Software GSVmulti

User-guide

Manual GSVmulti

Notes on this guide

- Colored texts indicate buttons of the program and italic text generally means designations in the program
- Further information is partly in small print
- The first part "Quick Start Guide" is an introduction. In the second part, "Planning and Managing Measurement Tasks", recommendations and important information are given, while in the third part, "Additional Features", extensive possibilities are presented; however, knowledge of these is not absolutely necessary for the basic use of the program.

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Quick Start Guide

GSVmulti (long form: GSVmultichannel) is an application program for displaying and recording measurement data and for configuring digital amplifiers. The following models are supported: GSV-8, GSV-6, GSV-4, GSV-3, GSV-2 and GSV-1A8USB. One or more GSV amplifiers can be used at the same time, so that up to 127 measurement channels can be displayed and processed.

Connecting the Amplifier

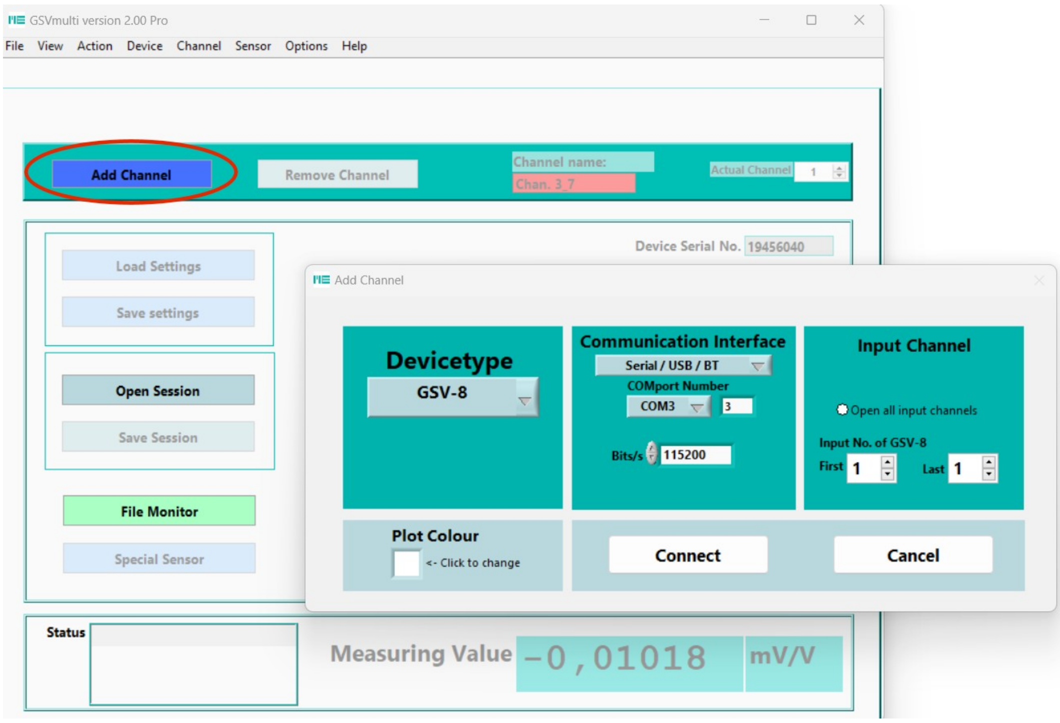
After starting the GSVmulti software, the functions

Add Channel, **Open Session** and **File Monitor** are available.

Add Channel opens the dialog for entering the connection data to open a GSV amplifier or additional channels of a device.

Please select the device model with device *type*, the *COMport number*[1] and the desired input channel(s).

Repeat *Add Channel* until you have all the channels and devices you want.



1 In the GSV1A8 and the GSV-6CAN it is a device number; here the *communication interface* is set or set accordingly.

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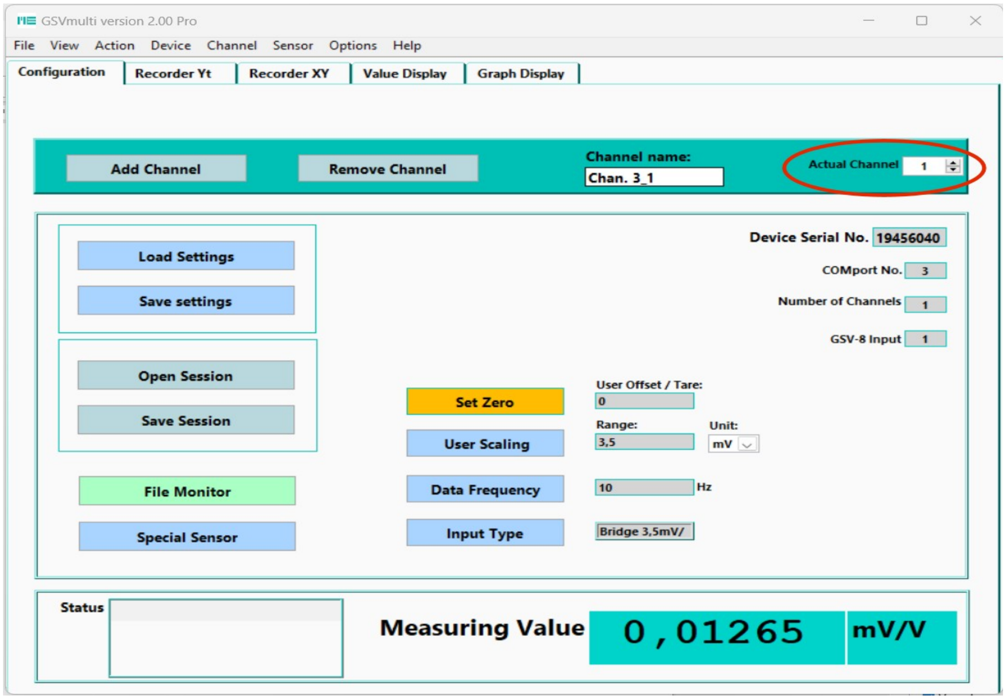
Tips: For devices with multiple input channels, *Open all input channels* allows you to open all available inputs from this amplifier. The default setting of the communication bit rate (bits/s) is automatically pre-selected based on the device model. If this is different, it must be set correctly.

Configuration tab

In this tab, navigate to the desired channels by selecting Actual Channel in the upper right corner. The names of the channels, e.g. "*Chan. 3_1*" you can overwrite Channel name with your own name in the text field and finish typing with Enter. Alternatively, you can do this from the menu bar with *channel > name*.



With the four buttons in the center, you define the essential properties of the sensor on the currently selected channel:

Set Zero: Performs a zero adjustment of the sensor. The button in yellow-orange color indicates that this setting is stored in the memory of the amplifier/sensor.
Note for temperature and voltage inputs: By default, the software prohibits zeroing of temperature and voltage inputs. This can be changed in Menu bar→*Options*, see S.93.

User Scaling: This opens a window for entering the scale or calibration data for the sensor. As a rule, this setting must be made once during commissioning, see S. 9.
Before changing the scale, the Input Type should be set, if it is not already set correctly.

Data Frequency: This is where the number of measured values sent via the interface per second is entered. Please select the frequency required for the measurement task. For multichannel devices, it is automatically the same for all input channels.
For multichannel devices, it means the number of whole data frames with input channels, i.e. the

total number of all measured values of all channels = *Data Frequency* x Input Channels. The lower the frequency, the lower the noise, i.e. the better the effective measurement resolution, see p. 18.

Input Type: Here the input type and the electrical measuring range are selected, see p. 8. **This step is usually performed first to configure a new sensor.**

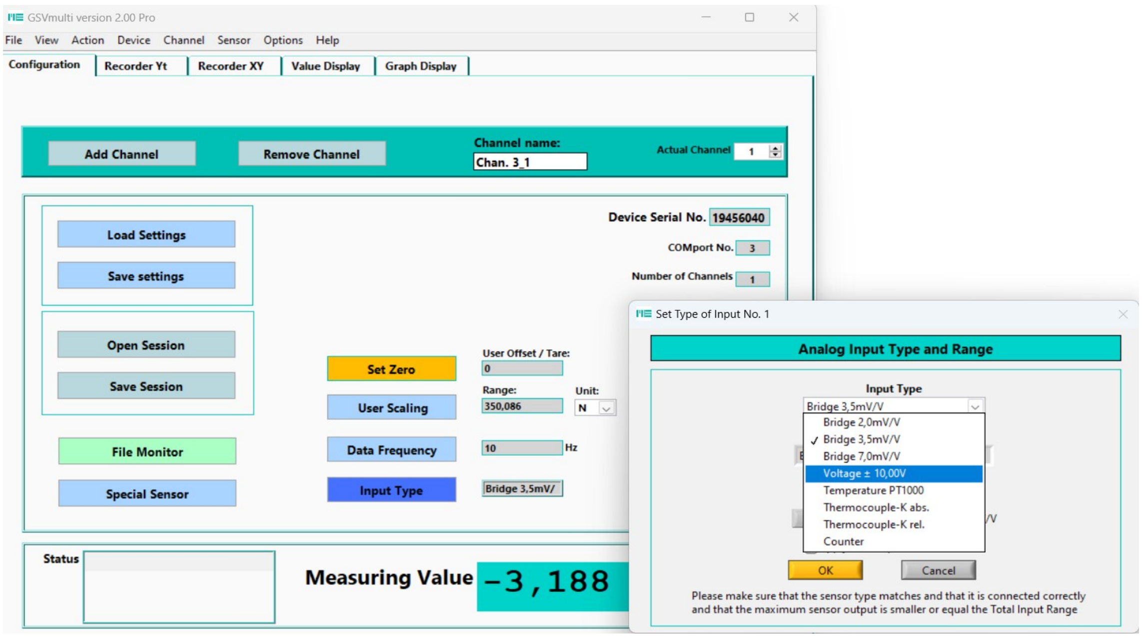
Load Settings can be used to restore the factory settings *(default)* of the amplifier or those that have previously been stored by the user in the memory of the device with **Save Settings** (Users 1-6, *if available for the device model).*

Input Type

The **Input Type** button opens the dialog for setting the electrical input range for the selected channel and sometimes different physical input types can be selected. The adjustment options depend on the model of the connected amplifier; In the following, they are shown as examples of the **GSV-8**.

Three measuring ranges of 2.0 mV/V, 3.5 mV/V and 7.0 mV/V are available for sensors with strain gauges. The three measuring ranges of the GSV-8 are connected to three permanently assigned bridge supply voltages.

- 2 mV/V: 8.75 V (Note: This supply voltage is not recommended for some sensors; see the sensor data sheet for more information).
- 3.5 mV/V: 5.0 V
- 7 mV/V: 2.5 V



The selected measurement range should be greater than or equal to the electrical output range of the sensor, i.e. greater than its characteristic value at its nominal value.

Tip: For some amplifiers, e.g. GSV-4 and GSV-8, temperature sensors or single-ended voltage inputs can also be selected. Other types of sensors almost always need to be connected to other ports on the device, and other cables may need to be used. The operating instructions of the devices provide information on this.
The definition of the bridge type (full, half or quarter bridge) for strain gauges is also done via the hardware of the GSV, for example via other connections or switches/jumpers. See its instruction manual and S.52

Note: With some GSV models, if the input type is changed, the scaling (U*ser Scaling)* is automatically reset, so that a previous sensor configuration may be overwritten!

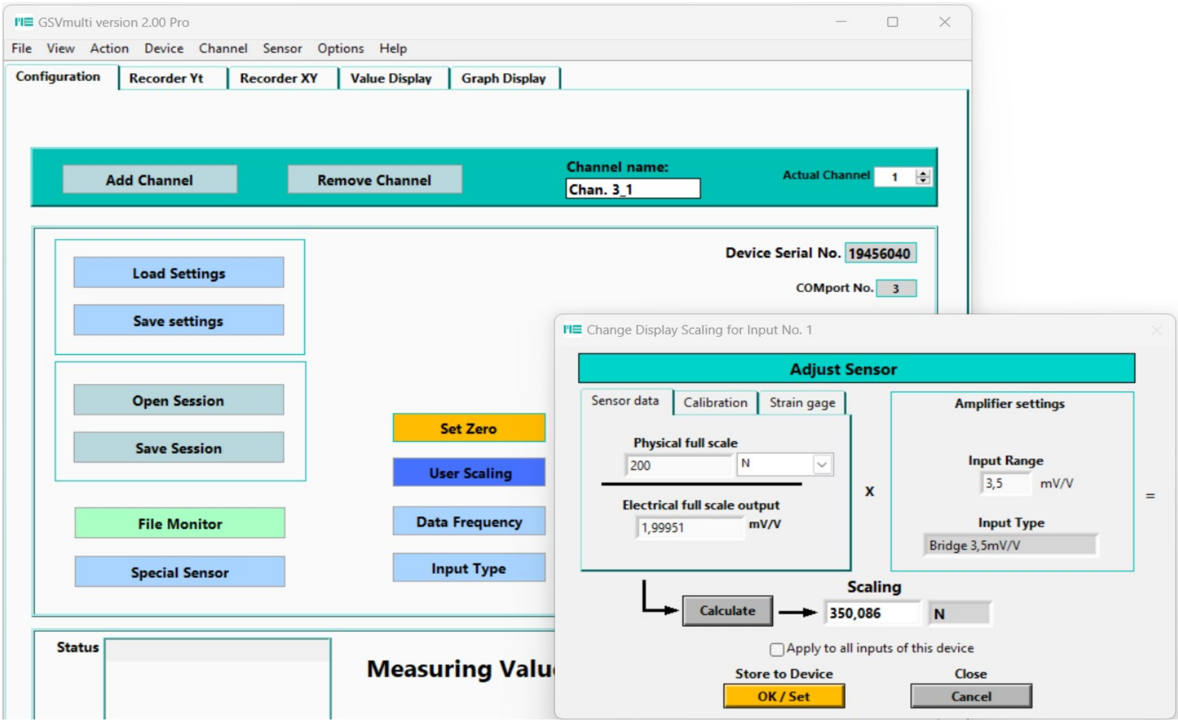
Scaling

The User Scaling button opens the dialog for entering or calculating the scaling factor with which sensors are adjusted.

The scaling factor is calculated from:

- The measuring range of the sensor (*Physical Full Scale*)
- The output signal change of the sensor at this 100% load (*Electrical Full Scale output*). This usually corresponds to the characteristic value specified in the test protocol of the sensor.
- The physical measuring range of the amplifier (*input range*). This is usually read automatically by the software.

The choice of unit does not affect the result, it is merely a label. Enter the *Physical full scale* of the sensor accordingly.



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Enter the values and then press **Calculate** and then **OK / Set** to save the scaling in the amplifier. The value will then appear in the *Configuration* tab next to *User Scaling* under *Range*. It corresponds to the full electrical input range, **but usually not to that of the sensor,** which is usually smaller.

Tip: If you connect sensors with TEDS, you don't need to enter the scale because it is set automatically. See p. 57

Recorder Yt

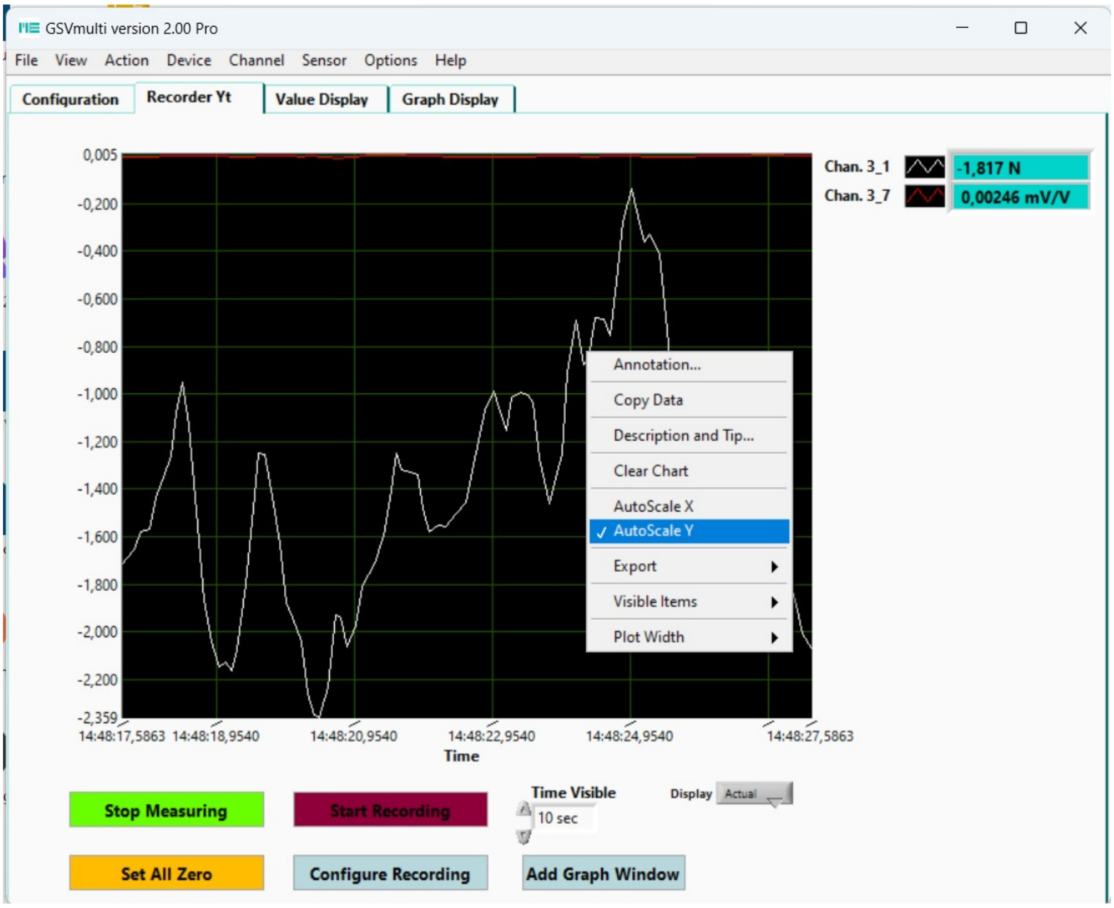
In the *Recorder Yt* tab, the measured values are displayed graphically in real time over the current time.

Use "Start Measuring" or "**Stop Measuring**" to start or stop the graphical display. **Start Recording, Stop Recording**, to start or stop recording measurement data to a file.

The displayed index card may be changed at any time, even during a measurement or recording, which is not affected by it.

Set All Zero performs zeroing for all channels. Note that the *Set Zero* button may be disabled for individual channels, e.g. for force/torque sensors or for other calculated channels. Then *Set All Zero* should be used.

Right-clicking on the graphic opens the context menu for various settings, such as: *AutoScale*.



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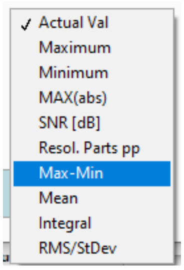
If *AutoScale Y* is disabled, you can click on the minimum and maximum values of the y-axis and change them by changing the full scale values and pressing Enter.

You can set the temporally visible range with ***Time Visible*** .

Under ***Display*** There is a selection of options for the display of the numerical measured values with a turquoise background, the so-called "Numerical Values". *Single Value Display*: For example, by *Max-Min* the noise amplitude or by *Resol Parts PP* a quality number "measuring range / noise amplitude" can be displayed, see p.20.



With the button **Configure Recording** , the properties for the recording of measured values, e.g. start and stop conditions as software triggers, can be defined. See p. 66.

With the **Add Graph Window** button you can open more graphic windows, e.g. to display forces and moments in different windows with their own graphical scaling or to perform a spectral analysis (FFT).

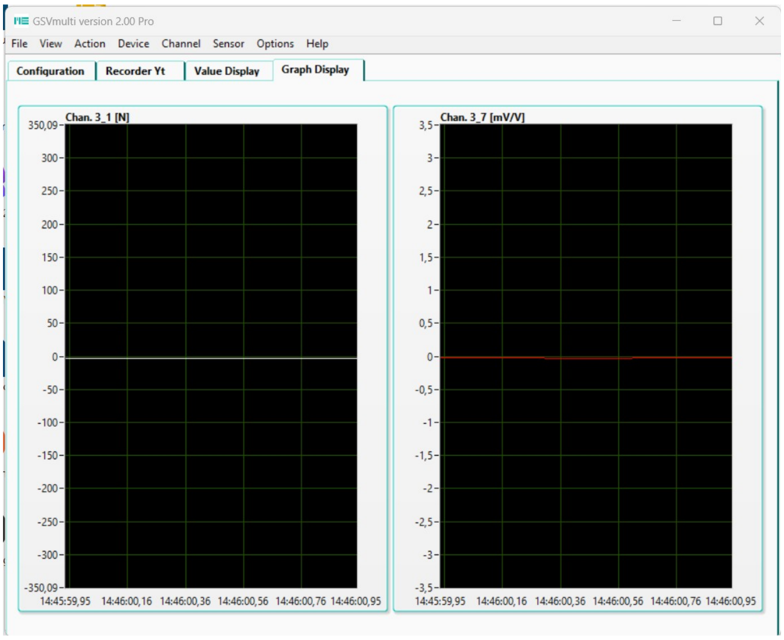
Load and save measurement job

All settings regarding the graphics window and naming of channels, as well as interface numbers etc. can be saved in a session file of type *.ucf when exiting the program or using the *Save Session* button, and can be restored by *Open Session* or by double-clicking on the ucf file before starting the program. No amplifier settings are stored in this file.

When restoring the channels, all saved channels of all devices are opened and other settings are also loaded, see p. 15.

Graphic Display Graph Display

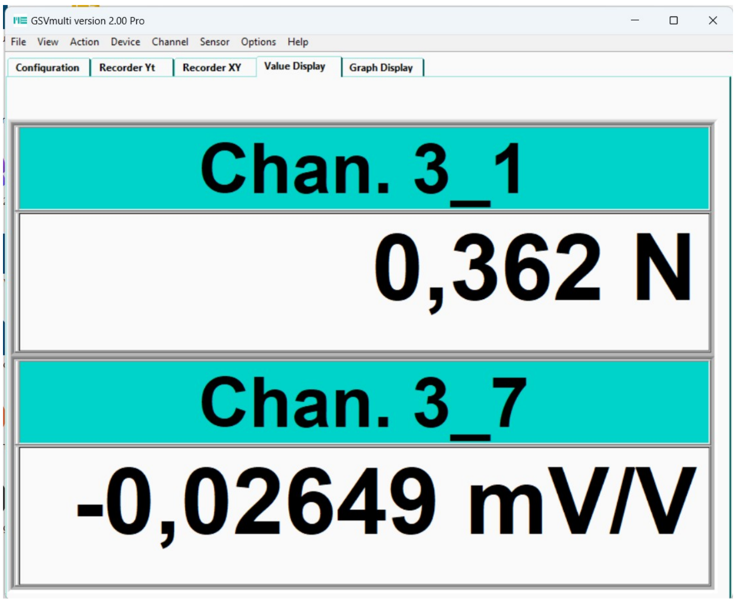
The *Graph Display tab* provides graphical displays over time for each channel.



The right-click menu offers similar capabilities as in Yt Recorder. Up to 16 channels can be displayed here.

Large Value Display

Below this index card, a numerical large display of all channels is available.



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Display of recorded measurement data

With File Monitor in the index card *Configuration* a file selection window opens, in which the last file with *Start Recording* is pre-selected. After confirming with OK, the display window for measurement data files opens. They can be displayed graphically or as a table of values and with Export can also be converted to other formats such as Excel or CSV. With the mouse scroll wheel or the zoom options of the graphics palette, the display can be enlarged, reduced or moved, and cursors for various functions can also be displayed; see p.75

Further help and sources of information

- Context Help can be opened under Menu bar → *Help* → *Show Context Help*. This is a small help window that displays information for each control when you hover over it.
- On the Internet, on the website me-systeme.de provides more information
- Some special functions, e.g. *MathScript*/MathChannel (only for PRO version) have their own instructions
- The operating instructions of the amplifiers used should be read for initial commissioning

General information about the software

- Buttons or other controls that cause settings to be saved in the device are highlighted in yellow.
- When operating functions that require multiple inputs within a dialog box, the operating order is usually from top to bottom and/or from left to right.
- All buttons and other input elements of the main window are also accessible via the menu bar at the top. This does not apply the other way around, i.e. there are also functions or dialog boxes that can only be accessed via the menu bar.
- For many functions, the menu bar also mentions keyboard shortcuts (so-called hotkeys) that also trigger this function. If it is noted here**: Ctrl+< key>, press and hold the Ctrl key (control) first, while then pressing <key>, e.g. Ctrl+PageUp:** First hold down Ctrl, then scroll up: Displayed the next channel in Configuration.

Planning and Managing Measurement Tasks

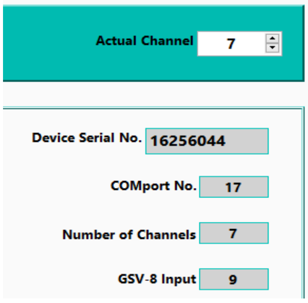
Before carrying out a measurement, it is useful to clarify the following questions:

- Which sensors and measurement channels are needed?
- Which measurement data rate should be chosen?
- Should the evaluation only take place during the measurement run time, i.e. as a live view in real time, or should the measurement be recorded first and evaluated later?

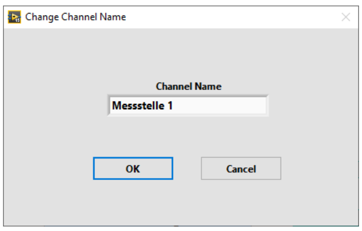
Especially in the case of measurements with important results or those that are time-consuming to perform, it is recommended to carry out one or more test measurements after planning and configuring the measurement system. If possible, this should be done with the same device and sensor copies in the same place and on the same PC where the actual measurement is to take place.

Channels

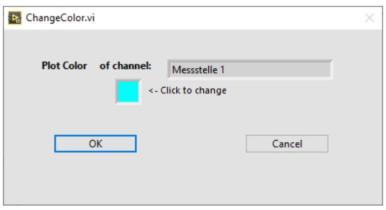
One measurement channel represents **one** physical quantity that is usually converted by sensors into electrical quantities that the amplifier captures and digitizes. In this process, the analog values are converted into numbers with a fixed number of measured values per second, the measurement data rate (*Data frequency*). The GSV-2 and GSV-3 amplifiers have only one measurement channel; for all others, the input to which the measurement channel belongs, as well as the device name, are displayed next to *Input in the* upper right corner of the *Configuration* tab. The device serial number appears next to *Device Serial No*.



The **channel number** that you see next to *Actual* Channel is determined by the order in which the channels were added by *Add Channel* and is usually freely selectable. An exception to this are *MathChannels*, which represent calculated software channels and are added to channels according to the hardware, or are automatically sorted accordingly, as [2] well as counter channels, see below.



It is convenient to give the measurement channels descriptive **names**. You can do this by changing the name directly in the *Channel Name* display field and then pressing the Enter key or by clicking on the menu bar → *channel* → *name*... click.



2 Calculated channels (*MathChannels*) are only available with GSVmulti PRO. This function is described in a separate manual.

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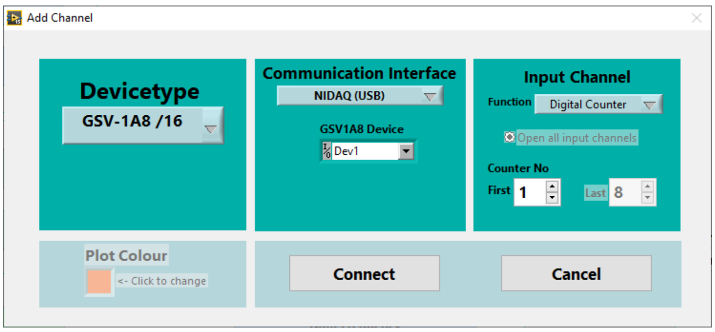
When the channels are added, up to 32 different colors are automatically assigned. You can change them in *the Add* Channel dialog at the bottom left or later with the menu bar → *Channel* → *Color...*

This color is also used to display the channel name under *Channel Name* in the *configuration* tab, and graphs of recorded measurement data files are also displayed in the *File Monitor* with this color.

Types of Devices and Measurement Channels

In the free version of GSVmulti there are currently two basic types of channels: analogue channels and counter input channels. The GSV1A8USB, GSV-6BT and GSV-8 amplifiers provide counter inputs that can be used to count digital pulses or measure frequency. A counter channel can be added after at least one analog channel of the same device has already been added. To do this, select *Function = Digital Counter* in the Add Channel *dialog on the right.*



For the GSV-8 and GSV-6BT, the meter must be activated and configured once, see p. 133. Scaling can also be used for meter inputs with *User Scaling* (but not calculated by every method).

In addition to the device or COM port number and input channel, the channel type also determines the default channel name.

GSVmulti PRO offers additional special channels, which are created by opening the following devices (*device type*):

- *GPS / GNSS* for satellite-based positioning: *Latitude,* Longitude, Altitude , *Speed* and *UTC time*
- Math Script: Math Channels Calculated by Custom Script
- *User Device*: Devices from other manufacturers that send measured values as a text string via a serial interface, see117.

These special channels have only limited configuration options; only the channel name, unit and color can be changed.

Load and save measurement session

The channel list can be saved with *Save Session*. You can then restore them at any time, even after restarting GSVmulti, with *Open Session*. This file also contains information about how the integrated devices are opened (COMport number, baud rate, input channel) and how they are displayed (channel name, color) and, in the case of special channels, also the unit and, if necessary, settings via special functions. With *Open Session*, the embedded channels are opened and the display properties are restored.

By double-clicking on the session file (e.g. in Windows Explorer) GSVmulti can be started and then this session will be opened automatically.

The session file **does not** contain the configuration data of the amplifiers (i.e. those that are stored with yellow buttons in the device). Instead, amplifier settings can be saved to a file using *Save Settings* → Save to *file and* restored → *Load from File using* Load Settings.

A backup with all settings files of all integrated amplifiers, including the session file, can be created using the menu bar → *Help* → *Create* ***Settings Archive***. It is a ZIP archive that contains these files.

Master-slave synchronization with multiple amplifiers

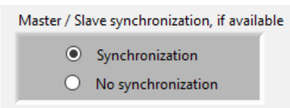
If more than one GSV device is integrated and the measurement data rates are relatively high or the recording time is rather long, it makes sense that the amplifiers are synchronized. Otherwise, due to the asynchronous data transmission, temporal errors can accumulate (i.e. magnify), so that after a certain time after the start of the measurement, the measured values of the different devices no longer coincide in time.

With master-slave synchronization, the time of transmission of a measurement data frame is adjusted via the serial ports of all devices (i.e. also via USB, Bluetooth, Ethernet).

It is a hardware feature that can be enabled on GSV-4, GSV-6BT/CPU and GSV-8 devices (available as an order option on GSV-3USBx2). In this case, a line must connect certain digital I/O connections of the devices with each other, i.e. a digital I/O port and (D)GND must be connected to the devices by cable. Exactly one of the devices is configured as the master and this generates a digital synchronization signal, namely a rectangle with the frequency of the set data rate. At one of the edges (usually rising, i.e. low→high) the master also transmits its measurement data frame and the slaves recognize this edge and also send their measurement data frames.

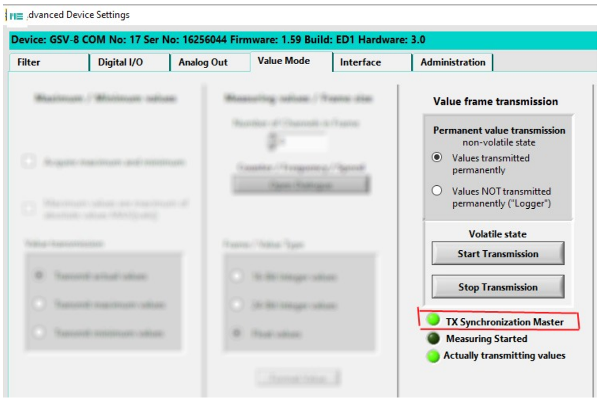
If the master-slave function is activated for all connected GSVs, GSVmulti will apply a sync sequence when clicking *on Start Measuring*; in which the transmission is temporarily stopped, the data buffers are deleted and the master is then started, so that all devices start sending measurement data at the same time.

The prerequisite is that synchronization is activated in the program options and that all connected devices support master-slave, are properly wired (see above) and configured

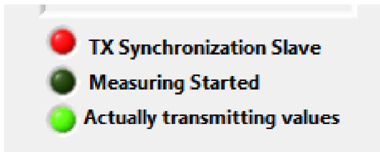


(see below). In the software settings, under the menu bar → *Options → Hardware -> Master / Slave synchronization, if available,* must be set to *Synchronization*, which is the case in the default settings.

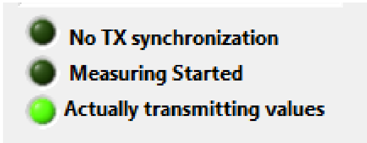
Master-slave synchronization is configured and verified in the **GSVs in the following ways** : In the *Configuration* with *Actual Channel* tab , select a channel that belongs to the device you want to configure or verify. Then click on Device in the menu bar and select *Advanced Settings...* In this dialog, the master-slave mode is displayed in the *Value Mode* tab :



Tx-Sync. Master made active



Tx-Sync. Slave mode active

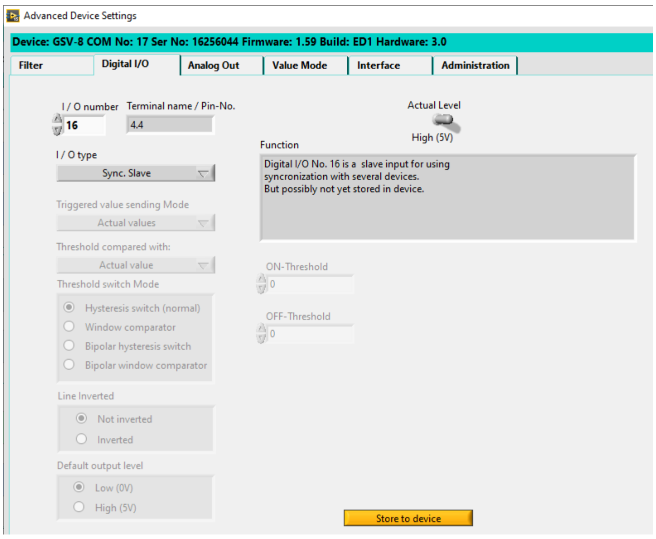


Without Tx-Sync.

This indicator is only available on GSV-3, -6 and -8.

Master or slave mode is activated in the *Digital I/O tab* in the *Advanced device Settings*. To do this, use the I/*O number* to select the digital I/O port to which the synchronization line is to be connected. Usually (and if this cable was purchased from ME) these are the following:

- **GSV-8**: *I/O number* **16** for master and for slave
- **GSV-6**: *I/O number* **1, 2** or 3 for master and **4** (TRIG) for slave
- **GSV-4**: any from 1 to 8 for master and for slave



In this case, it is best to put the slave into its mode first, in order to avoid accidentally connecting two outputs (master) through the connected sync cable, because this would be tantamount to a short circuit. To do this, select *Sync. Slave* with *I/O type*. Then *Store to device*.

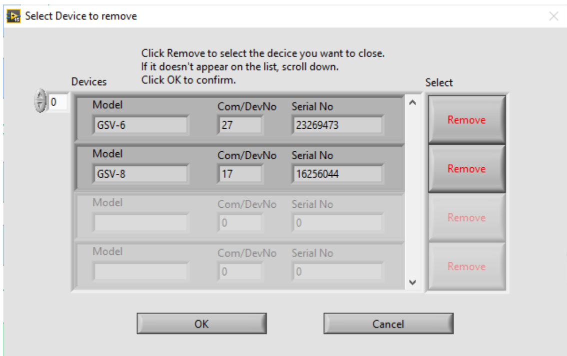
Then configure the master by setting his *I/O type* to *Sync. Master*.

With the GSV-8, you may receive an intermediate message warning that all I/Os 13-16 (i.e. those of the group of four to which the selected I/O belongs) will be switched as input or output. This must be confirmed; if these three other I/Os are intended for an incompatible function, other I/Os may need to be used.

If a slave device does not receive a synchronization signal, e.g. because the cable is not connected or the master is turned off, it does not send any readings, so that a *timeout* message will appear in the display of the C*onfiguration* tab.

Remove channels or devices

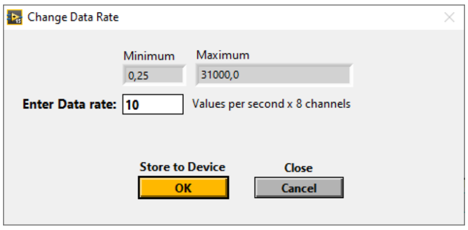
The channel displayed in the *Configuration* tab can be removed using Remove Channel. If you want to remove one or more hidden channels, you would first have to retrieve all hidden channels with Menu bar -> *Channel -> Unhide All*. Hidden channels were previously hidden using *Channel->Hide*, for example because they are only required as input values for a calculation but are not to be displayed, see e.g. S. 48



To remove all channels belonging to a particular device, you can click on Menu Bar->*Device->Close*. If several devices are open, a dialog will appear in which you select the device to be removed with *Remove* on the right and then confirm with *OK*. Then all channels of this device, whose name (*model*), comport and serial number (*Serial No*) are displayed on the left, will be removed, including hidden channels.

Selection of the measurement data rate

The *data frequency* is the number of measured values (samples) that the amplifiers take and transmit per second and per channel. If several amplifiers are used, it should be set as much as possible to the same value for all devices; otherwise, you may receive a warning message when you click on *Start Measuring*. The measurement data rate of multi-channel amplifiers is always the same for all input channels and it is to be understood as a single sample rate, i.e. per channel (i.e. multiplied by the number of input channels results in the sum sample rate).
To change it, use the Actual Channel button to navigate to a channel that belongs to the measurement amplifier and click ***Data Frequency***, which opens the *Change Data Rate* dialog. After successful modification, the same measurement data rate is displayed for all its channels.



The value range of the measurement data rate depends on the amplifier model and is displayed in the *Change Data Rate* dialog under *minimum* and *maximum* :

For many device models, the maximum also depends on other settings and configurations. For example, if the serial UART or RS232 interface is enabled, this maximum is strongly dependent on the communication bit rate, s. S.110

It is not possible to set all measurement data rates continuously. It is therefore possible that the data rate closest to the desired value is set; this is especially true for the GSV-4, GSV-6 and GSV-8 models, especially at high values. The operating instructions of the devices provide more detailed information on this.

Which measurement data rate is chosen depends on the measurement task. It should always be as low as possible, but sufficiently large if even short changes such as peaks or vibrations are to be acquired.

High measurement data rates (i.e. those above 50/s, depending on the application) and low data rates have the following advantages and disadvantages:

	High data rate	**Low data rate**
Advantages	Rapid changes are recorded, e.g. peaks, oscillations	Lower noise, i.e. better effective amplitude resolution
	Good frequency representation possible with FFT	Smaller files for data recording
	High temporal resolution	Reduced load on the PC
	In some cases, there is less time delay (latency) between signal change and measured value change[3]	Better suppression of disturbances, e.g. EMI
Disadvantages	Higher noise, i.e. poorer amplitude resolution	Rapid changes in the measurement signal are not detected
	Large files during data recording, resulting in slower file processing and more complex evaluation	Frequency representation (FFT) not very meaningful
	Increased utilization of the PC	The portion of latency that depends on the data rate is longer

Each amplifier has a maximum frequency of measurable signals, i.e. a limited bandwidth, so it always acts as a low-pass filter. In the case of digital amplifiers, this bandwidth is determined, among other things, by the measurement data rate; it is typically about 0.3 to 0.4 x measurement data rate. However, the bandwidth can be even lower, e.g. due to analogue pre-filters. The larger the bandwidth, the higher the noise, i.e. the dynamic, normally distributed portion of the measurement uncertainty increases with the bandwidth.

How much greater the noise is at a higher data rate also depends on the amplifier and the strength of external interference sources. Most amplifiers operate internally at a higher sampling frequency, which they then reduce by averaging or decimating digital filters. To compare the signal-to-noise ratio change when comparing two data frequencies f1 and f2, with f1>f2, the following applies as a rough rule of thumb:

$$\mathbf{R(f1) \approx R(f2) \times \sqrt{(f1/f2)}}$$

Example: At the measurement data rate f1 = 1000/s, the intrinsic noise R(f1) is about 10 times greater than at f2 = 10/s, because $\sqrt{(1000/10)} = 10$. Intrinsic noise only includes the noise generated by the amplifier itself without external sources of interference.

3 There is a constant fraction tk of this delay time and one dependent on the data rate, so the total latency= tk + t(Fdata).

Analysis of noise and signal-to-noise ratio

In many applications, it is possible to find out the most suitable measurement data rate through test measurements. It is advisable to start with a rather high data rate. As a result, external sources of interference can also be detected, especially if the test measurement takes place at the same location, in the same environment, for example with machines switched on nearby, as during the actual measurement.

For example, you can start with half (or more) of the maximum adjustable data rate.

Then leave the sensor unloaded for some time, i.e. avoid changing the useful signal. Now you can determine the signal-to-noise ratio and, if necessary, find interference frequencies.

To do this, start a measurement and select one of the following settings using the Display pull-down selection element :

Selection	Description	Unit	Internal calculation
SNR [dB]	Signal-to-noise ratio: Short peaks are smoothed out! It is related to the input measuring range, the average value is subtracted and the result is converted into decibels.	dB	$20\cdot\log(\frac{Range}{\sqrt{\frac{1}{N}\cdot\sum(x_i-\bar{x})^2}}$
Resol. Parts pp	Resolution in Parts pp: Peak resolution relative to the input measurement range	none	$\frac{Range}{Max-Min}$
Max-Min	Absolute peak resolution in the unit of physical quantity.	same as measurand	Maximum - Minimum

Selection	Description	Unit	Internal calculation
RMS/StDev	Root-Mean-Square / Standard Deviation in the Unit of Physical Quantity. With this selection, short peaks are smoothed out.	same as measurand	$\sqrt{\frac{1}{N}\cdot\sum(x_i-\bar{x})^2}$

Range is the measuring range of the amplifier input, as it is usually displayed in the *Configuration* tab. xi are all measured values of the sample, Max is the maximum value and Min is the minimum value of the sample. The sample is recorded via N=100 values or over one second, whatever is greater, i.e. at a measurement data rate > 100/s, N = measurement data rate.

The result is displayed in the turquoise green field on the right. By selecting *SNR [dB]* or *Resol. Parts pp*, the noise can be judged independently of the measuring range. ME Messsysteme usually specifies the peak value resolution for amplifiers (*Resol. Parts pp),* other manufacturers often only use the signal-to-noise ratio SNR.

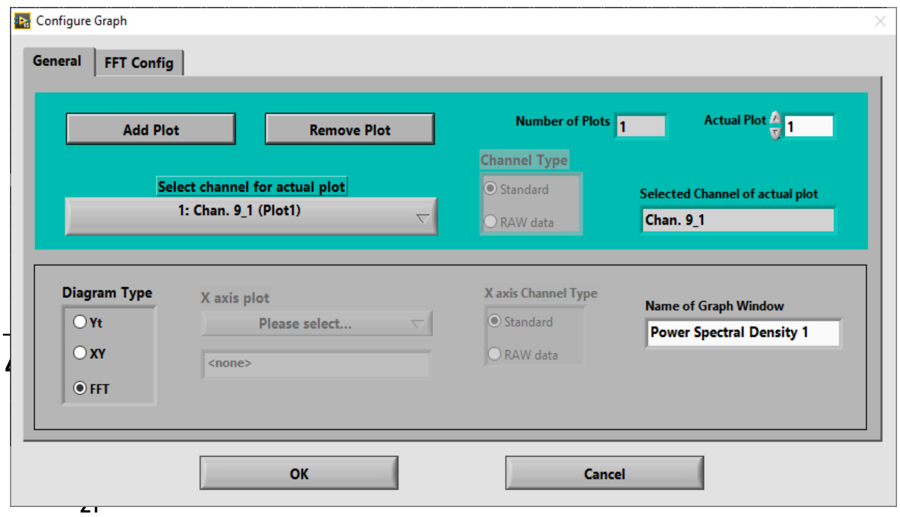
If a sensor is already connected and adjusted, *Max-Min* can be used to check peak noise and *RMS/StDev* can be used to check standard deviation, both in physical units.

The following table shows typical noise levels of a GSV-8. External interference has been eliminated here.

Fdata [Hz]	Input	SNR[dB]	RMS [nV/V][4]	NoisePP [parts]	NoisePP [nV/V]
10	2 mV/V	119	2,24	100000	20
10	3.5 mV/V	113	7,84	100000	35
10	7 mV/V	115	12,45	100000	35
1000	2 mV/V	103	14,16	24000	83,33
1000	3.5 mV/V	103	24,78	24000	145,83
1000	7 mV/V	103	49,56	24000	291,67
12000	2 mV/V	94	39,91	6500	307,69
12000	3.5 mV/V	94	69,83	6500	538,46
12000	7 mV/V	94	139,67	6500	1076,92

In the specification SNR and RMS, you get better values for the same test measurement, because short peaks are averaged away.

The illustration of the *Recorder Yt* tab above shows a test shot with a GSV-8 at a measurement data rate of 6000/s of a sensor with a measuring range of 2500 N. The absolute peak resolution *Max-Min* is therefore 0.89 N. The graph shows a clear interference signal already in the time



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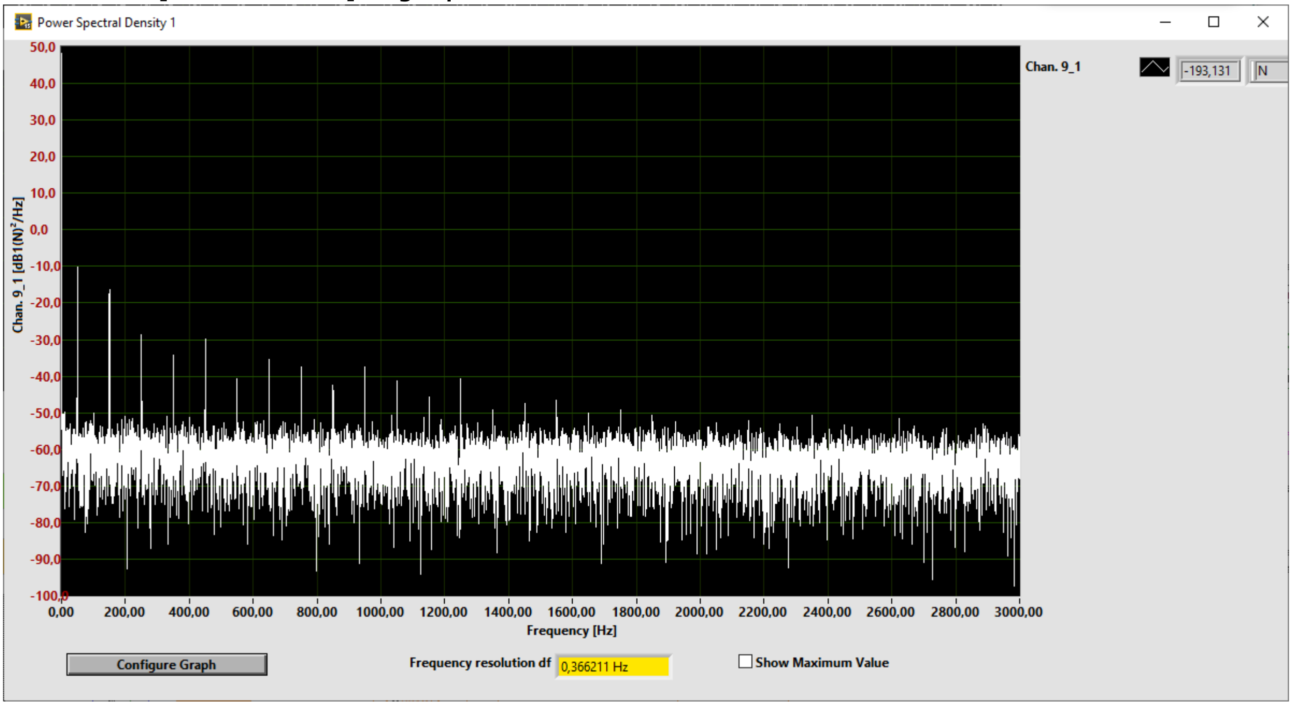
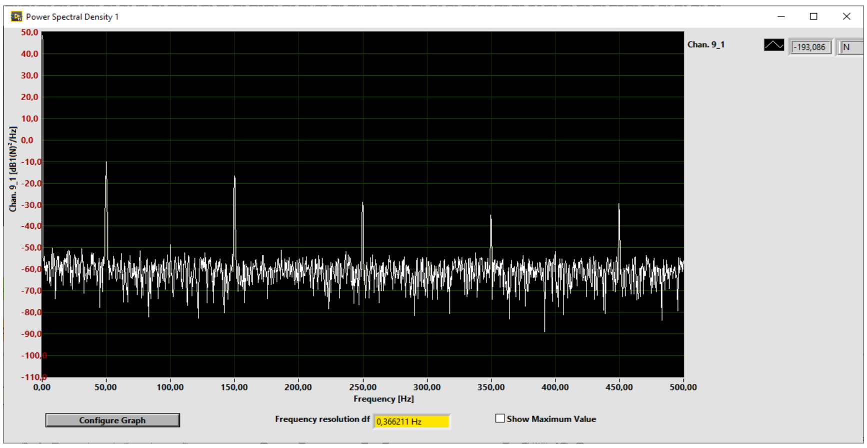
domain. To find out the cause, a **spectral analysis** is often very helpful. To do this, click on *Add Graph Window* and the configuration dialog for this graphical additional display opens first.
Set *Diagram Type* to *FFT*, click *Add Plot* and then select the channel with *Select Channel for actual plot*. An FFT window can only display one channel at a time, but you can open up to 6 Graph Windows by using *Add Graph Windows* multiple times.
The **FFT spectral display** opens:

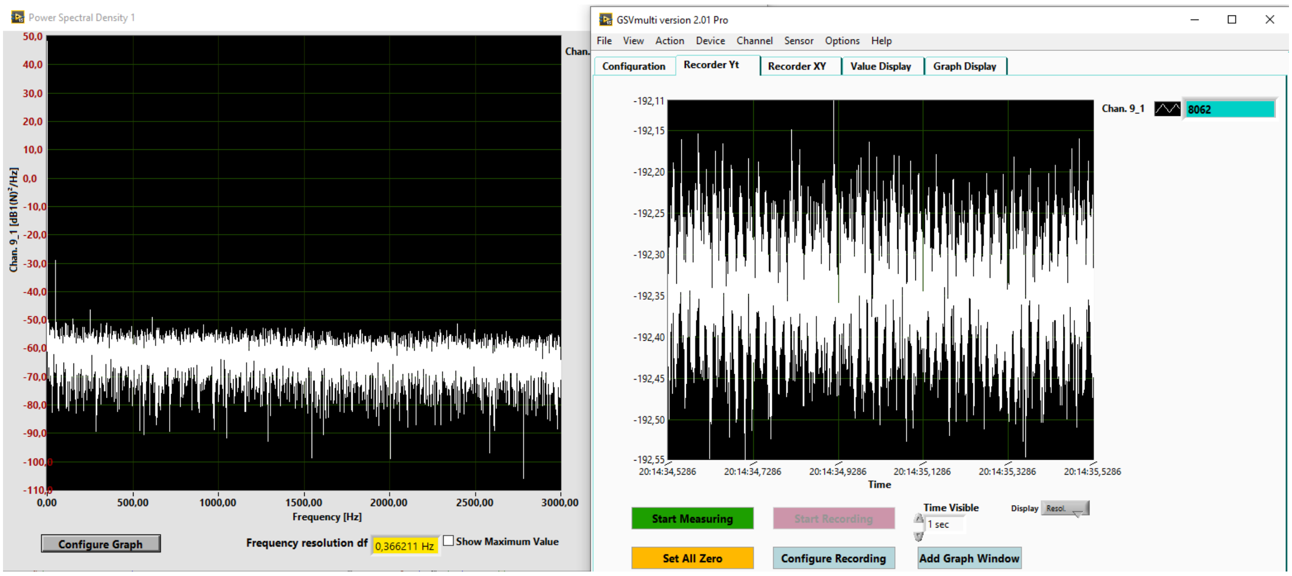


The displayable frequency range is always measured data rate / 2, in this case 3000Hz. Disturbance peaks can be clearly seen. To identify the frequency of the first one, you can *disable Autoscale X* (right-click on the graph) and edit the frequency range at the bottom right:



Here you can see **interference** at 50 Hz and odd multiples of it. This is a typical behavior in the case of **poor cable laying, lack of shielding** or, as in this case, the use of an **unsuitable power supply** of the amplifier**:** the mains frequency of 50 Hz causes significant interference (the multiples of this are probably generated by the unsuitable power supply, which induces a kind of square wave oscillation).

