Discom Production Test System

General Training

www.discom.de

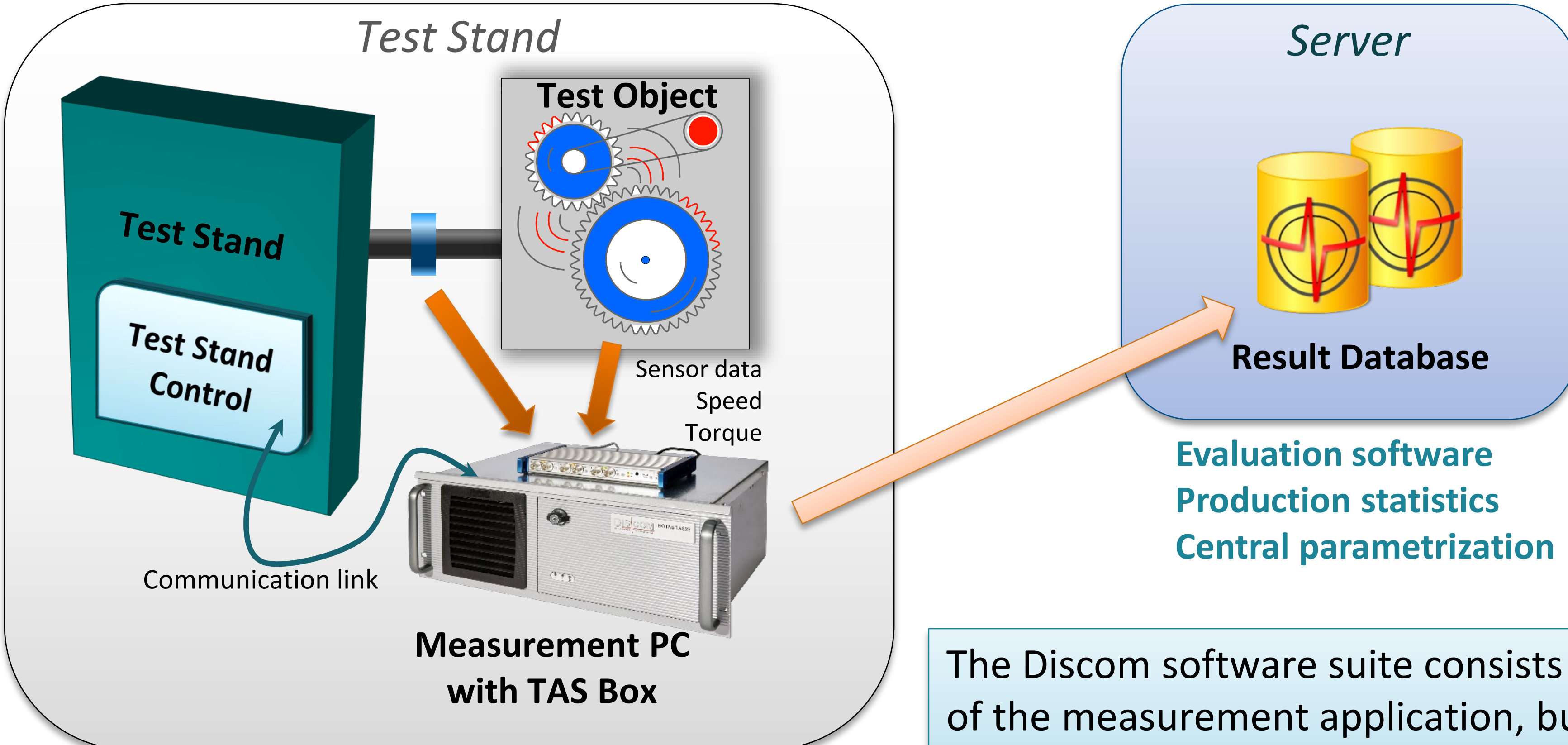
Transmission Test: Training Contents

- System overview
- Theory of transmission noise analysis
- Limit value and limit curve generation
- Typical gear defects and noise problems
- Components of the measurement software
- The parameter data base
- Result data base and evaluation software
- Wave file recording and playback
- Calibration
- Test stand and line management
- Backup and restore

Discom System Overview

Test Stand Environment

The measurement PC in the test stand processes the sensor data and communicates with test stand control. All results are transferred into the central result database.
The Discom evaluation software tools can be used in any place.



Measurement application

For single test stand projects, the measurement PC can also take the role of the server.

The Discom software suite consists not only of the measurement application, but also includes a suite of evaluation and administration tools.

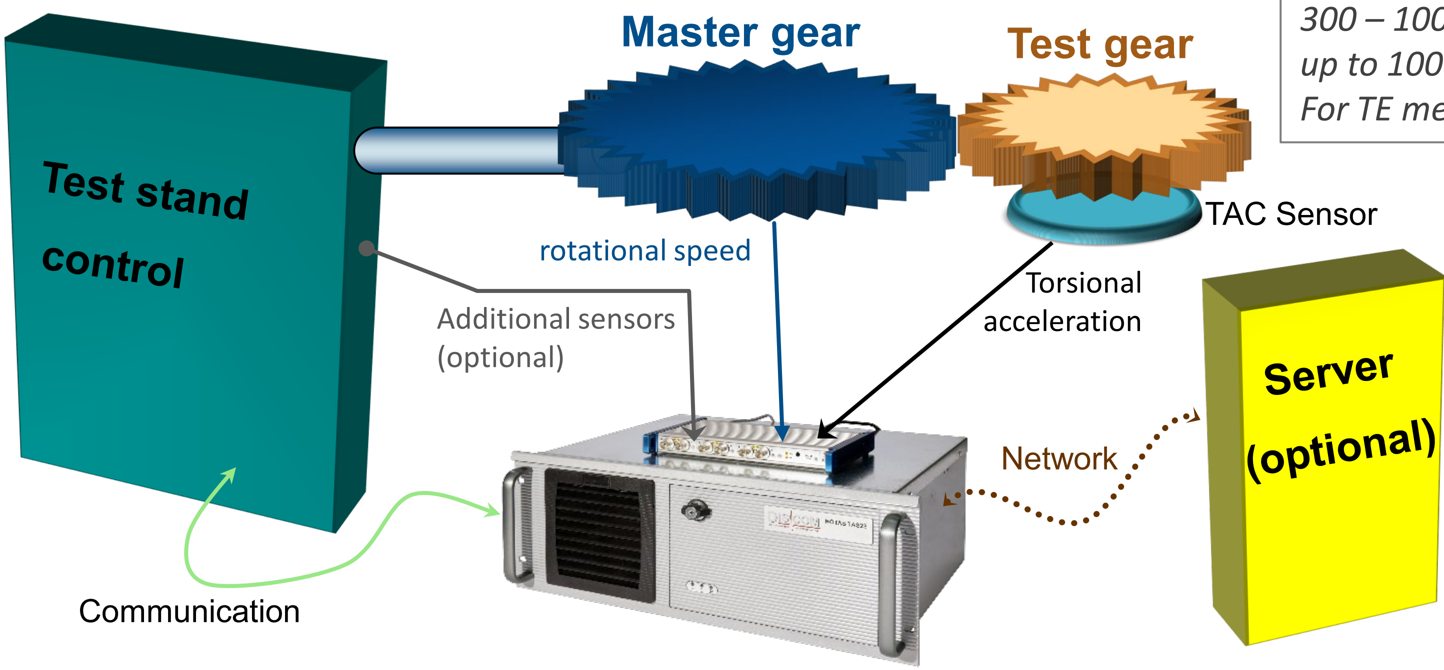
Test Stand Setup for Gear Testing

A standard gear tester uses the TAC Torsional Accelerometer as sensor and needs the precise rotational speed of either Master or Test gear (shaft).

Additional sensors e.g. for condition monitoring can be added.

Typical measurement rotational speeds:

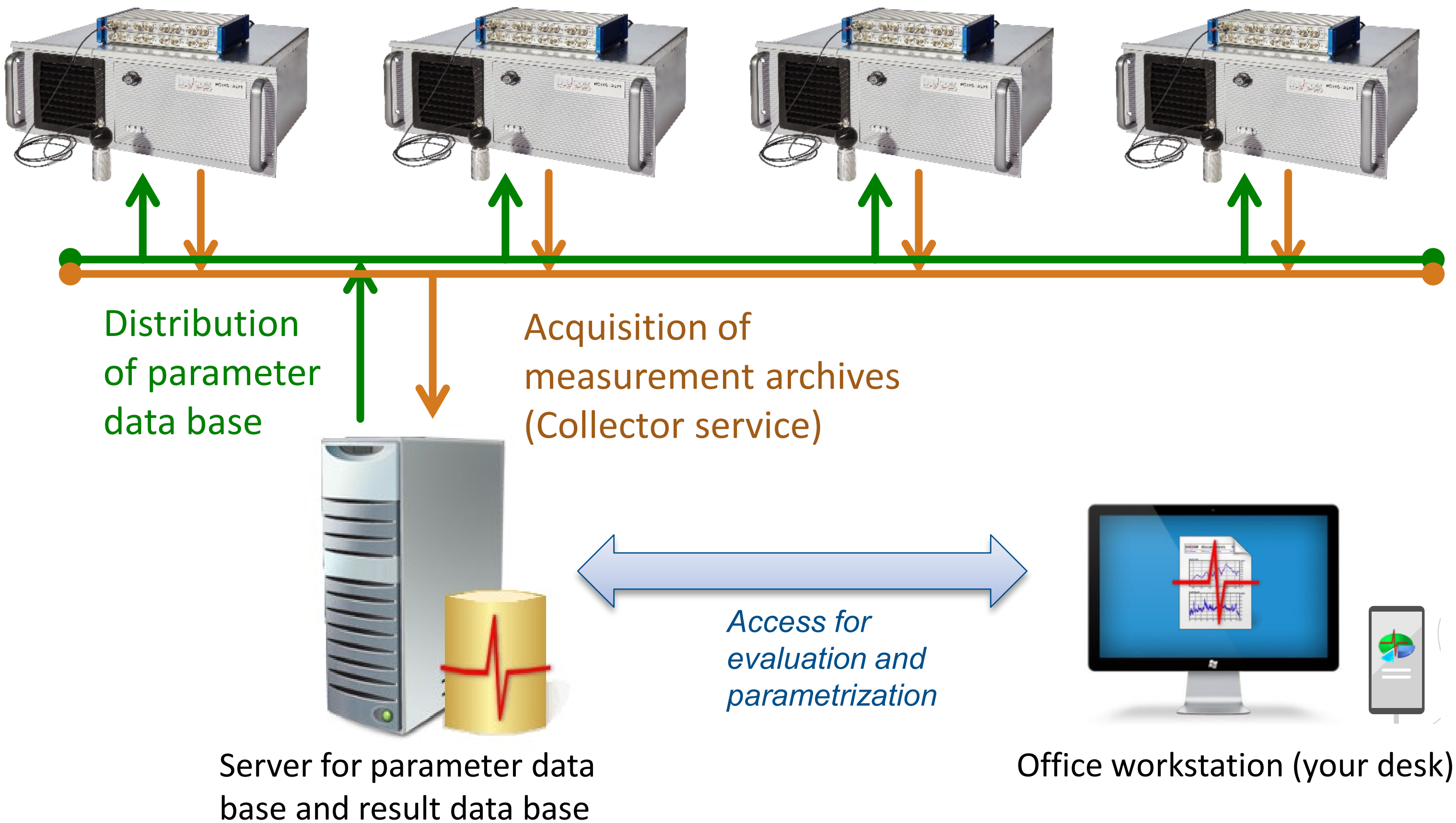
300 – 1000 rpm for gear testing
up to 10000 rpm possible
For TE measurement, 100 – 400 rpm



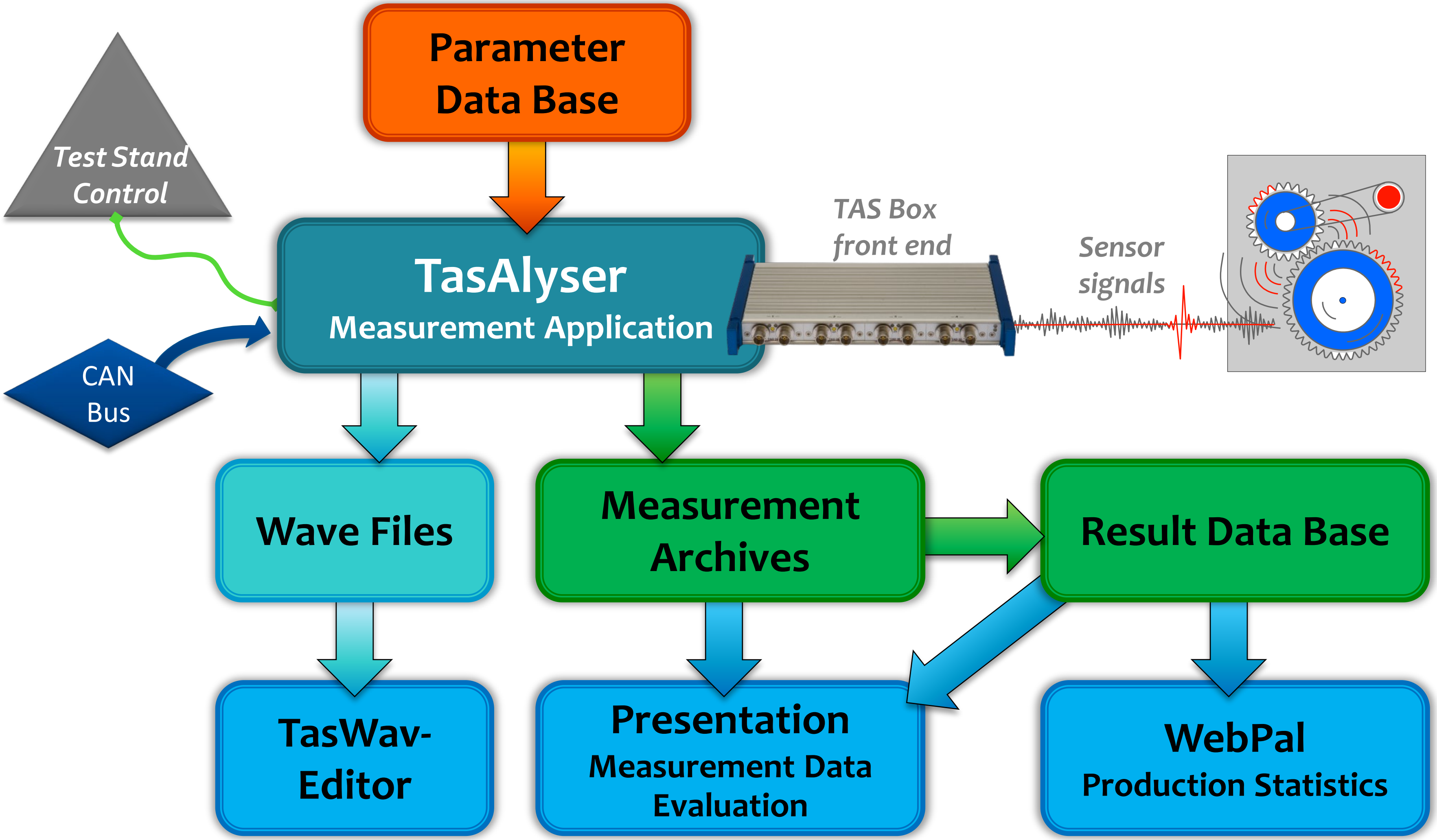
The Transmission Error (TE) measurement extension needs high-resolution rotary encoders on both shafts (Master and Test gear).

Working with multiple test stands

The result database and the parameter database master copy reside on a central server. Results are collected from the test stands to the server, and the parameter database is distributed from there to the test stands. Usually, you access the server via Web.Pal and remote desktop from your office workstation.



Discom Noise Analysis System Overview



Measurement Hardware

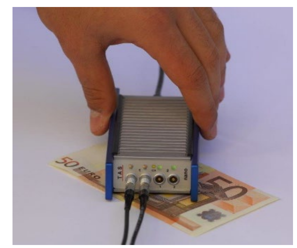
TAS Box Front End

The “**TAS Box**” is the data acquisition front end of the Rotas system.
It is connected to the measurement PC via USB. The *TasAlyser* measurement software can run on any Windows PC with Windows 7 upwards.
There are three basic models of the “Tas Box”:

A **TAS28** has up to 8 A/D and four speed channels. It is the standard TAS box model. The TAS28a variant provides a sampling rate of up to 200 kHz.

The new **TAS48** has 16 A/D channels, like a double decker TAS28a.

TasNano is as small as a smartphone and provides four A/D channels. It is specifically designed for mobile applications.



legacy versions:

TAS-28 card

TAS08 box

Technical data:

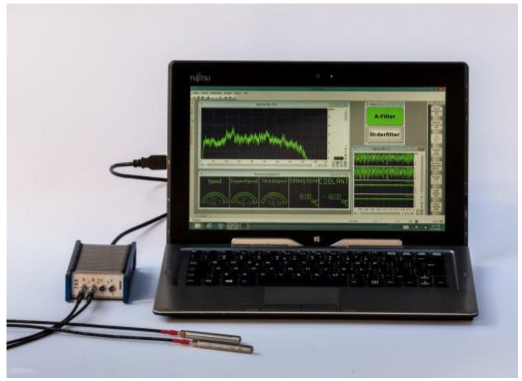
- Sampling rates up to 200 kHz, 24 Bit A/D converters
- A/D converter module: AC, DC or ICP coupling, input voltage up to 30V
- Modular system, can be extended for up to 16 A/D channels + 4 pulse channels for rpm speed
- Rpm speed module for pulsed speed signals with up to 10 MHz pulse rates
- Power supply for up to 5 IEPE sensors only per USB

TAS Hardware Extensions

DISCOM

The most basic Rotas system only uses one accelerometer and one speed sensor. This system can be extended in multiple ways:

- More Sensors, also of different types (like laser vibrometer).
- Microphone measurement parallel to vibration measurement.
- More speed inputs (like using both rear output speeds in addition to the input speed).
- Torque measurement for torque ramps and/or torque fluctuation analysis.
- Shifting force measurement for manual transmissions.
- Acquisition of control values (like speeds) via CAN bus and sample-precise integration into A/D data stream.
- Angular synchronous sampling and analysis of rotational fluctuations.



For use in vehicle drive tests, a **mobile version** of the TAS box is available (TAS-nano). It is connected to a standard notebook or tablet PC via USB. Speed information is read directly out of the CAN bus. The mobile system is fully compatible to the test stand system, so direct comparison of measurement results is possible.

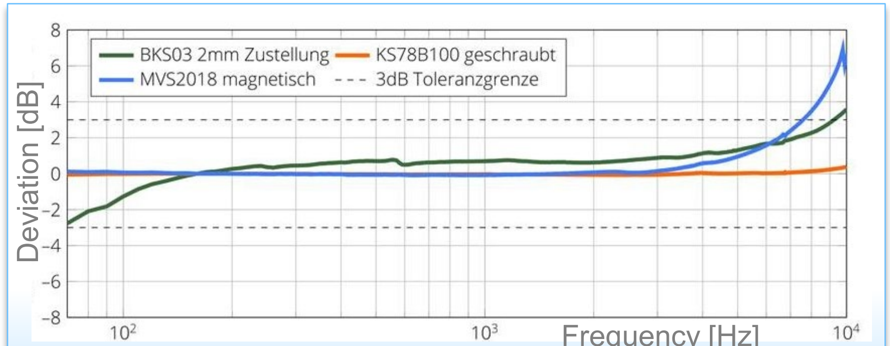
TAS-Mobile will typically measure the signals of four microphones in the vehicle cabin and optionally an accelerometer attached to the transmission.

BKS Accelerometers

Sensors BKS03 and BKS 10 are pressed onto the specimen's surface. The flexible silicone ball element and ring-shaped contact plate ensure close coupling to irregular surfaces even when applied non-perpendicular. In addition, the silicone ball element decouples the sensor from test stand vibrations.

The sensor tips are currently KS91 accelerometers from Metra Messtechnik, Germany. These sensors are nearly linear up to 14 kHz, compared to a screwed-on sensor.

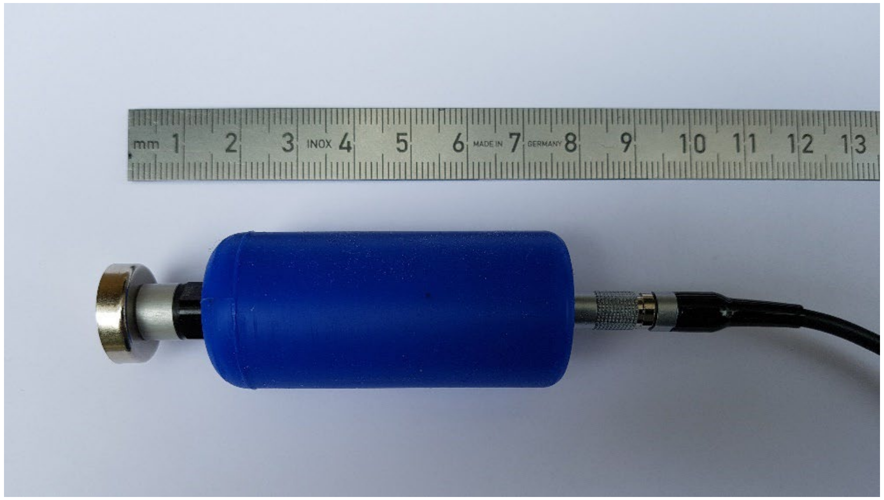
These accelerometers can measure up to ±700g (with standard amplifiers). ICP supply is provided by the TAS box.



Frequency response deviation between screwed-on vibration sensor (orange) and BKS03 (green).

MVS Magnetically Attached Accelerometer

The MVS magnetic accelerometer can be used instead of BKS sensors on test objects that move during the test.



Lightweight sensor and magnet:
< 10 g for high bandwidth (beyond 20 kHz)

Individually replaceable

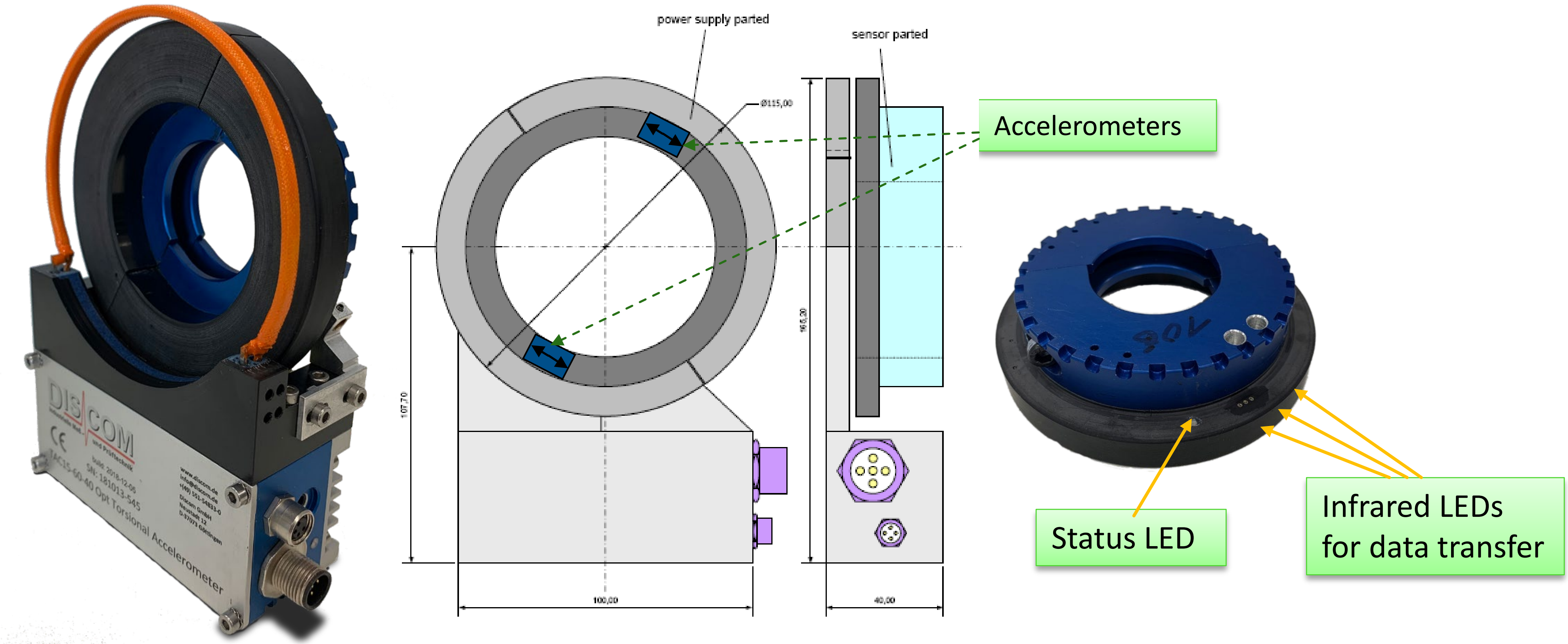
- Sensor
- Cable
- Magnet (configurable)
- Elastic Element

Cable with coaxial connector that can turn and persist high force: The sensor could be pulled off by the cable!

Easy to grip.

TAC Torsional Accelerometer

The TAC torsional accelerometer is mounted directly onto the axle of the test stand and measures torsional fluctuations instead of vibrations.

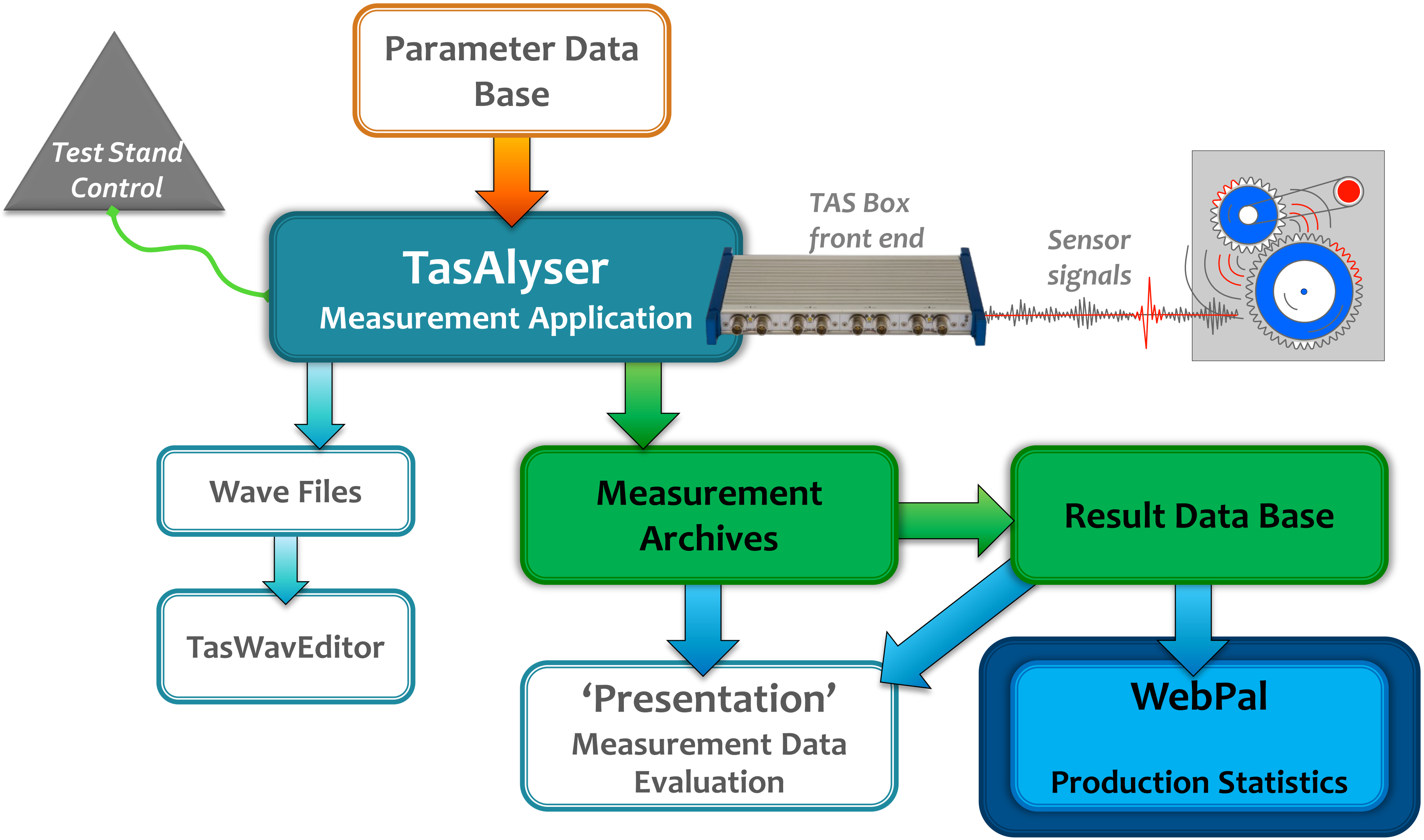


It uses two accelerometers on opposite 180° positions, so the influence of external vibrations and lateral acceleration (gravity) is cancelled.
It uses inductive power supply and infrared diodes for data transfer.

PRODUCTION STATISTICS (PART 1)

How to get an overview of your current production,
NOK rate and defects

Discom Result Database Overview



Intranet Production Analysis: Web.Pal

Web.Pal is an intranet-based service. Using your normal web browser, you can check production statistics, NOK rates, top N defect reasons, value statistics, trend analysis and more.

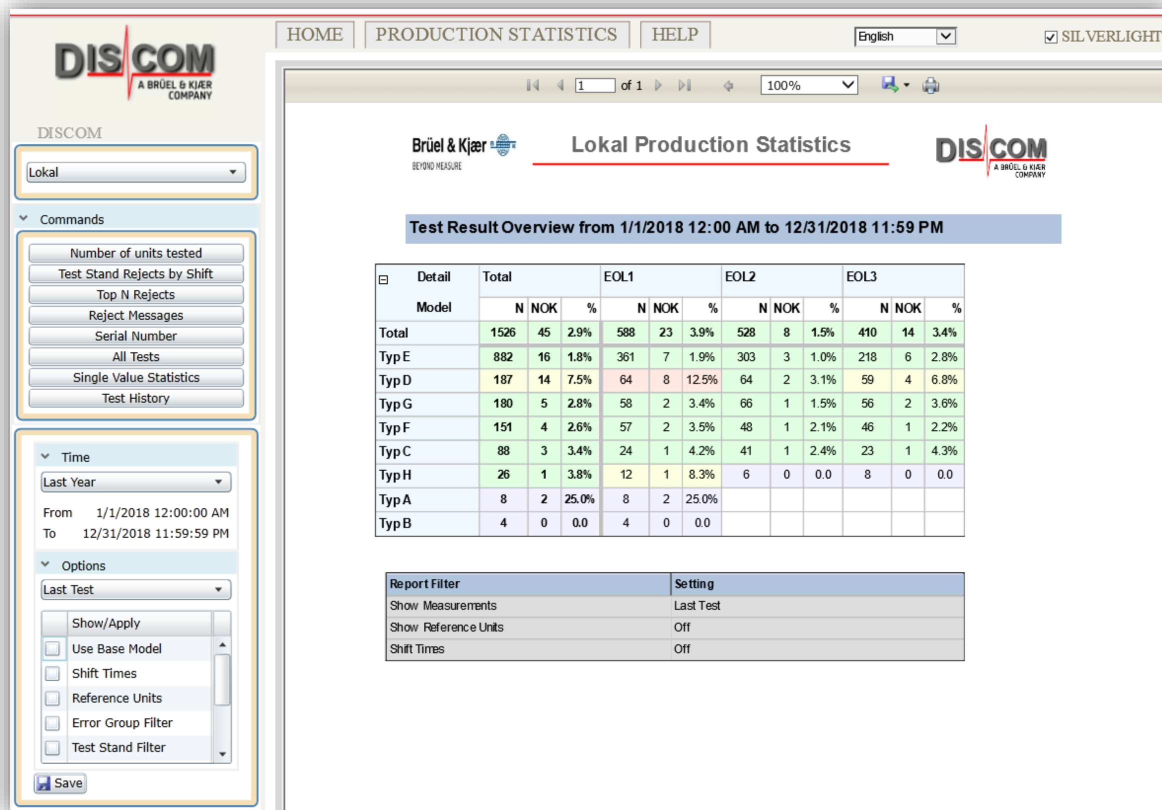
The Web.Pal application itself runs on a server computer, which is in many cases identical to the result database server.

Web.Pal was designed to assist you in identifying and solving all kinds of production problems.

The starting point for different ways of analysis is the production statistics, which displays for all test stands and types the production numbers and fault rates.

