Automotive
Energy & Power Analysis
Field Service
Environmental
Research & Development

TACHO PROBE

Manual

DEWETRON worldwide
www.dewetron.com

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1 Introduction and Basics

Most of the time a rpm measurement is needed at rotating machines . The reasons could be very different. Sometimes it is only an additional information, to all the other measurement channels, and sometimes particular analysis , like Order tracking, Balancing, averaged Orbit require this.

So we need to install a rpm sensor. For sure there are several sensors on the market.
So we could use an encoder, the DEWETRON RIE-Sensor, or only other reflecting probes that deliver a signal which is related to engine speed. All this sensors could be used.
But sometimes this takes a lot of effort to mount such sensors.
Imagine an encoder, or even the RIE-Sensor, this will take a while to install, and sometimes it is simply not possible to mount , because of space limitations.

So to find a reliable and easy to install sensor is not that easy.

For sure not all sensors can fulfil the requirements needed, at specific applications.

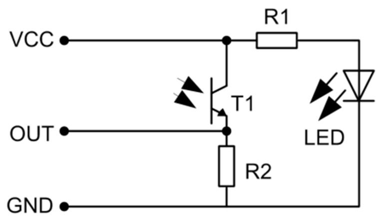
For example a Tacho Probe with one pulse could not be used to do a rotational vibration analyse.

Here a few Probes are introduced, which could help to solve the rpm measurement on rotating machines.

2 Tacho Probe

This sensor was mainly designed to measure a pulse coming from an reflective tape or any other object which reflects light.
It is used to measure the speed of a rotating shaft (rpm), or it could be also used to create a trigger event, based on a reflection.

The sensor is emitting light (LED) which is reflected from an object and received from a photo transistor T1. So the output of this sensor is an analogue voltage signal which is proportional to the reflected light.



A white color mark, a screw head, a flute or something similar, will already produce different light reflection and therefore a signal which could be used to trigger.
The typically distance to the object is about 2cm.

The sensor has to be connected to an analogue input channel of a Dewetron measurement system. Depending on the Input connector(DSUB, BNC), the power supply will be provided from the Analogue input channel, or from the counter input.

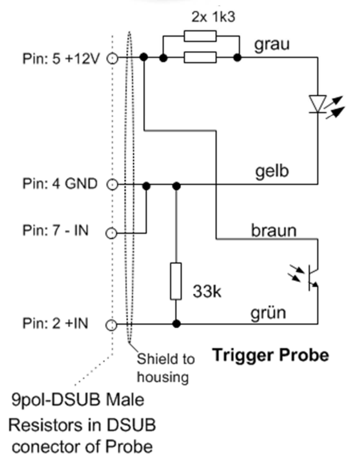
There are two connector options available.

2.1 SE-TACHO-PROBE-01

Here the power supply comes from the analogue input amplifier. So no additional power supply or any connector is needed to operate the probe.

The probe could be directly connected to this input amplifiers of DEWETRON

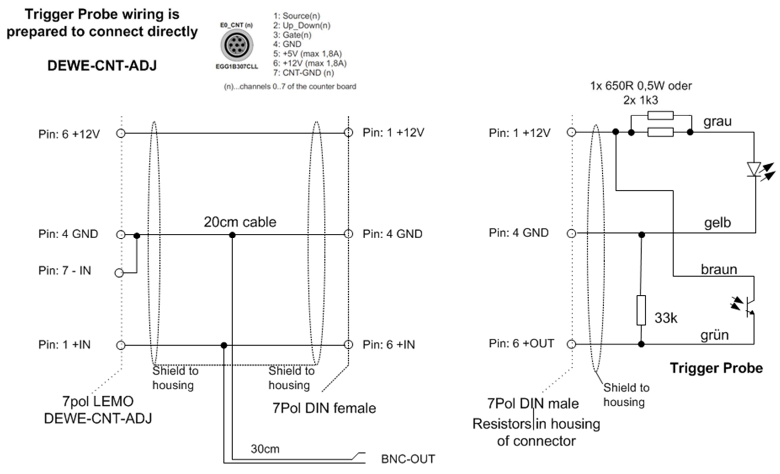
- MDAQV-200
- MDAQ-Bridge
- DEWE-43
- DAQP-LV
- HSI-LV
- DAQP-Frequ-A



2.2 SE-TACHO-PROBE-02

Here the Probe is connected to a Voltage input module with BNC or to an adjustable counter input. The power supply will always come from the counter input (+12V).