For comparison, the original power supply of the GSV-8 is now used:



The peak resolution is now much better with 8000 parts, it would correspond to an absolute resolution of 0.32 N with the above-mentioned sensor. The 50Hz mains frequency still sprinkles in somewhat, but by about 20 dB less (corresponding to an attenuation of 10). It is probably due to the fact that a short sensor cable was used, but without shielding.

Grounding the housing of the amplifier (if it is made of metal) often helps; the GSV-8 comes with a green grounding wire for this purpose. However, it does not always improve interference suppression. Grounding the sensor is also often helpful, especially if its metal body is isolated from the cable shield, as is usually the case with ME sensors.

It is recommended to eliminate or at least dampen interference at the source; for example, amplifiers and sensors should be placed as far away as possible from strong sources of interference (such as frequency converters for motors).

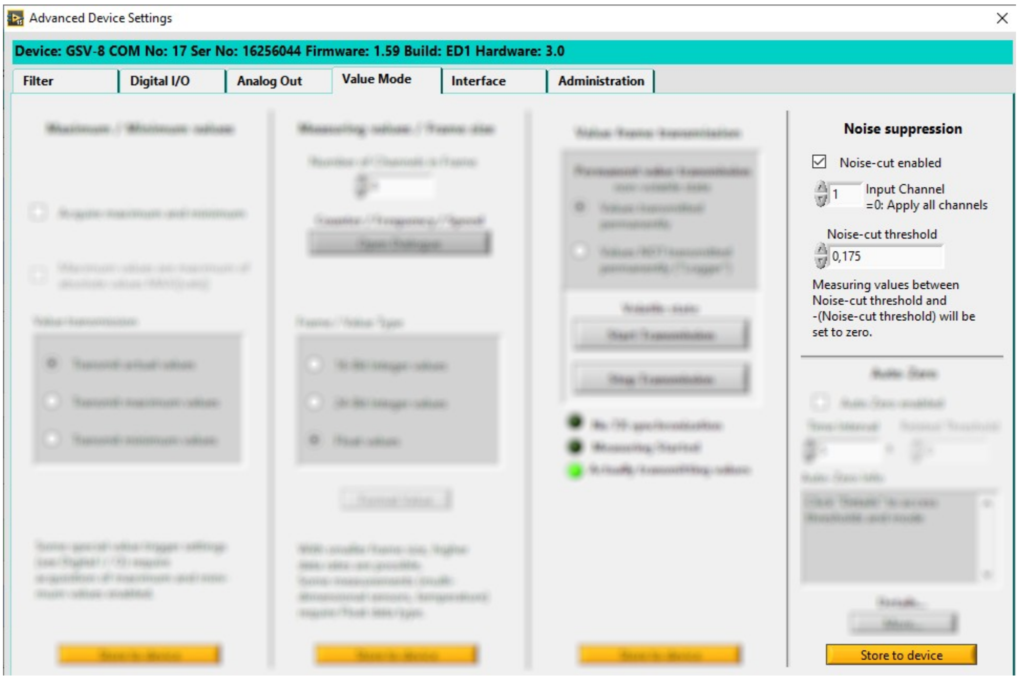
If this does not help, the measurement data rate can be reduced or - with the GSV-6 and GSV-8 - a digital filter can be configured as a band lock, see S. 100.

With the above-mentioned procedure, the success of a measure against disturbances can be directly observed.

Canceling noise around zero (*Noise Cut*)

The GSV-2 and GSV-8 devices can be configured to set the readings to exactly =0 when they are within a configurable amplitude range around zero, the *Noise-cut threshold*. The noise floor close to zero is thus cut off. If this function is not enabled and readings are consistently exactly =0 even though enough decimal places are displayed, this indicates a malfunction. However, when using the noise-cut mode, it can no longer be detected when measured value =0, which can be disadvantageous.

Noise-Cut is configured under Menu Bar *-> Device -> Advanced Settings... -> Value Mode -> Noise suppression*:

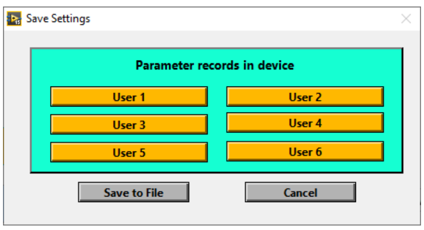


In the case of GSV-8, the number of the input channel to which the threshold value should apply must be entered under Input Channel; 0 sets the specified threshold value for all channels. With *Noise-cut enabled*, the function is activated for all channels. If it is desired that it should only apply to certain channels, set the threshold value to 0 for channels where it should be disabled. Under *Noise-cut threshold*, the upper, positive threshold value for the amplitude range of the Noise-Cut function is entered. The range then goes from threshold to -threshold, e.g. from -0.175 to 0.175 as shown. At the end, click on *Store to device* at the bottom.

Due to the decimating averaging of numerical live display, it can happen that a displayed measured value is briefly within the noise-cut interval; however, this is only a display effect that does not affect the original measurement data, see p. 33.

Manage device settings

In most amplifier models[5] , you can also store data sets with configurations. All amplifiers always restore the last valid settings when switched on. In addition, there are user records for alternative settings or backups. This is useful, for example, if you want to connect different sensors to the same channels of a device, or if you want to test different measurement data frequencies or filters, and much more. You don't always have to repeat the individual configuration procedures.

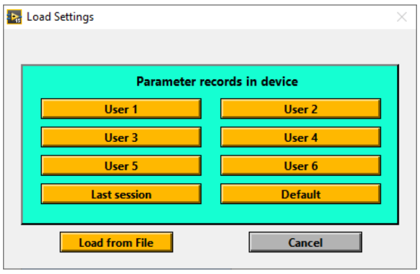


5 With the exception of the GSV-6 (so far, but also planned with this for future versions)

To **save these settings records,** click *Save Settings* in the *Configuration* tab and then select the record you want to save to. By default, it is labeled *User 1* to *User 2* or *User 6*; how many data sets are available depends on the model. There are two for GSV-3 and GSV-4, six for all others (except GSV-6).

Alternatively, you can use *Save to File* to save your device settings to a file. This is useful, for example, if you want to use a different amplifier of the same model for the same sensor(s), then you can save the settings in a file and then load it into the other device.

To load the settings, click on *Load Settings*.



With *Load from File* you can restore the settings from a file and with *User* 1 to *User 6* (2) you can restore the settings from the above-mentioned data sets in the device.

In addition, there is the possibility to restore the data that was valid at the time of switching on with Last Session. This can be useful if you have accidentally selected unfavorable settings (e.g. *Load User 1* to 6 or *Default*) or wanted to try something as a test that should not be stored permanently. *Last Session* loading is only available on the GSV-2 and GSV-8 (because these models do not save the current settings until shortly after switching off, so the power-on data is still available in the non-volatile memory).

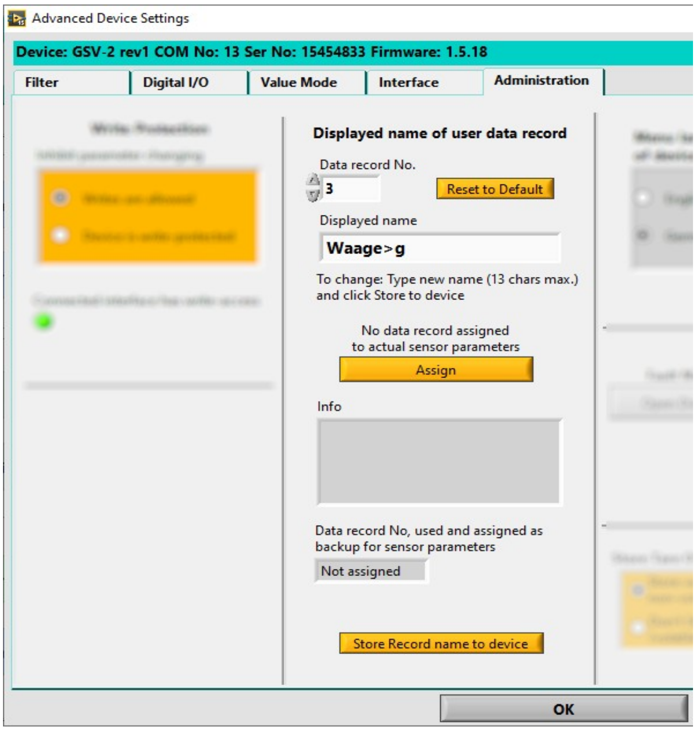
In addition, you can use *Default* to **load the manufacturer's settings**. These are the factory settings that the amplifier has by default. In the case of normal series devices, this corresponds to the configuration of the delivery condition (but this does not apply if the manufacturer has configured the device differently at the customer's request, e.g. to calibrate it for a specific sensor).

Factory Settings Loading is available on all amplifier models. The operating instructions or protocol documentation often provide information about the specific factory settings, often also the type plate. The default measurement data rate is usually 10/s.

Generally, *Load Settings* overwrites the current settings, i.e. they are lost (only with the GSV-2 and GSV-8, you can *undo it with* Last Session).

Assign and name device setting data for the GSV-2

With the GSV-2 you have the possibility to give your own names to the user records and to set this configuration as associated with a specific sensor or measurement campaign. This can be done by clicking on *Device -> Advanced Device Settings* in the menu bar. and select the *Administration* tab:

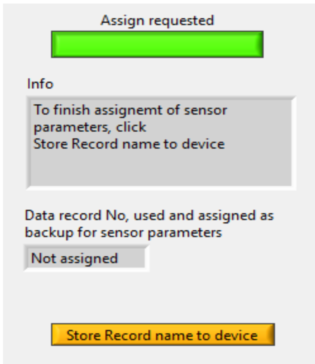


Prior to this, the current device settings should be configured as desired, e.g. input type, zero point, *user scaling, user offset,* measurement data rate, etc.

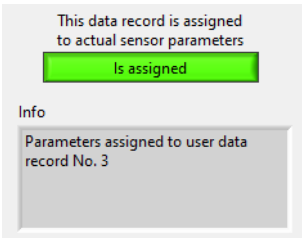
Then you first select the record number with *Data record* No, where 1 corresponds to the default name *"User 1*", up to No. 6 for "*User 6*". Then enter a suitable name in *Displayed name* (maximum 13 characters long).

Then click on *Assign to* assign the current settings to this data record.

This will change the output as shown on the left.



Lastly, click on *Store Record name to device:*



This assignment is automatically removed when device settings are subsequently changed. This can be prevented by setting the write protection, see S. 29

The new name of the record is now also displayed in the *Load Settings* and Save *Settings* dialog and also in the display on GSV-2 models with keyboard menu when entering the corresponding menu item.

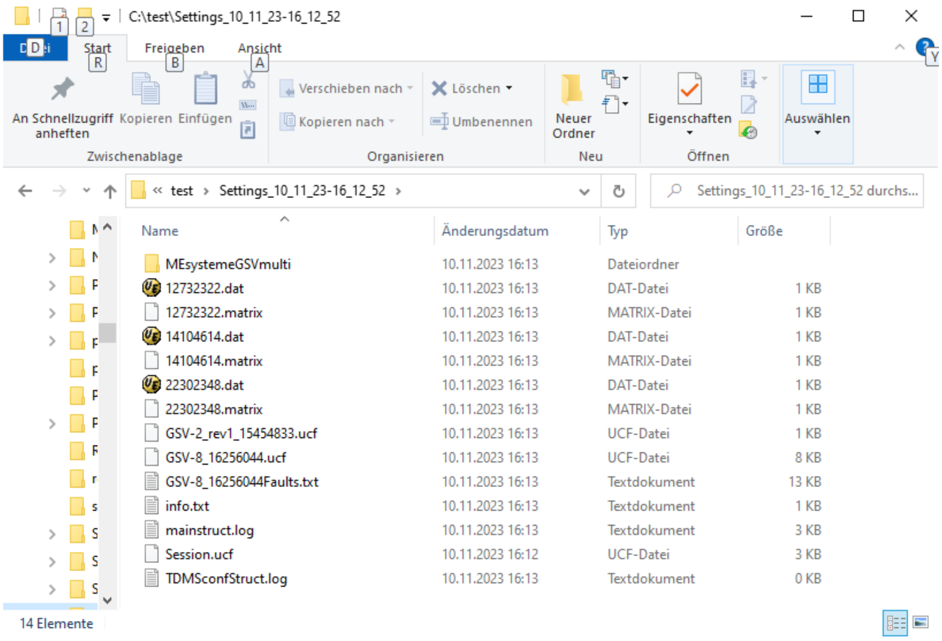
As long as the assignment of the settings (to the sensor or measurement) remains the same, because no relevant settings have been changed, the name of the data record is displayed on the display after the manufacturer's name, e.g.: 3: Scale>g

In *Administration* (see above), *Reset to Default* can be used to undo the naming and assignment.

Restoring Device Settings Files from a *Settings Archive*

If you click on *Help -> Create Settings Archive* , a ZIP file will be created that contains all relevant files with settings. The settings of all amplifiers that are open during this time are stored in files of this archive, as well as the last opened or saved *Session* File (see p. 15) is included with the original file name in the root directory of the archive.

The device settings files are in the root directory of the archive and have the file name pattern **<Device Model><Serial Number>.ucf.**



In the example shown, a GSV-8 and a GSV-2 were open. The device settings file of the GSV-8 is *GSV-8_16256044.ucf* and that of the GSV-2 is GSV-2_rev1_15454833.ucf. The default name of the session file is *session.ucf.*

The archive also contains the *.dat and *.matrix files of all multi-axis sensors, both software-calculated and those contained in the GSV-6 and GSV-8 devices, see p.44. GSV-8 also stores a file containing the contents of the error memory, here *GSV-8_16256044Faults.txt. info.txt* contains general information about the software version.

With the GSV-8 you can also open the *Settings Archive* directly to load all six-axis sensor data back into the device. This may be useful after a firmware update. To do this, click the *Recover All Six-Axis Sensors from Settings Archive* button in the menu bar → *Device* → *Advanced Settings* → *Administration* and then select the *.zip file.

Porting the device settings of the GSV-1A8 USB

In reality, the GSV-1A8 USB and GSV-1A16 USB amplifiers cannot store their device settings **in the device** (unlike all other GSVs). Instead, the device settings are emulated in files located on the PC in the directory C:\ProgramData\MEsystemeGSVmulti and in the *Settings Archive* in the sub-directory MEsystemeGSVmulti. In it, you have the file name <Serial Number>.ucf.

To run a GSV-1A8/16 USB with the same settings on another computer, you can copy these settings. To do this, first create the *Settings Archive* and unzip it on the target PC. On this you have to make the system directory C:\ProgramData visible with Windows Explorer, because it is usually hidden. Once you have done this, copy this settings file into the directory C:\ProgramData\MEsystemeGSVmulti without changing the name. GSVmulti should not be open. Then start GSVmulti and open the GSV-1A8/16 with Add Channel and save the channel list in a session file if desired.

Porting the session file to another PC

The session file contains a list of all integrated channels and other software settings such as additional *Graph-Windows* with their window scales and *Trigger Paste* and *Copy-Paste* Settings (see p.83).

It is a configuration file in text format, divided into sections whose entries are of the form <key name> = <value>. Section names are enclosed in square brackets **[**name**]**.

Each channel has its own section called [ch<Nr>]. On another PC, all settings can be valid as well, except for the COMport numbers of the connected devices and, if applicable, the window scaling of the *Graph Windows*.

In order to port the session file, the COMport numbers that the amplifiers have on the target PC must be known. To do this, they would have to be connected once and you can then look them up in the Windows Device Manager or open them with *Add Channel* as a test.

The session file can be opened with any text editor, e.g. Notepad.exe.

In all sections [ch<Nr>] that belong to an input channel of a device, the values of the entries ComNr must then be changed. Example:

```
[ch1]
device="GSV-8"
ComNr=17
Input=1
BaudRate=115200
OpenFlags=0
Name="Chan. 17_1"
SerNr = 16256044
Color = 16777215
IsHidden = FALSE

[ch2]
device="GSV-8"
ComNr=17
Input=2
BaudRate=115200
OpenFlags=0
Name="Chan. 17_2"
SerNr = 16256044
Color = 16711680
IsHidden = FALSE
```

As you can see e.g. in the section [ch1] with ComNr = 17, this GSV-8 had the COMport number 17 on the old PC. To port the session file to the new PC, change all values of ComNr (e.g. *ComNr = 5*) in

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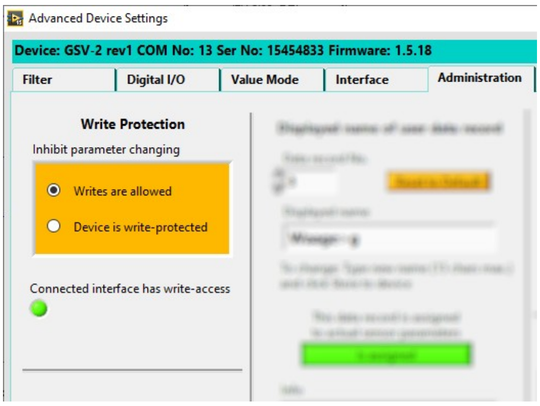
all sections that belong to this device instance. Identical device copies have the same serial numbers, i.e. the entries SerNr have the same value.

In the GSV1A8/16-USB, the ComNr corresponds to an entry DevNo = <no>, where the number is assigned by the driver. It will be listed in the drop-down list of the *Add Channel* dialog.

Protect device settings from modification

With the GSV-2, GSV-3, GSV-6 and GSV-8 models, you can protect the device settings from unauthorized or accidental changes via hardware write protection. If write protection is set, the attempt to change settings in the device will be rejected, and an error message will appear for the GSV-6 and GSV-8.



To set write protection, click on *Device -> Advanced Device Settings* in the menu bar and then select the *Administration* tab:

Under *Inhibit parameter changing*, you can set write protection with *Device is write-protected* and remove it again with *Writes are allowed*.

This may open a sub-dialog for entering a password. The password to be entered depends on the model, with the GSV-6 and GSV-8 it is already selected in the password dialog, so that you only have to confirm with OK:

- GSV-2 and GSV-3: Immutable password: **berlin**
- GSV-6: Immutable device password: **USC1**
- GSV-8: Changeable device password, Default: **BeIn**[6]

If write protection is not set, i.e. changing settings is allowed, the soft-LED ***Connected Interface has write-access*** lights up bright green. If it does not light up, i.e. is dark green, this may have another cause in addition to the set write protection: In devices with **multiple interfaces** (GSV-8 and GSV-2 CANopen), the communication interface with which the device was opened may **not have write permission** because the other interface has write permission. The following applies: In the field bus systems CANopen and EtherCAT, the field bus system usually always has write permission when it is on and not in the STOP- or INIT-state.
In the case of serial interfaces USB / UART / RS422 / RS232, the interface with which the device was first opened with an application program such as GSVmulti has write permission.

6 The GSV-8 allows you to change the device password, but it is not currently supported by GSVmulti, so it is unlikely that the device password will be different. However, if this is the case, **it must not be forgotten**, otherwise the GSV-8 would have to be sent to the manufacturer for repair.

Observation and evaluation of live data during measurements

The measurement data can be observed during the measurement in several ways:

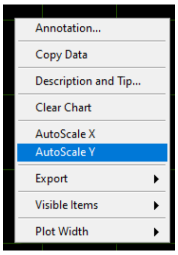
Numerical: As a large display in the tab *Value Display,* see p.*12.* Here, the measured values are always updated, even if *Start Recording (Recorder Yt)* has not yet been clicked. Other numeric displays include the *Value display* in *Recorder Yt* and in the *Recorder XY* and the single value display in *Configuration.* Basically, numerical displays are updated every 0.2 s (i.e. 5x per second) or less frequently when new measurement data is available less frequently. The latter depends on the measurement data rate (hardware setting), the software acquisition interval and, if applicable, the *Value display type* ab, see below.

Graphically: In the *Graph Display* tab, individual graphs are available for each measurement channel, but only for the first 16 channels, see p. 12. These graphs represent the readings over time. The scale of the Y-axis can be changed for each individual graph, as well as the *Autoscale* Condition (see below). The temporal latitude corresponds to that of the *Recorder Yt* under *Time Visible*. Also in the *Graph Display* the measured values are always updated, even if *Start Recording (Recorder Yt)* has not yet been clicked.

In *Recorder Yt* all channels are represented in a graph over time, after the measurement with *Start Recording* begun, see p. 10

In *Recorder XY* one or more channels are displayed in dependency of another, i.e. not over time, see p. 64.

With the button *Add Graph Window* Up to six additional windows can be opened that display live data, either as a Yt or XY chart or as an FFT spectrum, see p. 20. The *Graph Window* Windows are also stored with name, position, type, etc. in the *Session file*, see p. 15. You can distribute them evenly on the screen using menu bar -> *View → Sort Graph Windows.*



For each graphical display, the scaling of the axes can be done automatically if the *Autoscale* function is activated. This can be changed with the right-mouse button context menu by right-clicking into the graph.

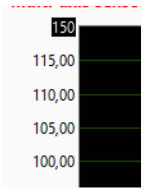
With *Autoscale X* , the entire amount of the measurement from the start time is displayed in the graph in the Yt recorder. The start time then remains constant on the left edge of the (horizontal) time line. However, the following should be noted:

- The total time with which this is possible is limited. As soon as that time has been exceeded, the time display at the left time-scale also begins to run and measurements that are older would be lost. This time is at least about 7 minutes. It can be enlarged with GSVmulti PRO from version 2.01 onwards, see S. 33.
- With a high **measurement data rate** (and/or high system load from other programs), GSVmulti requires a relatively large amount of RAM and processing

becomes **slower** as a result. As a result, the total time with *Autoscale X* is often longer[7], but it can happen that the program reacts very sluggishly.

Autoscale Y adjusts the full scale values of the Y-axis to match the visible readings. If there is no useful signal, but only noise, one can come to wrong conclusions about the noise amplitude because it is displayed optically enlarged.

It can be useful to use the *Autoscale Y* function in a test measurement and direct the sensors to an area where you want to measure and then enlarge that area slightly as full scale values:



For each graphical display, the scale of the measured value axis (usually the Y-axis) can be changed, unless it is set automatically by *Autoscale*. This axis scaling only affects the visibility of the graph, it has no effect on the scaling of the measured values by the amplifier.

Left-click on one of the two full scale values, enter the new value, and finish typing with the Enter key. It will be restored the next time the program starts.

Numerical display in *recorder Yt* and *XY*

In *the Recorder Yt* and *Recorder XY, the* measured values of all channels are displayed as numbers in addition to the graphical view. The display type can be configured with the Display drop-down menu and you can choose from the following options:

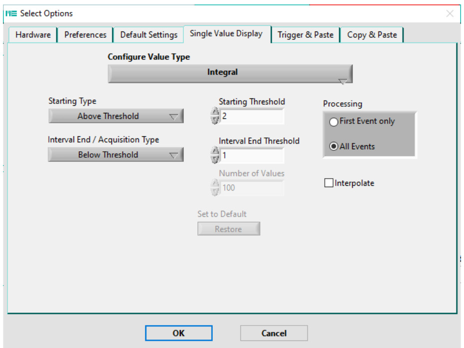
- *Actual Val*: Current reading as it is
- *Maximum*: Maximum value of the current measurement.
- *Minimum*: Minimum value of the current measurement.
- *MAX(abs):* Maximum value of the amount of the current measurement, thus taking negative minimums into account.
- *SNR [dB]*: Standard deviation, based on the measuring range in dB, see p. 20
- *Resol. Parts pp*: Peak value noise related to the measuring range in dB, see p. 20ff.
- *Max-Min:* Range between maximum and minimum value, see p. 20ff.
- *Mean*: Average, averaged over 100 values in the initial configuration and decimated. Alternatively, the time over which you want to average can be configured under Menu Bar->*Options->Single Value Display -> Mean*. This interval also determines the refresh rate of the mean (so it's not a moving average).
- *Integral:* The measured value is integrated, according to the settings under *Options* (see below)
- *RMS/StDev*: Standard deviation, see p. 20ff.

All of these values are reset when the measurement starts *(Start Measuring)*, when setting zero and when the type is changed. In the display, *Wait...* appears eventually.

7 The reason is that the Yt signal diagram can hold up to 5120 data packets (v. 2.01) and at high data rates the individual packets become larger. The slower the program becomes, the larger they become, i.e. the packets contain more and more readings.

The results are determined by *SNR [dB], Resol. Parts pp, Max-Min* and *RMS/StDev* over 100 values or over one second if the measurement data rate is greater than 100/s. This interval also determines the refresh rate of the value display.

Exceptionally***, the Integral*** display must be selected before starting the measurement. It can be configured, among other things, with regard to the integral boundaries under Menu Bar -> *Options -> Single value Display*. Choose *Configure Value Type = Integral.*



Starting Type can be used to specify which criterion should apply to the left integral boundary:

- *None: Consecutive Intervals* means that after reaching the right integral boundary *Interval End*, a new integral is automatically processed. To display the indefinite ever-running integral, this setting is combined with *Interval End = Infinite.*
- *Above Threshold*: If the *starting threshold* is exceeded, a new integral is formed (Y-condition of the left integral boundary).
- *Below Threshold*: If the starting threshold falls below the *threshold,* a new integral is formed (Y condition of the left integral boundary).

Interval End / Acquisition Type can be used to define the criterion for the right integral boundary:

- *Infinite*: The integral calculation continues for the whole measurement (indefinite integral)
- *Above* Threshold: When the *Interval End Threshold* is exceeded, the integral is terminated (Y condition of the right integral bound).
- *Below Threshold*: When the interval end threshold falls below the *interval end threshold*, the integral is terminated (Y condition of the right integral bound).
- *Number of values:* The integral is calculated using the number of measured values specified in *Number of Values* (time condition of the right integral bound: time = number / measurement data rate).

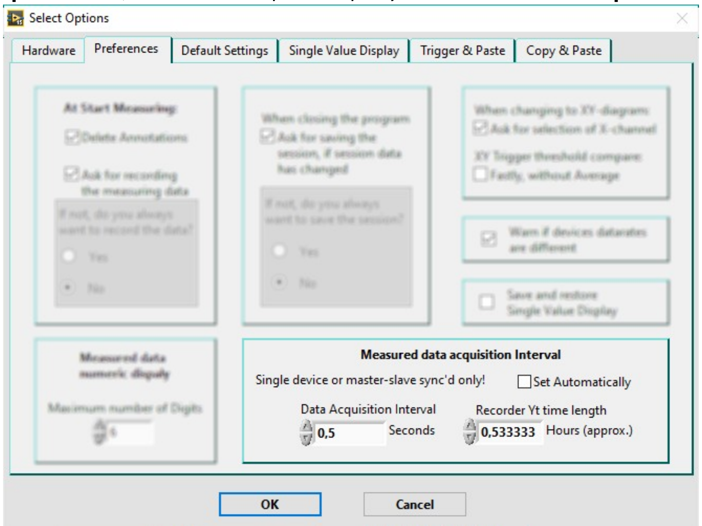
Processing allows you to specify whether to calculate only one integral (*First Event only*) and ignore all subsequent start conditions, or multiple integrals (*All Events*), so that after reaching the right integral limit, the process waits again for the start criterion to be met for the left integral limit. After completion of an integral, the last result value is hold in the *Single Value Display* in both settings, making it easy to read. In the case of the indefinite integral (see above), this setting has no effect. *With Interpolate*, an additional input value is created (interpolated) between two consecutive input values, which can lead to a more accurate result in some applications.

The values displayed in the *Single Value Display* can be copied to the clipboard at the time of measurement or pasted directly into other programs by hitting a key. To do this, configure under menu bar -> *Options -> Copy & Paste* -> *Value Type to Copy/Paste* to *As Shown in Single value Display,* see p. 83.

The memory behavior of the *Single Value Display* type can be configured under Menu Bar->*Options ->Preferences*. In the initial state, this is not saved and is set to *Actual Val* when the program starts. If *the Save and restore Single Value Display* checkbox is set, the type will be restored the next time the program starts.

Configuring the Time Duration of the Acquisition Interval

The time duration of the acquisition interval is the time that the software waits and collects readings until it displays them, so it is also the refresh interval. After an interval has elapsed, a data packet is passed on for processing and graphical display, so its length over time determines the packet size. This is also related to the storage depth of the graph in the *Recorder Yt*. It is relevant if you *Autoscale X* (see p. 30ff.) or if you want to use *Configure Recording -> Save Memory Data* to copy the values stored in the Yt graph into a measurement data file (see p.70). The storage depth in the *Recorder Yt* is set to 5120 packets, in the *Graph Display* there are 768 packets for each graph. With GSVmulti PRO



from v. 2.01 it may be possible to change this interval under Menu bar -> *Options -> Preferences -> Measured data acquisition Interval.* This setting only applies when using only one amplifier or several, all of which are synchronized with each other via master-slave. It also does not apply to the GSV1A8/16.[8]

In the default state and with the standard variant, the recording interval is determined automatically; then *Set Automatically* is selected and the recording interval is between 0.1 s and 0.2 s, i.e., it is updated between 5x and 10x per second.

If *Set Automatically* is not set, you can select the acquisition interval under ***Data Acquisition Interval*** or have it calculated by entering the temporal storage depth of the *Recorder Yt* in *Recorder Yt time length* (in hours).

If you choose the acquisition interval large, the program can become slow and sluggish with a high measurement data rate and many channels. If the result of

Acquisition interval x measurement data rate^2 x number of channels is

greater than 20 million, a warning is issued when the measurement starts.

Regardless of the setting of this acquisition interval, the **display interval** for numeric displays is always 0.25 s, i.e. a new number is displayed 4 times per second. If the measurement data rate is higher, it is decimated to 4/s by averaging, if it is lower, the display interval corresponds to the measurement data period.

Decimal Places of Numerical Readings

Basically, the number of decimal places depends on the display normalization *User Scaling* and the maximum number of digits. The latter is configurable and is 6 decimal places out of the box. If the number of decimal places exceeds the numerical resolution of the

8 These two restrictions may be removed for versions > 2.01; the revision history will provide information on this.

measurement data from the amplifier, lower-order decimal places are set to 0. This can be the case with the GSV-2 and GSV-3, for example, if the ASCII reading output is activated and configured accordingly, see p. 112. In the case of 16-bit amplifiers such as GSV-3, GSV-4 and GSV-6 (version 1.x), this can also be true with binary measurement data formats. The natural maximum of significant decimal places is 5 digits for 16-bit devices and 8 digits for 24-bit devices (GSV-2, GSV-8 and GSV-6 v.2.x).

The maximum number of decimal places displayed can be configured under ***Menu Bar -> Options -> Preferences -> Measured data numeric display***; the value range is 4 to 8.

The number of decimal places is usually calculated as follows:

Number of decimal places = *Maximum number of digits* - rounding up($\log_{10}$(User Scaling))

Examples: *Maximum number of digits*=5, User Scaling = 3.5: 4 decimal places

Maximum number of digits = 5, user scaling = 10,000: one decimal place

Maximum number of digits = 4, User scaling = 150,000: no decimal place

Maximum number of digits = 4, user scaling = 2: 3 decimal places

Maximum number of digits = 4, User scaling = 1: 4 decimal places

Recording of measurement data and subsequent evaluation

GSVmulti provides a wide range of options for storing measurement data. The configuration of data recording is described from p. 66 and the evaluation with the *File Monitor* from p. 75. Among other things, measurement data can be converted into CSV or Excel files, the recording can be started and stopped automatically, and much more.

It is even possible to view a preliminary result of the *.tdms measurement data file with the *File Monitor* while data is being recorded (i.e., when *Start Recording* is active). You will then see data from the beginning of the file without the part that is currently being written to. However, it is not possible to take notes (*Annotations*) as described on p. 91 be set or modified, because the *File Monitor* cannot save changes to a file that is currently written to. Notes are set during live measurement as described on p. 89.

Configuration of data logger devices

The Amplifier Models **GSV-6BT** and **GSV-2MSD-DI** offer the possibility to record measurement data in the device on an SD memory card, i.e. measured values can be stored independently of the PC. These functions are described in the user manuals (a separate one for the GSV-6BT). The logged measurement data files are available in a readable text format, but can also be opened with the File Monitor, see p. 75, converting them to tdms file format. With both amplifier models, the measurement data files can be copied from the SD card without having to remove it from the device, see p. 38. With the GSV-6BT, it is often useful to ensure that the **measurement application remains switched on** for recording after the communication connection is closed**.**, which is described from p. 115.

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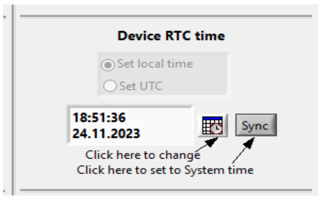
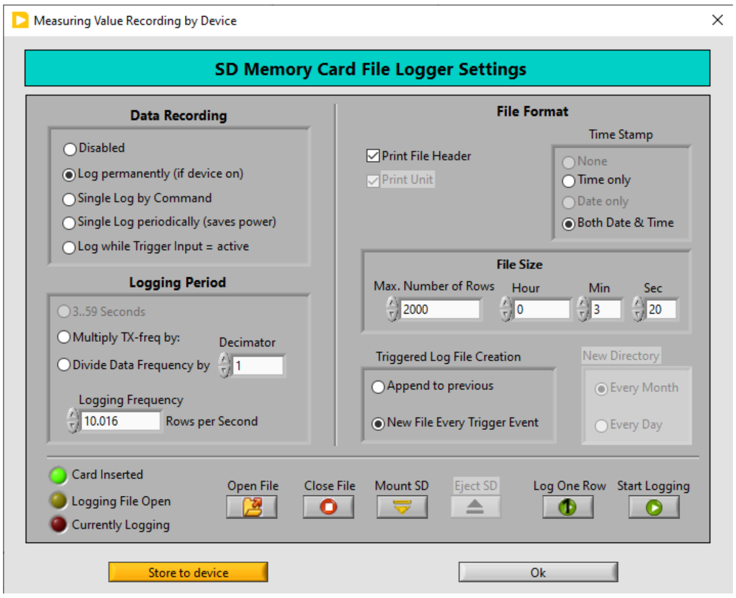
First of all, it is important that the built-in real-time **clock** is set correctly. After a change or drain of the battery or after a long time, the clock may be adjusted. To read the clock and set it, click on *Device -> Advanced Settings* in the menu bar and select the *Administration tab*:



By clicking on *Sync*, the clock will be set as close as possible to the time of the PC. Before that, you can specify with the GSV-6BT whether you want to set the clock to the local time zone (*Set local time*) or to UTC world time (*Set UTC*). In the view, the time is read from the device every 3 seconds.

To **configure the logger function**, first select a channel that belongs to the device you want to configure, in case that several devices ate opened. Then click on *Device* in the menu bar and select *Advanced Settings*. Select the *Administration* tab and click on *Settings* under *Measuring values Logger*.



Here is the dialog of a GSV-6BT with an SD card inserted. The radio buttons under *Data Recording* have the following meaning:

- *Disabled*: Recording is turned off
- *Log permanently (if device on):* The measurement data is constantly recorded as long as the device is connected and an SD card is inserted.
- *Single Log by Command* (GSV-6BT only): A line of measured values is recorded by a device command given by software. This can be done, for example, by clicking on the *Log One Row* button.
- *Single log by OK Key* (GSV-2 MSD-DI only): A line of measured values is written by pressing the OK key.
- *Single Log Periodically* (GSV-6BT only): The slow recording mode is activated. The time interval between two lines of readings is configurable from 2s to several hours under *Logging Period*. Since the GSV-6 is put into standby mode in the meantime, this mode is energy-saving, especially for periods of one minute or more, so that the battery lasts a long time.
- *Log while Trigger Input = active* (GSV-6BT only): It is recorded while the TRIGGER digital input has an active level and the GSV-6 is on (green LED on). For this purpose, a digital input must be configured accordingly, see p.121

The settings under *Logging Period* affect the **recording interval** and apply only to the GSV-6BT. Their appearance and meaning depend on the *data recording* mode.

With *Data Recording = Log permanently* and *Log while Trigger Input = active*, they mean the following:

- *Multiply TX freq by*: This allows the recording rate to be higher than the measurement data rate, which is transmitted via Bluetooth. This is useful if you want a high recording rate on the SD card and at the same time want to avoid connection problems with Bluetooth that can occur with high data transfer rates. Under *Factor* you can enter the factor between SD recording rate and transfer rate or you can enter the desired recording rate directly under *Logging Frequency*. The correlation is: *Logging Frequency =* Transmission Rate x Factor.
- *Divide frequency by*: This allows the recording rate to be smaller than the measurement data rate, which is transmitted via Bluetooth. Under *Decimator* you can enter the divisor between the transmission rate and the SD recording rate or you can enter the desired recording rate directly under *Logging Frequency*. The correlation is: *Logging Frequency =* Transmission Rate / *Decimator*.

With *Data Recording* = ***Single Log periodically*** , they mean the following:

- *3..59 Seconds*: The measurement data recording interval is in the range between 3 and 59 seconds. It can be entered under *Seconds*. This setting is only slightly energy-efficient because the amplifier remains on the entire time.
- *Minutes / Hours / Days*: The measurement data recording interval ranges from one minute to several days. The number of days is entered under *Days* (may =0), the hours under *Hours* (0 to 23) and the minutes under *Minutes* (1 to 59). Since the GSV-6 is put into standby mode in the meantime, this mode is particularly power-saving, so that the battery lasts a long time, the longer the recording interval, the longer.

Under *File Format*, the formatting of the measurement data files can be influenced. Examples of file contents below.

- *Print File Header*: A header is written at the beginning of each file. It contains information about the meaning of the columns, the number of channels, normalization, modes, unit if applicable, and recording rate. This checkbox is set by default. Omitting the header is not highly recommended, because importing the text file with the *File Monitor* may not have a good result.
- *Print Unit*: If this checkbox is set, the GSV-6BT writes the units of all configured channels in a line in the header; the GSV-2MSD-DI writes them after each measured value in a column (currently not deactivable for the GSV-6BT).
- *Log Max-, Min- and Mean* (GSV-2MSD-DI only): If this checkbox is set, the GSV-2 determines the maximum, minimum and mean value in addition to the current measured value, so that 4 measured value columns are written. Example GSV-2 MSD-DI, language = English:

```
Scaling: +100.000 Data frequency: 10.000 Hz                ← Print File Header activated
Date       Time               Value    Max     Min     Mean  Unit   ← Max-, Min- and Mean activated
23/11/23,19:43:38.25886       +5.913   +5.914  +5.913  +5.914   g   ← Print Unit activated
```

Under *Time Stamp*, the timestamp columns can be formatted. They are written to the first column of the measurement data file.

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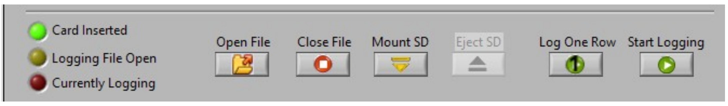
- *None* (GSV-2MSD-DI only): No time or date. This setting is not recommended because the import of the text file with the *File Monitor* may not have a good result regarding the timestamps of the tdms file. This is especially the case if *Print File Header* is disabled at the same time.
- *Time only*: The timestamp contains only the time with fractions of a second, not a date. Example GSV-2 MSD-DI, language = English:
  Scaling: +100.000 Data frequency: 10.000 Hz ← *Print File Header* activated
  Time Value Unit ← *Print Unit* activated
  19:20:13.61203 +6.328 g
- *Date only* (GSV-2MSD-DI only): The timestamp contains only the date, not the time. This setting may also not be recommended, see *None*. Example GSV-2 MSD-DI, language = English:
  Scaling: +100.000 Data frequency: 10.000 Hz ← *Print File Header* activated
  Date Value Unit ← *Print Unit* activated
  23/11/23 +6.256 g
- *Both Date & Time*: The timestamp contains both the date and the time. Example GSV-2 MSD-DI, language = English:
  Scaling: +100.000 Data frequency: 10.000 Hz ← *Print File Header* activated
  Date Time Value Unit ← *Print Unit* activated
  23/11/23,19:21:59.04858 +6.166 g

Under *File Size*, you can specify how large the file should be. This is useful so that the files do not become too large, which is particularly relevant for permanent data recording. The input is made as a specification of the maximum number of rows under *Max. Number of Rows* or as a specification of the maximum time over which a file contains measurement data, where the input is made under *Hour*, *Min* (minutes) and *Sec* (seconds). The time and line information are converted into each other when entered, based on the currently set measurement data rate. Only the number of lines is stored in the device. If this is reached during the recording, a new file is created.
Note: The minimum time length should never be less than one second, otherwise it will not be possible to create individually different file names, i.e. the minimum number of lines is equal to the measurement data rate.
The reason for this is that the file names consist of date and time, including the second.

With the GSV-2MSD-DI, you can specify under *New Directory* whether a new directory should be created for the measurement data files every day (Every *Day*) or every month (*Every Month*), see the operating instructions.

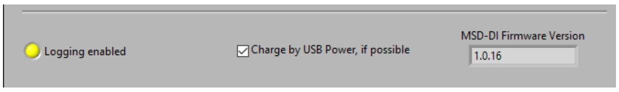
If the GSV-6BT *Data Recording* is set *to Single Log by Command*, Single Log File Creation can be used to specify whether the lines of measured values should always be appended to the last written *file (Append to previous*) or whether a new file should be created every day *(New File Every Day*) in which the measured value lines should be written. If *Data Recording is* set to *Log while Trigger Input = active*, you can choose between *Append to previous* and *New File Every Trigger Event*. With the latter, a new file is created every time a recording is started by activating the trigger level, and this has the advantage that the timestamps will also be correct when importing the file into a tdms file.
For appended data, the timestamps in the converted tdms file are incorrect.

At the bottom of the window are some soft LEDs and buttons, which are **immediately executed** in the GSV-6BT device and have the following meaning:



- *Card Inserted*: When this soft LED is lit, an SD card is inserted and mounted.
- *Logging File Open*: When this soft LED is lit, a file is open for writing. Attention: **The SD card must not be removed!**
- *Currently Logging:* Data is recorded.
- *Open File*: Clicking this button will open a file for writing
- *Close File*: A data recording is stopped and the file is closed
- *Mount SD:* An SD card that has just been inserted is mounted. Note: If an SD card is inserted when the GSV-6BT is turned on, it will automatically mount it.
- *Eject SD*: The inserted SD card is deactivated so that it can be removed afterwards
- *Log One Row*: If the *Data Recording* type is set to *Single Log by Command*, a line of readings will be written when this button is clicked
- *Start Logging*: If the *Data Recording* type is set to *Log Permanent*, clicking this button will start data recording

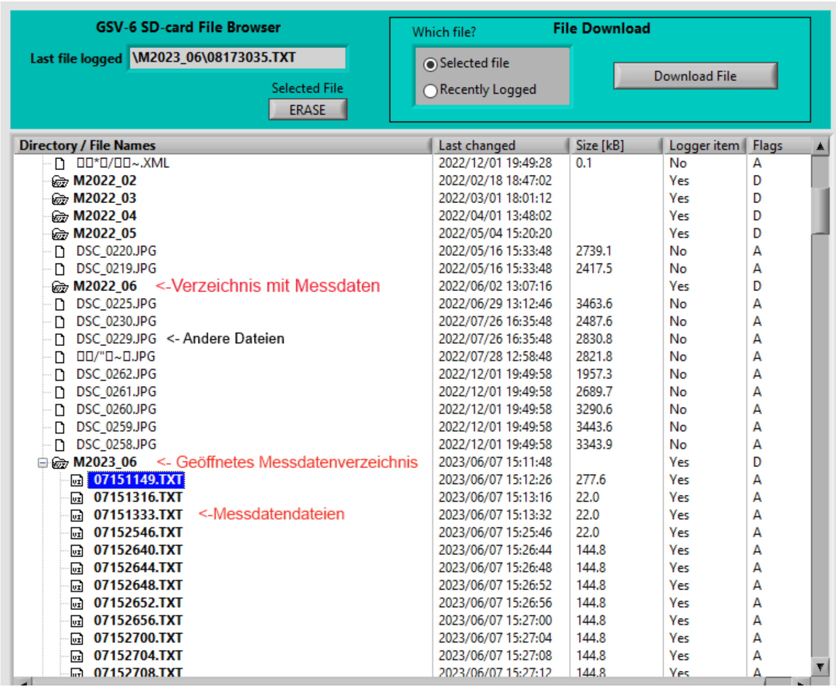
In the **GSV-2MSD-DI**, the elements at the bottom have the following meanings:



- *Logging enabled*: This soft LED lights up when data recording is enabled.
- *Charge by USB Power, if possible*: If this checkbox is active, the device tries to draw power via the USB interface. When it is on, these 500mA are not enough to charge the built-in accumulator, but when it is switched off, it is possible. In this state, it acts as a mass storage device on USB.
- *MSD-DI Firmware Version*: Version of the embedded software of the (second) controller for the management of USB, SD card, data recording, power management and logger menu.

Accessing the recorded measurement data of the data loggers

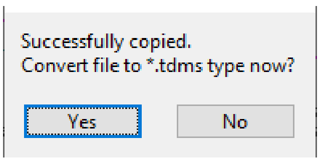
The GSV-2MSD can be switched to USB mode via the user menu to be able to use it as a card reader. To do this, the device can also be turned off instead; in both cases, the use of GSVmulti is not possible at the same time. In USB card reader mode, the SD card is accessed, e.g. with Windows Explorer, see user manual.



For the GSV-6BT, GSVmulti provides a **file browser** for copying files; it can be opened via Menu Bar *-> File -> Device File Browser* or Menu Bar *-> Device -> Advanced Settings -> Administration -> File Browser.*

In the upper left corner, next *to Last file logged*, the path to the last recorded file is listed. If in the top right corner under *Which file? Recently logged*, it can be downloaded directly by clicking on *Download File*.

If *Selected File* is selected, select the directory in the file view under *Directory / File Names*; it will be formed from M<Year>_<Month>. Double-clicking on it will unfold it, as shown here for M2023_06. Now you can highlight the file. Entries in bold in the file view are measurement data directories and files, where *Yes* is also listed under *Logger Item*. Then click on *Download File*, select the destination directory on your PC and the download will start, indicated by a progress bar. Copying (downloading) can take a long time for large files. The file size is displayed under Size [kB] and the download time can be estimated: time in seconds = file size [kB] x 0.12.



When it's done, it will ask if you want to convert the downloaded text file to tdms format. If you confirm this, the file can be opened with the *File Monitor*. However, this isn't necessary, because the text file can also be opened directly with the *File Monitor*.

Additional features

Note: Most of the configuration options shown below are applied to the device to which the channel selected with *Actual Channel* (Configuration tab) belongs.

Input Types and Measuring Ranges

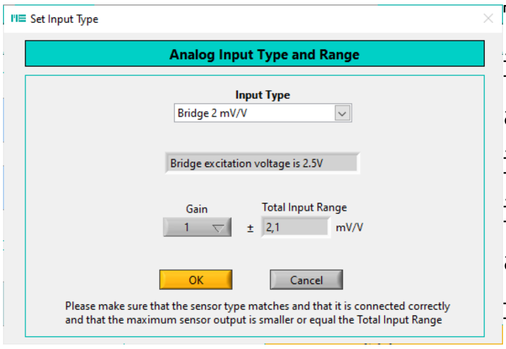
It is best to set the input type and measurement range (=input sensitivity) of the measurement amplifier before making other configurations that depend on this setting, such as *User Scaling*. The input type must match the sensor being used, and **different basic types** (e.g. bridge input, single-ended voltage input) **have different connections on the amplifier**. Each measurement amplifier model has different input types and measurement ranges, and there are special variants with alternative measurement ranges. Only GSV models are listed below where the input type is changeable only standard versions are shown; for the GSV-3, it is fixed and is indicated on the type plate.

The dialogue for setting the input type can be accessed in the Configuration tab by clicking on *Input Type*; it is also displayed to the right of this (see also p. 8). Some types cannot be set via the software or in this dialogue; in this case, a pop-up message will appear. All available types and measurement ranges are listed in the *Input Type* drop-down menu.

The following generally applies to bridge inputs: In order to measure the raw bridge deviation in mV/V, the user scaling must be set to the same value as the input measurement range. Some models automatically adjust the user scaling accordingly when the input type is changed, whilst others do not, as noted below.

GSV-2 Input types

Type	Range	Name	Sensor supply	Settable by Software?
Bridge input	± 1 mV/V	*Bridge 1 mV/V*	5 V	No (only with jumper)
	± 2 mV/V	*Bridge 2 mV/V*	2,5 V	Yes, if before not 1 mV/V
	± 3,5 mV/V	*Bridge 3.5 mV/V*	2,5 V	Yes, if before not 1 mV/V
Single-ended	0-10 Volt	*Voltage 10V*	-	Yes



The gain can be adjusted using the *Gain* control; it is usually left at 1. Gains of less than 1 (e.g. 1/2, 1/4) are not normally used; at high gains, the noise level is always higher. The zero-point adjustment range is determined solely by the hardware and is approximately twice (200%) the measurement range when Gain=1.

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On the GSV-2, the *User Scaling* is not set automatically when the *Input Type* is changed!

GSV-4 Input types

On the GSV-4, all input types can be changed via software.

Type	Range	Name
Bridge input	± 2 mV/V	*Bridge 2 mV/V*
	± 10 mV/V	*Bridge 10 mV/V*
Single-ended voltage input	0-5 Volts	*Voltage 0..5V*
	0-10 Volts	*Voltage 0..10V*
Temperature sensor PT1000	-250..1000 °C	*Temperature PT1000*
Temperature sensor Type K	-250..600 °C	*Thermocouple-K*

On the GSV-4, the *User Scaling* is set automatically when the *Input Type* is changed, i.e. the old user scaling value is overwritten!

GSV-6 Input types

On the GSV-6 (and GSV-61), all input types can be changed via software; however, the counter input cannot be changed in the *Input Type* dialogue (instead: see p. 133).

Type	Range	Name	Remarks
Bridge input	± 0,1 mV/V	*Bridge 0.1 mV/V*	**Gain=8** best, all Gains possible
	± 0,2 mV/V	*Bridge 0.2 mV/V*	Gain=8 best, all Gains possible
	± 0,3 mV/V	*Bridge 0.3 mV/V*	Gain=8 best, all Gains possible
	± 0,4 mV/V	*Bridge 0.4 mV/V*	Gain=8 best, all Gains possible
	± 0,5 mV/V	*Bridge 0.5 mV/V*	Gain=8 best, all Gains possible
	± 1 mV/V	*Bridge 1 mV/V*	Gain=4 best, all Gains possible
	± 2 mV/V	*Bridge 2 mV/V*	**Gain=2** best, Gain<=4 possible
	± 3 mV/V	*Bridge 3 mV/V*	**Gain=1** best, Gain<=2 possible
	± 4 mV/V	*Bridge 4 mV/V*	**Gain=1** best, Gain<=2 possible
	± 5 mV/V	*Bridge 5 mV/V*	**Only Gain=1** possible
	± 8 mV/V	*Bridge 8 mV/V*	**Only Gain=1** possible
Single-ended voltage input	±10 Volt	*Voltage Input*	Not available on all models
Counter	int16/24	*Counter*	Not available on all models, not settable here
Temperature Sensor PT1000	-250..1000 °C	*Temperature*	Not available on all models

On the GSV-6, the *User Scaling* is not set automatically when the *Input Type* is changed!

For the GSV-6's bridge input, the combination of measurement range and gain also determines the adjustment range for the zero-setting routine (Set Zero / Set All Zero). The gain determines the total input range; it scales down the largest available measurement range (standard GSV-6: 8 mV/V) and also takes the 5% measurement range overhead into account. *Total Input Range* = (8 / *Gain*) x 1,05.

Then, the adjustment range in % of the measuring range is: **±(*Total Input Range* / (Measuring range x 1,05) - 1) x 100.**

Example (default with GSV-6): Gain=2, Measuring range= 2 mV/V, *Total Input Range*= 4,2 mV/V: Bridge deviations up to ±2 mV/V can be adjusted to zero without limiting the measurable range, i.e. the adjustment range for the zero-setting is 100%.

