ELECTRIC MOTOR POWER ANALYSIS

SOFTWARE USER MANUAL

ELECTRIC MOTOR POWER ANALYSIS V23-2

1. Table of contents

2. About this document

This is the user's manual for the Motor Power Analysis module.
The Motor Power Analysis is part of the Power module and includes the usage of multiple other math modules and widgets as well. All related modules and widgets will be described in this manual.

Legend

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

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

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

Example
Gives you an example of a specific subject.

3. Introduction

Electric motor analysis is used to improve the motor performance by optimizing the efficiency of the electric input power to the mechanical output power.
All relevant settings for such types of analysis are found together under the Motor analysis tab of the Power module, as shown below:

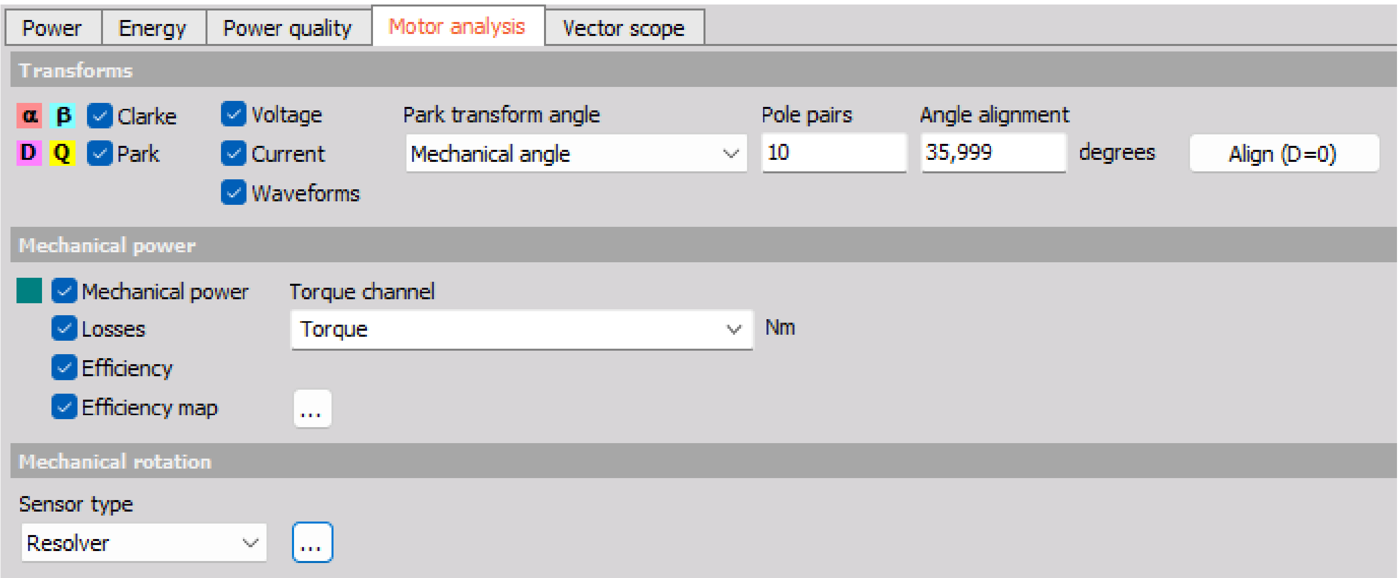


Illustration of all parameters for Motor analysis, found in the Power module.

Next to the Motor analysis transformations and efficiency calculations, the motor analysis module puts together functionalities from multiple processing modules, all able to be set up through the Motor analysis tab under the Power module. The Motor analysis module will in many cases include the usage of the following modules and widgets:

- 2D/3D mapping
- Resolver sensor
- Contour plot widget

These items will all be described in later sections of this manual.

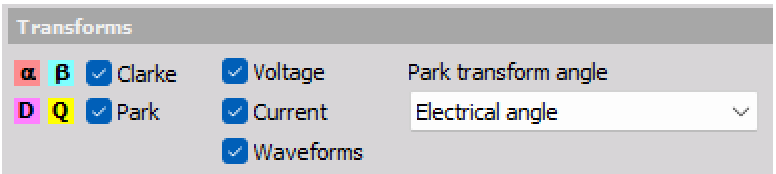
4. Motor Analysis setup

Under the Power module tab called Motor analysis you will find sections for settings up parameters for:

- Transformations
- Mechanical power
- Mechanical rotational

4.1 Transforms

One of the tools used for electric motor investigations are Clarke and Park transforms, which can be set-up as shown below:



Clarke and Park transformation settings.

- **Voltage and Current** - channels output asynchronous data with a rate equal to the Line frequency divided by the Number of cycles parameter - similar to other power output channels.

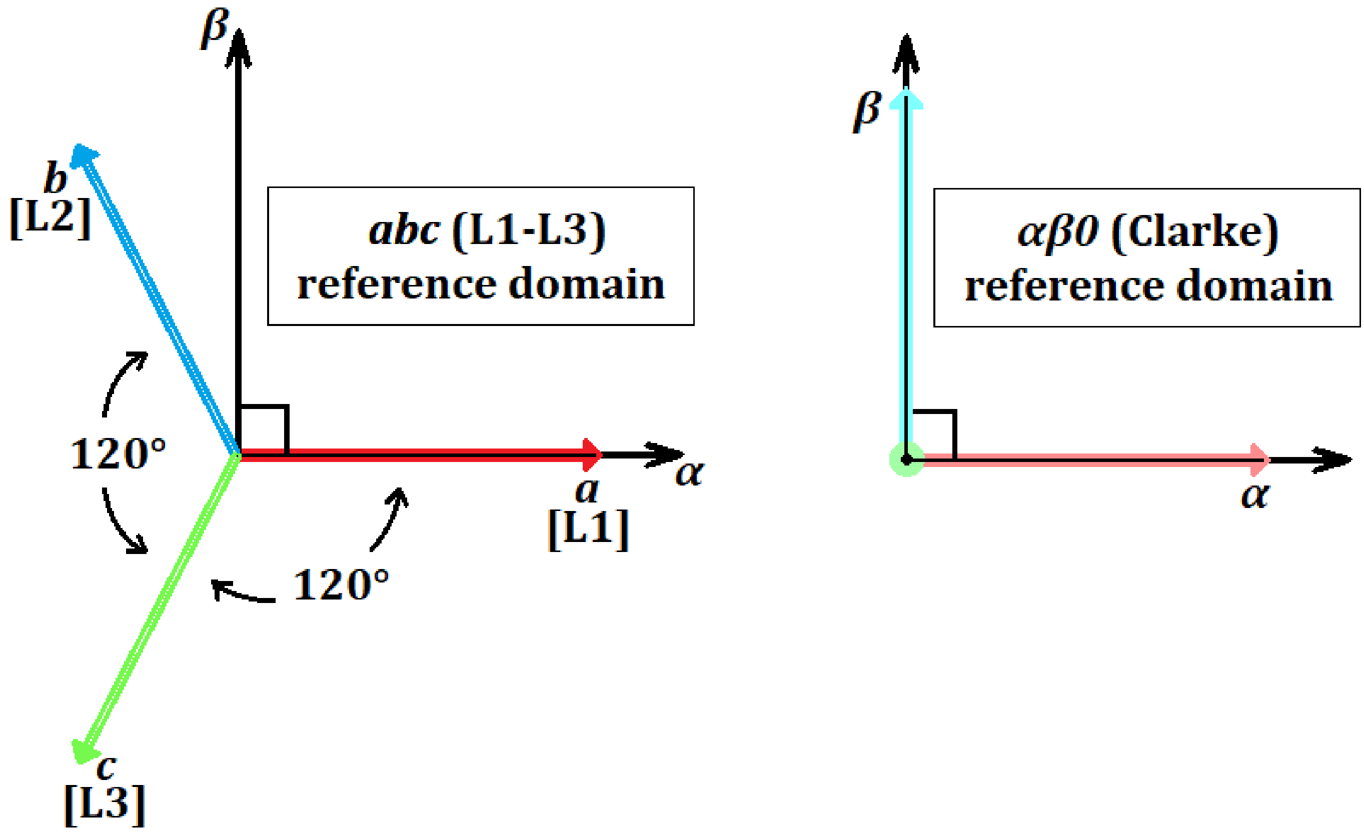
- **Waveforms** - channels output synchronous data with the same rate as the input channel's sample rate.

4.1.1 Clarke transform (abc to αβ0)

The Clarke transform can be used to simplify the analysis of three-phase circuits. It converts three-phase abc components to two-phase αβ orthogonal components. The αβ-domain relates to the fixed stator frame of reference like the abc-domain does.

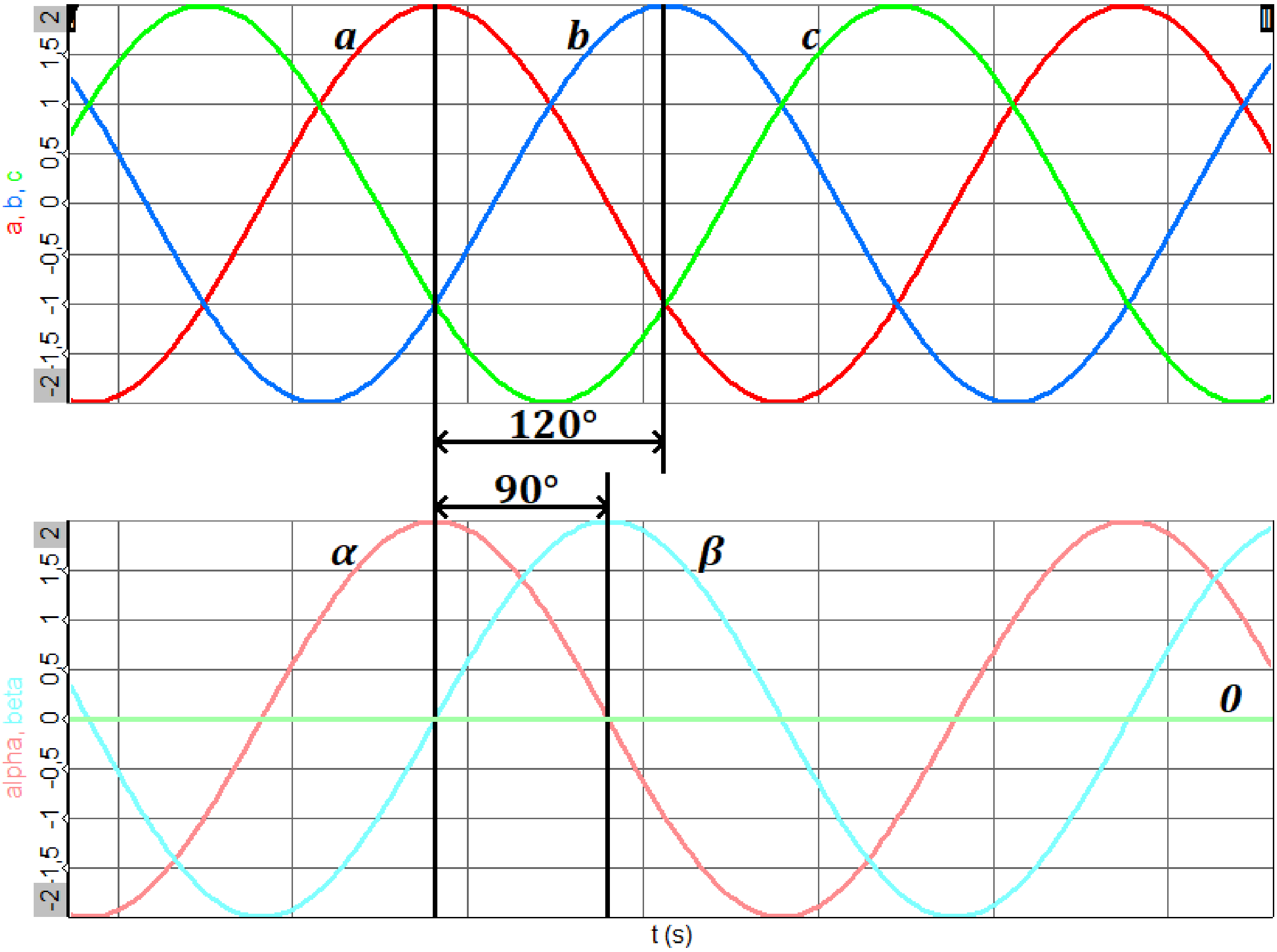
A useful application of the Clarke transform is for the generation of a reference signal used for space vector modulation control of three-phase inverters.

The difference between the abc reference frame and the αβ reference frame is that the αβ domain has projected three balanced phase quantities onto two stationary axes, as illustrated below:



Sketch illustration of the Clarke transformation from the abc reference frame to the αβ0 reference frame.

The difference between how a balanced three phase system can be illustrated in the abc domain and in the αβ domain over time is shown below:



Sketch comparison of a balanced three phase system in the abc domain and in the αβ0 domain over time.

It is seen above that for a balanced system, the zero (or γ) component is equal to zero.