The probe has got an additional adapter cable with LEMO and BNC.



Lemo connector is connected to Counter Input for power supply.
The output signal is provided via BNC and also via LEMO(including supply) to counter input.

So in case adjustable counters are installed, this could be used instead of analogue input.
This connection to counter input of the Lemo is always there even if no adjustable counter is installed, because it will not disturb the output signal.

- Voltage input with BNC connector
- LEMO Counter Input TTL
- LMEO Counter Input Adjustable

2.3 SE-TACHO-PROBE-0x

If there is a need to connect the probe to any other input module, only the adapter cable has to be modified. So please contact your local DEWETRON dealer for further assistance.

3 Analogue Setup

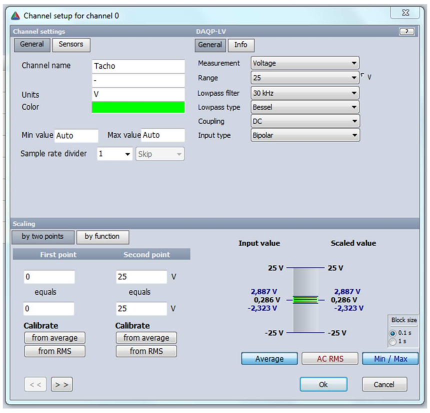
3.1 Analogue Input

Here either SE-TACHO-Probe-01 or SE-TACHO-Probe-02 could be used.
Probe 01 will be supplied directly from analogue input amplifier, where Probe 02 will be supplied out of counter and signal will be measured from analogue input amplifier(BNC INPUT).

0	Used	Store	Tacho	DAQP-LV 50 V .. 300 kHz (BE)
1	Used	Store	acceleration	DAQP-ACC-A 5000 mV .. 300 kHz; Exc 4 mA

Analogue Trigger probe is connected to a volatge amplifier DAQP-LV of channel 0.

The volatge input of the tacho probe is set to 25V, tacho probes power supply is 12 V so the maximum signal we get will be about 11V. Therefore 25V Range is suitable for it. Filter is set to 30kHz. There is no scaling needed , trigger probe output is volatge which will be later used to get the speed of the machine.



The example was related to DAQP-LV amplifier.
If other amplifier is used, voltage should be set >10V, and filter should be set >50kHz or to highest value.

In case reflection is changing over time, DC component of the signal could change, here AC coupling of the input would (could)help. In this case trigger level will become relative.

In case of noise, lower filter should be used.

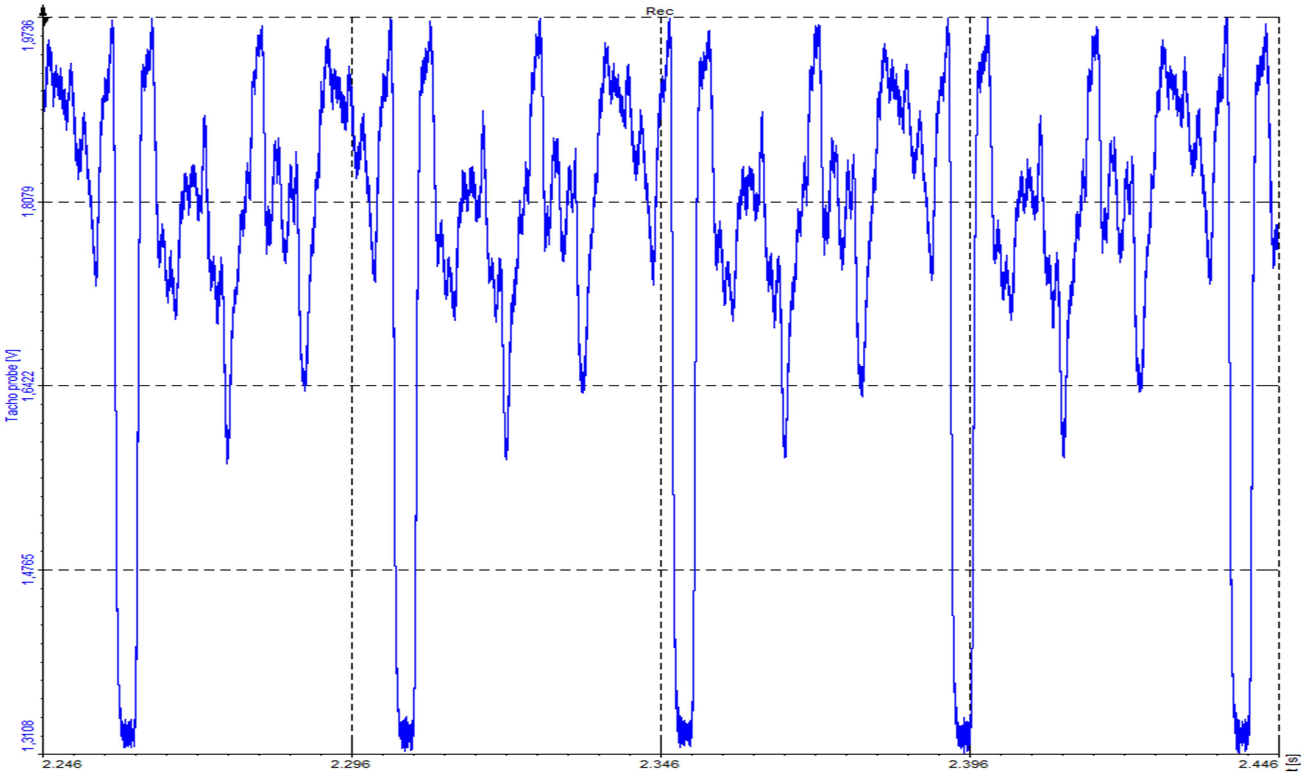
INFO: Be aware that a low filter will shift the PHASE at different engine speeds, which could influence the measurement.