If the measurement range is increased in the Input Type dialog, GSVmulti automatically reduces the gain value if necessary.

In particular, when a sensor with TEDS is connected (see p. 57), it is common for a different, 'non-standard' measurement range to be set, which is not listed in the table above. This is because there is an internal scaling factor that can divide the total input range continuously. In this case, this "special" measuring range is added to the list in the Input Type pull-down menu.

GSV-8 Input types

On the GSV-6 (and GSV-61), all input types can be changed via software; however, the counter input and the mapped digital value cannot be changed in the *Input Type* dialogue (instead: see p. 133 or p. , respectively).

Type	Range	Name	Sensor supply
Bridge input	± 2 mV/V	*Bridge 2 mV/V*	8,7 V
	± 3,5 mV/V	*Bridge 3.5 mV/V*	5 V
	± 7 mV/V	*Bridge 7 mV/V*	2,5 V
Single-ended voltage input	±10 Volts	*Voltage ±10.00V*	5 V (not necessarily required)
Temperature sensor PT1000	-250..1000 °C	*Temperature PT1000*	1,25 V
Temperature sensor Type K	approx. -250..445 °C	*Thermocouple-K abs.*	-
	-250..445 °C	*Thermocouple-K rel.*	-
Counter	Int16/Int24	*Counter*	-

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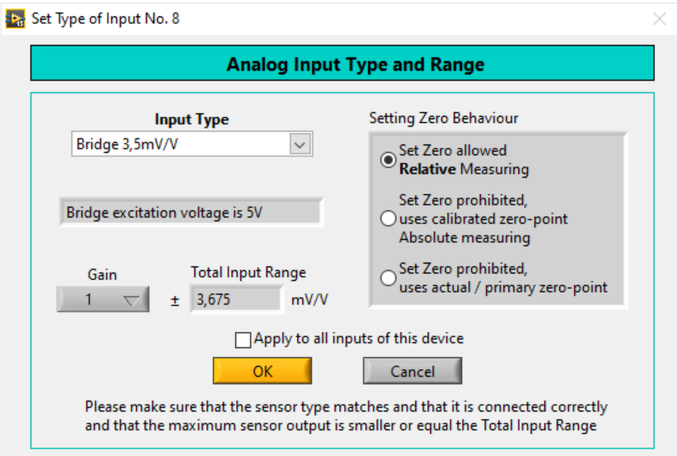
Mapped digital IOs[9]	uInt16	*Digital*	-

On the GSV-8, the *User Scaling* is set automatically when the *Input Type* is changed, i.e. the old user scaling value is overwritten!

When measuring absolute temperature using a Type K temperature sensor (*Thermocouple-K abs.*), a separate PT1000 temperature sensor must be connected to and configured on input 8. This is necessary for cold junction compensation.
The zero adjustment range of the bridge inputs is always ±100% on the GSV-8.



For the Total Input Range, the GSV-8 only takes into account the 5% measurement range overhead.

The setting can be applied to all input channels using *Apply to all inputs of this device*; this is possible on all multi-channel amplifiers.

For the meaning of the *Setting Zero Behaviour*, see p. 94.

9 This feature is only available from firmware version 1.61 onwards and is visible from GSVmulti version 2.03 onwards

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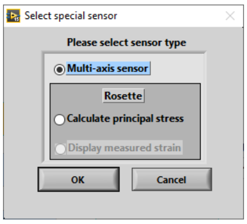
Integration of multi-axis sensors

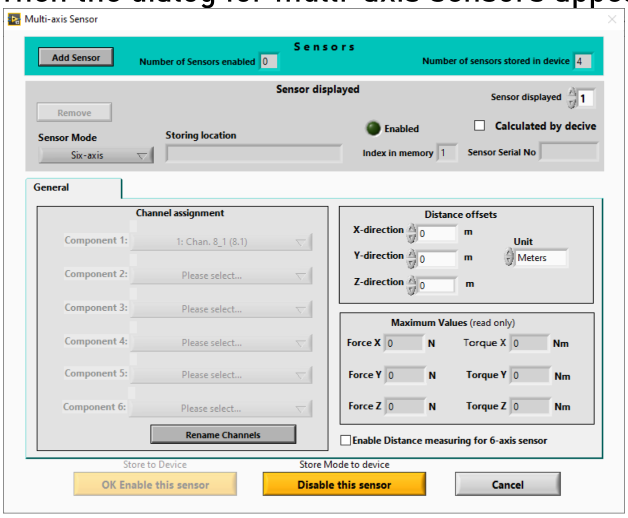
When using K6D or F6D six-axis sensors or K3R series three-axis sensors, a calibration matrix must be loaded once.[10] It can be found in the files that came with the sensor. In the case of the GSV-6 and GSV-8 amplifiers, the calibration matrix for six-axis sensors is usually stored in the instrument because they can perform the calculation themselves (exceptions and limitations: see table below). Otherwise, the files with the calibration data of the multi-axis sensors must remain stored on the PC, because GSVmulti needs them at the measurement runtime to calculate the forces and torques. In this case, at least 6 channels per sensor must always be open.

These files with the calibration data have the following naming convention (please do not rename):
<Sensor Serial Number>.dat<Sensor Serial Number>.matrix
Both files must be in the same directory.

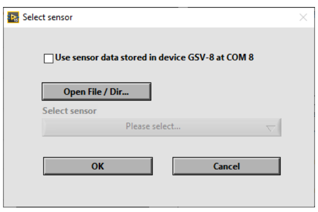


First of all, all required input channels must be open and all of them must have the same *Input Type*, i.e. the same input sensitivity. If this is the case, click on *Special Sensor,* then the following intermediate dialog will open, which you leave as it is and confirm with OK:

Then the dialog for multi-axis sensors appears:



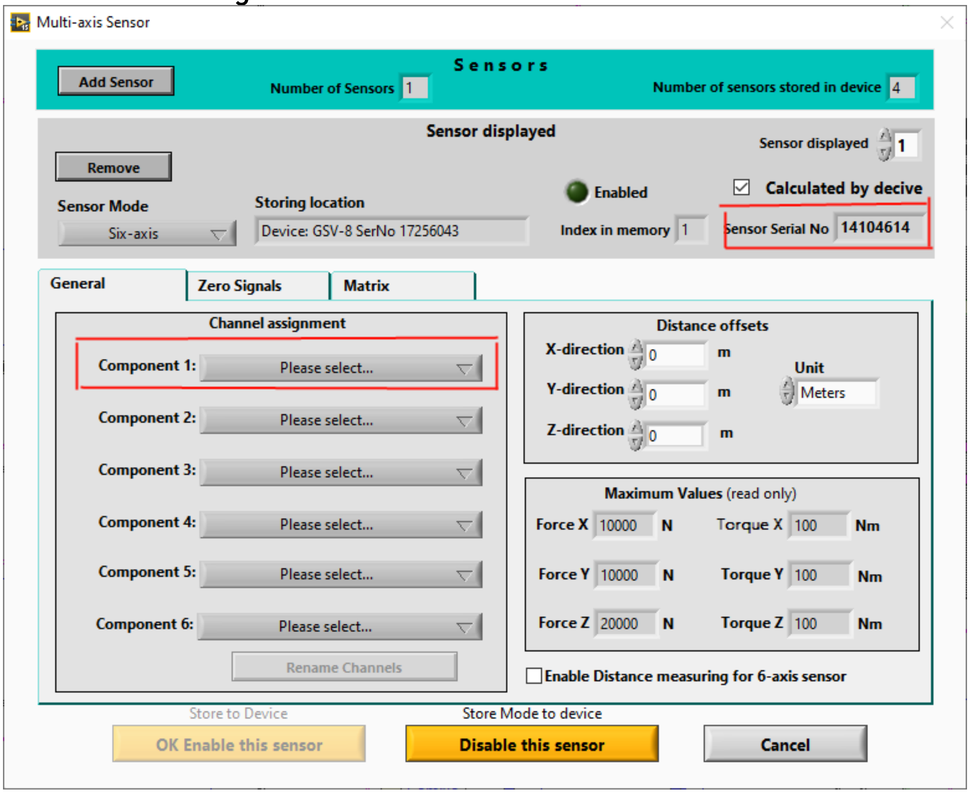
Click on *Add Sensor* in the top left corner*,* then a sub-window will open:



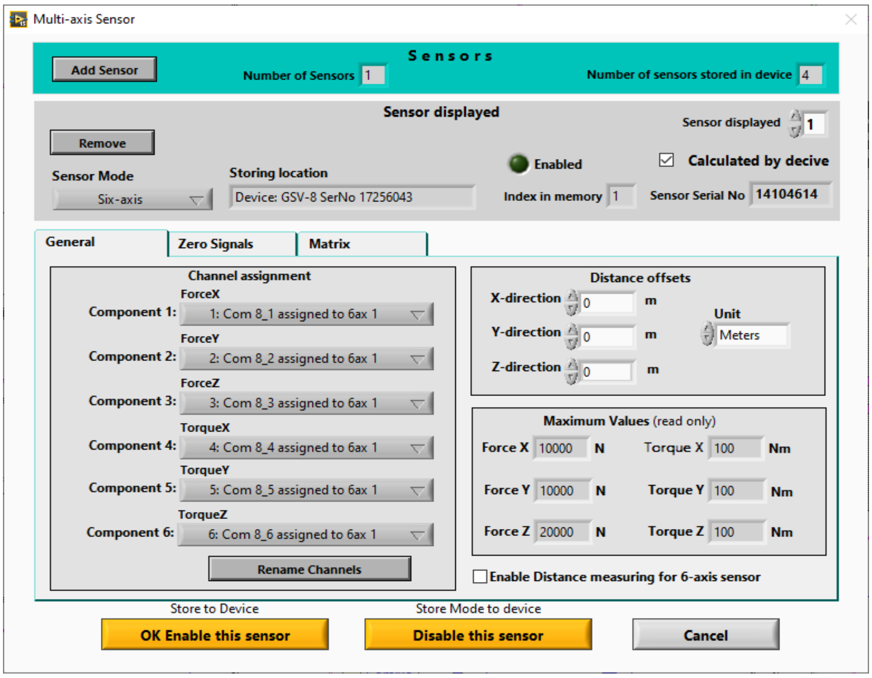
Click on *Open File/Dir* to load the calibration data for the first time. In the file selection window that opens, select the *.dat file belonging to the sensor.

10 The K3A and K3D series do not necessarily require a calibration matrix, but using one can improve the cross-talk. F6D sensors with an e at the end of the model designation have a built-in GSV-6 amplifier and the calibration matrix is usually already installed.

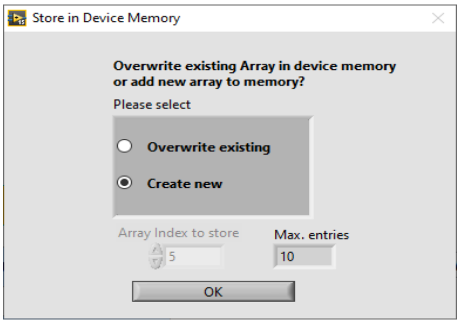
The multi-axis sensor dialog then looks like this on a standard six-axis sensor:



To be on the safe side, please first compare the serial number on the sensor's nameplate with the one shown under *Sensor Serial No*; they must match.
Now, select the first channel of the input component 1, with *Component 1*. If your GSV-6 or -8 amplifier will perform the calculation itself (the *Calculated by device* checkbox is then enabled), components 2 to 6 will be selected automatically. Otherwise, i.e. for software-calculated sensors, you have to select all input components manually. The dialog now looks like this:

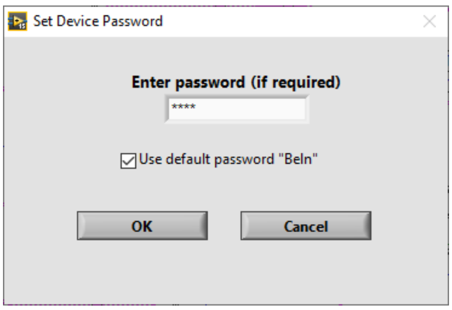


If desired, the output channels of the calculation can be automatically renamed with *Rename Channels*, so that the channel name denotes the physical size and direction. To enable six-axis sensor measurement and, if necessary, save the sensor data to the GSV-6 or GSV-8, click OK Enable this sensor.
If the six-axis data is stored in the device and data already exists there, you will be asked if you want to overwrite an existing record or create a new one. In case of overwriting, you may be able to specify the memory index:

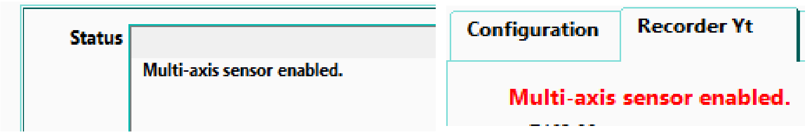


GSV-6 and -8 can store up to 11 such sensor data sets. You will then be asked for the device password when saving and calculating in the device. As a rule, this is not altered; So you can confirm the pre-selected password with OK. For GSV-8 it is "**BeIn**"

If the sensor calculation has been activated, you will receive a confirmation message and the dialog will close.



The status messages in the Configuration and Recorder tabs show the multi-axis sensor being activated:



After loading the six-axis data, a zero adjustment should be performed with the sensor unloaded, by clicking on *Set All Zero* in *Recorder Yt* (see p. 92).
To deactivate the multi-axis calculation, open the *Multi-axis Sensor* dialog again. The green soft-LED *Enabled* is now lit. You can now deactivate the multi-axis calculation with *Disable this sensor.*

Learn more about the Multi-Axis Sensor Dialog

Under Sensor Mode, you can see the sensor type or mode. In the case of six-axis sensors, it depends on the type of sensor and the selected calibration data. In the case of three-axis sensors, it is possible to switch between three different calculation modes.
There are the following types, or modes:

Sensor Mode	Sensor Models	Computable by GSV-8	Computable by GSV-6	Matrix	Remarks
Six-axis	K6D, F6D	Yes	Yes	6 x 6	Determined by sensor data
Six-axis,2nd order	K6D, F6D	Yes	Eventually [11]	2 matrices of 6 x 6 each	Determined by sensor data
Three-axis Fz,Mx,My	K3R	Eventually[11]	Eventually [11]	3 x 4	Three-axis mode selectable, here force, 2x torque
Three-axis Fx,Fy,Fz	K3R	Eventually [11]	Eventually [11]	3 x 4	Three-axis mode selectable, here 3 forces
Three-axis Fz,sx,sy	K3R	No	No	3 x 4	Three-axis mode selectable, here force, 2x travel
Six-axis,6x12 Matrix	e.g.: K6D-225	Eventually, see below	No	6 x 12	Determined by sensor data, 12 input channels required
Any Axis, NxM	e.g.: K3D	Eventually [11]	Eventually [11]	from 1x2, typ. 3 x 3	Determined by sensor data

11 Yes, provided the following version requirements are met: GSVmulti: version 2.02 or later, GSV-8: from 1.61, GSV-6: from 3.47

Notes on sensor modes:

- In principle, there must be at least as many channels available as there are columns in the matrix.
- The "*Six-axis, **2nd order***" mode corresponds to the **Matrix Plus** solution. Here, the second, square matrix is also displayed in an additional tab. When calculated by the GSV-8, the maximum data frequency is limited to 2000/s.
- For the modes calculated by software, all **input components must be selected individually** under *Channel assignment* in the *General* tab. As a rule, these are input channels 1-6 for multi-channel devices.
- In ***6x12 Matrix*** mode, also components 7 to 12 must be selected **additionally** by ticking the *Compo 7 to 12* checkbox in the channel assignment menu. These are usually the first six input channels of a second measurement amplifier. In this case, 'master-slave' synchronization of the measurement data transmission between the two devices is recommended; however, that requires certain hardware specifications to be met, see p. 16.
- For the three-axis modes *Three-axis Fx,Fy,Fz and* Three-axis Fz,sx,sy, a lever arm length must be entered on the right under Distance offsets; these input elements are then marked in red.
- With the K3R sensor, input channel 4 has no significance as an output channel. In 6x12 matrix mode, this applies to input channels 7 to 12. Although these are required as input values for the calculation, no physical output quantity is assigned to them. After renaming the channels, they are labeled '*dummy*'. You can hide these channels in the main window so that they are no longer visible; that can be done by selecting this channel with *Actual Channel* in the Configuration tab of the main window and then clicking on *Channel -> Hide* via the menu bar.
- For the sensors/modes calculated by software, it is useful to save the entire configuration in a session file. Then the above-mentioned selection process of the sixth-axis data does not have to be carried out again, but after the next program start you can simply restore them with *Open Session*.
- In case of the sensors/modes calculated by software, when recording measurement data (see p. 10 and 66), an additional TDMS file is created that contains the raw data, i.e. the mV/V values that the sensor outputs directly. The file names of the raw data are in the form <date-time>RAW.tdms, i.e. RAW is appended to the file name of the file with the normal physical measurements. The raw data may help to determine the cause of problems or you can use a different matrix afterwards.

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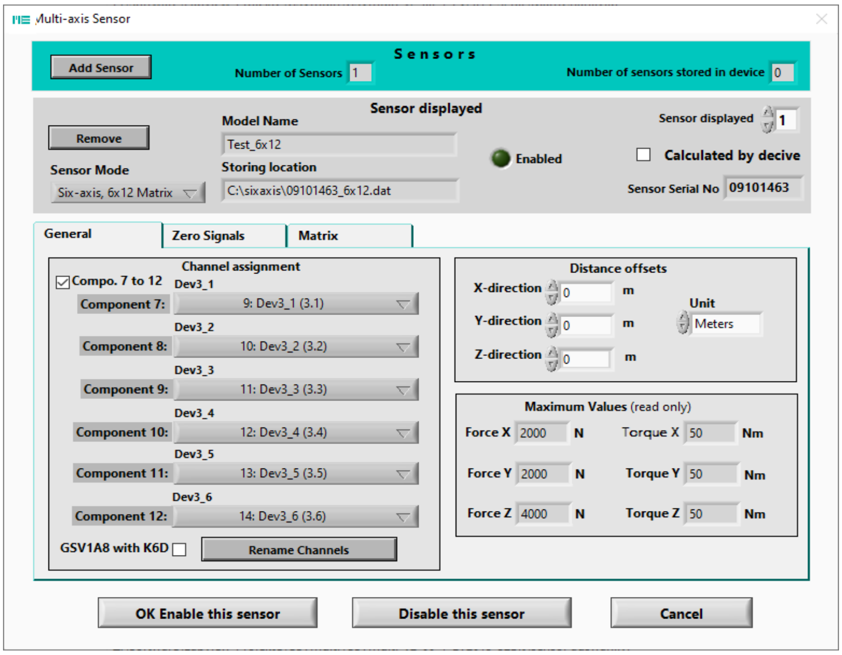
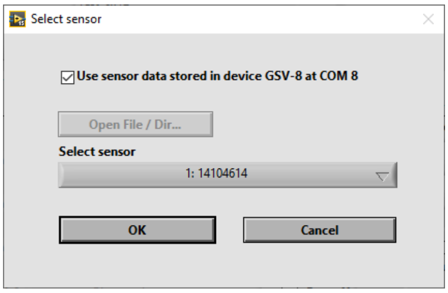


Channel assignment for sensor with 6x12 matrix

Changing the sensor configuration and using multiple multi-axis sensors

- If **different calibration data** is to be loaded for the **same sensor**, or if further calibration data is to be saved in the same GSV-6/-8, it is recommended that you first disable the six-axis calculation using 'Disable this sensor' if it is currently active. If the data was stored in the device, it will be retained (unless it is overwritten by reloading it via the relevant setting in the 'Store in Device Memory' dialogue).
- If you **want to use other calibration data stored in the device,**



proceed as shown above (after the current sensor has been disabled), but set the checkbox *Use sensor data stored in device* in the *Select Sensor* intermediate dialog and then select the desired sensor based on the serial number and the storage set with *Select Sensor*. The input components are then automatically assigned because they belong to the amplifier and cannot be changed.

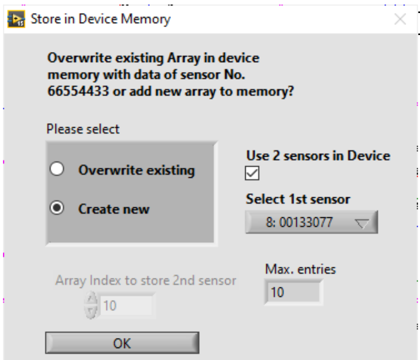
- In the GSV-6 or GSV-8, only **one of the stored calibration data arrays** is active**, always the one** that was lastly activated with *OK Enable this sensor*. The number of the active sensor is also part of the user settings *User 2* to *User 6* of the GSV-8, so that you can also switch between sensor data with *Load Settings* if the configuration has previously been saved with *Save Settings*.
- If **several multi-axis sensors** are to be used for a measurement, repeat the above-mentioned loading process without removing sensors first. Accordingly,

there must be enough input channels in the measuring system for this purpose. In *the Multi-axis Sensor* dialog you can select the one you want to display with *Sensor displayed* in the upper right corner. The number of active sensors is displayed at the top in *Number of Sensors*. With the GSVmulti PRO variant, up to 8 multi-axis sensors can be used, with the standard variant up to 4. From version 2.93, GSVmulti also shows the number of active sensors in the status bar, e.g. "***2** Multi axis Sensors enabled*"

Using two Multi-axis sensors with GSV-8

With GSVmulti version 2.03 or later and the GSV-8 with device firmware version 1.61 or later, two matrices can also be used simultaneously in a single GSV-8, provided that the total number of input channels required is <= 8; in other words, this is only possible with K3R and K3D sensors.
To do this, first load and activate the first sensor, whose first input component is always Input 1, as shown above. Then open the multi-axis dialogue again and use *Add Sensor* to open the data for the second sensor. You must now select its *Component 1* correctly; this is Input No. 4 if the first sensor is a K3D (3x3 matrix) or Input 5 if the first sensor is a K3R (3x4 matrix), i.e. *Component 1* is always the first available input.

Then click *OK, Enable this Sensor* and in the *Store to Device Memory* dialogue box, choose *Create new* to create a new storage location. You should also tick the checkbox on the right labeled *Use 2 sensors in Device* and, using *Select 1st sensor*, choose the first sensor based on its displayed storage location and serial number.



Notes:

- If two sensors are enabled and you click ‘Disable this Sensor’, both sensors will be disabled.
- If you intend to activate two sensors that are both already stored in the device, it is best to proceed as described above, except that in the *Add Sensor* sub-dialogue, you should click *Use sensor data stored in device*, then first select the first sensor and activate it by clicking *OK*. If the *Store to Device Memory* dialogue mentioned above opens, leave the *Use 2 sensors in Device* checkbox unchecked for the first sensor. Then repeat the process for the second sensor, **correct the component assignment using *Component 1***, and this time tick the *Store to Device Memory* checkbox and select the storage location of the first sensor. In the *Store to Device Memory* dialogue, the selection options for the storage location will be grayed out because the data has already been saved.

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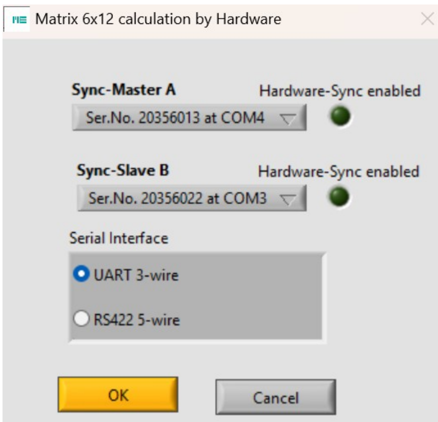
Hardware-computed 6x12 Matrix with two GSV-8

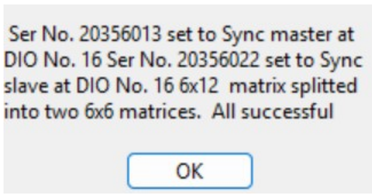
With GSVmulti version 2.03 or later and two GSV-8 units running firmware version 1.61 or later, a 6x12 matrix can also be distributed across both GSV-8 units, so that the calculations are performed by the hardware. To do this, both GSV-8 units must be connected via a sync cable to the digital ports so that they form a master-slave system; they must also be connected using a special crossed UART cable (this is therefore not possible with the EtherCAT variant).

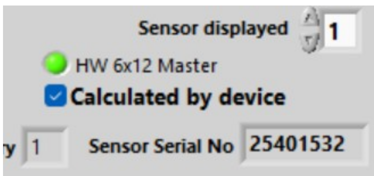
The master then outputs the calculated force and torque values via the USB port and the analogue output. Once configured, the slave no longer needs to be opened, but it must remain switched on at all times during measurements. The master receives the results of the calculation of sub-matrix B from the slave via UART and adds these to the result of its sub-matrix A. When **setting to zero** using *Set All Zero* or the **TA button on the master**, the slave's raw values are also set to zero. All other configuration settings, e.g. the measurement data rate, must still be carried out separately on both devices.

To configure the system, both GSV-8 units must first be connected via USB, with at least input channels 1–6 opened on both. Then open the multi-axis dialogue and use *Add Sensor* to load the 6x12 sensor data from the file. Immediately afterwards (without selecting any components), tick the *Calculated by device* checkbox and a sub-dialogue will open. In this sub-dialogue, use *Sync-Master A* to select the device that is the master, connected to sensor port A, and *Sync-Slave B* to select the slave, connected to port B. Use *Serial Interface* to select the type of UART cable; this is usually UART 3-wire.

Then click *OK* and the devices will be configured, with the 6x12 matrix split into two 6x6 matrices. In this configuration, any missing device settings are added: both UART baud rates are set to the same value (namely the higher of the two), the UARTs are enabled, and the DIO type for DIO number 16 is set accordingly. The input components are selected automatically.







Other display and control elements in the *Multi-Axis* Sensor window

General: Distance Offset: Here you can enter distances of a force application point, which are taken into account when calculating the torques. The calibration matrix is usually determined by the manufacturer in such a way that the torques at the sensor origin apply. Often, however, there are still attachments to the measuring platform and you want to measure the moments at this point. **The directions of the *distance offsets* up to and including program version 2.00 are opposite to those of the sensor coordinate system; from 2.01 onwards they correspond to the coordinate directions of the sensor in the case of a software-calculated system.**

General: Maximum Value: The maximum values of the sensor. Within these limits ±maximum, the accuracy specifications of the sensor apply. If the maximum values are exceeded, this is indicated by the red *Sensor Overload* button at the top of the main window. This can then be clicked to get more detailed information about the maximum value exceedance.

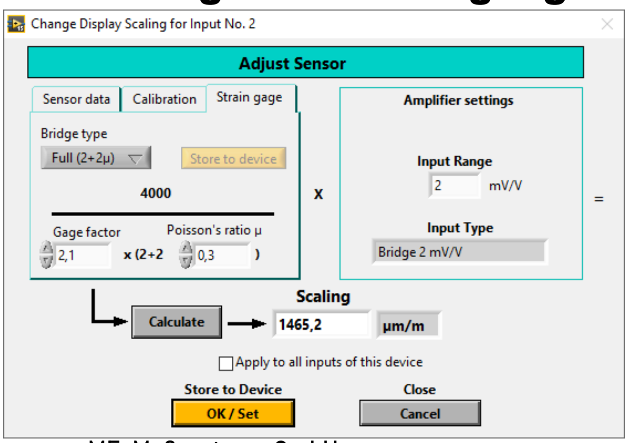
Zero Signal: Bridge deviation values at no-load of the sensor at the time of calibration of the sensor by the manufacturer. With GSV-8, previous zeroing of the sensor (with *Set All Zero*) can be canceled by clicking on the yellow *Untare* button. You can then inspect the difference between the original zero-load values and the actual bridge deviation in the measured values, displayed in physical quantities. The Untare function corresponds to pressing the CHK button on the GSV-8 when six-axis calculation is active on the device; however, it is permanent rather than temporary like a button press. A significant deviation from zero in these values when the sensor is unloaded is an indication of wear or plastic deformation.

Matrix: The elements/coefficients of the calibration matrix.

Storing location: Storage location of the calibration matrix. If the device (*Device...*), the memory index is also displayed under *Index in memory*.

Enable Distance measuring for 6-axis sensor: With the GSV-8, instead of the forces Fx and Fy, the distances Sx and Sy can be calculated in meters, which indicate the distance of a force application to the sensor origin; i.e. a force <>0 must be applied to Fz.

Measuring with strain gauges



Strain gauges are small sheets of metal grid that are glued to a body to measure its surface strain or compression. The elongation is a ratio and is given in µm/m, this (pseudo-) unit is equivalent to microstrain (µInch/Inch) and others, generally: "Strain x 10-6"

In order to adjust the strain gauge so that it measures correctly in µm/m, it is necessary to know the gauge factor, which indicates how much the resistance or bridge output voltage changes due to strain. In addition, you need to know the type of the bridge; Single strain gauges are always quarter bridges and require a bridge completion, which is placed either externally or in the amplifier, see its operating instructions. In the case of bridges with transverse contraction, it is also necessary to know the transverse contraction number of the material to which the strain gauge is glued, the *Poisson's ratio*. It indicates the ratio of longitudinal to transverse elongation.

To adjust, click on *Sensor->Strain gage...* or on *User Scaling* and then select the small tab *Strain gage*.

Use Bridge type to select the type of bridge:

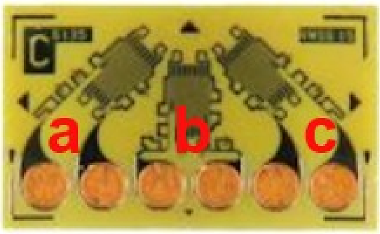
> ***Full (4):*** Full bridge with all 4 strain gauges in the longitudinal direction. No bridge completion necessary.
>
> ***Half (2):*** Half bridge with 2 strain gauges in the longitudinal direction. Half-bridge completion necessary.
>
> ***Quarter (1):*** Single DMS. Quarter bridge completion necessary.
>
> ***Half (1+µ):*** Half bridge with one strain gauge in the longitudinal and one in the transverse direction. Half-bridge completion necessary. Transverse contraction number *Poisson's ratio* must be specified.
>
> ***Full (2+2µ):*** Full bridge with 2 strain gauges in longitudinal and two transverse directions. No bridge completion necessary. Transverse contraction number *Poisson's ratio* must be specified.

Under *Gage factor*, the gage factor is entered, and under *Poisson's ratio*, if applicable, the transverse contraction number. The Input *Range* is displayed correctly on most amplifiers, with the exception of the GSV-3.

Then click *Calculate*, and then click *Store to Device*. The new *User Scaling* is set and the unit is then µm/m.

Stress measurement with rosette strain gauges

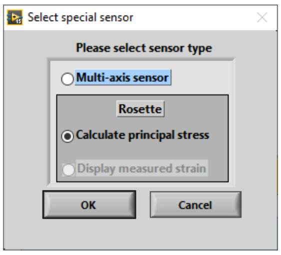
When using triple-rosette strain gauges, GSVmulti can be configured to convert the signals from the strain gauges into mechanical stresses and angles of the main stress.



Mechanical stress is a measure of the stress on a body (to which the rosette strain gauge is glued) due to its external load.

Rosette strain gauges are used, which have an angle of 45° to each other. These three individual strain gauges have to be completed on the hardware side with quarter bridge completions to the full bridge and at least three channels are required. Some GSV-6 models and GSV-8 amplifiers meet this requirement, as does the GSV-4 after internal modification. The corresponding user manual explains how to connect quarter-bridge strain gauges correctly.

To configure this type of strain measurement, click on *Special Sensor* in the *Configuration* tab*,* then the following intermediate dialog opens, in which *Calculate principal Stress* is selected:



Alternatively, you can select *Sensor>Rosette Stress* in the menu bar.

Then the *Rosette Sensors* dialog opens. In it*,* click *Add Rosette* to add a stress measurement.

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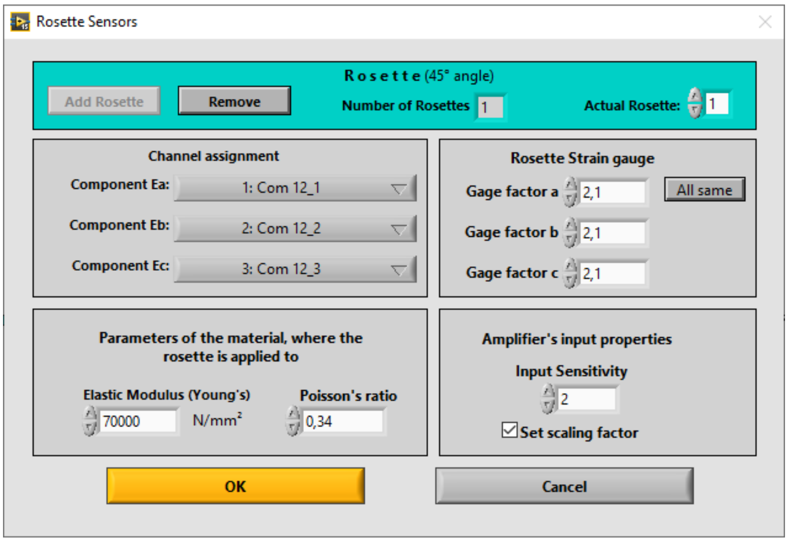
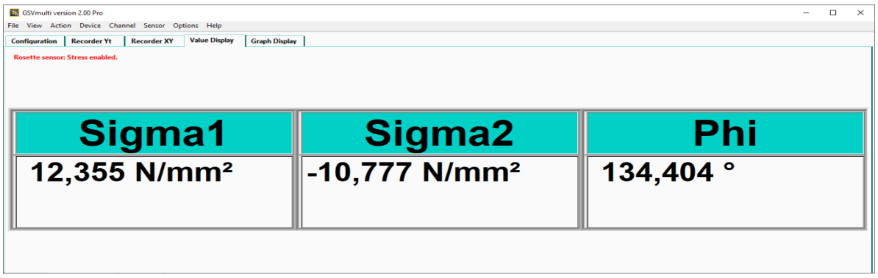


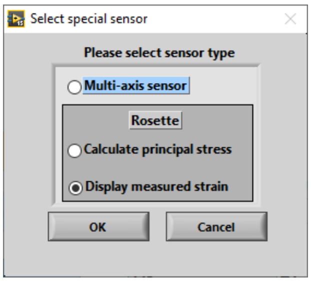
With *Channel assignment*, you then have to select the channels to which the respective input components (*Component Ea, Eb, Ec*), i.e. the individual strain gauges a, b and c, are connected. Under *Elastic Modulus, the* modulus of elasticity of the material to which the strain gauges are glued is entered, under *Poisson's ratio,* its transverse contraction number. The image above shows typical values for pure aluminum as examples. Under *Rosette Strain gauge* next to *Gage factors a, b* and *c*, the gauge factors of the strain gauges used are entered; with *All* same, you only have to do this once, as long as all three are the same. The *Input Sensitivity* of the amplifier is automatically displayed correctly on most GSV models, except GSV-3. Finally, click *OK*. The channels are then renamed *Sigma 1* for the principal stress, *Sigma 2* for the secondary stress and *Phi* for the angle of the principal stress direction to the strain gauge a. Also the units are changed to N/mm² and ° for angle degrees, respectively:



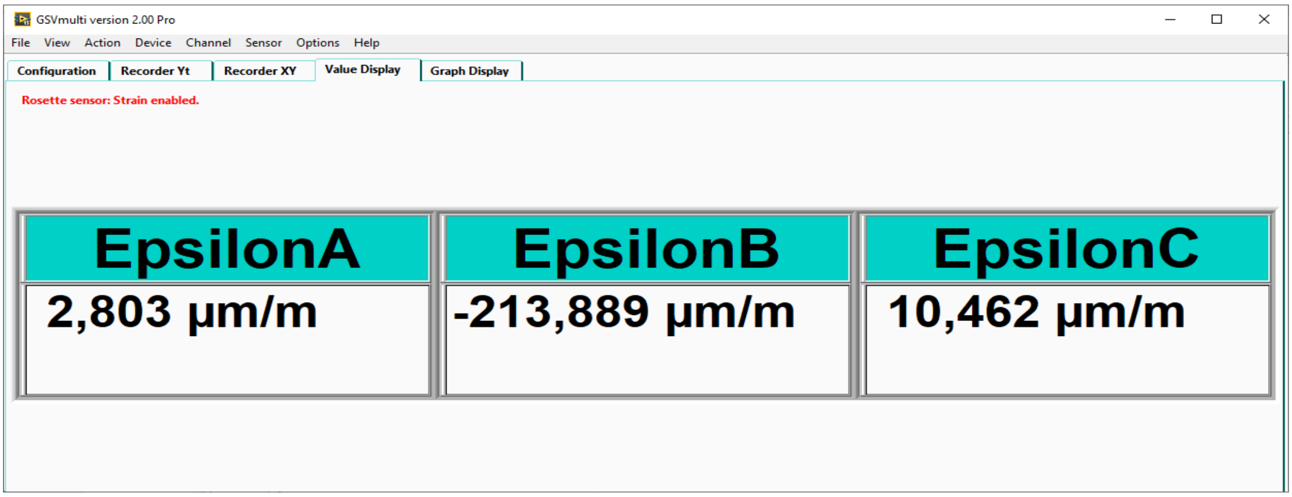
When using multiple rosette strain gauges for multiple measuring points of mechanical stress, this configuration is repeated for each rosette. The channel names are then appended with _1, _2, and so on. The channel names can also be changed manually (see p.7), but the units do not. It's a good idea to store this whole configuration with *Save Session* so that they can be restored easily the next time the program is started with *Open Session* (see p.64).

Switching between stress and strain measurement

When stress measurement is activated, the status message *Rosette Sensor: Stress enabled* appears. In the meantime, without losing the configuration data of the stress measurement, you can switch to strain measurement. To do this, click on *Special Sensor* again and then select *Display measured strain*.



Alternatively, you can also click on *Sensor>Rosette Strain* in the menu bar. The units,



channel names and status messages change.

To return to the stress measurement, select *Calculate principal stress* in the *Select Special Sensor* intermediate dialog or Menu bar>*Sensor>Rosette Stress* and confirm the Rosette dialog with OK.

Note on saving the rosette configuration: The channel names are stored in the *session* file, but the stress measurement data is only stored if the stress measurement is active at the time of saving. The strain configuration results from the *User Scale*, which is stored in the amplifier as well as the units.

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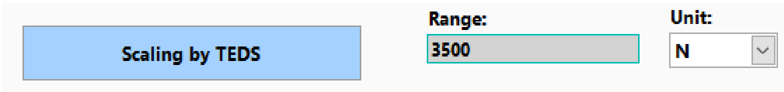
Sensors with TEDS

Some sensors have a memory module where individual configuration data for this sensor is stored. These are standardized in the TEDS standard according to IEEE 1451.4 (Transducer Electronic Data Sheet).

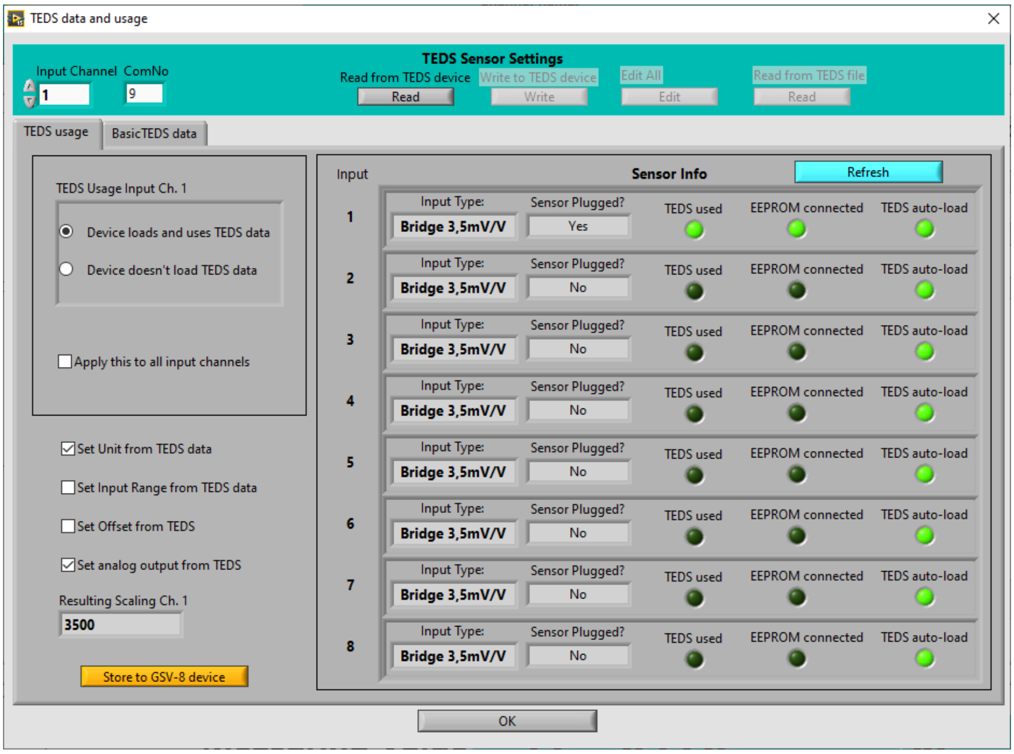
Currently, only the GSV-8 and GSV-6 amplifiers support sensors with TEDS (GSV-6 only on channel 1).

When connecting a sensor with TEDS or powering it on with the sensor connected, the GSV-8 reads the memory and sets scaling (*User Scaling*), unit and input sensitivity automatically so that correct physical readings are displayed, i.e. *User Scaling* cannot and does not have to be set as described on p.9.

When this is done, the label of the *User Scaling* button changes to *Scaling by TEDS:*



In general, the user does not have to do anything else. To explicitly read the memory content or change the TEDS loading options, you can access the TEDS dialog by clicking this button or by clicking on the menu bar -> *Sensor -> TEDS...*



The display *TEDS usage -> Sensor Info*

With GSV-8, each row shows whether a sensor is connected and whether the TEDS data has been loaded. With GSV-6, only channel 1 is valid. The entries mean:

- *Input Type:* TEDS templates with IDs 33 and 35 (see below) can only be used with bridge inputs, ID 25 only with voltage input.
- *Sensor Plugged?* The GSV-8 can usually determine whether a bridge sensor is connected, in which case the entry is *Yes*; otherwise *No* or *Unknown*. The latter is regularly the case with *Input type* = voltage or temperature as well as with the GSV-6.
- *TEDS used*: This soft LED "glows" bright green when TEDS data has been successfully loaded. In this case, *EEPROM connected* is also active.
- *EEPROM connected:* This soft LED "glows" bright green when a TEDS memory device has been connected and detected. This applies even if the content of the data could not be interpreted as known and compliant; in this case *, TEDS used* does not light up. This is regularly the case with empty memory modules.
- *TEDS auto-load*: This soft LED "glows" bright green if the GSV has been configured to use TEDS data on this channel, see *TEDS usage*.

Configuring TEDS Device Behavior

The GSV is configured by the manufacturer's settings in such a way that it tries to load TEDS data when it is powered on (GSV-8 even when changing sensors); In addition, there are four checkboxes for detailed settings, which only apply if TEDS data is to be loaded for this channel.

- *TEDS Usage Input Ch.* <no> Basic TEDS loading property for the channel selected in the upper left corner under *Input Channel.*
- *Set unit from TEDS data*: If set, the unit is also set based on the TEDS data (valid for all channels with TEDS enabled).
- *Set input range from TEDS data:* If set, the input measurement range / input sensitivity is also set based on the TEDS data (valid for all channels with TEDS enabled).
- *Set offset from TEDS*: If set, the zero point is also set based on the TEDS data (valid for all channels with TEDS enabled). If this is set, zeroing with Set Zero (main window -> *Configuration*) is still possible, but after the next power cycle, the zero point is loaded from the TEDS again.
- *Set analog output from TEDS*: If set, the scaling factors of the analog outputs are set based on the TEDS data so that the maximum physical value corresponds to the analog nominal output value (valid for all channels with TEDS enabled).

If you want to change the basic TEDS loading property, you can use *Apply this to all input channels to* specify whether the selected setting should apply to all input channels. Then click *Store to GSV device*.

With the light blue button *Refresh* you can update the displays after changing settings or reconnecting a TEDS module.

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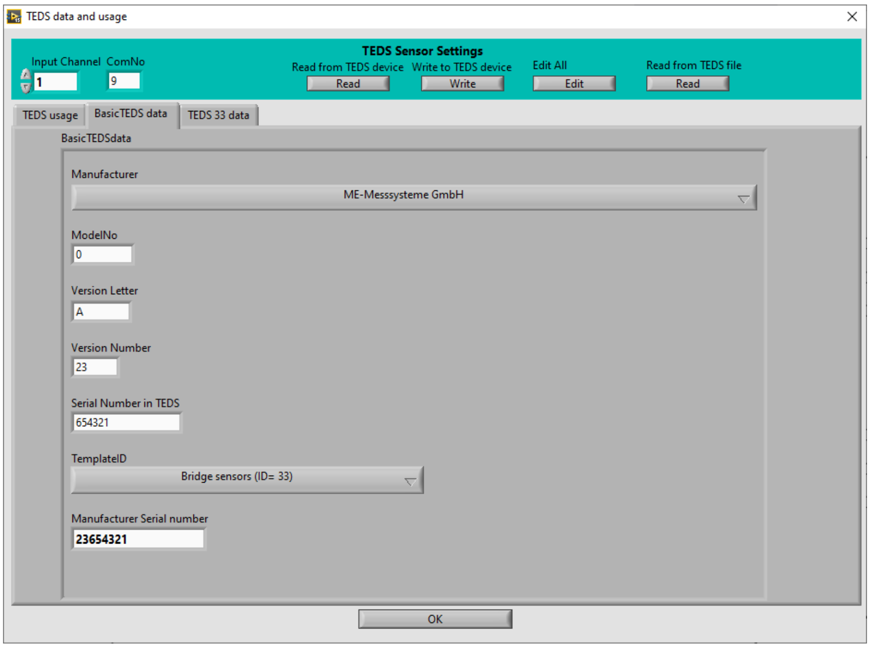
Reading and viewing TEDS content

After clicking on *Read from TEDS device*, the contents are displayed in the Basic TEDS data and *TEDS 33 data* (or *TEDS 35 data* / *TEDS 25 data*) tabs. The different templates correspond to different data formats for different categories of sensors. The *Basic TEDS data* is organized in the same way for all templates, they contain an ID for the sensor manufacturer, the Template ID and the serial number as well as the entries *ModelNo*,



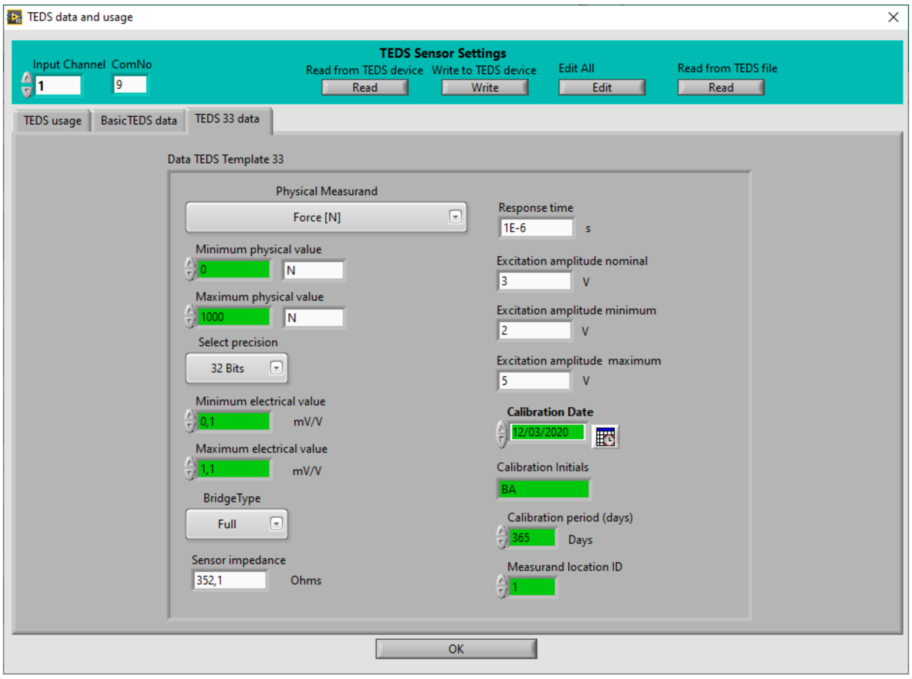
Version Letter and *Version Number,* which the manufacturer can set as desired.

In the case of sensors from ME-Meßsysteme, the sensor serial number is shown in *Manufacturer Serial number.*

The GSV-6 and GSV-8 support Template ID 33 for Wheatstone bridge sensors and ID 35 for strain gauges, while the GSV-8 also supports ID 25 for accelerometers.

The template ID-specific data content is displayed in the right-hand tab; In the following, only ID 33 for bridge sensors is described.

If you have opened the TEDS window via the Menu Bar -> *Sensor -> TEDS*, some entries with the GSV-8 are displayed with a green background; these are those that experienced users can modify for certain reasons - e.g. during a recalibration - in order to then write the data back to memory, but this is only possible with the GSV-8 (see below). The white ones are immutable properties of the sensor, which are usually not changed.



The entries in detail:

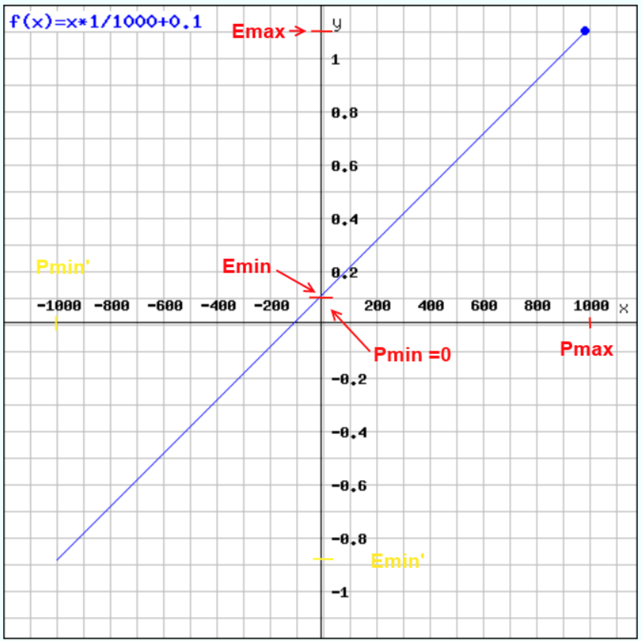
- *Physical Measurand*: The physical quantity of the sensor to which this calibration applies. This also determines the unit. Based on this value, the unit of the GSV is set, if configured accordingly.
- *Minimum physical value*: X-coordinate "Pmin" of the lower point of the two-point form of the sensor characteristic, see drawing below
- *Maximum physical value*: X-coordinate "Pmax" of the upper point of the two-point form of the sensor characteristic, see drawing below
- *Select Precision*: Numerical representation of the coordinate points (Pmin/max, Emin/max). 32 bits are recommended.
- *Minimum electrical value*: Y-coordinate "Emin" of the lower point of the two-point form of the sensor characteristic curve in mV/V, see drawing below
- *Maximum electrical value*: Y-coordinate "Emax" of the upper point of the two-point form of the sensor characteristic curve in mV/V, see drawing below
- *Bridge Type*: Bridge Type of the sensor (Full, Half, Quarter)
- *Sensor impedance*. Sensor internal resistance in ohms
- *Response time*: Settling time of the sensor in case of rapid changes (jumps) of the measured variable, in seconds
- *Excitation amplitude nominal*: Recommended sensor excitation voltage in volts
- *Excitation amplitude minimum*: Minimum sensor excitation voltage in volts
- *Excitation amplitude maximum*: Maximum sensor excitation voltage in volts
- *Calibration Date*: Date of last sensor calibration

- *Calibration Initials*: Initials of the person who calibrated
- *Calibration period*: Recommended time to recalibration, in days
- *Measurand location ID*: User-specific identification number of the measuring point

Editing and writing TEDS data

The GSV-8 can also be used to write memory devices (so-called 1-wire EEPROMs). The following types are supported: 24B33, MAX31826, 28E07,[12] 243110

In order to be able to write, the TEDS dialog must be activated via Menu Bar -> *sensor* -> *TEDS...* , then (except for an empty module) you must first read with *Read from TEDS device*.