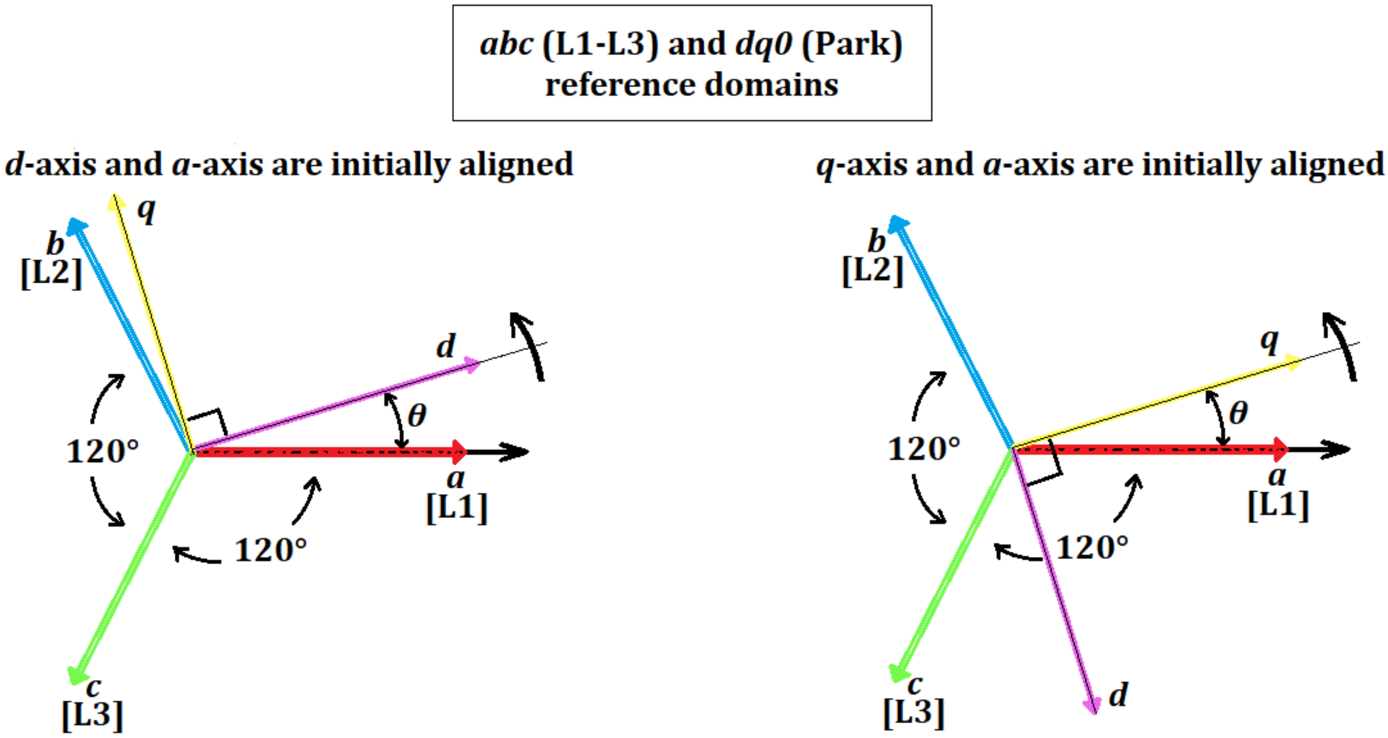
The amplitude invariant transformation formula is given by:

$$\begin{bmatrix} \alpha \\ \beta \\ 0 \end{bmatrix} = \frac{2}{3} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

The amplitude invariant Clarke transformation formula.

4.1.2 Park transform (abc to dq0)

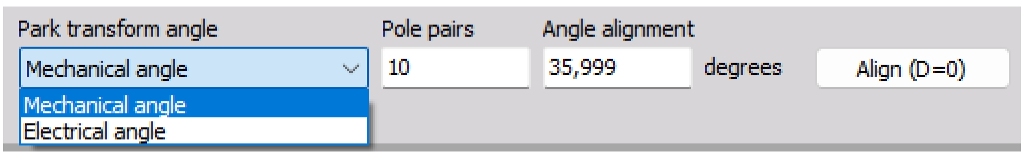
The dq-domain relates to the rotor rotating frame of reference. The Park transform is conceptually similar to the Clarke transform: Whereas the αβ (Clarke) transform is the projection of the phase quantities onto a stationary two-axis reference frame, the dq (Park) transform can be thought of as the projection of the phase quantities onto a rotating two-axis reference frame - a rotational transform of the αβ reference frame:



Sketch illustration of the Park transformation from the abc reference frame to the dq0 reference frame

The initial angle alignment is set by the user to either start with the d (direct)-axis at the a-axis or the q (quadrature)-axis at the a-axis. The difference is shown above.

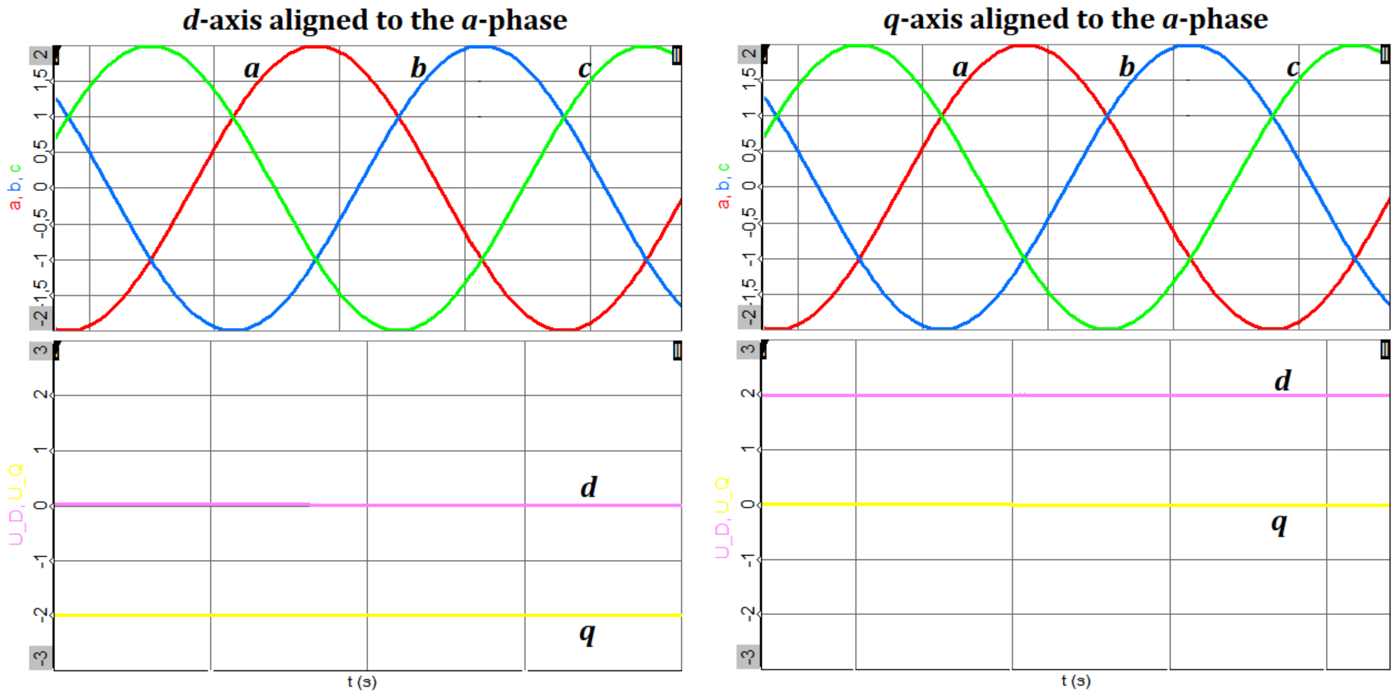
The rotating reference frame can be set to follow either the Electrical angle or the Mechanical angle:



Showing extended Park transformation parameters relating to Mechanical angle settings.

For the mechanical angle the number of rotor pole pairs are set to determine and sync to the correct rotational angle. In this way the electric and mechanical angle can be aligned.
In practice, the alignment can be done by driving the motor externally while measuring the induced voltage phase together with the mechanical angle. The angle shift between them is then used for the Park transform Angle alignment.

The difference between how a balanced three phase system can be illustrated in the abc domain and in the dq domain over time is shown below:



Sketch comparison of a balanced three phase system in the abc domain and in the dq0 domain over time.

The amplitude invariant a-phase to d-axis transformation formula is given by:

$$\begin{bmatrix} d \\ q \\ 0 \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos(\theta) & \cos(\theta - \frac{2\pi}{3}) & \cos(\theta + \frac{2\pi}{3}) \\ -\sin(\theta) & -\sin(\theta - \frac{2\pi}{3}) & -\sin(\theta + \frac{2\pi}{3}) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

Amplitude invariant a-phase to d-axis Park transformation formula.

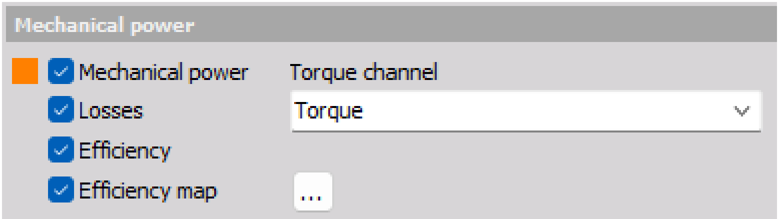
The amplitude invariant a-phase to q-axis transformation formula is given by:

$$\begin{bmatrix} d \\ q \\ 0 \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \sin(\theta) & \sin(\theta - \frac{2\pi}{3}) & \sin(\theta + \frac{2\pi}{3}) \\ \cos(\theta) & \cos(\theta - \frac{2\pi}{3}) & \cos(\theta + \frac{2\pi}{3}) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

Amplitude invariant a-phase to q-axis transformation formula.

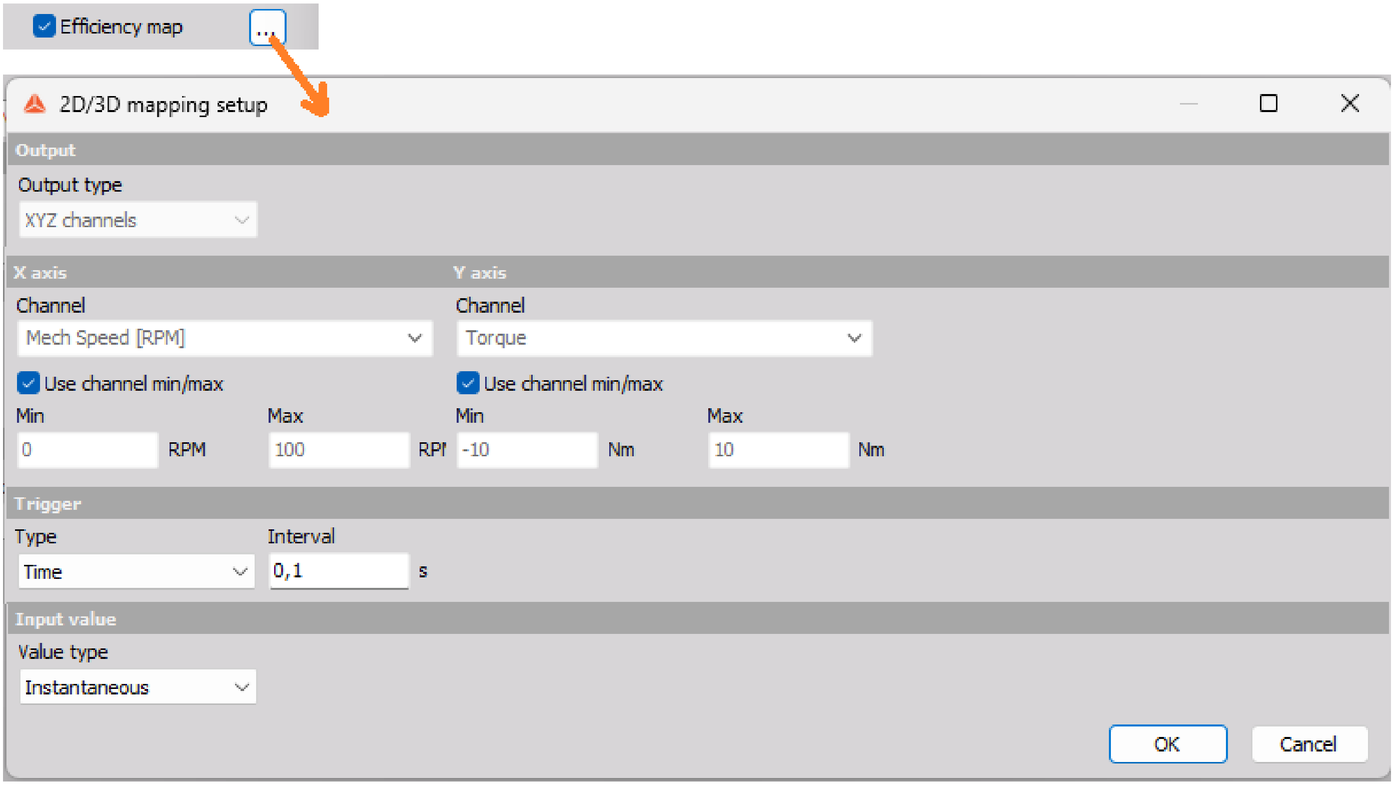
4.2 Mechanical power

In order to analyze the power conversion efficiency from electric to mechanical power, a Torque channel has to be specified. The Torque channel drop-down list will contain all channels having the unit [Nm]. With a Specified Torque channel the Mechanical power, Losses and the Efficiency can be determined.



Output result options for Mechanical power and related Torque channel selection.