Now the sensor could be pointed to the rotating part of the machine.
To get one pulse per revolution, a color mark, screw head, flute, or a strong black tape or reflection stripe must be available on the shaft to get a nice signal.
In our case a black tape was used to reduce the reflection once per revolution.

The distance should be about 1-2cm depending on reflection.

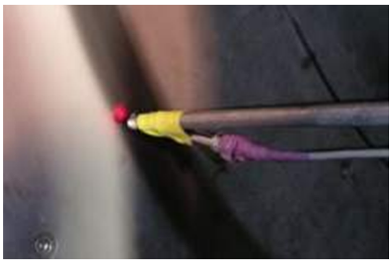
3.2 Check the Signal

Before rpm is extracted with further math functions, we should check the tacho signal.



On the shaft of the engine a black tape is used to create the trigger pulse. So every time the black tape passes, the reflection decreases, and therefore the voltage output of the trigger probe drops. We could see a nice trigger signal which will give us a volatge drop every revolution. But we can also observe a small drops between which is caused from an other part on the shaft which decreases the reflection like dirt or rust.
But this will not disturb, because it is very small compareed to the main signal, so if we set the right trigger level (1.5V) for the rpm detection we will get a nice signal.

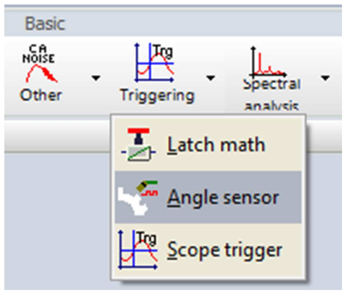
In case the trigger level is not high enough or is burried under noise, the probe must be readjusted to get a clear trigger pera revolution.



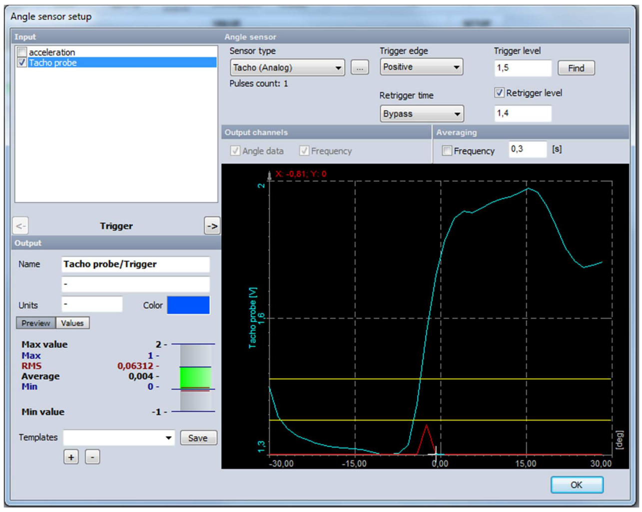
3.3 Get RPM and Angle signal

Now we have to extract the angle and the frequency, to get rpm and a angle based view if this is required.

- For this an angle sensor mathematic is prepared in the math section of DEWESoft.



- On the left we have to specify the input channel which reflects our tacho signal.
- The sensor type describes which sensor is connected.