The red coordinates correspond to the TEDS data shown; The negative yellows are alternatively possible.

The green entries in the TEDS data tabs can be edited directly and then written by clicking on *Write to TEDS device.* The device password of the GSV-8 (default: **BeIn**) must be entered or confirmed.

To describe a previously empty block or to modify and write the white entries and those in the *Basic TEDS data*, experienced users proceed as follows:

1. Click on *Edit All*, then enter the unlock password **MEsysTEDS42** . Tabs of all three supported templates 33, 35 and 25 open.

12 Only from hardware version 4.2

2 Edit data, making sure that only the data in the template = tab used is changed. The template itself, i.e. the sensor category, is selected in *Basic TEDS data -> TemplateID* . If the memory module was previously empty, all entries must be verified and, if necessary, set.

3 Click *Write data to TEDS device*, then enter device password.

It is also possible to write TEDS data to a file using *Write TEDS data to file* and read such a file again using *Read TEDS data from file.*

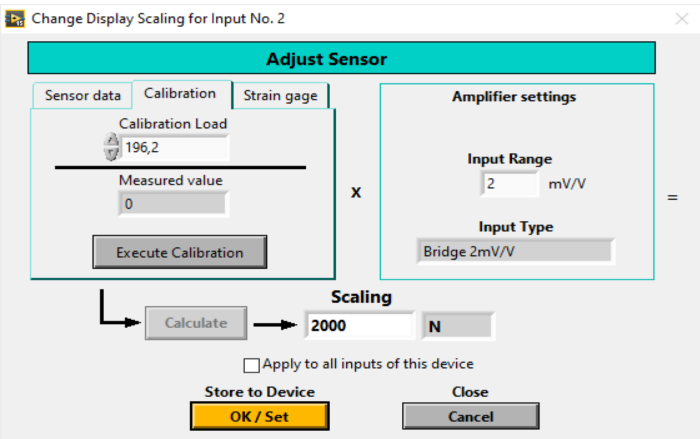
Adjusting Sensors with a Known Load

General sensors that do not fall under the previously mentioned categories of multi-axis sensors with calibration matrix, sensors with TEDS or rosettes strain gauges for voltage measurement are usually adjusted according to the data on the test report or calibration sheet, as shown on p. 9.

If you no longer have this data at hand, or if the sensor may have changed its transfer characteristics due to aging or harsh environmental conditions, you can adjust it using an interactive process. This may also be possible when using strain gauges, namely when a mechanical quantity such as force, pressure or torque leads to a significant and reproducible elongation at the strain gauges.

For the adjustment process, it is necessary that a precisely known load can be applied to the sensor. It is recommended to choose this load in such a way that it either corresponds approximately to the maximum value of the range in which you actually want to measure or so that it is in the range of approx. 30% to 100% of the nominal measuring range of the sensor.

It is also necessary that the load (more precisely: the load to be measured) can be removed from the sensor. First, do this and observe the reading. If it deviates significantly from zero, it is recommended to set it to zero with *Set Zero* before starting the procedure.



Then you can begin the procedure, either by Menu Bar *-> Sensor -> Calibrate...* or by clicking on *User Scaling* and selecting the small *Calibration* tab*:*

In the example shown on the left, a force sensor with a nominal range of 2 kN is to be adjusted with a weight of 20 kg. However, it is meant to be measured in newtons. To do this, multiply the mass in kg by the gravitational acceleration factor g, the mean value of which is 9.81 m/s². The result of the calibration load in the unit to be measured is entered in *Calibration Load.*

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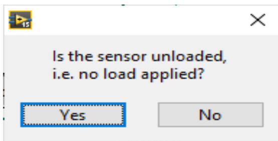
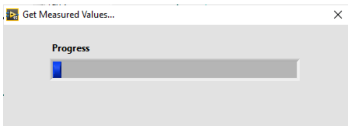
The input sensitivity *Input Range* on the right is displayed correctly on most amplifiers.

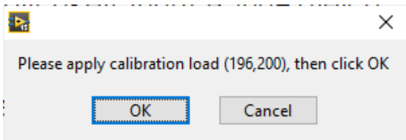


Then click on *Execute Calibration*. You will first be asked to confirm that the sensor is load-free:

Confirm this with *Yes*. Subsequently, some readings are taken; Meanwhile, a bar display appears:

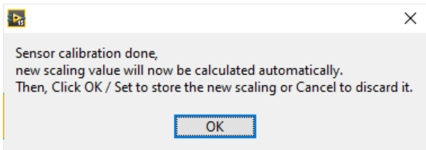


Then you will be asked to apply the load:

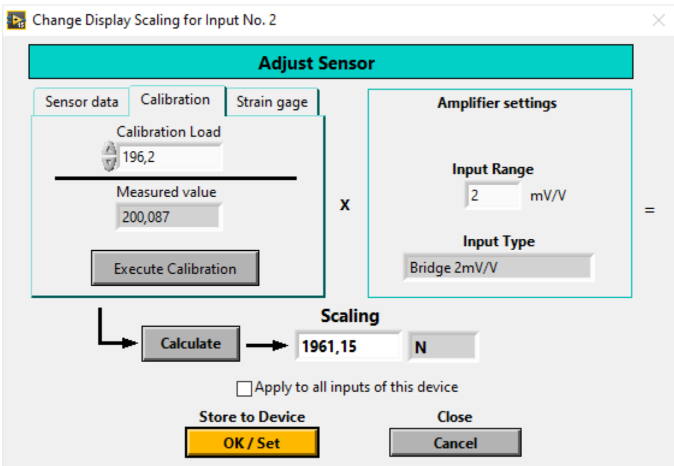


Do that. If the sensor vibrates slightly as a result, wait a moment until it stops, and then click OK.

Then some measurements are taken again until this message appears:



The recalculated *User Scaling* value is displayed under *Scaling:*



Now click *OK / Set* to save the new scaling value in the device.

Startup

GSVmulti can also be started by double-clicking on a session file that was previously saved with *Save Session*.[13] Then this session will be loaded. It is also possible to open a *.tdms measurement data file by double-clicking, then GSVmulti is started and this file is opened with the *File Monitor*. However, if GSVmulti is already open, this method cannot be used.

You can also start GSVmulti with a program shortcut and call parameters, so that actions are executed automatically. This can be created in the Windows Startup Menu, so that the program opens automatically when the PC starts. This is useful, for example, if measured values are to be recorded continuously, so that after a power failure or an automatic restart, this recording is started again.

Up to 3 call parameters are possible.

First parameter: There are three options for this:

1. "**-l**" When the program starts, the last loaded or saved session is automatically opened, see below.
2. First Call Parameter = Complete Path to Session File (*.ucf): This device session file is loaded.
3. First call parameter = Complete path to measurement data file (*.tdms): This measurement data file is opened with the File Monitor.

Ad 1.: If the first call parameter is "-l", up to two additional parameters can optionally be specified.

Second parameter:

"**-rYt**": After the session has been loaded, a recording with the *Recorder Yt* is started automatically, see p. 10. The recording configuration defined with *Configure Recording* applies, see p. 66.

"**-rXY**": After the session has been loaded, a recording with the *Recorder XY* is automatically started, see p. 64. Either the recording configuration defined with *Configure Recording* (see p. 66.) applies or threshold-based triggering, if it was previously enabled. Furthermore, the channel last selected for the X-axis is still used as X-axis.

Third parameter: recording time in seconds. At the end of this time, the program will be closed. This is useful, for example, to prevent the measurement data file from becoming very large, possibly even filling up the drive.

XY Recorder

In the *Recorder XY* tab, one or more readings can be displayed over another channel. Therefore, at least two channels must be open. In contrast to the *Recorder Yt*, the

13 After the initial installation, Windows may ask once if you want to open the file with GSVmulti. If this is confirmed, Windows saves this file <-> program association.

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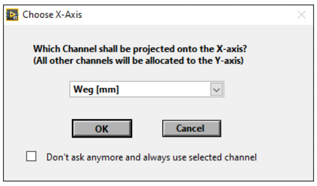
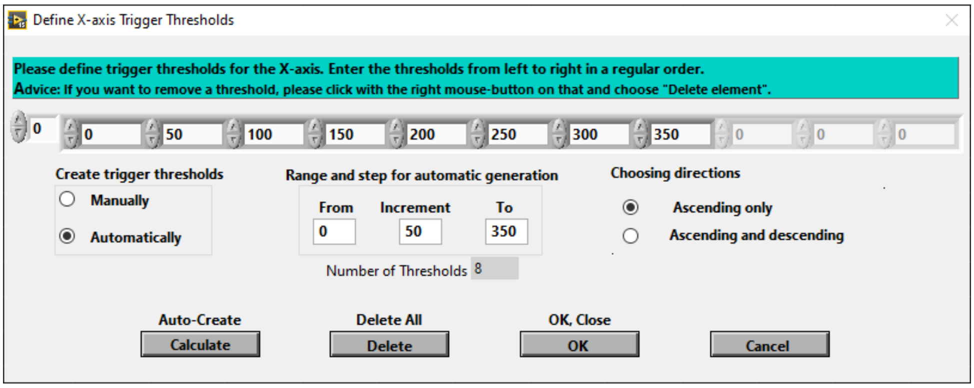
measured values are not displayed according to y= f(t) over time, but over another channel y= f(x). The channel projected to the X-axis is selected when entering this tab.



Essentially, the *Recorder XY* provides similar functions as the *Recorder Yt*.

In addition, it offers a threshold-dependent display or recording. If this is active, only individual values (i.e. points that are connected to each other) are displayed, and only if the value of the channel projected on the X-axis exceeds the previously defined thresholds.

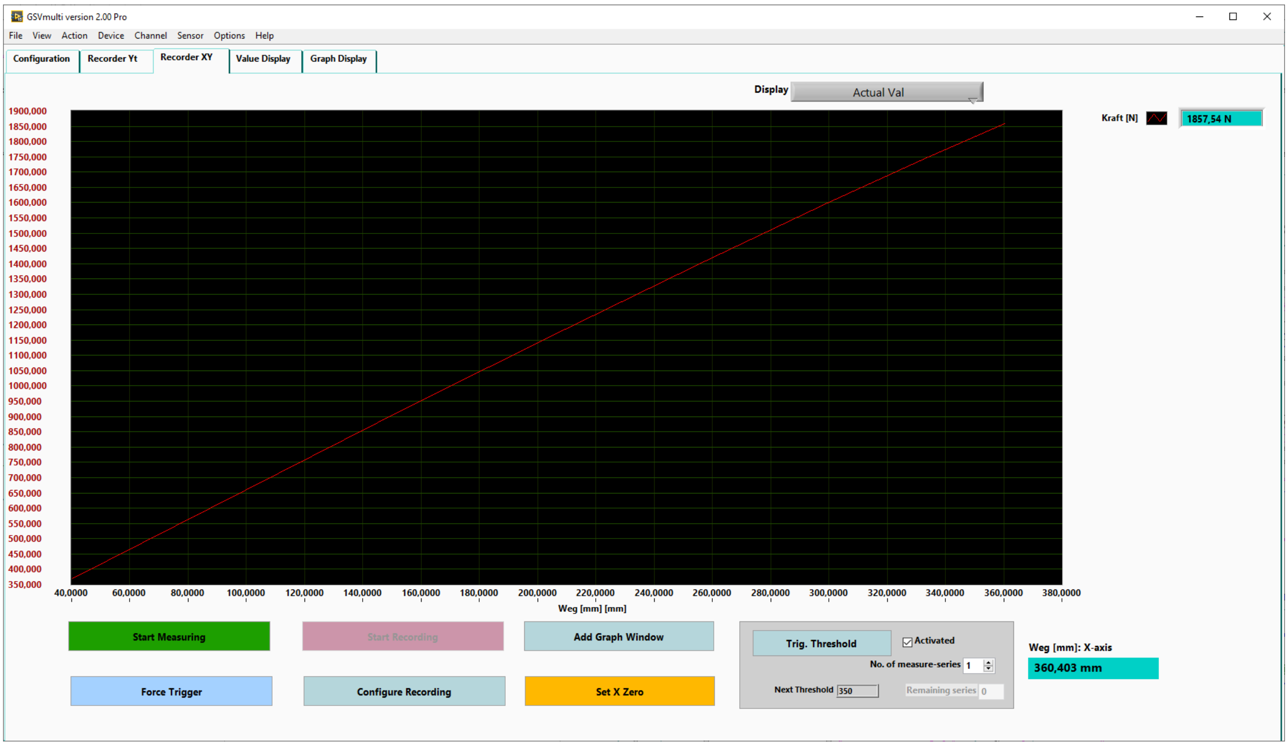
The thresholds must therefore be set in advance; to do this, please click on *Trigger Thresholds*. Then a window will open in which you can set the threshold values, which you can do manually by entering them directly (activate *Manually)* or you can have the threshold values generated automatically by entering the start, end value and increment (*From*, *To* and *Increment*).



Up to 11 threshold values are displayed here, if there are more, you can change the first one on the left with the index element on the far left. Grayed-out entries do not exist.

Then start the measurement (if you haven't already) and click on the *Activate* checkbox*,* which will then change to *Activated.*

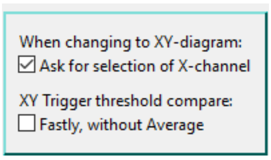
Note: The settings defined in *Configure Recording* (see p. 66) do NOT apply with trigger thresholds enabled.



Example: *Recorder XY* for Force-Displacement Measurement

Software Options for XY Recorder

The question of choosing the channel of the X-axis can be suppressed, so that the same X-channel is used every time you switch to the *Recorder XY* tab. You can do this by removing the checkbox *Ask for selection of X-channel* under Menu bar *-> Options -> Preferences -> When changing to XY-diagram*.



The other checkbox in this field describes the behavior when comparing the trigger threshold of the XY recorder under XY *Trigger threshold compare*. At measurement data frequencies >5 Hz, if *Fastly, without Average* is not enabled, an average over approximately 200 ms is formed from the measured values and compared to the current threshold. If this checkbox is set, this is done for each individual measured value without averaging.

Configuring the Recording of Measurement data

Clicking on the *Configure Recording* button in the *Recorder Yt* or *Recorder XY* tab opens a window in which the recording can be prepared and configured. This is only possible as long as the recording is not (yet) running, i.e. its configuration cannot be changed while the recording is active. The measurement data is stored in an efficient binary file format, the **tdms** format. In addition to the measurement data, it also contains metadata, so-called *Properties*. These files can be viewed and exported to other formats using the *File Monitor*.

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Automatically start and stop recording

Various conditions for starting or stopping can be defined in the ***Trigger Recording*** tab in the *Configure Recording* dialog. The contents of this tab may change depending on the settings you choose, so it is recommended to follow the order of operation from top to bottom. First of all, the top radio button under *Start Recording* and/or *Finish Recording* must be set *to Automatically*.

Start condition

The start condition *Start Trigger Type* can be the exceeding of the measured value of a given channel with a definable threshold value or a digital level of a line connected to the digital input of the GSV (only for the GSV-4, GSV-6 and GSV-8 amplifier models). In this case, the type of digital input is usually set to *GP input* (under Menu bar *→ Device → Advanced Settings→Digital* I/O); however, this is not necessary, i.e. other I/O types may also be selected in the device settings.

- *Value exceeds threshold*: Recording begins when the measured value is greater than the threshold value and the previous measured value was smaller than or equal to the threshold value, i.e. when the threshold value is exceeded
- *Value drops below threshold*: Recording begins when the measured value is less than the threshold value and the previous measured value was greater than or equal to the threshold value, i.e., when the measured value falls below the threshold
- *Value change delta threshold*: Recording begins when the absolute value of the difference between a measured value and its predecessor is greater than or equal to the threshold value, i.e. if |Reading(k) - Reading(k-1)| >= threshold value.
- *Digital I/O*: Recording starts when there is a digital level change. The level edge is defined with the *Level Change Edge* switch and the number of the digital connection (line) is selected with the *Digital I/O* selection element.

For the threshold-dependent start condition, the threshold value must be entered under *Threshold Value,* and the *Trigger Channel* selector must be used to enter the channel whose measured value is to be compared with the threshold value.

If you enter a number > 0 under *Number of Pre-Trigger* values, measured values with the defined number will be recorded even before the start condition occurs. You can also set the *checkbox Auto-Create Annotation at Trigger*, so that when the trigger condition is met, a note (*annotation*) is automatically created at this point, depending on the type, one of the texts: *"Start Rec: Threshold exceeded", "Start Rec: Fallen below Threshold", "Start Rec: D-threshold exceeded", "Start Rec: Digital-In Rising"* and "*Start Rec: Digital-In Falling*".[14]

Under *Event Number* you can specify whether the start condition for recording is tested once or several times. If *Record single event (file)* is selected, it will no longer be checked after the automatically started recording due to the defined trigger condition. In the case of *Record several events (files),* the trigger operation is checked again after the

14 The *Pre-Trigger Values* function is only available with GSVmulti PRO

automatically started recording has ended, so that several automatically started measurement data files can be recorded.

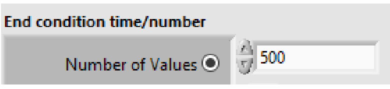
Termination Condition

To automatically stop recording, you can choose from two basic categories under *End Condition Type*:

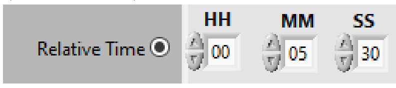
- *Time / Number of values*: After a configurable time or after reaching a number of measured values, the recording is stopped
- *Signal Trigger*: A threshold condition or digital I/O level stops recording

Time / Number of values can be used to select one of the following termination conditions under *End condition time/number:*

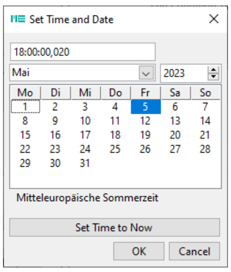
- *Number of values*: Once the number of measuring values has been reached, the

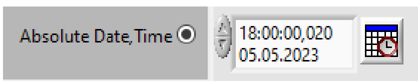
  

  recording will be stopped. To the right of it, enter the number:
- *Relative Time*: After reaching this time, counted from the start of the recording, it is finished. To the right of it, enter the time under *HH* (hours), *MM* (minutes), and *SS* (seconds):

- *Absolute Time (Daily file):* At the specified time, the recording ends and a new file is created each day. The *When finished: Generate new file* checkbox is automatically selected. To the right of it, enter the time under *HH* (hours), *MM* (minutes), and *SS* (seconds).
- *Absolute Date, Time:* At the specified date and time, the recording stops. A new file cannot be created automatically, so the checkbox *When finished: Generate new file* is disabled. To set the date and time, click on the calendar icon on the right and select the date in the following dialog at the bottom and enter the time in the format <hour>:<minute>:<second> at the top, confirm with *OK*.





Signal Trigger allows you to select one of the following termination conditions under *End Trigger Type*:

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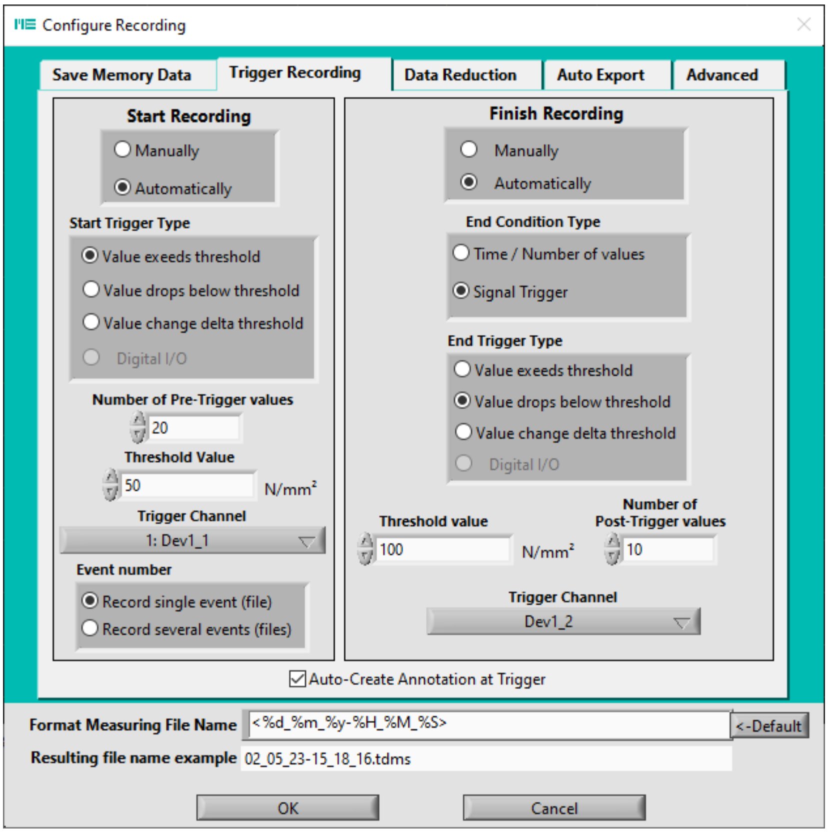
- *Value exceeds threshold*: The recording is terminated when the measured value is greater than the threshold value and the previous measured value was smaller than or equal to the threshold value, i.e. when the threshold value is exceeded
- *Value drops below threshold*: The recording is stopped when the measured value is smaller than the threshold value and the previous value was greater than or equal to the threshold value, i.e. when the measured value falls below the threshold
- *Value change delta threshold*: The recording stops when the absolute value of the difference between a measured value and its predecessor is greater than or equal to the threshold value, i.e. if |Reading(k) - Reading(k-1)| >= threshold value.
- Digital I/O: Recording stops when a digital level change occurs. The level edge is defined with the *Level Change Edge* switch and the number of the digital connection (line) is selected with the *Digital I/O* selection element.

For a threshold-dependent termination condition, the threshold value must be entered under *Threshold Value*, and the channel whose measured value is to be compared to the



threshold value must be entered with the *Trigger Channel* selection element.

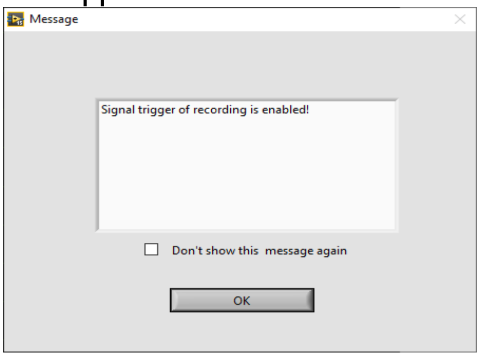
If you enter a number > 0 under *Number of Post-Trigger values*, measured values with the defined number will be recorded even after the termination condition has occurred. You can also set the checkbox *Auto-Create Annotation at Trigger*, so that when the trigger condition is reached, a note (*annotation*) is automatically created at this point, i.e. depending on the type, one of the texts *:"Stop Rec: Threshold exceeded", "Stop Rec: Fallen below*

Threshold", " Stop Rec: D-threshold exceeded", " Stop Rec: *Digital-In Rising*" and " *Stop Rec: Digital-In Falling*" is written in the tdms file.[15]

For the termination conditions *Number of values* and *Relative Time,* the checkbox *When finished: Generate new file* at the bottom can be activated. This means that once the recording ends, recording automatically resumes in a new file, and the selected termination condition remains in effect.

Using Automatic Recording

After the recording configuration is closed with OK, it is saved for the next program start. **To activate the automatic start of recording, the measurement must be started in the *Recorder Yt* (or *XY*) by clicking on *Start measuring***. A message will appear:



The *Start Recording* button flashes while waiting for the Start Trigger condition. Once this is reached, the recording will start and the Start Recording button will switch to:

If multiple files are to be recorded, the status message "*Number of recorded files ready: 1 Waiting for Trigger...*" appears after a file was terminated.

These *.tdms measurement data files are stored in the last selected directory. To set or change this, it is recommended to start a recording manually once (i.e. with *Start Recording = Manually*), because only then a file selection window appears.

Additional Configuration Options for Data Recording

***Save Memory Data* tab:**

If a measurement has been taken in the *Recorder Yt* with *Start Measuring* without it being recorded, some data can even be saved afterwards by clicking *Save History*. This index card has nothing to do with the actual recording configuration. It can only be accessed by clicking on *Configure Recording* in *Recorder Yt*.

15 The *Post-Trigger Values* function is only available with GSVmulti PRO

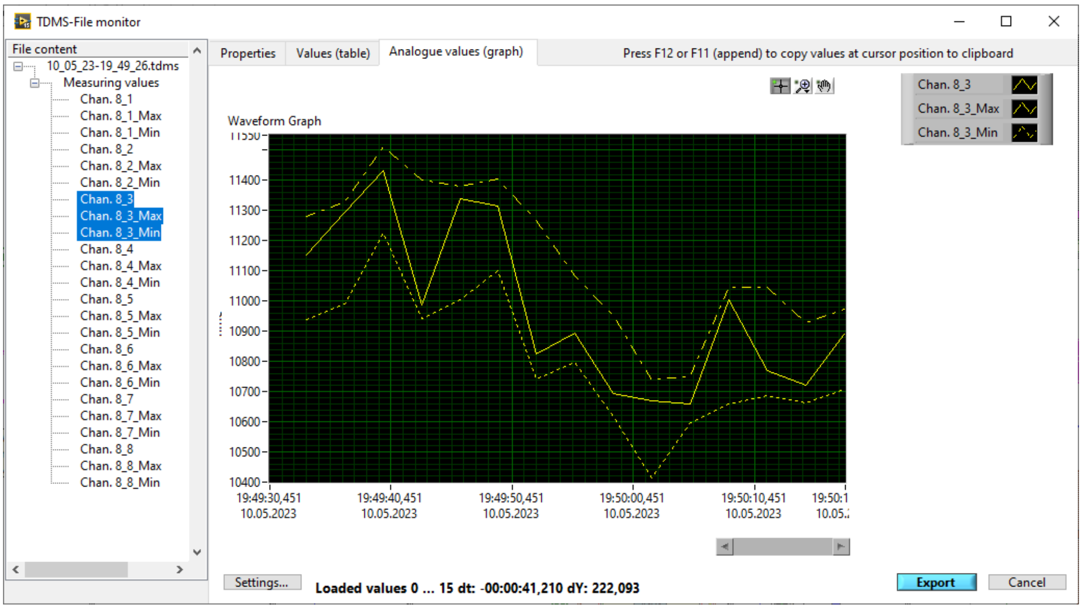
***Data Reduction* tab:**
Especially with a high measurement data rate or many channels, the measurement data files can become quite large. With *Data Reduction*, this size can be reduced and, if necessary, short peaks can be recorded at the same time.

Recording Interval: Use *One value per time interval* to enable data reduction, or *Record every value* to disable.

Time interval: This is where the length of the data period is defined. It must be greater than the reciprocal of the measurement data rate of the integrated amplifiers (*Data frequency*).

Decimating Average: If this radio button is set to *Mean values inside interval*, the arithmetic average is calculated on all measured values within the specified data interval. At the beginning of a new data interval, it is restarted (decimating averaging).

Create Additional Channels with Maximum/Minimum Values: If *Create Maximum / Minimum values* is activated here, GSVmulti creates additional channels in the measurement data file (one for maximum and one for minimum of each original channel), which specify the maximum value and the minimum value in the data interval. These are determined anew at the beginning of a new data interval. Together with *Decimating Average*, average and peak values can be acquired at a relatively high measurement data rate, without files becoming very large. In the *File Monitor*, the channels of the maximum and minimum values are displayed in dashed lines, and the channel names are appended with "_Max" and "_Min" respectively.



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***Auto Export* tab**:

The measurement data files have a specific binary format, the *.tdms format, which can only be read by a few other programs (e.g. NI Diadem). With *Auto Export*, a tdms file can be automatically converted to another format, e.g. generally readable text formats, during the measurement runtime when each recording is finished. *Enable Auto-Export* must be enabled. Alternatively, tdms files that have already been recorded can also be converted in the *File Monitor*.

Select Destination file type: Specifies the file format of the exported file.

Text file (tab separator): A table file is created in text format. The readings of the channels and the time/date stamp are separated by the tab character. A header is generated. The file extension is *.txt. If this type is selected, you can alternatively select the format of the measurement data files that the GSV-6BT writes to SD card by activating *GSV-6 Logger Format*.

CSV file (select separator): This format is very similar to the text file, but you can use *Cell Separator* to specify the separator for the cells and the file extension is *.csv. This format can be opened with many popular spreadsheet programs, such as LibreOffice Calc.

Excel Spreadsheet: An Excel spreadsheet is generated. The export can take a long time with large files / high measurement data rate and then also affects the system performance (in which case the csv format is more recommended).

Influx DataBase: A measurement data file in Influx format is generated. If this type is selected, the *Measurement Name* should be specified. You can filter out missing or extremely implausible measured values (e.g. due to disturbances) with *Eliminate missing and excess values*. An influx file can be uploaded to a measurement database; At ME-Systems, a small additional background program is available on request, which does this.

Timestamp in UTC: For some file types, the timestamps converted to Universal Time can be used for the exported file.

Append to selected destination file: If this checkbox is enabled, the exported measurement data will be attached to an existing file. That one should already exist and be of the same file type. If you set this checkbox, please use the yellow file browser button to the right of *Destination Path of exported file(s)* to select the file to which you want to append.

Advanced tab:

Various special setting options are combined here.

Record Hidden Channels: If channels have been hidden with Menu bar -> *Channels -> Hide* or if hidden channels are defined in the lastly opened *Session*, you can activate this checkbox to specify that they should be included as well.

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Additional File: At the end of the recording, a second measurement data file is generated, which contains readings of all channels filtered by a maximum or minimum value condition. Filter condition and number of values can be defined. This function is activated with the checkbox *Create second file with filtered values*.

Filter Criterion: Specifies whether to filter by a maximum or minimum value. The entire original file is searched based on the criterion.

Number of Values around trigger / Number of values in filtered file: Number of readings per channel in the filtered file.

Channel to apply criterion: Channel to which the Max./Min filter condition is applied.

Timestamp Calculation: With the generated *.tdms file format, timestamps are not stored with every row of measured values. Instead, the start time and a time increment dt are stored, and the timestamps are formed from it for display or export to another file format. For this reason, only time-continuous (equidistant) measurements can be recorded. This section can specify how GSVmulti should calculate the time increment dt at the end of the recording. Note: If data reduction is enabled, i.e. *One value per time interval* is enabled in Data Reduction, these entries are grayed out because the time increment is defined by the data reduction setting.

Auto-Select dt mode: If this checkbox is activated (default), GSVmulti decides for itself which calculation method is to be used for dt based on predefined criteria. If there are amplifiers whose measurement data rate is considered to be insufficiently accurate, the *Calculate dt from Final time* mode is used. If all amplifiers are very precise in time and the data frequencies of all GSVs are set to the same value (when using multiple devices), the measurement data rate of the amplifier(s) is used for the calculation, i.e. the *Use device data rate* mode.

Select dt mode: If Auto-Select dt mode is not enabled, this can be used to specify the calculation method for dt.

Calculate dt from Final time: Calculates dt based on the start time, the end time, and the number of readings, i.e.: dt= (end time - start time) / (number of values-1).

Use device data rate: This calculates dt based on the data frequency set in the amplifier, i.e. dt= 1/data frequency

User defined dt: This can be used by the user to set dt (this may result in an incorrect or fictitious end time). If this method is selected, an input field *Enter Data Period* appears, in which the time increment dt must be entered in seconds.

Resulting dt: When using the *Use device data rate* or *User defined dt* methods, the resulting time increment is displayed here.

Replace Missing values: In case of connection stability issues, this option replaces missing readings from a device (determined by timeout counting) with a very high marker value of 1E+300. If *Eliminate missing and excess values* is enabled under *Auto Export*, these values will be omitted when exporting to the *Influx DB* format. **Do not use this option** under normal conditions, especially when triggered recording is activated by threshold or with software-calculated special sensors!

Formatting the file name

In the *Format Measuring File Name* input element at the bottom of the window, the **name of the measurement data files** can be formatted. It then applies to the tdms files and possibly also to exported other formats and consists of the date and time of the start time of the file in the initial configuration (default). This is indicated by the format string *<%d_%m_%y-%H_%M_%S>*. You can enter almost any text before or after the time/date format string, i.e. before **<** or after **>**. The special characters % [ ] \ / : * ? " < > | are to be avoided. In the case of files that are automatically started by *Trigger Recording*, [No] can also be appended, which automatically appends incrementing numbers to the file names. With the *Default* button on the right, the entire format string can be reset to the initial configuration. Within the formatting codes, included between < and >, almost any text and character may be used, except [ ] \ / : * ? " < > | and the % character, which initiates a formatting code. These are:

Code	Meaning
%a	Abbreviated day of the week (e.g. Mon)
%A	Full weekday name (e.g. Monday)
%b	Abbreviated month name (e.g. Jan)
%B	Complete month name (e.g. January)
%c	locale-specific default date/time formatting
%d	Day of the month (01-31)
%H	Hour (24-hour format) (00-23)
%I	Hour (12-hour format) (00-12)
%j	Day number of the year (001-366)
%m	Month number (01-12)
%M	Minute (00-59)
%p	AM or PM Entry
%S	Second (00-59)
%U	Week number of the year (00-53), where the first Sunday is the first day of the first week
%w	Day of the week as a decimal number (0-6), where 0 represents Sunday
%W	Week number of the year (00-53), where the first Monday is the first day of the first week
%x	locale-specific date
%.1x	long date format
%.2x	abbreviated long date format
%X	locale-specific time
%y	Year within the century (00-99)
%Y	Year, including century (e.g. 2023)

Code	Meaning
%z	Difference between local time and UTC (HH:MM:SS)
%Z	Time zone name or abbreviation (depending on the operating system's local settings)

Example 1: *Format Measuring File Name:*

My measurement< On %d-%m-%y at %I-%M-%S%p> [No]

yields the file name:

"My measurement On 22-04-26 at 07-27-23PM_01.tdms"

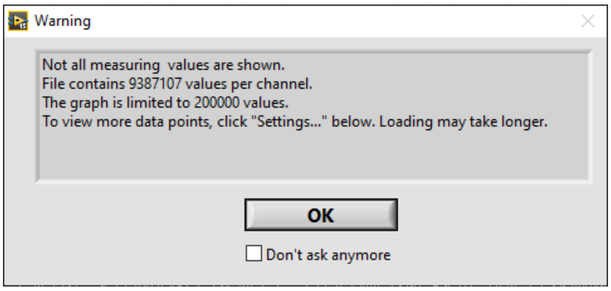
Under ***Resulting file name example***, an example of the file name is displayed.

Note: **The generated names of the measurement data files must** not appear more than once **in the same directory**. In the case of default formatting, this is ensured by the fact that the file name contains the time with seconds (since several files cannot be recorded within one second anyway). A time format including seconds is recommended or, if recording starts automatically, the function tag **[No],** which generates sequential numbers.

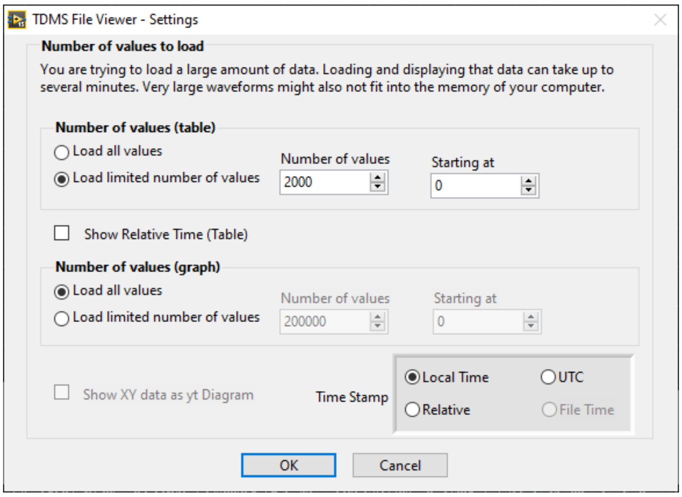
Using *the File Monitor*

Clicking on *File Monitor* in the *Configuration* tab opens a window that opens a *.tdms file. Alternatively, a measurement data file in text format can be opened, which was generated by one of the data logger devices GSV-2MSD-DI or GSV-6BT. In this case, the *.txt file is converted to a *.tdms file before opening and the user is asked for the location of the generated tdms file. The TDMS tools offer further possibilities, see S. 143

The measurement data can then be viewed, checked and exported. When opening and changing the tab, the following warning message may appear for large files:

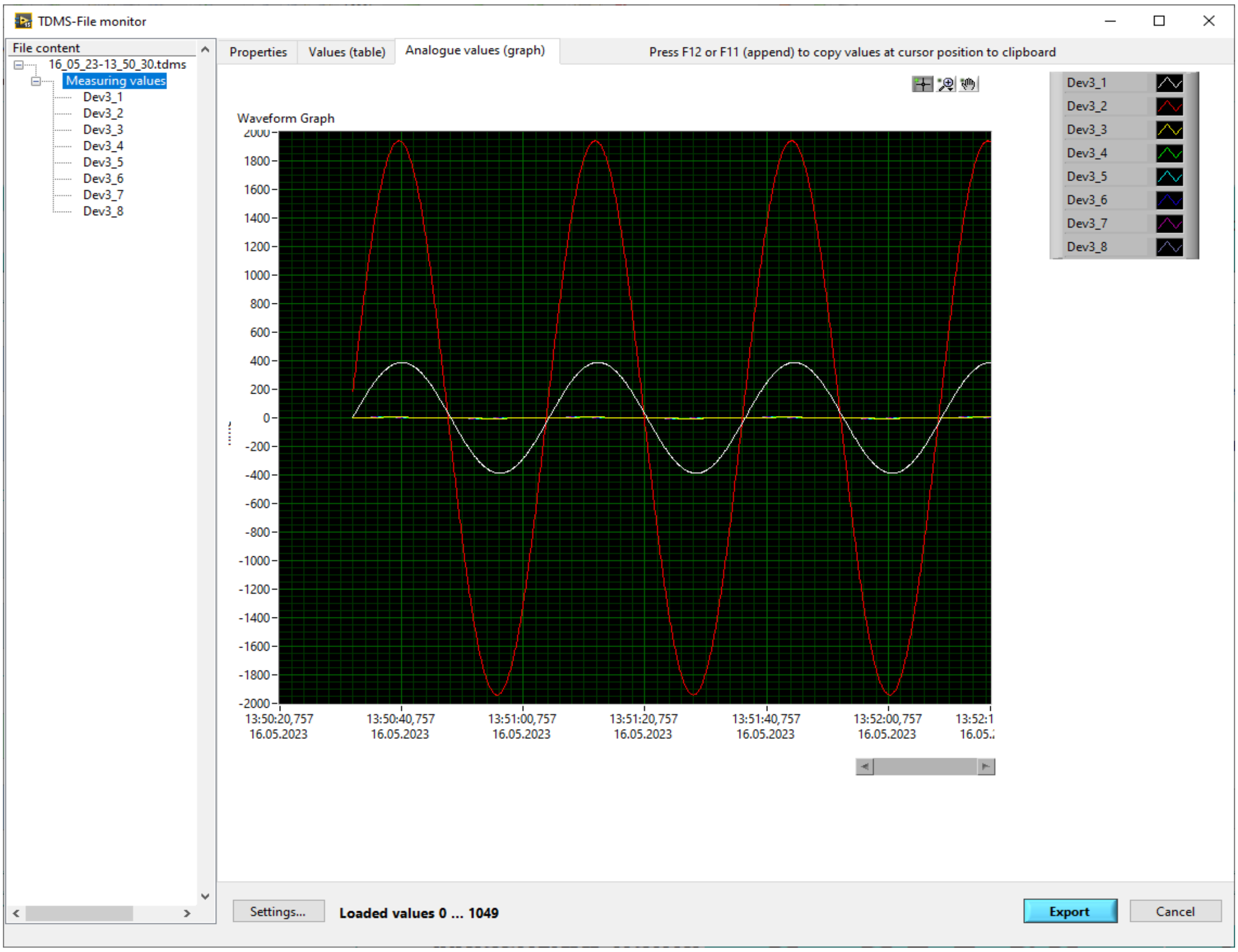


It means that only 200000 consecutive readings of the file have been opened. You can change this by setting the number of values to be opened under Settings or by selecting *Load All Values*:



The opening data set options can be set separately for the *Values (table)* = table of values and *Analogue values (graph)* = graphical view.

If you choose *Load all values*, it may take a long time to open.



In the status bar t the bottom, the number of loaded values is indicated by *Loaded values*.

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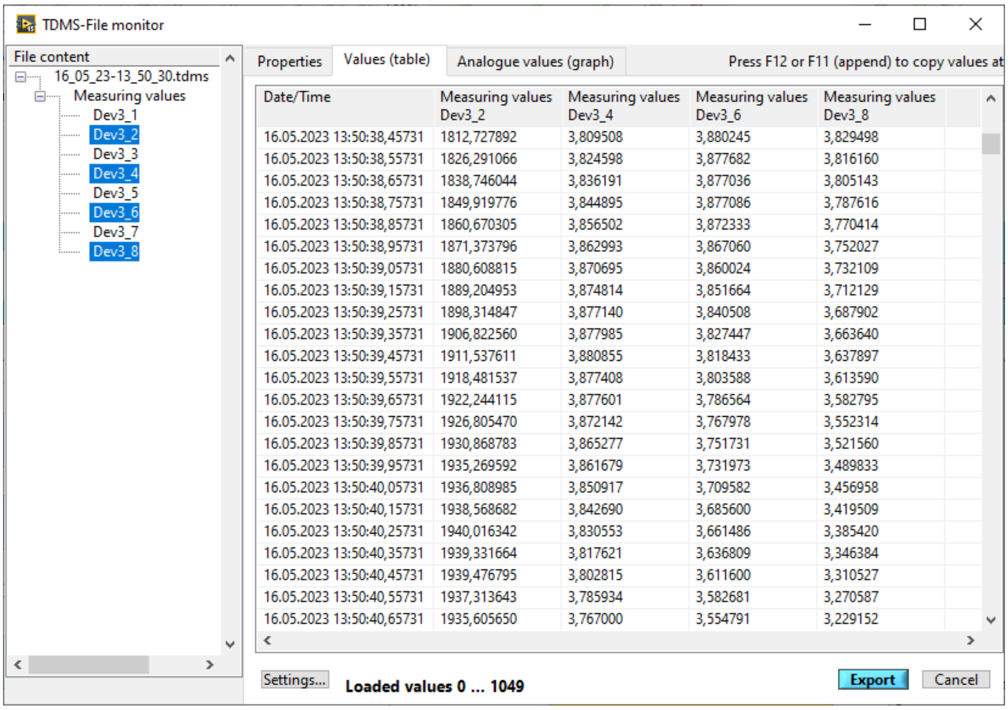
Under *File content*, the tree view on the left, select the channels to be displayed. If *Measuring values* is selected, all channels are displayed. To display multiple channels, select them by holding down the Ctrl key and left-click them at the same time.

Channel names and colors are the same as those used in the measurement.

Properties displays the file's metadata, see Appendix. Some settings of the measurement with which the file was created have been stored here.

Values (table) is a numerical table of values.



Date/Time	Measuring values Dev3_2	Measuring values Dev3_4	Measuring values Dev3_6	Measuring values Dev3_8
16.05.2023 13:50:38,45731	1812,727892	3,809508	3,880245	3,829498
16.05.2023 13:50:38,55731	1826,291066	3,824598	3,877682	3,816160
16.05.2023 13:50:38,65731	1838,746044	3,836191	3,877036	3,805143
16.05.2023 13:50:38,75731	1849,919776	3,844895	3,877086	3,787616
16.05.2023 13:50:38,85731	1860,670305	3,856502	3,872333	3,770414
16.05.2023 13:50:38,95731	1871,373796	3,862993	3,867060	3,752027
16.05.2023 13:50:39,05731	1880,608815	3,870695	3,860024	3,732109
16.05.2023 13:50:39,15731	1889,204953	3,874814	3,851664	3,712129
16.05.2023 13:50:39,25731	1898,314847	3,877140	3,840508	3,687902
16.05.2023 13:50:39,35731	1906,822560	3,877985	3,827447	3,663640
16.05.2023 13:50:39,45731	1911,537611	3,880855	3,818433	3,637897
16.05.2023 13:50:39,55731	1918,481537	3,877408	3,803588	3,613590
16.05.2023 13:50:39,65731	1922,244115	3,877601	3,786564	3,582795
16.05.2023 13:50:39,75731	1926,805470	3,872142	3,767978	3,552314
16.05.2023 13:50:39,85731	1930,868783	3,865277	3,751731	3,521560
16.05.2023 13:50:39,95731	1935,269592	3,861679	3,731973	3,489833
16.05.2023 13:50:40,05731	1936,808985	3,850917	3,709582	3,456958
16.05.2023 13:50:40,15731	1938,568682	3,842690	3,685600	3,419509
16.05.2023 13:50:40,25731	1940,016342	3,830553	3,661486	3,385420
16.05.2023 13:50:40,35731	1939,331664	3,817621	3,636809	3,346384
16.05.2023 13:50:40,45731	1939,476795	3,802815	3,611600	3,310527
16.05.2023 13:50:40,55731	1937,313643	3,785934	3,582681	3,270587
16.05.2023 13:50:40,65731	1935,605650	3,767000	3,554791	3,229152

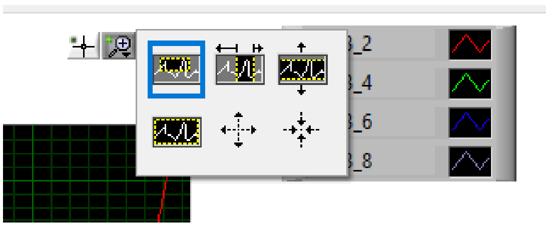
Analogue values (graph) is the graphical view. There are more options here.

At the top right are three small  buttons for tools with the following basic meanings:

Left button: **Move cursor** (see below)

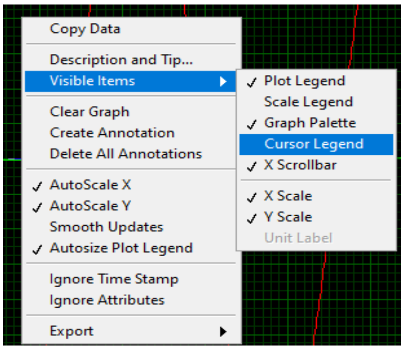
Middle Button: **Zoom Options**

Right button: **Move image section** by dragging with the mouse button



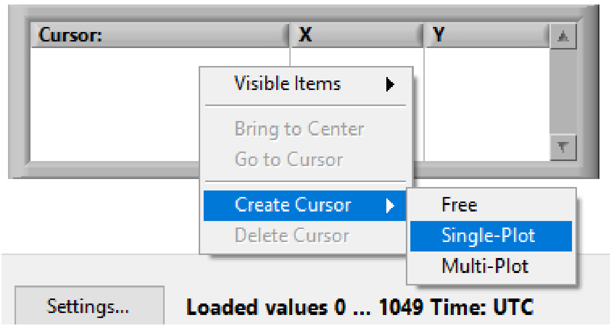
After selecting **the zoom option**, the zoom section can be selected by dragging with the mouse button (holding down the left button). Alternatively, the vertical **mouse wheel** can be used to zoom. The zoom option at the bottom left means: Everything is visible. Alternatively, this can be achieved by right-clicking in the graph and selecting Autoscale X / Y or turning it off and on again (if already selected) or turning the mouse wheel down.

Using **the** cursor

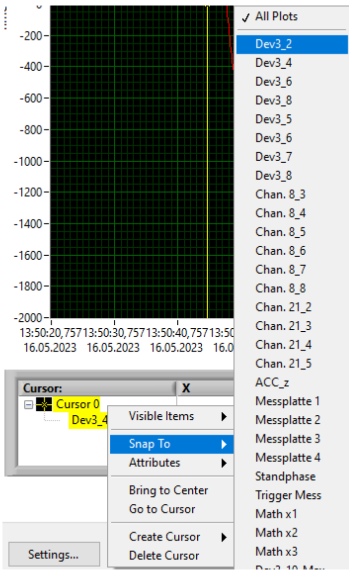


To display one or more cursors, the cursor menu must first be displayed. To do this, right-click in the graph and select *Visible Items->Cursor legend.*

At the bottom, the cursor legend appears.



Right-click into it and select *Create Cursor->Single-Plot*. With the *single-plot* cursor you have the most possibilities. The cursor is associated with one of the displayed channels. The coordinates are displayed, with the X coordinate in Yt diagrams corresponding to the time and Y to the measured value of that channel at the cursor position.



To change the channel assignment, right-click on the cursor number, here cursor *0* in the cursor legend and select *Snap to.* A channel list appears, but only the top entries can be used, i.e. those whose names belong to visible channels.

The coordinates are also displayed in the status bar at the bottom, the time here with higher resolution for measurements with high data frequency.

The cursor appears as a yellow line cross in the graph. In order to be able to move it, the corresponding tool must be selected from the three small buttons above (see above). In addition, the vertical yellow line of the cursor must be visible in the zoom section. If this is not the case, you can display everything as shown above and zoom back in if necessary.

You can create a second cursor with Create Cursor as shown above, and then you have more options. First, the coordinate differences are displayed in the status bar, and

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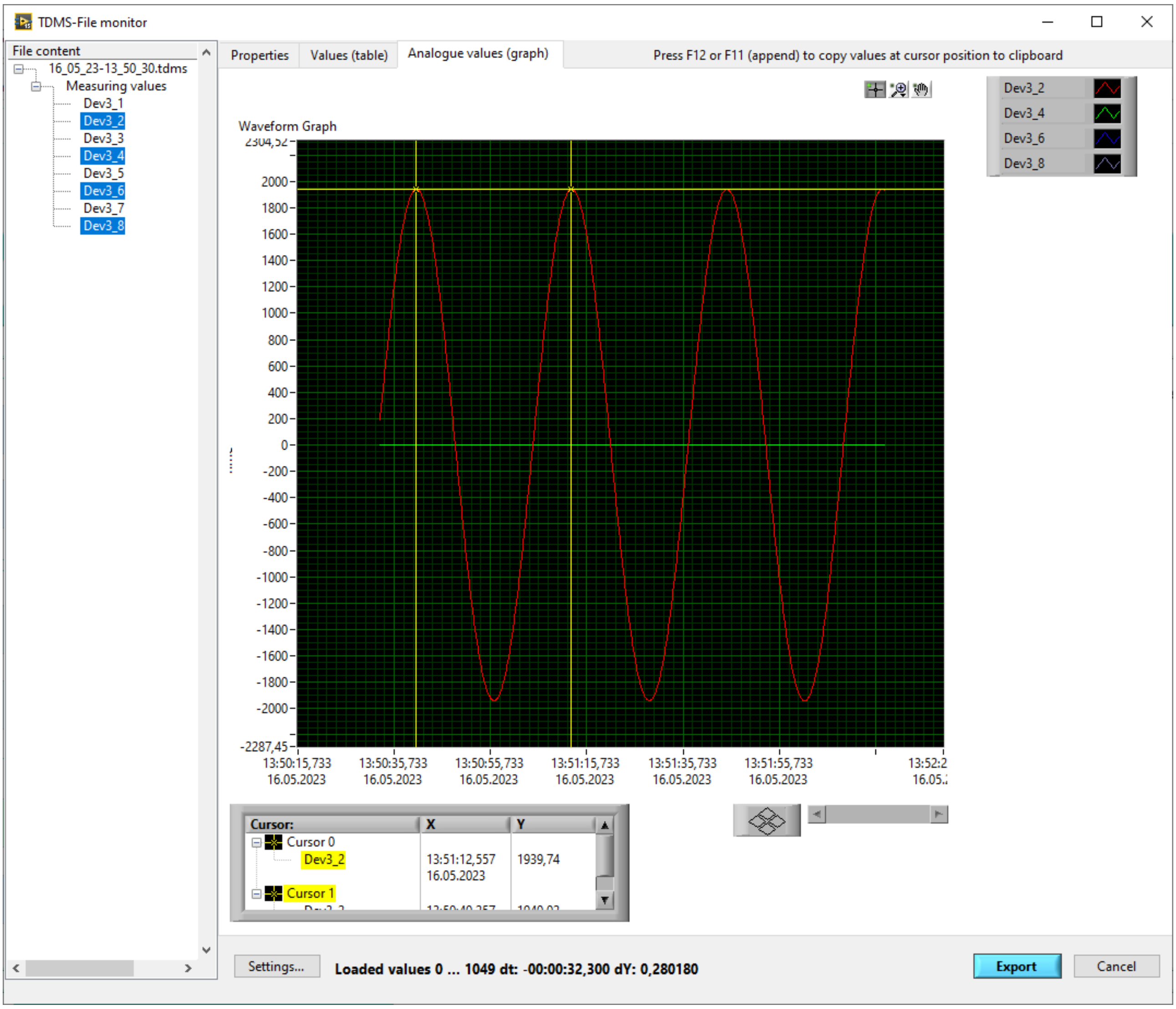
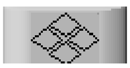
second, the function keys can be used to copy a temporal range of measured values as text to the clipboard, instead of just one value per channel.