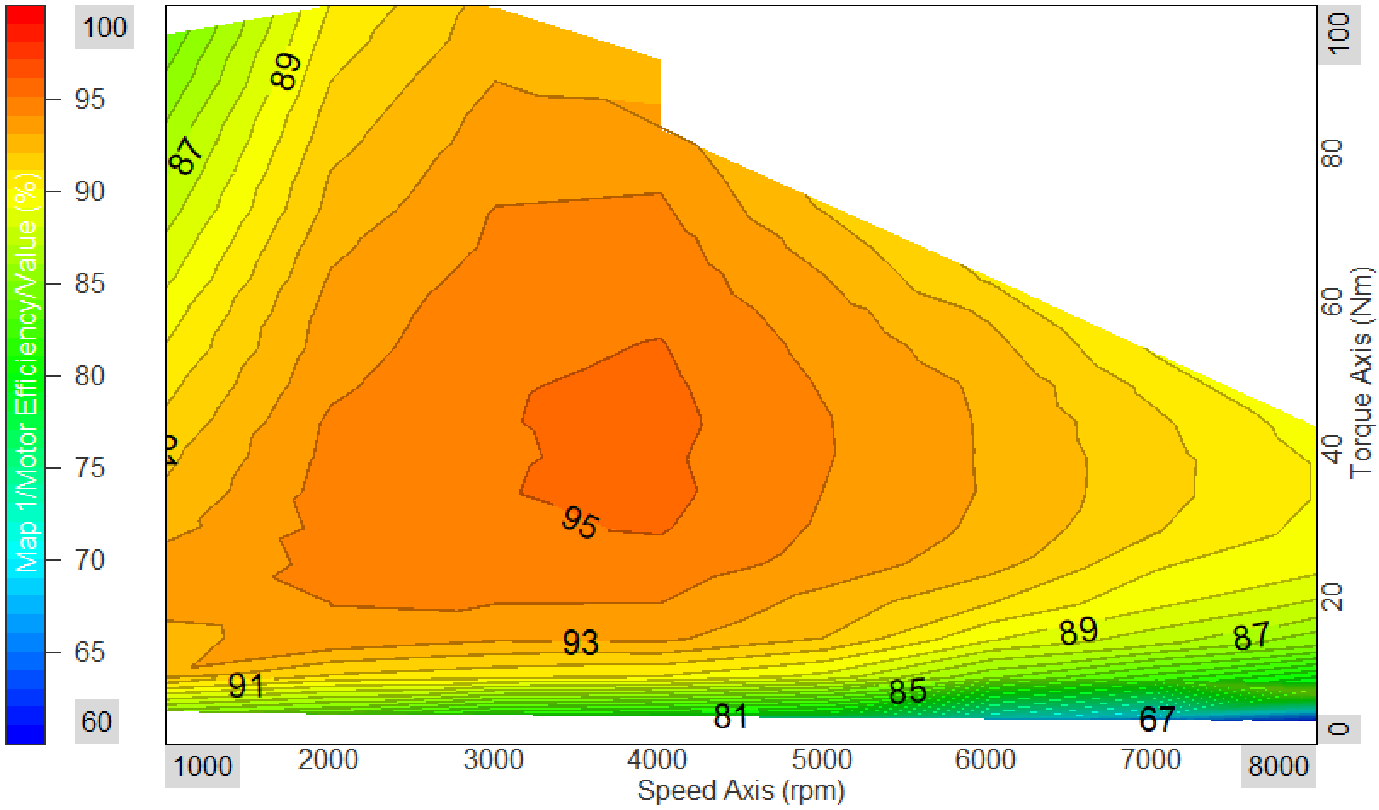
A 3D Efficiency map can also be constructed which is typically set-up to show the motor efficiency across a speed range and at the same time across a torque load range.



Efficiency map expanded settings. A pre-defined instance of the 2D/3D mapping math module.

The settings for the Efficiency map is an instance of the 2D/3D mapping module, which is described in more detail under the link.

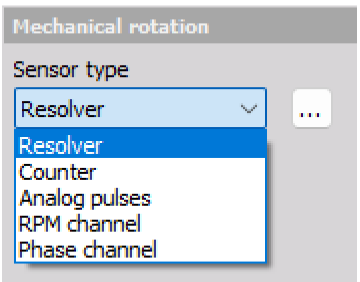
After settings up the speed and torque axis settings to match the measured ranges, the efficiency map can be shown in Measure mode using the Contour plot widget as illustrated in an example below:



Example of an Efficiency map result shown in a Contour plot display widget.

4.3 Mechanical rotation

When outputs are selected that relate to the mechanical rotation, then the parameter section Mechanical rotation will be visible:



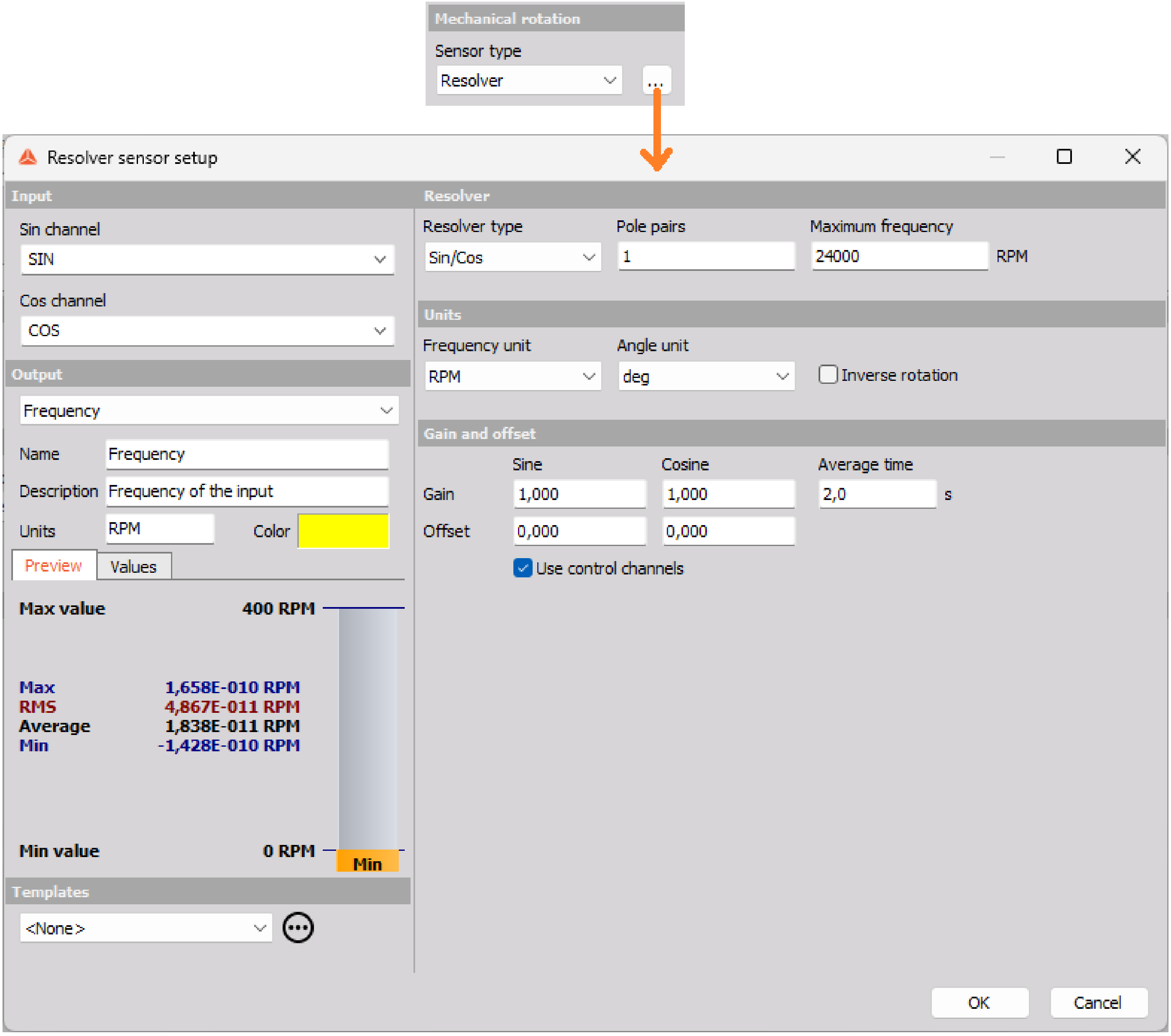
Mechanical rotation settings section - showing parameters relating to the selected Resolver sensor type.

Outputs that relate to the mechanical rotation are the Park transform (dq) channels, and any of the outputs under the Mechanical power parameter section.

4.3.1 Sensor type

A variety of sensor types are supported for Motor analysis, including Resolver sensors.

If the Resolver sensor type is selected then all settings for the used Resolver math instance can be shown by pressing the [...] icon as illustrated below:



The Resolver sensor module setup page, which can be accessed from the Motor analysis tab under the Mechanical rotation parameter section.

A more detailed description for the different types of sensors can be found under the links below:

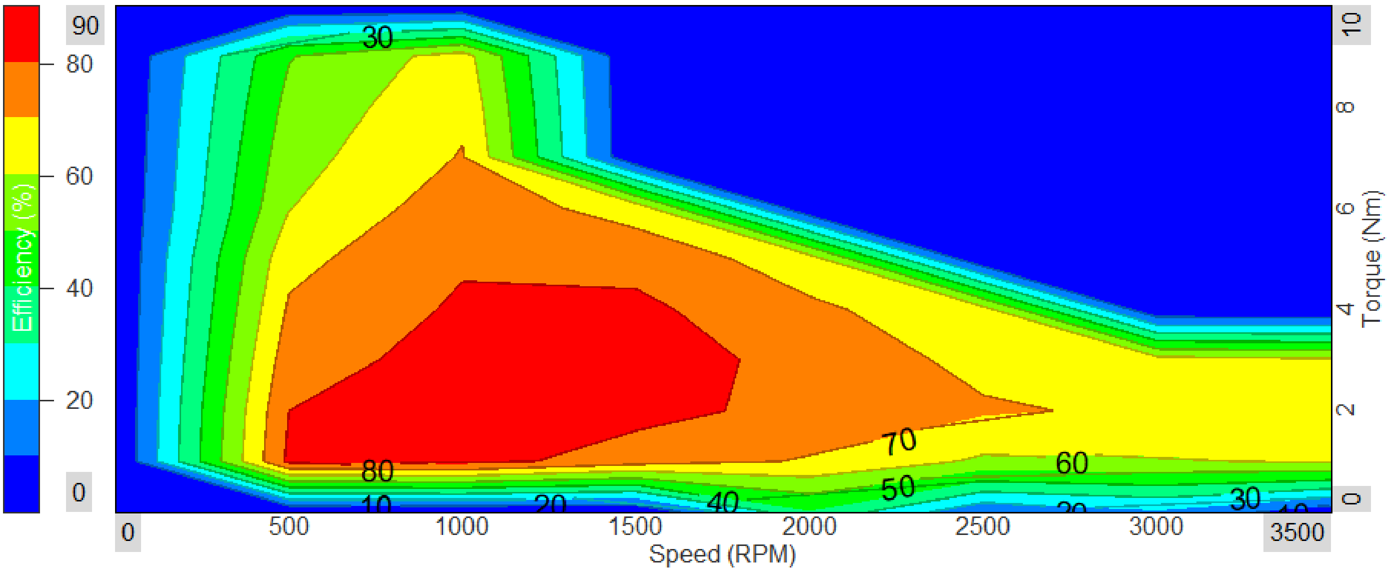
- Resolver sensor
- Counters and related sensors (web-links)
- Angle sensor math (web-link)

5. Efficiency map

The Motor analysis Efficiency map output uses a 2D/3D mapping module. With a 2D/3D mapping module you can add/map/tag one or two additional channels to the selected input channels. In this way you can correlate various measured physical quantities to other measured channels by mapping the data and adding their dimensions together.

For example, a sound pressure signal can be mapped to measured wind speed and hereby output a 2D vector channel with a sound pressure value for each wind speed index defined.

For Motor Power Analysis the mechanical speed and torque is mapped to the calculated power efficiency. This outputs a 3D plot, referred to as an Efficiency map which shows the efficiency across various speeds and torques. A simulated concept illustration of this is shown below using the Contour plot display widget:



A simulated concept illustration of an efficiency map output channel - plotted using the Contour plot display widget.

5.1 Linked to Motor Power Analysis

Since the 2D/3D mapping module plays a special role for Motor Power Analysis as an Efficiency map, the module can be set up directly from the Power Analysis module as illustrated below:

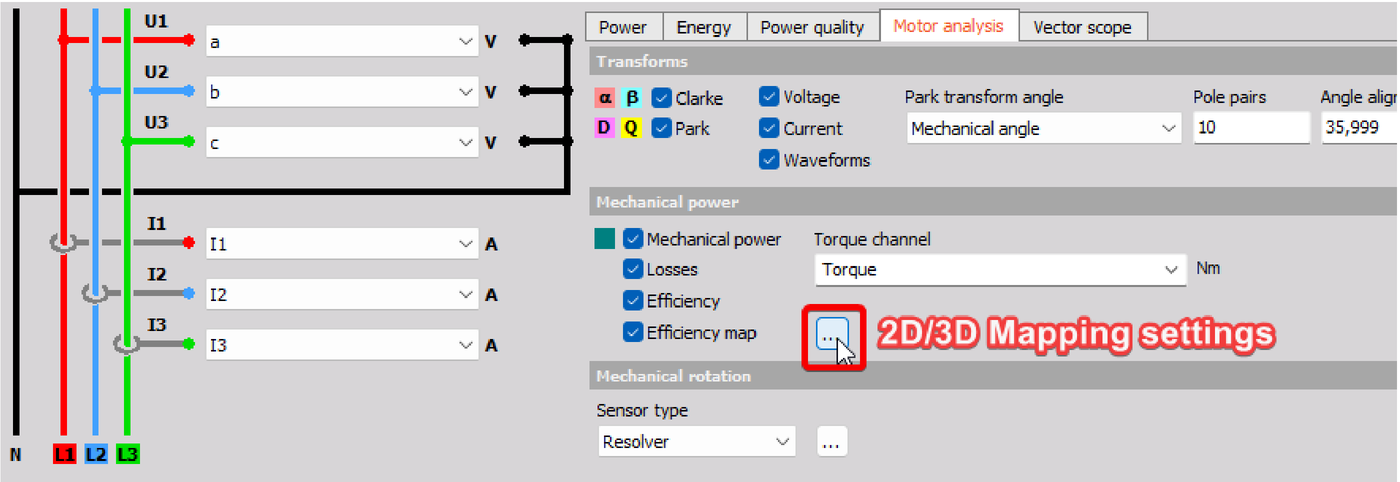
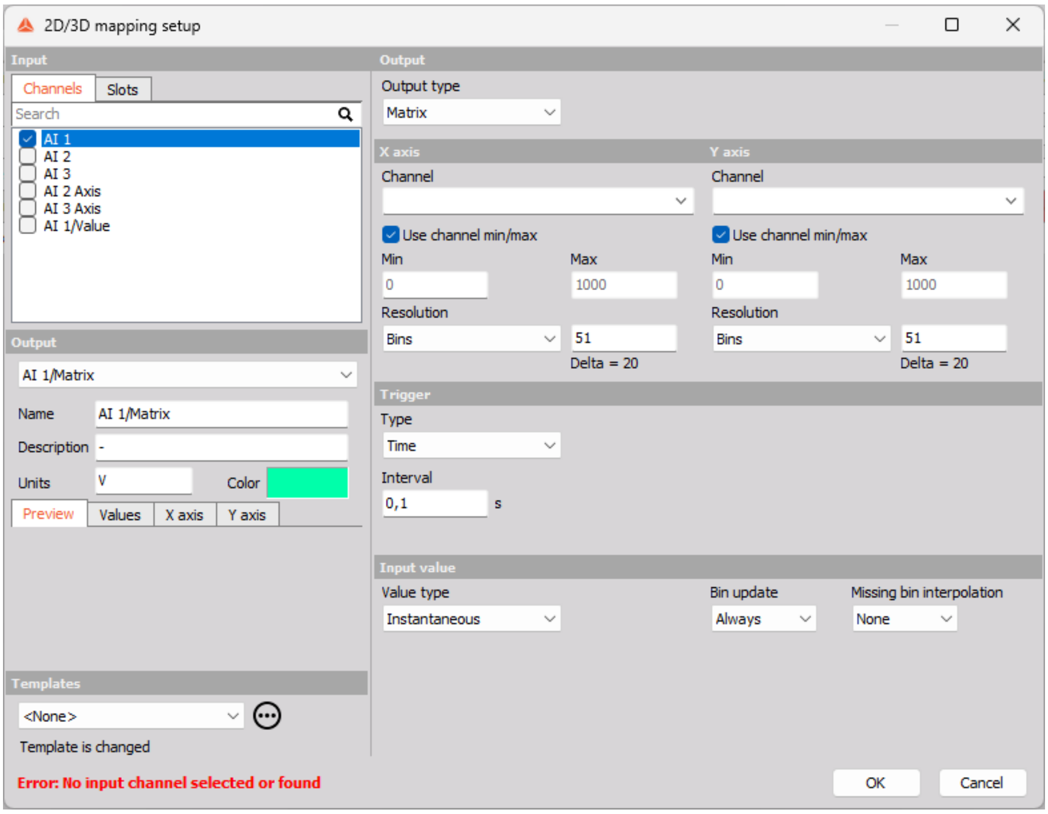