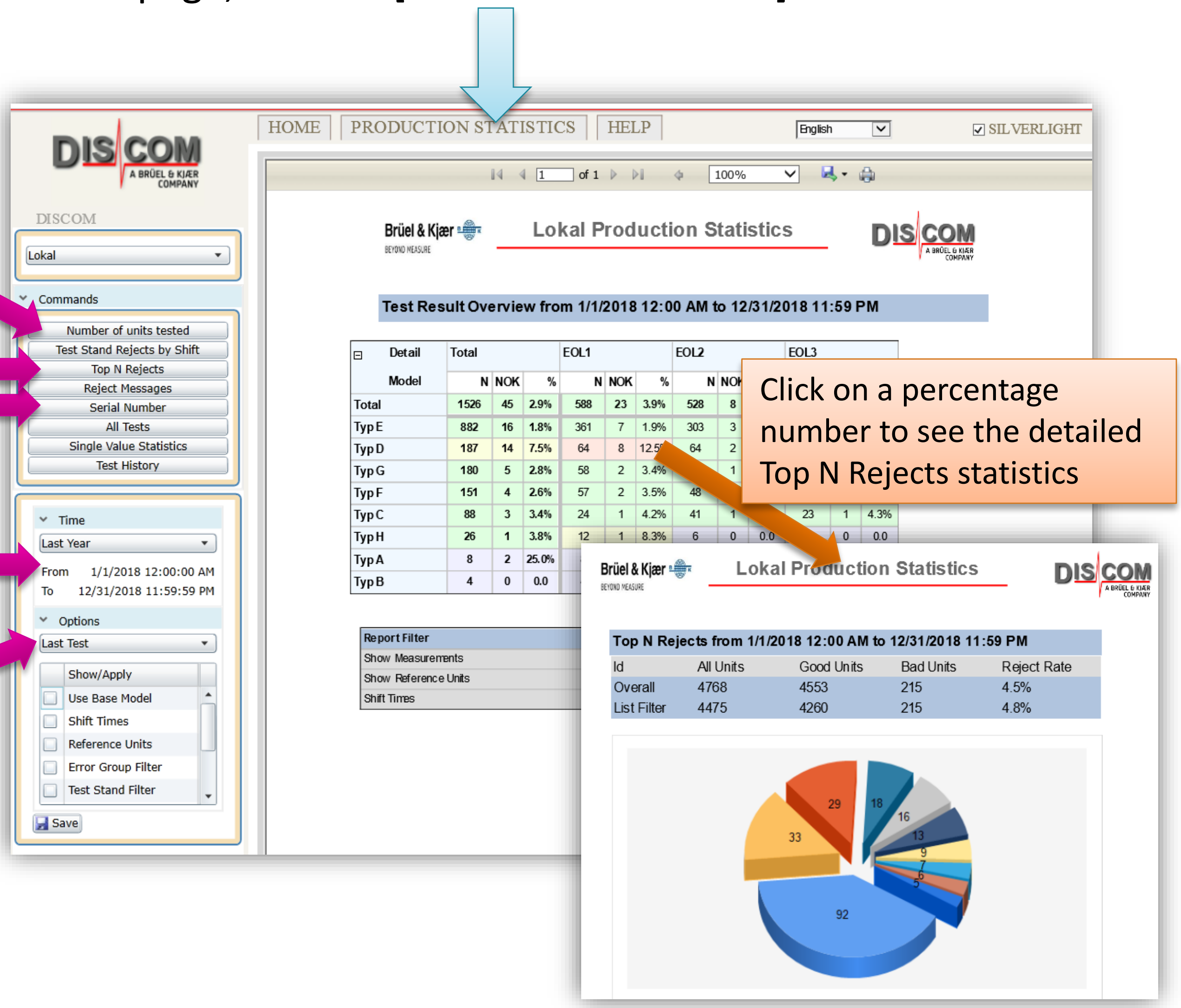
You can select specific time ranges for your analysis, exclude test stands or certain error types, and use a bunch of additional options and filters.

Just click on a percent number to go to the detailed analysis.



Web.Pal: Basic Operations

After connecting to the Web.Pal start page, click on [PRODUCTION STATISTICS] in the title bar to get to the main page:



[**Number of units tested**] gets you to the production statistics tabular overview.

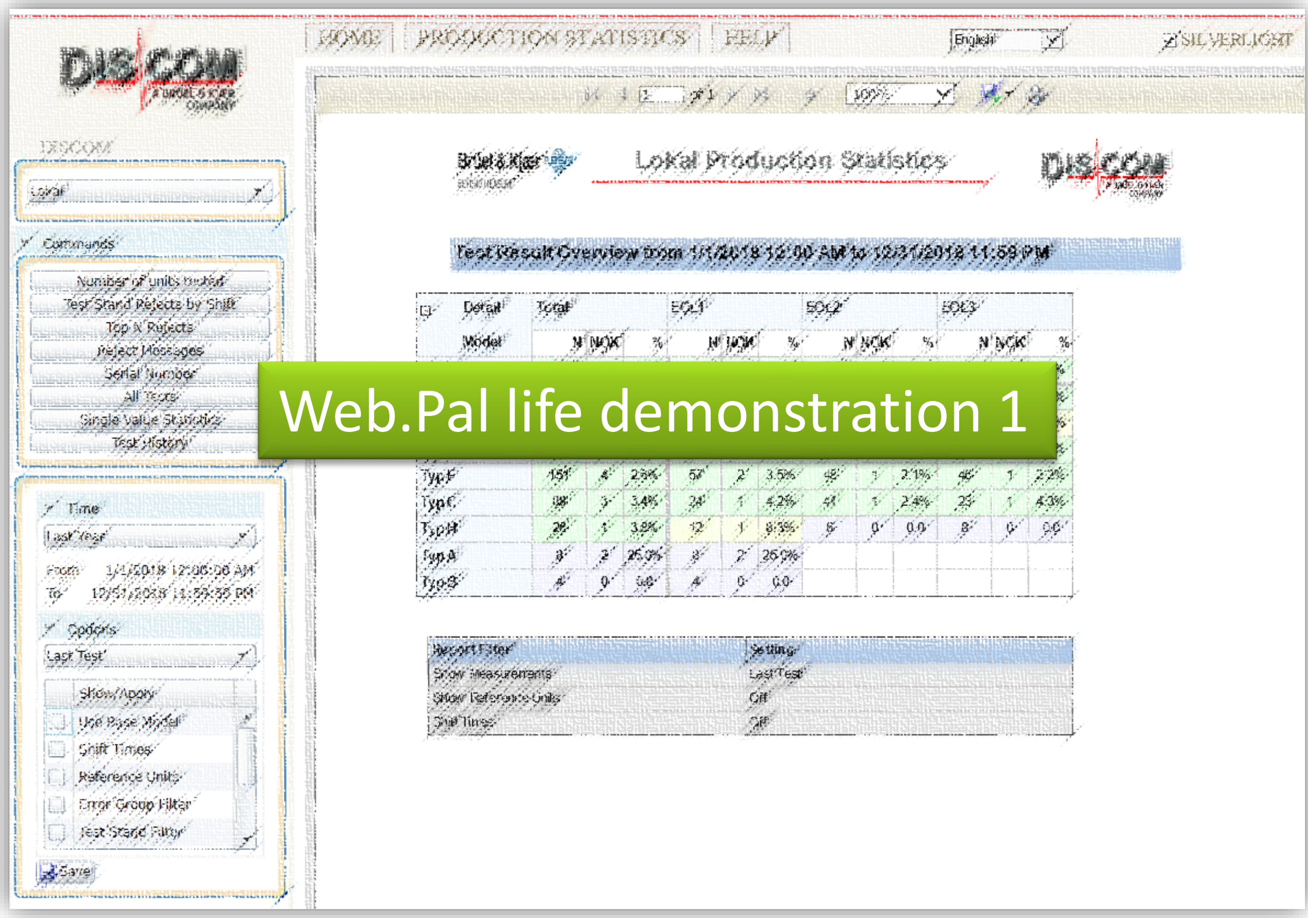
[**Top N Rejects**] directly links to the reject statistics pie chart.

[**Serial Number**] lets you find all results for a certain serial number.

Set the **time range** for which you want to see the statistics.

Test Repetition Options:
First Test: this looks at the first test for each serial number
Last Test: this is your final production result
All Tests: includes all repetitions.

Demo



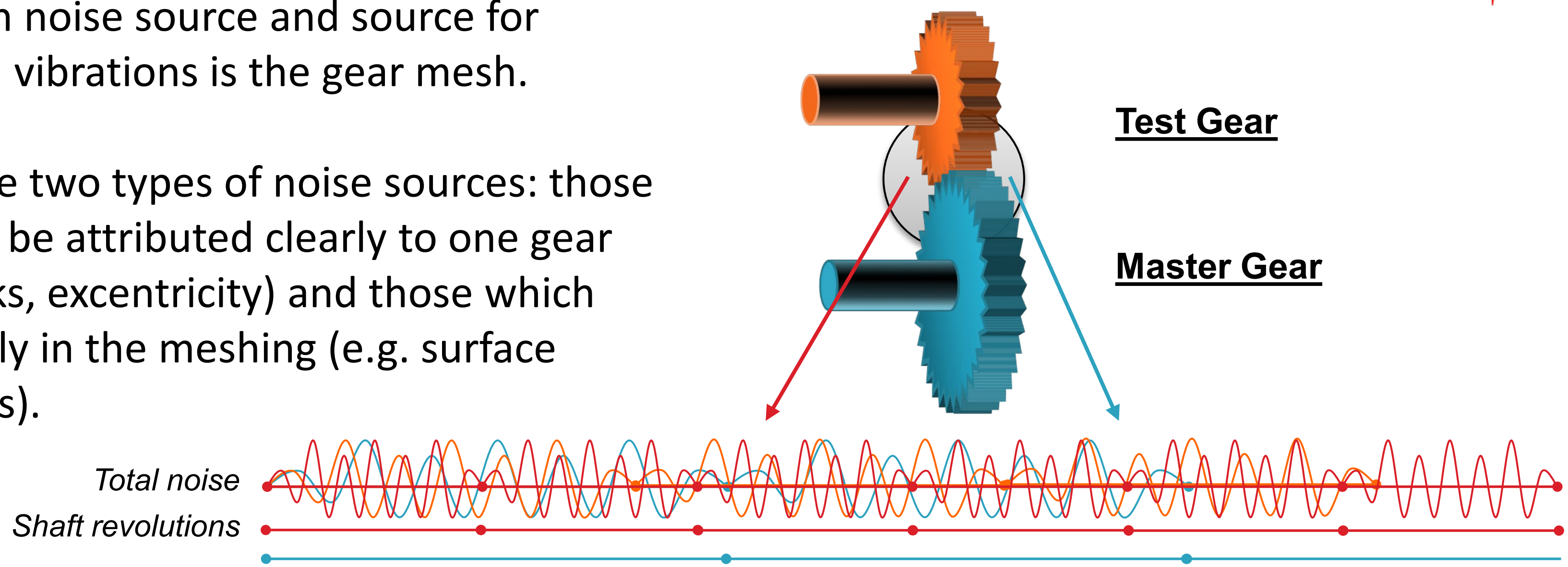
Analysis Methods

To be able to understand the top N defect statistics of Web.Pal, we have to look into the analysis methods.

Rotational Synchronous Noise Analysis

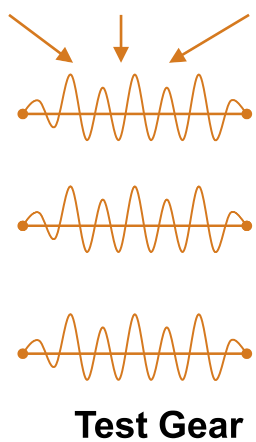
The main noise source and source for torsional vibrations is the gear mesh.

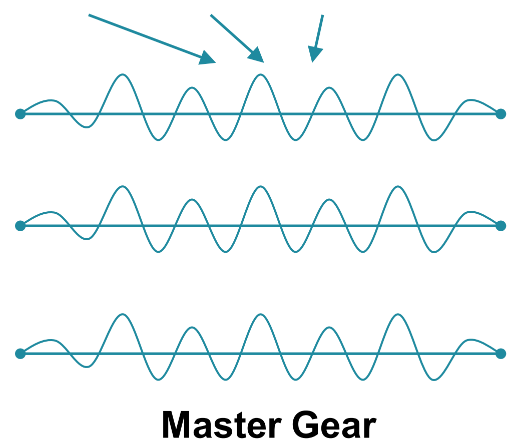
There are two types of noise sources: those who can be attributed clearly to one gear (e.g. nicks, excentricity) and those which show only in the meshing (e.g. surface problems).



Rotation-synchronous order analysis:

The signals are sampled synchronous to the shafts (for each shaft independently).



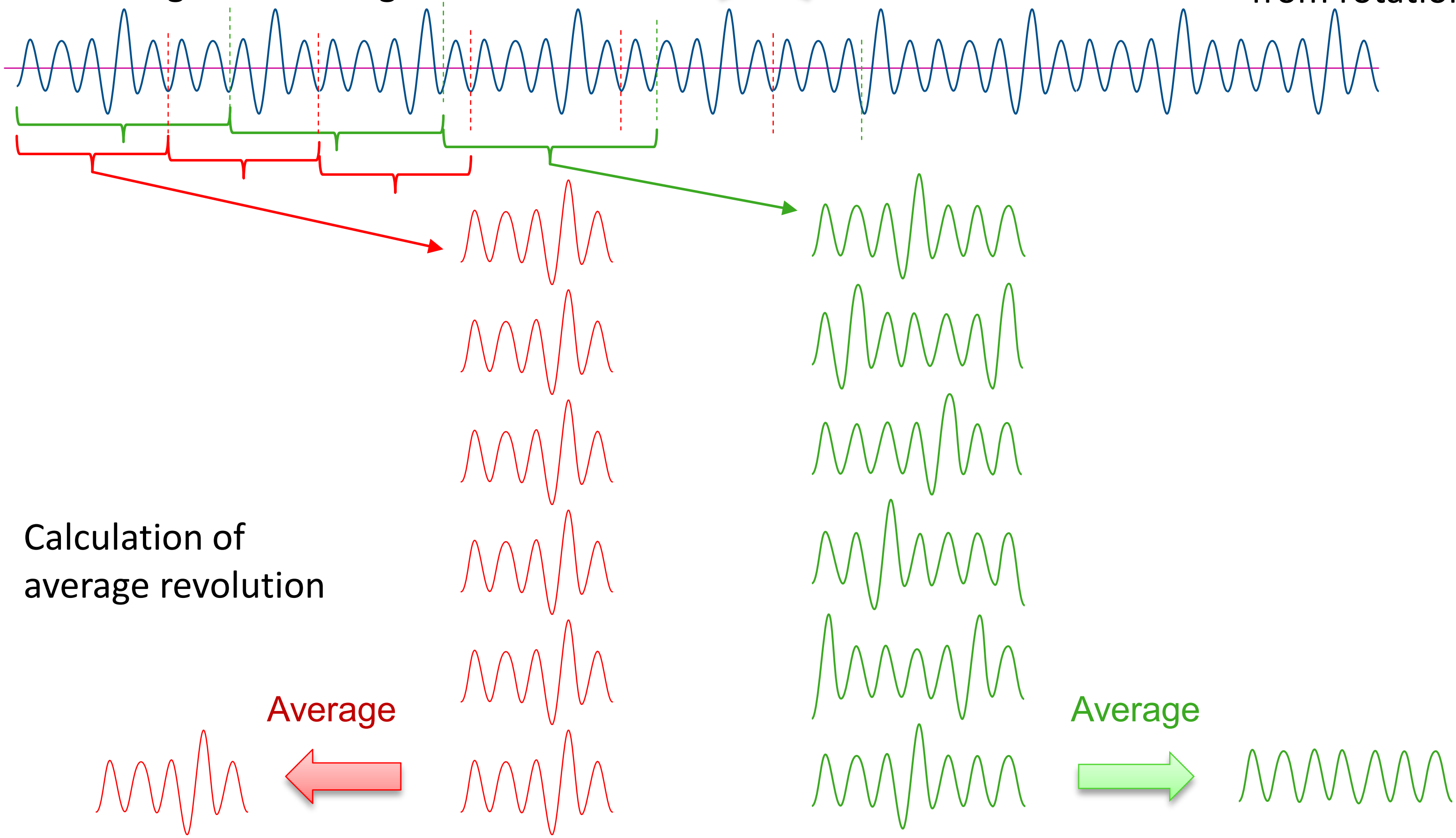


Rotationally Synchronous Analysis: Principle

Example: gear mesh with 5 and 7 teeth

Partitioning of source signal into revolutions

Duration of revolutions is calculated from rotational speed.

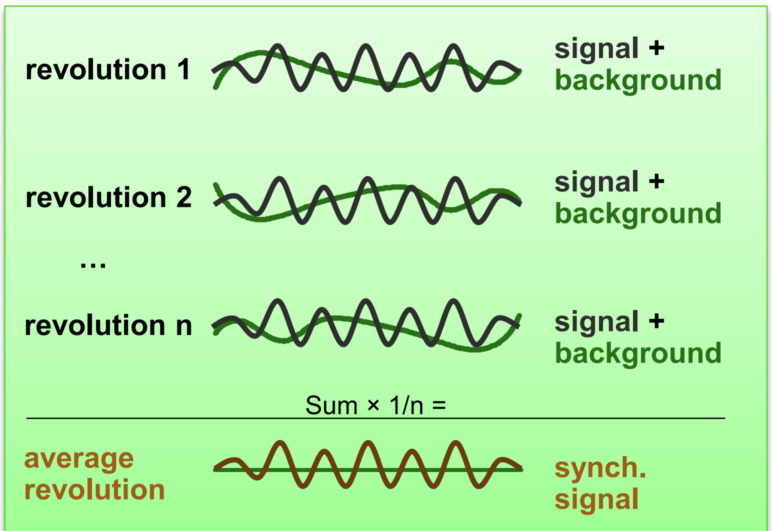


Calculation of average revolution

Separation of Noise Sources

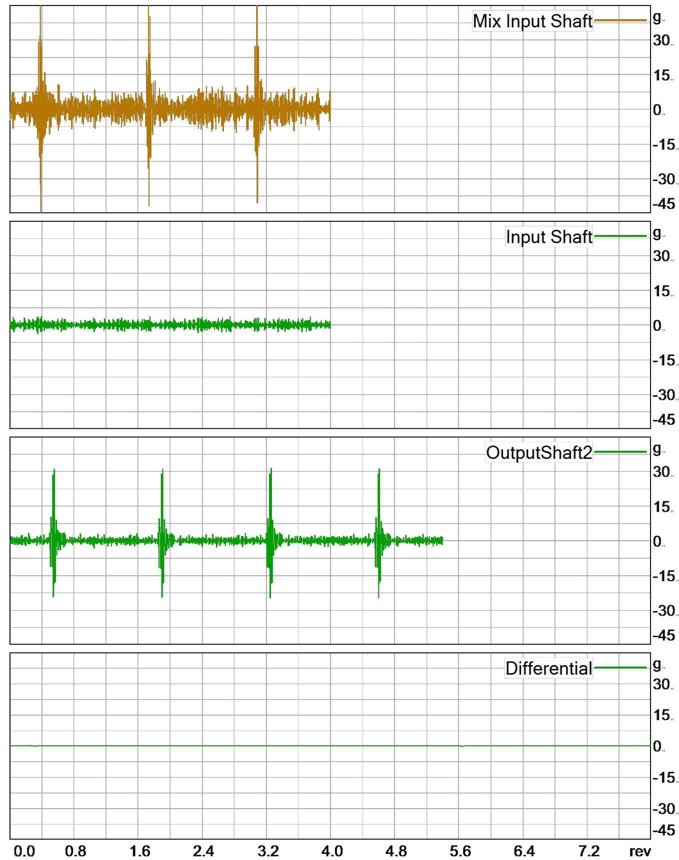
The system calculates a running (exponential) average from about 10 revolutions for each shaft.

This way, all noise components which do not repeat in each revolution are averaged out, so only the rotationally synchronous noise components remain.



Time Signals

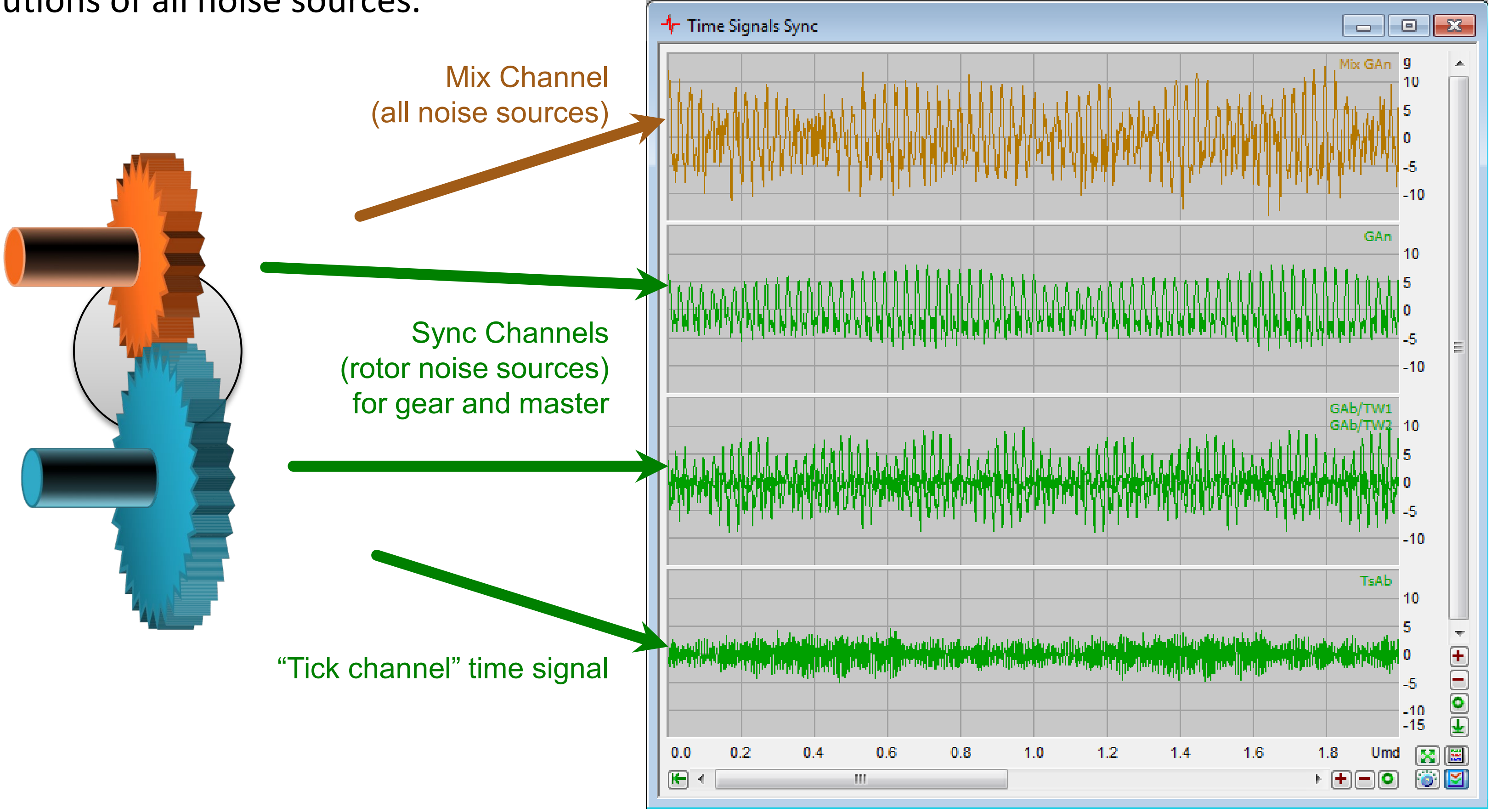
07-11-2013 17:07
Nick on intermediate shaft



Processing Channels

TasAlyser computes for each rotor (and each sensor) one **synchronous channel**, which shows the acoustical properties and defects of that shaft.
These channels are labelled for example „Input Shaft Sync“.

In addition, the **Mix channel** is processed without rotation averaging, so it contains the contributions of all noise sources.

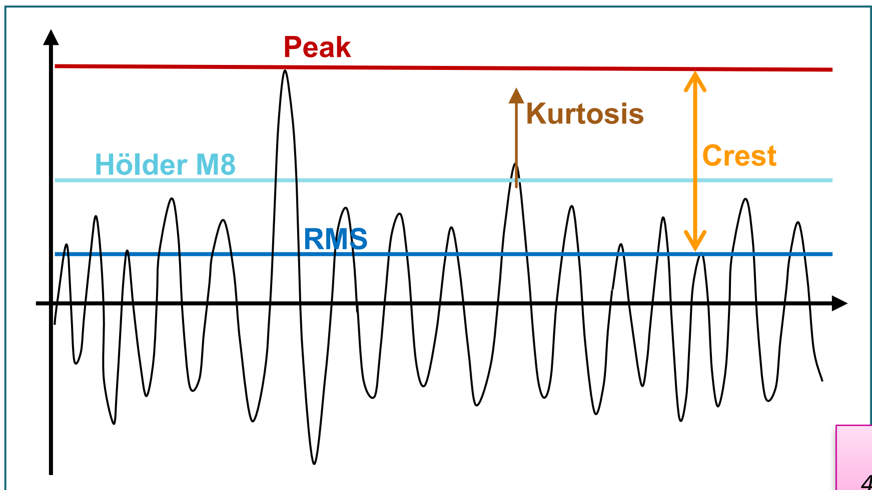


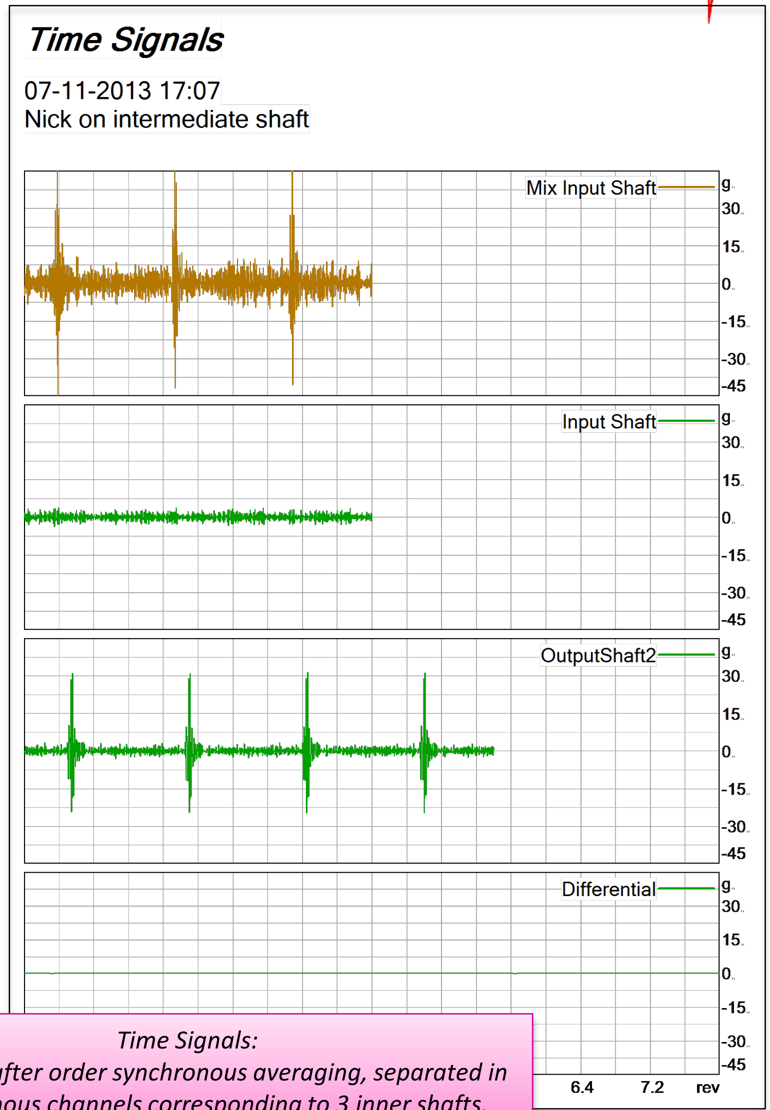
Energy Metrics from the Time Signals

Rotational synchronous averaging separates the synchronous channels. The time signals of the averaged rotations are processed for the detection of nicks.

The values computed from the time signals are

- overall energy (**RMS**)
- highest value (**Peak**)
- **Crest** value (= Peak / RMS)
- **Kurtosis** (fourth moment of signal distribution)
- **Hölder Mean** (like RMS with higher powers)



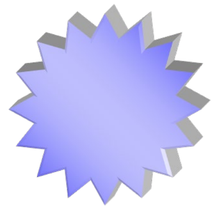


Time Signals:
4 rotations after order synchronous averaging, separated in 3 synchronous channels corresponding to 3 inner shafts.

Orders, Frequencies, Harmonics

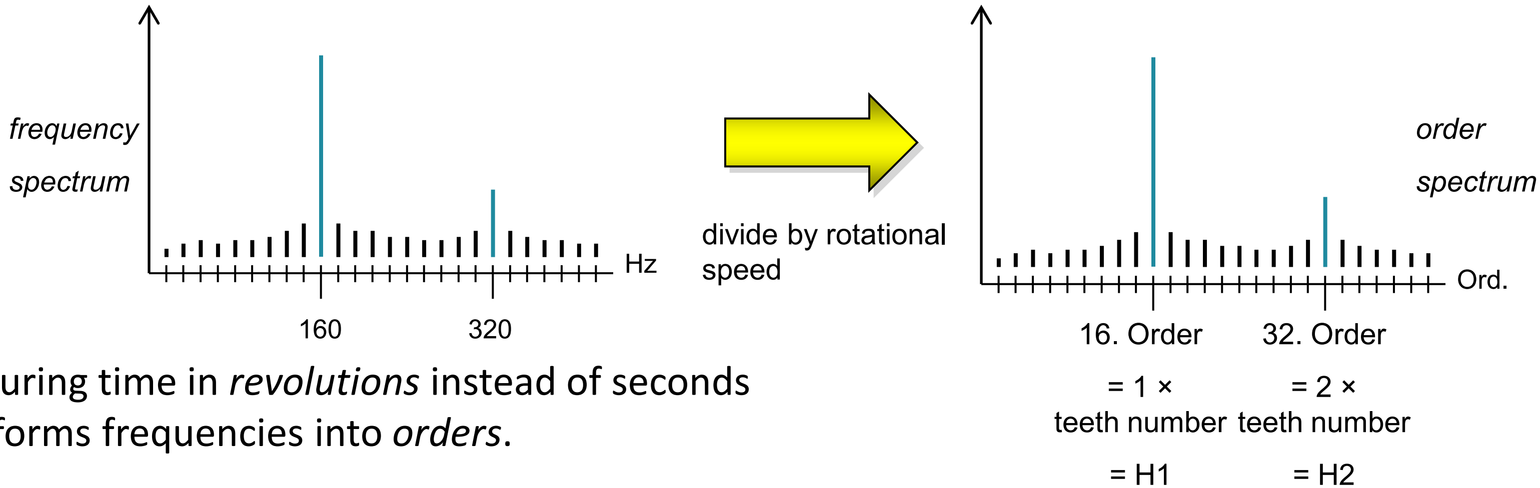
What is **Order Analysis**?

Gear with 16 teeth:



Rotating at 600 rpm = 10 rotations per second = 10 Hz

Gear mesh frequency = no. teeth x rotational frequency = 160 Hz



Measuring time in *revolutions* instead of seconds transforms frequencies into *orders*.

Therefore, order spectra are independent of the rotational speed, order spectra lines stay in place even in speed ramps.

The order corresponding to the teeth number is called „first harmonic“, labelled „H1“. Double teeth number is „second harmonic“ or „H2“ and so on.

The position of an order in the order spectrum is independent of the rotational speed!

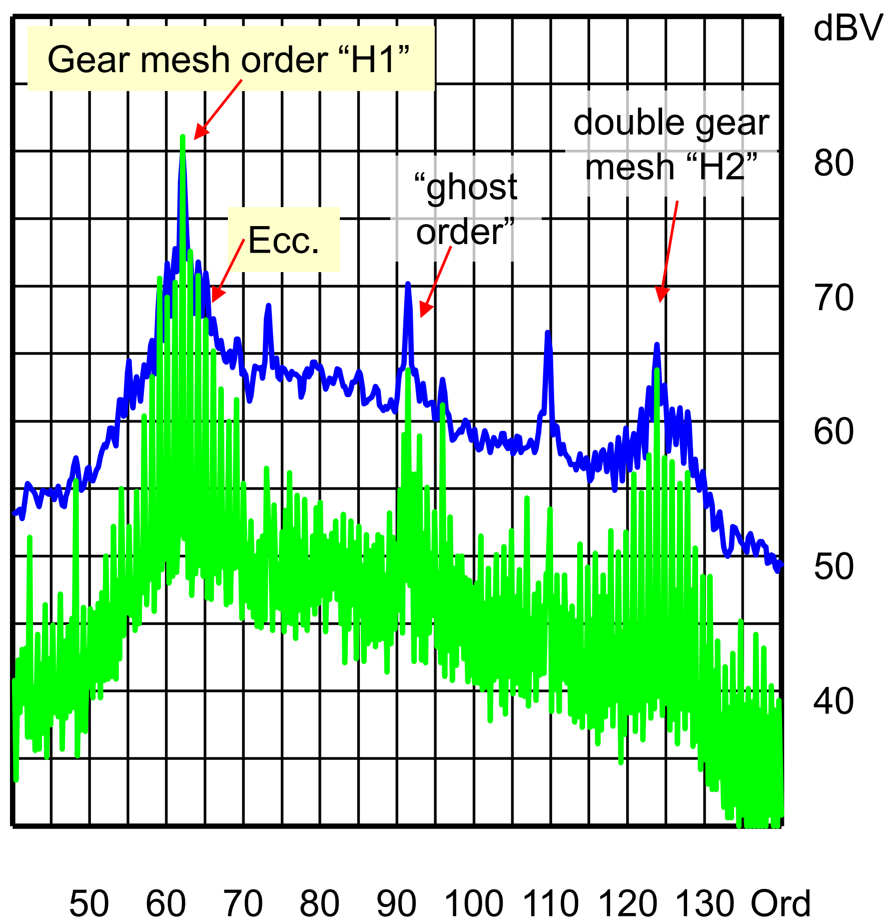
Order Spectra

The rotationally synchronous analysis generates periodic (cyclic) signals. This corresponds to the cyclic nature of the gear sets. These signals can be transformed into the spectral domain without any time domain windowing, thus giving exact order spectra.