In the image above, you can see how you could determine the period of a signal, for example. Two cursors were generated, both of which are assigned to the same channel

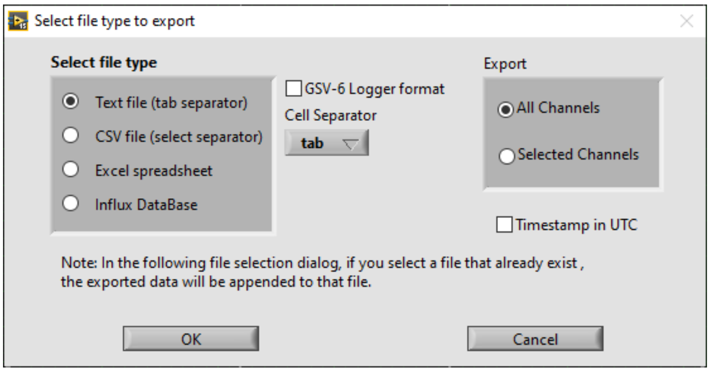


(=plot) (here "Dev3_2"). You can also move the active cursor, which is highlighted in yellow in the legend, with the arrow keys, e.g. so that ***dY*** in the status bar becomes as small as possible. Then you can read the period with ***dt:***, here 32.3 seconds.

Copying and Exporting Measuring values

Exporting to other file formats

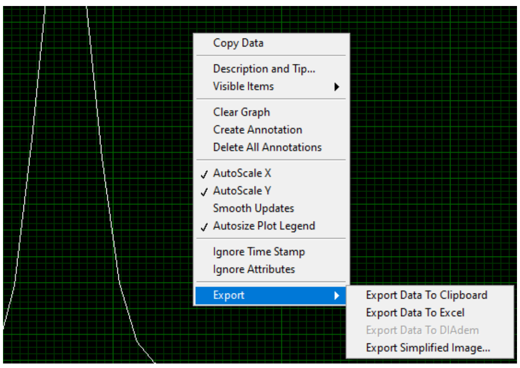
The entire file, i.e. all temporal readings, can be converted to another format by clicking on the *Export* button.



The file types and options are the same as those mentioned in *Configure Recording* -> Auto Export tab:. In addition, you can use the radio buttons under *Export* to specify whether all channels should be exported (*All Channels*) or only the ones marked on the left in the construction view (*Selected Channels*). After clicking *OK*, a file selection dialog opens. If you enter a suitable, already existing file, the measurement data will be attached; otherwise, a new file will be created with header rows and/or column headers. The first column always contains a timestamp with the date and time.

As with automatic export, notes (annotations) are inserted in the last column for the target file types *Text file* and *CSV file,* at the corresponding point in time for plot-bound *annotations,* if present.

Further **export options** are offered by the right-mouse button context menu of the graphical view (mouse pointer in the graphic, right mouse button ->*Export*):



This means that only the data visible in the graph will be exported.

- ***Export Data To Clipboard*** copies the data as text to the clipboard in the following format (here only one channel and two lines):

-Chan. 17_3	Time - Chan. 17_3
14:31:37,106 25.05.2023	-0,789969

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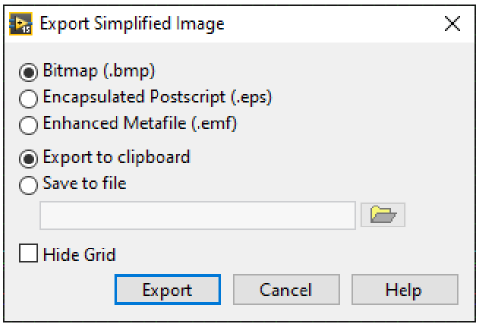
14:31:37,106 25.05.2023 -0,791009

A separate timestamp column is created for each channel. Timestamps and readings are separated by tab; Date and time with spaces.

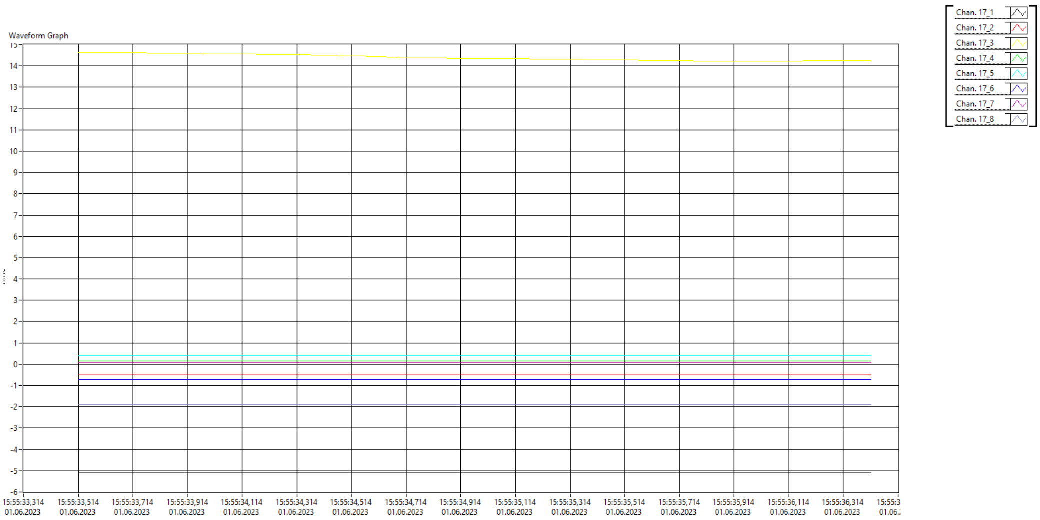
- ***Export Data To Excel*** opens Excel (if available on your PC) and inserts the data, creating a timestamp column for each channel. The file can then be edited and saved with Excel if necessary.
- ***Export Simplified Image*** provides the option to export the graph as an image. You can select the format and enter whether the image should be copied to the clipboard or saved as a file. The background of the image is white, the plot color remains unchanged, see image below.



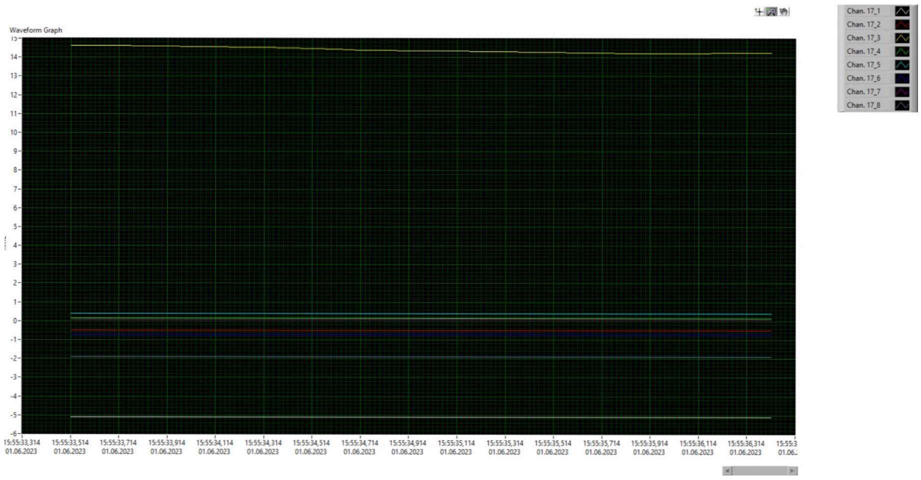
Copy to clipboard

In principle, data copied to the clipboard can only be pasted into suitable other programs, i.e. data in text format into text or spreadsheet programs and images into image processing programs.

The above-mentioned possibilities are those of the right-mouse button context menu of the graphs: Right mouse button->*Export->Export Data To Clipboard* to copy the visible area as table text and ->*Export>Export Simplified Image->Export to Clipboard* to copy the image to the clipboard, which then looks like this, for example:



Similarly, an image can also be copied to the clipboard by **right-clicking->*Copy Data***. In this case, the image corresponds more to the view of the graph in the *File Monitor* window, i.e. the background is black, e.g.:



You can also copy **individual measurement** values or selected areas as text to the clipboard. To do this, you need one or two cursors, which must first be created as shown in the section on Using the cursor. Then you can do the following by pressing the function keys F11 or F12:

- **F12**: Copying the readings of all channels marked on the left in the tree view at the cursor position
- **F11**: Append the measured values of all selected channels at the cursor position to the data that is already present in the clipboard.
- Hold **Ctrl** and **F11**: Copy all temporal readings of all selected channels as table text between two cursors. To do this, two cursors must have been created.[16]
- Hold the **Ctrl** key and **F12**: Append all temporal readings of all selected channels as table text between two cursors to the data that is already present in the clipboard.[16]

These copy functions with F11/F12 only copy the measured values without a timestamp. The readings are separated by tab characters.

16 Copying the area between two cursors is only available with GSVmulti PRO

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Copy and paste at measurement time

Even while a measurement is in progress, measured values can be copied to the clipboard so they can be pasted into other programs (e.g., word processing or spreadsheet software).
With GSVmulti PRO, it is also possible to insert a configurable string (text) containing measured values directly into other programs, either by pressing a function key or automatically when threshold values are exceeded.

Copying Measured values to the Clipboard

If at least one measurement channel is open and GSVmulti has the input focus, pressing the F12 function key copies a text of measured values to the clipboard. If the clipboard already contains text, pressing F11 appends text of measured values to the clipboard. This works regardless of whether a measurement has been started in the recorder Yt/XY or not. The formatting of the measured value text cannot be changed in the standard version (default format) and is as follows for multiple measurement channels:

<Measured Value Channel 1><TAB><Measured Value Channel 2><TAB><Measured Value Channel N>

Example with 6 channels:

-0,004810 0,230499 0,083257 -0,098635 0,094652 -0,870234

If F11 is used to append measured values, a line break is inserted before the measured value text, e.g.

Text to clipboard

-0,004293 0,210927 0,108514 -0,122475 0,083306 -0,860497

This allows you to create several lines of measured values by placing the first one on the clipboard with F12 and then adding more with F11, e.g.:

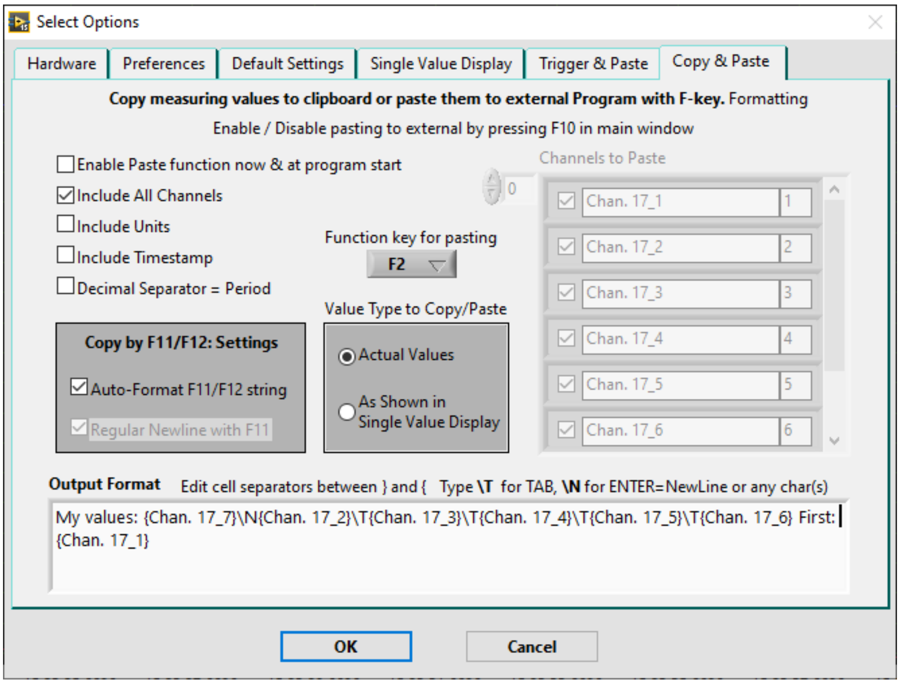
-0,004248 0,198070 0,101477 -0,120024 0,089766 -0,856605

1,996082 0,214995 0,107485 -0,129403 0,104570 -0,860058

Inserting a measured value text into other programs using the F key[17]

If another program has the input focus, a text string with measured values can be inserted into it by pressing a function key. This feature can be configured under Menu Bar>*Options>Copy & Paste*:

17 This feature is only available with GSVmulti PRO



For example, with the configuration shown here, when pressing F2 in another program, the following text is inserted:

My values: 1,996199

0,184941 0,098549 -0,111647 0,104588 -0.882169 First: 0.033925

Pasting into another program must first be enabled by using the Menu bar>*Action->Enable Value Paste by F<no>* **or pressing F10.** It is not relevant whether a measurement started with *Start Measuring*. If Paste is enabled, "*Paste to external enabled"* will appear in the status bars of the main window.

Specifically, the controls in *Options>Copy & Paste* mean:

- *Enable Paste function now & at program start:* If this checkbox is checked, the Paste function will be activated immediately and when the program is restarted. "*Paste to external enabled"* will then appear in the status bars of the main window.
- *Include All Channels:* When enabled, all existing channels are inserted into the formatting string *Output Format*. Otherwise, the channels inserted there can be selected individually with *Channels to Paste*.
- *Include Units:* If this checkbox is set, each measuring value is appended by its configured unit, with a space between the value and the unit.
- *Include Timestamp:* If this checkbox is set, a timestamp with a date is inserted at the beginning of the measured value text (default). Its format depends on the Windows language setting (locale) and is as follows for German:
  DD.MM.YYYY HH.MM.SS,bbbbb e.g. 8.8.2023 18:43:46.09986
- *Decimal Separator = Period:* If this checkbox is set, a period will be used as a decimal separator in any case, even in German Windows; otherwise – depending on the Windows language setting – a comma may be used.

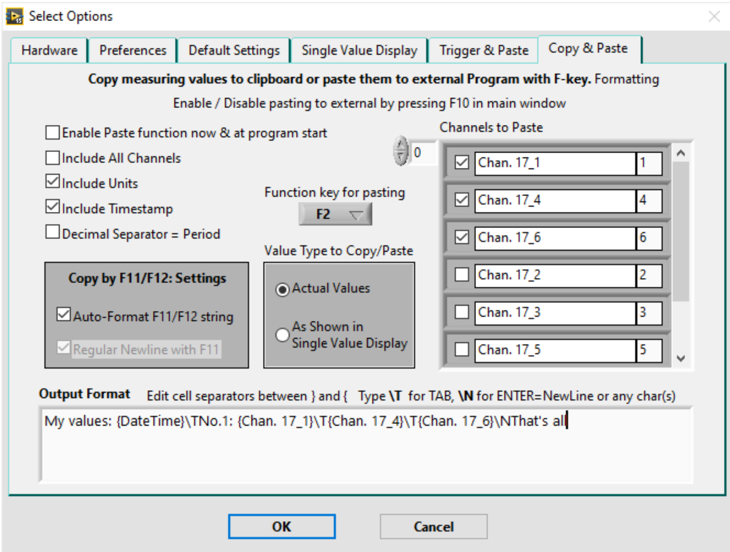
- *Copy by F11/F12: Settings*
    - *Auto-format F11/F12 string:* If this checkbox is not set, the measured value text, which is copied to the clipboard with F11/F12 when GSVmulti has key focus, will be formatted in the same way as defined here. Otherwise, i.e. if the checkbox is set, the default formatting described in Copying Measured values to the Clipboard is applied.
    - *Regular Newline with F11:* If this checkbox is set and *Auto-Format F11/F12 string* is not set, a line break will always be inserted first when pressing F11.
- *Function key for pasting:* Selector for the **function key** that is used to insert the measured value text into the other program. Note: It is highly recommended to select a function key here that does not trigger any or no relevant function in the other program in which you want to insert.
  The user manual of that program can be useful for this purpose, or you can try it out first. Otherwise, both functionalities are likely to be triggered, which can lead to problems (possibly malfunction or even crash of this other program).
- *Value Type to Copy/Paste:* Here you can choose whether to insert the measured values of the main display or those of the *Single value display* of the *Recorder Yt*.
    - *Actual Values:* The main display of "normal" current values is inserted as they appear in the *Value Display* and *Configuration* tab
    - *As Shown in Single Value Display:* The numerical display of the *Single Value Display* in *Recorder Yt* can be switched between different display types, see *Recorder Yt*. If this radio button is selected, the converted values displayed here will be used for insertion.
- *Channels to Paste:* If *Include All Channels* is disabled, measurement channels can be added to the measurement text to be inserted by checking the corresponding checkbox. In the middle is the channel name and on the right is the channel number. Hidden channels cannot be selected. When selecting a channel checkbox, the placeholder for the measurement value of this channel *{channel name}* appears in the formatting string *Output Format* and from the first value the default separator \T is inserted between measured values. *Output Format* can be edited manually at the end and ultimately applies to the generation of the text to be inserted.

The Formatting String *Output Format*

In the formatting string, any text can be written **between** the placeholders for variable entries, i.e. measured values *{channel name}* and timestamp *{date time}*, which then appear in the output text. In these texts, the special characters
\T for a tab indentation (TAB) and
\N for a line break can also be used anywhere.

It is also possible to change the channel order. However, the channel names must be spelled exactly correctly.

For example, this configuration:



with the formatting string:

My values: {DateTime}\TNo.1: {Chan. 17_1}\T{Chan. 17_4}\T{Chan. 17_6}\NThat's all

Inserts the following text (measured values & timestamps are variable, of course):

My values: 08.08.2023 18:49:31,09163 No.1: 1.995757 mV/V -0.117022 mV/V -0.857558 mV/V

Thats all

If you change the channel order to, for example:

My values: {DateTime}\TNo.4: {Chan. 17_4}\T{Chan. 17_6}\T{Chan. 17_1}

The following text is generated:

My values: 08.08.2023 18:57:55,31113 No.4: -0.094565 mV/V -0.869309 mV/V 1.995695 mV/V

Insertion of a measured value text into other programs **via trigger**[18]

Measured value texts of this type can also be automatically inserted into another program by exceeding or falling below configurable threshold values (instead of pressing a function key). This can be used, for example, to output measurement value strings at pre-configurable reference points or way marks or similar. It can be configured in Menu Bar->*Options->Trigger & Paste:*

18 This feature is only available with GSVmulti PRO

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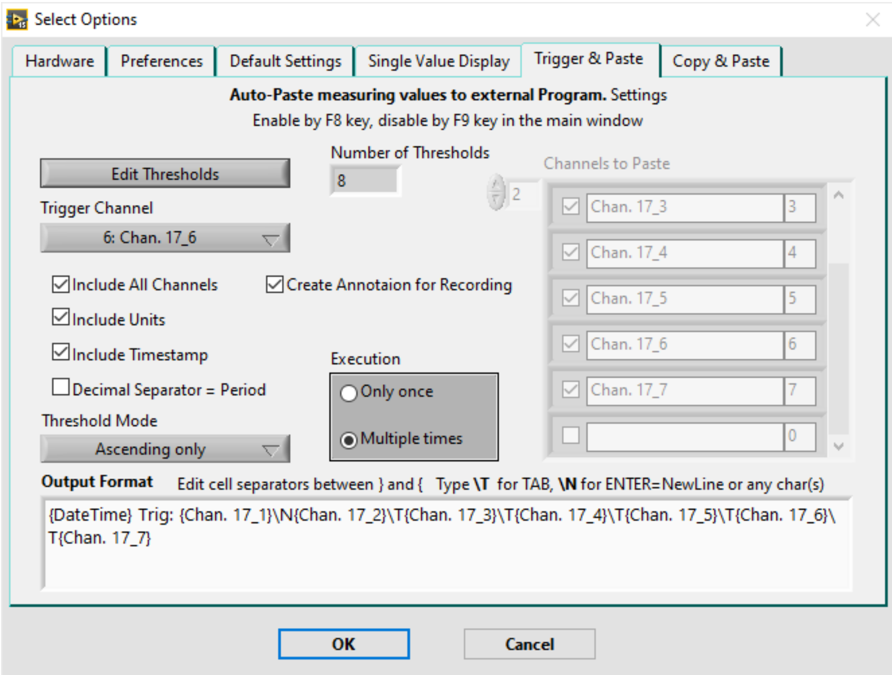
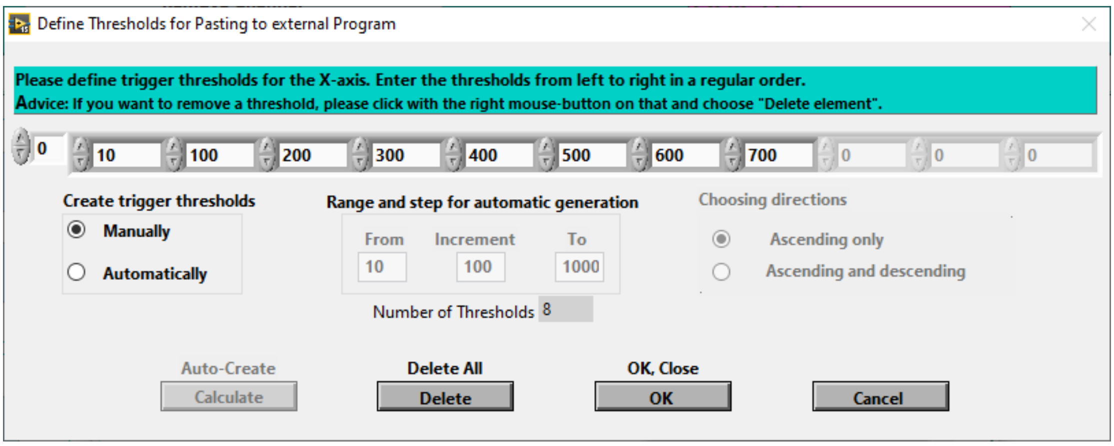


If the following four conditions are met, a measuring value text is inserted into another program:

- The measurement was started in the *Recorder Yt*
- The Trigger Paste function was activated with the function key F8 or Menu bar->*Action->Enable Trigger Paste*
- The other program to insert into has the input focus
- The threshold condition is met, i.e. the measured value of the *Trigger channel* has exceeded or fallen below the current threshold

Those controls in *Options-> Trigger & Paste* that have the same name as in *Options-> Copy & Paste* also have the same function with respect to the measurement value strings exported via trigger condition. Furthermore, there are the following:

Edit Thresholds:
When clicked, a window opens with which the threshold values can be defined.



In it, they mean:

- The small number at the top left (here in the picture =0) is the index of the first threshold value displayed. It is important to use them (e.g. with the small arrow keys to the left of them) if the number of threshold values is >11; otherwise, it should be =0 to see all thresholds.
- The numbers to the right (top) are the thresholds. These can always be changed manually. A grayed-out entry means "not present"; you can also delete a threshold value by right-clicking on it and selecting *Delete Element*. The threshold values should be selected in a regular order, which should match *Threshold Mode* (in the *Options* window), see below.
- With *Create trigger thresholds = Automatically*, the threshold values can also be generated automatically with even distances. To do this, the first threshold value is entered under *From*, the distance under *Increment* and the last threshold value under *To*. You can have them created either only ascending (*Choosing directions* = *Ascending* only) or ascending and *descending*. If you have configured this, the threshold values are created by clicking on *Auto-Create* (*Calculate*).
- To finally set, click *OK, Close*

Other controls in *Options > Trigger & Paste:*

- *Trigger Channel:* Selects the channel whose readings are to be compared with the thresholds.
- *Threshold Mode*: Specifies whether the thresholds are in ascending and/or descending order and whether the trigger event should be triggered when a threshold value is exceeded or fallen below the threshold:
  - *Ascending only*: The threshold values are in ascending order and are triggered when a threshold value is exceeded (i.e. when the measured value becomes > threshold value)
  - *Ascending, then descending:* The first thresholds are in ascending order and are triggered when a threshold value is exceeded, the last thresholds are in descending order and are triggered when a threshold value falls below
  - *Descending only:* The threshold values are in descending order and are triggered when a threshold value falls below a threshold value (i.e. when the measured value becomes < threshold value)
- *Execution* This can be used to specify whether the threshold-related output of measured value strings should continue to occur after a threshold set has already been completely finished (*Multiple times*) or not (*Only once*).
- *Create Annotation for Recording*: If this checkbox is set, *Annotations* are set for the trigger events, i.e. notes that give short texts to the recorded tdms files at these points, which are displayed in the File Monitor, namely *"Threshold No* <number> *exceeded*" or "*Value below threshold No.* <Num>" (threshold value fallen below).

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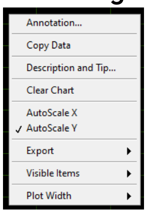
Annotations in Measurement Files

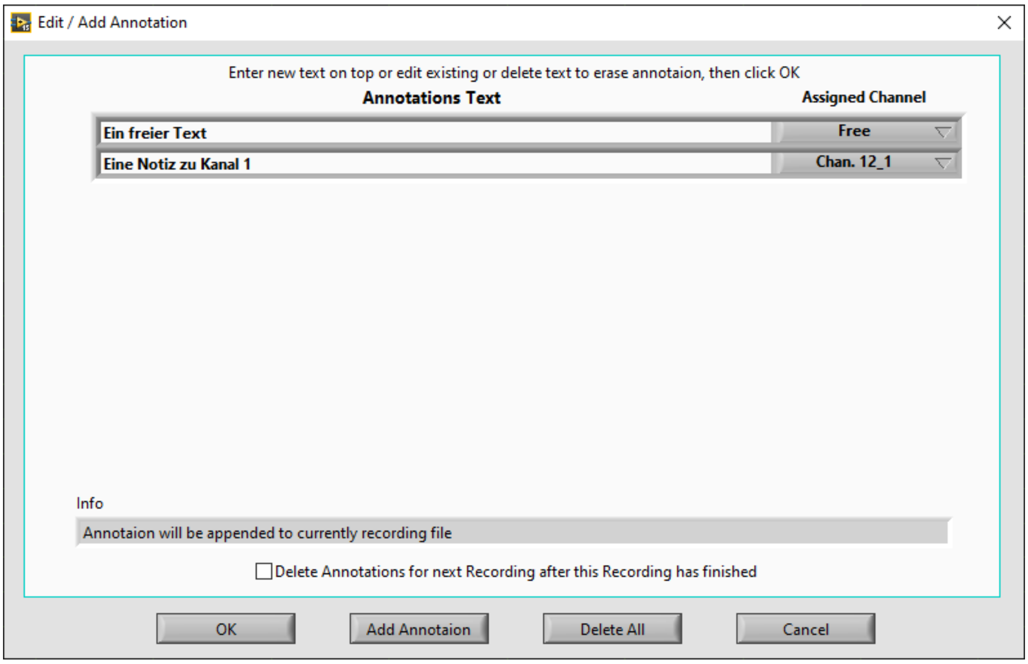
It is possible to add text to recorded *.tdms measurement value files, e.g. to store information about the type or conditions of the measurement with the measured value curves. These texts are displayed in *the File Monitor* and can also be exported to text formats. They can be set during the measurement or afterwards in the *File Monitor*.

Setting Notes While Recording a Measurement

After a measurement value recording has been started, e.g. with *Start Recording*, notes can be set by right-clicking in the graph of the *Recorder Yt* (or *Recorder XY)* and then selecting *Annotation* in the context menu.

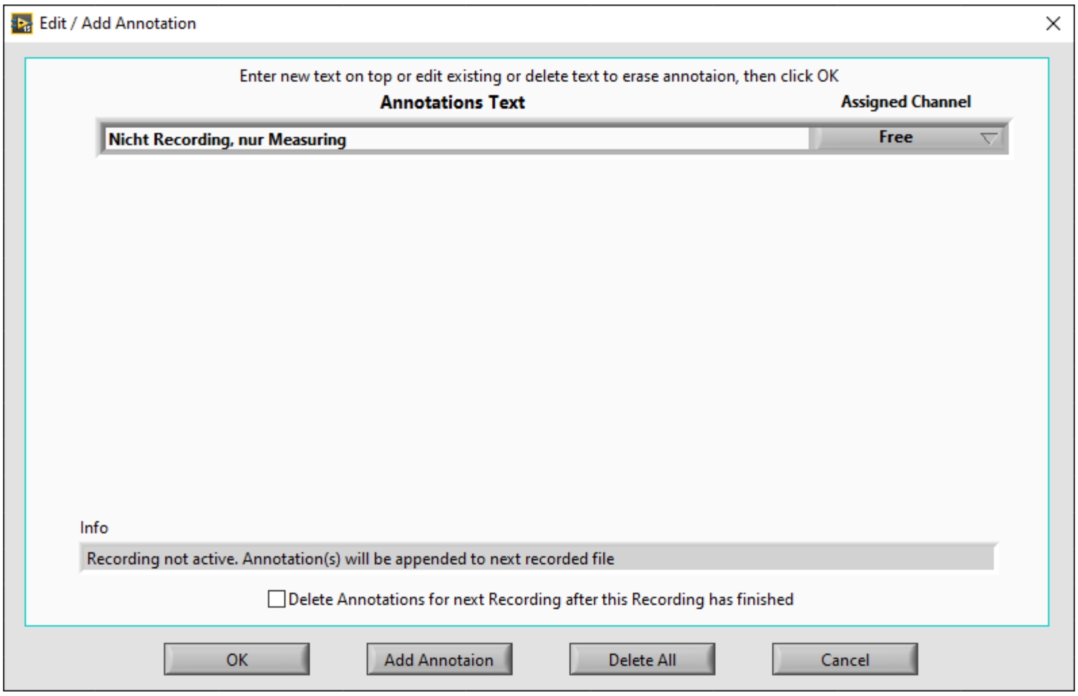


Then the *Annotation* window opens.



The test cursor is automatically placed in the top text input line, so that you can enter the new text right away. The note can be assigned to a specific channel or unassigned *(*Free) using *Assigned Channel*. You can also edit texts previously set here.

It is also possible to enter texts before the recording has started, they will then be added to an upcoming recording. The assigned time is then the start of the recording.

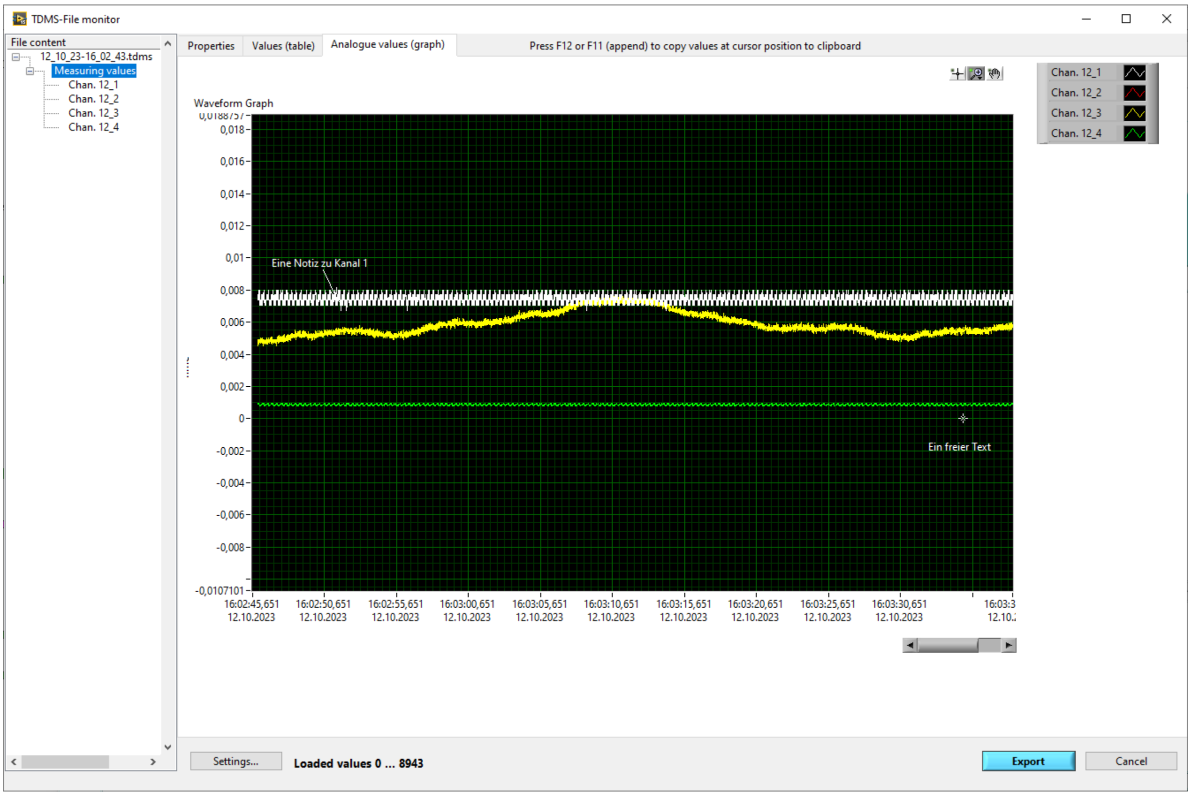


The checkbox *Delete Annotations for next Recording after this recording has finished* is then valid for the next but one recording, as none is currently running. So, in any case, the note will be added to the upcoming recording; if this checkbox is set, it will then be deleted so that the next recording no longer contains it; if it is not set, the *Annotations* are added to each recording. This behavior can also be set under Menu Bar *-> Options -> Preferences -> At Start Measuring* using the *Delete Annotations* checkbox, which has the same function. If it is set, all notes that were added to the last recording will be deleted when a new recording is made.

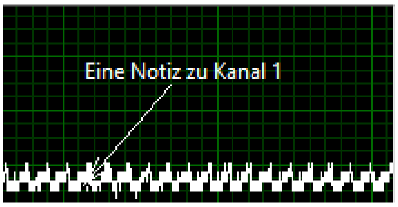
In the File Monitor, the notes are only displayed with Yt data[19]:

A text assigned to a channel is marked with an arrow on this plot, while a free text is not. The arrow also points to the time at which *Annotation...* has been clicked.

19 If they were set in the XY Recorder, they are present but cannot be displayed. If you go to Settings... Show XY Data as Yt Diagram enabled, they will be displayed. They are also exported when exported to a text format.



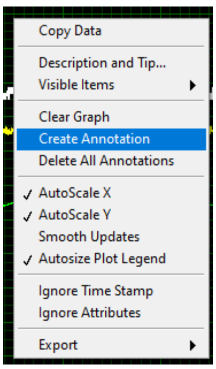
The cursor pointer can be used to move the position of the text or the time/arrow:



Once you have done this, when you close the *File Monitor*, you will be asked if you want to save the file, because this information (text and time position) is also saved.

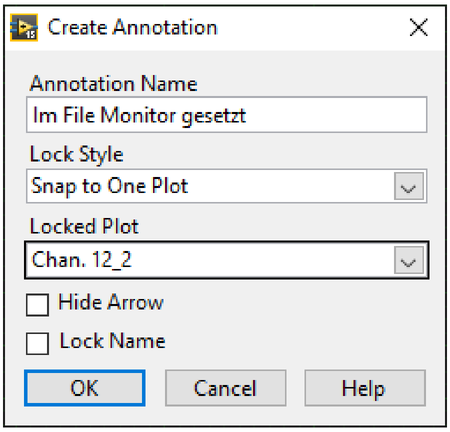
If the tdms file is exported to a text format (*Text File* or *CSV File*), the notes will be inserted in the last column, at the time they belong to. When exporting to Excel, InfluxDB, or GSV-6 format, the notes are not exported.

Setting Notes in *the File Monitor*



You can also add new annotations to the *File Monitor* by right-clicking on the graph and selecting *Create Annotation* from the context menu.

The text is then entered in the following window under *Annotation Name* :



The note can be assigned to a specific channel (*Snap to One Plot*) or defined as unassigned (*Free*) using *Lock Style*. The assigned channel is selected with *Locked Plot*.

When you close the *File Monitor*, you will be asked if you want to save so that the new notes are saved as well.

Offset and Zero Point

The *Set Zero* button in the *Configuration* tab causes the amplifier to set the raw input value to zero. In doing so, he determines a summand "raw offset", which he adds to the raw measured values.

In the case of multi-axis sensors and voltage measurement with rosette strain gauges, all associated input channels must be set to zero so that the calculation of the physical quantities remains correct. As a result, this button is grayed out for channels that belong to multi-axis sensors. Instead, use *Set All Zero* in the *Recorder Yt* or *Recorder XY* tab.

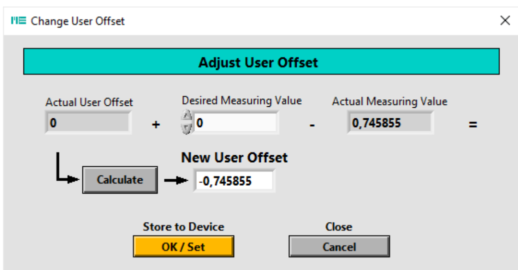
In the case of the GSV-2, GSV-6 and GSV-8 amplifiers, a user offset can also be used, which the amplifier adds after multiplying by the scaling factor (*User scaling*). Measurement processing can be mathematically expressed as follows:

Measured Value = (Raw Reading + Raw Offset) x Sensor Scale + User Offset

For standard sensors, the sensor scaling corresponds to a multiplication by the *User Scaling*, for multi-axis sensors it is a more complex calculation (see p. 44 or p.53).

This means that the *User offset* can also be used for multi-axis sensors for individual channels. It is displayed in the *Configuration* tab under ***User Offset / Tare***.

If you click on this number, you will be taken to the dialog for setting the *User offset*:

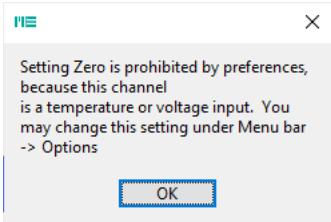


You can use it to enter a new offset directly in *New User Offset* and save it with *OK / Set* or have a new value calculated. To do this, enter the desired measurement value in *Desired Measuring Value* (or leave 0 here) and then click on *Calculate*. Some measured values are automatically taken and the calculated value then appears in *New User Offset*. Save to device with *OK / Set*.

Limitations of Zeroing

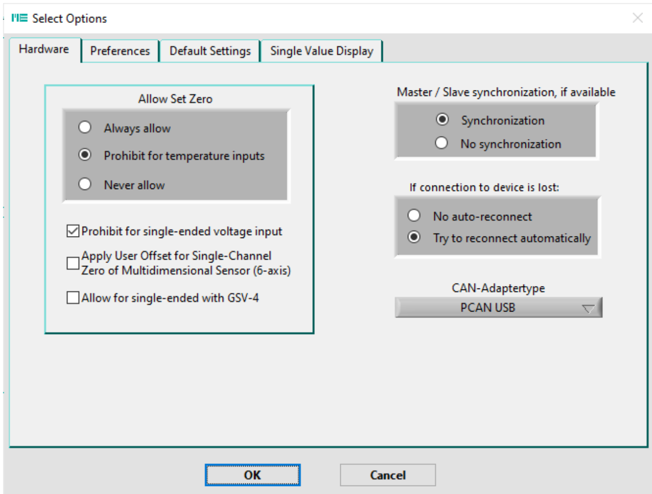
For PT1000 and Type K temperature sensors, zeroing with *Set Zero* state is not permitted by default, and the same applies to the single-ended voltage input.

If you click on *Set Zero* , this message appears:



In the case of voltage inputs, you often want to measure the absolute voltage, like a voltmeter, and a changing the zero point would falsify this. Also when measuring temperature, zeroing would falsify the measurement, unless the sensor has a temperature of 0°C.

To remove these restrictions, click on *Options* in the menu bar and select the *Hardware* tab:



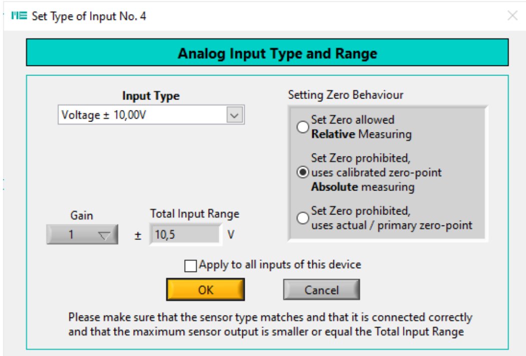
To allow zeroing for voltage inputs, leave *Prohibit for temperature inputs* in the upper left corner and clear the check box *Prohibit for single-ended voltage input*. In the case of GSV-4, the check box *Allow for single-ended with GSV-4* must also be checked. In this case (GSV-4) the password **berlin** must be entered. Confirm with OK at the end.

To also allow zeroing for temperature inputs, you have to select *Always allow* under *Allow Set Zero.*

This configuration - like all settings in the *Options* menu - is not stored in the amplifier, but in the software settings.

Restricting Zeroing for Single Channels

The GSV-8 also allows you to configure the zeroing behavior for bridge and voltage inputs in the device settings.[20] This can be set in the *Input Type* dialog under *Setting Zero Behavior*:



The following options are possible:

- *Set Zero allowed, Relative Measuring:* Setting zero is allowed
- *Set Zero prohibited, uses calibrated zero-point. Absolute measuring*: Zeroing is prevented and absolute ("true") voltage or bridge deviation is measured. The raw offset used (see above) is a manufacturer's calibration value that only compensates for internal offset errors of the amplifier, not external ones. The currently set RawOffset may be lost.
- *Set Zero prohibited, uses actual / primary zero-point:* Zeroing is prevented and the currently set raw offset is left unchanged.

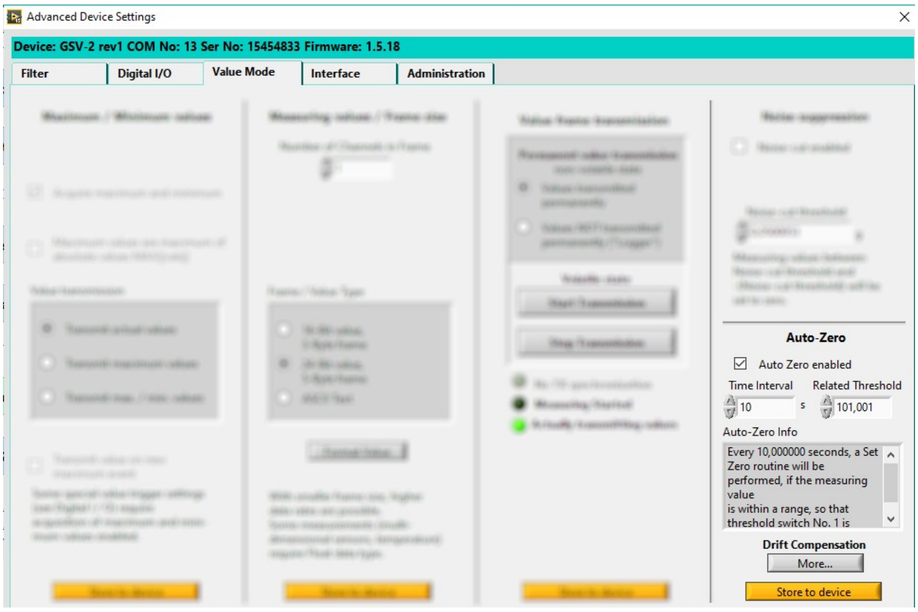
Memory behavior of the zero point on the GSV-6

With the GSV-6, it is possible to specify under the Menu bar → *Device → Advanced Settings → Administration* whether the zero point should be stored in non-volatile manner. This is the default setting (and permanently set for all other GSV models), i.e. after a zeroing with *Set Zero / Set All Zero*, the zero point is restored after switching the device off and on (*Store value non-volatile*). If you turn off saving with *Don't Store (volatile),* the zero point is lost after a power cycle. This setting can be useful if the zero adjustment is triggered very frequently, e.g. by a machine or a system, such as automatically before each measurement process. This is because the flash memory of the zero point (and all other operating parameters) wears out and disabling the save function prevents the maximum amount of writes from being exceeded.

Auto-Zero

The GSV-2 and GSV-8 devices can be configured to perform a zero adjustment on their own under certain conditions, namely when the reading remains within a range around zero for a certain amount of time. This time interval and range can be set in Menu bar → *Device → Advanced Settings → Value Mode → Auto-Zero.*

20 Firmware version 1.54 or higher

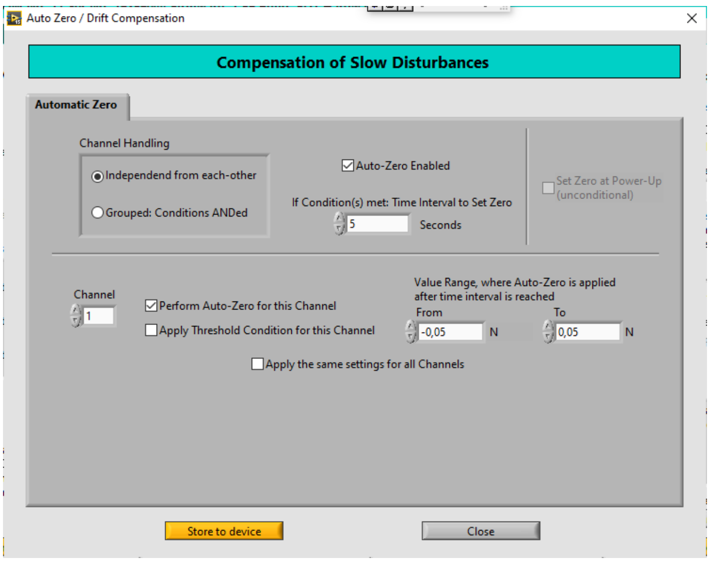


This function can be useful, for example, to suppress thermal drift of a sensor; in this case, you would set the threshold close to zero and ensure during measurement that the load is removed frequently and for a sufficiently long duration. When measuring a continuous load that never goes to zero, the Auto-Zero function is less suitable; but the GSV-2 provides a special drift compensation algorithm for this application, see p.139

In the GSV-2, the Auto-Zero threshold is the same as the lower threshold switch No. 1, i.e. a zero adjustment is performed after the specified time when threshold switch 1 is inactive.

The *time interval* of *Auto-Zero* of *GSV-2* and GSV-8 is stored internally as a count that counts measured values, i.e. after a change in the measurement data rate, it may have to be set again.

After changing the settings, click *Store to device* at the bottom.



With the GSV-8, the auto-zero conditions can be linked between channels. These advanced settings open after clicking on *Drift Compensation More...*

At the top are settings that apply to all channels, while those at the bottom are for the input channel selected with *Channel*.

- *Auto-Zero enabled*: This allows the entire function to be enabled and disabled globally.
- *If Condition(s) met: Time Interval to Set Zero:* Displays or sets the time interval after which the zeroing will occur if the other conditions are met. Internally, it is stored as a counter value, see above.

- *Channel Handling*: Here you can choose whether the threshold condition is checked independently for each channel or for all channels together:
  - *Independent from each-other* means that the time interval for each channel is counted independently and individually, as long as its reading is within its respective threshold range, if the channel is configured accordingly.
  - *Grouped: Conditions ANDed* means that the time interval will only continue to be counted if **all** channels with *Apply Threshold Condition for this Channel* enabled remain below their individual threshold

The measured values are set to zero when the time interval has expired and if *Perform Auto-Zero for this channel* is activated for this channel.

- *Channel*: Selects the channel for which the following settings apply unless *Apply the same settings for all channels* is enabled.
- *Perform Auto-Zero for this Channel:* Auto-zero this channel when the other conditions are met.
- *Apply Threshold Condition for this Channel:* If *Grouped: Conditions ANDed* is also active, this can be used to select whether the threshold condition for time interval counting is checked for this channel, see above.
- *Value Range, where Auto-Zero is applied after time interval is reached*: Here, the threshold range around zero is set, where the value in *From* must be negative and in *To* positive, and it is: *From* = -*To*. It is best to enter only the positive one in *To*, *From* will then be set automatically.
- *Apply the same settings for all Channels:* If enabled, the channel-specific settings apply equally to all input channels.

In the end, changes are saved with *Store to device* .

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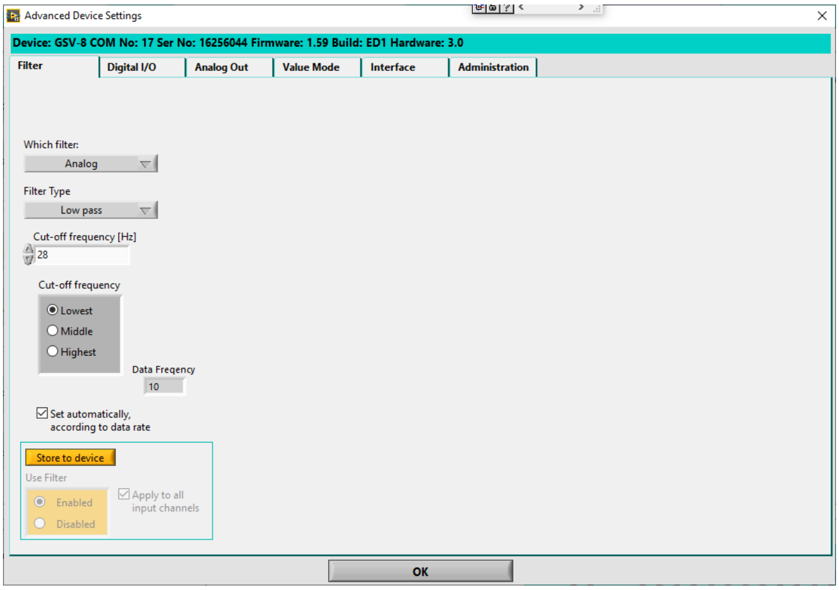
Analog and digital filters

Filters act in the frequency range of the measurement signal, i.e. they only allow a certain frequency range to pass through and the other ranges are attenuated. All GSV amplifiers originally act as low-pass filters, i.e. they process measurement signals of constant magnitudes with f=0 up to a certain cut-off frequency fg. The cut-off frequency is the signal frequency at which the amplitude is already attenuated by -3dB, i.e. by a factor of 0.707. In the case of a low-pass, the attenuation increases further above this cut-off frequency. In the case of digital amplifiers, this results from the measurement data rate (see p. 18), the analogue pre-filter and, if enabled, an additional digital filter, see p. 98. The lowest of these two or three low-pass cut-off frequencies is effective for the bandwidth of the measurement signal.

Analog Filters

All GSV digital amplifiers have an analog pre-filter, which is located in front of the AD converter in the signal processing chain. Usually, its cut-off frequency is half of the maximum measurement data rate or less.

The settings of the analog filter can be changed on the GSV-2 and GSV-8 with Menu bar → *Device* → *Advanced Settings* → *Filter* → *Which Filter = Analog*:



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In the GSV-2 and GSV-8, the analogue cut-off frequency can be switched in three settings. In the initial configuration, *Set automatically, according to data rate* is set and then it is selected automatically based on the measurement data rate:

Model (additional condition)	Measurement data rate	Analog Filter: Cut-off Frequency
GSV-2 (without FIR filter, see below)	Less than or equal to 7.14/s	3.5 Hz
	From 96 to 625/s	260 Hz
	Greater than or equal to 625/s	1700 Hz
GSV-2 (with FIR filter, see below)	Less than or equal to 15/s	3.5 Hz
	From 15 to 1071/s	260 Hz
	Greater than or equal to 1071/s	1700 Hz
GSV-8	Less than or equal to 80/s	28 Hz
	From 96 up to and including 3000/s	850 Hz
	Above 3000/s	11400 Hz

The cut-off frequency is displayed under *Cut-off frequency [Hz].* If *Set automatically, according to data rate* is not set, the cut-off frequency can be selected manually with the *Cut-off frequency* radio buttons.

Since the GSV-2 and GSV-8 are both equipped with Sigma-Delta AD converters, the original input sampling frequency is in the Mhz range and the analog pre-filter therefore also acts as an anti-aliasing filter for each of the three setting options.