Illustration of how 2D/3D mapping settings can be opened through the Motor analysis tab in the Power module.

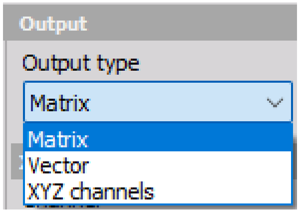
By clicking on the [...] icon next to the Efficiency map checkbox the settings for the 2D/3D Mapping module will appear as shown below. The related parameters for the 2D/3D mapping module are described in the following sections.



Settings for the 2D/3D mapping module.

5.2 Output

After selecting which input channels you want to map data to, you must define the Output Data structure:

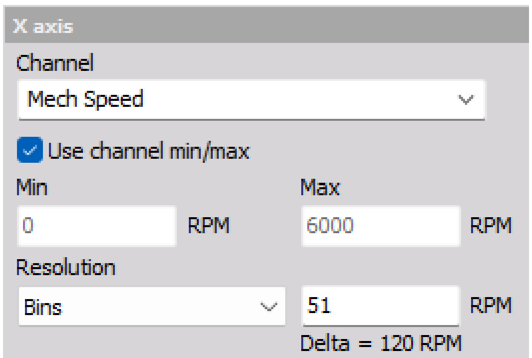


Supported output data structure types.

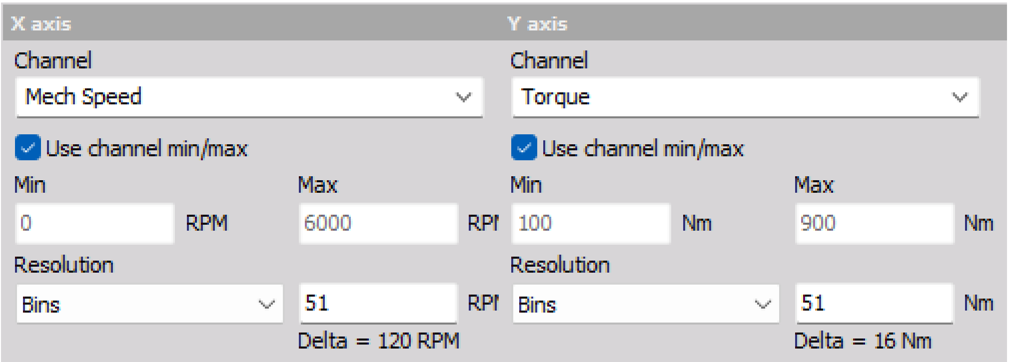
- Vector - will output channels with one additional dimension. Here you must define one bin axis definition. Vector results can e.g. be illustrated using the 2D graph widget.
- Matrix - will output channels with two additional dimensions. Here you must define two bin axis definitions. Matrix results can e.g. be illustrated using the 3D graph widget.
- XYZ channels - will output three individual channels related to the three inputs, but now having the same data rate. XYZ channels results can e.g. be illustrated using the dedicated Contour plot widget.

5.3 Axis 1 and 2

Depending on if the Data structure is set to Vector, Matrix, or XYZ channels, you will be able to set-up definitions for one or two bin axes:



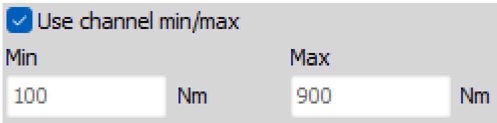
Data structure: Vector



Data structure: Matrix and XYZ channels

5.3.1 Use channel min/max

Min. and Max. defines the lower and upper limit of the axis range.



Min and Max axis settings.

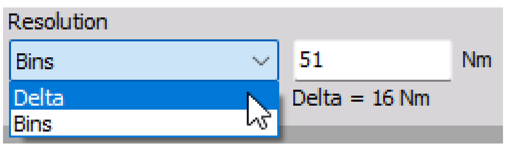
When the 'Use channel min/max' checkbox is enabled the axis range is automatically determined from the Min. value and Max. value channel properties. The channel properties Min. and Max. values are found in the channel table for the related channel type, e.g. under Analog in or Math:

Name	Min	Values	Max
AI 1	-10,00	-5,159 / 5,404	10,00
AI 2	-50,00	-2,66 / 3,88	50,00
AI 3	-50,00	-0,68 / 1,90	50,00
AI 4	-200,00	-46,10 / 51,01	200,00
AI 5	-1000,00	-543,0 / 566,3	1000,00

Example of where to find used Min and Max values for the related axis channels - here under the Analog in tab.

5.3.2 Resolution

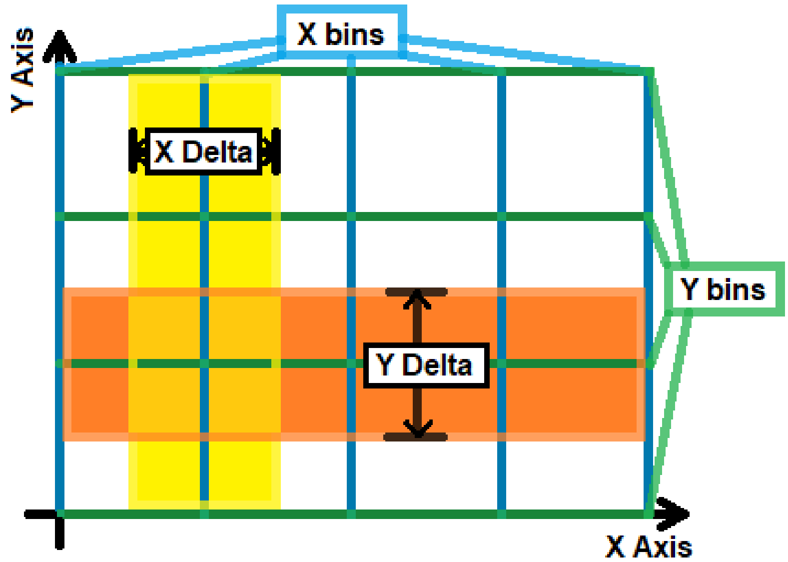
The axis resolution defines the grade with which variating axis values are split into different bins. The resolution can be defined in either number of Bins or in Delta bin width:



Resolution settings for the X and Y axis.

- Bins - Select how many different bins the input values can be classified to. Defined number of bins will determine the Delta bin width based on the Min and Max axis values. The number of bins will be equidistantly spread.

- Delta - Select the axis Bin width and the interval with which the input values can be classified by. The first and last edge bins will have half the Delta width compared to the other bins.



Sketch illustration of how Delta and Bins are defined.

It can be seen from the picture above that the Delta interval of a bin is placed around the center of the bin - having half the Delta width to each side of the bin axis value.
In the above picture the X axis number of bins is set to 5 and the Y axis Bins is set to 4. Delta is defined by:

$$\text{Delta} = \frac{\text{Max} - \text{Min}}{\text{Bins} - 1}$$

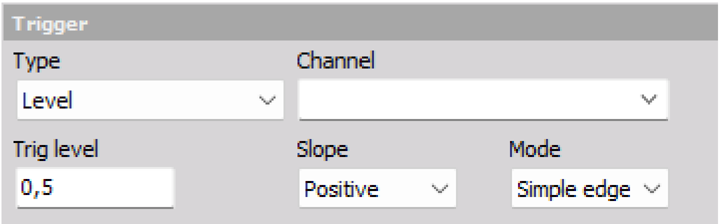
Formula used for defining Delta.

and Bins are defined by:

$$\text{Bins} = \frac{\text{Max} - \text{Min}}{\text{Delta}} + 1$$

Formula used for defining Bins.

5.4 Trigger



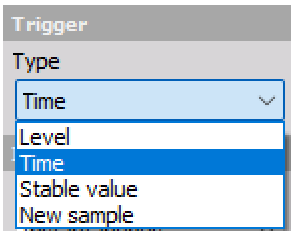
The Trigger parameter section.

In the 2D/3D mapping module there is a section for Trigger parameters and another section for Input value parameters. The difference between Trigger settings and Input value settings are as follows:

- Trigger settings determine when to include new Input value data for the 2D/3D mapping module output.
- Input value settings determine how to process the raw input data before being added to the output.

The Input value data can be included based on one of the flowing Trigger Types:

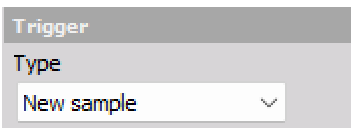
- New sample
- Time
- Level
- Stable value



Supported Trigger types.

5.4.1 New sample

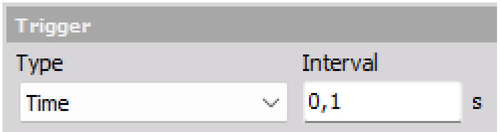
The Trigger Type New sample will include all input data samples. This Trigger Type is sometimes referred to as Free-run or Continuous.



Trigger type: New sample.

5.4.2 Time

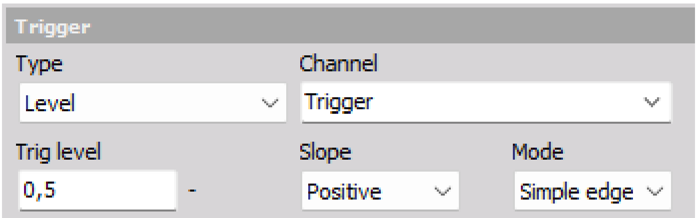
The Trigger Type Time will include new input data with an interval set by the time Interval parameter.



Trigger type: Time.

5.4.3 Level

The Level Trigger Type includes new input data each time the selected Trigger Channel activates a new trigger event.



Trigger type: Level.

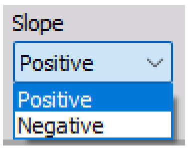
Trigger events are activated based on the trigger parameters: Trig level, Slope, and Mode:

5.4.3.1 Trig level

The Trig level defines the value needed to be reached/crossed before a trigger event can be activated.

5.4.3.2. Slope

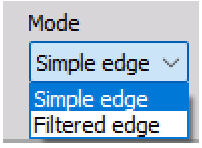
The Slope defines if a trigger event is activated when the Trig level is crossed with a Positive or Negative Slope/direction:



Level Trigger Slope settings.

5.4.3.3 Mode

The Trigger Mode defines conditions that must be fulfilled before trigger events are activated:

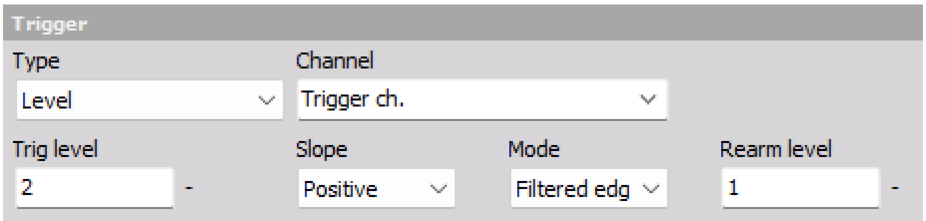


Level trigger Mode settings.

Trigger events are activated:

- **Simple edge** - each time the Trig level is crossed with the set Slope direction,
- **Filtered edge** - similar to Simple edge, but a Rearm level is required to be reached before the next trigger event can be activated.

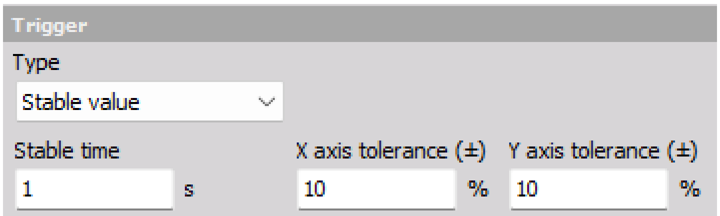
  For example, in the picture below the Slope is Positive and the Rearm level is set to 1. This means that after the trigger Channel has reached the Trig level of 2, then the trigger channel level must decrease below 1 before a new trigger event can be activated. If not the Rearm level is reached then only the first trigger event will be activated:



Filtered edge example that includes a rearm level.

5.4.4 Stable value

The Trigger Type Stable value includes new input data as long as the data is determined to be stable.



