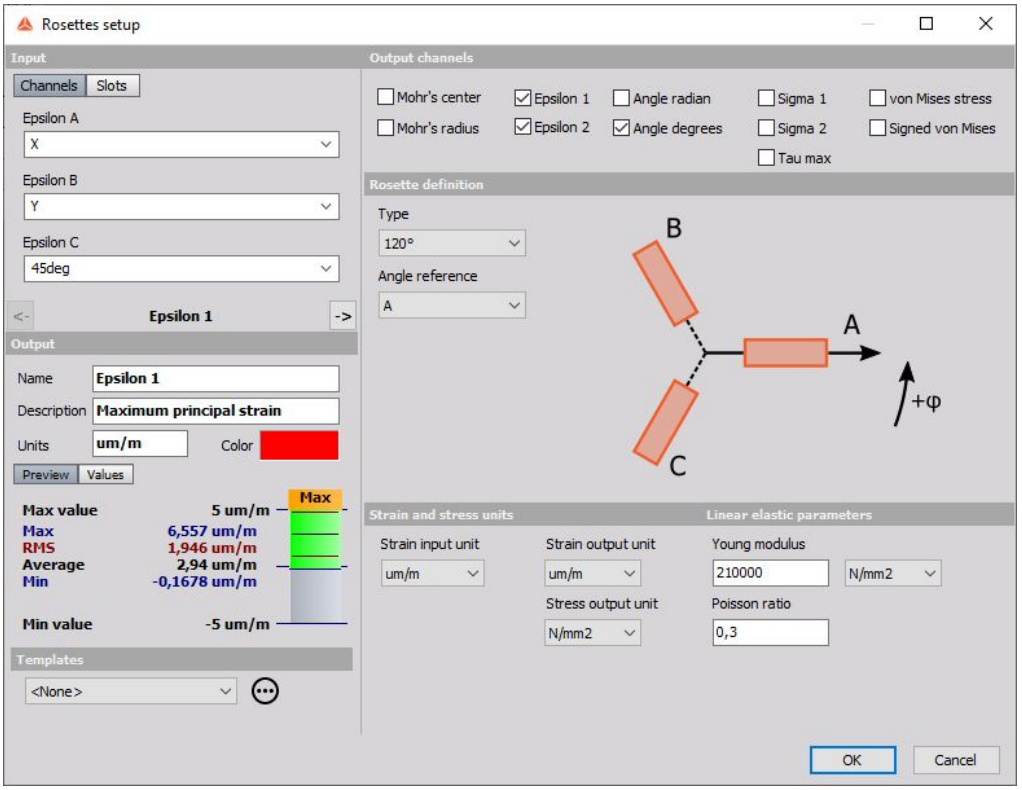


Image 46: Rosettes setup

Please visit our webpage for more details and manual.

10. Warranty information

Notice
The information contained in this document is subject to change without notice.

Note:
Dewesoft d.o.o. shall not be liable for any errors contained in this document. Dewesoft MAKES NO WARRANTIES OF ANY KIND WITH REGARD TO THIS DOCUMENT, WHETHER EXPRESS OR IMPLIED. DEWESOFT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Dewesoft shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory, in connection with the furnishing of this document or the use of the information in this document.

The copy of the specific warranty terms applicable to your Dewesoft product and replacement parts can be obtained from your local sales and service office. To find a local dealer for your country, please visit https://dewesoft.com/support/distributors.

Calibration

Every instrument needs to be calibrated at regular intervals. The standard norm across nearly every industry is annual calibration. Before your Dewesoft data acquisition system is delivered, it is calibrated. Detailed calibration reports for your Dewesoft system can be requested. We retain them for at least one year, after system delivery.

Support

Dewesoft has a team of people ready to assist you if you have any questions or any technical difficulties regarding the system. For any support please contact your local distributor first or Dewesoft directly.

Dewesoft d.o.o.
Gabrsko 11a
1420 Trbovlje Slovenia

Europe Tel.: +386 356 25 300
Web: http://www.dewesoft.com
Email: Support@dewesoft.com
The telephone hotline is available Monday to Friday from 07:00 to 16:00 CET (GMT +1:00)

Service/repair

The team of Dewesoft also performs any kinds of repairs to your system to assure a safe and proper operation in the future. For information regarding service and repairs please contact your local distributor first or Dewesoft directly on https://dewesoft.com/support/rma-service.

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Trademarks

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Safety instructions

Your safety is our primary concern! Please be safe!

Safety symbols in the manual

Warning
Calls attention to a procedure, practice, or condition that could cause the body injury or death

Caution
Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

General Safety Instructions

Warning

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Dewesoft GmbH assumes no liability for the customer's failure to comply with these requirements.

All accessories shown in this document are available as an option and will not be shipped as standard parts.

Environmental Considerations

Information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling a Dewesoft system:

System and Components Recycling

Production of these components required the extraction and use of natural resources. The substances contained in the system could be harmful to your health and to the environment if the system is improperly handled at its end of life! Please recycle this product in an appropriate way to avoid unnecessary pollution of the environment and to keep natural resources.

This symbol indicates that this system complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). Please find further information about recycling on the Dewesoft web site www.dewesoft.com

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment and is outside the scope of the 2002/95/EC RoHS Directive. However, we take care of our environment and the product is lead-free.

General safety and hazard warnings for all Dewesoft systems

Safety of the operator and the unit depend on following these rules.