Digital Filters

Digital filters are implemented in the device's software, i.e. they process digital (discrete-time and discrete-value) signals. Basically, with GSV devices there are two different types of filters: FIR and IIR filters. In the case of digital filters, the cut-off frequencies fg depend on the measurement data rate Fs; it is always less than half of the measurement data rate and actually acts as a divisor (i.e. a factor <1) to the measurement data rate. **Therefore, if the data rate changes, the cut-off frequency changes accordingly.** GSVmulti displays the measurement data rate in the configuration window.

FIR Filter

A FIR (Finite Impulse Response) filter processes only a sequence of input readings, this sequence consists of the current and past, unfiltered readings. It is always stable, i.e. the output signal does not contain any artifacts, regardless of the filter settings and the input signal, so it corresponds to the input signal or the input signal with a smaller amplitude. However, like all filters, it requires a certain time delay, the filter runtime.

An important parameter is the filter order, which determines how steep the transfer function is in the attenuation range. The higher the order, the steeper it is, i.e. frequencies

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above the cut-off frequency are more attenuated; however, the runtime is also longer at higher order, see pictures below.

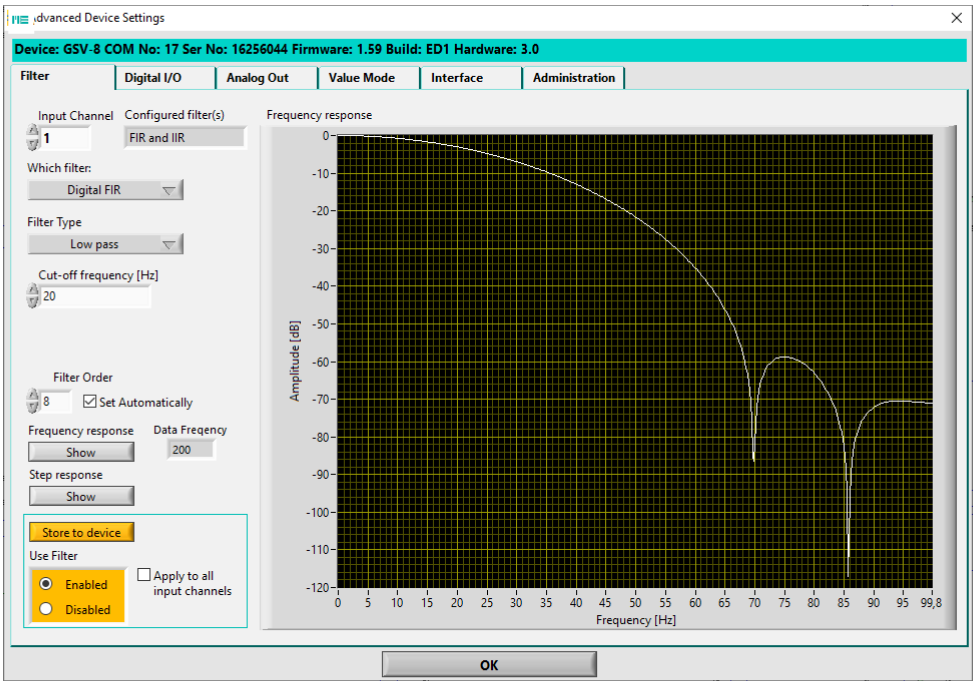
The GSV-2, GSV-3 and GSV-8 devices offer FIR low-pass filters, they are configured under Menu bar → *Device* → *Advanced Settings* → *Filter* → *Which Filter = Digital FIR*. At the bottom left, the filter can be enabled or disabled with *Use Filter*.

GSV-2: Two different switchable FIR filters can be switched on, one of second order with the -3dB cut-off frequency = measurement data rate * 0.18. Its transfer function is smooth, with no overshoot in the step response and it has a runtime of only 3 readings.

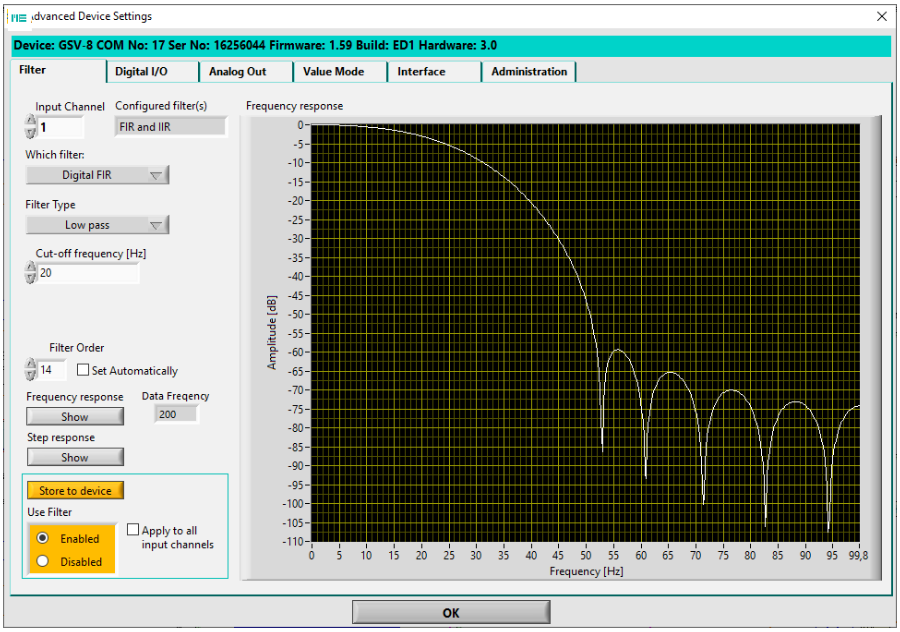
Also, a 5th order with cut-off frequency = data rate * 0.23 is selectable. Its transfer function is much steeper in the damping range, but with about 6% overshoot in the step response; in addition, the runtime is 6 readings.

GSV-3: The GSV-3 only offers the 2nd order FIR filter with the same characteristics as the GSV-2.

GSV-8: With the GSV-8, the FIR low-pass filter can be set individually for each channel, with the desired cut-off frequency being entered under *Cut-off frequency [Hz].* The filter order can be selected manually under *Filter Order* or set automatically if the *Set Automatically checkbox* next to it is set. The value range ranges from 4 to 14 in steps of two (i.e. only even orders are possible). If the filter order is selected automatically, the filter is optimized for runtime, i.e. the lowest possible order is selected. The nominal attenuation in the restricted range, i.e. above the cut-off frequency, is fixed at 60dB.



FIR with fg= Fs/10: Order=8 automatically selected. Damping= -60dB reached at 2/3 x Fs.



FIR with fg= Fs/10: Damping= -60dB already reached at Fs/4 with maximum order of 14.

IIR Filter

IIR filters can be configured individually for each channel of the GSV-6 and GSV-8. An Infinite Impulse Response (IIR) filter handles both a sequence of input values and one of output values from previous filter runs. As a result, a better filter characteristic in the frequency range can often be achieved at a lower order. IIR filters can be unstable, but GSVmulti's calculation algorithm avoids unstable results. Under certain circumstances, one of the following error message texts is displayed:

"DLL.Dfilter: Digital filter calculation failed to converge"
"DLL.Dfilter: Resulting coefficients discarded, because they may limit measuring precision (gain too big)"

The filter order is fixed at four. For the IIR filter, the *Filter Type* option allows you to choose between four different filter characteristics, which differ in terms of whether they pass or attenuate low or high frequencies, or specific frequency ranges.

- *Low Pass*: Low frequencies below the cut-off frequency are passed, above they are attenuated. Application example: Interference or vibration suppression for specific input channels.
- *High Pass*: Frequencies above the cutoff frequency are passed, while those below it are attenuated. This also suppresses a constant frequency at f=0. Example application: Vibration measurement or detection of temporal changes (transients).
- *Band Pass*: Frequencies below the *Lower cut-off frequency* and above the *Upper cut-off frequency* are attenuated and frequencies that fall between these two cut-off frequencies are passed. Application example: Measurement of vibrations in a certain frequency range.

- *Band Stop*: Frequencies between the *Lower cut-off frequency* and the *Upper cut-off frequency* are attenuated. Application example: Suppression of a certain interference frequency or vibration. **Note: Narrow band *Band Stop* filters where the ratio of center frequency to data rate is less than 1/10 often have little or no effect, or may even be counterproductive!**

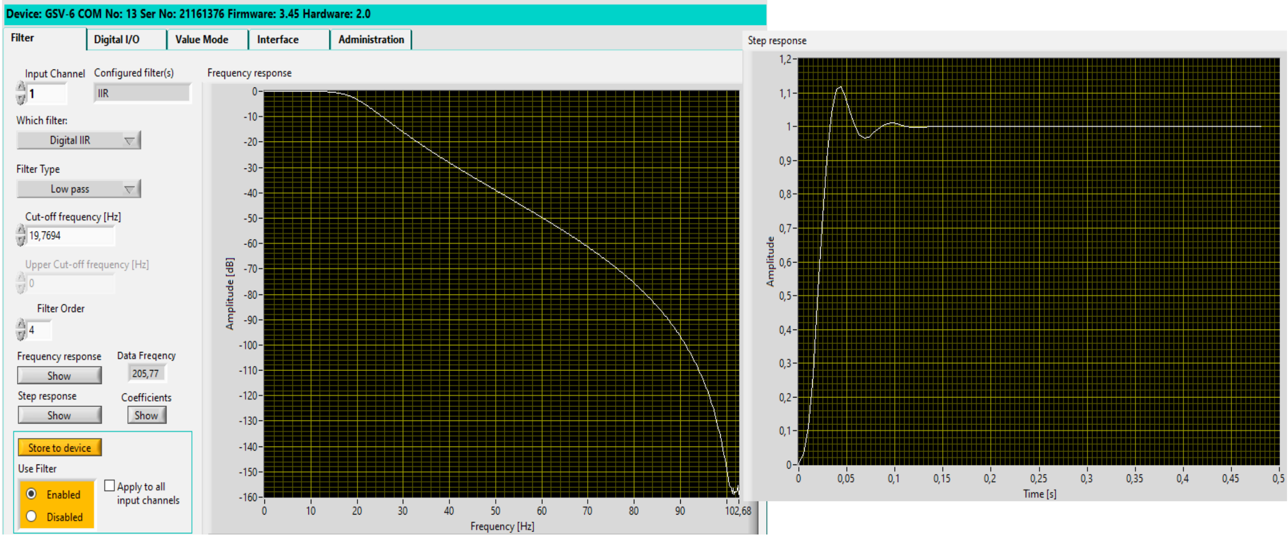
Filter configuration and simulation with GSV-6 and GSV-8

Typically, the controls in Menu bar → *Device → Advanced Settings → Filter* are used in the order from top to bottom. If you want the configuration to be different for the input channels or if you only want to apply it to one channel only, first select it with *Input Channel*. If filters are already configured, this will be displayed under *Configured filter(s)* , namely: *None* (never configured) *IIR*, *FIR* or *FIR and IIR* (both). With *Which Filter*, you can choose between *IIR* and *FIR* for displaying and configuration, if GSV-8 is used. With *Filter Type* you select the characteristic of the IIR filter (*Low Pass, High Pass, Band Pass* or *Band Stop*, see above). If the filter has only one cut-off frequency (*Low Pass / High Pass*) it is operated with *Cut-off Frequency*. If it has a lower and an upper one, it will be *Lower Cut-off frequency* (lower) and *Upper Cut-off frequency* (upper). In the case of the FIR filter, the filter order can be changed under Filter Order (see p. 98).

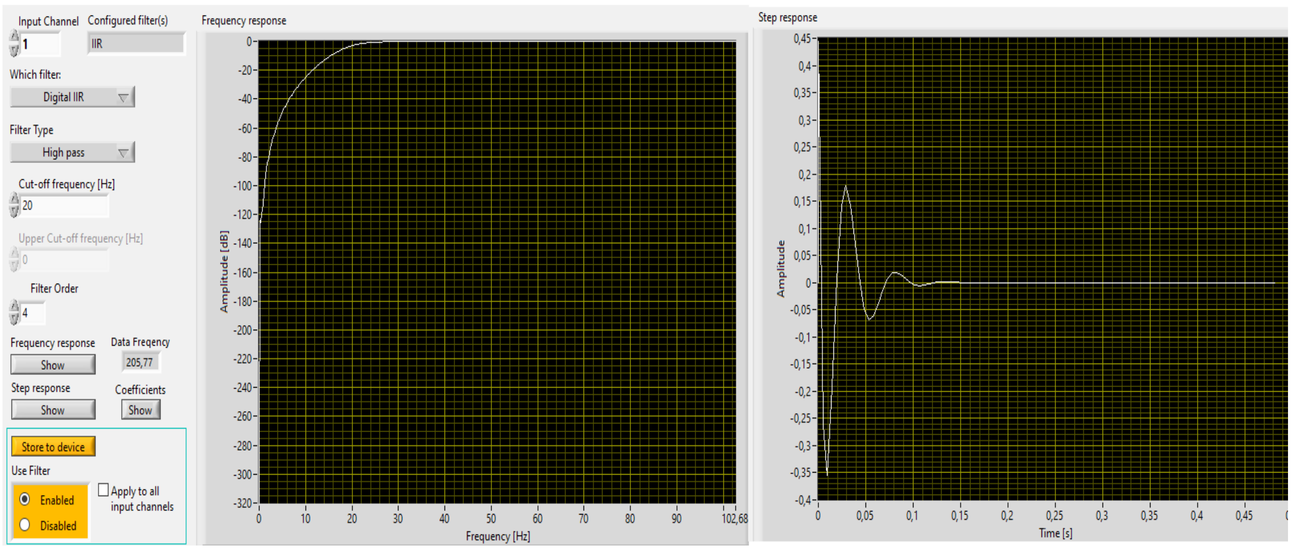
By clicking on the *Frequency Response→Show* button, the filter is simulated **in the frequency domain**. The frequency response in the range f=0 to f= Fa/2 is plotted on the right side of the image on the X-axis and the attenuation in dB (decibels) is plotted on the Y-axis, so that 0dB means: frequency is not damped. The *Step Response→Show* button simulates the filter in the time domain. A step is passed to the filter, whose amplitude changes from 0 to 1 at time t=0, and the output signal of the filter, the step response, is displayed on the right side of the graph. On the X-axis, the time is plotted in seconds, and on the Y-axis, the amplitude is plotted as a factor, where 1 is the input amplitude at t>0. This allows the runtime and overshoot to be determined. The filter simulator simulates the true computational core with the original algorithm of the GSV-6 and GSV-8 in the time domain. *Show coefficients* can be used to display the filter coefficients, i.e. the result of the filter determination.

With *Store to Device*, the displayed filter configuration is stored in the device. If the checkbox *Apply to all input* channels is set, it will be set for all input channels. If *Use Filter* is set to Enabled, the filter will be activated in the device; if *Apply to all input* channels is set at the same time, the filter will be activated for all input channels with filters enabled and with *Use Filter = Disabled* it will be disabled.

It is highly recommended to perform the filter simulation with F*requency Response* and *Step Response*, because the filter is calculated here and you can detect any discrepancies early. The following are examples of simulation results of all filter types of IIR filters in the GSV-6.



IIR low pass with fcutoff= Fs/10. The damping curve (left) differs from that of the FIR filter. The step response (right) shows overshoot, typical for IIR-filters, here 11%.



IIR high pass with fcutoff= Fs/10. The damping has a maximum at f=0 (DC), after the decay time of the step response (right), the output signal is again =0.

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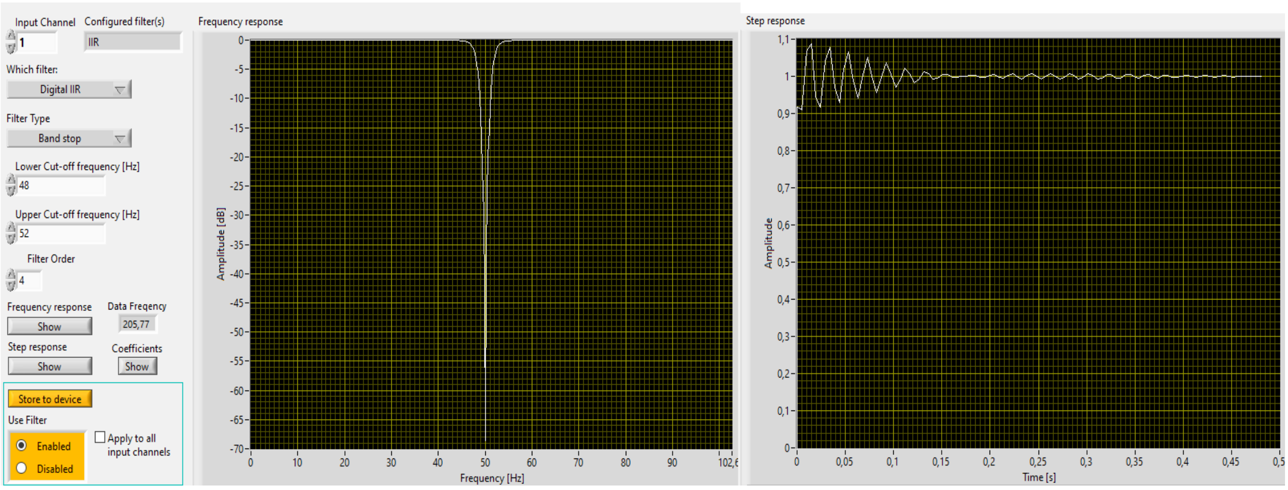
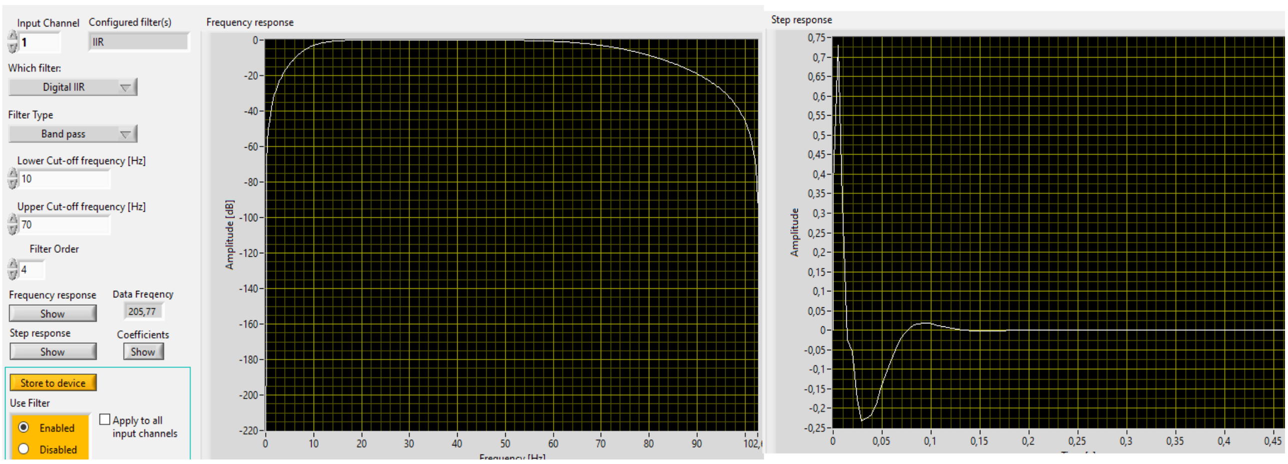


IIR Band stop for damping 50 Hz (power grid hum).



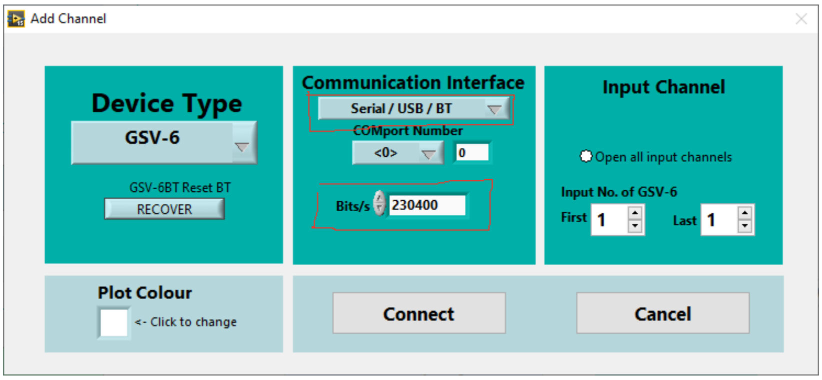
*IIR Band pass from Fs/20 to Fs*0.35. The step response is similar to that og the high pass.*

Communication Interfaces and Measurement Data Frames

A communication interface, consists of one or more electrical signals that transmit information. For GSV devices, the serial interface can run on different hardware ports, e.g. USB, UART, RS232, RS422, Ethernet or Bluetooth Classic/SPP. In the Add Channel dialog, the correct communication interface is automatically selected based on the chosen device type; with the exception of GSV-6/GSV-61, where the Communication Interface can be selected between Serial/USB/BT, CAN, and optionally EtherCAT. An adapter is required for the CAN bus, see page 107.

Bitrate/Baud Rate, On/Off

The serial ports of all GSV devices have the basic configuration of 8 data bits, no parity and 1 stop bit (8N1).[21] The **communication bitrate** must be selected correctly in the *Add Channel* dialog on most devices. This does not apply to the USB interface of the GSV-8 and the GSV-2MSD-DI and to the Bluetooth Classic Interface (e.g. GSV-6BT). For these devices, the Bits*/s* setting in *Add* Channel is irrelevant on these interfaces. This also applies to GSV-8 over Ethernet, because a converter device, e.g. Moxa, is connected in between, in which the bitrate must be correctly configured.



If the device type is selected*,* the default bitrate is suggested; however, if it is set differently in the device, it must be selected accordingly by *Bits/s*. It is best practice to use the small arrow keys, because the control element contains a list of valid bit rates (= baud rates) supported by the device.

The bit rate of serial interfaces is one of the main factors that limit the maximum measurement data rate (see p. 18 and 113); however, this only applies if it is relevant. The GSV-8 and some GSV-2 and GSV-6 models have multiple communication interfaces, and **the lowest relevant bit rate of an activated interface most restricts the maximum data rate.** In the case of the GSV-8, this could be the bit rate of a UART, RS422, or CAN interface.

However, very high bitrates cannot be transmitted with certain hardware interfaces; e.g. the maximum bitrate for RS232-V24 is often only 115200 bits/s; even a very long interface cable has a restrictive effect here.

Bit rate and on/off status of interfaces are controlled under Menu Bar *-> Device -> Advanced Settings -> Interface*. Which interfaces can be operated depends on the device model; the *Interface* tab may not be present. Only GSV-2, GSV-6 and GSV-8 have configurable bit rates; the GSV-2 must have a hardware configuration jumper set for this purpose; see GSV-2 operating manual.

21 Except for rare special types such as GSV-2 with parity

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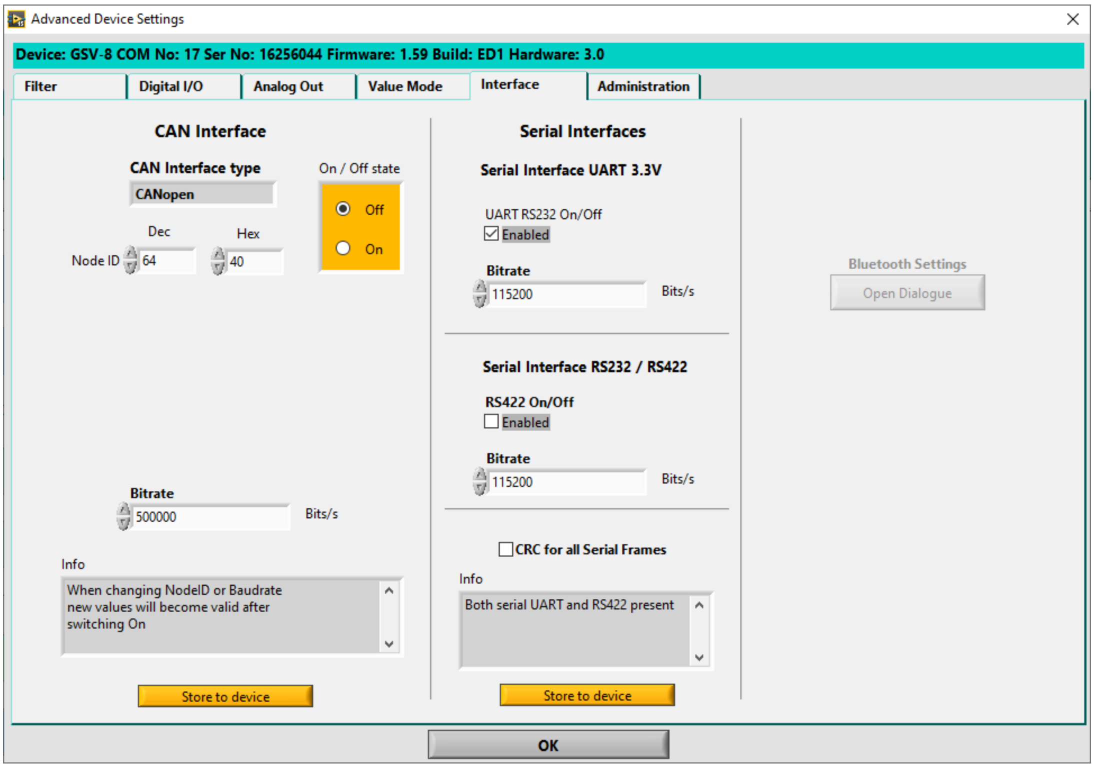
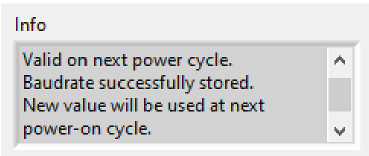


Changes to interface settings will only take effect after the device has been rebooted. After clicking on *Store to Device*, this will be noted in the text box *Info:*



With the GSV-8, UART, RS422 and the CAN interface can be switched off with the *Enabled On/Off* checkbox, if they are available. It makes sense to do this when it is not needed, because the maximum measurement data rate may then be greater. Each device has at least one interface that cannot be switched off, in the case of GSV-8 this is USB.

GSV-8 with Ethernet uses the UART interface for the Ethernet converter device; the bitrate must therefore be set in the same way for both devices (GSV-8 and Ethernet converter). With GSVmulti, this can only be done on the GSV-8 side; the Ethernet (TCP-IP) device server Moxa Nport5110A is configured via Ethernet.

The RS422 interface is differential, i.e. the transmit and receive signal uses two lines each, five in total. As a result, significantly higher bit rates and longer cables can be achieved.

The following bitrates are supported; the default value is **set to bold,** all in Bits/s:

GSV-2 and GSV-3, depending on the version UART, RS232, USB, RS422: 4800**,** 9600, 19200, **38400**, 57600, 115200, 230400, 250000, 460800, 625000, 921600, 1250000. Greater than 230400 not recommended for RS232-V24.

GSV-6: depending on version, UART, Ethernet, USB: 19200, 38400, 57600, 115200, **230400**, 460800, 921600.

GSV-6 CAN interface: 25000, 50000, 100000, 125000, 250000, 500000, **1000000**

GSV-8 UART 3.3V, Ethernet: 19200, 38400, 57600**, 115200,** 230400, 460800

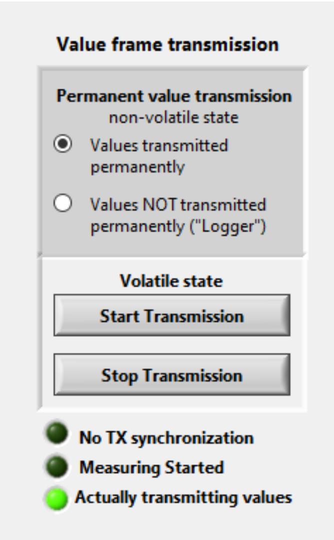
GSV-8 RS422: 19200, 38400, 57600, **115200**, 230400, 460800, 921600, 1250000, 1458333, 1750000, 2500000, 3500000

GSV-8 CANopen: 50000, 100000, 125000, 250000, **500000**, 1000000

GPS/GNSS and *user device*[22], serial, USB: 2400, **4800**, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600. The bitrate is selected in the *Add Channel* dialog, GSVmulti cannot change it on these devices.

Permanent measurement data transmission

When delivered, all amplifiers automatically transmit measured values at the configured measurement data rate. The automatic measurement data transmission can be configured on the GSV-2, GSV-3, GSV-6 and GSV-8 under Menu bar → *Device → Advanced Settings → Value Mode → Value frame Transmission.*



Even if it is switched off, GSVmulti usually still displays running measured values because it temporarily starts the transmission when the device is opened, i.e. it then performs a general *Start Transmission*.

The setting of permanent data transmission, which is stored permanently, therefore applies mainly after the device has been switched on. It is operated under ***Permanent value transmission non-volatile state***. If the *Values transmitted permanently* option is selected, the device sends measurements after being switched on; if *Values NOT transmitted permanently* is selected, it does not. If a device stops sending measurements immediately after being switched off, after some time, the *Timeout* message will be displayed in the Configuration tab of the main window instead of the measurement value. This can be temporarily resolved by clicking the *Start Transmission* button under *Value frame transmission -> Volatile state*. The *Actually transmitting values* LED will then illuminate again.

Disabling permanent data transmission is useful for the following applications, for example:

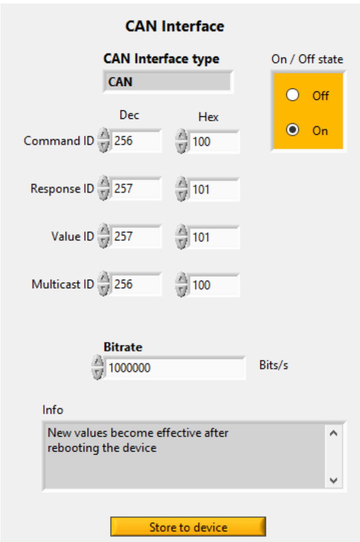
- GSV-6BT with high measurement data rate >200/s to facilitate Bluetooth connection. If necessary, the *Set Frequency* dialog will activate this accordingly.
- Measurement data transmission triggered by digital input, see p.121
- Other software, e.g. that reads measured values only on request (via the Get Value command)

22 These types of devices are only available with GSVmulti PRO.

CAN and CANopen settings

In addition to the bitrate, one or more CAN IDs can be changed for the CAN interface. CAN is a bus system to which several devices, so-called nodes, can be connected. GSVs with CAN also have several services: sending measurement data, receiving commands and sending command responses. Devices and services are distinguished on the CAN bus by the CAN IDs; each CAN-ID shall therefore only occur once on the same bus (exception: on the GSV-6, the *Response ID* may be the same as the *Value ID*). With the CANopen application protocol, only the Device ID (Node ID*)* can be changed, the CAN IDs of the services result from this in a way that is specified by the CANopen standard.

GSVmulti supports CAN converter hardware from the manufacturer PEAK Systems, namely the PCAN USB model by default. Alternatively, you can use Menu bar*->Options->Hardware->CAN adapter type* to switch to the PCAN PCI model, etc.



The settings for CAN-ID and bitrate can be accessed via Menu bar -> *Device -> Advanced Settings -> interface*. For CANopen devices, the *Node ID* is displayed and changed here. The following IDs can be set for the GSV-6-CAN:

- *Command ID:* ID for command request. It must be different from the *Response ID* and the *Value ID*.
- *Response ID*: ID for responses to commands. It must be different from the *Command ID*.
- *Value-ID:* This ID is used to send measurement data. It must be different from the *Command ID*.
- (*Multicast* ID: This ID is reserved and is not currently in use.)

On some GSV-6 models, the CAN interface settings are accessible even if the hardware version does not offer a CAN interface. They are then to be ignored, the *On / Off state* should then always be off.

On newer GSV-6 models, the CAN application protocol can be switched from *ME-CAN* to *CANopen* using the *CAN Type / Protocol* element. GSVmulti can only communicate with the device via CAN using ME-CAN; this means that **after switching to CANopen and restarting, it can no longer be opened via CAN bus by this software**. However, it is possible to switch it back to ME-CAN via CANopen; see the CANopen documentation.

EtherCAT

Starting with version 2.03, GSVmulti can be upgraded to GSVmulti EC to access the GSV-61 EC devices and EtherCAT six-axis sensors, such as the K6D55i or K6D80ri, via the EtherCAT field bus. This requires two steps to prepare the software:

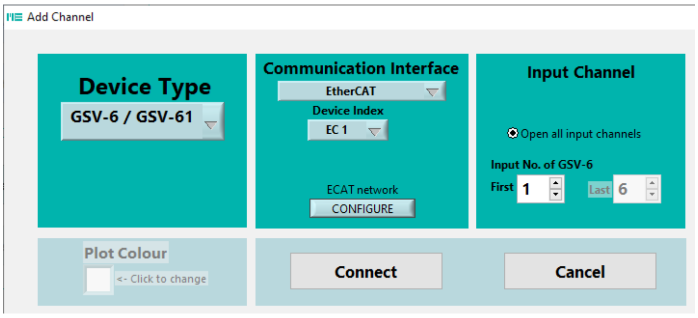
1. Install additional software, specifically the EtherCAT Master from Ackermann Automation (Acontis). The setup can be downloaded here.
2. Apply the EtherCAT license, which must be purchased. This is done via Menu bar → *Help*

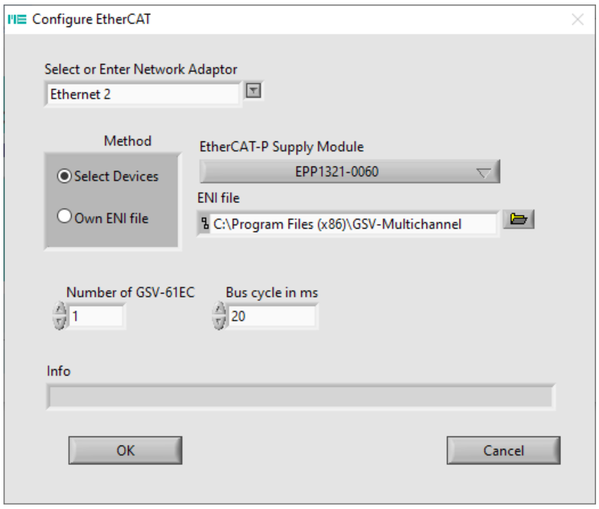
→ *Apply Ecat License*. A wizard will then open where you enter the license key you received from us; to do this, it is best to open the PDF file, copy the key to the clipboard (Ctrl + C), and paste it into the wizard (Ctrl + V). An internet connection is required, and you may need to allow access through a firewall.

EtherCAT licensing is independent of whether the GSVmultiPRO license is present; in other words, the licenses can be combined as desired. Once the license has been successfully activated and the program restarted, *EC* is appended to the program name in the title bar of the main window.

EtherCAT Hardware / Topology

To open the GSV-61EC or K6D55i, please select *Devicetype= GSV-6/GSV-61* in the *Add Channel* dialog and then select *EtherCAT* using the *Communication Interface* selector.





A *Configure EtherCAT* sub-dialog box will open. If it does not, click on *ECAT network/Configure* to open it.

When opening an EtherCAT device for the first time, you must first select the network adapter to which the EtherCAT devices are connected using "Select or Enter Network Adapter." It is recommended not to use the same adapter that connects the PC to a local network or the Internet; in other words, we recommend using a second, dedicated network adapter for EtherCAT, such as an external USB 3.0 Ethernet adapter. However, if the PC is not required to have a TCP/IP network connection via Ethernet at the same time, you can also use the only available Ethernet adapter. A hub or switch cannot be used. Reconfiguring the network card and network settings is generally not necessary; TCP/IP settings are left as is by the EtherCAT master and ignored.

There are two methods to define the EtherCAT network topology:

1. **Select all connected devices** using *Method = Select Device*. The GSV-61 and EtherCAT sensors feature an EtherCAT-P port, to which the network signal with superposed DC operating voltage has to be supplied. This requires an EtherCAT-P power supply terminal, which is selected using the EtherCAT-P Supply Module. All power feed-in devices supported here are from Beckhoff:

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EPP1321-0060: One EtherCAT-P device can be connected

EPP1322-0001: Up to 3 EtherCAT-P devices can be connected

EK1100+EK1310: Combination of two DIN-rail terminals; one EtherCAT-P device can be connected

none: No EcatP: Special variants of the GSV-61 (and, in future software releases, the GSV-8 as well) do not require an EtherCAT-P power supply; in such cases, this option should be selected.

When using the *EPP1322-0001*, the correct number of connected GSV-61EC units must be specified under *Number of GSV-61EC*, regardless of how many devices are actually opened. The "Info" section will then indicate which devices (EC1, EC2, and EC3) are connected to which port.

Based on this input, GSVmulti then selects one of the EtherCAT Network Information files (ENI files) that were installed with the program for the combinations listed above (specifically, in the program directory under \EthercatENI).

2. Select an **existing EtherCAT Network Information (ENI) file** using *Method = Own ENI file* option. GSVmulti cannot generate ENI files on its own, and if more complex topologies or devices other than those mentioned above are used—for example, more than 3 GSV-61EC units with branch terminals—this file must be available. It can be created using other programs, such as TwinCAT from Beckhoff or EC Engineer from Acontis. ME-Systeme may be able to assist with the creation process if necessary.

To select the ENI file, click the yellow folder icon to the right of *ENI file*. The file should remain in this folder and should not be renamed.

Bus cycle

When measurement is started by clicking *Start Measuring*, all EtherCAT devices enter the so-called Op-State. The EtherCAT master then periodically transmits frames at the bus cycle time, to which the EtherCAT devices append their measurement data. This period can be set in *Configure EtherCAT* using *Bus cycle in ms*. Although it is adjustable from 1 ms to 200 ms, cycles under 10 ms are rarely achievable on Windows (depending on PC performance and load), and cycles over 50 ms can slow down the connection to the device and the opening of configuration dialogs. The default setting of 20 ms is suitable for data frequencies up to 50 Hz; 10 ms usually works well too.

After configuring the EtherCAT settings, GSVmulti saves them by clicking *OK* (in its configuration file) and restores them in the future. Use *Device Index* in the *Add Channel* dialog to select the device to be opened. If several devices are to be opened, *Add Channel* must be executed multiple times, as with all other GSVs. The EtherCAT configuration must not be changed after opening an EC device.

Usage

As with all measurement amplifiers, measured values are displayed even without clicking *Start Measuring* (EtherCAT devices are then in the PreOp state, and the measured values are read via SDO every 100 ms). Clicking *Start Measuring* puts the device into the Op state, and measurement data is read via Input-PDO.

The *Data Frequency* also applies to EtherCAT devices, where it refers to the internal measurement data acquisition rate. Since data is transmitted in the OP state in synchronously with the bus cycle, GSVmulti downsamples the measurement data to the measurement data rate in integer steps, using the formula N = 1 / (bus cycle [s] × measurement data rate [Hz]). Since N is an integer >0, the resulting true measurement data rate may differ from the nominal rate.

All basic device settings in the *Configuration* tab and the *Multi-axis/Rosette* dialog can also be accessed via EtherCAT; however, the *Advanced Device Settings* cannot. Only the hardware and firmware versions are displayed there.

CRC on GSV-6 and GSV-8

With the checkbox Menu Bar -> *Device -> Advanced Settings -> Interface -> CRC for all Serial Frames*, a checksum calculation can be activated for all serial ports on the GSV-6 and GSV-8. As a result, the device appends a CRC-16 checksum to the measurement data frames and GSVmulti then also uses a CRC-8 checksum for command requests, the command responses are then sent with it as well.

A checksum can be useful if the serial protocol does not run via a USB, Ethernet or Bluetooth interface, but is sent directly (e.g. RS232, RS422, UART), especially if electromagnetic interference is present. The checksum extends the measurement data frame size by 2 bytes, so that the maximum measurement data rate may be slightly lower. More detailed information on the indication and calculation of the checksum can be found in the protocol documentation. Data frames where the CRC check fails are silently filtered out, i.e. if CRC errors occurs (e.g. due to strong interference), measured values are omitted, but no corruption of the data streams occurs (i.e. it is extremely unlikely).

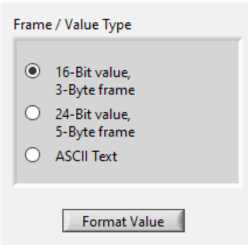
Data Frame: Channel Count and Data Type

The GSV-2, GSV-3, GSV-6 and GSV-8 amplifiers offer various settings regarding the type of data transmitted via the digital interface. GSVmulti can evaluate all configurable data types; if necessary, it automatically converts the incoming measurement data using *User*

Scaling. However, a change in the data type may be useful or necessary if other programs are to be used that only cope with a certain data type or if the measurement data rate is to be increased, because the measurement data type can also limit this maximum.

The measurement data type can be changed under Menu bar → *Device* → *Advanced Settings* → *Value Mode* → *Frame / Value Type*. The details of the measurement data frames and the decoding of the measurement data are described in the device's user manuals and for the GSV-6 and GSV-8 in the protocol description.

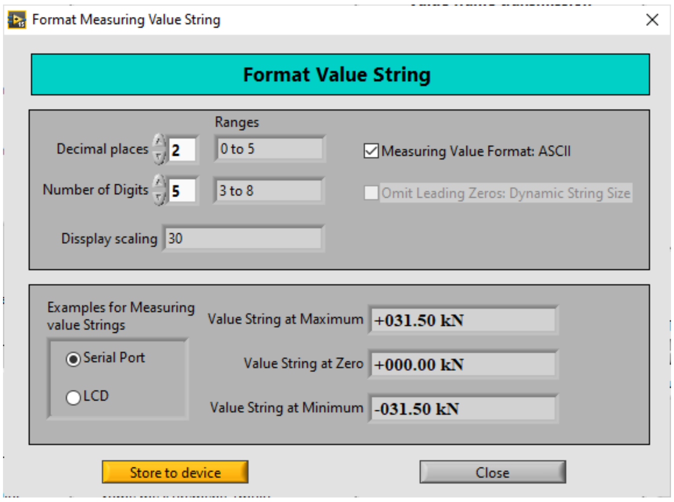
Measurement data type for GSV-2 and GSV-3



It can be chosen between two different binary data formats and text data format.

- *16-Bit value, 3-Byte frame*: Settable on GSV-2 and 3. The measurement data frame consists of only 3 bytes, the first is a constant prefix, followed by 2 bytes with binary-coded readings. **This setting allows for the highest measurement data rate,** see p. 18. In the GSV-2, the lowest byte of the 24-bit value is omitted, so that this setting is only recommended with rather high measurement data rates, where the effective resolution is reduced anyway due to the higher noise. For the GSV-3, this is the default data type.
- *16-bit* value, 4-byte frame: GSV-3 only: The measurement data frame consists of 4 bytes, the first is a constant prefix, then comes a flag value that contains the state of the threshold switch, then the binary-coded 16-bit measured value. The 4-byte frame allows for safer frame synchronization when using other software, because the masked second byte can be taken as a preamble, making missynchronization much less likely.
- *24-bit* value, 5-byte frame: GSV-2 only: The measurement data frame consists of 5 bytes, the first is a constant prefix, then comes a flag value containing the state of the threshold switches, then the binary-coded 24-bit measured value. The 5-byte frame allows for more secure frame synchronization when using other software, because the masked second byte can be taken as a preamble, making missynchronization much less likely. For the GSV-2, this is the default data type.
- *ASCII Text*: Adjustable for GSV-2 and 3. The measurement data frame is an ASCII-compliant text, with the first byte always representing the sign + or – and the frame ending with the control characters CarriageReturn and LineFeed (0x0D0A). This is a widely compatible format and it is easiest to evaluate (with most programming languages) with self-written programs; however, the maximum measurement data rate is the lowest because it takes up to 18 bytes to transmit a measured value.

Formatting of the measured value text



With the GSV-2 and GSV-3, the number of digits of the measured value in the text frame can be configured in a sub-dialog that opens when you click on Menu bar → *Device* → *Advanced Settings* → *Value Mode* → ***Format Value***. In the case of GSV-2 models with an LCD display, this also changes the display of the measured values. The number of possible *Decimal places* also depends on the *User Scaling (=Display scaling)*. The maximum number of significant digits under *Number of Digits* is =8 for the 24-bit amplifier and =5 for the 16-bit device GSV-3. At the bottom of the configuration dialog, examples of the measured value text are displayed based on the number of digits selected above, optionally for the display (*LCD*) or the *Serial Port*. This can also be used to count the number of bytes per frame, where +2 for the suffix must be added to determine the maximum measurement data rate (Byte Count, see p. 113).

This device setting *Number of Digits* is independent of the software setting (see p. 33), however, if it is lower than that of the software when the ASCII measurement frame is enabled, zeros are appended, i.e. it then determines the lowest display step.

Measurement data type for GSV-6 and GSV-8

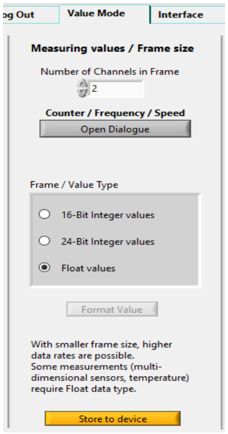
You can choose between integer data format and floating-point representation. The selected measurement data type applies to all available interfaces except EtherCAT and CANopen.

- *16-bit Integer values*: Integer binary format in which each measuring value in the data frame is represented by 2 bytes. **This setting allows for the highest measurement data rate, see p**. 18.
- *24-bit Integer values*: GSV-8 only: Integer binary format in which each measured value in the data frame is represented by 3 bytes.
- *Float values*: Floating-point representation, in which each measured value in the data frame is represented by 4 bytes and gives fully scaled readings, provided that the sensor connected to the corresponding channel is correctly configured. **This setting is required for displaying physically scaled measured values** for certain sensor types such as multi-axis sensor (see.p. 44) and temperature sensors. It's the default setting.

Number of channels in the measurement data frame

With the GSV-1A8USB, only the channels that have been opened with *Add Channel* are transmitted. For the GSV-6 and GSV-8, this number can be configured under Menu bar

→ *Device* → *Advanced Settings* → *Value Mode* →*Number of Channels in Frame*. For these two models, it determines the maximum adjustable measurement data rate: the fewer No. of channels, the higher it is (however, the absolute maximum of the measurement data rate, e.g. 48000/s for standard GSV-8, cannot be exceeded). With the GSV-4, the number of channels is fixed =4.



With the GSV-6 and GSV-8, only input channels can be opened in the *Add Channel* dialog that are also present in the measurement data frame. If the number of channels is reduced, open channels are automatically removed and are no longer present; if this number is increased, the new channels can then *be opened manually* using *Add Channel*.

The minimum number for GSV-8 is = 2, so that only input channels 1 and 2 are available; for older GSV-6 devices only the number of channels 1, 2, 3 or 6 can be set. The setting must be completed with *Store to device*. With the GSV-8, the number of channels between the UART and USB interface is managed independently of each other and is operated for the respective active interface, i.e. **USB is used to set the number of channels of the USB frame, and UART/RS422 is used to set the number of channels of the UART and RS422 interface.**

If there are one or two counters or frequency counter channels (see p. 133), the maximum number of channels increases accordingly.

GSV-6 and GSV-8 behave differently in terms of data acquisition in connection with this setting. The GSV-8 internally captures all 8 channels[23], regardless of *Number of channels in frame*; the GSV-6, on the other hand, captures only configured channels if No is 1, 2 or 3.

Data Frame and Measurement Data Rate

The communication bitrate (**baud**, in bits/s) and the number of bytes per measurement data frame (number of bytes) determine the maximum *Data Frequency*. This may be limited by other settings, and there is also an absolute maximum for each device model, which is indicated in the data sheet or the user manual and cannot be exceeded. **If there are multiple interfaces, such as the GSV-8, the lowest Fdata,max of all enabled interfaces determines the maximum.**

Serial communication is used for all devices and interfaces where the communication bitrate is relevant (see p. 104), the maximum measurement data rate theoretically is as follows:

Fdata,max = baud / (number of bytes x 10)

The value must be rounded down, and it may be lower depending on the device. This may be due to the fact that only certain values can be set for *Data Frequency*. GSVmulti displays the value range in the *Configuration* Tab -> *Data Frequency* dialog, so you can first change the settings of the measurement data frame and then read the maximum there.

23 In the case of high-speed special model, there are 4 channels

GSV-6 and GSV-8 have the same serial data protocol in which the structure of the measurement data frames is specified. The following applies:

ByteNumber = N x DT + 4

or, if the CRC checksum is enabled:

ByteNumber = N x DT + 6

Whereby:

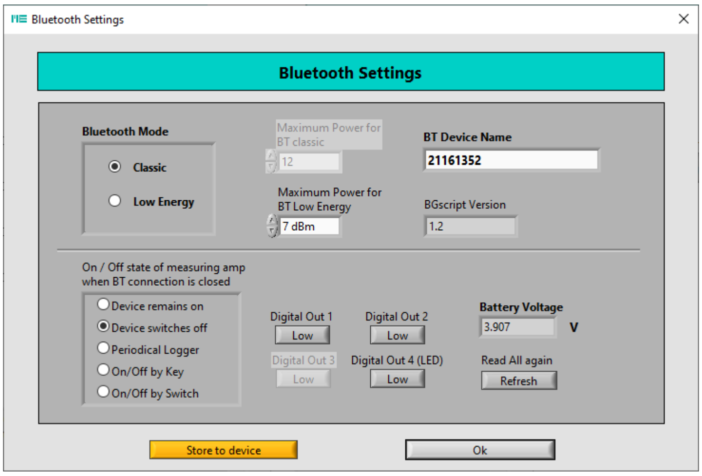
N: Number of channels in the measurement data frame

DT: Number of bytes of the measuring value, i.e. =2 for 16-bit integer, =3 for 24-bit integer, and =4 for float data type.

Example: 6 channels, float, without CRC: byte count=28; Fdata,max= 822/s at baud=230400 bits/s (e.g. GSV-6).

Bluetooth settings of the GSV-6BT

The dialog for device behavior and communication settings of the Bluetooth interface of the GSV-6BT can be accessed via Menu bar → *Device* → *Advanced Settings* → *interface* → *Bluetooth Settings*, i.e. you click on the Open Dialogue button. When entering this menu, the measurement data transmission is stopped, i.e. while it is open, the *Timeout* message appears under *Measuring Value* in the main window *Configuration*.



The *Bluetooth Mode* must be Classic in order to open the GSV-6BT with GSVmulti; this "SPP" device profile emulates a serial port. **The *Low Energy* mode is not compatible with GSVmulti.** It follows the BLE/Gatt standard and there's a separate manual for this. It can be used to communicate with the GSV-6BT with smart phones and a BLE/Gatt app, for example, to read out measured values, among other things. To enable it, set it to *Low Energy* and then click *Store to device*. After you close GSVmulti or remove all channels of this device using Menu bar -> *Device -> Close,* the Low-Energy mode is activated. With a Gatt browser program / app you can switch back to Classic Mode to be able to access the device via GSVmulti again; the manual ba-gsv6bt-gattservices_en.pdf describe how to do this.

Under *Maximum Power for BT Low Energy* you can reduce the maximum transmit power for the Low Energy mode; by default it is set to Maximum = 7dBm. With less transmitting power, the battery can last a little longer, however, the range is reduced, less than -3dBm is not recommended.