Trigger type: Stable value.

Input channel data are determined to be stable based on the following parameters:

5.4.4.1 Stable time

Input data across the Stable time interval is used to determine the value deviation. If the value deviation across the Stable time is greater than the defined X or Y axis tolerance, then the input data is not stable in that given axis direction.

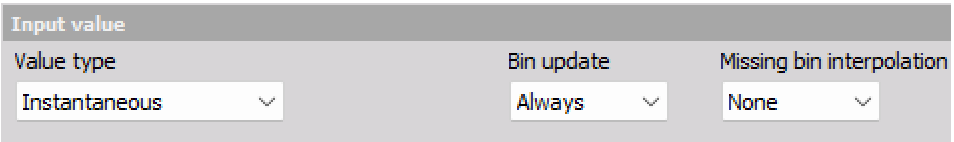
5.4.4.2 X and Y axis tolerance (±)

The X and Y axis tolerance values determine how stable/steady the input data values must be in order to get included in the processing of the 2D/3D module.

Vector and Matrix outputs
For Vector and Matrix Output types the X and Y bin tolerances (±) are expressed in percent relative to the bin width Delta. Values are stable if raw input values are not variating more than the set tolerance over a single bin, during the Stable time. If values are shifting between bins they are set as not stable, independent of the used tolerance setting.

XYZ channels outputs
For XYZ channels Output type the X and Y axis tolerances (±) are expressed as absolute values with the unit of the axis channel. Values are stable if raw input values are not variating more than the set absolute tolerance.

5.5 Input value



The Input value parameter section.

The difference between Trigger settings and Input value settings are:

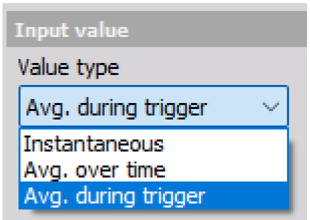
- Input value settings determine how to process the raw input data before being added to the output.
- Trigger settings determine when to include new Input value data for the 2D/3D mapping module output.

5.5.1 Value type

The Value type determines how raw input data is processed, before being applied to output channels based on triggers.

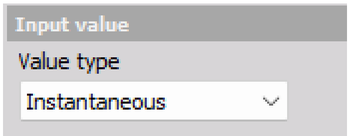
The following Value types are supported:

- Instantaneous
- Avg. over time
- Avg. during trigger



Supported ways of handling the Input values.

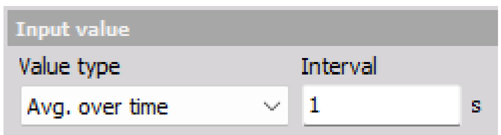
5.5.1.1 Instantaneous



Input type: Instantaneous.

No processing is done - the raw input samples are directly sent to output channels when triggered.

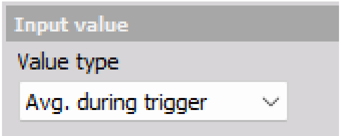
5.5.1.2 Avg. over time



Input type: Avg. over time.

Input samples are linear averaged over the defined averaging time Interval. Averaged values are added to the output result when triggered. New linear mean averaged values are calculated each time the set Interval time has passed.

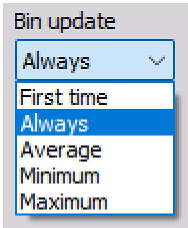
5.5.1.3 Avg. during trigger



Input type: Avg. during trigger.

This Value type is only available when using a Level Trigger. Input samples are linear averaged over the full duration of an active Trigger event.
When a trigger event gets activated the averaging begins and when the trigger event ends the averaging stops and the averaged value is added as a new Level triggered output.

5.5.2 Bin update



Select how data at individual vector or matrix bins/cells should be updated.

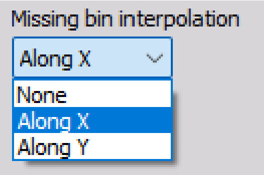
The Bin update determines what to do when multiple values are added to the same axis bin. Since the Output type - XYZ channels do not use defined bins, the Bin update setting is only present when using the Vector or Matrix Output type.

The following Bin update modes are supported:

- Always - overwrites the previous bin value.
- First time - keeps the first added bin value.
- Average - linear mean across all values added to a bin.
- Maximum - keeps the maximum value found across all values added to a bin.
- Minimum - keeps the minimum value found across all values added to a bin.

See more about bins under the section Resolution.

5.5.3 Missing bin interpolation

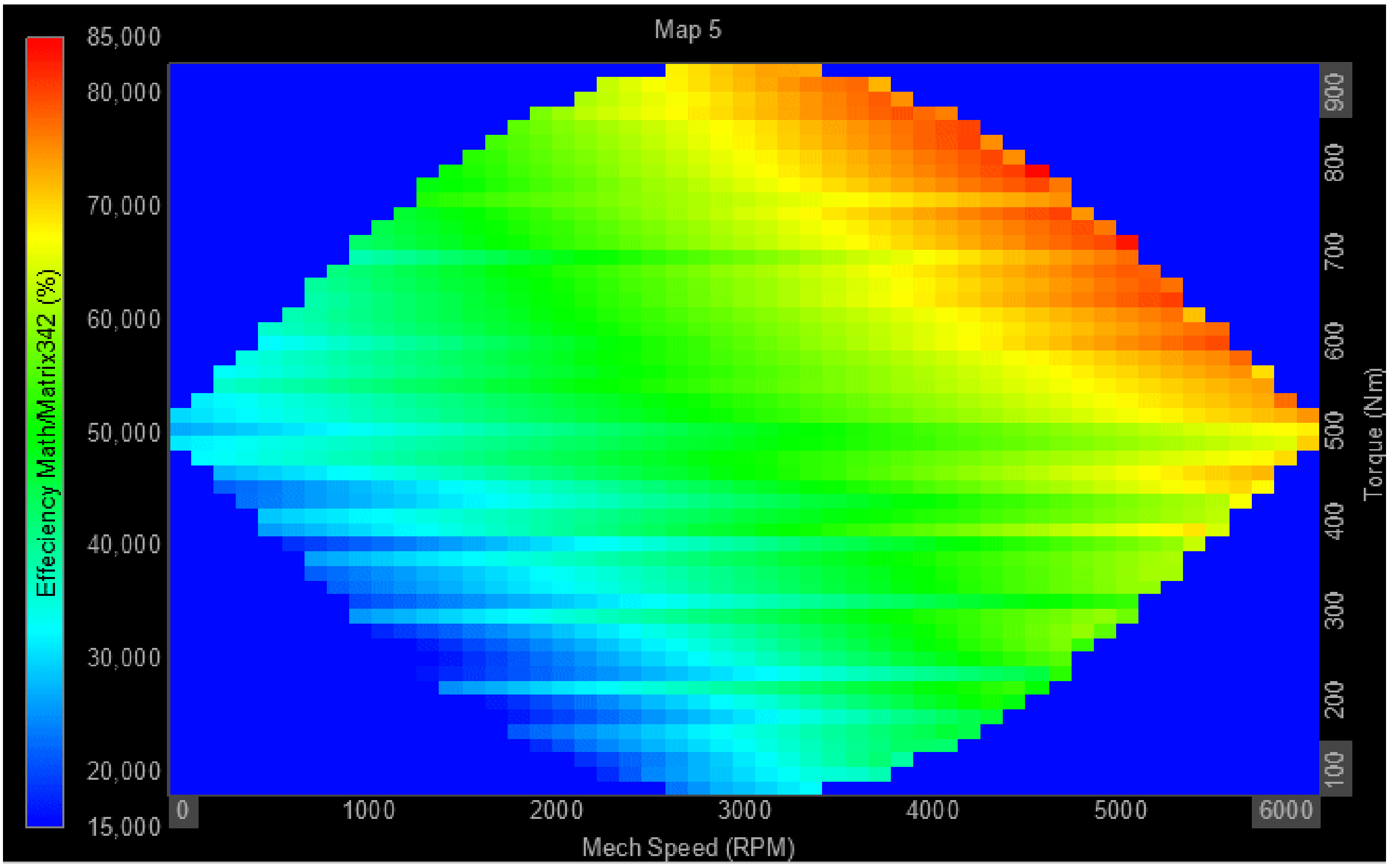


Select if empty bins between measured values should be linear interpolated.

Missing bin interpolation gives the ability to linearly interpolate values for all unmeasured bins between two measured bins.
The following Missing bin interpolation is supported:

- None - no bins get interpolated values. Only measured bins will contain valid values.
- Along X - unmeasured bins between measured X axis bins are linear interpolated.
- Along Y - unmeasured bins between measured Y axis bins are linear interpolated.

For example, selecting interpolation Along X will interpolate unmeasured bins as illustrated in the video below:



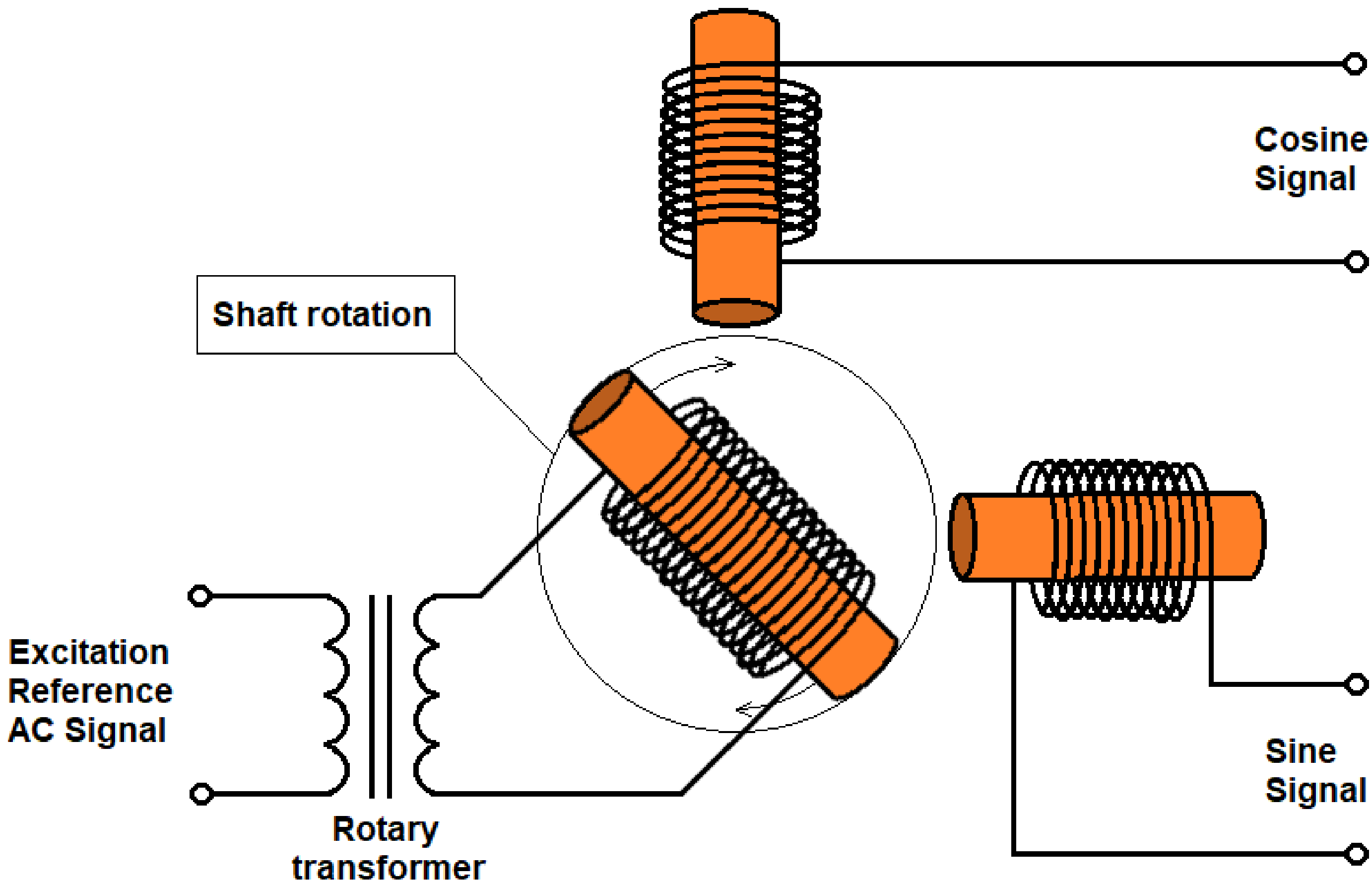
6. Resolver sensor math

Resolver sensors are used for measuring rotational speeds and angle positions. The Resolver sensor math module is used to decode such signals from resolver sensors.

A resolver sensor transforms energy in wire windings into a sine and a cosine signal which will have a frequency relating to the rotational shaft speed. The resolver sensor math module uses filters and math internally to decode the sine and cosine signal magnitude values into angle positions and derived speeds.