This allows for high spectral resolution with up to 60 dB SNR. Eccentricities (Ecc) can be easily distinguished from the gear mesh orders. All kinds of modulation can be detected. The noise components can be traced to their origins.

Blue: Conventional spectrum with Kaiser Bessel Window.

Green: Rotationally synchronous order spectrum without windowing function.



Processing Channels Spectra

In TasAlyser, order spectra are computed in parallel for all processing channels (and sensors).

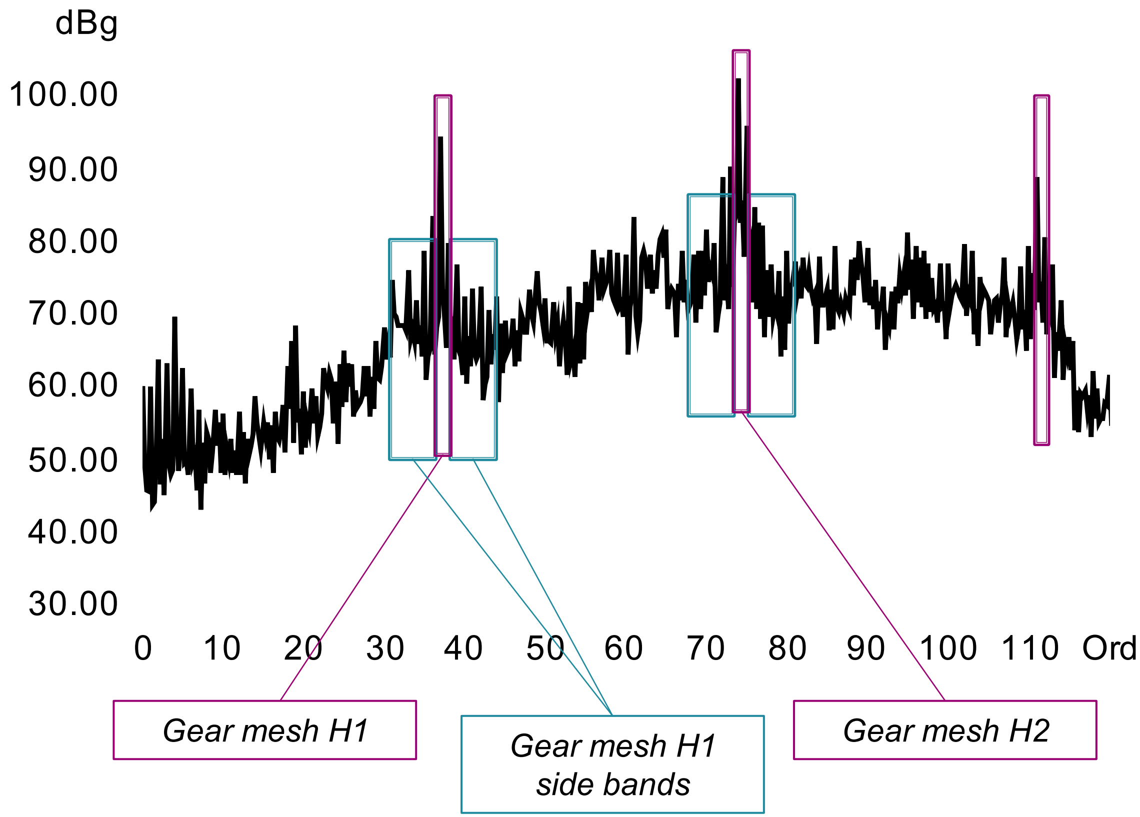
This gives order spectra for each rotor plus the Mix spectrum:

In addition, "classical" fixed frequency FFT channels (labelled "FixFs") are processed in parallel.

Values from Order Spectra

From the order spectra, at positions of interest (e.g. gear mesh orders, side bands) **spectral values** are extracted.

These values generate their own statistics, and separate limits can be applied.



For setting up the spectral values in the data base, positions are given relative to gear mesh frequencies (H1, H2 and so on).
The measurement program calculates the resulting order positions using the kinematics model of the transmission.

For order bands there is the choice between extracting the maximum or the energetic sum.

Order Tracking

The components of a transmission that cause the most prominent spectral components are its gear mesh orders. A finely tuned evaluation of the resulting audibility inside the car is possible with **order tracks**.

The fundamental harmonics of the principal gear mesh(s) are recorded over rpm speed (or torque). Limit curves can be adjusted according to the car's sensitivity at different speed ranges.

All kinds of spectral values (single orders, sums of orders or complete bands) can be tracked. Different kinds of evaluations are possible.

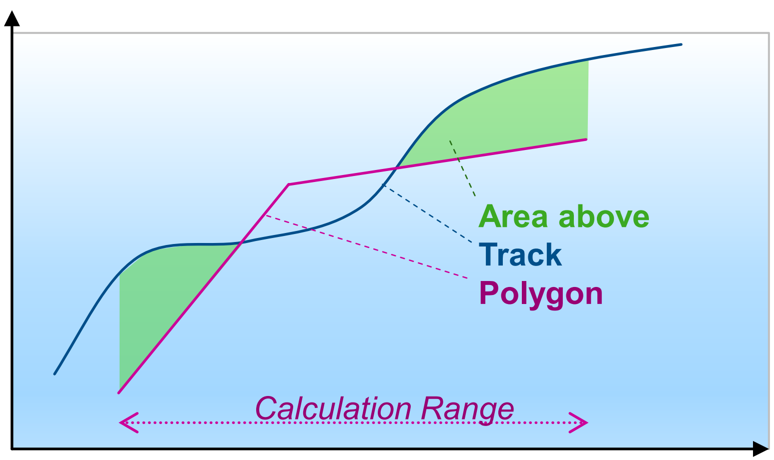
Speed Band Evaluation

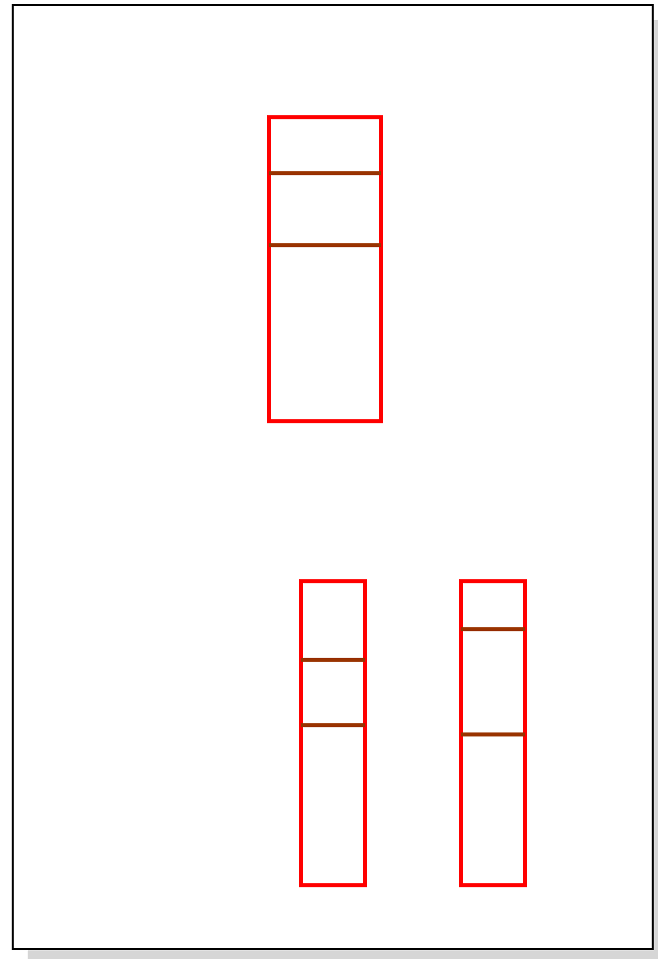
For **Speed Band evaluation**, rpm speed intervals are defined (e.g. 3500 – 4700 rpm). The evaluation takes the maximum of an order track within the speed band and compares this to a limit value.

Thereby, gear mesh noise and other noise sources can be evaluated in critical speed ranges with easy-to-manage single values.

Speed bands can be defined individually for each test step and order track; multiple speed bands are possible.

A more advanced form of speed band evaluation is evaluation of the area between track and a reference polygon.





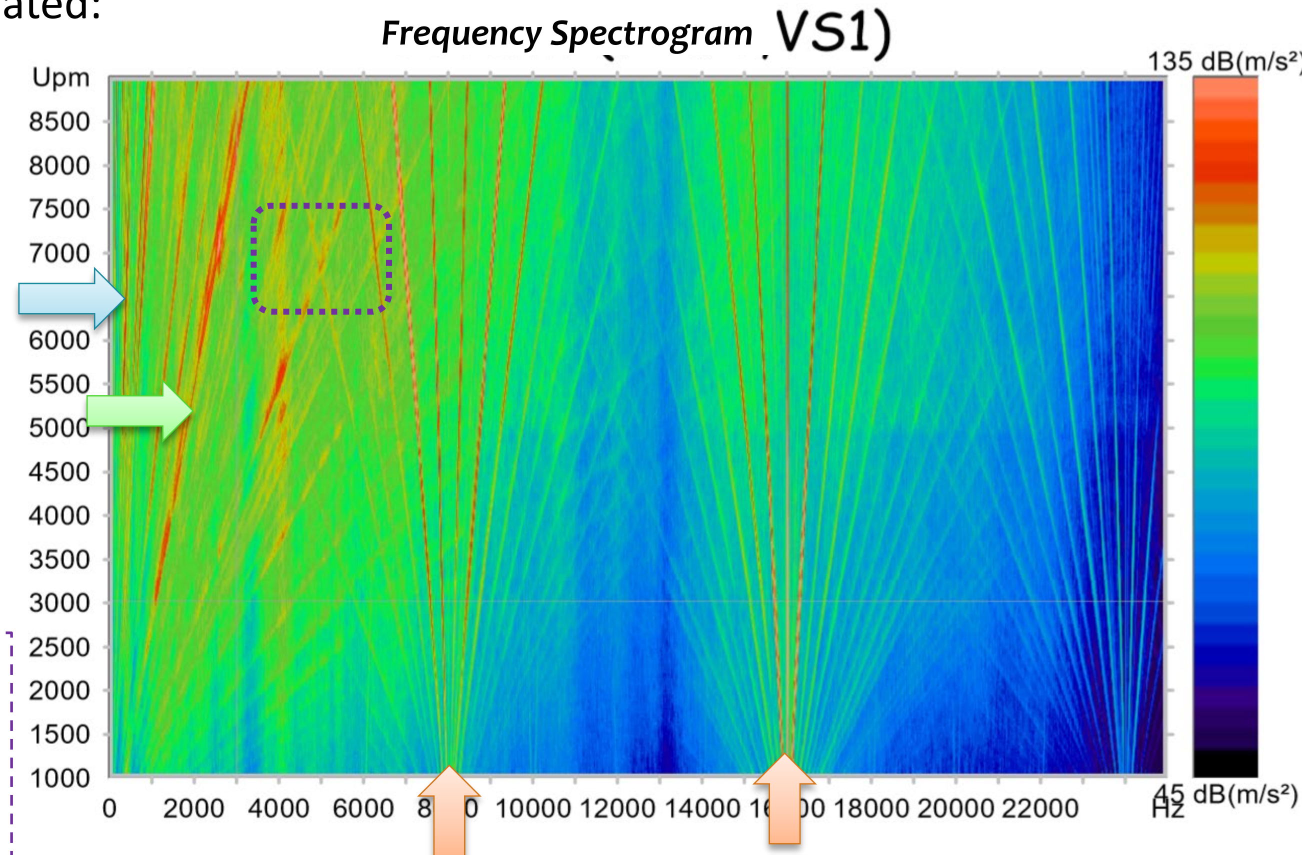
E-Drive Analysis

In E-Drive test, noise components from the transmission and the electric motor can be identified and separated:

Motor orders:
Slot orders
Imbalance
Bearings

Transmission orders:
Primary step
Final drive
Harmonics

At certain speeds, transmission orders and inverter orders will cross and enhance each other.



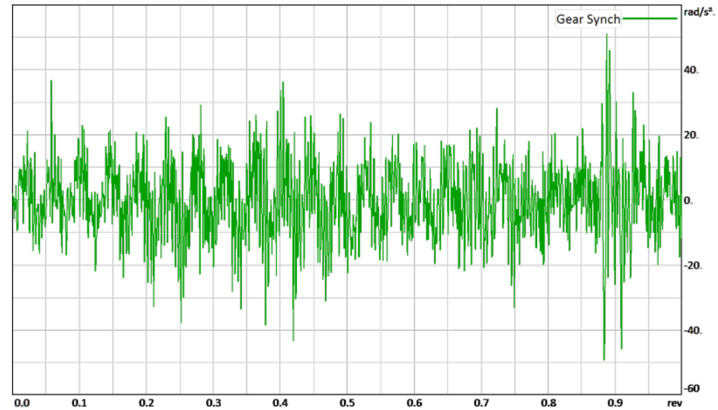
Inverter frequencies:
Base frequency 8kHz
Modulation side bands
Harmonics

Tracks of motor orders, transmission orders and inverter side bands can be measured and evaluated independently.

"Tick Channel" Analysis

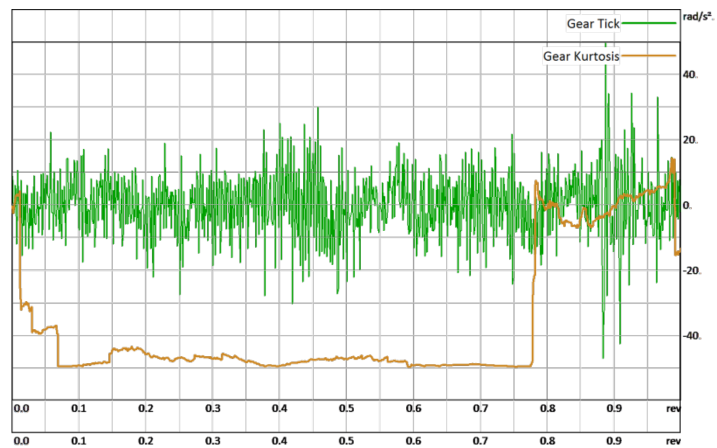
This channel uses a special processing chain to better detect ticking noises (from nicks), even in the presence of loud gear mesh noise.

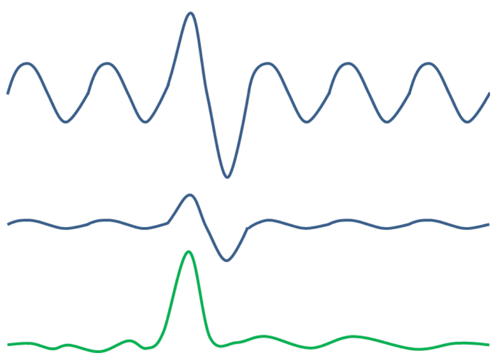
The analysis is based on a rotational synchronous time signal.



From this signal and based on the teeth number known from the parameter data base, the "average tooth" is calculated and subtracted from all teeth. (→ *Time Signal Tick*) This way, deviations from the "average tooth" are emphasized.

On the Tick channel signal, a running Kurtosis is calculated (*Kurtosis Tick*), which detects these deviations. The peak and Crest values of the Kurtosis curve are compared to limit values.

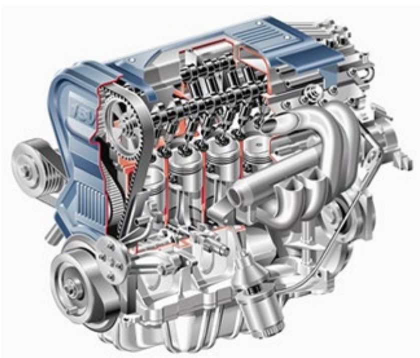


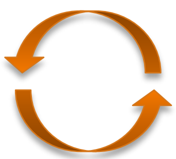


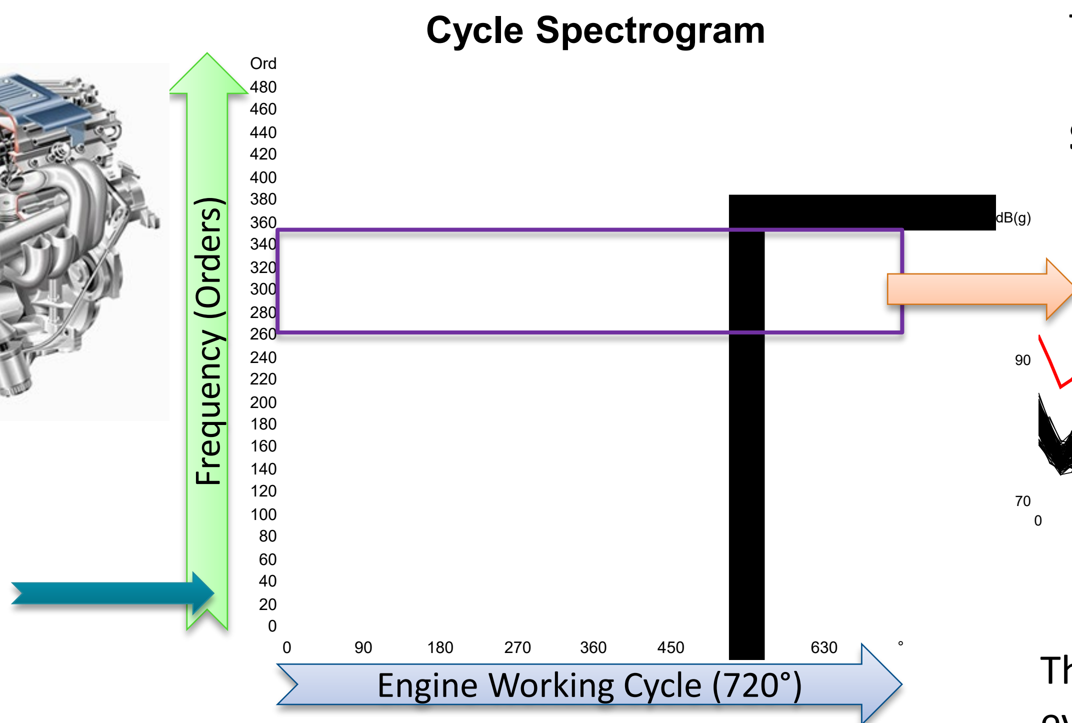
Combustion Engine Analysis

Combustion Engines produce instationary noise patterns which cannot be covered by simple spectral analysis.

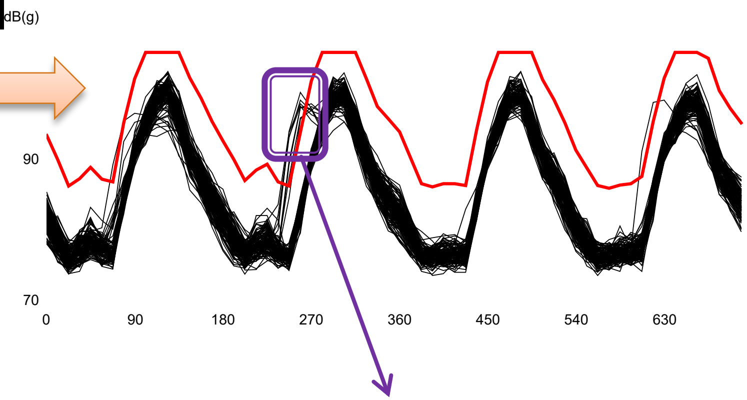
A short time spectrogram calculated over the working cycle of the engine (720° crank shaft) allows the detection of pulse noises correlated to the different engine components.







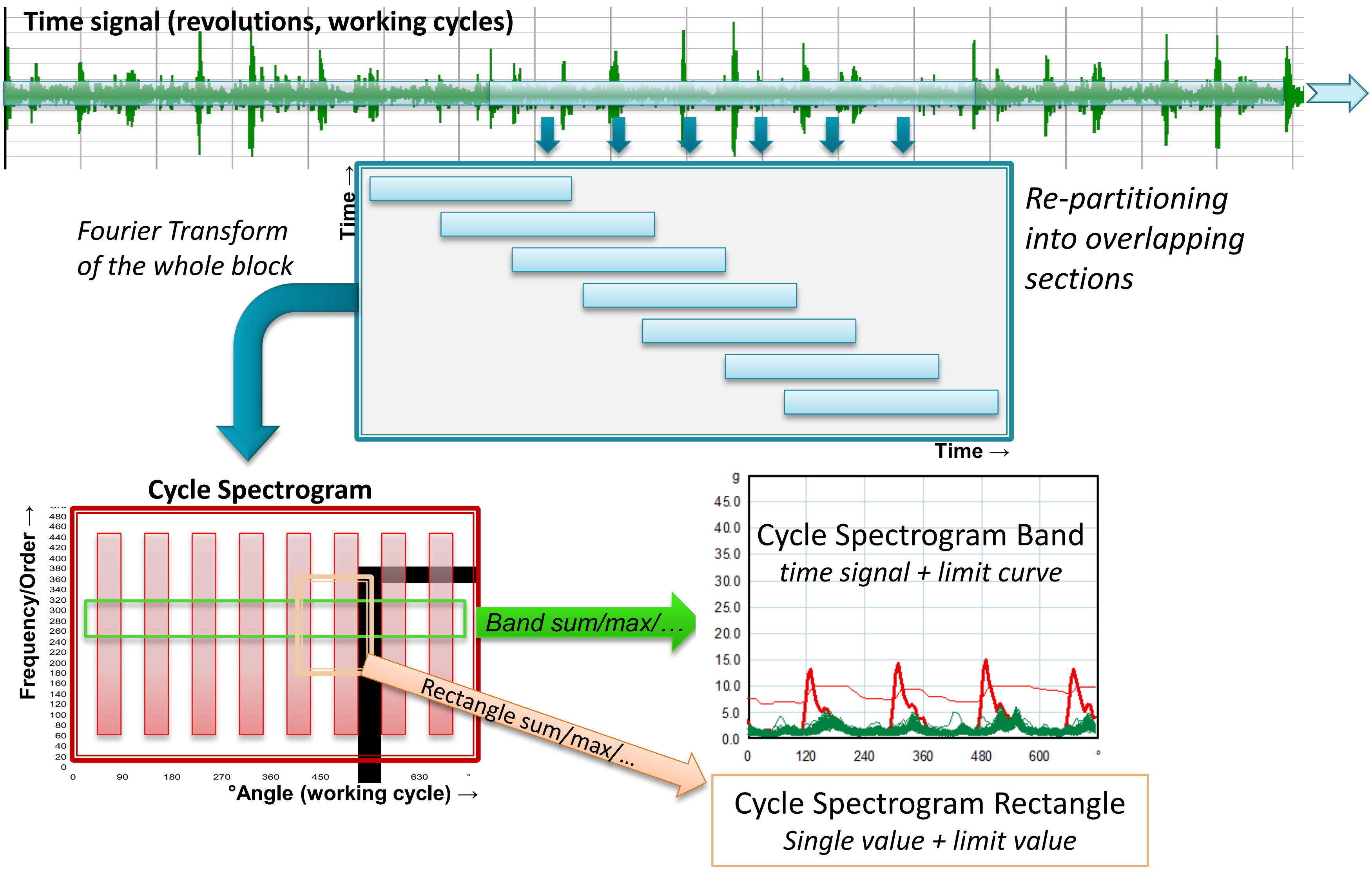
The energy in selected frequency bands is added up to create **Cycle Spectrogram Band** curves:



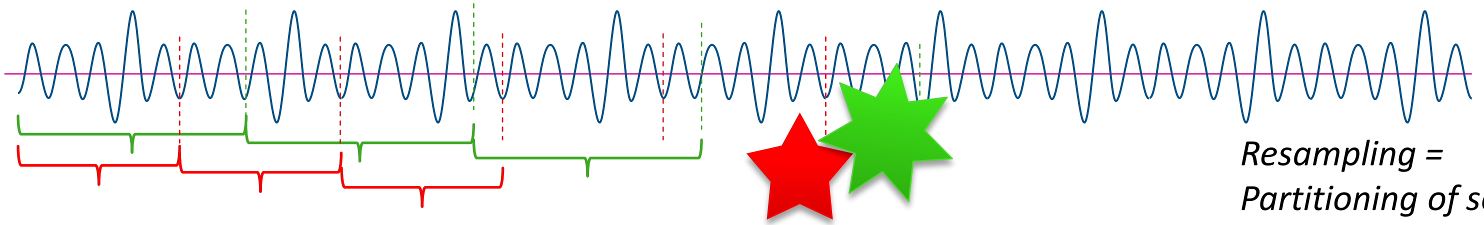
The Cycle Spectrogram Bands are evaluated against limit curves running over the angular position. This allows the detection of defects correlated to cylinders, valves etc.

Cycle Spectrogram

The Cycle Spectrogram is a short time spectrogram aligned to the engine working cycle.

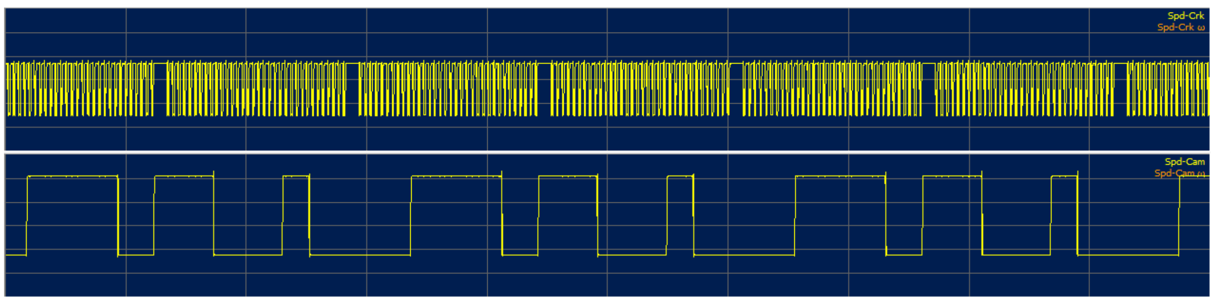


Synchronization to Working Cycle



Resampling =
Partitioning of source signal into revolutions with fixed number of samples/revolution

- Each output block of the Resampling must start with a 0° sample position
- Necessary: 0° information, in addition to regular speed
- The 0° position markers are “attached” to the regular speed data
- Can also be used in gear testing application (mark tooth with nick)
- Source of 0° information can be a normal pulse signal (1 pulse per revolution = TDC signal), or the cam shaft pulse pattern.

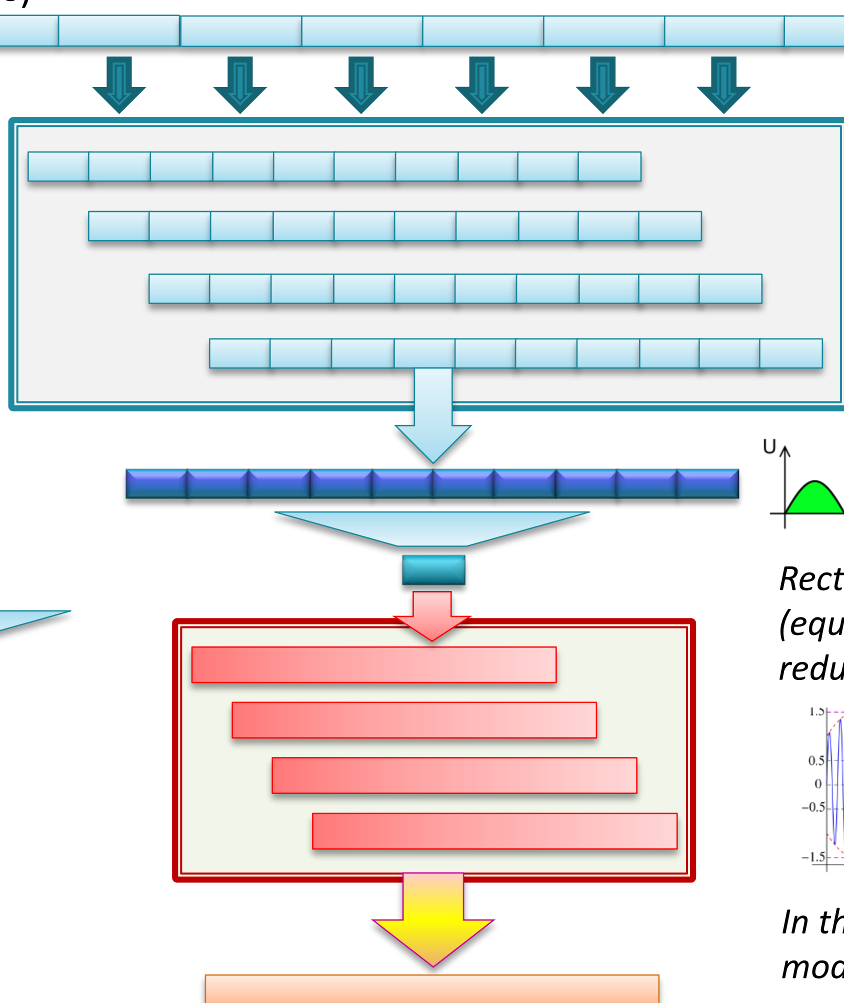


Crank shaft speed signal: 60-2 pulses/rev.

Cam shaft speed signal: pattern of long/short pulses

Modulation Detection using Envelope

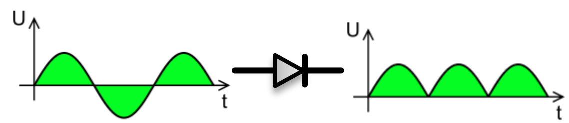
Time signal (revolutions)



Re-partitioning into long, overlapping sections

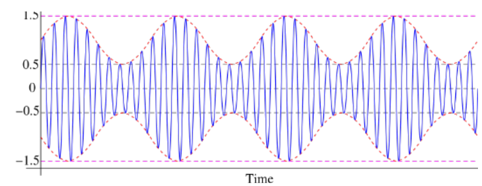
Typically, each section is 16 – 32 revolutions long; section advance is one revolution.

Rectification



Downsampling (32:1)

Rectification and downsampling (equivalent to low-pass filtering) reduces the signal to it's envelope.