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Device behavior when Bluetooth connection is closed

In addition to the hardware measurement application (GSV-6CPU), the GSV-6BT contains a second microcontroller, which can also switch the GSV-6CPU on and off. When the Bluetooth connection is open, i.e. when the blue device LED is on, the measurement application is always switched on, which is indicated by the glowing green device LED (both in Classic and Low Energy mode). The device status when the Bluetooth connection is closed (blue LED off) can be inspected under *On / Off state of measuring amp when BT connection is closed* and it can be configured. This is useful for recording measurement data on the SD card in stand-alone mode, see p.34. When the measurement application is switched off, the device is in standby mode and consumes very little power, so the battery lasts for a very long time. Specifically, the options are:

- *Device remains on*: The measurement application remains on at all times.
- *Device switches off*: The measurement application is switched off after the connection is closed and remains off. (state of delivery)
- *Periodical Logger*: The measurement application is briefly switched on by a hardware clock (RTC) at a definable time interval >= 1 minute in order to record a row of measured values, see p.34, *Single Log Periodically.*
- *On/Off by Key*: The measurement application can be switched on and off with a button connected to a specific digital line (BT-DIO3). With the GSV-6BT M8 model variant, this is already available as standard, see user manual.[24]
- *On/Off by Switch*: The measurement application can be switched on and off with a switch connected to a specific digital line (BT-DIO3).[25]

Other BT Settings Displays and Controls

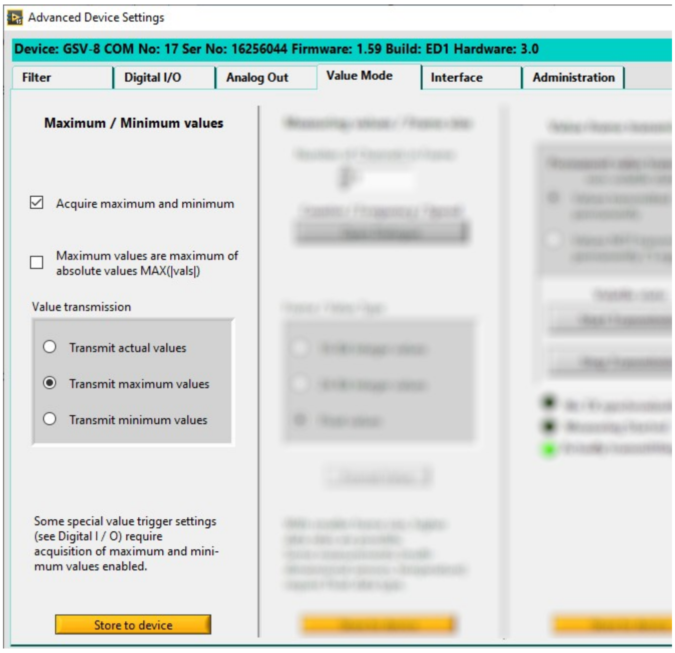
- *BT Device Name:* The Bluetooth name of the device in BT-Classic mode. Changing this name is possible, but not recommended for end users
- *BGscript Version*: The firmware version of the second microcontroller (BT controller).
- *Digital Out 1 / 2*: This allows the digital outputs "IO_1" or "IO_2" of the BT controller to be switched to high as a test. The condition is volatile. These digital outputs are not to be confused with "SW1-3" = "DIO1-3" = "Threshold output", which are controlled via the measurement application, see p.121.
- *Digital Out 4 (LED):* This allows the user LED of the BT controller to be switched on as a test. The condition is volatile.
- *Battery Voltage*: The voltage of the battery. **If it is less than 3.7V, it should be charged!**
- *Read All again*: Read all settings again.

24 Available from BGscript version 1.00
25 Available and fully functional as of BGscript version 1.02

Transmission of the maximum or minimum value

With the GSV-2, GSV-3, GSV-6 and GSV-8, the measured value frame can be reconfigured so that instead of current measured values, only maximum or minimum values are transmitted, i.e. positive or negative peak values. If you use this device mode, the current measured value is no longer displayed. To see both, you can switch a numerical display via software, as shown on p 31. With **Menu bar -> *Device* -> *Advanced Settings* -> *Value Mode* -> *Maximum / Minimum values*** on the other hand, the configuration of the device will be changed. This can be particularly useful when using other software or if the GSV-2 shall show the maximum value on the device display.

To transmit maximum values, *Value transmission* is set to *Transmit maximum values*. In the case of the GSV-8, the *Acquire maximum and minimum box must also* be set so that the max and min values are determined. You can then also set the transmission with *transmit minimum values* to minimum values.



With the GSV-2 and GSV-8 there is the possibility to transfer maximum of absolute values. This means that the maximum of the measured values is transmitted with the "omitted sign". To do this, activate the checkbox *Maximum values are maximum values of absolute values MAX(|vals|)* and at the same time select *Transmit maximum values.* The devices then calculates the absolute value of the measured values and determines the maximum value, which is always positive.

With the GSV-2 there is also the *value transmission* mode *Transmit max. / min values.* This is similar to the maximum absolute values, but the sign is not omitted, instead it's transferred as well. Example: Measured value first =0, then new max value 10. Now a new minimum value of -12 is detected. With transmit *max. / min values,* the GSV-2 now transmits **-12,** with *Maximum values of absolute values* it would transmit 12.

All devices generally transmit the maximum or minimum values with the set measurement data rate, i.e. if there is no new maximum or minimum, the previous one is repeated.

However, the GSV-2 also offers a maximum event mode. If the *Transmit value on new maximum event* checkbox is set, only new maximum values will be transferred. As a result, it regularly happens that the GSV-2 does not transmit any measured values, i.e. the measurement data stream is irregular and GSVmulti then displays *Timeout* more often in the measured value display in the *Configuration* tab.

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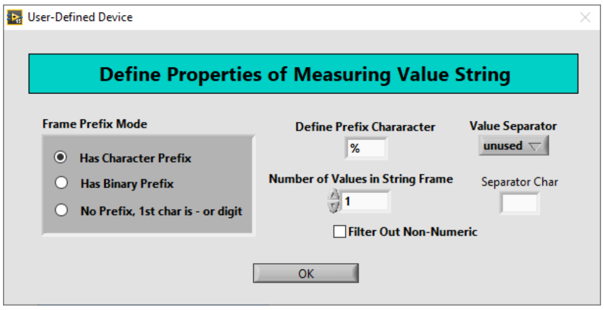
Definable measured value text for integration of other devices

With GSVmulti PRO it may also be possible to display the measured values of other measuring devices, under the following conditions:

- The device transmits via a serial port (real or virtual) with the basic setting of 8 data bits, no parity and 1 stop bit (8N1).
- One of the following bitrates is supported: 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600.
- The device sends **text** with measured value frames as an ASCII or UTF-8 string, i.e. it is 8 bits per character.
- It sends the measured value frames automatically and autonomously, i.e. they do not have to be requested.
- The layout of the measured value frame remains constant, i.e. its basic structure does not change during the measurement runtime.
- The decimal separator in the measured value is a period, not a comma.
- Each measurement frame is terminated by carriage return and line feed, i.e. by the control characters LF,CR (0x0D0A).

To open such a device, select *the UserDefined device type* in the *Add Channel* dialog under ***Device Type***. The dialog for configuring the measured value text opens automatically if necessary; if it doesn't, click on *Value String/DEFINE.*



It offers the following setting options:

Frame Prefix Mode: A prefix is a character that always comes first in each measurement frame; there are three choices:

Has Character Prefix: There is a prefix and it is entered in *Define Prefix Character* as a character, e.g. $ or % or A.

Has Binary Prefix: There is a prefix and it is entered into *Define Binary Prefix (hex)* as a 2-digit hexadecimal number, e.g. 0A or B4 or 80.

No Prefix, 1st char is - or digit: There is no prefix and the measuring frame starts with a measuring value, i.e. the first character is - + or one of the digits from 0 to 9.

Number of values in String/Frame specifies how many measuring values, i.e. channels the frame contains. Each value can then be mapped to a channel in GSVmulti, but this doesn't have to be done for every value in the frame. So this number should be correct, regardless of whether you want to display all values or not. If *Open all input channels* is activated in the *Add Channel* dialog, the first reading in the frame will be assigned to the first channel of this device, the second to the second, and so on. If you want to change the displayed channel order, you have to click *Add Channel* in the desired order for each channel to be opened, deactivate *Open all input channels* and select the channel, i.e. its position in the measurement data frame with *Channel/Pos*.

If the measuring value frame contains more than one value/channel, a character must be defined to separate the values within the frame. With ***Value Separator***, you can select the following:

comma ,
semicolon ;
Pipe |
space
tab
other

If *other* is selected, enter the separator under *Separator Char*.

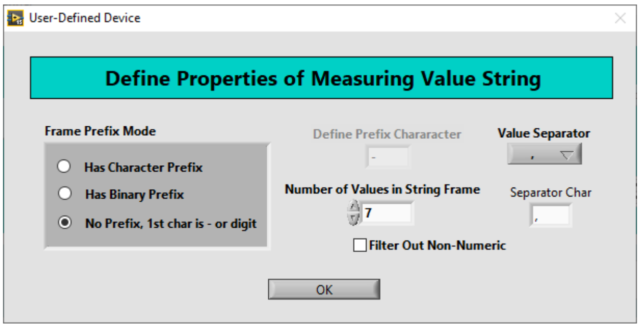
If, in addition to numbers and separators, the measurement value string contains other texts or characters that are different from the separator (see example 3), you can activate the ***Filter-Out Non-Numeric checkbox***. GSVmulti then analyzes the measurement strings in more detail and filters out unnecessary parts; however, this requires computing time, so that the performance of the PC may be weaker.

The definition of *User-defined Device* will be used in the *Session* i.e. it is recommended to use, *Save/Load Session* if everything works, see page 15.

Examples:

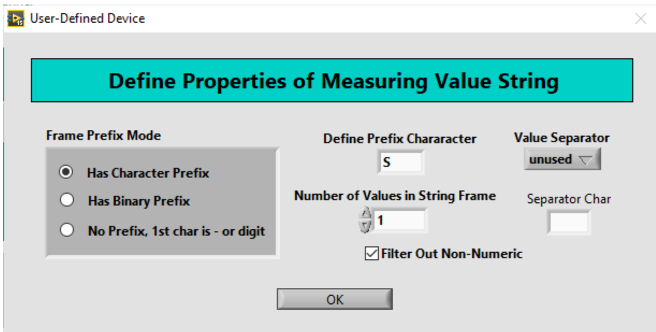
1. In the *User Defined Device* screenshot shown above, the frame has the prefix % and only one measuring value.This would correspond to the following string:
%-123.789<CR><LF>

2. A measured value text looks something like this
-2.699876,+0.97575,0.000001,6899.076,6,0,1<CR><LF>
Then you configure *User Defined Device* as follows:



3. A measured value text looks something like this:

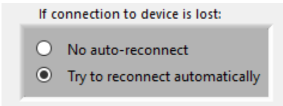
ST,NT,+ 1.3 <CR><LF>
Then configure *User Defined Device* as follows:



Automatic resumption in case of loss of communication connection

The stream of measurement data may be interrupted; this could be caused, for example, by a lost wireless connection or a communication cable that has been accidentally disconnected. GSVmulti detects this and displays *Timeout* on the Configuration tab after 5 seconds:

If the measurement data rate is less than 2/s, then this time is not 5s, but 10/ measurement data rate in seconds. The further reaction of the program depends on the configuration and whether a measurement was started with *Start Measuring* or not. If measuring was started, GSVmulti will try to reconnect automatically. This behavior can *be configured under Menu Bar -> Options -> Hardware -> If connection to device is lost:*

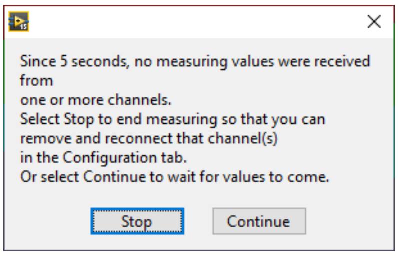


In the initial configuration, the automatic resumption *Try to reconnect is automatically* is enabled*,* it can be disabled with *No auto-reconnect*.

If it is activated and the measurement is started, the following happens if a GSV amplifier GSV-2, -3, -4, -6 -8 does not transmit any measurement data for at least 4.5 seconds:

1. The connection is tested with a read command. If it is successful, only the command *Start Transmission* is issued in order to try to revive the permanent transmission of measurement data (see p. 106). If it is not successful, the interface connection is closed first. This is necessary in order to be able to open them again afterwards. If more than one GSV is open, this will be done with all of them and, if necessary, an array of GSVs with connection problems will be created.
2. Now an attempt is made to reopen the GSV with connection problems. If this is successful, the measurement is continued, if not, this is tried again and again at regular intervals of about 1 second. If measurement data is recorded during this time (*start recording*), the missing data can subsequently result in inaccurate time stamps.

If the automatic resumption of the connection is disabled under *Options->Hardware* , the user will receive the following message after 5 seconds without measurement data:



The user can then click on Stop, so the measurement and, if necessary, the data acquisition will be stopped. You can then use Menu bar *-> Device -> Close* or *Remove Channel* to close and reopen the connection manually *(Add Channel / Device -> Open*). Or you can click on *Continue* in this message and the program will continue to wait for measurement data without any other actions.

Digital inputs/outputs and threshold switches

The GSV-2 and GSV-3 models offer configurable threshold switches, and the GSV-4, GSV-6 and GSV-8 offer freely configurable digital inputs and outputs that can also be configured as threshold switches. A threshold switch is a digital output that is switched on or off when the measured value is above or below a threshold value.

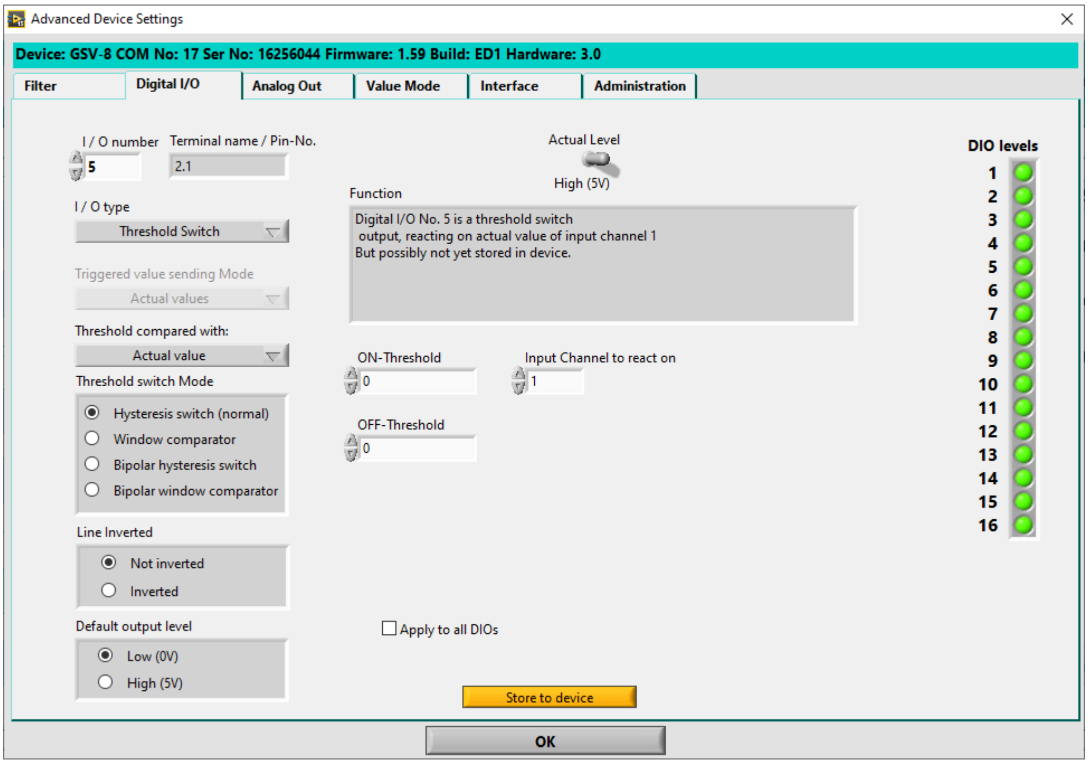
The settings dialog for the digital inputs and outputs can be accessed with Menu bar -> *Device -> Advanced Settings ->* ***Digital I/O***

On the GSV-4, GSV-6 and GSV-8, several soft LEDs are displayed on the right under ***DIO levels***, which glow bright green when the digital I/O is high, i.e. when 5V or 3.3V is present; when low =0V is present, they are dark green. The number of soft LEDs displayed corresponds to the number of digital I/Os: 12 for the GSV-4, 5 for the GSV-6 and 16 for the GSV-8. Only for the *I/O types QEI input, Sync. Master and Sync. Slave* (see below) the states are not displayed or are not reliably valid because they change too quickly.

Actual Level is a soft switch that displays the state of the I/O that is currently selected with *I/O number*. In the case of the *I/O type GP output*, the level of the digital output can be changed with this, see below. The *Actual Level* and *DIO levels* controls are well suited to test the function of the digital inputs and outputs.

If the configuration is changed, it can be applied to all digital IOs if the *Apply to all DIOs* checkbox is set (provided it is allowed for all). As the last step of a change for each I/O, click *Store to device.*

It is useful to first select the digital line whose configuration you want to view or change



with *I/O number,* as some functions are fixed to specific lines. The GSV-3 has only one threshold switch, here *I/O number* cannot be changed. The GSV-2 has two threshold switches, which can be selected with it.

Under *Terminal name / Pin-No*, the name or pin number of the line is displayed, as it is mentioned in the user manual, for example. The *I/O type* shows the function of the line; this is also described in more detail in the text output *Function*. In case of a configuration change, it should be set after selecting the *I/O number*. The following functions are available:

GP Input: Digital input for general use, e.g. triggered measurement data recording as described from p. 67.

QEI Input (GSV-8 only): Digital input is assigned for counter function, here Read-Only, i.e. this type cannot be set here and cannot be changed if it is set. Instead, the counter input can be changed in the Counter/Frequency dialog, see p. 133

Tare Single: Digital input to perform zeroing on a single input channel, which can be selected with *Input channel*

Tara All : Digital input to perform zero setting of all input channels

Reset Digital Out: (GSV-6 & GSV-8 only) digital input that puts all digital IOs configured as output into the power-on state that can be defined with *Default output level*.

Reset Max/Min: (GSV-6 & GSV-8 only) Digital input that can be used to reset the maximum and minimum value acquisition. In the case of the GSV-8, this only makes sense if it is activated in the *Value Mode* tab under *Acquire maximum and minimum*.

Trigger Send value (GSV-4 & GSV-8 only): Digital input with which the transmission of one or more measured values via the USB and UART interface is triggered, provided that the permanent measurement data transmission is deactivated (see p.106). The type of value and other details are displayed on the GSV-8 with *Triggered value sending Mode*; with the following choices:

Actual Values: Triggering the sending of a measurement frame with current readings via the interface(s) at the inactive-to-active edge of the digital input.

Maximum Values: At the inactive-to-active edge on the digital input, the maximum value acquisition (all input channels) is started and at the active-to-inactive edge, a frame with these maximum values is sent to the interface(s).

Minimum Values: At inactive-to-active edge on the digital input, the minimum value acquisition (all input channels) is started and at active-to-inactive edge, a frame with these minimum values is sent to the interface(s).

Mean values: At the inactive-to-active edge on the digital input, a decimating averaging of all input channels is started and at the active-to-inactive edge, a frame with these mean values is sent to the interface(s).

Send while active: While the input level is active, frames of measured values with current readings are sent to the interface(s) at the set data rate.

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GP Output: Digital output for general use (general-purpose); the state can be set with other programs or with the software switch *Actual Level*

Threshold Switch: The digital output serves as a threshold switch, see p. 123 for details.

Sync. Master: The amplifier generates a square wave signal at this digital output, which is used to synchronize the transmission of measured values on devices that are used as Trigger Sync. slave, see p.16.

Sync. Slave: Digital input to which a square wave signal should be applied, which is used to synchronize the transmission of the measurement data, see p.16.

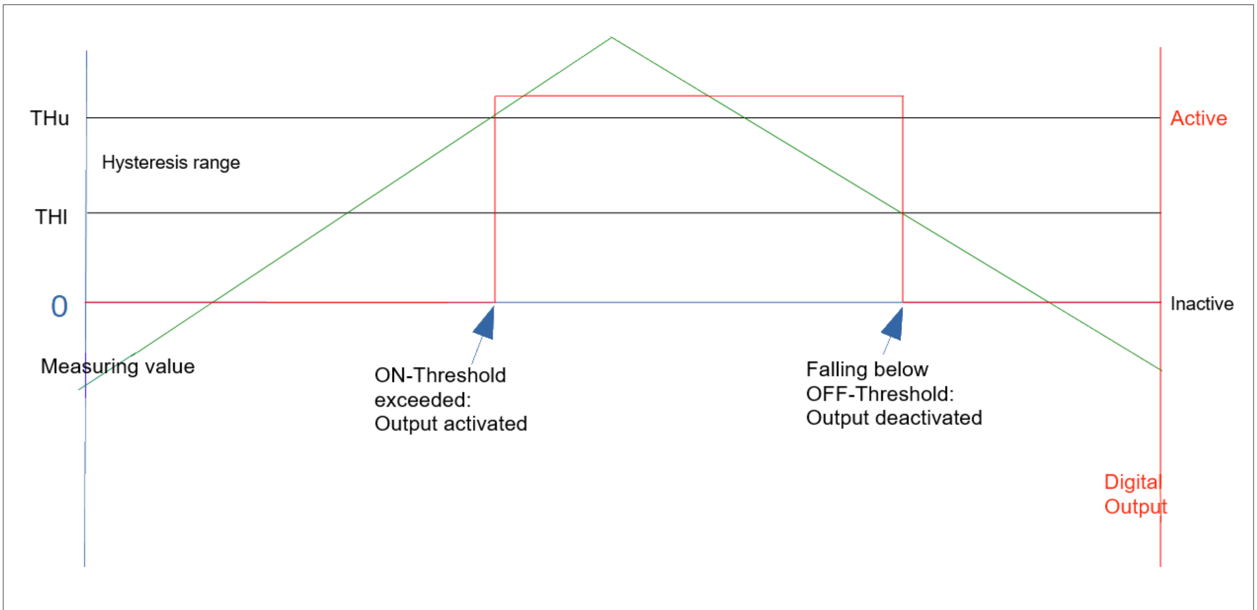
Trigger File Log (GSV-6BT only): Digital input on which the recording of measurement data files on SD card can be triggered, so that measurement data is logged while the active level is applied, see p.34.

Threshold switch

The threshold switch compares the measured value with two configurable threshold values, an *Upper Threshold* (or *ON-Threshold*) and a *Lower Threshold* (or *OFF- Threshold*). Depending on the result of the comparison and depending on the mode, the digital output is enabled, deactivated or the previous state is left unchanged. With *Threshold switch Mode*, you can choose from up to four different modes. Depending on the device model, not all of them are available, i.e. entries may be grayed out.

Hysteresis switch (normal), all amplifier models***:*** The threshold switch with hysteresis distinguishes three cases and behaves as follows:

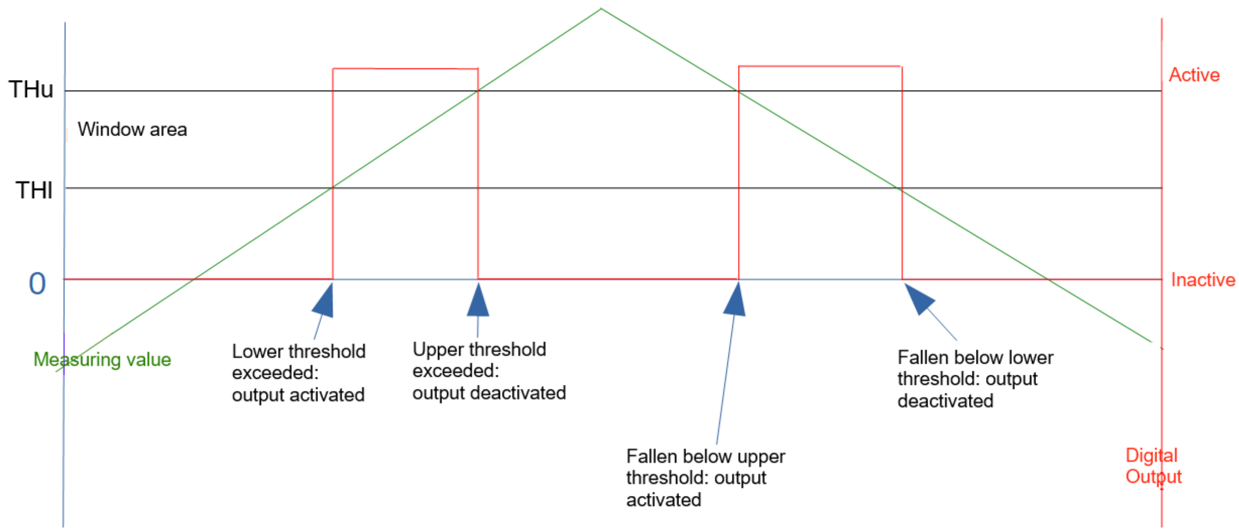
- If the measuring value MV (or maximum or minimum value) is greater than the upper threshold value "THu" (*ON Threshold*), the output is activated, i.e. if MV>THu: out,new=active
- If the measuring value MV (or maximum or minimum value) is less than the lower threshold value "THl" (*OFF Threshold*), the output is disabled, i.e. if MV<THl: out,new=inactive
- If the measured value (or maximum or minimum value) is between the two thresholds, i.e. in the hysteresis range, the digital output remains unchanged, i.e. if MV<THu || MV>THl: out,new=out,old. This helps prevent, for example, the output from switching rapidly back and forth when the measured value fluctuates around the threshold value.



Threshold switch with hysteresis

Window Comparator: (GSV-2, GSV-3, GSV-6 and GSV-8) The threshold sensor works as a window comparator, i.e. two cases are distinguished:

- If the measuring value MV (or maximum or minimum value) is greater than the upper threshold or less than the lower threshold, the output is disabled, i.e. if MV>THu || MV<THl: out,new=inactive
- If the measuring value MV (or maximum or minimum value) is between the two thresholds, i.e. within the "window", the output is activated, i.e. if MV<THu && MV>THl: out,new=active.



Window Comparator

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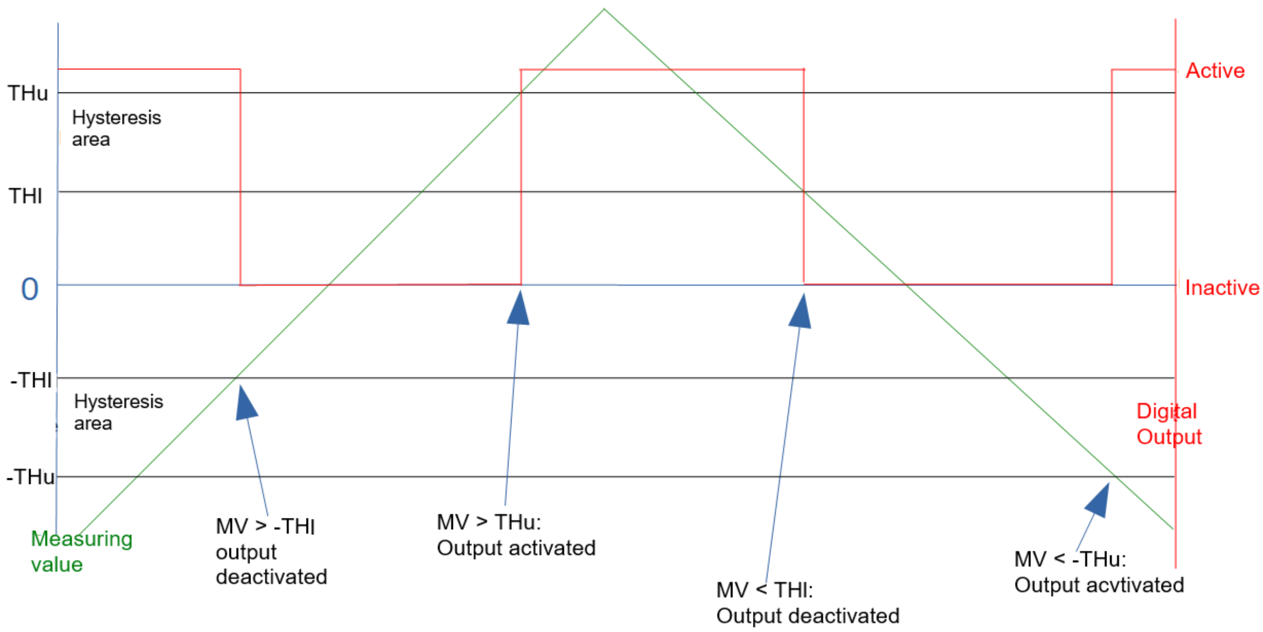
Bipolar hysteresis switch: (GSV-2, GSV-6 and GSV-8) Bipolar threshold switch with hysteresis: This mode is similar to the *hysteresis switch (normal),* but the functionality is additionally "mirrored" in the negative range, i.e. it behaves as follows:

- If the measuring value MV (or maximum or minimum value) is greater than the upper threshold (*ON Threshold*) or less than the negated upper threshold, the output is activated, i.e. if MV>THu || MV<(-THu): out,new=active
- If the measuring value MV (or maximum or minimum value) is less than the *OFF* threshold and greater than the negated lower threshold, the output is disabled, i.e. if MV<THl && MV>(-THl): out,new=inactive
- If the measuring value MV (or maximum or minimum value) is between the two thresholds in the positive or negative range, i.e. in one of the two hysteresis ranges, the digital output remains unchanged. I.e. if (MV<THu && MV>THl) || (MV>(-THu) && MV<(-THl)): out,new=out,old.

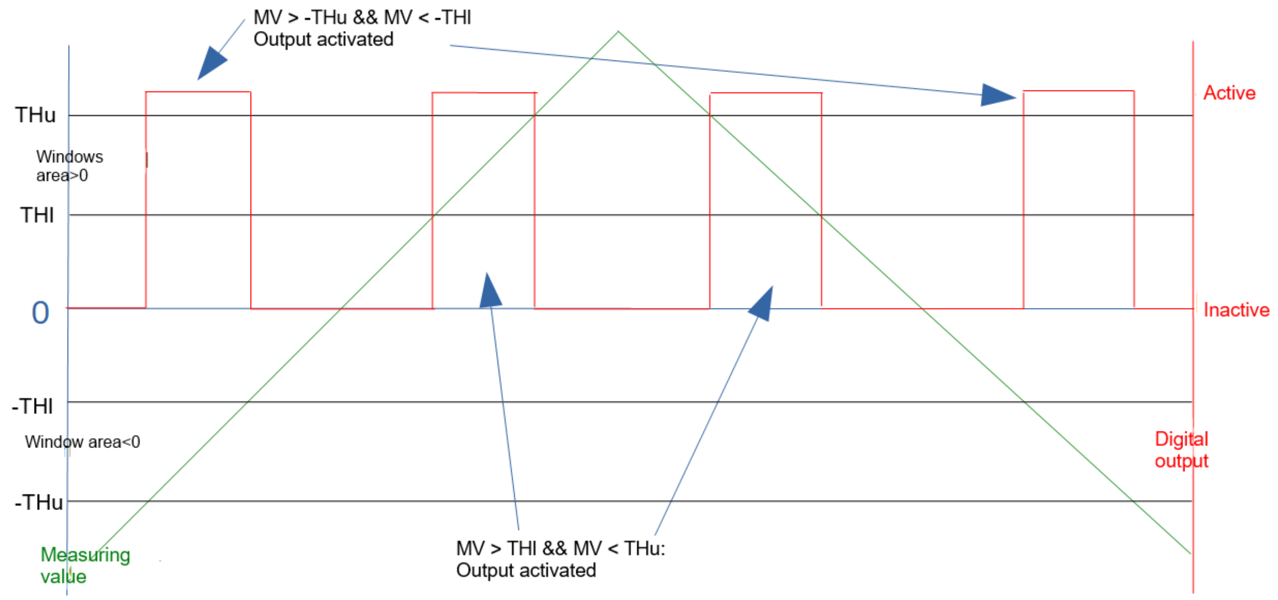


Bipolar hysteresis switch

Bipolar window comparator: (GSV-6 and GSV-8) Bipolar window comparator: This mode is similar to the window comparator, but the functionality is additionally "mirrored" in the negative area, i.e. it behaves as follows:

- If the measuring value MV (or maximum or minimum value) is greater than the upper threshold or less than the lower threshold and greater than the negated lower threshold or less than the negated upper threshold, the output is disabled, i.e. if MV>THu || (MV<THl && MV>(-THl)) || MV<(-THu): out,new=inactive.

- If the measuring value MV (or maximum or minimum value) is between the two thresholds in the positive or negative range, i.e. within one of the two "windows", the output is activated, i.e. if (MV<THu && MV>THl) || (MV>(-THu) && MV<(-THl)): out,new=active.



Bipolar window comparator

The *Threshold compared with* selector can be used to define whether the actual value, the maximum value, or the minimum value will be compared with the thresholds. If maximum or minimum value is selected with GSV-8, you have to make sure that the checkbox *Acquire maximum and minimum* is ticked under Menu bar -> *Device -> Advanced Settings > Value Mode → Maximum / Minimum values*, **so that the GSV-8 actually carries out the maximum and minimum value acquisition.**

The threshold values themselves are entered under *ON-Threshold* for *Upper Threshold* and *OFF Threshold* for the *Lower Threshold*, in the unit in which the input channel to be compared with is configured. With the GSV-4 there are only 8 threshold pairs available, which are assigned with *threshold number*, they are also assigned to specific input channels, see below.

In the case of GSV-6 and GSV-8, with ***Input channel to react on*** the input channel is selected, whose measurement/max/min value is to be compared with the two threshold values. In the GSV-8, numbers 1 to 8 are analog input channels and 9 and 10 are counter channels. This selection is possible for the GSV-8 regardless of whether the channel is part of the number of channels in the data frame (see p.112); however, counters should only be selected if they are configured. In case of the GSV-6, on the other hand, the channel to be compared must also be present in the frame; here No. 1 to 6 are analog input channels and No. 7 is the counter channel (if available).

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In the GSV-4, the input channel that is compared to the threshold values is selected with *Threshold number*, where Nos. 1 and 2 are assigned to the input channel 1, Nos. 3 and 4 to channel 2, Nos. 5 and 6 to channel 3, and Nos. 7 and 8 to the input channel 4.

Active/Inactive Level, Inversion

In the description of the functions of the Digital IOs, the terms "active" and "inactive" are used. In case of the GSV-2, GSV-3, GSV-4 and the GSV-6 and GSV-8 in the delivery state (*Not inverted*) they mean the following:
Active: High, i.e. 5V (or GSV-6: 3.3V)´
Inactive: Low, i.e. 0V

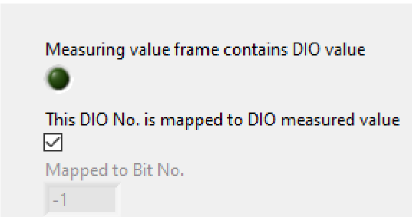
For the GSV-6 and GSV-8, this assignment can be reversed, i.e. inverted, for most digital I/O types, using ***Line inverted***. If this radio button is set to *Inverted*, it means:
Active: Low, i.e. 0V
Inactive: High, i.e. 5V (or GSV-6: 3.3V)
The following I/O types can be inverted: *Tara Single, Tara All, Reset Digital Out, Reset Max/Min, Trigger Send value, Threshold Switch, Trigger File Log.*

Default Digital Output Level

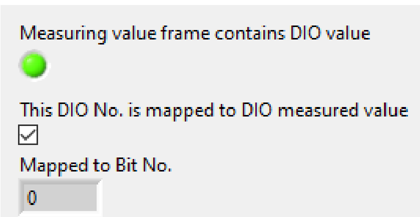
For the GSV-6 and GSV-8, you can specify the level that should be applied to digital I/Os configured for one of the output types after the device is powered on, provided the output has not yet been set by other means, such as by the threshold switch or, in the case of GP outputs, by the user. This can be done under ***Default output level***. The inversion setting with *Line inverted* is irrelevant, i.e. the *default output level* is either Low (0V) or High (5V/3.3V).

Digital I/Os as measured values on the GSV-8

With GSV-8 (firmware version 1.61 or later) and GSVmulti (version 2.03 or later), digital I/Os can be mapped to an additional measurement value. The levels of all 16 I/O lines are always recorded synchronously with the measured values by the GSV-8 (starting with this version) at data rates >25/s; at lower data rates, they are still recorded with a 40 ms sampling interval.



Each of the 16 digital I/O lines can be mapped to the digital measured value, regardless of the configured I/O type. To do this, go to Menu Bar > *Device > Advanced Settings > Digital IO*, select the *I/O number*, check the box labeled *This DIO No. is mapped to DIO measured value* and save the setting to the device by clicking *Store to Device.*

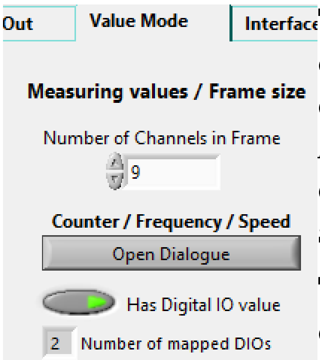


Then, the soft LED is lit and the Bit number of this IO line is displayed under *Mapped to Bit No.*

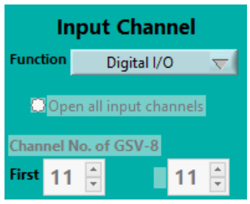
The digital reading contains the lowest mapped DIO number in bit 0, followed by the next highest in bit 1, and so on. If only one is mapped, only the values 0 or 1 are possible: 0 = low, 1 = high. If two are mapped, e.g., No. 7 and No. 11, the readings

mean:
0: Both low.
1: Nr. 7 high, Nr. 11 low.
2: Nr. 7 low, Nr. 11 high.
3: Both high.

The "Line inverted" setting has no effect; the level is reproduced as is.



The presence of the digital measurement channel is also displayed under *Value Mode* and the mapping can be completely deleted (but not set) here by unchecking *Has Digital IO value,* then confirming the prompt with *OK* and clicking *Store to device* at the bottom of this section.

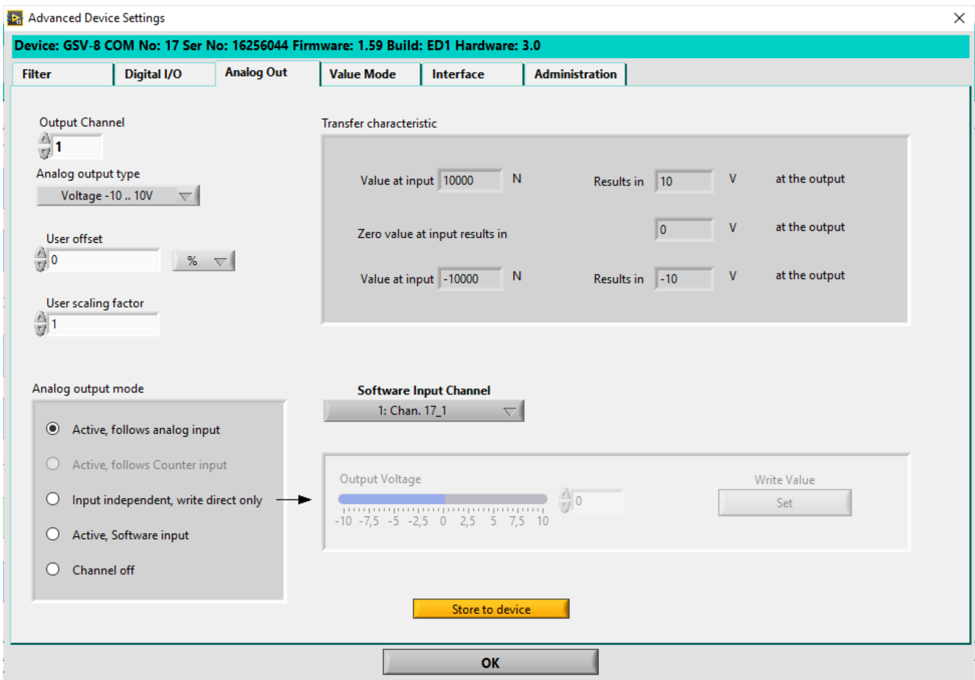


The digital measurement value must be opened using *Add Channel* by selecting *Function = Digital I/O* in the *Add Channel* window on the right (similar to counter channels).

The digital measurement value is always the last one in the measurement data frame and has the fixed input number 11. It has no *User scaling* or offset and cannot be set to zero. This function can also be combined with the counter, allowing the GSV-8 to transmit up to 11 channels.

Analog output of the GSV-8

The GSV-8 offers eight configurable analog outputs, which can be configured under Menu Bar *-> Device -> Advanced Settings ->* ***Analog Out***.



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With *Output Channel* , you first select one of the 8 analog outputs whose configuration you want to view or change.

Analog output type is the type of analog output that specifies the output current or voltage and the range. The following types are available:

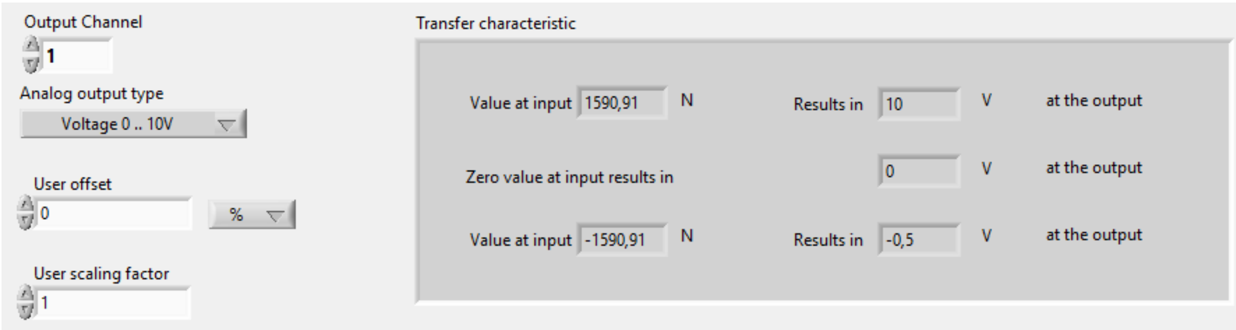
> ***Voltage 0 .. 10V: Voltage output, unipolar from 0 to 10V.***
> Zero point: 0V (if user offset =0)
> Saturation: negative: -0.5V, positive: 10.5V
>
> ***Voltage -10 .. +10V:*** Voltage output, bipolar from -10 to 10V.
> Zero point: 0V (if user offset =0)
> Saturation: negative: -10.5V, positive: 10.5V
> Default type of manufacturer setting
>
> ***Voltage 0 .. 5V:*** Voltage output, unipolar from 0 to 5V.
> Zero point: 0V (if user offset =0)
> Saturation: negative: -0.25V, positive: 5.25V
>
> ***Voltage -5 .. 5V:*** Voltage output, bipolar from -5 to 5V.
> Zero point: 0V (when user offset =0)
> Saturation: negative: -5.25V, positive: 5.25V
>
> ***Current 4.. 20mA:*** Current output, unipolar from 4 to 20mA
> Zero point: 4 mA (when user offset =0)
> Saturation: negative: 3.2mA positive: 20.8 mA
>
> ***Current 0 .. 20mA:*** Current output, unipolar from 0 to 20mA
> Zero point: 0 mA (when user offset =0)
> Saturation: negative: 0 mA positive: 21 mA

The zero point at the analog output can be changed by ***User offset***, so that even unipolar types can be measured bipolarly, i.e. positive and negative numerical or measured values can be displayed analogously. The *User offset* can be entered either as a percentage of the output range (%) or in volts (V) or mA, to do so, select the desired unit from the drop-down menu next to the field.
For example, if the analog output type is *Voltage 0 .. 10V* and the *User offset* is set to 50% or 5V, the ranges change as follows:

> ***Voltage 0 .. 10V:*** Voltage output, bipolar from 0 to 10V.
> Zero point: 5V (when user offset =50%)
> Saturation: negative: -0.5V, positive: 10.5V

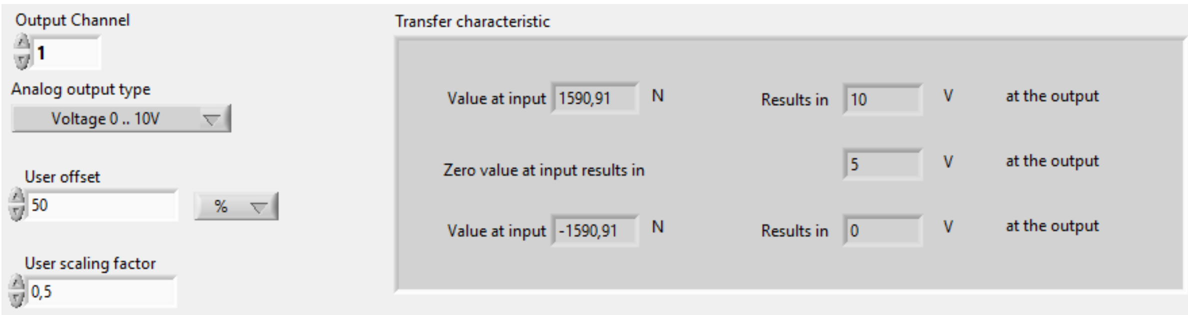
To ensure that full scale negative value is represented by 0 V and full scale positive value by 10 V, the *User scaling* factor is 0.5. The *User offset* and User scaling factor shown here only affect the analog output and are not to be confused with *User scaling* and *User offset, which* are operated in the main window *(Configuration tab*).

These results can be read after each change of the inputs by the display ***Transfer characteristic*** (Transfer function). The positive and negative full-scale values correspond to the user scale or, if the six-axis sensor is enabled, to its maximum value. For standard sensors, the user scale generally does not correspond to the nominal value of the connected sensor, see p. 9. With the above example, the following can result:



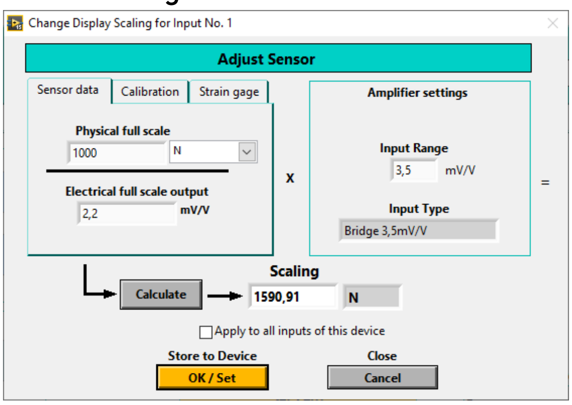
The positive full output of 1590.91 results in 10V at the output.

To be able to measure bipolar, set the *User offset* to 50% or 5V, the *user scaling factor* is then automatically set to 0.5:



The digital value =0 (*Zero value at input*) now results in 5V at the output, the negative full scale value results in 0V at the output.

In this example, the *Value at input* of 1590.91 N is obtained from a 1000 N force sensor with the following data:



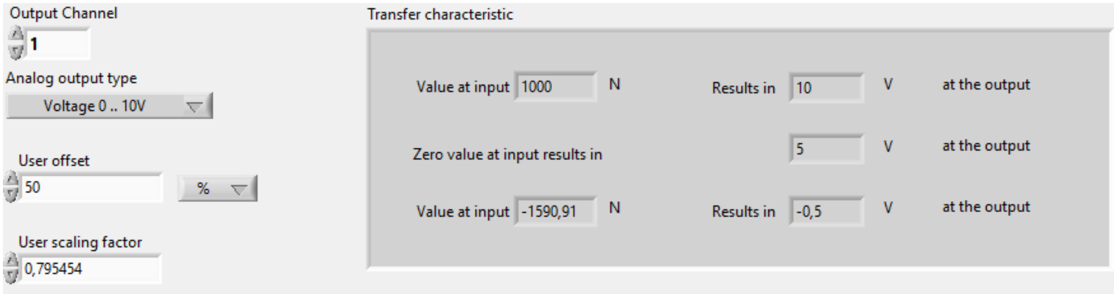
Often you want the nominal value of the sensor to correspond to the full scale of the analog output and not the amplifiers input sensitivity. In this case, that would be:

1000 N => 10V
-1000 N => 0V

So you convert the analog output's *User scaling factor* manually:

New *User scaling factor* = (full level/sensor nominal value) x old *User scaling* factor

Here: (1590.91/1000) * 0.5 = 0.795455

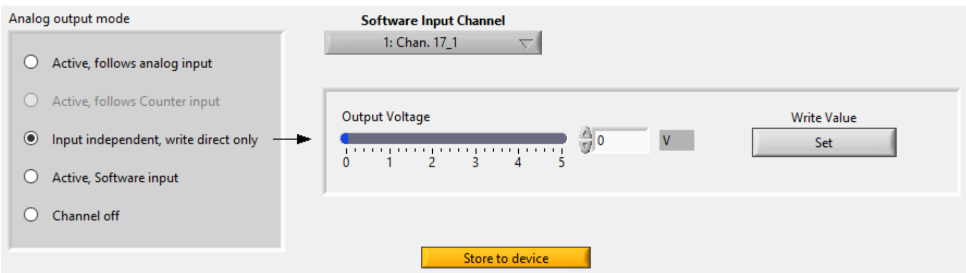


Analog Output Mode

By default, the analog output follows the sensor signal of the corresponding input channel, i.e. input 1 -> output 1, etc. However, this assignment can be changed by ***Analog output mode.***

The following options exists:

> ***Active, follows analog input***: The analog output follows the reading of the corresponding input channel; Default mode of the manufacturer's settings.
>
> ***Active, follows Counter Input***: The analog output follows the measured value of the counter or frequency measurement. This setting is only possible on output channels 7 and 8 and the counter/frequency measurement itself should be configured as described from page 133. Output channel 7 corresponds to the first counter channel and output channel 8 to the second; if only one counter channel is configured, output no. 7 is used.
>
> ***Input independent, write direct only***: The analog output is separated from the input and can only be set by the software's write command. This is useful, among other things, for testing the output. To do this, first select this mode and then click on *Store to device*. Afterwards, under *Output Voltage* or *Output Current*, use the slider or numeric number input to set the voltage or current, and then click *Write Value / Set*. Then this value should be output, regardless of *User offset* and *User scaling factor*.



Active, Software Input: The analog output is separated from the input and is driven by GSVmulti at the measurement runtime. This setting is only available with GSVmulti PRO and is explained in more detail below.

Channel off: The analog output is disabled.

Analog output of software channels

With GSVmulti PRO it is possible to output any channel continuously to the analog output. This is particularly useful when it comes to software-calculated channels, e.g. math channels or software-calculated multi-axis sensors (see p. 44). Math channels are channels that display the results of a user-defined computational rule (*MathScript*); they are described in detail in a separate manual.

If this *Analog output mode* is selected, you have to use the *Software Input Channel* selection element to select the source channel, i.e. it must already be integrated at the time of configuration. Only displayed channels can be selected, not hidden ones (i.e. not those that have been hidden with Menu bar *->* C*hannel -> Hide*).

If you then click *Store to device*, in the GSV-8 the *Input independent, write direct only* mode is stored and the information about the analog output via software is stored by GSVmulti in its configuration file. It makes sense to store the entire channel configuration in a *Session* file, see p. 15

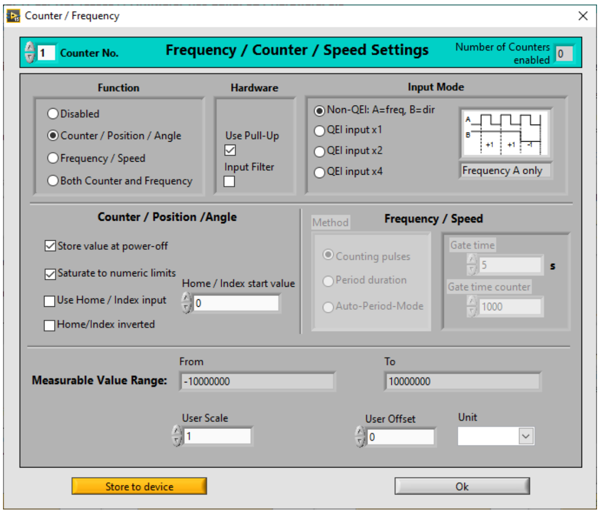
The analog output settings *User offset* and *User scaling factor* are also taken into account for the calculation of the software-generated analog output, but *Transfer characteristic cannot* display any meaningful values with them (see above). If *User offset* =0 and *User scaling factor* =1, the values are interperetd and output as Volts and mA, respectively, depended on *Output Type*.

The analogue output only takes place during the measurement runtime, i.e. after clicking on *Start Measuring*.

The update rate of the software analog output follows the measurement data rate if it is less than 1000/s. Otherwise, it tries to output a value every millisecond. However, the refresh rate may be limited by the load and performance of the PC. Also, the temporal equidistance of the samples of the output DAC is not necessarily given, i.e. it can happen that a little more time passes between two updates than usual.