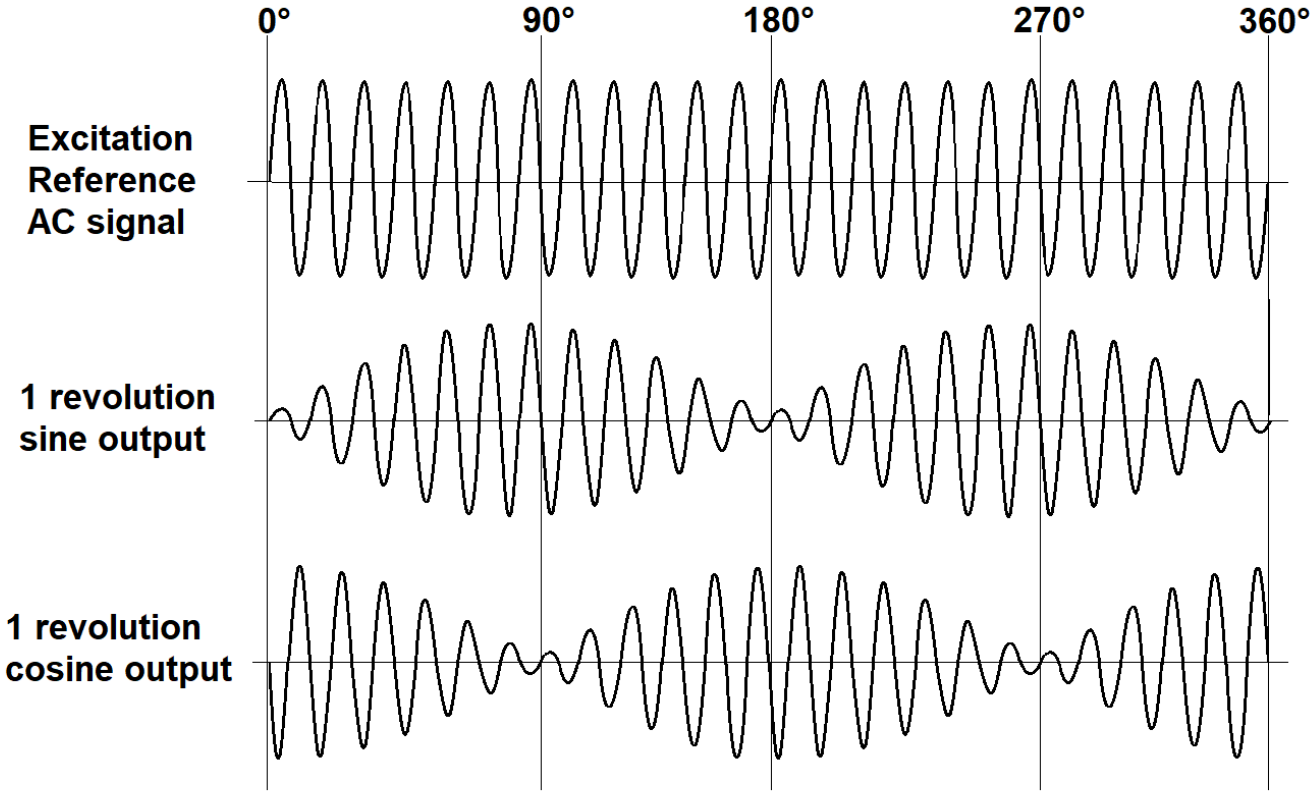
Resolver sensors come in multiple variants. For example, a rotor excited transmitter resolver has three windings: an excitation reference winding, a sine winding, and a cosine winding. Here, the excitation reference winding is used to drive a high frequency AC signal on the resolver rotor part. The sine and cosine windings on the stator part are used to detect the induced excitation signal, but now modulated by the mechanical rotation speed.

A sketch of such a resolver type is shown below:



Sketch illustration showing the principle of a rotor excited transmitter resolver type.

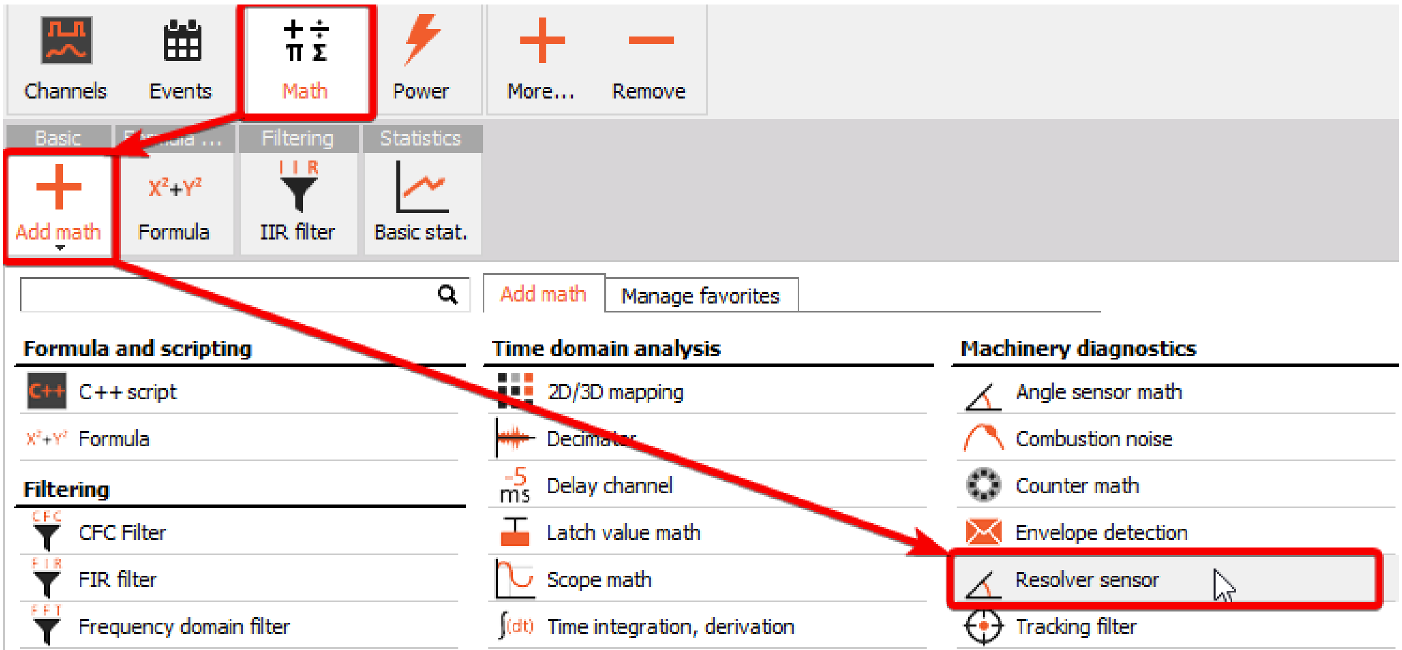
The excitation signal together with the output modulated sine and cosine signals are sketched below to illustrate the modulation and the phase shift between the sine and cosine outputs.



Sketch of the three signals of an excited resolver sensor. First, the high frequency excitation signal, and then the sine and cosine modulated output waveform of one period.

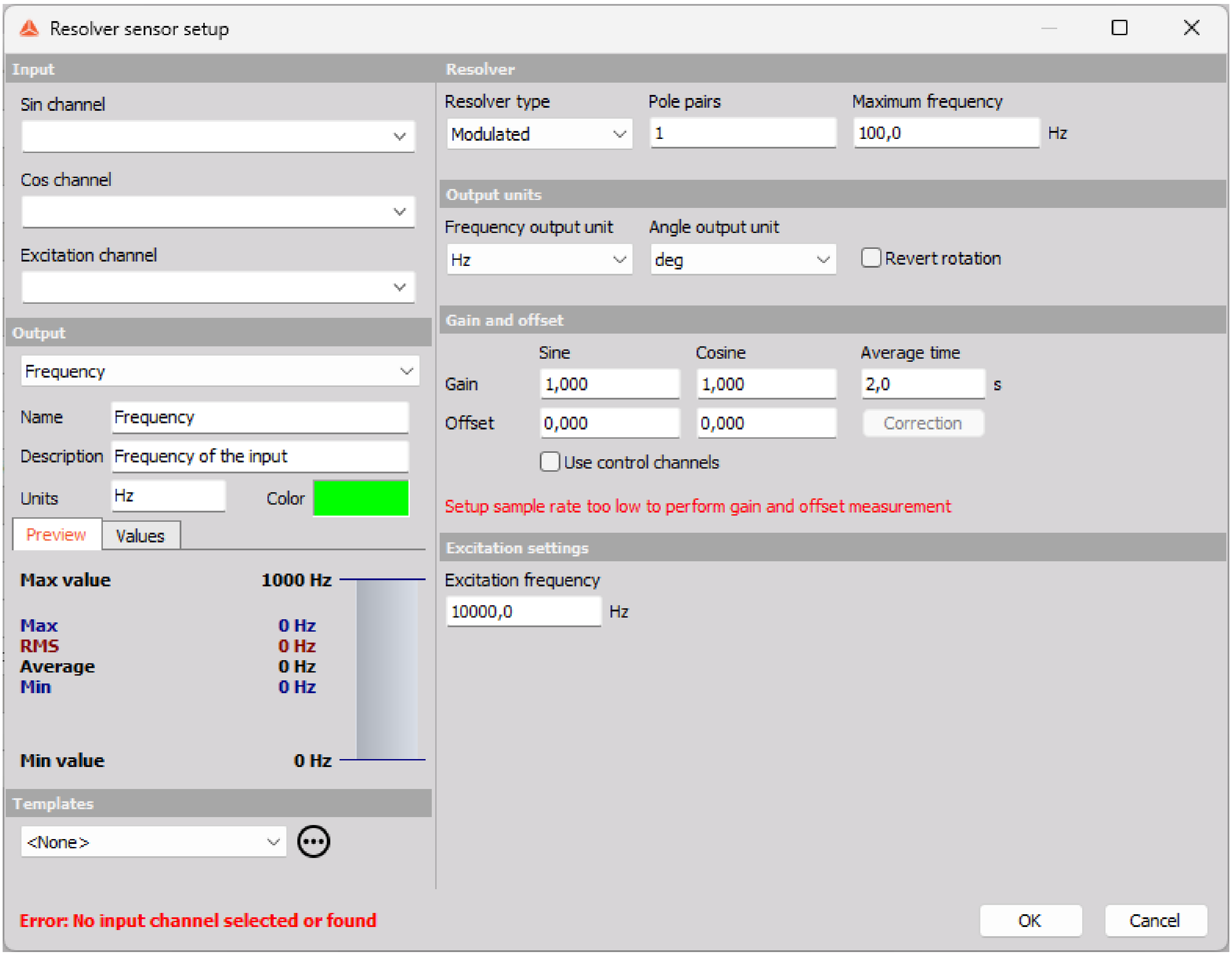
6.1 Adding Resolver sensor math module to a setup

The Resolver sensor math module can be added to the setup under Math by pressing the Add math button and then selecting the Resolver sensor module, located under the Machinery diagnostics section:



The Resolver sensor math module can be added to a setup under the Math module.

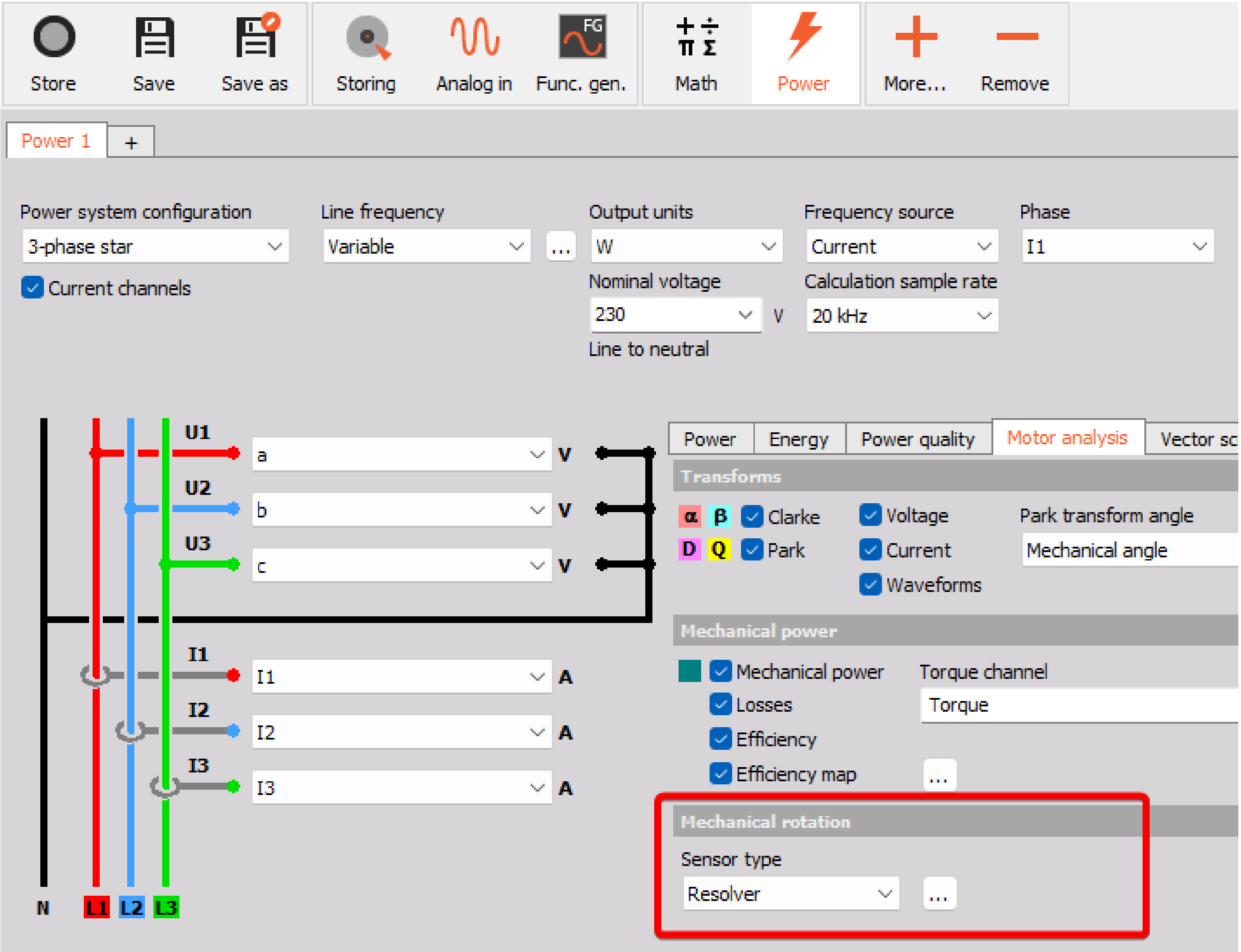
When you add the math module or press the Setup button on newly activated Resolver sensor module, the following Resolver sensor setup window will open:



The Resolver sensor math module setup.