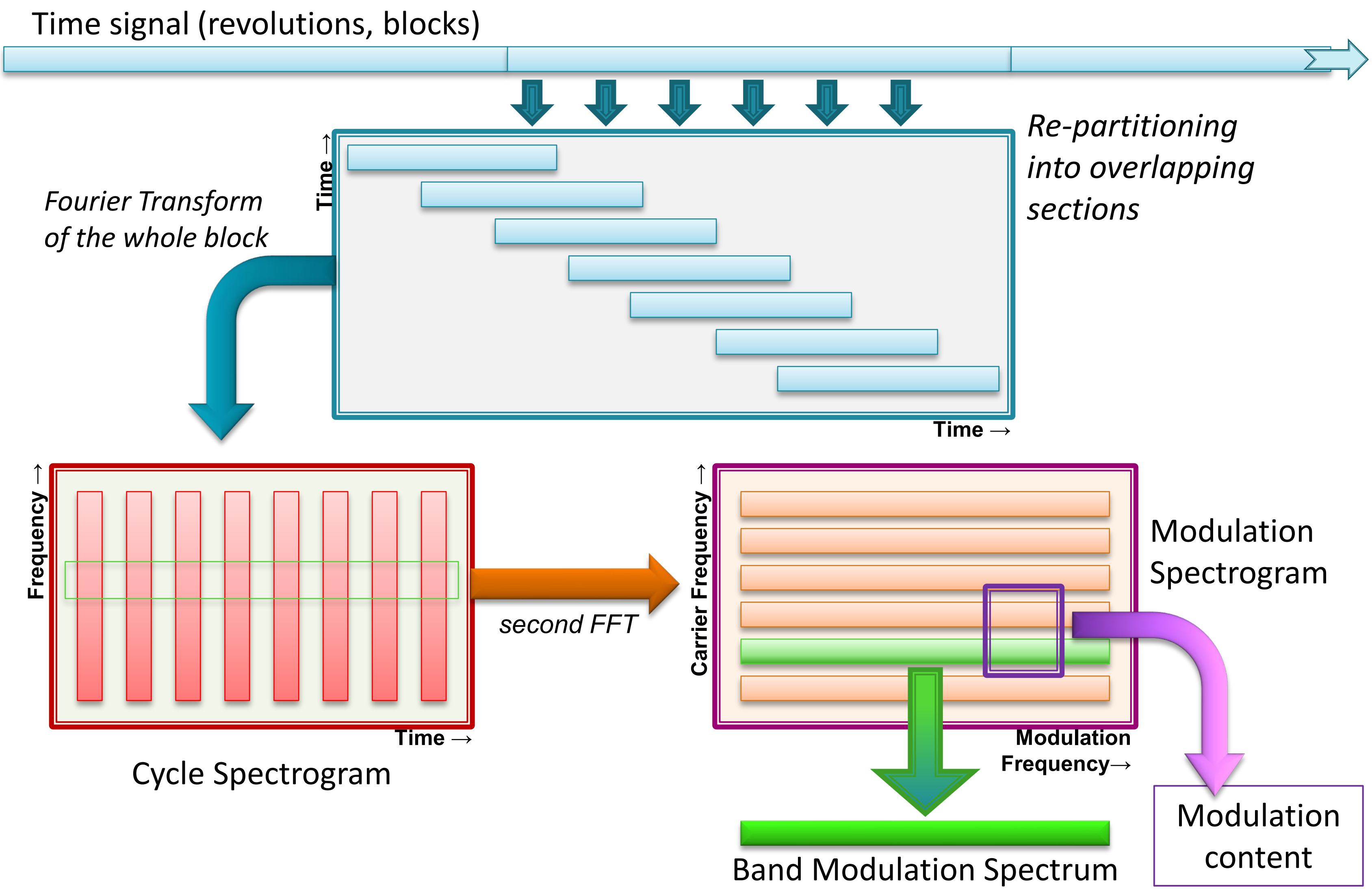
Spectrum (FFT)

Averaging

Modulation Spectrum

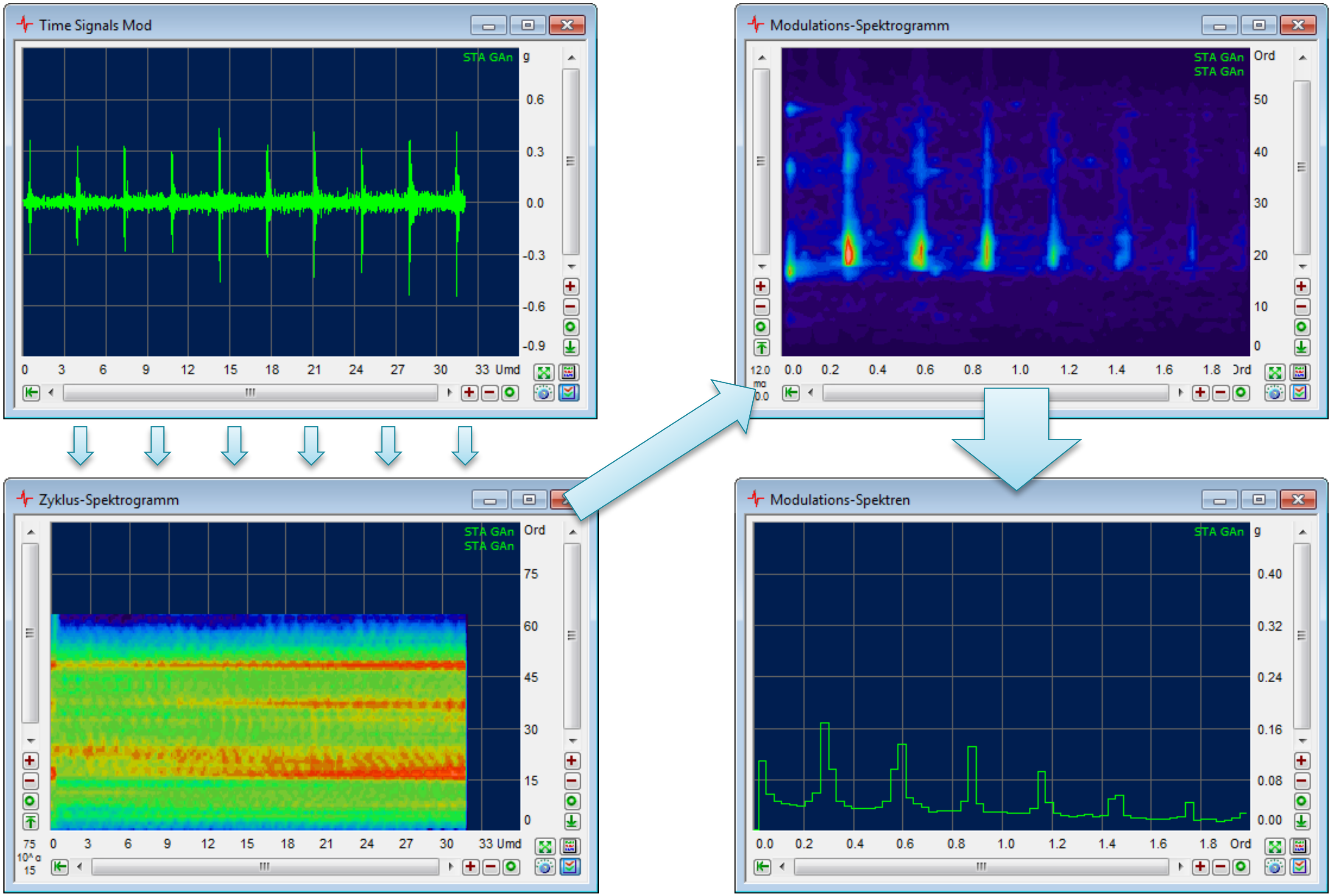
In the modulation spectrum, modulation frequencies (orders) can be found.

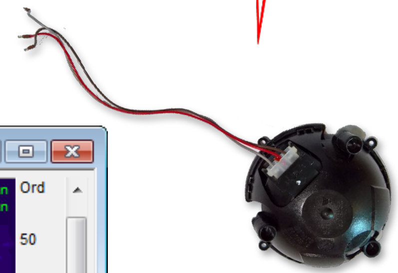
Modulation Spectrogram



Modulation Analysis

Steps of Modulation Analysis, very useful for actuators

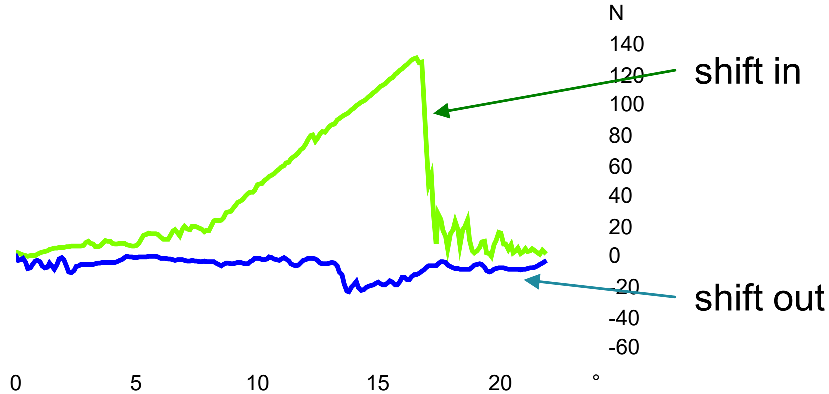


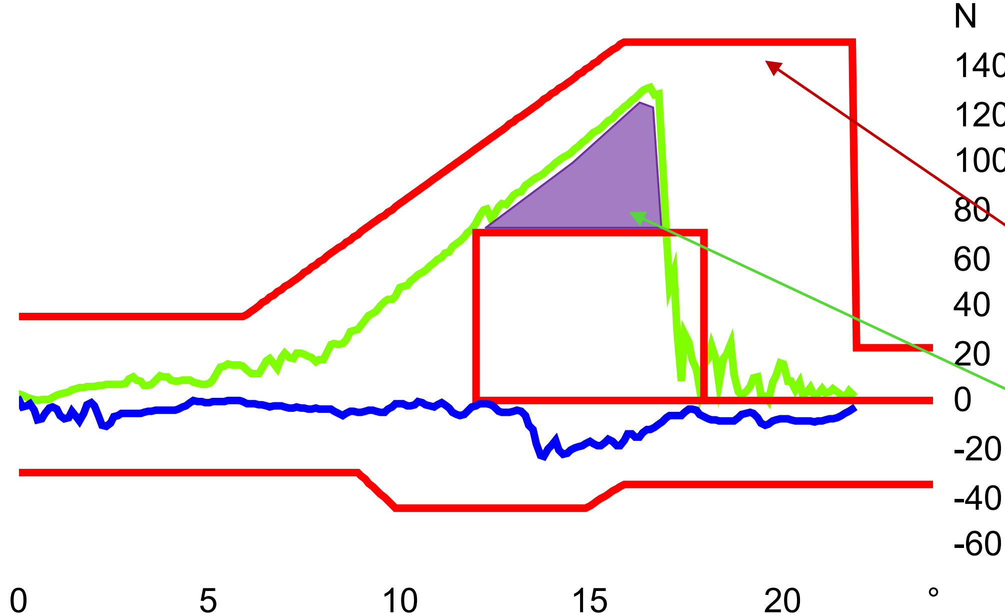


Shifting Force Evaluation

Measurement:

The system measures force and position over time and constructs the curves ***force versus position***, for shift-in and shift-out directions, separated by gears and conditions (like shift up / down)



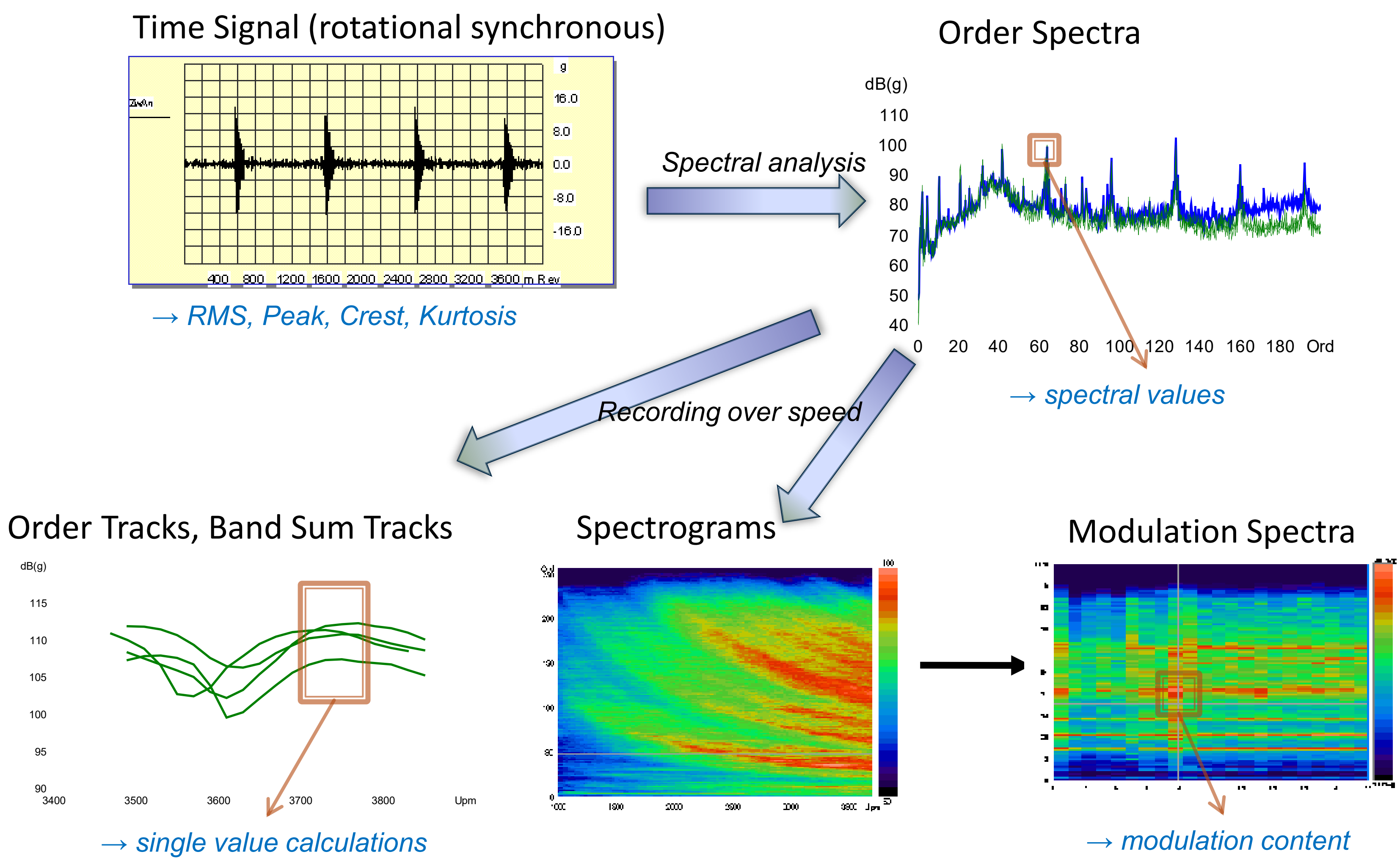


Evaluation:

Shift in and shift out curves are checked against **upper limits** (force too high, blocking shifter).

The shift in curve is checked for **minimum work** (area above threshold) to test for presence of synchronizer ring.

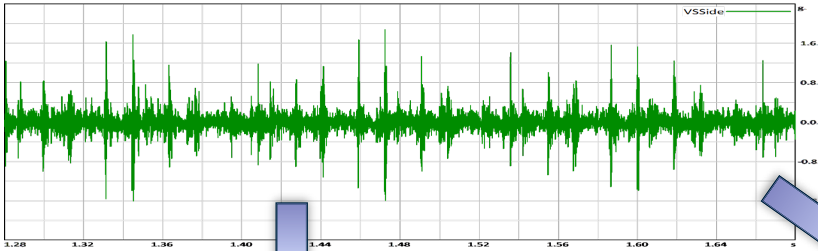
Evaluation Overview – Transmissions, E-Drives



Evaluation Overview – Combustion Engines

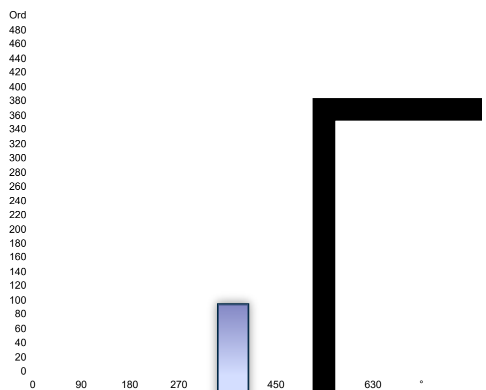
DISCOM

Time Signal (for each sensor)

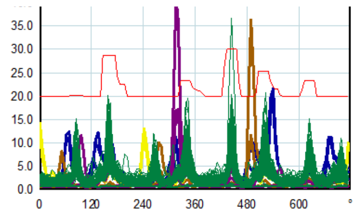


Single Values:
RMS, Peak

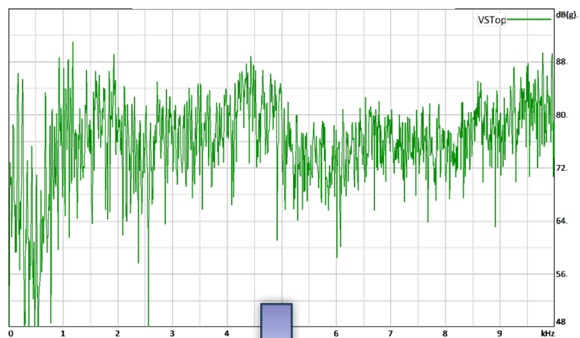
Cycle Spectrogram



Cycle Spectrogram Bands

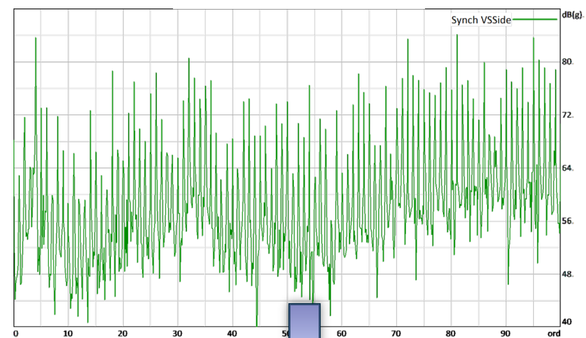


Frequency Spectra



Single Values:
Spectral Values
(Frequency Bands)

Order Spectra

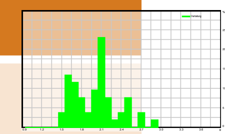


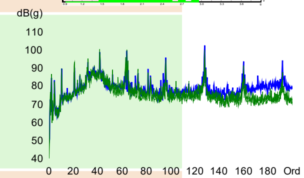
Single Values:
Spectral Values
(Order 2, Order 43, …)

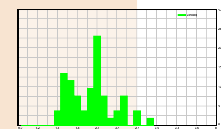
Result Types

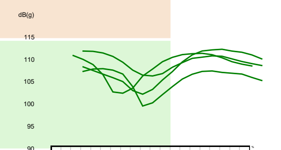
The results can be **single values**, **curves** or even higher dimensional objects like **spectrograms**.

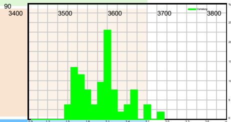
Source	Examples	Result Tyes
Time Signals	RMS, Crest, Peak	Single value
Spectra	Order spectra (synchronous and mix), fixed frequency spectra	Curve (spectrum)
Single orders taken from spectrum (or sums of orders, band sums)	Gear mesh order value H1, side bands, order sum Hx, specifically selected orders	Single value
Orders tracked over ramp	Gear mesh order track, RMS track	Curve (track)
Values computed from tracks	Speed bands, differences	Single Values
Spectra tracked over ramp	Spectrogram	Spectrogram
Short Time and Modulation analysis	Short time spectrogram, Modulation spectrogram, modulation content	Spectrogram → Spectrum / single value

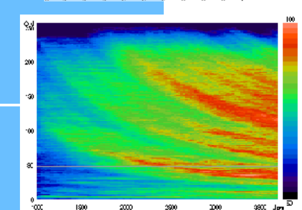












Typical Gear Defects

Separation of Gear Defects

The acoustical signal of one sync. channel contains the components of all gears connected to that rotor. (For example, intermediate shaft has two gears on it.)

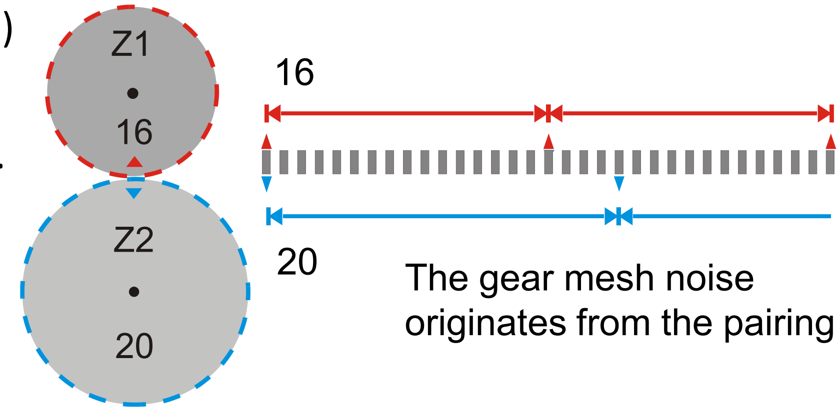
Knowing the transmission ratio, the periodicity of each gear and it's gear mesh order can be calculated. Gear mesh noise originates from the pairing of the gears, not from one individual gear.

Eccentricities and surface defects can be separated because they have cycles that correspond to the originating gear. The following errors can be assigned individually:

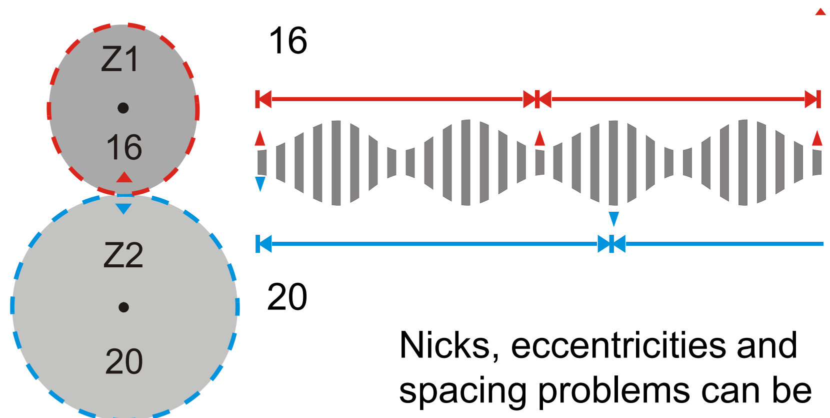
- ✓ Nicks
- ✓ Tooth spacing
- ✓ Surface waves ("Ghost Orders")
- ✓ Eccentricities
- ✓ Deviation from circular shape

Defects resulting in generally increased gear mesh noise are unseparable (like the clapping of hands):

- ✖ General surface problems
- ✖ Contact Problems

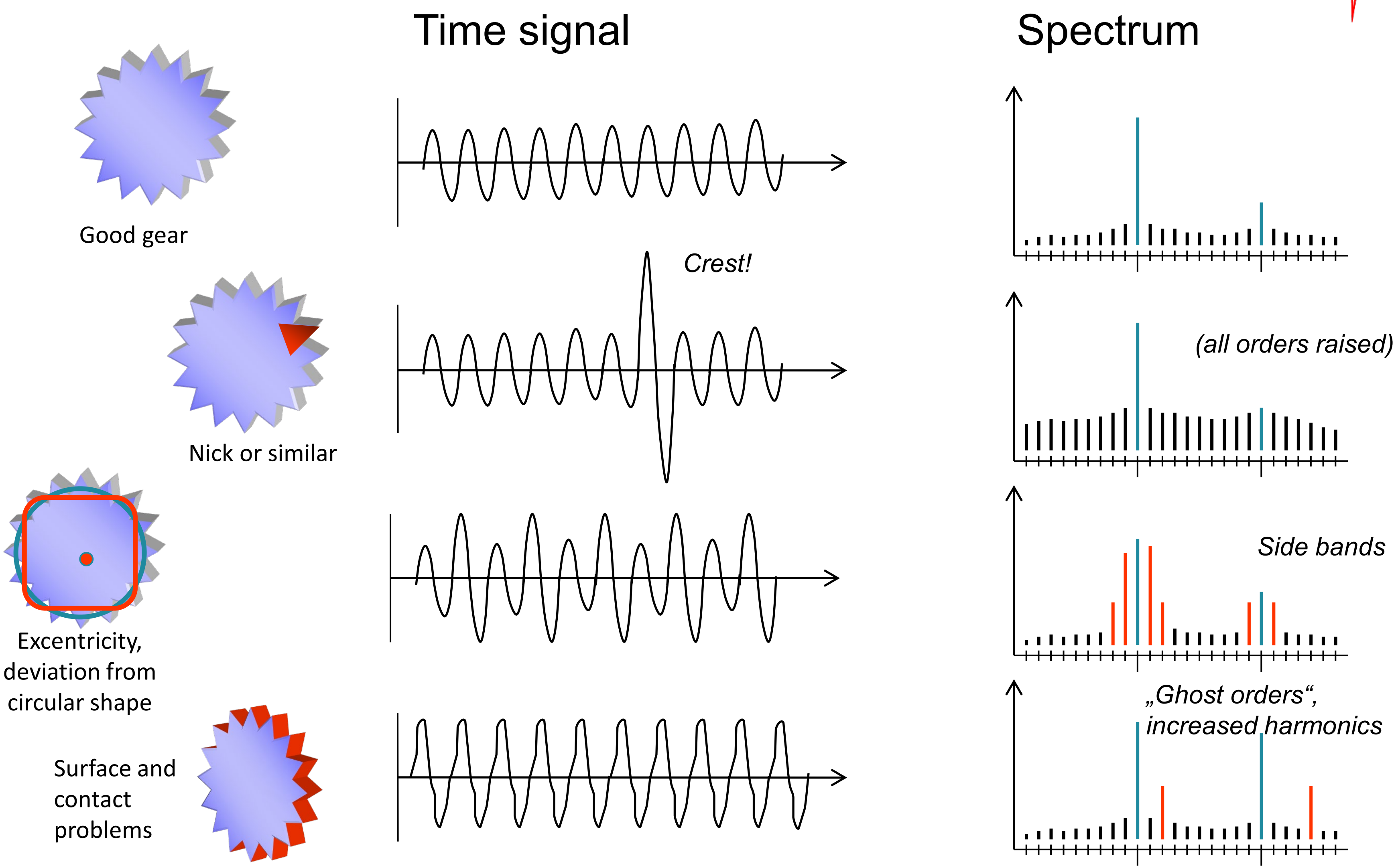


The gear mesh noise originates from the pairing



Nicks, eccentricities and spacing problems can be assigned to the wheels.

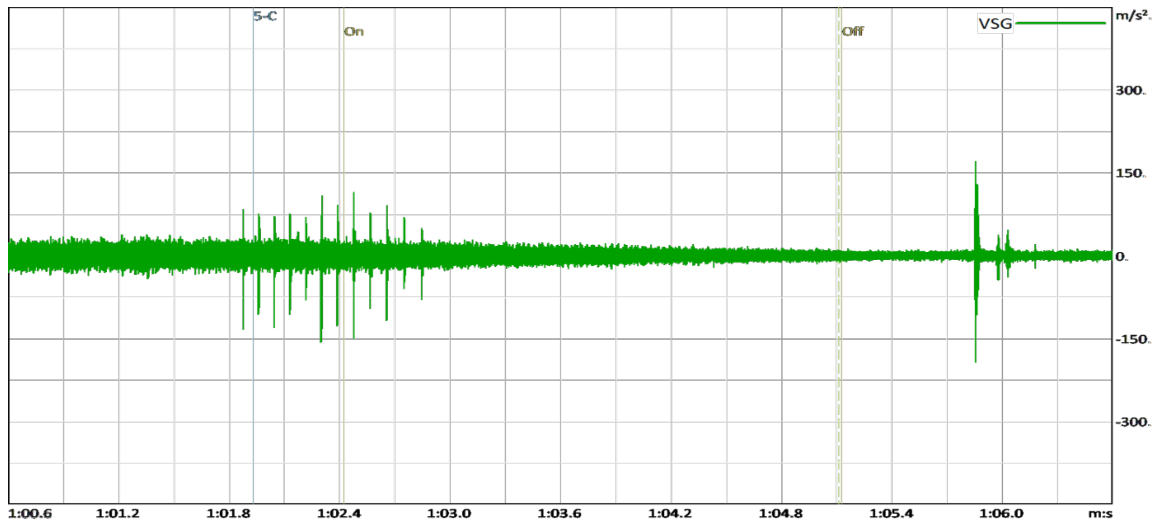
Typical Gear Defects



Example: Nick Flattened

When a transmission gets into the EOL test stand, this is typically the first time that torque is applied to the gears.

A small nick or spike on the gear surface, or small dirt particles, will get flattened out during the first run of that gear:



It is therefore highly recommended to repeat test steps with “nick” errors, because in many cases the nick has vanished after the first run.

Logarithmic Reference

The dB scale is a <u>logarithmic scale</u> for energy values. (Human perception uses a similar scale.)

dB numbers are always relative to a reference value r, which is called the **logarithmic reference**.

Given an energy y, the dB value is calculated as

$$\mathrm{dB}(y) = 10 \log(y / r) = 10 \log(y) - 10 \log(r)$$

The sensors are measuring amplitudes, not energies. Therefore, if x is a measured amplitude value, the energy is proportional to x^2, and since $\log(x^2) = 2 \cdot \log(x)$, for spectral values and similar data the formula is

$$\mathrm{dB}(x) = 20 \log(x/r)$$

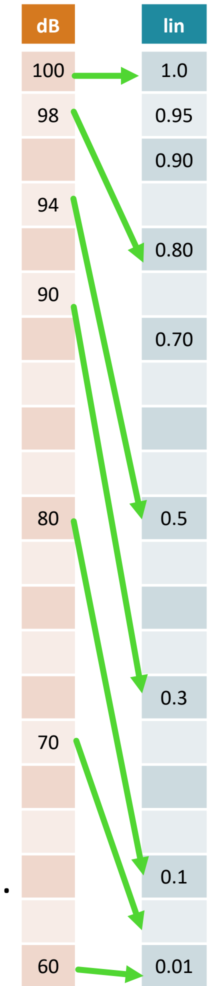
$$x = r \times 10^{(y/20)}$$

Examples: with $x = 1\mathrm{g}$

- for log. ref. $r = 0.1$ the dB value is 20 log(1 / 0.1) = 20
- for log. ref. $r = 10^{-5}$ the dB value is 20 log(1 / 0.00001) = 100

  (Rule of thumb: 1 g = 100 dB(g).)

Standard logarithmic reference for vibration measurements: 10^{-5} g or 10^{-6} m/s²



Because of the logarithmic nature, any offset in the dB scale translates to a factor in the linear scale.
So for example, +6 dB ≈ $2 \cdot x$, + 10 dB ≈ $3 \cdot x$, +20 dB = $10 \cdot x$, +30 dB ≈ $30 \cdot x$, +40 dB = $100 \cdot x$.

Logarithmic Scale Illustration

Logarithmic reference: 1 ct 

Assuming that the Power of money goes with the amount squared:
money power = money amount²

1€ corresponds to $20 \times Log_{10}(1€/1ct)$ = 40 dB

100€ = 10^4ct, corresponding to 80 dB:

10,000€ corresponds to 120 dB:

Price difference between coffee to go (2.90€)
and extended restaurant meal (35€)

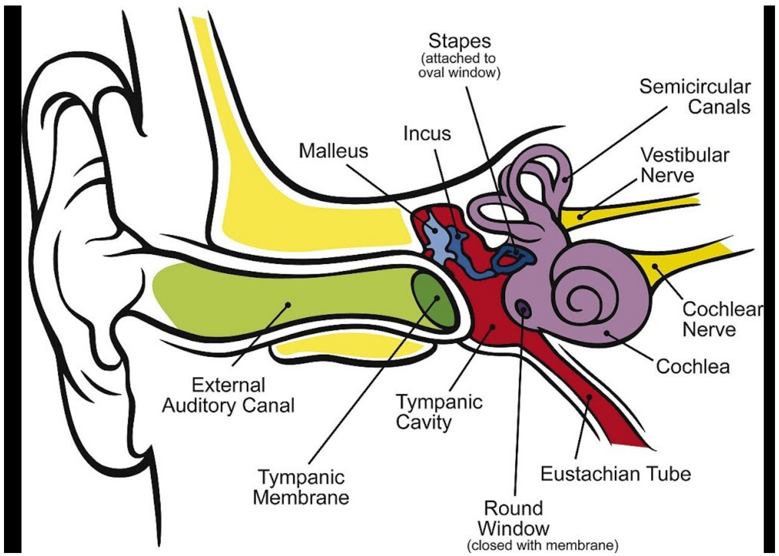
$20 \times Log_{10}(35/2.9) \approx 21.6$ dB

Human hearing works for the whole scale,
from 1 ct to 10,000€

Sound Propagation, Human Hearing

Material	Sound Velocity (m/s)	Wave length at 500 Hz	/ 2 kHz
Air	343	67 cm	17 cm
Water	1500	3 m	75 cm
Silicone	1000	2 m	50 cm
Steel	5900 (long ↔) 3200 (trans ↕)	12 m 6.4 m	3 m 1.6 m
Wood	3300	6.6 m	1.65 m
Stone	6100	12.2 m	3 m

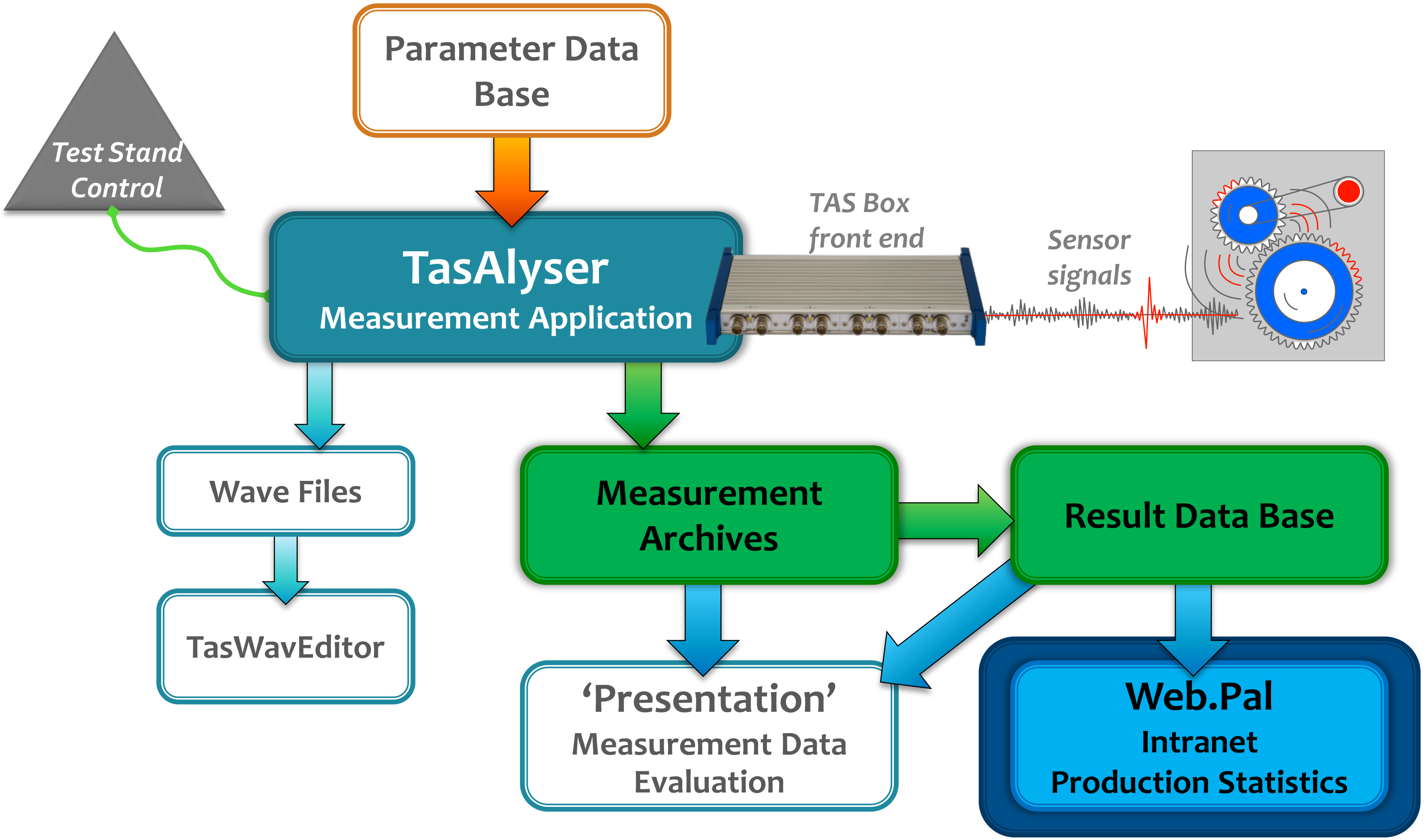
at 3000 rpm:
500 Hz = order 10
2 kHz = order 40



Web.Pal Production Statistics

Web.Pal can be used to get insight into production processes, defect hotspots and trends.