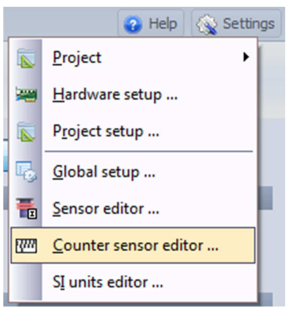


Tacho probe = 1 Pulse/rev
CDM sensor = x Pulses/rev (screw heads of a flange)
60-2 = 58pulses and 2 are missing.

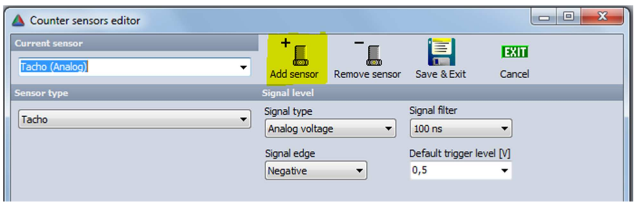
are a few examples of sensor types. For more information refer to online help PRESS F1 of DEWESOFT online help.

In our case we have 1 puls/rev so it is a analogue tacho signal. This Tacho sensor must be created in the Counter Sensor editor of DeweSoft.

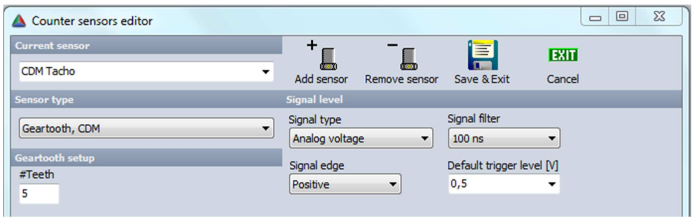
3.3.1 Create Analogue Tacho Counter Sensor



➔ Settings, → Counter sensor editor will open the counter sensor editor.



In the editor we create a new sensor called Tacho (Analog) and select Tacho for sensor Type. Tacho type is always 1 Pulse per revolution.



If we get more pulses from the analogue trigger probe, because we are looking to the screw head of a flansch where 5 screws are used, we have to use the Geartooth ,CDM sensor type.

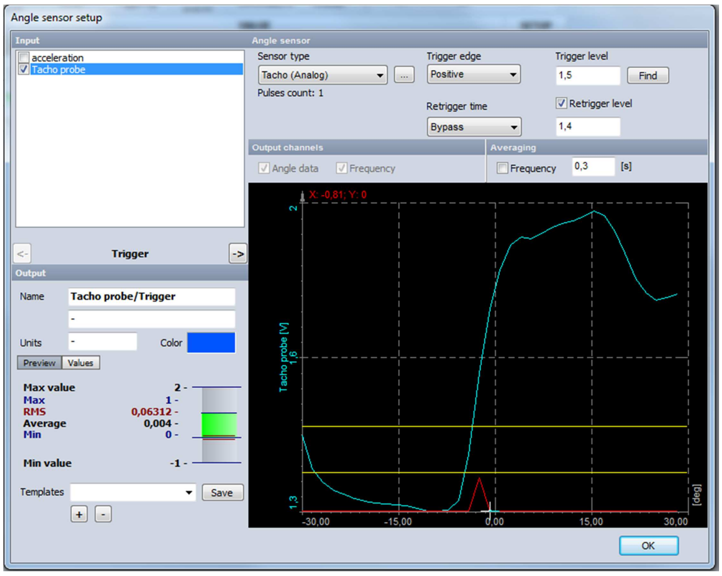
Signal type is indicating which type of signal we get from the probe. In our case we get an analog voltage, so we have to set this to analogue volatge. Signal filter is used if tacho signal has noise on it, so it has to be high for at least 100ns that it will be counted. Signal edge predefines if pos. or neg. slope is used to trigger, and also a default trigger level could be set.

➔ It is possible to enter a value in the DEFAULT trigger level field.

INFO: Signal type is used for filtering the sensor, so if Digital (TTL) is selected instead of analogue it will not appear in the Sensor list of Ordertracking if Analogue Pulses is used as source.
The same if Counter sensor is set up as analogue sensor, and should be used when “Counter” is selected as frequency source in Ordertracking.

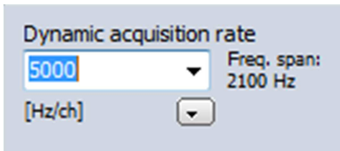
The next Step is to enter the trigger levels and the retrigger level. So module will find the edge and calculate frequency and angle between those. From point 3.2 where we checked the signal in the recorder, we could see that about 1,5V and 1,4V would be the right settings for trigger and retrigger.