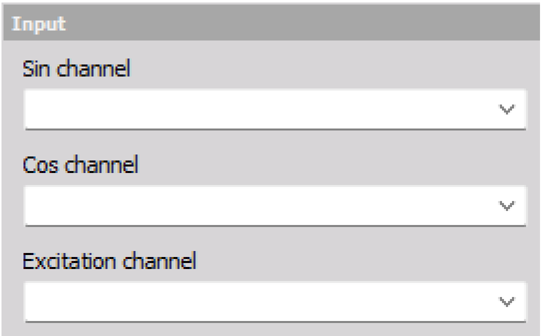
6.2 Linked to Motor Power Analysis

The Resolver sensor module can also directly be configured in the Power module under the Motor analysis tab. For Motor power analysis the resolver module can be used as the speed source for the efficiency mapping output:



Direct usage of the Resolver sensor math module inside the Motor analysis section of the Power module.

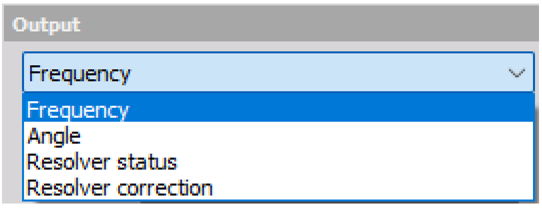
6.3 Input section



Select which channels to use for the resolver sensor math.

The Input section is used to select the Sin and Cos channels from the resolver sensor, and also the Excitation channel if the Resolver Type is set to Modulated.

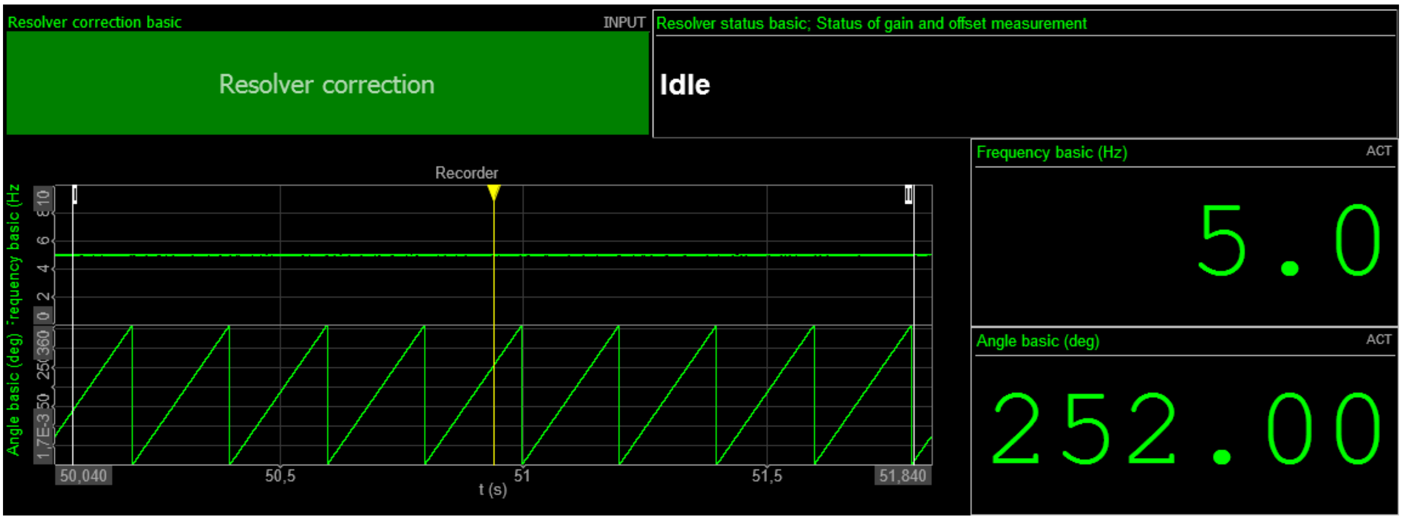
6.4 Output section



List of possible output channels from the Resolver sensor math module.

The Output section shows all the produced output channels:

- Frequency - the rotation speed expressed in revolutions per second [Hz], or revolutions per minute [RPM].
  - Display widget: Recorder or Digital meter.
- Angle - the rotation angle expressed in degrees [deg], or radians [rad].
  - Display widget: Recorder or Digital meter.
- Resolver status - the state of the resolver correction process.
  - Display widget: Discrete display.
- Resolver correction - a control channel for managing when to start the Correction determination process.
  - Display widget: Input control.



Showing a Measure display design used for monitoring the Resolver related output channels. At the top the Correction and Status channel are used, and underneath the Angle and Frequency channel are shown both over time and in digital meter widgets.

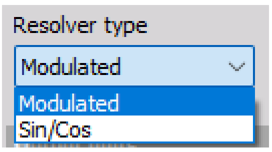
6.5 Resolver setup section

Showing the first section of parameter to set for the Resolver sensor math.

The Resolver section under the module setup is used to select the:

- Resolver type
- Pole pairs
- Maximum frequency

6.5.1 Resolver type



Select if the used Resolver sensor signals are excited with a carrier modulation frequency or not.

The Resolver sensor module supports resolver sensors with and without AC voltage excitation:

- Modulated: used for Transmitter resolver types that are driven by an excitation AC voltage.
- Sin/Cos: used for Transformer resolver types without excitation AC voltage

6.5.2 Pole pairs

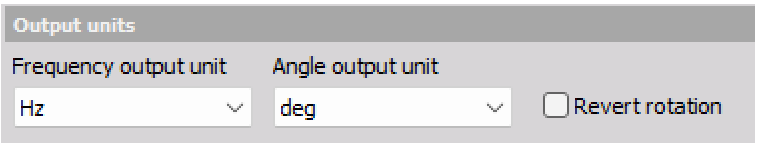
Pole pairs are used to specify the number of resolver pole pairs on the rotor part. Two-pole-resolver types have 1 pole pair, whereas Multi-pole-resolver types can have more.

6.5.3 Maximum frequency

The maximum frequency is used for low-pass filtering of the sine and cosine signals. A low-pass filter can improve the angle and speed determination by reducing noise on the input signals.

The low-pass filter will have a flat frequency response up to the Maximum frequency, and the sample rate will be kept at a rate several factors higher than the Max frequency setting, in order to ensure that flat response.

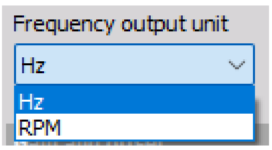
6.6 Output units section



Decide which format to use for the angle and frequency values.

The Output units section determines how the rotation outputs should be scaled.

6.6.1 Frequency output unit

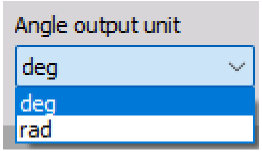


Frequency output channel unit options.

The rotation speed can be set to either:

- [Hz] - rate of rotation per second - the rotation Frequency.
- [RPM] - rate of rotation per minute - Rounds Per Minute.

6.6.2 Angle output unit



Angle output channel unit options.

The rotation angle can be set to either:

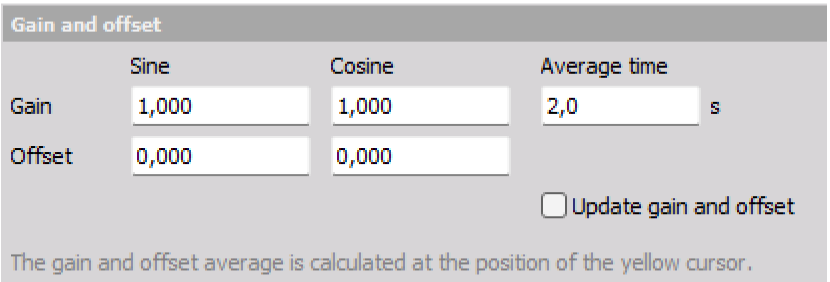
- [deg] - rotational displacement expressed in degrees.
- [rad] - rotational displacement expressed in radians.

6.6.3 Revert

Enabling Revert will change the Sin and Cos input channels around, and in practice this will invert the angle and speed channel values from positive to negative or opposite.

6.7 Gain and offset section

The Gain and offset section is used to increase accuracy and reduce the effects of initial settling of the processing of the resolver sensor module.



Gain and offset correction parameter section, here shown as how it appears in Analyze mode (post processing).

The Gain and Offset values for the Sin and Cos channels can be typed in manually or determined automatically.

6.7.1 Manual Gain and Offset

If the Sin and Cos channels have known Gain and Offset levels then they can be typed in manually. For example, e.g. the Sin channel might have a DC offset of 0.23 V and a gain level of 2.43 V.
When the Resolver type is set to Modulated the Gain and Offset values can be more complex and difficult to determine manually, and here using automatic value determination can be convenient.

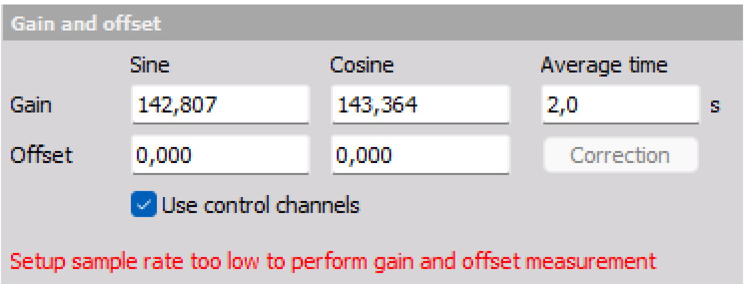
6.7.2 Automatic Gain and Offset

The automatic Gain and Offset determination can be performed over the user-defined Average time duration, both while in Measure mode and in Review mode.

6.7.2.1 Correction in Measure mode

In Measure mode the Gain and Offset values can be automatically determined either in:

- Ch. setup - clicking on the Correction button in the module setup under Ch. setup
- Measure - using the control channels under Measure.



Gain and offset correction parameter section, here shown as how it appears in Measure mode (live processing).

NOTE:

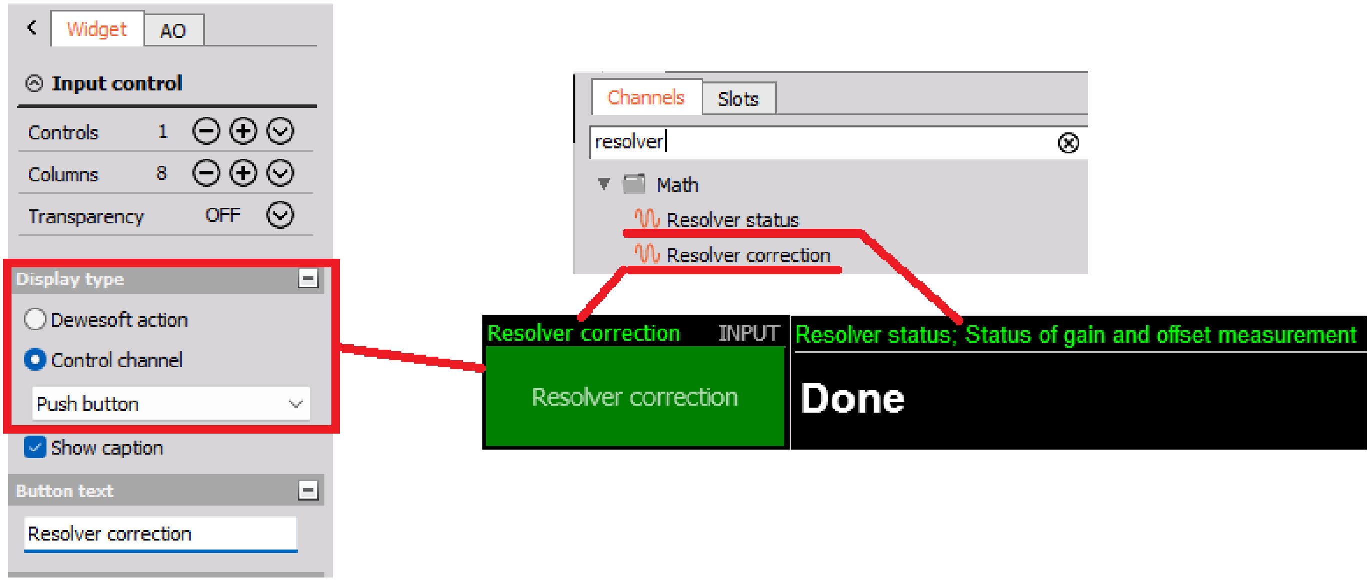
1. When using the Correction button under Ch. setup, the determination will be based on the Ch. setup sample rate and not the Acquisition sample rate. The Acquisition sample rate is used in Measure mode.

2. The Correction button in Ch. setup and in Measure will be disabled if the used sample rate is too low or if the rotation speed is variating too much.

3. The minimum rotation speed for performing Gain and Offset correction measurements are 10 Hz, 600 rpm.

By enabling the checkbox for Use control channels, additional channels will be available under Measure which can be used to set up and control when to start the Gain and Offset determination.

By adding Input control widget buttons resolver Correction can be managed as illustrated below:



Illustrating how an input control widget can be used to control the correction process of the Resolver sensor math module. The status indication is read out in a Digital meter widget.

The Resolver status channel - can be added to a Discrete display widget to show the status of the Correction process.

The Resolver correction channel - can be added to an Input control display widget set as a Push button type, to push when to start the Correction process.