Discom Result Database Overview



Intranet Production Analysis: Web.Pal

Web.Pal is an intranet-based service. Using your normal web browser, you can check production statistics, NOK rates, top N defect reasons, value statistics, trend analysis and more.

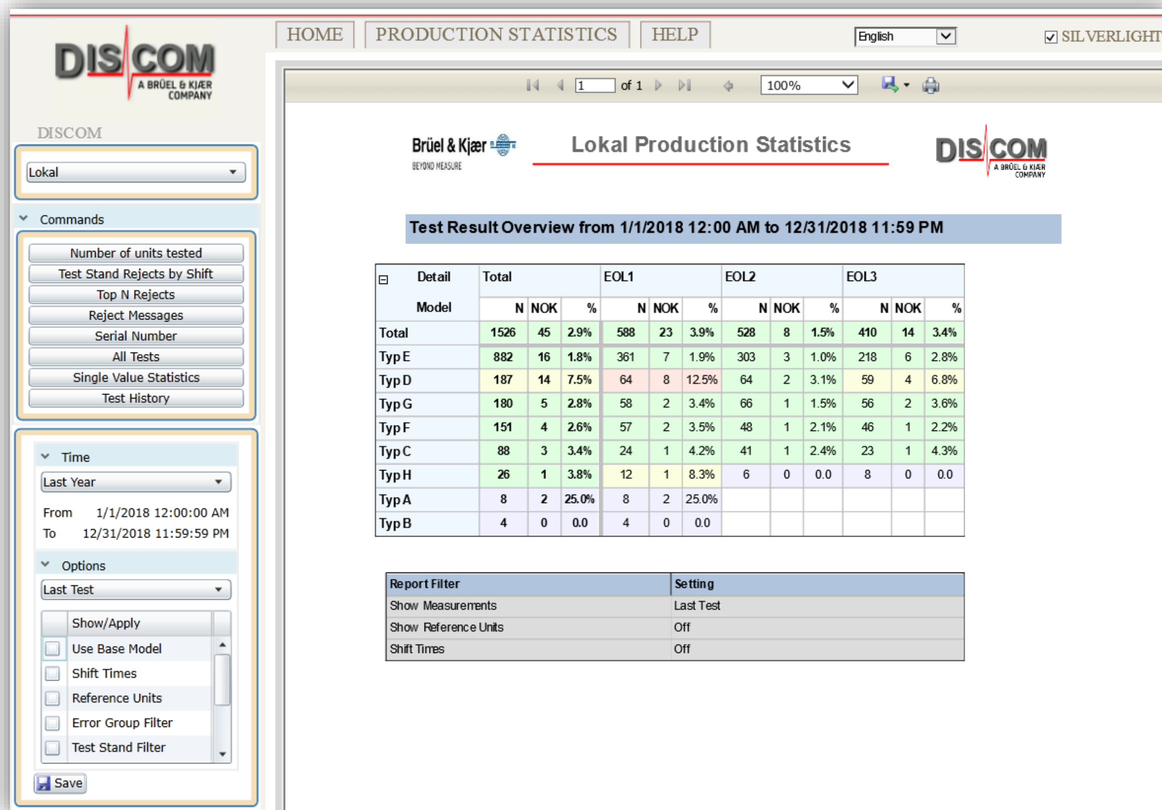
The Web.Pal application itself runs on a server computer, which is in many cases identical to the result database server.

Web.Pal was designed to assist you in identifying and solving all kinds of production problems.

The starting point for different ways of analysis is the production statistics, which displays for all test stands and types the production numbers and fault rates.

You can select specific time ranges for your analysis, exclude test stands or certain error types, and use a bunch of additional options and filters.

Just click on a percent number to go to the detailed analysis.



Detail	Total			EOL1			EOL2			EOL3		
Model	N	NOK	%	N	NOK	%	N	NOK	%	N	NOK	%
Total	1526	45	2.9%	588	23	3.9%	528	8	1.5%	410	14	3.4%
Typ E	882	16	1.8%	361	7	1.9%	303	3	1.0%	218	6	2.8%
Typ D	187	14	7.5%	64	8	12.5%	64	2	3.1%	59	4	6.8%
Typ G	180	5	2.8%	58	2	3.4%	66	1	1.5%	56	2	3.6%
Typ F	151	4	2.6%	57	2	3.5%	48	1	2.1%	46	1	2.2%
Typ C	88	3	3.4%	24	1	4.2%	41	1	2.4%	23	1	4.3%
Typ H	26	1	3.8%	12	1	8.3%	6	0	0.0	8	0	0.0
Typ A	8	2	25.0%	8	2	25.0%						
Typ B	4	0	0.0	4	0	0.0						

Report Filter	Setting
Show Measurements	Last Test
Show Reference Units	Off
Shift Times	Off

Web.Pal: Basic Operations

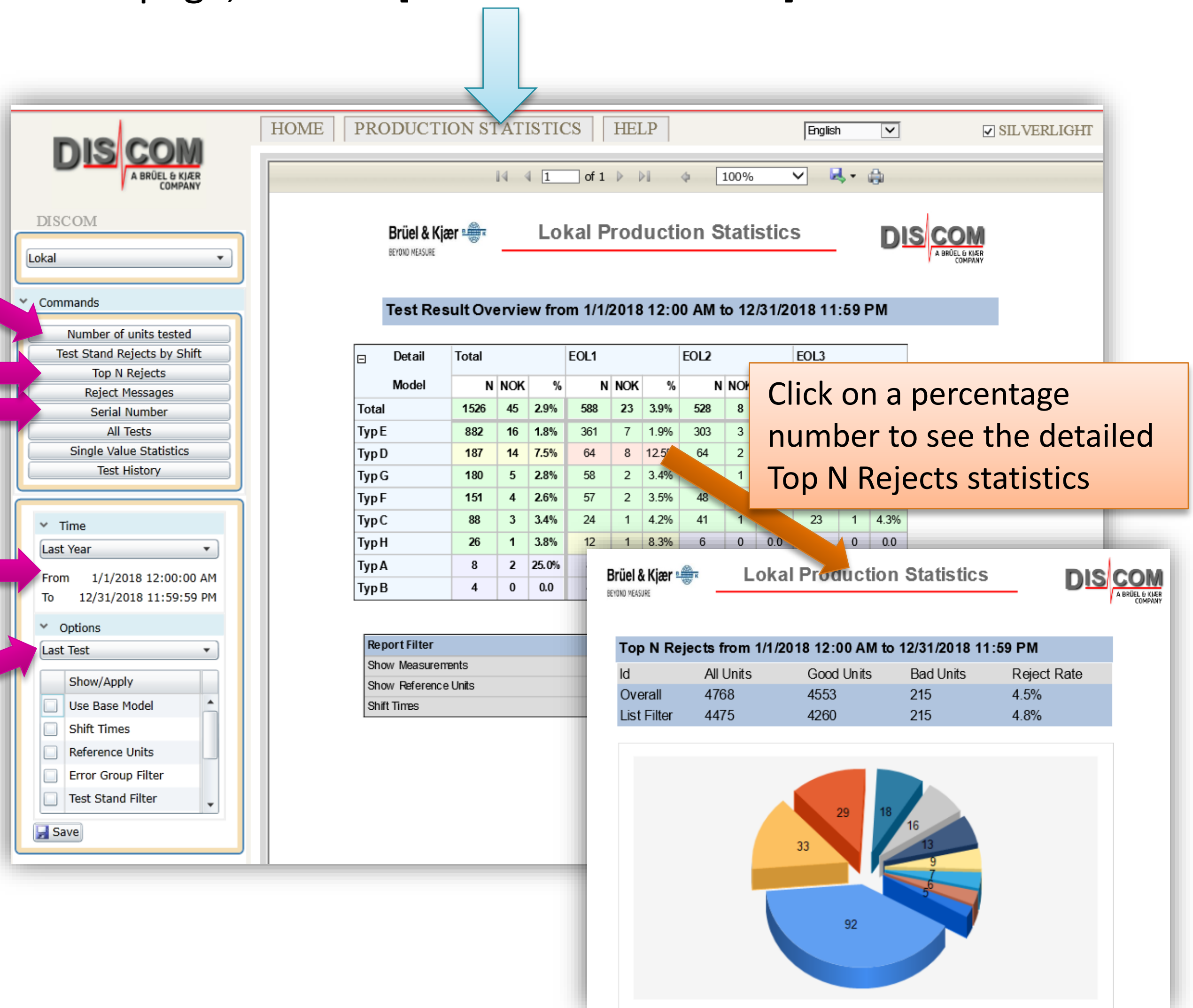
After connecting to the Web.Pal start page, click on [PRODUCTION STATISTICS] in the title bar to get to the main page:

[**Number of units tested**] gets you to the production statistics tabular overview.

[**Top N Rejects**] directly links to the reject statistics pie chart.

[**Serial Number**] lets you find all results for a certain serial number.

Set the **time range** for which you want to see the statistics.



Test Repetition Options:

First Test: this looks at the first test for each serial number

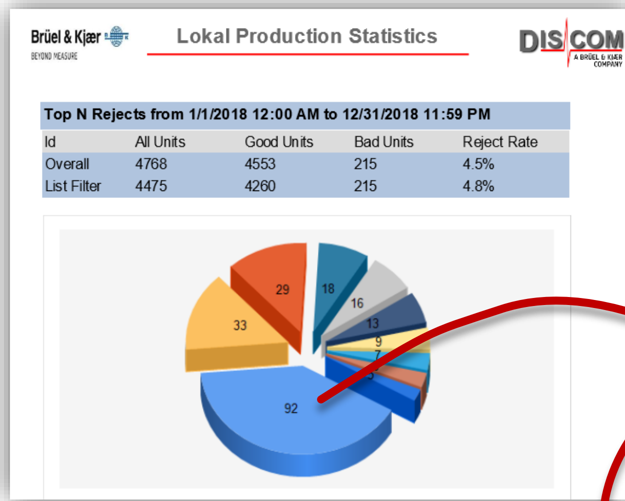
Last Test: this is your final production result

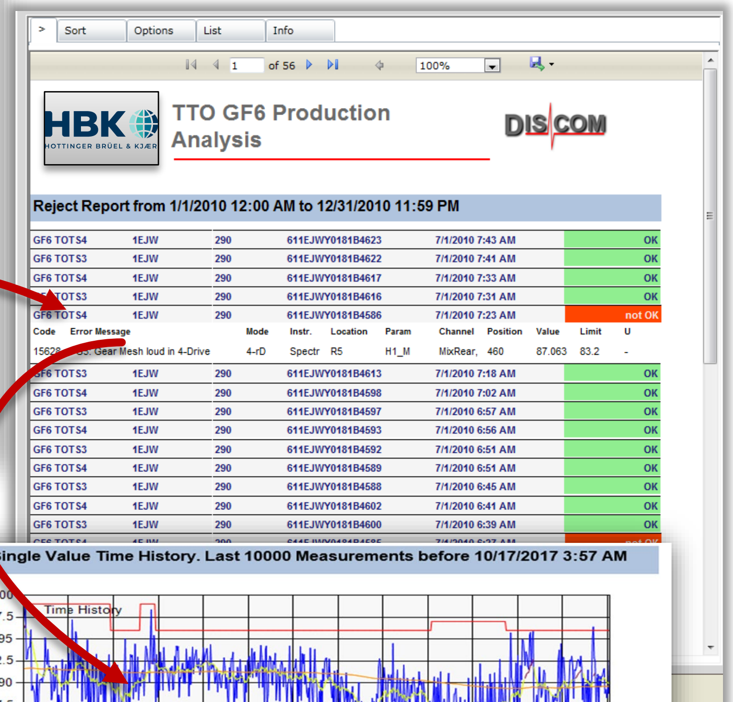
All Tests: includes all repetitions.

Problem Trackdown using Web.Pal

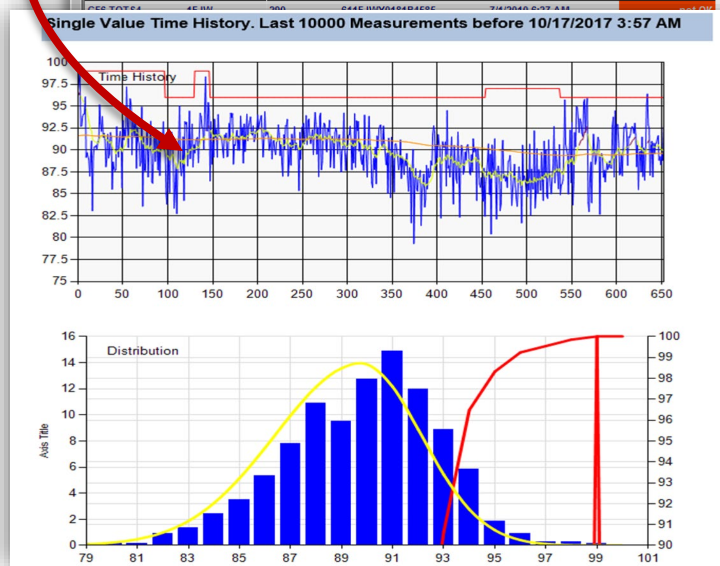
Click on a percentage number in production statistics to get the detailed rejects statistics:

This graph can also be reached by the [Top N Rejects] button on the start page.





Clicking on a diagram pie piece leads to the list of measurements with this defect. Proceed from there to single value statistics, measurement history or type and test stand comparison.
From the single value statistics, you can read if the limit value should be adjusted or if changes occurred at a certain point in time.



Web.Pal can directly call the Presentation application for any measurement to show curve data and more.

Links Within Web.Pal Report

DISCOM

The list of defects in Web.Pal contains clickable links which lead to more information

Click on the error code for a single value (like Spectral Value) to get to the single value statistics for this value.

Click on the serial number to open a new window with a full list of all single value result data.
(You have to allow Popup Winodws in Internet Explorer Settings for this website.)

These fields show the repetition number of this measurement and the final result. Click on the field to open a new window showing all repetitions for this serial number.
(You have to allow Popup Winodws in Internet Explorer Settings for this website.)

Click on the test bench name to load this measurement into the Presentation application.
(Web.Pal will download the data as a file and present you the usual choice between Open and Save.)

C.F.GAUSS — GaussData Production Statistics — DISCOM

EOL TB1 | JJJ | 7777 | 0133 K 080117 | 9/21/2010 12:31 AM | 83d | 2/19 not OK

Code	Nr	Error Message	Mode	Instrument	Location	Param	Channel	Pos.	Value	Limit	U
901	0	Referenzgetriebe: Wert Triebsatz	6-S	SpectralValue	Tellerrad	TAb_H1	SK6	35.00	89.56	76.00	dBg
900	1	Referenzgetriebe: Wert Gang	6-Z	SpectralValue	InputShaft	GAn_H1	SK1	40.00	83.84	76.00	dBg
72	2	Tellerrad laut	6-S	Ord	Tellerrad	O36.00	Tellerrad	36.00	80.43	75.00	dBg
72	3	Tellerrad laut	6-S	Ord	Tellerrad	O217.00	Tellerrad	217.0	85.46	75.00	dBg
72	4	Tellerrad laut	6-S	Ord	Tellerrad	O34.00	Tellerrad	34.00	76.12	75.00	dBg

0212 K 090919 | 9/21/2010 3:41 AM | 1/2 rpt. OK

Instrument	Location	Param	Channel	Pos.	Value	Limit	U
SpectralValue	Hohlwelle	BevAb_H1	SK5	35.00	104.5	103.0	dBg

0217 K 090919 | 9/21/2010 3:56 AM | 1/2 rpt. OK

Instrument	Location	Param	Channel	Pos.	Value	Limit	U
SpectralValue	InputShaft	GAn_H1	SK1				

0013 K 090921 | 9/21/2010 5

Code	Nr	Error Message	Mode	Instrument	Location	Param	Chan
18	0	Beveloid laut / Schub	5-S	SpectralValue	Hohlwelle	BevAb_H2	SK5

EOL TB2 | LLM | 4004 | 0010 K 090921 | 9/21/2010 5

Code	Nr	Error Message	Mode	Instrument	Location	Param	Chan	Pos.	Value	Limit	U
			In	Fmin	rein	-	FXCL				
		wer	6	W	F-A	-	raus				
		wer	5	W	F-A	-	raus				
		wer	6	W	F-B	-	rein				
		wer	4	W	F-B	-	rein				
		wer	4	W	F-A	-	raus				
		wer	3	W	F-A	-	raus	0	448.1	0	N°
		wer	2	W	F-B	-	rein	0	184.4	0	N°
		wer	2	W	F-A	-	raus	0	1281	0	N°

4003 | 0005 K 090920 | 9/21/2010 5:38 AM | 1/1 not OK

Code	Nr	Error Message	Mode	Instrument	Location	Param	Channel	Pos.	Value	Limit	U
75	0	Welligkeit Zahnflanke Beveloid	4-S	Ord	BevAn	O37.00	BevAn	37.00	98.75	95.85	dBg

Addressing Any Value: Clavis

The **Clavis** is the unique identification of a measurement value in the measurement application and in the data bases.
It consists of 6 elements:

- **Test Step** (= „Mode“, e.g. 3-rD, Stdy, …)
- **Instrument** (e.g. order spectrum, RMS, spectral value)
- **Object/Location** (e.g. input shaft, pinion gear, oil pump)
- **Processing Channel** (Synchronous, Mix, Fixed frequency)
- Instrument **Measurement Parameter** (e.g. H1, Main Order Band)
- **Sensor** (e.g. vibration sensor VS-1, Microphone Mic)

“Clavis” is Latin and means “key”: the unique key to find a value.

Because limits are distinct for types and test stands, the unique identification for a limit value has 8 elements:
Clavis + **type** + **test bench**.

Web.Pal Single Value Statistics

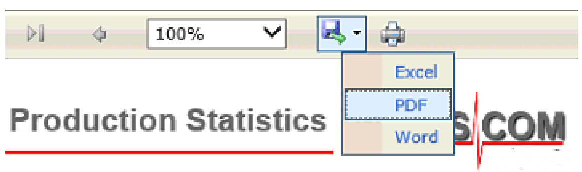
The Single Value Statistics can be reached directly from the Web.Pal start page or by clicking on a single value error code in the reject messages report.

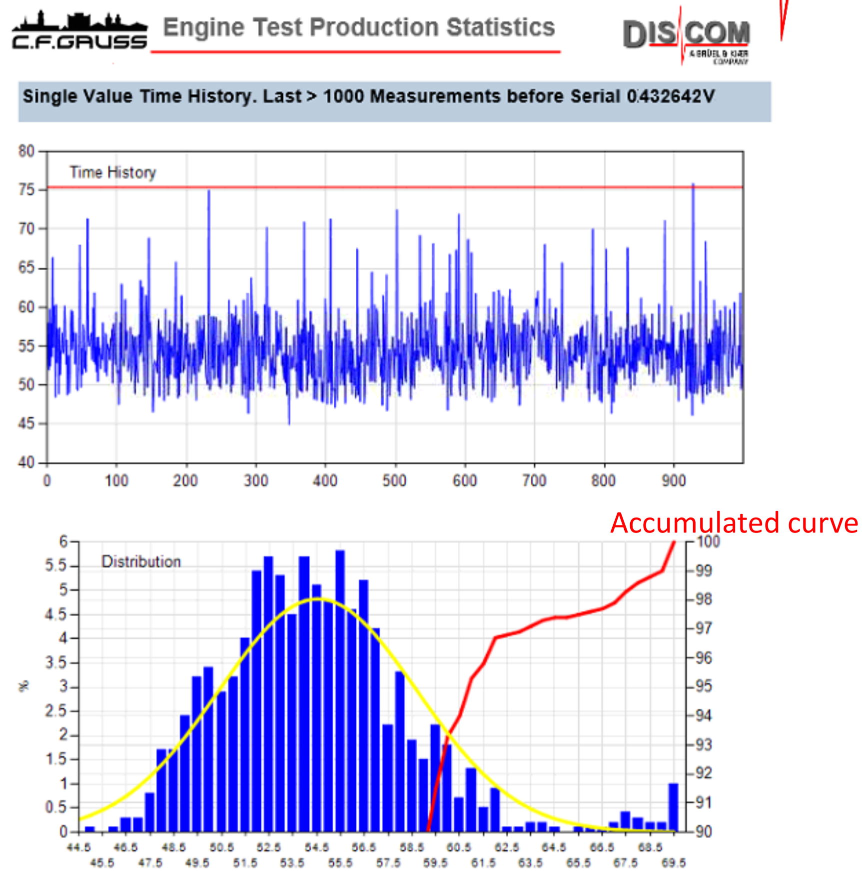
The data range of the statistics is set in the options (see next page).

Time series and distribution also show the limit value.

In the table below, specifications about the selected metric, data range, and applied filters can be read.

This report can be exported as pdf or office document. (The export is available for all Web.Pal reports.)





Test Stand	Model	Mode	Instrument	Param	Location	Channel	Sensor
[Gauss-EOL1]	[081]	5-Rd	Spectral Value	Order4	InputShaft	Mix,VSFront	

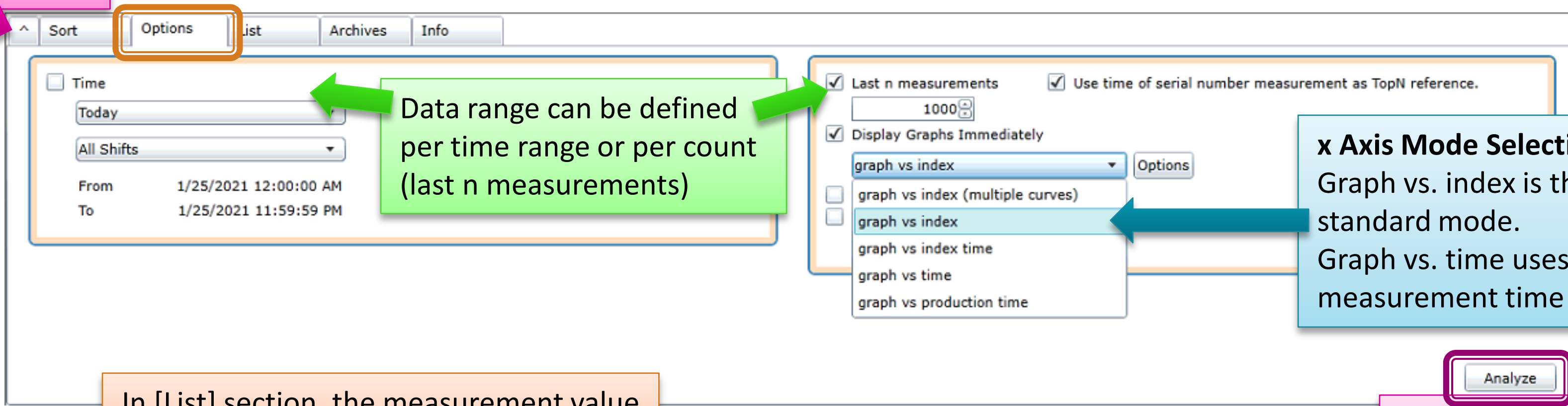
Curve Data	Average	Standard Dev.	Minimum	Maximum	Color
Value	54.54	4.166	44.98	75.89	0
Limit	75.42	8.35E-06	75.42	75.42	1

Report Filter	Setting
Show Measurements	All Tests
Show Reference Units	On

Web.Pal Single Value Statistics Options

Singe Value Statistics has flexible options for selecting data for analysis.

Minimize the options pane with this arrow.

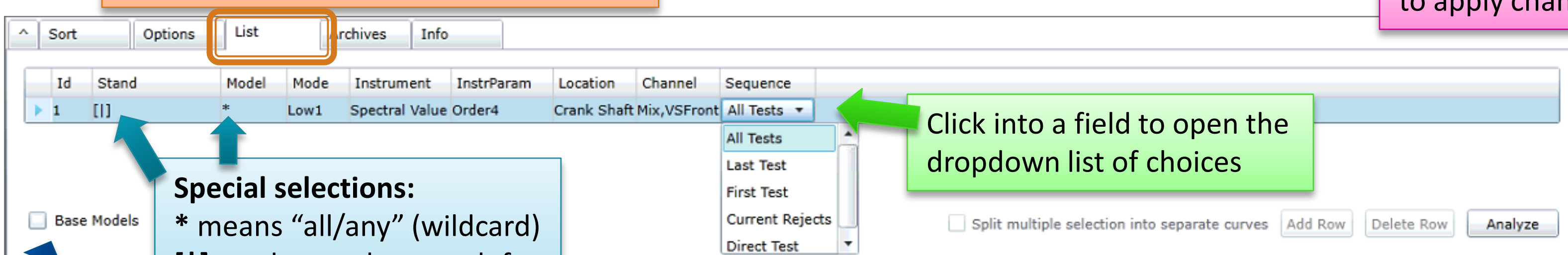


Data range can be defined per time range or per count (last n measurements)

x Axis Mode Selection:
Graph vs. index is the standard mode.
Graph vs. time uses the measurement time as x axis.

Press [Analyze] button to apply changes

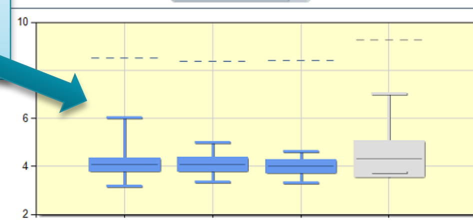
In [List] section, the measurement value for the statistic is selected.



Click into a field to open the dropdown list of choices

Special selections:
***** means “all/any” (wildcard)
[|] produces a box graph for this selection category

Use this checkbox if you want to select via base types instead of types.



Box graph shows mean value, standard deviation range, min and max value, and current limit. Box is grey if too few values for a solid statistics.

Web.Pal address

When connected to the internal network with access to the server, enter this address in your web browser to call up Web.Pal:

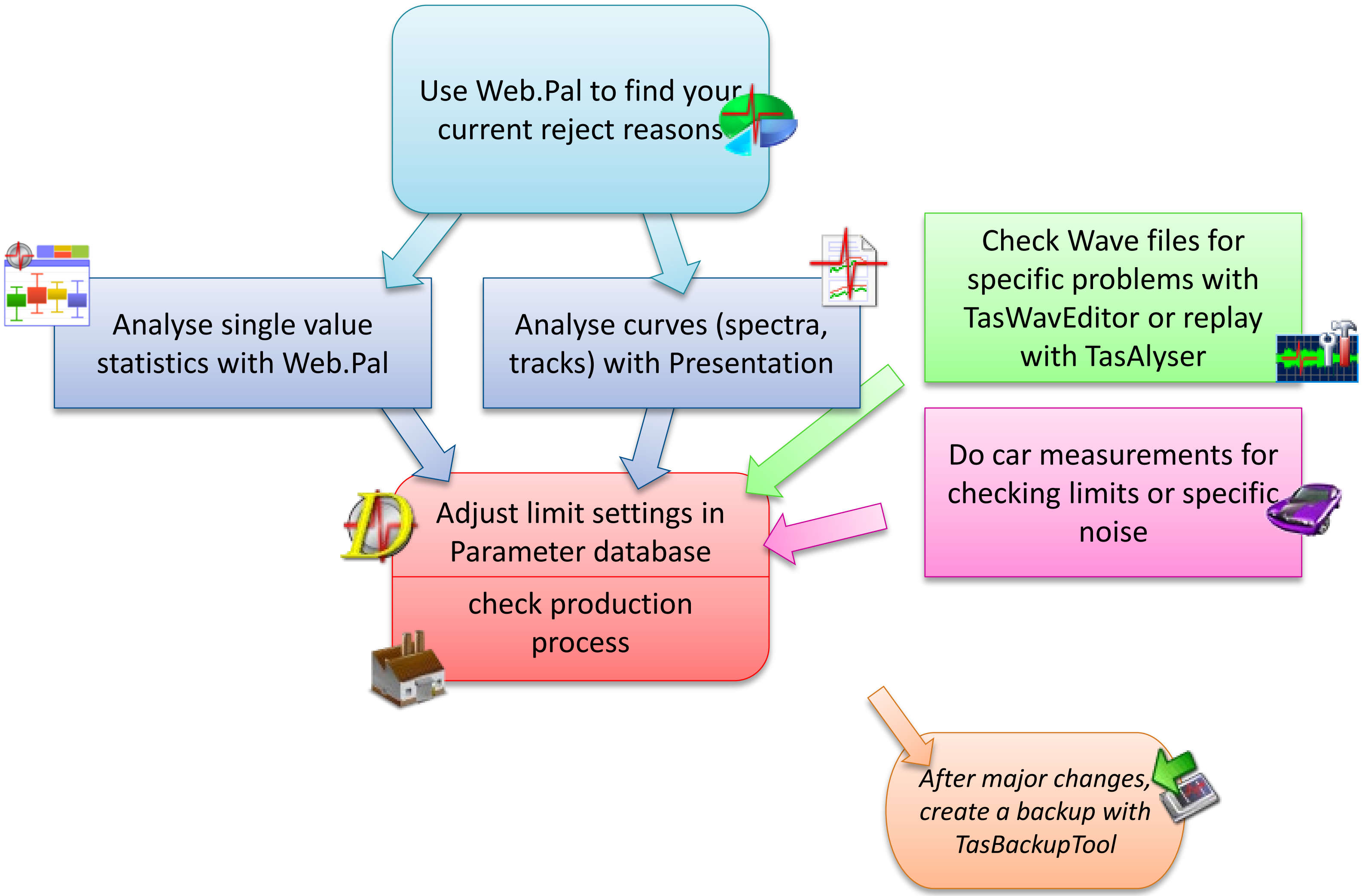
```
http://123.456.789.10/RotasWebPal/Default.aspx?User=yourName
```

insert server's IP address or network name here

use any name without blanks to create a new user with individual settings

Web.Pal was designed for Microsoft Internet Explorer 11 and needs the Microsoft "Silverlight" Browser extension. Microsoft Edge can be set up for Web.Pal.