Retrigger is working like this: After a trigger was detected (1.5V) a new trigger will be only detected if Retrigger value is crossed before. So if signal is noisy around trigge level double trigger could appear. With set retrigger we could overcome this.



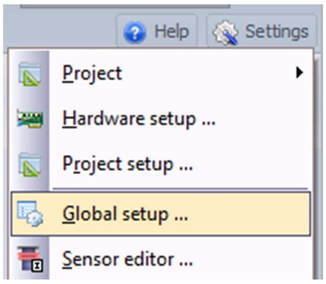
3.3.2 Setup sampling rate

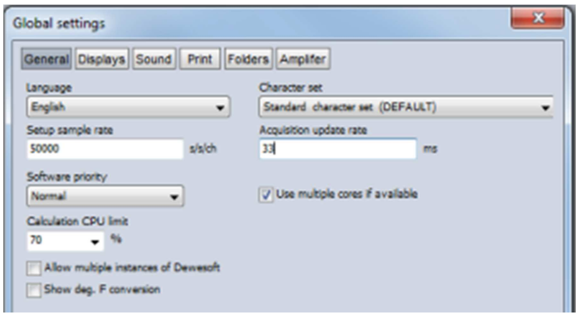
INFO: We are in setup mode so DEWESoft is running with the setup sampling rate. The setup sampling rate which is actually set could be seen like this.



Create a new Setup or Start DeweSoft, the sampling rate shown now in the Dynamic acquisition rate is the setup sampling rate. If the trigger signal is very fast it could be that it is not possible to see the shape and therefore a reliable trigger in the angle math. In this case the setup sampling rate has to be set higher.

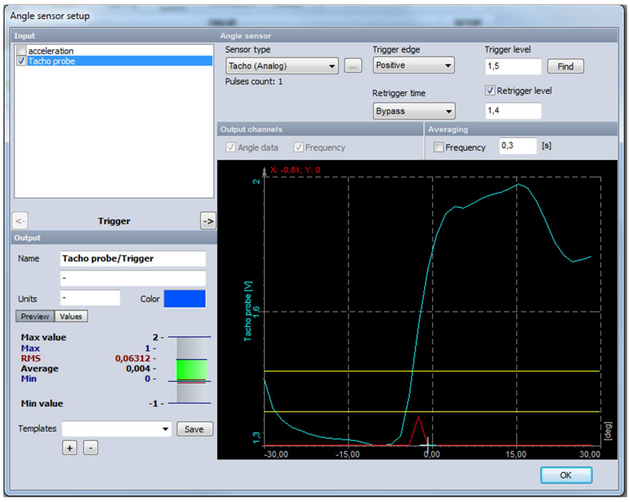
- ➔ Global Setup
- ➔ Setup sampling rate





Set sampling rate according to tacho signal.

3.4 Results channels



The angle math will output:

- Trigger signal with a duration of 1 sample every time the edge is detected.
- The frequency in Hz.
- And a angle signal from 0-360deg.

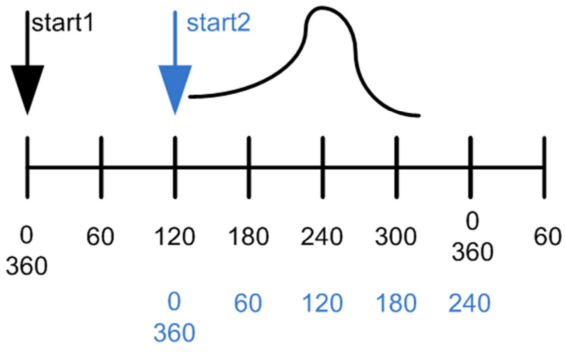
  This is possible because we only have one puls per revolution. So start and stop is defined.

In case CDM sensor is set up, angle will run continuously up, so we will not get an angle signal running from 0 to 360deg.