![ME logo]

Counter and frequency measurement with GSV-6BT, GSV-6T3, and GSV-8



With the GSV-6BT and the GSV-8 you have the possibility to evaluate the signal from digital pulse generators and to map it to one (or in the case of the GSV-8 two) additional measurement channels. The pulse generator can be an incremental encoder with A/B track or a simple optical or magnetic switch. Depending on the encoder, arrangement and device configuration, quantities such as position, angle of rotation or displacement as well as speed or frequency can be measured. Detailed descriptions are available for both devices in the form of separate operating instructions, the connection assignment can be found in the general operating manuals. The configuration dialog is opened via **Menu Bar -> *Device -> Advanced Settings -> Value Mode*** by clicking on ***Counter/Frequency/Speed Open Dialogue***. In the lower area you can control *User Scale, User Offset* and the *Unit* unit; these settings correspond to those in the main *Configuration* window. Next to ***Measurable Value Range***, the measurable range of values *From To* is displayed, which is also updated based on user input.

With the GSV-8, up to two sensors with pulse output can be connected, which can then be selected with ***Counter No***. If only one is used, it must be number 1. ***Function*** describes the basic function:

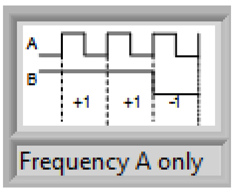
Disabled: The counter input is turned off and the counter channel does not exist.

Counter / Position / Angle: The QEI input is configured as a counter, i.e. pulses or pulse sequences are counted as integers. More details below.

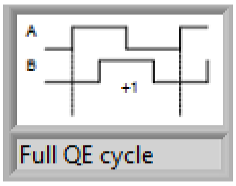
Frequency/Speed: The QEI is used to measure frequency. This setting is suitable for measuring speed or frequency, for example. More details below.

Both Counter and Frequency (GSV-8 only): From input 1, both the counter reading and the frequency are calculated and output in two additional channels. The operation/ display *User Scale, User Offset,* the *Unit* and the display of the value range is switched with *Show/Store values for*.

Under *Hardware* and ***Input Mode***, settings are defined, which can be selected on the basis of the connected sensor, among other things. The *Input Mode* determines the type of pulse acquisition, they may depend on other modes like *Function* and *Method*, see there.

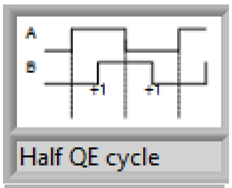


Non-QEI: A=freq, B=dir: The QEI encoder evaluation is disabled, a square wave signal is expected at input A. Input B determines the counting direction (or the sign in the case of frequency measurement): High = left open: Forward. Low = Set to ground: Backwards. This mode can be applied to all measurement types and methods.



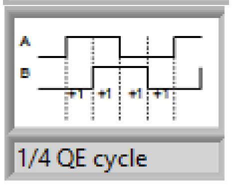
Full QE cycle

QEI input x1: During a complete quadrature cycle (see figure), the count is incremented or decremented by 1; the direction of counting depends on whether the A signal leads or lags the B signal: if the A pulse comes first, the count increments; if the B pulse comes first, the count decrements. This mode provides the highest level of false signal suppression.



Half QE cycle

QEI input x2: During a full quadrature cycle (see figure), the count is incremented or decremented by 2, and during a half cycle, by 1. The direction of counting is always determined by whether the A signal leads or lags the B signal.



1/4 QE cycle

QEI input x4: For a full quadrature cycle (see figure), the count is incremented or decremented by 4, and for a 1/4 cycle, by 1.

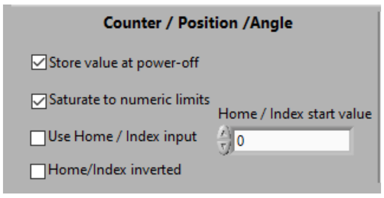
Under *Hardware* you can set the following for GSV-8:

Use Pull-Up: If this checkbox is set, there are pull-up resistors at the QEI/counter inputs. This setting is necessary if the connected pulse sensor only switches between the states 'open' = high impedance and 'closed' = connected to GND (so-called open-drain output). In this way, encoders with an operating voltage different from 5V may also be used. If, on the other hand, it is a 5V push-pull output, you can omit use pull-up.

Input filter: The acquisition hardware offers an input filter that can suppress very short interference pulses; however, the maximum frequency of the inputs is reduced to 200 kHz in all modes and the measurement accuracy for period duration measurement is also somewhat degraded (see ba-gsv8-Inkrementalenkoder.pdf).

Meter Measurement

For measurements as counters, the *Function* selection is set to *Counter / Position / Angle*. This setting is suitable, for example, for measuring position, angle of rotation or displacement. It can be counted forward and backward, see description of the *Input Mode,* which are all available here. *User Scale* and *User Offset* are used to convert the meter reading to the quantity of interest, so the final result can also be non-integer. The counter can be set to 0 with *Set Zero*, just like any analog reading. The following options are available:



Store value at power-off: When the device is switched off, the current meter value is saved and restored the next time it is switched on. This is useful, for example, for absolute displacement measurements; however, care must then be taken to ensure that the displacement sensor is never moved when the device is switched off.

Saturate to numeric limits: The count is saturated when the maximum is exceeded or fallen below the minimum; this saturation value depends on the integer measured value data type (see p.112) and is 10 million for the float type. When the counting direction is reversed and it returns into the representable value range, the saturation state is automatically reset. GSV-8: When saturation is off, the counter overflows, i.e. from high positive or negative values to zero, and when the internal 32-bit counter overflows, from high positives to negative values and vice versa. GSV-6: When the saturation is off, the counter overflows, i.e. from high positive to negative values in the forward direction and vice versa in the reverse direction.

Use Home / Index input: In addition to the required A, B, and GND connections, the QEI decoder features an additional *Home/Index* input. If this option is enabled and the input is active, the counter value is set to a predefined value specified under *Home/Index start value*. In many cases, 0 is used, so that a pulse at the Home/Index input resets the counter.

Home/Index inverted (GSV-8 only): If *Use Home / Index input* is set, you can use it to set the active level: Checkbox set: Active=Low; not set: Active=High. On the GSV-6, the Home/Index input is inverted by default.

Frequency / RPM / Speed by Counting

Here, the difference between 2 meter readings within a measurement data period is evaluated. The frequency to be measured must therefore be higher than the measurement data rate.

The different *Input modes* are all available. This frequency measurement mode by counting is suitable for measuring quite high frequencies at a relatively low data rate, e.g. those supplied by an encoder with many pulses per revolution. To enable this mode, set ***Method*** under *Frequency / Speed* to ***Counting Pulses***. In this mode, the basic unit, i.e. the evaluation of the measured values with *User scale* = 1, is Hz, i.e. /s.

Gate time

In order for the frequency (or speed) to be displayed correctly, the raw meter value must have changed as often as possible within a data period, i.e. the difference in amount of a new meter value to the previous one must be >=1.
The measurement data rate is the same for all channels, i.e. it also applies to the evaluation of the meter. In order to be able to measure relatively low speeds/frequencies at rather high data rates, it is possible to increase the data period for frequency measurement. This is done with the help of an (integer) data period multiplier, the *gate-time counter.* The *gate time,* which consists of the *Gate time counter* and the measurement data rate, is also displayed and operable, and indicates the gate time in seconds.
The minimum frequency that can be measured is thus calculated as:
fmin = Data Rate / Gate-Time-Counter [Hz]

Frequency / speed / velocity by period duration measurement

Here, the period duration of arbitrary square wave signals is measured directly. This mode is particularly suitable for speed measurement where only a few pulses (e.g. 1 pulse per revolution) are generated per revolution, e.g. by a magnetic switch moving relative to a magnet on the rotation circuit.

GSV-8: The quadrature encoder mode is irrelevant here; it always evaluates the time between one edge at input A and the next at input B. If the QEI evaluation is off (*Non-QEI: A=freq, B=dir*), the period duration of a square wave signal is measured at input A and B determines the direction of rotation. In this measurement mode, the accuracy and value range of the measurement are independent of the data frequency and the QEI decoder mode.

GSV-6T3/GSV-6BT: The GSV-6 switches on an oscillator with f=1MHz at input A and the **measurement input is input I** ("index"). The input mode is therefore set to *Non-QEI: A=freq, B=dir,* i.e. the rotary encoder A/B input is not available. Input A must be left open, otherwise the device could be damaged!
Input B determines the sign of the measured value or the direction of rotation; If it is left open (=high), it is always positive.
The measurement data rate in this period duration mode must be significantly greater than the maximum frequency to be measured, and at least 3 times higher than this.

In both devices, the gate-time counter has a different meaning in this mode: it determines the time after which the measured value is set to zero when there are no more pulses at the measurement input. As a result, this determines the measurable minimum.
Even in the period duration mode, the basic unit, i.e. the evaluation of the measured values with *User scale* =1, is Hz, i.e. /s.

GSV-8: Frequency / Speed Measurement with Auto-Period Mode

When *Method* is set to auto-period mode, the GSV-8 automatically decides whether to use the counting method or the period duration measurement based on the measured frequency. If the counter value is less than 2000 per period of the measurement data rate,

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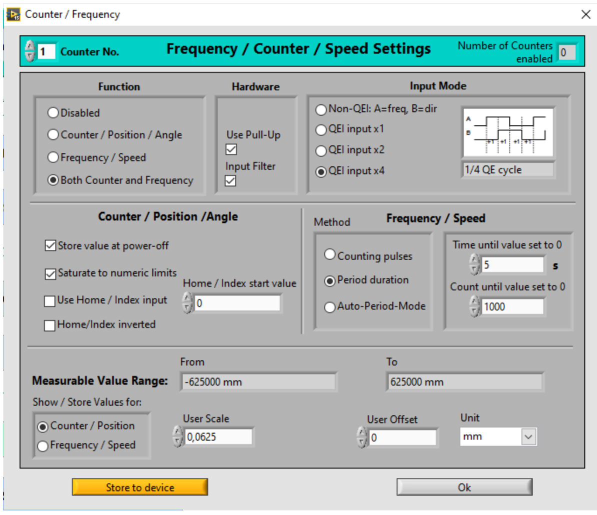
the period duration measurement is used, otherwise the counting method. The threshold value, for example, is 20 kHz at the default measurement data rate of 10 frames/s. In this way, the measurement uncertainty can be kept below 0.05% v.s. over the entire measuring range.
Gate time is not used in this mode, nor does QEI input mode have any effect.

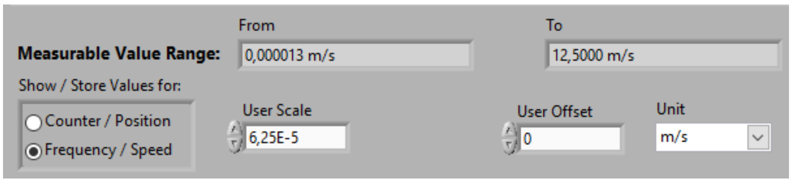
Examples of setting *User Scale* to fit specific encoders:

Example 1: With a rotary encoder, the speed is to be measured in revolutions per minute (unit rpm). The encoder delivers 360 complete quadrature cycles per revolution. The input mode is *QEI input x1*. Then *User Scale* is set to the following value: 60 rpm / 360 = 1/6 = 0.1666667 rpm.

Example 2: With the same encoder, you want to display RPM = rpm, but the input mode is *QEI input x4.* Then you set *User Scale* to the following value:
60 rpm / (360*4) = 1/24 = 0.041666667 rpm.



Example 3: With a magnetic linear encoder and GSV-8, position in mm and speed in m/s should be displayed at the same time. It delivers 4 complete quadrature cycles per mm. For example, you can configure it like this:
The first measurement channel is the *Counter*, User Scaling = 1/(4*4), the second is Speed, *User Scaling =* 1/(4*4*1000)



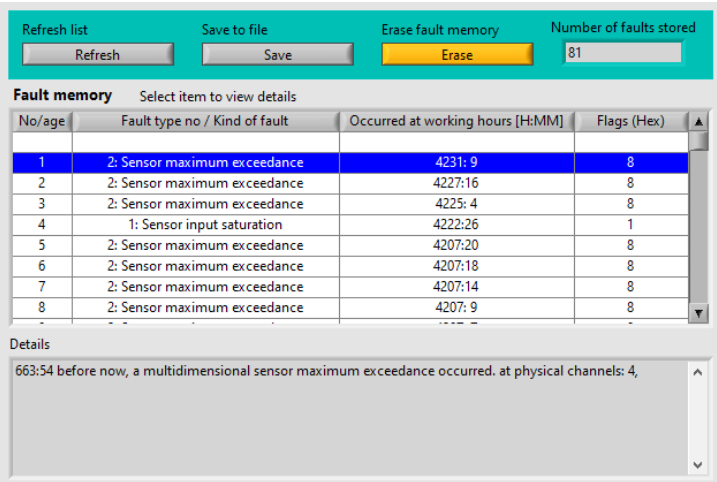
When the counter/frequency measurement is configured, a new channel is created in the device, which can be opened as described on p. 15.

Learn more about device administration

In the following, previously uncovered settings and information are described, which can be accessed in Menu bar → *Device* → *Advanced Settings* → *Administration.*

Fault memory of the GSV-8

The GSV-8 has an error memory, which mainly stores faults caused by an incorrect connection or a faulty sensor. Up to 81 errors are saved. They can be viewed by clicking on ***Fault Memory*** / *Open Dialogue* :



Clicking on them will highlight the entries and show *Details* of this error at the bottom under. *No/age* is the number of the entry, starting with the most recent. Under *Occurred at working* hours, the operating time (the time of the operating hours counter, s. p. 139) at which the error occurred, is displayed in the format Hours:Minutes. *Fault type no / Kind of fault* specifies the type of fault and can contain the following entries:

1: Sensor input saturation:

One sensor input was saturated, i.e. the measuring range was exceeded. Under *Details*, input channel(s) identifies the input *channel(s)* where the error occurred. Possible causes:

- Defective sensor
- Overloaded sensor
- Defective sensor cable
- Incorrect sensor connection
- *Input type* selected incorrectly, i.e. input measuring range too small

2: Sensor maximum exceedance: A multi-axis sensor exceeded the maximum value stored for that sensor. Under *Details, physical channels* refers to the input channel(s) where the error occurred. It may have the same causes as (1), in addition, incorrect sensor calibration data may have been loaded, see p. 44

3: Sensor or sensor connection broken: An incorrect common-mode voltage at Ud+ or Ud- was detected at a bridge input. Under *Details*, input channels indicate the input channel(s) where the error occurred, and the line Ud+ / Ud- is also mentioned. Possible causes:

- Defective sensor
- Incorrect sensor connection
- Defective sensor cable: short circuit or line open

4: Analog output: wrong connection: Fault at the connection of an analog output. Possible cause is an open current output or an overheated output driver, e.g. due to a short circuit of a voltage output. An unconnected current output (*open* *current output*) is interpreted as an error, the output channel is mentioned under *details* (*... at channel...*)

5: Digital output: Wrong connection: Short circuit on a digital output (DIO no), which is mentioned in *Details*. Another possible cause is that an output has been connected to a DIO pin that is configured as an output (level collision).

Flags (hex) are information about channel or I/O numbers that are defined differently for each error number and documented in the protocol description.

With ***Save to File,*** the error memory content can be exported to a text file, which has the name FaultMemory.log by default. It contains a header that specifies, among other things, the current operating hours (*device working hours*) and one row for each entry. For example, the error memory shown above yields the following file header and the first line:

Fault memory saved from GSV-8 Ser.No: 16256044 Date: Wed, Jan 24, 2024 Time: 19:59 Device working hours: 4895:5

No/age	Fault type no / Kind of fault	Occurred at working hours [H:MM]	Flags (Hex)	Details
1	2: Sensor maximum exceedance	4231: 9	8	663:56 before now, a multidimensional sensor maximum exceedance occurred. at physical channels: 4

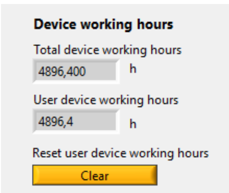
With ***Erase Fault Memory*** , the error memory can be erased; it will prompt for the device password. The deletion cannot be undone!

By clicking on ***Refresh***, errors that may just have occurred can be reloaded. The GSV-8 stores new errors in a time interval of at least two minutes.

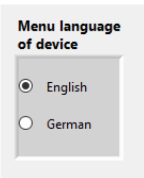
The log file of the error store is also part of the *Settings Archive*, see p. 27.

Operation Hour meter of the GSV-8

The GSV-8 and GSV-6BT have hour meter that counts the time the device is turned on. They appear in the *Administration* tab under *Device working hours*. There are two counters: an absolute one that cannot be reset (*Total device working hours*) and one that can be set to 0 by the user, e.g. to log the duration of a specific measurement campaign. It is called *User device working hours* and is set to 0 by clicking on *Reset user device working hours / Clear.*



GSV-2 Menu Language



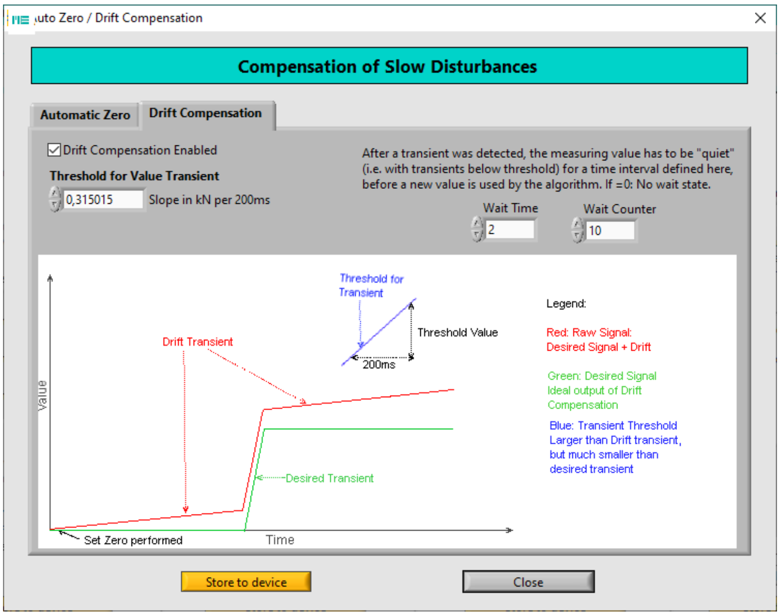
For GSV-2 amplifiers with keyboard and LCD menu, you can set the language of the device menu under *Menu language of device* (*English* or *German*).

Drift compensation with GSV-2

Most sensors drift due to temperature changes. For some, this is well compensated, for others, such as strain indicators and individual strain gauges, this is not always possible. For such cases, the GSV-2 offers a drift compensation algorithm that compares the transient of the measured value (i.e. its temporal change/derivation) with a predefined threshold. Readings that change more slowly than this transient threshold are not output by the GSV-2, but are stored internally. Measured values that change faster than this transient threshold are output, and the difference to the stored ("drifted") measured value is formed.

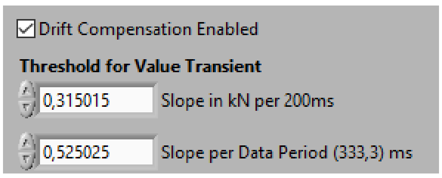
It is therefore crucial for the applicability of this drift compensation that the measured values of interest (the useful signal) **immediately follow a rather rapid change.**

You can access the Drift Compensation configuration dialog by clicking on the *Drift Compensation button* at the bottom right of Menu bar *-> Device -> Advanced Settings -> Value Mode.*



Configuration of drift compensation, data frequency here 5/s

The transient threshold is given under *Threshold for Value Transient in* Slope in *<unit>* per 200ms for a constant time interval of 200ms. If the measurement data rate is less than 5 /s, the transient is also specified under *Slope per Data Period (*<1/Measurement Data Rate>*) ms* per measurement data period, because this is then less than 200ms. In the picture on the left e.g. for 3 /s.



Multiplying the *Slope per 200ms* by 5 gives the change per second.

You activate drift compensation with *Drift Compensation enabled*. The measured value is then only output after a valid useful signal change, i.e. if the measured value changed faster than the transient threshold value. In addition, you can define a waiting period within which even rapid changes (e.g. vibrations) are ignored after a valid measured value. This is displayed under *Wait Time* in seconds; *Wait Counter* is a counter of this time

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at 200ms intervals. After detecting a valid reading, this time is waited until the current transient is compared with the transient threshold again as described above.

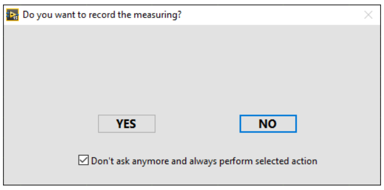
Low measurement data frequencies <50/s are recommended for the use of drift compensation.

A typical application is a strain indicator on a metallic pillar supporting a crane. The load lifted and dropped by the crane is to be measured. The pillar is subject to temperature fluctuations, which are noticeable as drift in the signal of the strain indicator. The pick-up and release of the load is much faster than the temperature drift, as long as the load does not fall below a certain minimum. First, test measurements without drift compensation are made in order to determine the useful signal transients and the optimal measurement data rate (s.p. 18, but you don't need a very high rate when testing here; approx. 10 Hz) and records them. In this example, the test measurements should include the recording and specification of minimum and maximum loads and, if necessary, different travel speeds. From the recording of the measurement, one can then determine the transient threshold value and, if necessary, the waiting time (the latter e.g. from the time of oscillation due to the load change) in order to configure the drift compensation. Subsequently, further tests with compensation activated are recommended. Drift compensation can increase the measurement uncertainty somewhat.

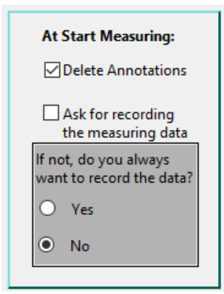
Other Software Preferences

Here, previously uncovered settings are explained under Menu Bar -> *Options ->* Preferences *and* ->*Default Settings.*

In the initial configuration, when the measurement is started, the user is asked if he wants to record it. This question can be suppressed by activating the checkbox *Don't ask anymore and always perform selected action* for this message:

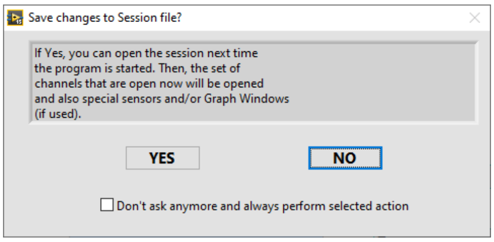


Depending on whether Yes for recording or *No* for not recording is clicked, this will apply to any future click on *Start Measuring*. This behavior can also be configured in Menu Bar -> *Options* -> *Preferences -> At Start Measuring:*

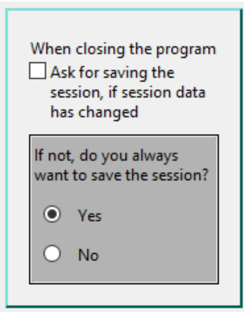


If the checkbox *Ask for recording the measuring data* is not set, the question about recording is not asked at *Start Measuring*. Then you specify under *If not, do you always want to record the data?* whether *Start Measuring* always starts a recording automatically (*Yes*) or not (*No*).

By the **Closing the program** the user is asked if he wants to save a session file if something has changed that is relevant to the session setting (e.g. channels have been added or removed), see p. 15.

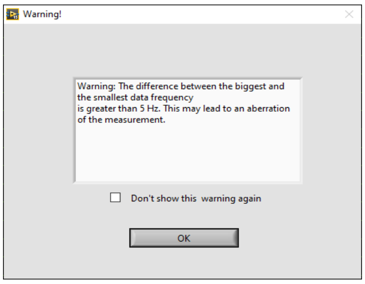


You can suppress this question by activating the checkbox *Don't ask anymore and always perform selected action* in this message. Depending on whether *Yes* for Save or *No* for Don't Save is clicked, this applies to any future program exit, but in any case it will only be saved if relevant information has been changed. With automatic session saving, a file selection box opens at program exit, in which the last session file is pre-selected. This behavior can also be configured in Menu Bar *-> Options -> Preferences -> When closing the program*:



If the checkbox *Ask for saving the session, if session data has changed* is not set, the question of saving when the program is terminated will not be asked. Then you can go to *If not, do you always want to save the session?* to specify whether to save after each relevant change (*Yes*) or never automatically (*No*).

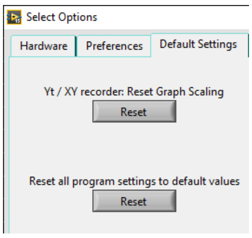
If several GSVs are integrated and they have **different measurement data frequencies** (which is not recommended), the user will be warned if the difference is greater than 5 when clicking on the Recorder Yt or XY tab:



If you activate the checkbox *Don't show this warning again*, this warning will no longer be displayed. This can also be configured with a checkbox under Menu Bar -> *Options* -> *Preferences* with *Warn if device data rates are different.*

Other settings in *Options->Preferences* concerning the *Recorder XY* (p. 66), the *Single Value Display* (p. 31), the number of decimal places of measured values displayed (p. 33) and the time interval of acquiring measurement data from the amplifiers (p. 33).

Under Menu Bar -> *Options -> Default Settings* you can reset to the **basic settings of the software.**



If you click *Yt / XY recorder: Reset Graph Scaling*, currently (up to and including version 2.1) only the scales of both axes of the XY recorder and the Y-axis of the Yt recorder are reset. When you enter the corresponding main tab, this comes into effect.

If you click *Reset all program settings to default values*, all software settings will be **reset** to the state they were in after installing

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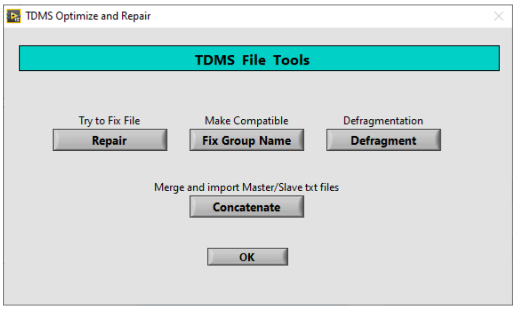
GSVmulti. To do this, a query must be confirmed (*Are you sure to reset the program settings?*) and you will then be informed that the reset will only take effect after a restart of the program. The reset does not affect the settings of the amplifier hardware, but it cannot be undone.

Tools for Measurement Data Files: TDMS Tools

The standard format for measurement data files, *.tdms, has been mentioned several times, e.g. p. 34. Menu bar -> *File -> TDMS Tools* opens a window for the selection of different tools that can be used to perform special tasks and repairs on measurement data files.



With ***Try to Fix File / Repair*** you can try to repair a broken tdms measurement data file. There is no guarantee that this will succeed and it is also possible that parts of the data will be lost, but the rest will become readable again. Such a defective file can occur, for example, if the PC crashes during a recording or if there was a power failure or GSVmulti has been closed irregularly (e.g. by the Windows Task Manager). When trying to open such a file using the *File Monitor*, an error message appears.

After clicking on *Try to Fix File / Repair*, select the broken tdms file, it will then be saved under a different name, namely appending _fixed to the original file name.

Make *Compatible / Fix Group Name* makes a *.tdms file **created by another program** compatible **with GSVmulti** so that it can be opened with the *File Monitor*. In tdms files, the channels are always assigned to groups and GSVmulti expects a group named *Measuring values*. After clicking on *Make Compatible / Fix Group Name,* select the file you want to change. The first group of the file is renamed after confirmation by the user and its channels can then be viewed in the *File Monitor*, as long as they are regular measurement data. Attention: GSVmulti does not rename this file up to and including version 2.1, but only changes it. Therefore, it is recommended that you manually rename the file before using *Fix Group Name*. As of version 2.2, *_changed* will be appended to the original filename.

Defragmentation/Defragment is used to defragment tdms files. This can be useful for very large files, because they can have some redundant entries, such as properties.

Concatenate Master-Slave Files from GSV-6BT

The GSV-6BT supports the hardware synchronization described on p. 16. The recording of measurement data on the SD card (see p. 34) cannot, however, be synchronized in a trivial way for various reasons. The recording can and should be started via a hardware switch by configuring and wiring the digital input not used for master-slave sync (see p. 121 Type: *Trigger File Log*), but the timing of when the recording will actually begin is somewhat uncertain.

However, the GSV-6BT supports a mechanism to mark two lines about 0.2 to 0.4 seconds after the start of recording a file in the master and slave devices at the same time. The master writes an M at the end of this line and the slave an S.

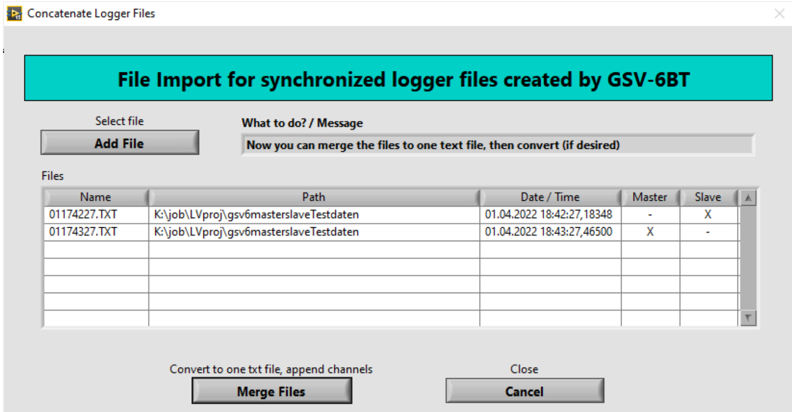
For example:

22/04/01,17:43:27.46500 -0.00423 2.10000 2.10000 -2.10000 -2.10000 -2.10000 19964.02930 **M**

22/04/01,17:42:27.18348 -0.00410 2.10000 2.10000 -2.10000 -2.10000 -2.10000 32014.39063 **S**

In this example, the two RTC clocks had a time difference of about 1 minute. You can minimize the time difference a bit by changing the RTCs of both GSV-6BT by clicking on Sync. as from p. 34 described, but they will still diverge somewhat.

To merge these two files, first click on *Merge and import Master/Slave txt files / Concatenate* in the *TDMS File Tools* and the following dialog will open:



With Add File, *you select* the files that belong together one after the other. One should be that of a master, which you can see by the X in the Master column. Then click on *Merge files* and select the destination directory for the measured value file in text format, which then contains all channels of both devices in adjacent columns and is time-adjusted. If necessary, measured values are omitted at the beginning and at the end in order to equalize the number of measurement lines. Then you can choose whether you want to convert this file to another one in tdms format. The channels of the master form the first columns, those of the slaves the others, whose channel names _1 and possibly _2 and so on are appended:

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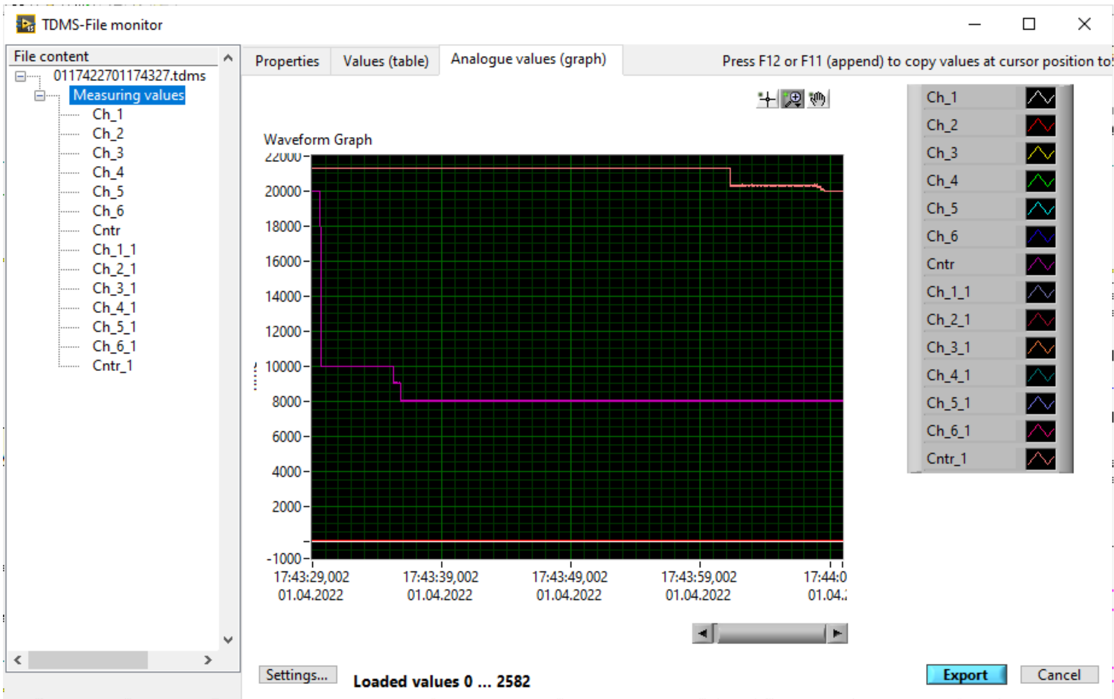


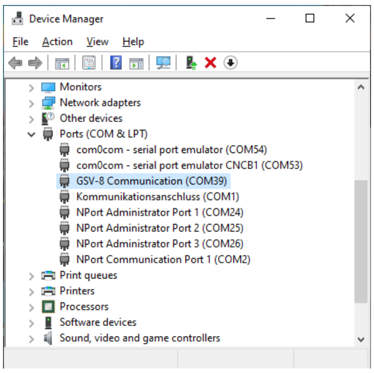
Troubleshooting

The following describes common problems, error messages, and possible solutions. Further tips can be found on the Me website, e.g. in the Knowledge base.

1. The device cannot be opened with *Add Channel*

In order to be able to open a device successfully, three pieces of information should be known and entered correctly:

- The device model, e.g. GSV-2, GSV-8, GSV-6 serial or GSV-6CAN. Some smart sensors have a built-in digital amplifier, e.g. a GSV-6 CAN. The nameplate, data sheet or operating instructions should provide information.
- The COMport number. In many cases, there are only a few entries in the pull-down menu *COMport Number* of the *Add Channel* dialog and you can easily find the right one. Entries in angle brackets, as shown here, are probably not correct. In rarer cases, the COMport number is known, but not in the list. Then you can enter them in the small number input element to the right of the pull-down menu. To find out an unknown COMport number, you can look in Windows Device Manager: click on the Windows icon in the Start bar, type Dev or type Device Manager in the search box on the task bar and then open it.



It can contain entries such as "USB Serial Port" for GSVs with USB, or "BX-8 Communication", a GSV-8. "Serial-over-Bluetooth connection" or similar is the COMport of a **Bluetooth device**. To do this, however, the BT must already be coupled. If there is no serial over BT entry in the device manager, you have to pair the device. To do this, the power supply must be connected and it must be nearby, and the PC also needs a Bluetooth adapter. Then you can proceed as follows: here , select the Windows version at the top and proceed as under "How to pair a [...] other device". If that doesn't work or the GSV can't be found: Under Windows 11 the Device Discovery needs to be set to Advanced. To do this, select "Show more devices" in the Bluetooth settings. The assigned COMport number can also be seen under "More Bluetooth options", where "Outgoing" is the correct port.

- The baud rate (bit rate). For most serial ports, it must be selected correctly, see p. 104

If the device fails to be opened, an **error message often appears.** Here is the breakdown of the most common messages:

- ***Error 2*** *occurred ...* or:
  Error 536870914 *occurred at ... Possible reason(s): OS reported Error 2: Port or file not found.*
  Windows returns this error message (File not found), a common reason is a wrong **COMport number,** see above.

- ***Error 5*** *occurred ...* or:
  Error 536870917: Windows returns this error message (Access denied), usually the **COMport is already open by another program.**

- ***Error 121*** *occurred ...* Windows returns this error message. If it's a **Bluetooth device** , the battery could be low or not plugged in. Error messages with the same text but different error numbers <2000 can also occur with a BT-COMport.

- ***Error 805306456*** *occurred ... Possible reason(s): MEGSV86xx.DLL: Command response from device timed out*. The GSV-6/-8 API returns this error message. Or:
  MEGSV4.dll Error: No answer from GSV Or:
  Error 805306612 ... *Possible reason(s): MEGSV.DLL: Com port could be opened, but no GSV answered.* The GSV-2/-3 API returns this error message.
  The COMport could be opened, but no GSV answered. Possible causes:
  - The GSV is not properly powered
  - A USB converter cable (if used) is defective or incorrectly connected on the UART or GSV side
  - An RS232 cable (if used) is defective or incorrectly connected
  - The baud rate is incorrect, see above and p. 104
  - The baud rate is correct, but is not supported by the USB converter (if used) or other interface converters or converters or are not configured accordingly (e.g. Moxa for Ethernet).

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- There is a different GSV model connected to the COMport than the one set under Device Type, or a completely different device or no device at all is connected
- GSV-8 over UART: The UART interface used in the GSV-8 is switched off, see p. 104

Another possible cause is that **Windows has assigned the same COM port number to more than one device**. The other device to which this number has been assigned is usually hidden in Device Manager (see image above). You can click on 'View' in the Device Manager menu bar and select '**Show hidden devices**'. If you then see multiple entries under 'Ports (COM&LPT)', i.e. "<Name> (COM<Number>)" with the same Number, proceed as follows:
1. Disconnect the GSV from the PC via USB. The incorrectly assigned entry will then be greyed out.
2. Remove all multiple entries by Richt-Mouse clicking on them and selecting 'Uninstall device'. Confirm uninstalling. Note: That won't uninstall the driver, but clear the device assignment.

3. Connect the GSV again. Windows now eventually assigns a new COMport number.

2. There are no readings

This problem also occurs if only one of the GSVs is not transmitting any readings. GSVmulti expects a measurement data stream from all open GSVs. Often, *timeout* is displayed in the measured value display of the *Configuration* tab. Possible causes:

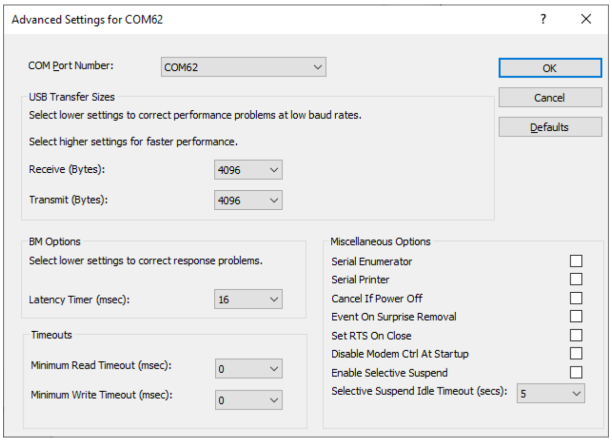
- The device is configured as a synchronization slave, see p. 16. If the GSV is to be operated as a stand-alone device without a master, none of the Digital IOs should be configured as *Sync Slave*; If necessary, this can be changed to *GPinput* s. p. 121
  If it is to be operated together with a master, it must be properly configured and connected to the slave with a sync cable.
- The permanent transmission of measurement data is switched off, see p. 106
- The configured measurement data rate is too high, see p. 18
- Communication has been interrupted in the meantime. Tips on that issue on p. 120. The cause can be, for example, a disconnected interface cable or a poor BT radio connection.

3. The measured values run slowly and jerkily in the graphical display

This is usually just a display problem, i.e. data is only lost in extreme cases and the timestamps are correct. Possible causes:

- The measurement data rate is set unusually low (e.g. 1/s), see p. 18. The GSV-2 or GSV-3 may be set to slow mode. To change, simply increase the measurement data rate.

- Driver setting unfavorable. With the following GSVs with USB: GSV-2TSD-DI, GSV-3USB, GSV-4USB, GSV-6T3, GSV-61 or GSV-6Dev, you can shorten the waiting time of the buffer of the FTDI interface driver. To do this, open the Device Manager (see 1.) and right-click on the corresponding COMport entry and select "Properties", then Port Settings and click *Advanced*. Then set the Latency Timer to 1ms in the following dialog, confirm everything with OK and restart the PC if necessary.



- The PC is very busy. To find out which program is slowing down your PC, you can hold down the Ctrl and Alt keys at the same time, then press Delete and then select the Windows Task Manager. In it, open the Processes tab and sort by CPU so that the top one shows the highest CPU load. Consider closing this process. If it is GSVmultichannel that requires the high CPU load and perhaps also a lot of RAM, this can be normal with many measurement channels and high measurement data rates. MathChannels, in particular, can require a lot of load (depending on the computational overhead). What can help:
  - Avoid opening the *Graph Display* tab, especially if there are more than 3 channels open. The many individual graphs in it require more load than the *Recorder Yt*. The *Configuration* tab requires the least amount of system load.
  - Do not resize a window during the measurement. Window scaling requires performance, which is delayed and low-prioritized, but still temporarily takes away performance from the measurement task.
  - For *MathScript*: If possible, reduce the complexity of the script, for example, by combining constants and reducing the number of operations. The *MathScript* parser does not perform any optimizations.
  - Remove channels you don't need (*Remove Channel*) or hide them, see p. 18
  - Reduce the measurement data rate, see p. 18

4. When using multiple GSVs, the readings are divergent in time.

Solution: Set the measurement data rate of all devices as equal as possible and, if possible, use the master-slave synchronization, see p. 16

5. Data is deleted from a graphical chart

The *Recorder Yt* stores a history, i.e. "behind" the left edge there is still measurement data stored in the graph. This has a constant depth of data packets. If *Autoscale X is* selected, it can happen that data falls out after a certain time; something similar can also happen in

Recorder XY at high measurement data frequencies or very long recording times. The following can help:

- Increasing the acquisition interval, see p. 33
- Recording of the measured values (*Start recording*) and subsequent evaluation instead of live evaluation
- In *Recorder XY*: Use of the trigger function, if possible, see p. 64

6. Attempting to change a configuration setting in GSV fails

If you get an error message when trying to change a device setting (yellow control) or if you don't read it as expected when you read it again, but it is unchanged, this can have various causes. For the GSV-6 and GSV-8, one of the following error messages is usually displayed; however, the causes and solutions described may also apply to the GSV-2 and GSV-3:

- ***Error 939524213*** *occurred ... Possible reason(s): Device: Access from this port denied (other port seems to have write access)*: Another interface has the **Writing rights** and the one with which the device has just been opened cannot change any operating parameters. This other interface can be another serial port (e.g. UART on GSV-8) or **CANopen at GSV-2** and GSV-8-CAN or GSV-8 EtherCAT. With CANopen, you can switch off the CAN interface as a remedy (see p. 107) or use a CANopen master program to put the device in the stopped state. With EtherCAT, you can restart the GSV-8 with the EtherCAT interface disconnected or put it in the INIT state; in both cases, the green LED on the device must be off.
- ***Error 939524209*** *occurred ... Possible reason(s): Device: Access denied, because write functions are blocked:* The general **Write protection** is enabled. This state can also be activated in GSV-2 and GSV-3, see p. 29
- ***Error 939524183*** ... *Possible reason(s): Device: Parameter too big in relation to other parameters / Settings:* The parameter is too large, possibly in relation to other parameters. Often when setting the measurement data rate.
- ***Error 939524180*** *... Possible reason(s): Device: Parameter absolutely too big:* The parameter is absolutely too big.
- ***Error 939524181*** *... Possible reason(s): Device: Parameter absolutely too small:* The parameter is absolutely too small.
- ***Error 939524188*** *... Possible reason(s): Device: Parameter improper with respect to device settings:* The parameter is inappropriate due to other device settings.

7. **Readings are not within the expected range**

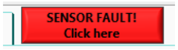
If a reading has a significant deviation at a known test load on the sensor or does not show zero at no-load, it can have many causes.

First, with no load, you should perform *Set Zero* or *Set All Zero* (see p. 92) and then apply a test load. If the result deviates significantly from the expected value, the following can be checked:

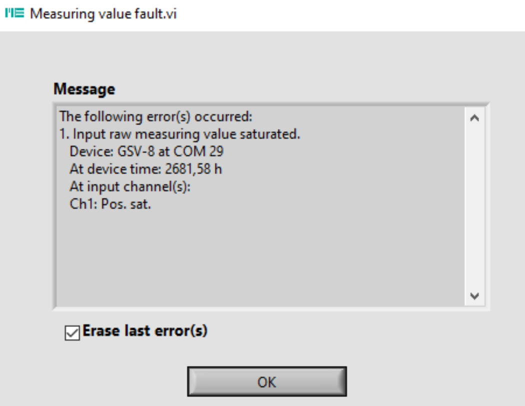
- Is the correct calibration matrix configured for multi-axis sensors? s. p. 44

- Is a common sensor configured correctly? s. p. 9

- If the measured value is in saturation, i.e. it does not increase even when the load is increased, then the input measuring range may be too small, see p. 8. In this case, you typically see an error message when using GSV-6 or GSV-8 *Sensor Fault!* which appears at the top.



If you click on it, a saturation error Input *raw measuring value saturated is* displayed, e.g.



8. The readings are unstable

There is slow instability, which is called drift. At a constant load, the readings then typically change slowly in one direction. The most common cause is temperature changes, and the amplifier and sensor also drift after being switched on. Therefore, you should wait about 20 minutes to an hour after switching on until the sensor and amplifier have reached their operating temperature.

If the sensor experiences temperature drift and the GSV-2 is being used, drift compensation may be applied, see p. 139.

Rapid instability is most often caused by the noise of the amplifier or by disturbances, namely electrical EM interference or unwanted mechanical vibrations. This can be improved, for example, by carefully shielding of the cables, a better power supply or a lower measurement data rate, see p. 18.

9. Problems with data evaluation with TDMS files

If information about the acquisition of the measurement data is unknown, such as the display scaling or the measurement data rate, it can be found by opening the tab *Properties* in the *File Monitor*. To do this, select the group on the left side of the tree view *Measuring Values* or the channel. The *Properties* and their meanings are listed in Appendix B on p. 153.

If a TDMS file cannot be opened, an error message appears, or the measurement data appears to be incomplete, the repair tools described on p. 143 may help.

10. After connecting a GSV-2/-3/-4/-6 via USB, the mouse moves on its own

With some driver versions for FTDI USB chips, there are rare cases where the USB mouse moves on its own in a 'spooky' manner after connecting a GSV to the USB port.

Solution: Update the driver, or: In the advanced driver settings, uncheck the Plug & Play checkbox for the serial interface and then restart the PC.

Appendix A: Hotkeys

If GSVmulti has the key focus, you can trigger functions with the following keyboard combinations:

Keyboard shortcut	**Path of the menu bar**	**Meaning**
Ctrl **o**	File->Open Session	*Open Session*
Ctrl **s**	File->Save Session	*Save Session*
Ctrl **t**	File->Open File Monitor	*Open File Monitor*
F1	File->Start Recording Yt	Start recording with *Recorder Yt*
F2	File->Start Recording XY	Start Recording with *Recorder XY*
F3	File->Stop Recording	Stop Recording
Ctrl **q**	File->Quit	Close program
Ctrl **n**	View->Configuration	Switch to *Configuration* tab
Ctrl **y**	View-> Yt Recorder	Switch to *Recorder Yt* tab
Ctrl **x**	View-> XY Recorder	Switch to *Recorder XY* tab
Ctrl **d**	View->Value Display	Switch to *Value Display* tab
Ctrl **+**	View->Add Graph Window...	Open a new graph window
F4	Action->Start Measuring Yt	Start Measurement in Time Graph
F5	Action->Start Measuring XY	Start Measurement in XY Diagram
F6	Action->Stop Measuring	Stop Measurement
F8	Action->Enable Trigger Paste	Enable triggered pasting into another program
F9	Action->Disable Trigger Paste	Disable triggered pasting into another program
F10	Action->Enable / Disable value Paste by F-Key	Enable/disable pasting into another program
F11	Action->Append values to clipboard	Append readings to clipboard
F12	Action->Copy values to clipboard	Paste Readings to Clipboard
Ctrl **a**	Action -> Set All Zero	Zeroing All Channels
Ctrl **l**	Device->Load Settings...	Load device settings
Ctrl **e**	Device->Save Settings...	Save device settings
Ctrl **f**	Device->Frequency...	Changing the Measurement Data Rate
Ctrl Image↑	Channel ->Next	Increase Display Channel
Ctrl Image↓	Channel->Previous	Decrease the displayed channel
Ctrl **z**	Channel ->Zero	Set Displayed Channel Zero
Space bar	-	Retrieve a single measured value from your device (send command GetValue)

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Appendix B: TDMS Properties

With the recorded TDMS files, properties are saved, which can be displayed in the File Monitor. Here is a list of all *properties.*

Name	**Description / Contents**	**Data type**	**Condition/Sensor/ File Type**
1. At group level, i.e. in *Measuring values*			
File Type	"Standard" / "Raw data"	String	All
Diagram Type	"Yt"/"XY" chart type	String	All
Program Version	GSVmulti version used to create this file	String	All
Start Mode	Method of starting the measurement	String	All
Finish Mode	Method of starting the measurement	String	All
Decimation	About Software Decimation	String	All
AnnotationNum	Number of notes	Int	Only if available
AnnotName<0..N>	Note text	String	Only if available
AnnotVals<0..N>	In-program encoding of additional note information	String	Only if available
2. At the channel level			
Final Time	Termination Time	Time Stamp	All of them, but only available in the 1st channel
DT Mode	Timestamp calculation method for *wf_increment* "tf": start, final time, and value count" 1/f0" Device Measurement Data Rate "user": User-defined time increment	String	All of them, but only available in the 1st channel
ToffsetUTC	Time zone: Offset to UTC, in hours	Double	All of them, but only available in the 1st channel
ChannelType	Input type: "analog": Analog input "counter": Counter/Frequency" "Longitude": GPS/GNSS Geocoordinates "Altitude" GNSS Height of geoid in m "Speed" GNSS speed in km/h "UTC time" UTC time of GNSS/GPS "Math" Computed MathChannel (MathScript) "Digital" Mapped digital IO	String	All
NI_ChannelName	Channel Name	String	All
NI_DataType	Encoded data type of content (=10)	Int	All
NI_ChannelLength	Total number of readings per channel	Int	All

Name	Description / Contents	Data type	Condition/Sensor/ File Type
NI_UnitDescription	Unit	String	All
wf_start_time	Start time of recording	Time Stamp	All
wf_increment	Time increment in seconds	Double	All
wf_samples	Number of readings in the last data packet	Int	All
wf_start_offset	Start offset, always =0	Double	All
InputNo	Amplifier input channel	Int	All
Serialnumber	Serial number of the amplifier or MathScript No.	Int	All
DevComNo	COM port or device number	Int	All
Color	RGB value of channel color	Int	All
DeviceType	Amplifier Model Name	String	All
Frequency	Nominal measurement data rate of the amplifier	Double	All
Scaling	*User scaling* or hardware-calculated multi-axis sensors. Measuring range	Double	All
name	Channel name (Unique identifier!)	String	All
unit_string	Unit	String	All
Axis	Plot axis mapping "X"/"Y"	String	XY only
PysicalName	Default name, e.g. "Com1_1	String	Raw File
SensorIndex	Index of the multi-axis sensor in the sensor array	Int	Raw File
Emodul	Modulus of elasticity	Double	Rosette Measurement
Poissons	Poisson's ratio (transverse contraction number)	Double	Rosette Measurement
GageFactor	Gauge factor of Strain Gauge	Double	Rosette Measurement
InSens	Input Sensitivity of Measurement Amplifier	Double	Rosette Measurement
SpecialSensor	"Multi-dimensional/Six-Axis/RosetteStress"	String	Raw File
CalculationInput	Multi-dimensional: "Component1-6"	Int	Raw File
SensorTypeNo	Type of multi-axis sensor / calculation	Int	Multi-axis sensor (SW)
SensorSerNo	Sensor Serial Number	Int	Multi-axis sensor (SW)
GeoOffsetX	Geometric distance in m, X-direction	Double	Multi-axis sensor (SW)
GeoOffsetY	Geometric distance in m, Y direction	Double	Multi-axis sensor (SW)
GeoOffsetZ	Geometric distance in m, Z-direction	Double	Multi-axis sensor (SW)
SensorPath	Sensor calibration data file path	String	Multi-axis sensor (SW)

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Name	Description / Contents	Data type	Condition/Sensor/ File Type
MadeFromChan	For additional file Max/Min/Average: Source channel	Int	Max/Min/Mean Channel
MscriptPath	Path to MathScript that created this channel	String	Math channels
InType	Input Type (Device-Dependent Enumerator)	Int	All
InRange	Analogue input range	Int	All
HW-Sync	Hardware Synchronization: "Master"/"Slave"	String	When using HW-Sync

Revision

Changes		
Version	**Status**	**Processor**
00.00.01	Initiated	HK, SW
v2.4	quickly reviewed	SW
v. 2.5.	Carefully reviewed and updated, 6/24/2026	SW

Made in Germany

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