Your Daily Workflow



Demo

Web.Pal life demonstration 2

Homework:
a) try out yourself
b) try to connect to measurement PC's Web.Pal via intranet

Discom Limit Generation

About Limits

In EOL testing, there are two major objectives:

- Find pieces which will be audible in the car
- Find pieces with defects that limit the lifetime

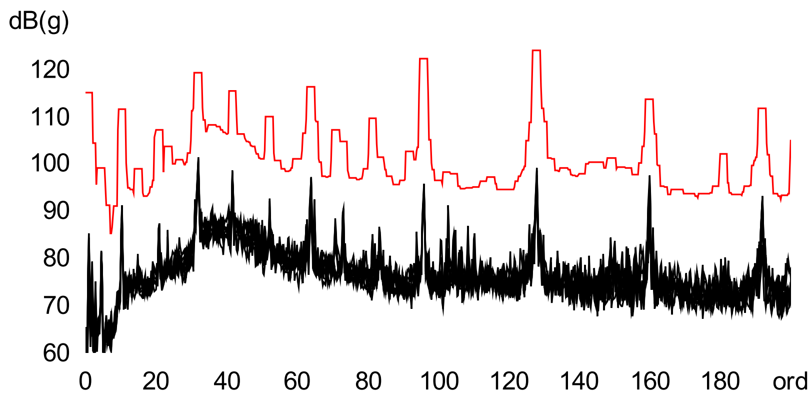
This requires two limit strategies:

- Fixed limits confirmed by drive tests in car
- Automatically learned limits, based on statistics

The Discom system uses a combination of **learned** and **fixed** limits which give a high flexibility for all kind of situations.

The limit parameters are controlled in the parameter database, allowing for easy management even with many different types and test steps.

Curves (like spectra and order tracks) have a limit for each curve point, resulting in a limit curve.

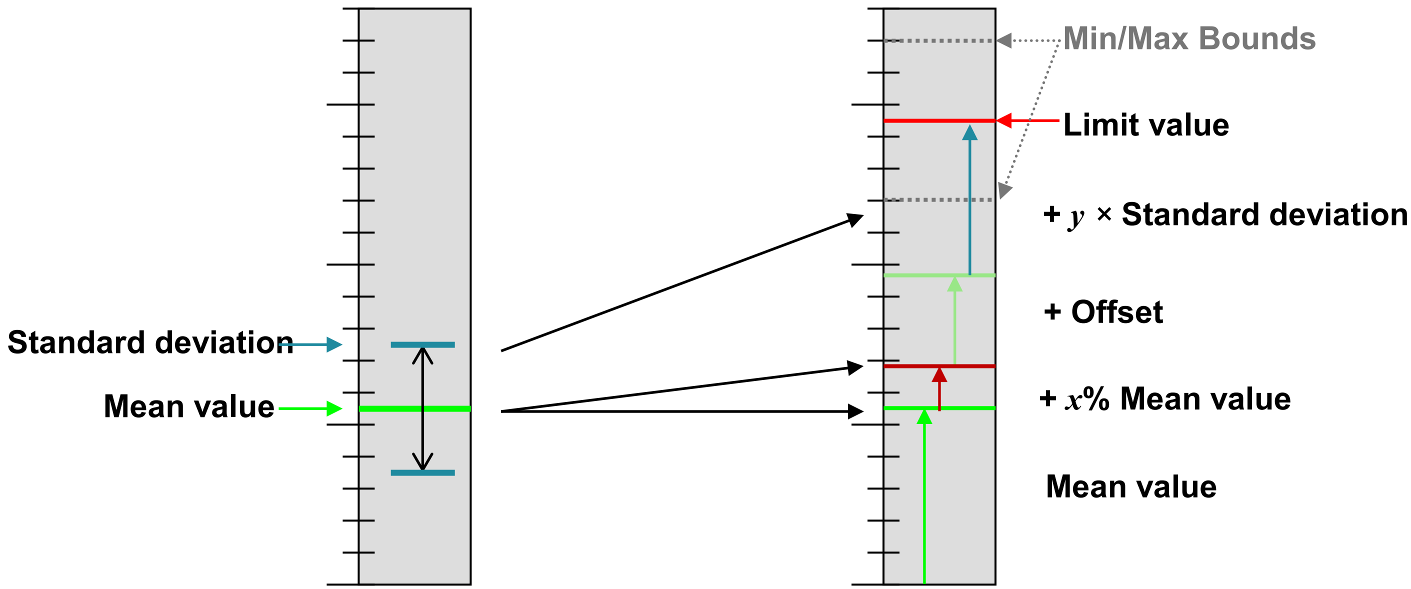


Generating Limit Values

The limit values and curves are based on **learned production process statistics**.

From the learned mean values and standard deviations, the limits are constructed according to two rules. Combining these rules, learned or fixed limits can be achieved.

The parameters for these formulas are set in the parameter data base and can be adjusted at any time. They are specific for transmission types and test benches.



Measurement Statistics

Calculation rule of the limit value:

1. *Limit* = *Mean* + *x %* *Mean* + *Offset* + *y* × *Standard deviation*
2. apply bounds: *Min* ≤ Limit ≤ Max

In the parameter data base you set *Offset*, add *x%*, *factor y*, *Min* and *Max* boundary

Limit Calculation Examples

DISCOM

Calculation of the limit value:

1. Limit = *Mean* + x % *Mean* + *Offset* + y × *Standard deviation*
2. apply bounds: *Min* ≤ Limit ≤ Max

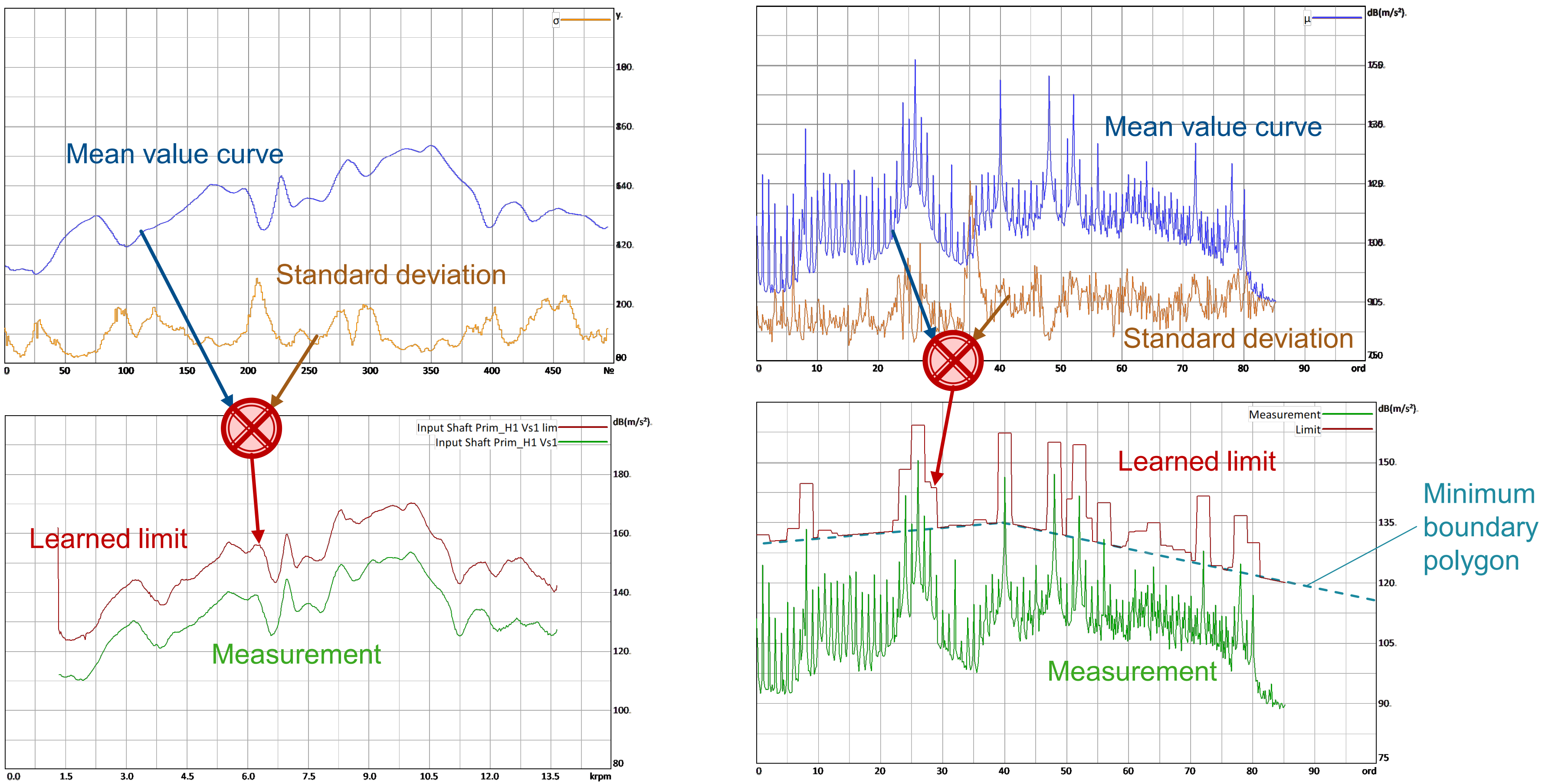
Parameter	Offset	% mean	Factor Std.Dev	Formula result (1)	Min bound	Max bound	Resulting limit (2)
for Order Value with mean = 79.4, standard deviation = 1.8							
Example 1	5	0	3	**89.8**	70	120	**89.8**
Example 2	5	0	3	**89.8**	95	95	**95.0**
Example 3	10	0	0	**89.4**	95	105	**95.0**
Example 4	0	35	1	**108.99**	95	105	**105.0**
for RMS with mean = 5.2, standard deviation = 1.8							
Example 5	1	0	3	**11.6**	5	20	**11.6**
Example 6	0	100	0	**10.4**	5	20	**10.4**

Limit Curves

For curves (spectra, tracks), the limit is learned for each position individually.

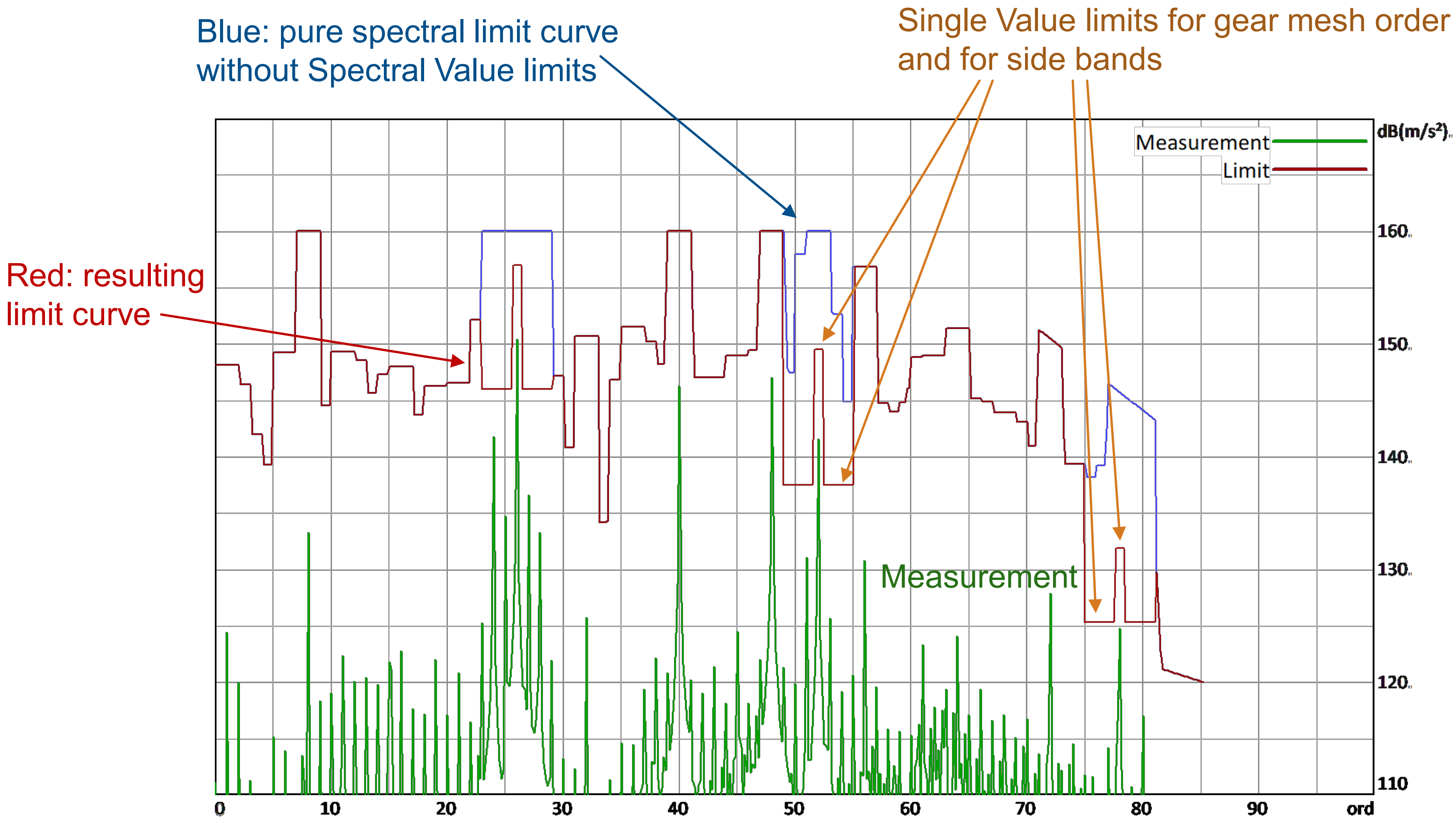
Each curve point has it's own mean value and standard deviation, and the learned limit curve is constructed point-wise according to the same method as for single values.

The Minimum and Maximum bounds are defined as polygons.



Spectral Limit Curves

For order spectra, the limit curve combines the learned spectral limit and the single value limits which are defined for gear mesh orders and side bands.



The limit curve and the spectral value limits can have different calculation parameters!

Suggestions for limit parameters

DISCOM

Quantity	Offset, Mean%, Factor Std.Dev.	Min and Max boundaries
RMS (Max) (linear)	0.3 + 150% + 1×	Min and Max from Web.Pal statistics
Crest, Kurtosis	(fixed limits)	15 ~ 20 in Mix 12 ~ 15 in Sync
RMS Min	(fixed limit)	0.05 ~ 0.1
Spectral Values, “Speed Bands”	8~10 + 0% + 1×	Start with Min ≈ 90, Max ≈ 120, then refine from statistics or from car measurements
Order Spectra	8~12 + 0% + 2×	Min ≈ 80, Max ≈ 120
Order Tracks, RMS Tracks (log)	8~12 + 0% + 0-1×	From statistics or mobile measurements

single values (RMS (Max) through Spectral Values)

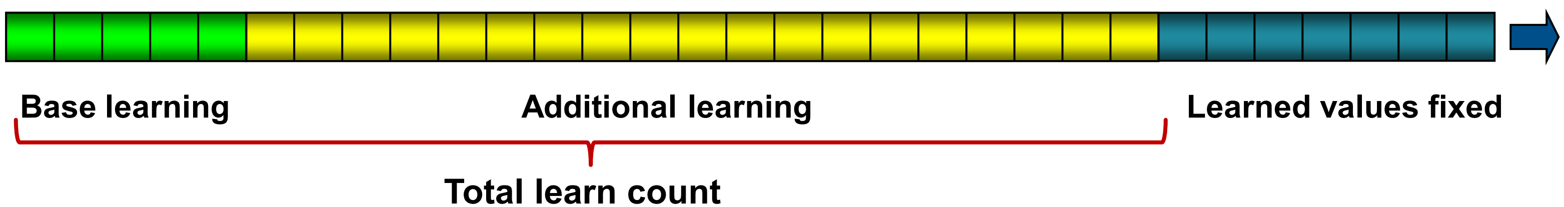
curve limits (Spectral Values through Order Tracks)

Learning Process

The learning of the limits is done in two steps: **base learning** und **additional learning**.

The base learning encompasses only a few transmissions (e.g. 5). During base learning the measured value is compared to the *Maximum boundary* from the parameter database. At the end of base learning the preliminary limits are set.

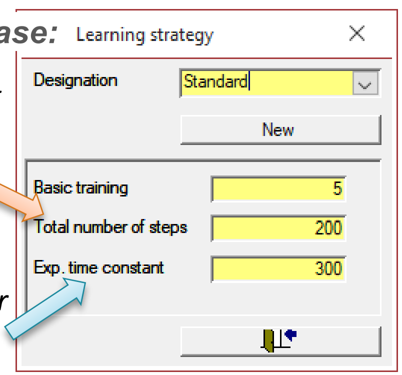
The additional learning encompasses a lot of transmissions (e.g. 200 in total). Each one is tested against the limit values calculated from the previous tests. If it is found to be ok it is added to the statistics. This way the limit values are fine tuned.



The automatic learning also permits the unattended start of a new gearbox type at a test bench and provides “reasonable“ starting limit values that can be refined through the parameter database.

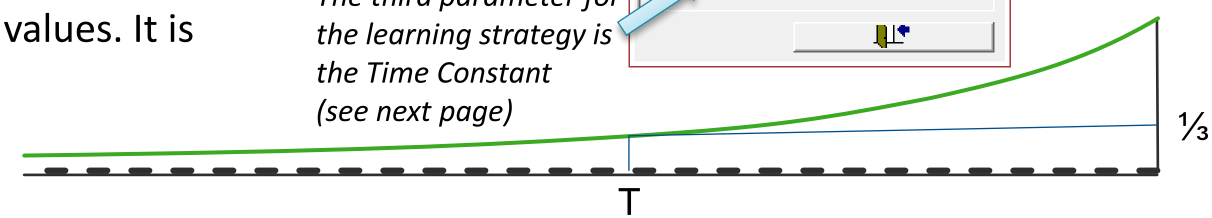
The learning process can be restarted or extended at any time – also for single test steps or specific values. It is controlled from the parameter data base.

in parameter database:



Set total learn count to -1 for continuous, infinite learning.

Learning uses exponential averaging. The third parameter for the learning strategy is the Time Constant (see next page)



Exponential Averaging

Exponential Average (or Moving Average) uses a recursive formula:

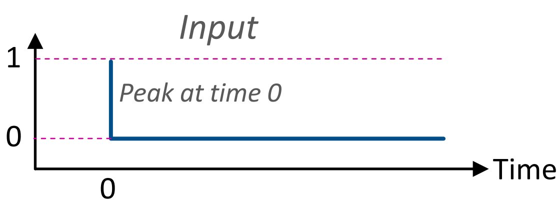
$$y_N = (1 - \alpha)x_N + \alpha y_{N-1} \qquad \alpha \in [0, 1]$$

Next output value (y_N) — Current input value (x_N) — Previous output value (y_{N-1})

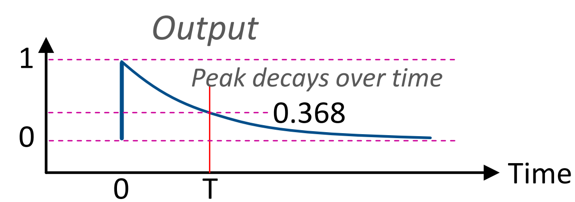
Example: next output value = 10% current input + 90% previous output. In that case, α = 0.9

For this averaging, the parameter α controls the weighting between current input (fast reaction) and previous outputs (history). For common applications, α ranges between 0.9 and 0.999.

Instead of setting the value of α, it is easier to use the *Time Constant* T:



The Time Constant is the time it takes for a single peak at time 0 to decay to 37% (= 1/e)



There is a simple relation between α and T: $\alpha = e^{-\frac{1}{T}}$

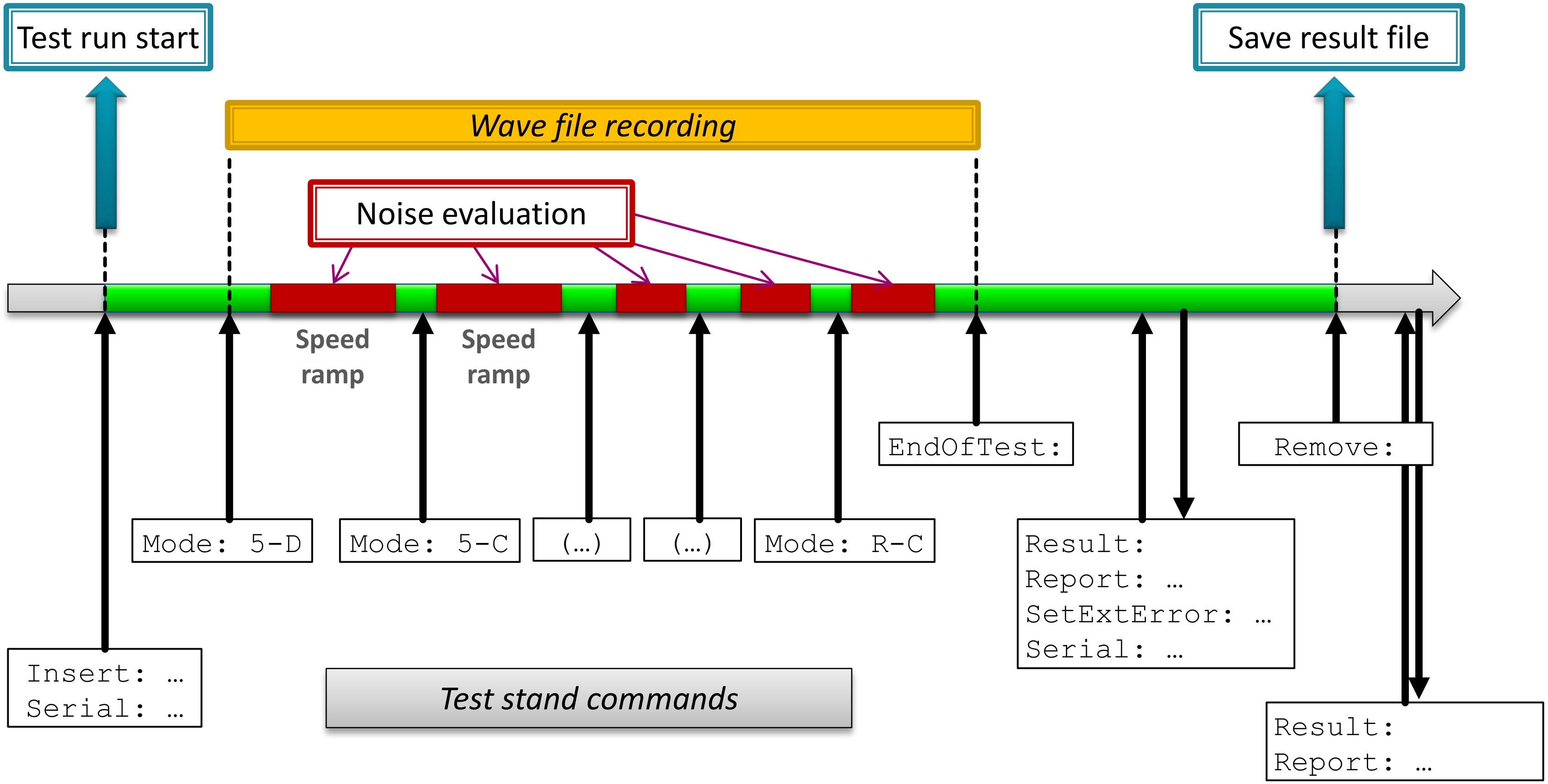
For T=10, α = 0.907 (≈90%), and after t =23 the peak has decayed to 10%.
For very large T (much larger than the expected number of inputs), the exponential average approximates the block average.

About the Test Run

A test run consists of test steps.

Within each test step, values and curves are calculated and compared with the limits.

Test Run Structure and Control



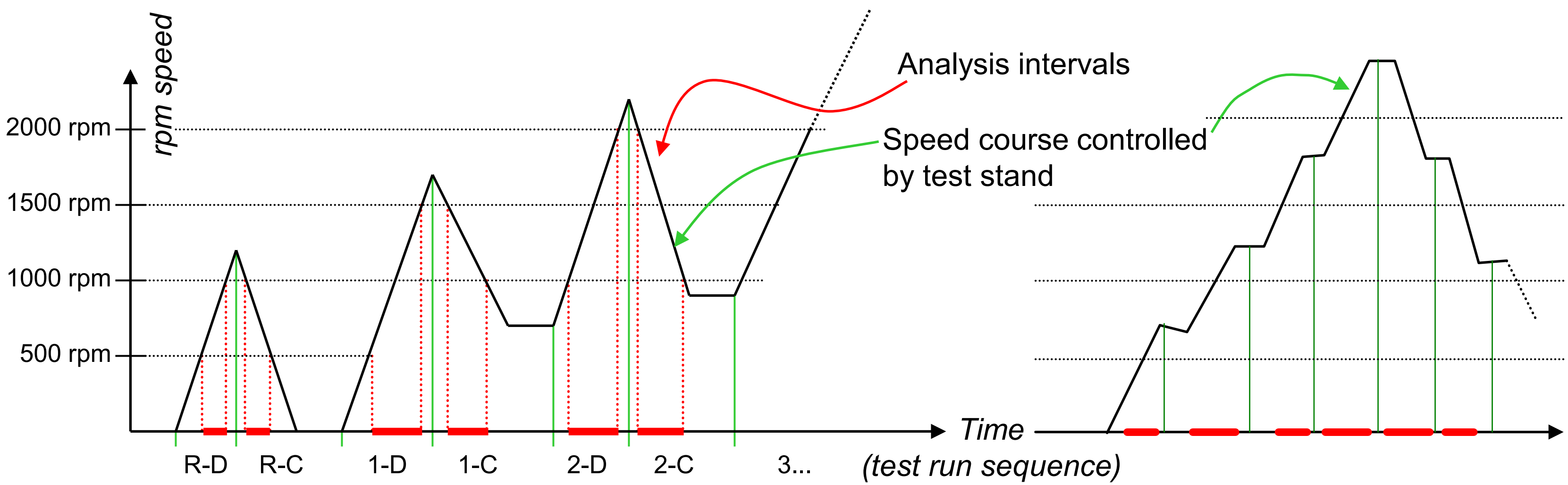
Prototype test run sequence

At the beginning of each **test run**, the test stand control provides the information which gearbox type is to be measured, sends the serial number and starts the test sequence. Each test run consists of a number of **test steps**. Each test step will generate it's specific results.

Examples for test steps: "3rd gear speed ramp up (drive)", "torque ramp phase 1", "differential test".

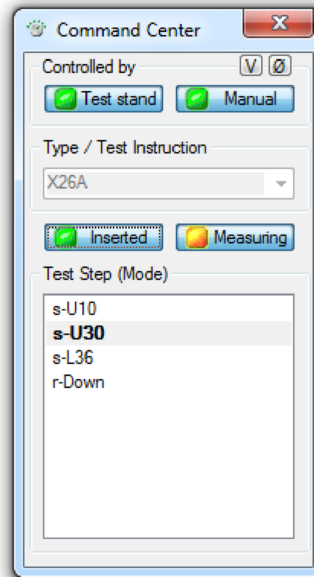
Test steps can be run in any sequence, they can be repeated or omitted.

In each test step all measurements applicable for that test step are performed and according error messages are generated. When a test step is repeated, all results and errors from the previous run are discarded.



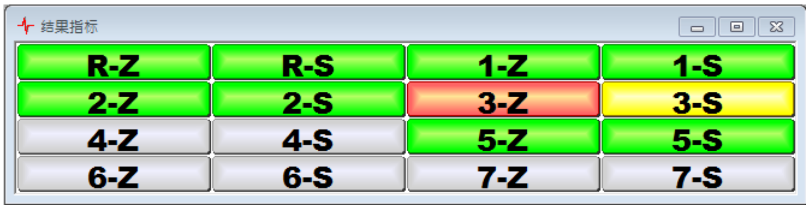
Command Center and Result Display

The **Command Center** window shows the progress of a test run. It displays the transmission type for this run, shows the current test step and signals a running acoustic measurement.
This window can also be used to manually control a test run.



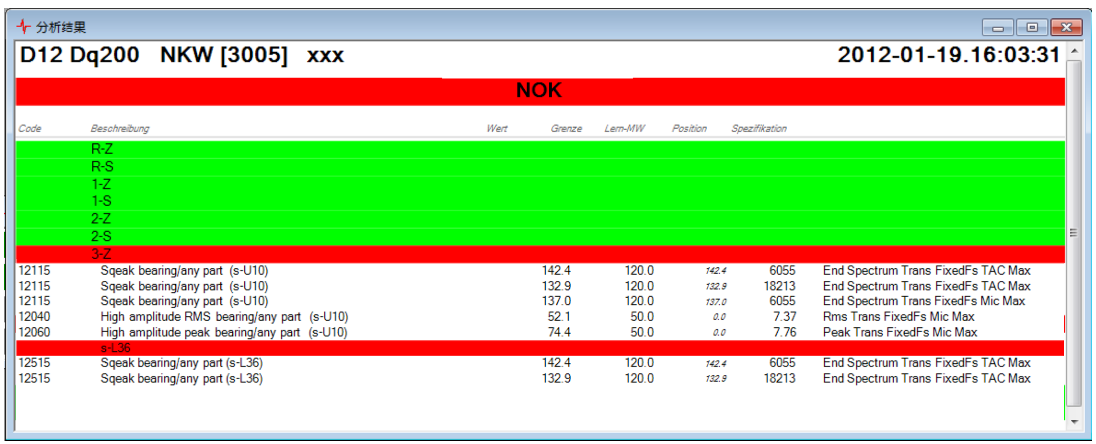
The results for each test step are shown in the **Result Display** window:

Grey = not yet measured

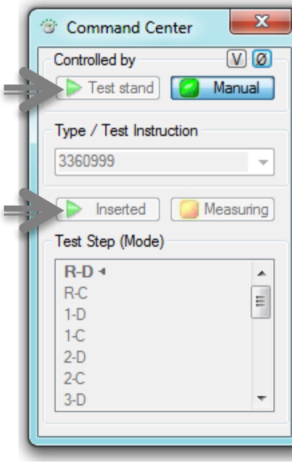


Yellow = current test step

In the Analysis **Results window** the overall result and the defect messages (if any) are shown. The defect messages consist of error code, text description, value and limit and also show the learned mean value.



When a test run is played back from wave file, the command center window is locked and the buttons show a 'play' icon.



Speed, Control Values, Trigger

Speed, torque and similar values are called **Control Values**.

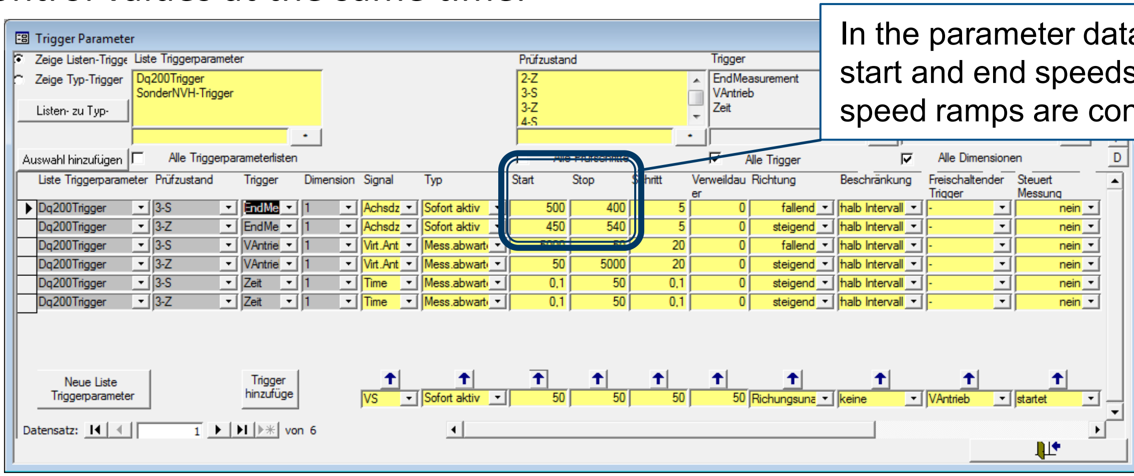
Control values specifies the terms and conditions for a measurement. They can be used for driving ramps (speed ramps, torque ramps).

Other examples for control values are time, temperature, forces or positions.

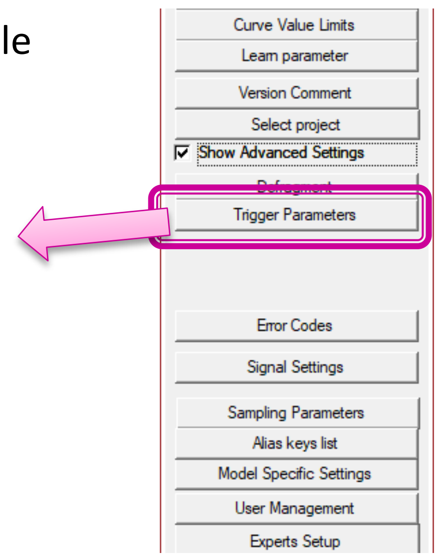
Control values are displayed in „Instruments“

Double-click on an instrument to open the settings. Right-click on the instrument to change it‘s appearance. „Grab“ the instrument anywhere to move it.

Ramp measurements (using speed or torque) are controlled by **Triggers**.
The trigger settings are located in the parameter data base. It can track multiple control values at the same time.