- Use this system under the terms of the specifications only to avoid any possible danger.
- Read your manual before operating the system.
- Observe local laws when using the instrument.
- DO NOT touch internal wiring!
- DO NOT use higher supply voltage than specified!
- Use only original plugs and cables for harnessing.
- You may not connect higher voltages than rated to any connectors.
- The power cable and connector serve as Power-Breaker. The cable must not exceed 3 meters, the disconnect function must be possible without tools.
- Maintenance must be executed by qualified staff only.
- During the use of the system, it might be possible to access other parts of a more comprehensive system. Please read and follow the safety instructions provided in the manuals of all other components regarding warning and security advice for using the system.
- With this product, only use the power cable delivered or defined for the host country.
- DO NOT connect or disconnect sensors, probes or test leads, as these parts are connected to a voltage supply unit.
- Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), a non-interruptible safety earth ground must be provided from the mains power source to the product input wiring terminals.
- Please note the characteristics and indicators on the system to avoid fire or electric shocks. Before connecting the system, please read the corresponding specifications in the product manual carefully.

- The inputs must not, unless otherwise noted (CATx identification), be connected to the main circuit of category II, III and IV.
- The power cord separates the system from the power supply. Do not block the power cord, since it has to be accessible for the users.
- DO NOT use the system if equipment covers or shields are removed.
- If you assume the system is damaged, get it examined by authorized personnel only.
- Adverse environmental conditions are Moisture or high humidity Dust, flammable gases, fumes or dissolver Thunderstorm or thunderstorm conditions (except assembly PNA) Electrostatic fields, etc.
- The measurement category can be adjusted depending on module configuration.
- Any other use than described above may damage your system and is attended with dangers like short-circuiting, fire or electric shocks.
- The whole system must not be changed, rebuilt or opened.
- DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until the safe operation can be verified by service-trained personnel. If necessary, return the product to Dewesoft sales and service office for service and repair to ensure that safety features are maintained.
- If you assume a more riskless use is not provided anymore, the system has to be rendered inoperative and should be protected against inadvertent operation. It is assumed that a more riskless operation is not possible anymore if the system is damaged obviously or causes strange noises. The system does not work anymore. The system has been exposed to long storage in adverse environments. The system has been exposed to heavy shipment strain.
- Warranty void if damages caused by disregarding this manual. For consequential damages, NO liability will be assumed!
- Warranty void if damage to property or persons caused by improper use or disregarding the safety instructions.
- Unauthorized changing or rebuilding the system is prohibited due to safety and permission reasons (CE).
- Be careful with voltages >25 VAC or >35 VDC! These voltages are already high enough in order to get a perilous electric shock by touching the wiring.
- The product heats during operation. Make sure there is adequate ventilation. Ventilation slots must not be covered!
- Only fuses of the specified type and nominal current may be used. The use of patched fuses is prohibited.
- Prevent using metal bare wires! Risk of short circuit and fire hazard!
- DO NOT use the system before, during or shortly after a thunderstorm (risk of lightning and high energy over-voltage). An advanced range of application under certain conditions is allowed with therefore designed products only. For details please refer to the specifications.
- Make sure that your hands, shoes, clothes, the floor, the system or measuring leads, integrated circuits and so on, are dry.
- DO NOT use the system in rooms with flammable gases, fumes or dust or in adverse environmental conditions.
- Avoid operation in the immediate vicinity of high magnetic or electromagnetic fields, transmitting antennas or high-frequency generators, for exact values please refer to enclosed specifications.
- Use measurement leads or measurement accessories aligned with the specification of the system only. Fire hazard in case of overload!

- Do not switch on the system after transporting it from a cold into a warm room and vice versa. The thereby created condensation may damage your system. Acclimatise the system unpowered to room temperature.
- Do not disassemble the system! There is a high risk of getting a perilous electric shock. Capacitors still might be charged, even if the system has been removed from the power supply.
- The electrical installations and equipment in industrial facilities must be observed by the security regulations and insurance institutions.
- The use of the measuring system in schools and other training facilities must be observed by skilled personnel.
- The measuring systems are not designed for use in humans and animals.
- Please contact a professional if you have doubts about the method of operation, safety or the connection of the system.
- Please be careful with the product. Shocks, hits and dropping it from already- lower level may damage your system.
- Please also consider the detailed technical reference manual as well as the security advice of the connected systems.
- This product has left the factory in safety-related flawlessness and in proper condition. In order to maintain this condition and guarantee safety use, the user has to consider the security advice and warnings in this manual.

EN 61326-3-1:2008
IEC 61326-1 applies to this part of IEC 61326 but is limited to systems and equipment for industrial applications intended to perform safety functions as defined in IEC 61508 with SIL 1-3.

The electromagnetic environments encompassed by this product family standard are industrial, both indoor and outdoor, as described for industrial locations in IEC 61000-6-2 or defined in 3.7 of IEC 61326-1.

Equipment and systems intended for use in other electromagnetic environments, for example, in the process industry or in environments with potentially explosive atmospheres, are excluded from the scope of this product family standard, IEC 61326-3-1.

Devices and systems according to IEC 61508 or IEC 61511 which are considered as “operationally well-tried”, are excluded from the scope of IEC 61326-3-1.

Fire-alarm and safety-alarm systems, intended for the protection of buildings, are excluded from the scope of IEC 61326-3-1.

Documentation version history

Version	Date	Notes
V21-1	05-01-2021	New template and updated pictures