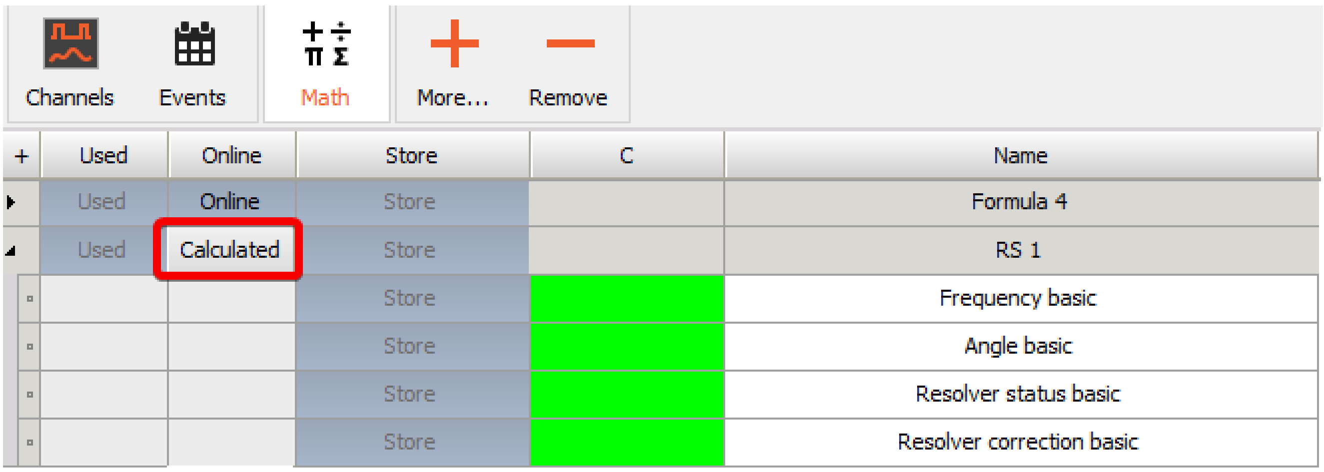
6.7.2.2. Correction in Analyze mode

In Analyze mode the Gain and Offset correction can be determined and applied to already stored data. The Gain and Offset values can be determined automatically based on the user-defined position of the yellow cursor, as illustrated below:

Showing how the yellow cursor is used for deciding at which time location the automatic correction determination should be started to be calculated from.

After setting the yellow cursor at some desired time location where the rotation speed is being steady, go back to Ch. setup and check the Update gain and offset checkbox on. Then go back to Measure and press Recalculate. Now the Gain and Offset values have been updated in the module to match the determined values at the yellow cursor.

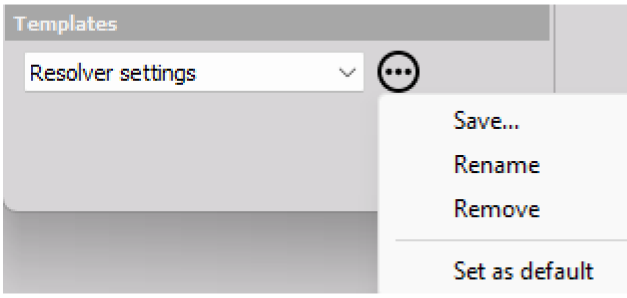
If the yellow cursor is moved after recalculation then you need to go back to Ch. setup and click on the Calculated button for the Resolver Math module to force it to require a new Recalculation at the new position.



Showing how you can force the Resolver sensor math module to enable the option to redo a correction calculation.

6.7.3 Use of Templates

In cases where the same Gain and Offset values should be applied to multiple stored data files, a module setup Template can be saved and applied on all files to easily align the resolver setup parameter values. Template settings are shown below:

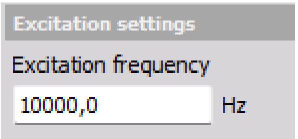


Resolver module settings can be saved as a Resolver settings template and reused for other resolver module instances, or loaded in to use for other setup files.

For example, if a set of measurements have been acquired with no resolver correction applied, then a Resolver setup template can be applied with settings containing valid Gain and Offset values.

Also, this is useful if some of the other measurements do not have a steady speed range where such Correction values would be possible to be determined.

6.8 Excitation settings section



Input field for the used excitation frequency when the Resolver type is set to Modulated.

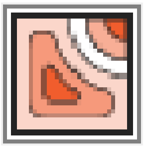
The Excitation frequency is relevant for Modulated resolver sensor types. For modulated resolver types the Excitation frequency should be set equal to the excitation AC voltage frequency.

The Excitation frequency is used to determine the signal envelope of the modulated Sin and Cos signals by performing demodulation.

For Modulated Resolver types the sample rate is being kept factors above the excitation frequency in order to maintain clear information of the modulated signals.

7. Contour plot widget

The Dewesoft Contour plot shows three-dimensional arrays (Matrix data), or a group of three scalar channels where two channels specify the axis (xy) positions and the third specifies the values for those positions.



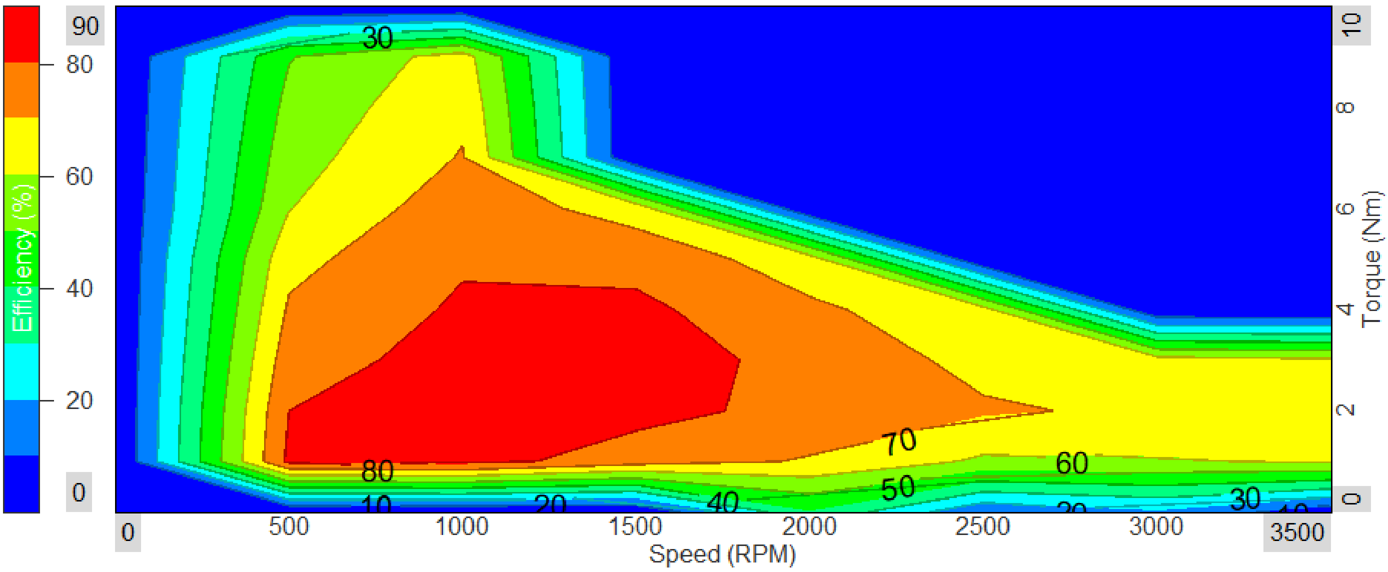
The icon that indicates the Contour plot widget, when entering the list of widgets to add to the display layout.

The widget is intended for illustration of data values mapped across two axis dimensions. Values within a certain interval will belong to the same contour, having the same color. The contour borders can be indicated with isolines. The closer the isolines are together the larger the changes in values are in that area of the plot.

Contour plots are used in different domains, but for many it is mostly know for plotting weather data, such as contours of geographical elevation and depth, barometric pressure, rainfall amounts, and wind speeds over a geographic area.

But, contour plotting can also be pretty valuable as an alternative to the 3D graph for other scenarios where you as a user want to overview trends in data across ranges of different physical quantities - to see how the different measured parameters are correlating with each other.

One example of this is when performing Motor analysis where among other things the motor efficiency is investigated. Here, motor efficiency contours are plotted across a range of speeds and torque loads, as shown below:

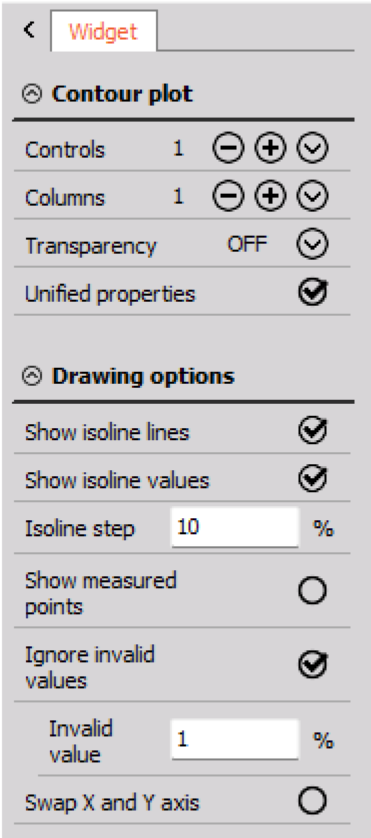


Example of the Contour plot display widget - used for Motor analysis - motor efficiency mapping.

In the plot above the motor efficiency is mapped out - making it possible to overview the optimal speed and torque range for the motor to operate within.
In general the 2D/3D mapping math module can be used to tag/map two scalar channels to a third channel. The mapped channels will then work as axis positions for the third channel. Such output data can be visualized in the Contour plot widget.

7.1 Properties

The Contour plot widget properties are divided into two groups. First, common general widget properties, and second, specific Contour plot widget properties.



Contour plot display widget properties.

7.1.1 Show isolines and isoline values

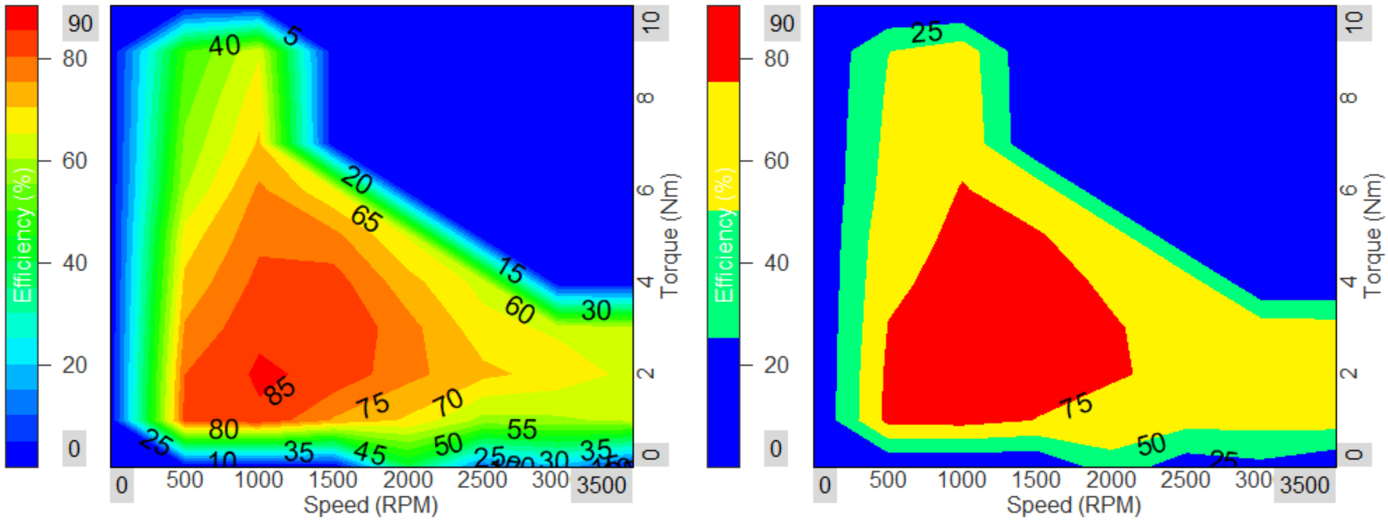
Enabling isolines will draw black border lines (isolines) between the different contours. In some cases the isolines can help with highlighting the different contours.

Enabling isoline values will add values at the contour borders, on top of the isolines. The numbers indicate the specific values found between the different contours.

7.1.2 Isoline step

The Isoline step defines the resolution of contours. If the isoline step is increased the number of contours are reduced and vice versa.

Below you see an example with two contour plots, where the left plot has an isoline step of 5 [%] and the right plot has a step size of 25 [%].



Example of how changing the Isoline step size will affect the plot. The left plot uses a smaller step size than the right plot.

7.1.3 Show measured points

Enabling Show measured points will draw dots at all locations where data is available.
If the data source is a Matrix, then the measured points will be positioned in a rectangular grid. If the data source is three grouped scalar channels (XYZ channels) then the measured points can be spread randomly over the plotted area.

7.1.4 Ignore invalid values

By enabling Ignore invalid values, data points with a certain user-defined value will be ignored.
For example you might want data points having a value of 0 to be ignored since zero might indicate invalid data. This is done by typing 0 at the Invalid value field.

7.1.5 Swap X and Y axis

Enabling this will switch the plot graph view from (X, Y) to (Y, X).

8. Warranty information

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

8.1 Calibration

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

8.2 Support

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

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

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

8.3 Service/repair

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

8.4 Restricted Rights

Use Slovenian law for duplication or disclosure. Dewesoft d.o.o. Gabrsko 11a, 1420 Trbovlje, Slovenia / Europe.

8.5 Copyright

8.6 Trademarks

We take pride in our products and we take care that all key products and technologies are registered as trademarks all over the world. The Dewesoft name is a registered trademark. Product families (KRYPTON, SIRIUS, DSI, DS-NET) and technologies (DualCoreADC, SuperCounter, GrandView) are registered trademarks as well. When used as the logo or as part of any graphic material, the registered trademark sign is used as a part of the logo. When used in text representing the company, product or technology name, the ® sign is not used. The Dewesoft triangle logo is a registered trademark but the ® sign is not used in the visual representation of the triangle logo.

9. Safety instructions

Your safety is our primary concern! Please be safe!

9.1 Safety symbols in the manual

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

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

9.2 General Safety Instructions

Warning

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

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

9.2.1 Environmental Considerations

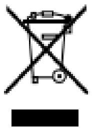
Information about the environmental impact of the product.

9.2.2 Product End-of-Life Handling

Observe the following guidelines when recycling a Dewesoft system:

9.2.3 System and Components Recycling

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



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

Restriction of Hazardous Substances

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

9.2.4 General safety and hazard warnings for all Dewesoft systems

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

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

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

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

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

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

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

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

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

10. Documentation version history

Version	Date	Notes
V23-1	2023-04-12	First version manual created.
V23-2	2023-06-08	Pictures and some text sections updated to match the 2023.3 SW version.