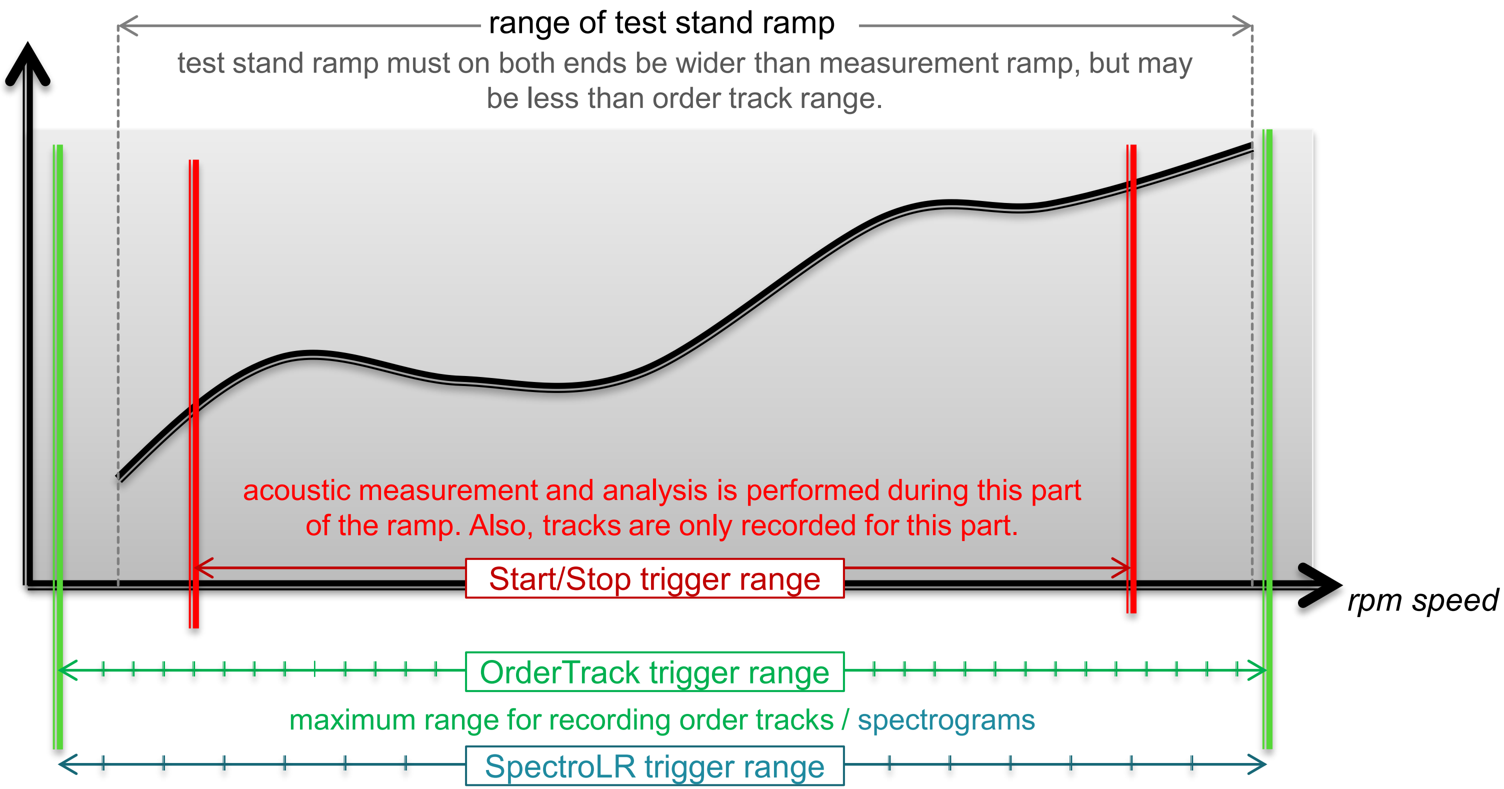


In the parameter data base, start and end speeds for speed ramps are configured.



Start/Stop and Track Triggers

Many projects use multiple trigger definitions: one to control the start and stop speed for ramp measurements (called 'StartStop') and one for defining the range and resolution of order tracks and spectrograms.



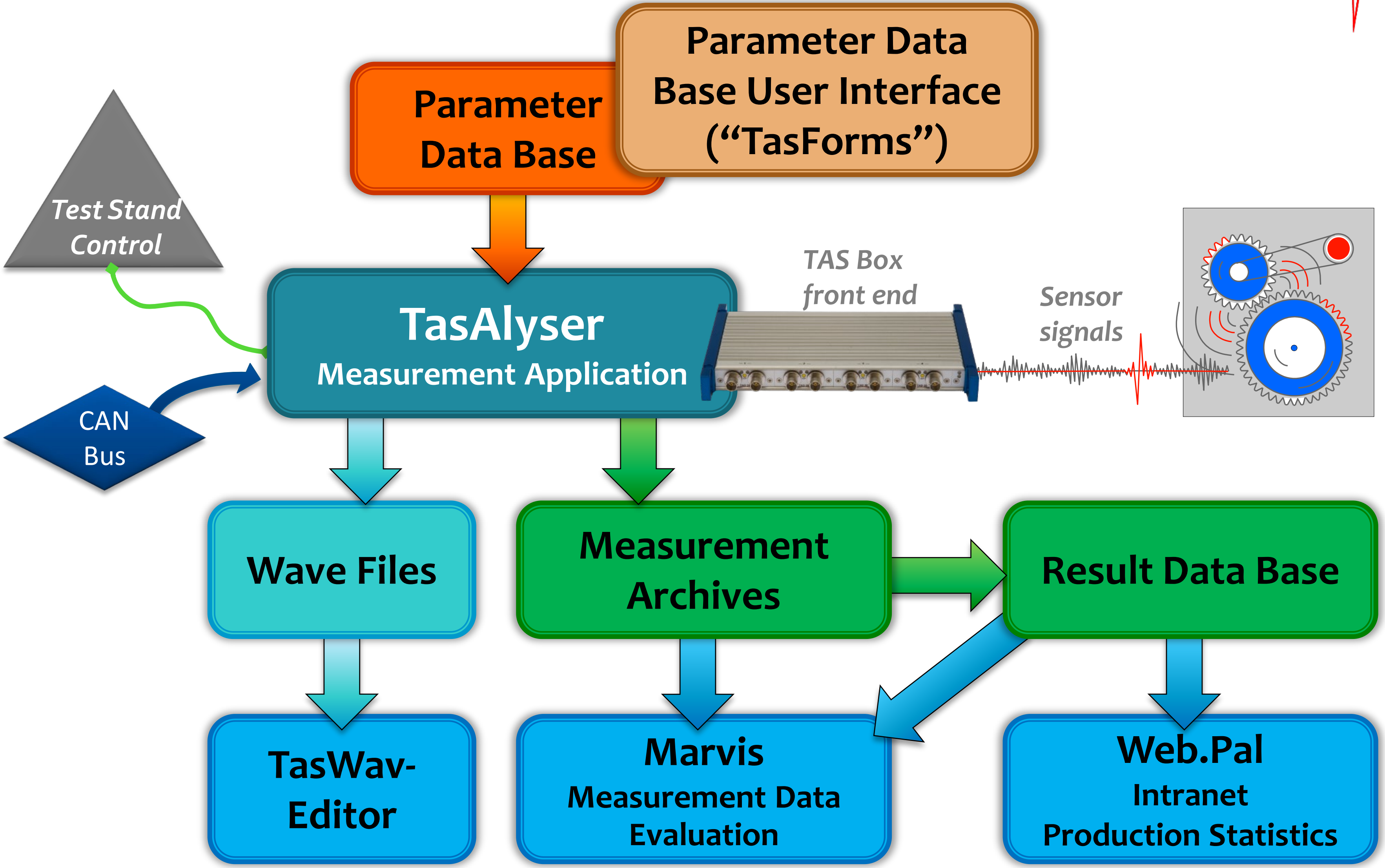
Start/Stop trigger and order track triggers can use different control values. Also, Start/Stop can be replaced by commands from the test stand (e.g. for measuring a steady state for a certain time).

The Parameter Database

The parameter database stores measurement setup and limit value settings for multiple types and multiple test stands.

Almost all parametrization is done in the database, not in the measurement application.

System Overview: Parameter Data Base



Where to find the applications

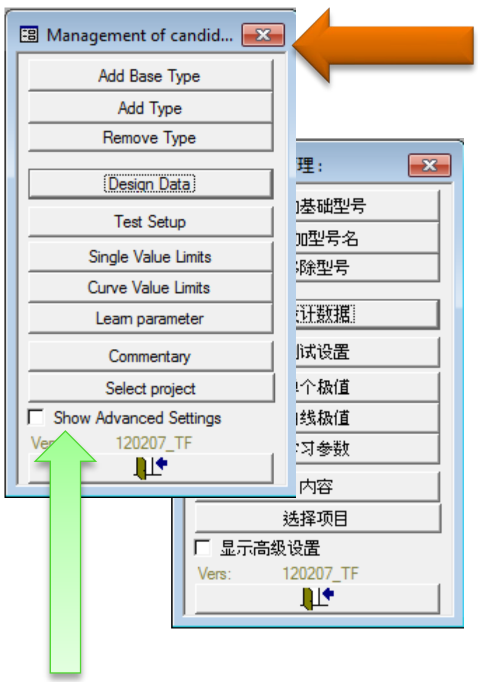
On the measurement computer’s desktop, look for a folder “Rotas for Experts”.

This folder contains a collection of start link for the most important tools, including the parameter database user interface.

Parameter Database User Interface

The parameter data base is a Microsoft Access data base. Thus, the data base file can be handled as a normal file (for creating backups, copying between test stands etc.)

The user interface TasForms is based on Microsoft Access. It can be switched to multiple languages.

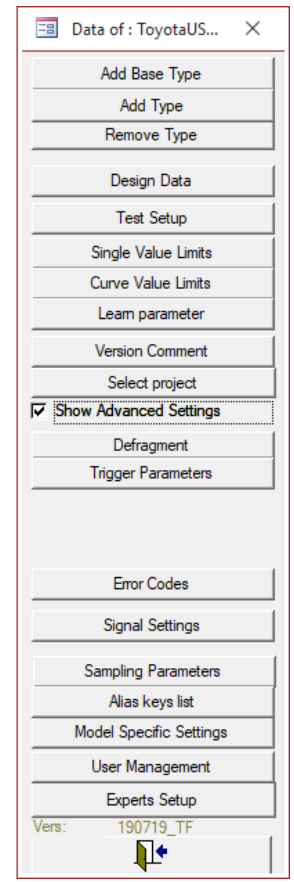


The start form of the parameter database offers access to the most frequently used functions: managements of types and limit settings.

In the advanced settings, measurement setup, sensor configuration and other parameters can be changed.

TasForms automatically stores backups of previous versions when you leave the data base and confirm the changes.

Check “Advanced Settings” to expand the start form and get access to all functions:



Addressing a value: Clavis

The **Clavis** is the unique identification of a measurement value in the measurement application and in the data bases.
It consists of 6 elements:

- **Test Step** (= „Mode“, e.g. 3-D)
- **Instrument** (e.g. order spectrum, crest, spectral value)
- **Object/Location** (e.g. input shaft, pinion gear, oil pump)
- **Processing Channel** (Synchronous, Mix, Fixed frequency)
- Instrument **Measurement Parameter** (e.g. H1)
- **Sensor** (e.g. vibration sensor VS-1, Microphone Mic)

“Clavis” is Latin and means “key”: the unique key to find a value.

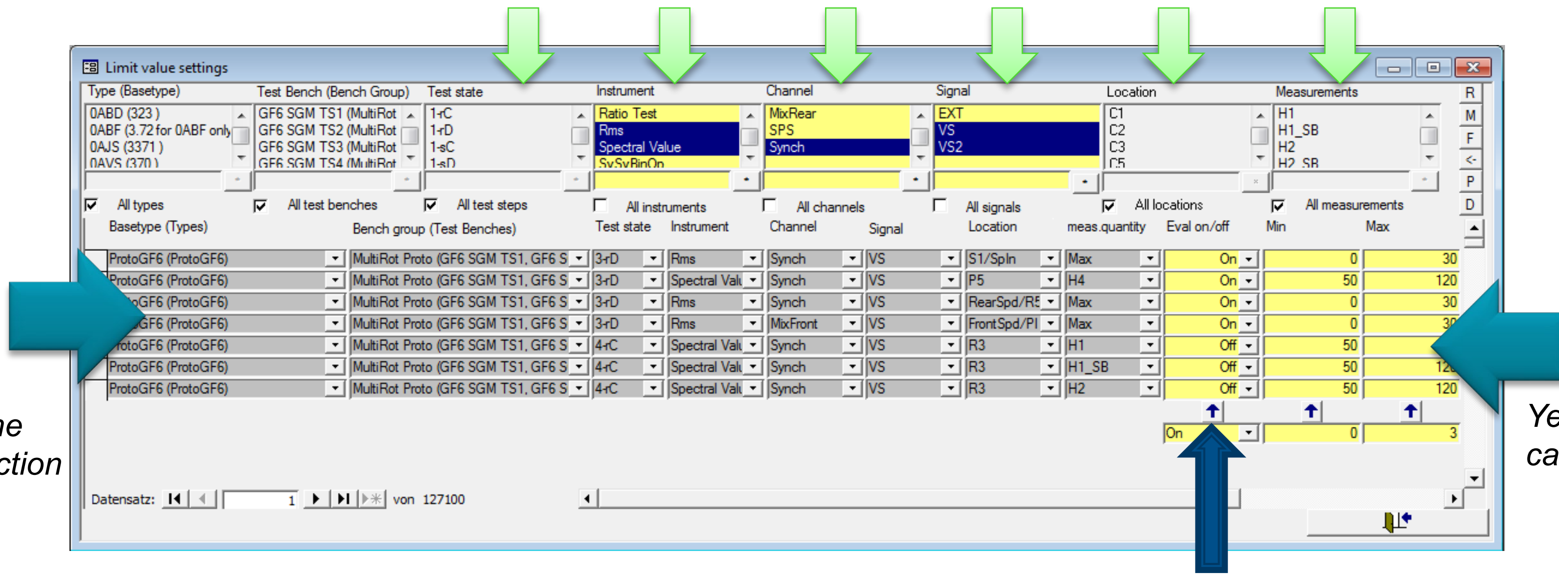
Because limits are distinct for types and test stands, the unique identification for a limit value has 8 elements:
Clavis + **type** + **test bench**.

TasForms Clavis Selection

Measurement values, limits and other parameters are addressed using their **Clavis**:

In all forms, in the top part the objects of interest are selected (by Clavis).
The main part then only lists the according parameter entries, where they can be changed.

List of parameter entries matching the Clavis selection



Yellow fields can be edited

Use the “up arrow” button to set all fields in the column at once to the same value

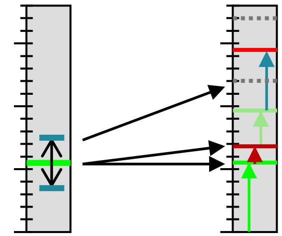
Adjusting the Limits

Each limit value is calculated using these rules:

lim = Mean Value + MV% + Offset + ***f*** ×Std.Deviation

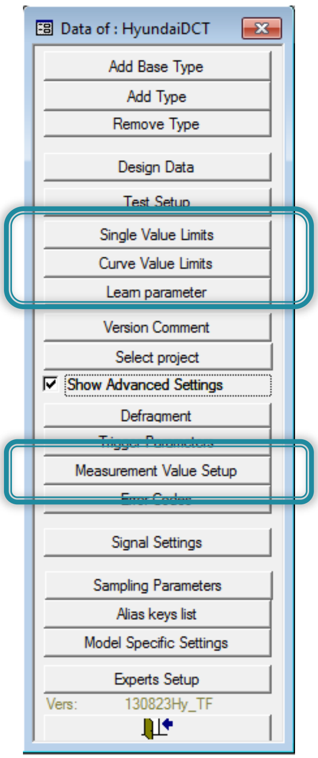
lim ≤ Max.Boundary

lim ≥ Min.Boundary



Mean value and standard deviation are stored in learn files.

Offset, MV%, factor ***f***, Min and Max boundary are set in the parameter data base.



The parameters are be split into two places:

Because of their different nature, Min and Max parameters for single value limits and curve value limits are separated.

In "Learn parameter", a new learn of mean and standard deviation can be initiated (see next pages).

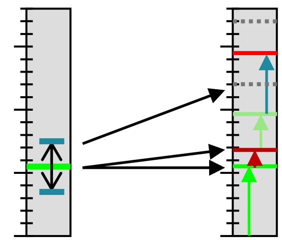
The three calculation parameters Offset, %Offset and Factor are entered in "Measurement Value Setup".

Depending on the project, these parameters can also be integrated into the limit value tables. In that case, there is no "Measurement Value Setup" button.

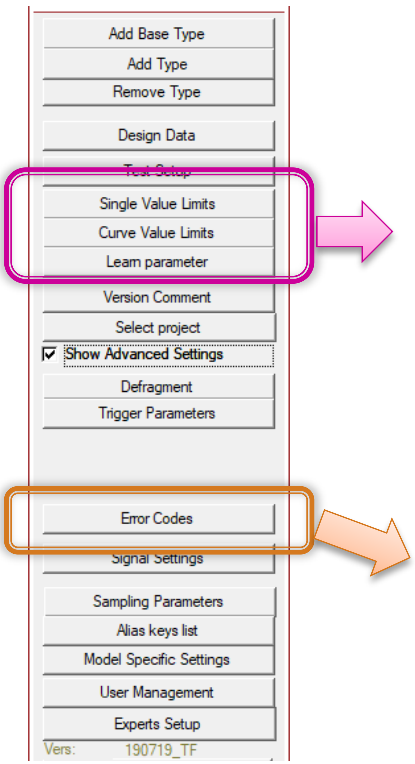
Adjusting the Limits

Each limit value is calculated using these rules:

lim = Mean Value + MV% + Offset + ***f*** ×Std.Deviation
lim ≤ Max.Boundary
lim ≥ Min.Boundary



Mean value and standard deviation are stored in learn files.
Offset, MV%, factor ***f***, Min and Max boundary are set in the parameter data base.



The parameters are split into two places:

Because of their different nature, limit parameters for single value limits and curve value limits are separated.

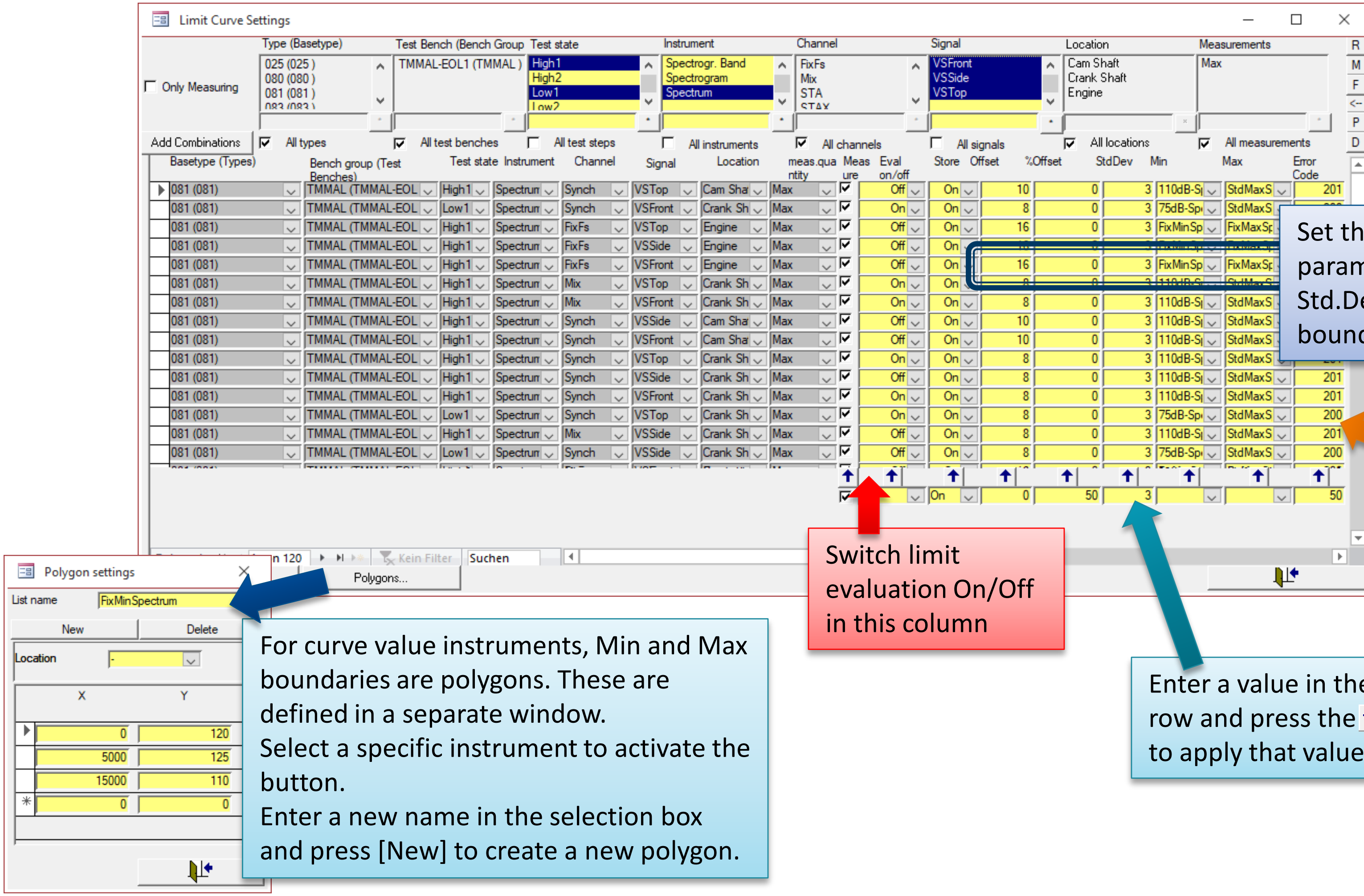
In “Learn parameter”, a new learn of mean and standard deviation can be initiated (see next pages).

New measurement values (new metrics) are also set up in the Single Value Limits or Curve Value Limits forms, respectively.

The Error Codes form is used to define defect codes and associated text messages.

Limit Settings Form

In the Limit Settings form, start by selecting the Clavis combination for which you want to review or change settings.



Set the limit calculation parameters (Offset, %+Mean, Std.Dev.-factor, Min and Max boundary) in these columns.

Error code can be set for each Clavis individually

Switch limit evaluation On/Off in this column

Enter a value in the bottom row and press the 🠝 button to apply that value to all rows.

For curve value instruments, Min and Max boundaries are polygons. These are defined in a separate window.
Select a specific instrument to activate the button.
Enter a new name in the selection box and press [New] to create a new polygon.

Defect Codes

Defect codes and defect messages can be freely defined in the parameter database.

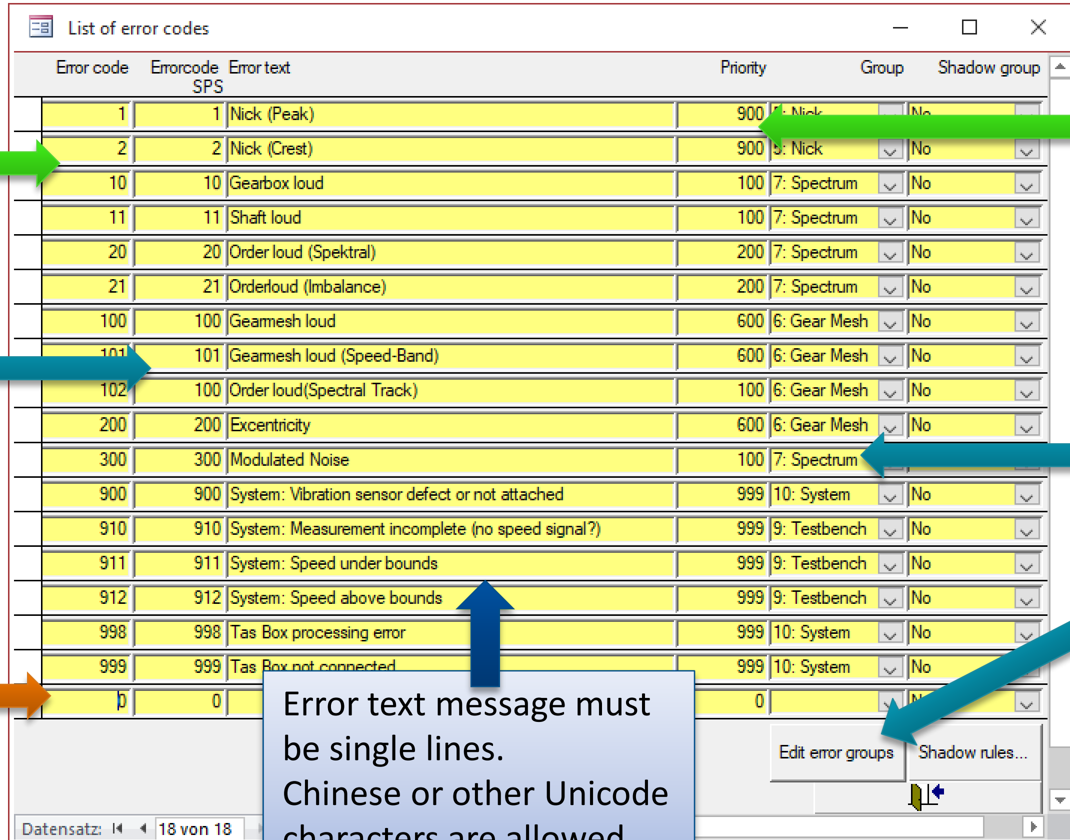
Error Codes

The defect codes are then assigned to measured values in the [Measurement Value Setup] or [Single/Curve Values Limits] forms.

Error code numbers can be chosen freely (0 is not allowed, no upper limit).

The "External error code" (or PLC error code) is the number sent as a result to the PLC. Multiple errors can use the same "external" code.

Add a new defect code definition in the last line of the list.



List of error codes

Error code	Errorcode SPS	Error text	Priority	Group	Shadow group
1	1	Nick (Peak)	900	[illegible]	No
2	2	Nick (Crest)	900	[illegible]: Nick	No
10	10	Gearbox loud	100	7: Spectrum	No
11	11	Shaft loud	100	7: Spectrum	No
20	20	Order loud (Spektral)	200	7: Spectrum	No
21	21	Orderloud (Imbalance)	200	7: Spectrum	No
100	100	Gearmesh loud	600	6: Gear Mesh	No
101	101	Gearmesh loud (Speed-Band)	600	6: Gear Mesh	No
102	100	Order loud(Spectral Track)	100	6: Gear Mesh	No
200	200	Excentricity	600	6: Gear Mesh	No
300	300	Modulated Noise	100	7: Spectrum	[illegible]
900	900	System: Vibration sensor defect or not attached	999	10: System	No
910	910	System: Measurement incomplete (no speed signal?)	999	9: Testbench	No
911	911	System: Speed under bounds	999	9: Testbench	No
912	912	System: Speed above bounds	999	9: Testbench	No
998	998	Tas Box processing error	999	10: System	No
999	999	Tas Box not connected	999	10: System	[illegible]
0	0		0		[illegible]

Edit error groups | Shadow rules...

Datensatz: 18 von 18

Error text message must be single lines.
Chinese or other Unicode characters are allowed.

"Priority" defines the sorting of defect messages. The defect messages with highest priority is listed first and is used for standard production statistics.

Errors are sorted into groups, which are defined in a separate form.
The error group of the error with highest priority defines the overall result code.

Overall result codes:
1 = OK, 0 = NOK,
2 = no evaluation,
3 = system error

Initiate new learning of limits

There are two ways of initiating a re-learning of all limits:

- The direct way: delete the learn files
- The delicate way: use the parameter data base (next page)

The direct way

On the measurement computer(s), quit the measurement application. Go to the folder

`C:\Discom\Measurement\MultiRot\(Project name)\Locals\LearnData\`

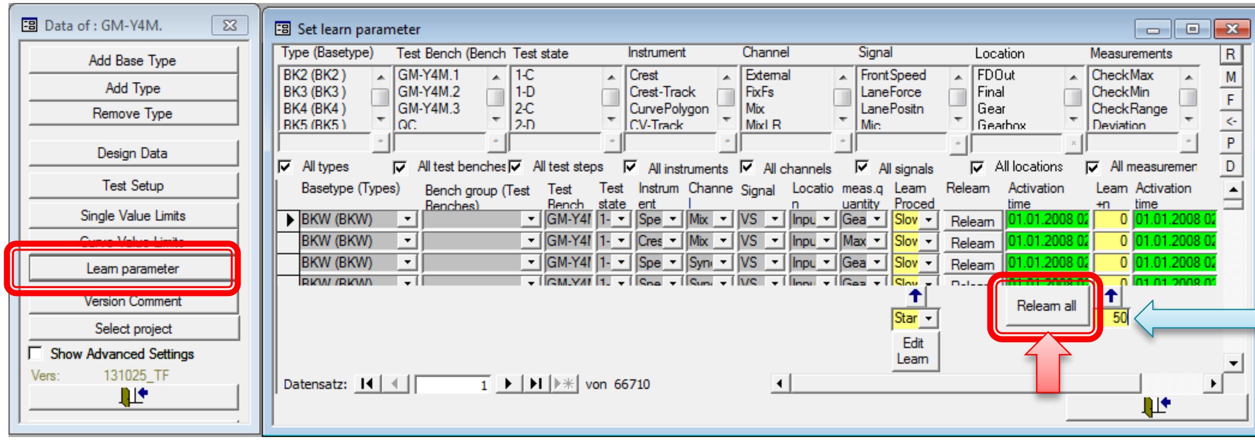
Delete all files in there (or only those for the base types you wish to re-learn), then start TasAlyser again.

The delicate way

Although the learn data are saved locally on the measurement computer in the LearnData folder, learning is managed in the parameter database (see next page).
This allows initiating a new learn for several test stands at once (if a central parameter database is used), re-learning only specific limits (e.g. only for a specific test step), or refining the learned limits with additional learn data (instead of starting all over).

Initiate new learning in Parameter Database

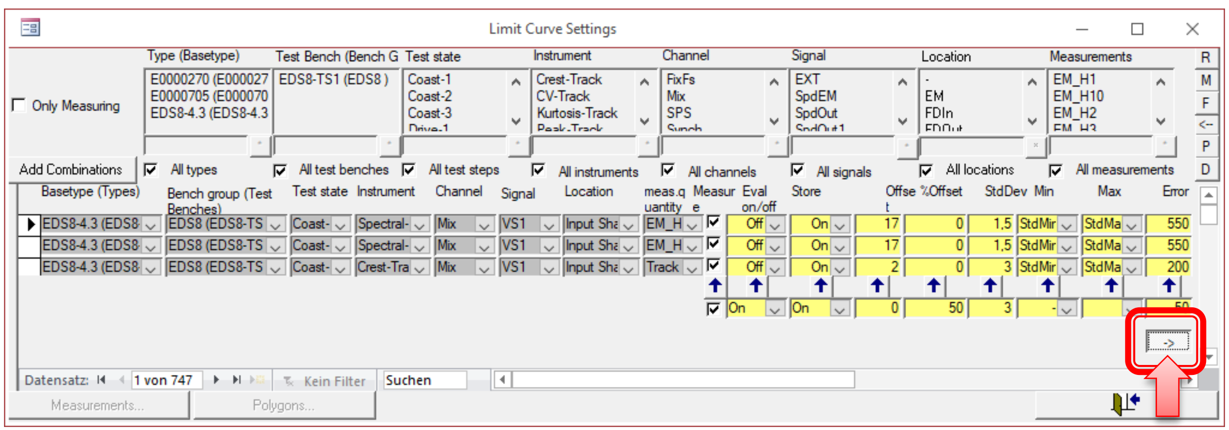
In the parameter data base, open the “Learn Parameter” form and press “Relearn all”:



You can select specific types, test stands, test steps or measured values in the upper part in order to re-learn only specific limits.

To refine some limits, enter a number (e.g. 50) into the “Learn +n” column.

If you do not have the “Learn Parameter” button in your project, go to the Limit Forms and press the “Expand” button in the lower right corner to get the learn parameter settings:



Since the learn parameter are associated with the limit parameters, if you want to re-learn all limits, you have to initiate this twice: for the single value and for the curve limits.

Learning (of mean value and standard deviation) is done even when evaluation is switched off for a Clavis.