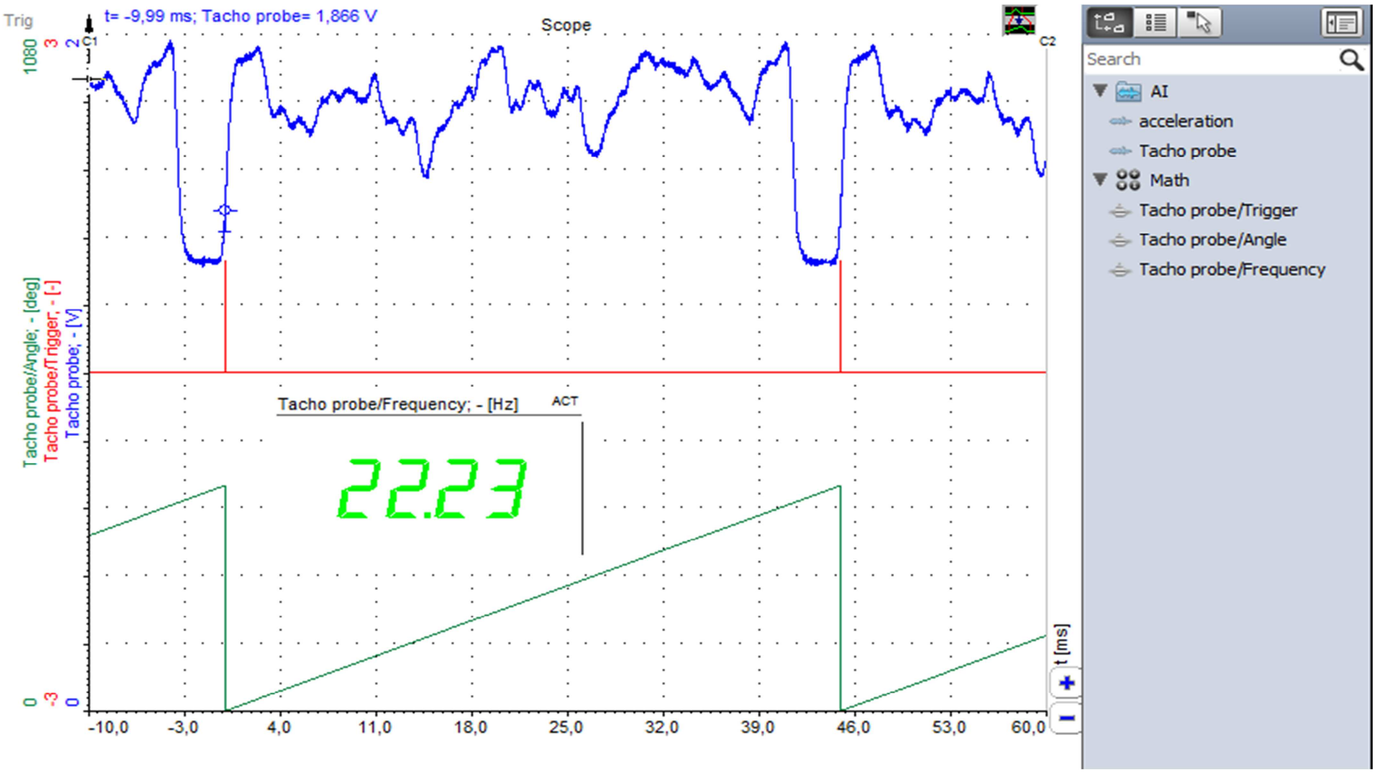
Why? Example:

CDM sensor is used on screw heads, lets assume we get 6 pulses (6 screws), so we could extract the frequency, the Trigger signal, and also the Angle.
Every screw pulse, will equal 360/6= 60deg. So first pulse is 0deg next will be 60deg, … the last will be 360 or 0deg. It would be possible to reset every 6th screw.
Lets assume we do that and do an angle based measurement, like described at 4.1.
At that measurement we could see a peak around 240deg.
If we stop the measurement now, and restart it, the peak will be at 120deg, even if nothing was changed on the machine. At an other restart it will be at 300deg, and on a other restart we could see it again maybe on 240deg.

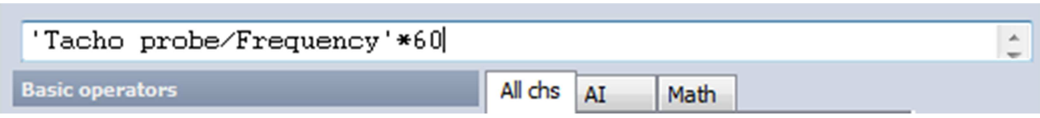
Why?
The start is not defined at a CDM sensor. So at the first measurement where the peak was seen at 240deg, … the angle math started, on screw 1, … on the second it started on screw 3, … so start and end is not defined and we can not get a defined phase angle out of it.
To avoid errors, the angle will run only up at a CDM sensor.
But some applications need a defined start position to get reproducible angle, Order tracking, Balancing, … or if I want to have comparable angle based measurement.



So if this needed Trigger Probe must be operated in Tacho Mode = 1 Pulse/rev. or an other sensor must be used. (CDM + TRIG sensor, Encoder with Zero Pulse)



To get speed in RPM a simple math formula can be used to calculate the rpm signal.

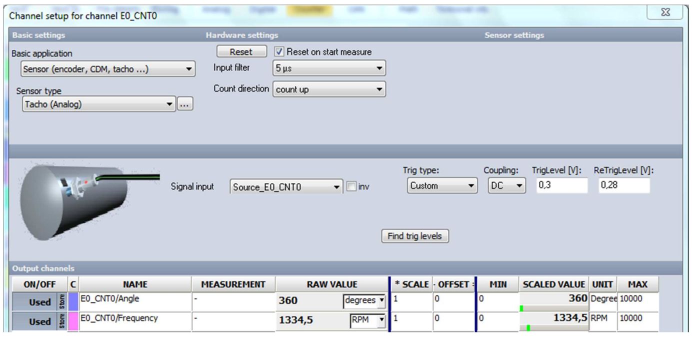


Now the angle math was insert manually to get out engine speed and angle.

4 Adjustable counter Setup

As mentioned if adjustable counter is available, or if no analogue amplifier with supply voltage, SE-TACHO-PROBE-02 should be used.
In this configuration the probe is supplied from the Counter and the output signal is provided on BNC cable and also on the LEMO Counter input of the counter. (Source of counter x).

At the adjustable counter, in comparison to non adjustable counter input, the Trigger level and also retrigger level could be entered. So in other words we can set trigger level from 0 to 40V.
To do this we have to set the Trg Type to CUSTOM. After that the trigger level and retrigger level could be entered.



Sensor type will be also Tacho or CDM, and result output will be angle, and speed in Hz or rpm. Also here only Tacho Signal (1pulse/rev.) will deliver an angle signal from 0 to 360deg.
If CDM is used Angle will continuously run up. Why it similar to analogue Tacho sensor like described in 3.4.

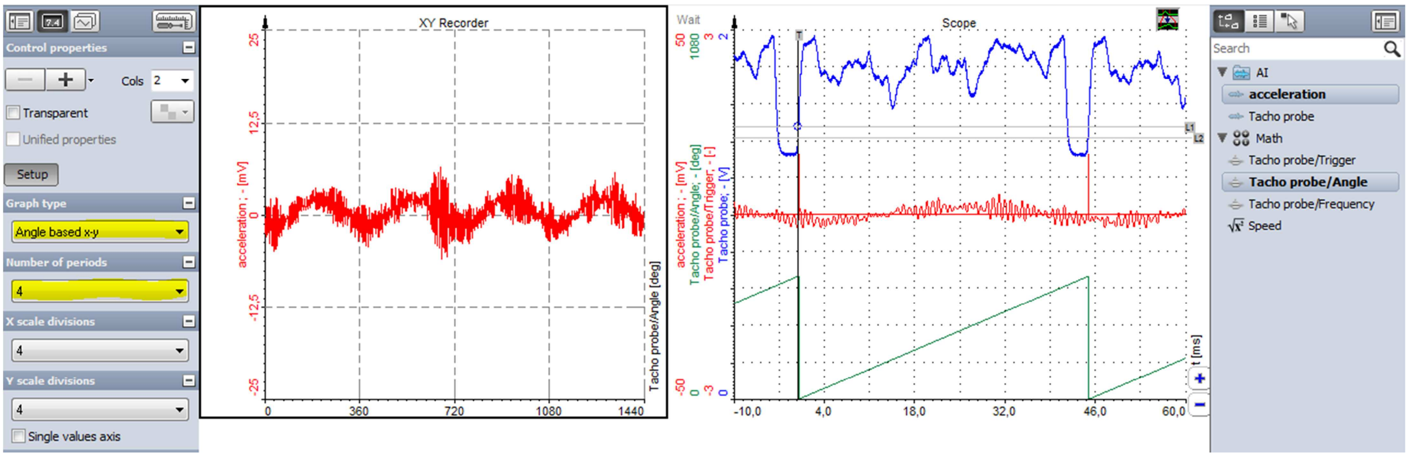
Even if the adjustable counter is used, the output signal should be checked first like described in section 3.2(output on BNC cable). Because without a visual view it would be hardly possible to set the right Trigger and Retrigger level in the counter setup.

If the probe is connected to adjustable counter, one more analogue input channel would be available, and at very high input frequencies of tacho probe counter would give better frequency resolution.

5 Applications

5.1 Create angle based view

The Tacho probe delivers RPM and also an angle signal. If now XY diagram is used and angle is applied to x axis, and for example acceleration or any other signal to y axis, this signal could be shown angle based.



So on the right we could see the signal time based and on the left the signal is shown angle based.

At XY-Diagram graph type has to be changed to angle based xy view, and after that number of periods(revolutions) could be chosen.

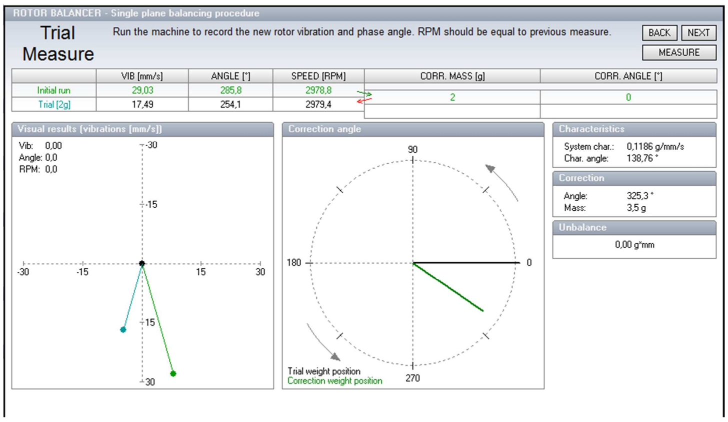
INDO: At XY diagram deselect all channels first. The first channel applied after, will be the X channel and the next one(s) are used for the Y channel(s).

5.2 Order tracking

Also Order tracking needs rpm signal, if the probe is used in Order tracking, the Order tracking module will add this Angle Math function automatically and use the results out of it. Setup will be the same, all settings are controlled out of Order tracking module, and therefore it will be locked in the math section. For further information please refer to Order tracking user Manual.

5.3 Balancing

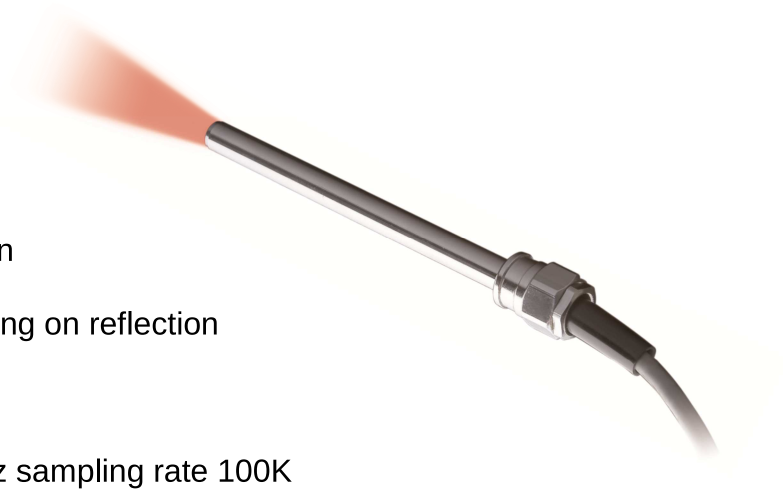
For Balancing application this is the perfect probe. Also Balancing needs Order tracking and therefore a speed (rpm) and angle signal. And for balancing Fans, Shafts, … or other rotating parts this probe is very easy and fast to setup. For further information please refer to Order tracking or Balancing user manual.



5.4 Rpm measurement

The probe is also perfectly suitable for a fast and quick rpm measurement.
So additionally rpm signal to all the other signals.

6 Specifications



Length:	140mm
Temperature range:	-10℃ ….. +60℃
Min Frequency:	< 10Hz depending on Reflection
Max Frequency:	about 10kHz depending on reflection
Supply Voltage:	9-15V DC
Current consumption:	25mA

typically phase shift:	@ 1Pulse/rev 50kHz sampling rate 100K	
	600rpm	0deg
	6000rpm	6deg
	(depending on reflection, measured on test pad).	

This probe is working on the principle of light received. So reflection and sharpness of object will define the output signal. Because waveform can change with speed, trigger position changes, and therefore the angle position. That's why it is suitable for RPM measurement, but not for high accurate phase measurement.

Applications:

Balancing
Order tracking
Common RPM measurement