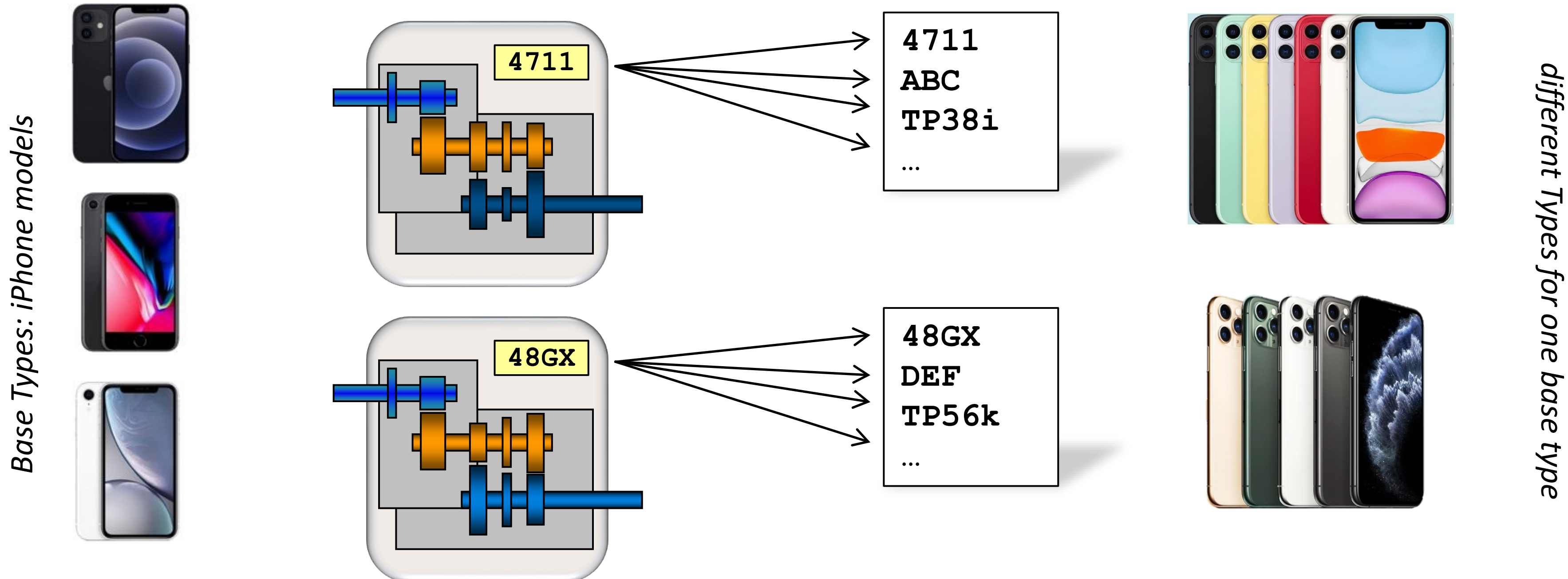
When a new metric is created, it will automatically start learning (independent of whether it is currently evaluated against a limit or not).

Types and Base Types

The parameter data base uses **types** and **base types**.

Base types differ in their kinematics (ratios, gears, …).

Each base type can have additional *names* associated. These names are Types.



Limits, testing parameters and the like are linked to base type.

The type name is used by test stand control and appears in measurement reports, result data base and production statistics.

In the same manner **test stand groups** can have multiple **test stand** names.

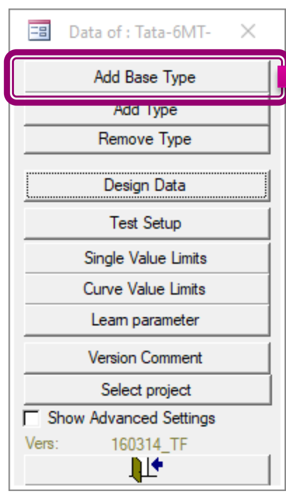
How To Create a New Base Types

A **Base Type** is different from other types by teeth numbers or other kinematic properties. All limit and measurement parameters are linked to base types.

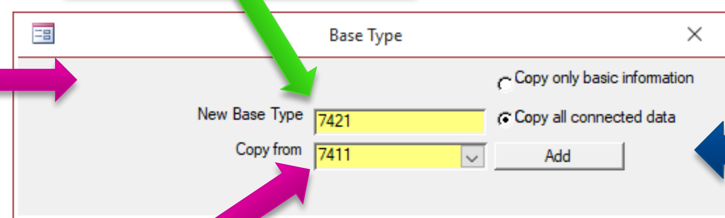
Each base type can have more than one associated **Type Names**. Type names are used for production statistics and PLC communication.

A new base type is always **created as a copy of an existing** base type. Afterwards, the teeth numbers and other properties are modified as needed.

To create a new base type, in TasForms press the [Add Base Type] button.



Enter the name of your new base type



Keep the choice “Copy all connected data” and press [Add]

For “Copy from”, select an existing base type with similar properties. *Take specific care* to select either 5 gear or 6 gear base type, according to your new type.

It may take some time for TasForms to create all table entries for the new type. After completion, you get a confirmation message:

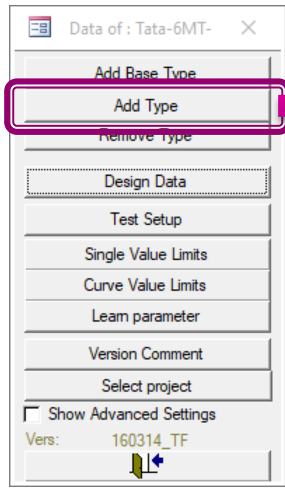
Additional Type Names

Each base type can have more than one associated type name.

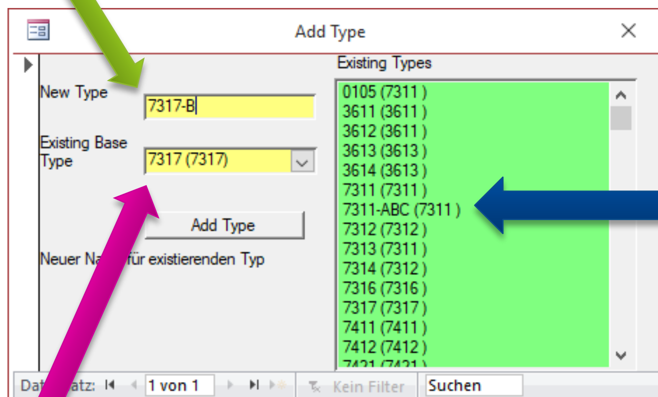
Production statistics and evaluation use type names by default, but limits are linked to base types.

Every base type also appears as a type name.

To create a new type name, press the [Add Type] button.



Enter the new type name here



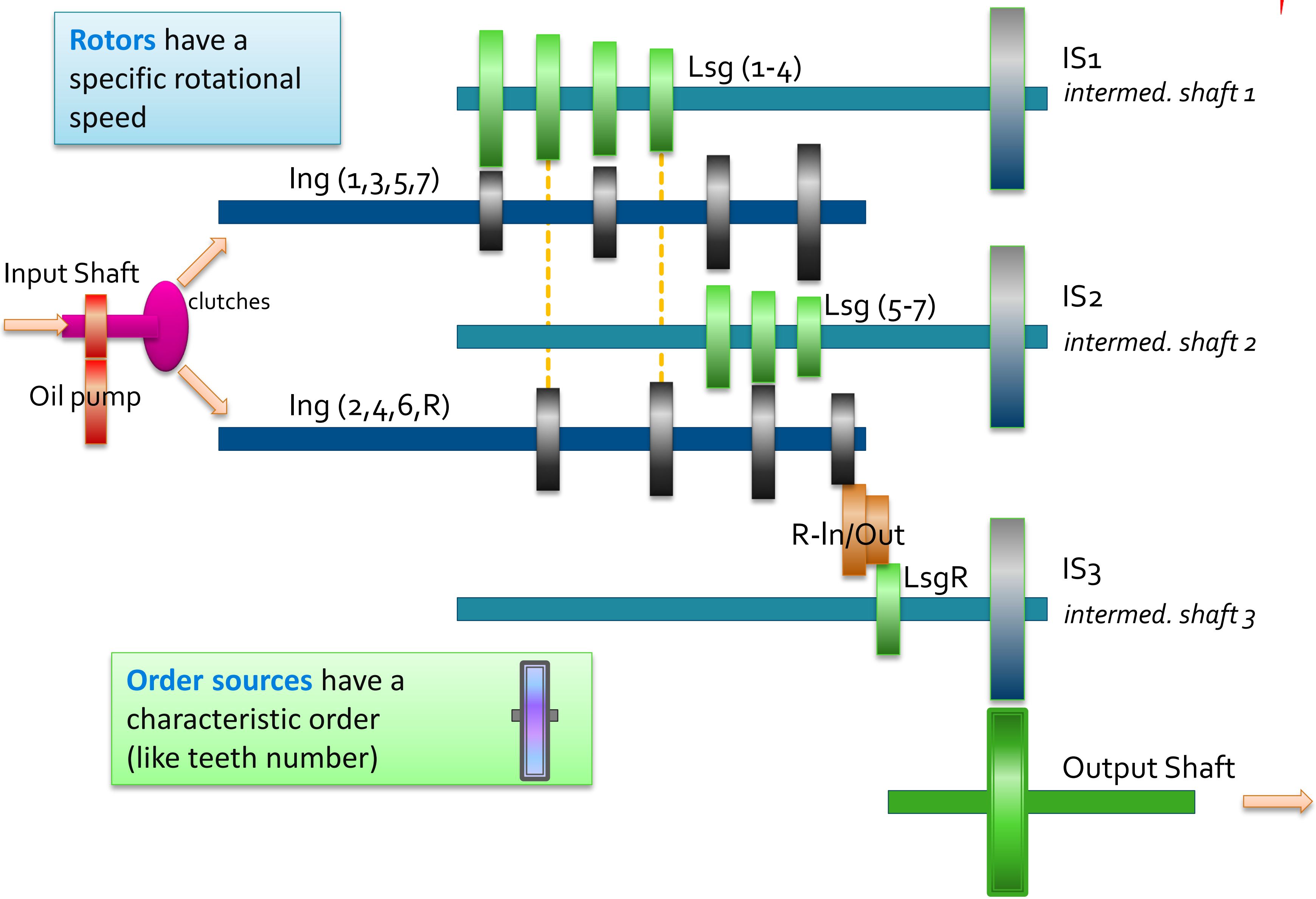
The list shows all existing type names. Each name has in parentheses the according base type.

You have to select the base type which gets this new name.

The parenthesis show other names linked to this type name.

Rotors and Order Sources

Rotors have a specific rotational speed



Order sources have a characteristic order (like teeth number)

Creating New Metrics

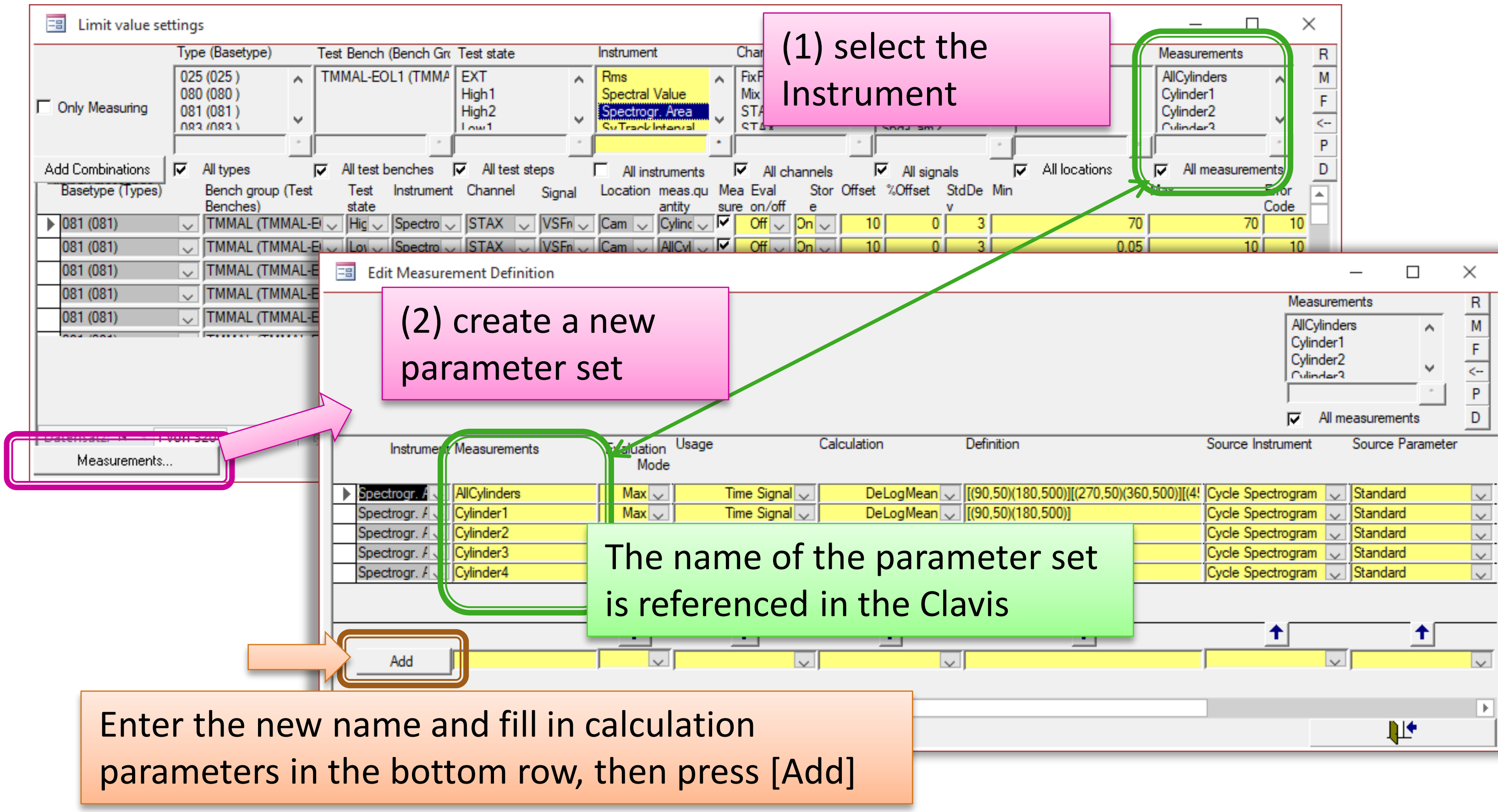
Creating new metrices is done in the parameter database.

It involves choice of method (“instrument”), definition of calculation parameters and creation of Clavis entries for the values.

Creating Metrics

Creating a new metric involves three steps:

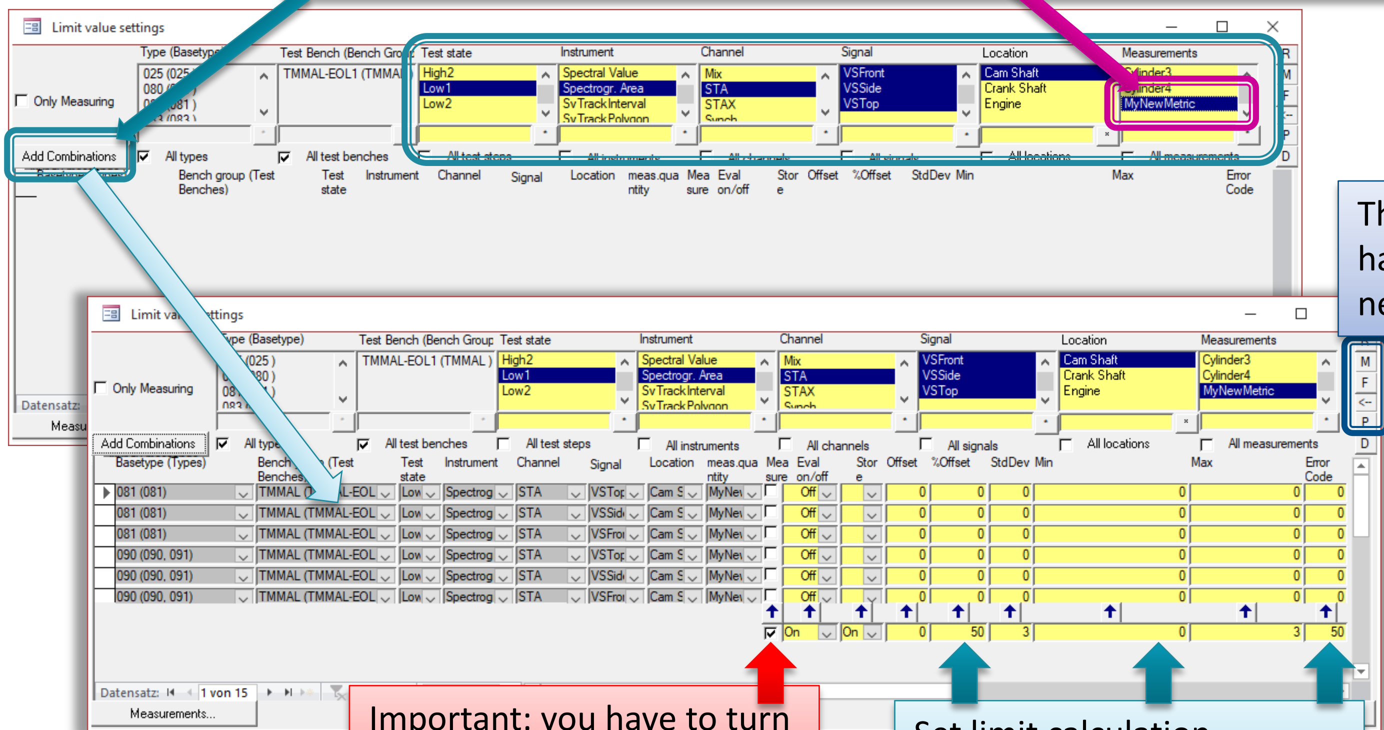
1. Choose the appropriate instrument in the [Limit Settings] form
2. Create a new measurement parameter set for this instrument
3. Create the measurement values for the new parameter



Creating Measurement Values

After having created the Measurement Parameter (calculation parameters), the third step is to create the actual values (the Clavis list).

(3) Select the exact Clavis combination(s) you want to create values for, using your new 'Measurement' parameter.
Then press [Add Combinations].



These little buttons come in handy when creating the new measurement values:

1. Select the Clavis combination with an existing 'Measurement' parameter.
2. Press [M] button.
3. Switch to the new 'Measurement' parameter.
4. Press [<–] button.

Important: you have to turn "Measure" check mark on to activate the new values.

Set limit calculation parameters, error codes etc.

THE TASALYSER APPLICATION

Although the TasAlyser measurement application is a central component of the Discom production test system, after the initial setup users interact with it rather little.

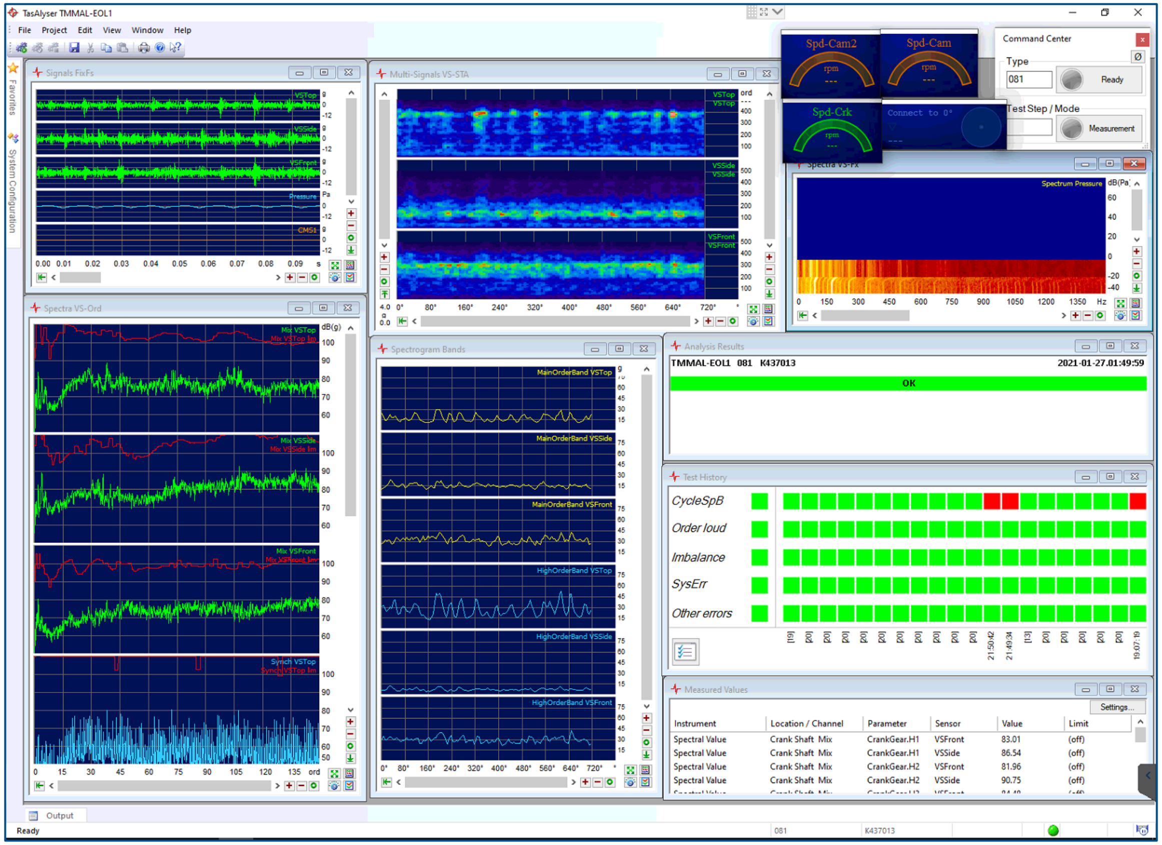
TasAlyser

The TasAlyser measurement application loads a **measurement project** which defines the processing and display modules (like the Excel application load a spreadsheet which contains the actual data and calculation rules).

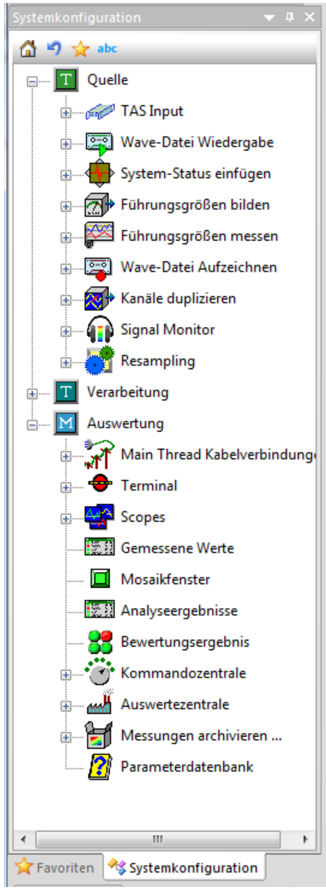
Because of the modular structure, a TasAlyser project can be adapted to various measurement and evaluation requirements.

The user interface offers multiple data and result display windows.

Internally, TasAlyser uses multi-processor parallel computing and can process the sensor data faster than real-time.



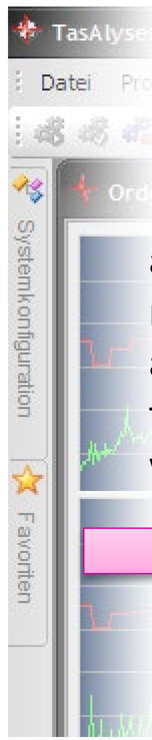
System Configuration and Favorites



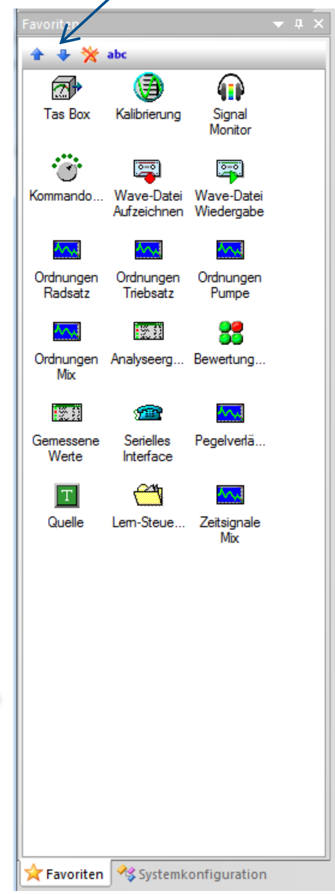
The docking window **System Configuration** provides access to all software modules of the TasAlyser application. Double-click on an item opens the associated display or settings window.

sort favorites here

Those modules which are needed most often can be added to the **Favorites** docking window.



Because both windows are not needed during normal operation, they are folded to the edge of the TasAlyser main window.

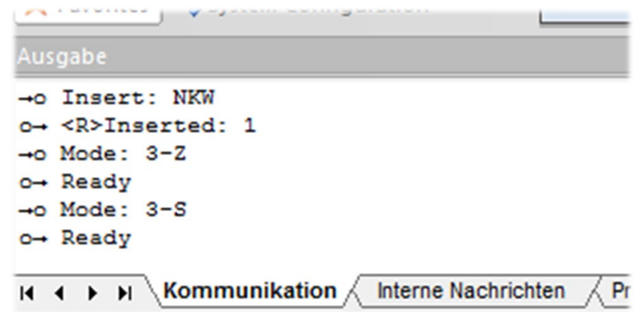


Test Stand Communication

The TasAlyser application and the test stand control usually* talk to each other via **UDP (network)** or a **serial RS232 interface**.

The test run is controlled using **text commands**, and TasAlyser answers with text messages.

In the Output window (usually docked at the bottom of the main window) the communication can be monitored:



TasAlyser provides a **wide range of commands**, which can be **extended** for special purposes.

Examples for commands:

Command	Description
Insert: [Type]	Get ready for a new test run with gearbox [Type]
Mode: [A]	Select test step [A]
Measure: 1/0	Measurement start/stop
Remove:	End test run.
Result:	1 = OK, 0 = not OK, …

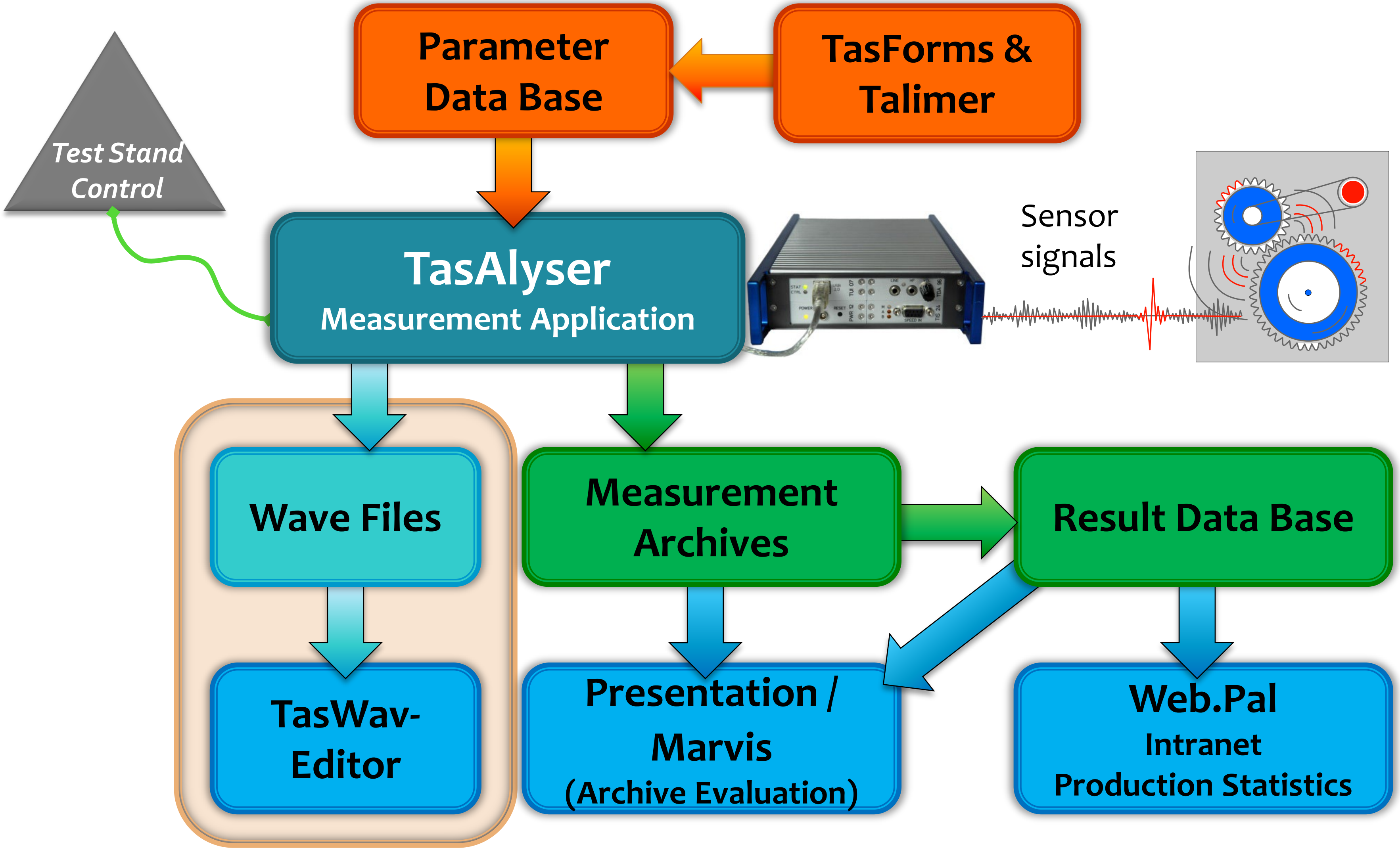
** Optionally, other ways of communcation can be used, e.g. Profibus, bit parallel or TCP/IP. But also when using Profibus or TCP/IP, the communication has the form of text messages.*

Wave Recording and TasWavEditor

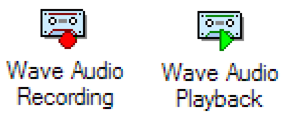
TasAlyser records each test run in a wave file.

These wave files can be analyzed further with TasWaveditor.

System Overview: Wave Files



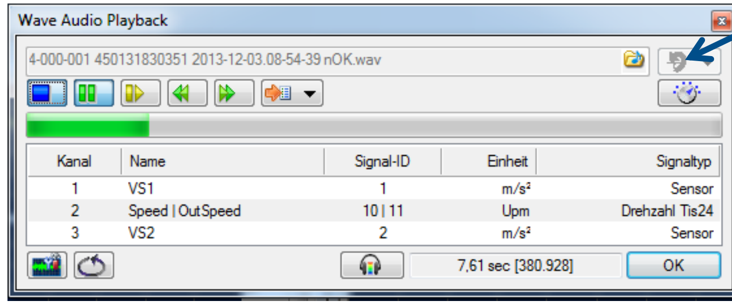
Wave File Recording



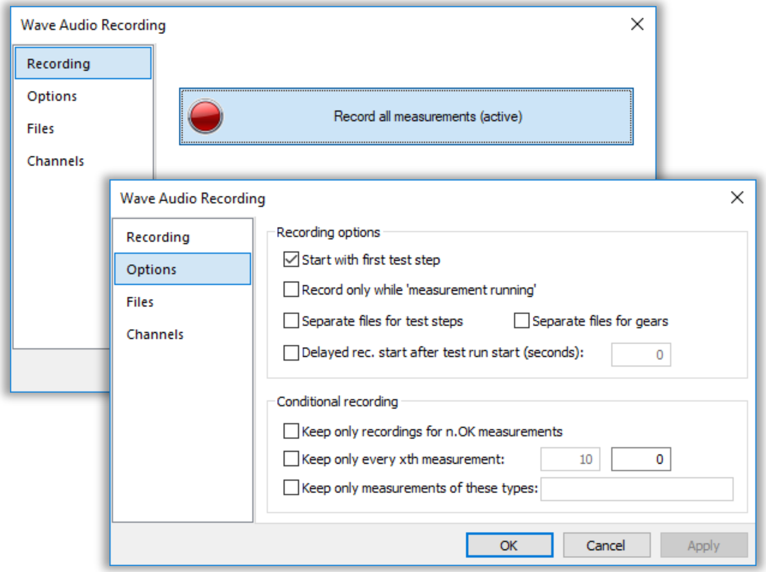
The TasAlyser application records all sensor data directly into a wave file. Channel information and test sequence cue points are stored in the wave file header.

From such a wave file, the complete test run can be re-played.

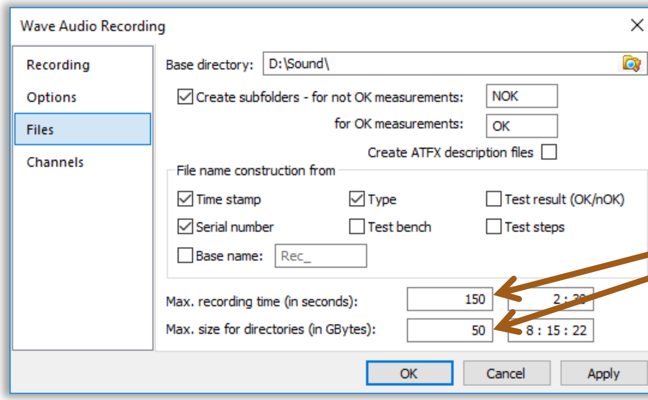
Press this button to recall the last recorded measurement



Typically, you will record the complete test runs of all measurements, but other settings are available.



Wave files cannot be larger than 2 GB, which limits the maximum recording time. If needed, the recording can be split up into parts.



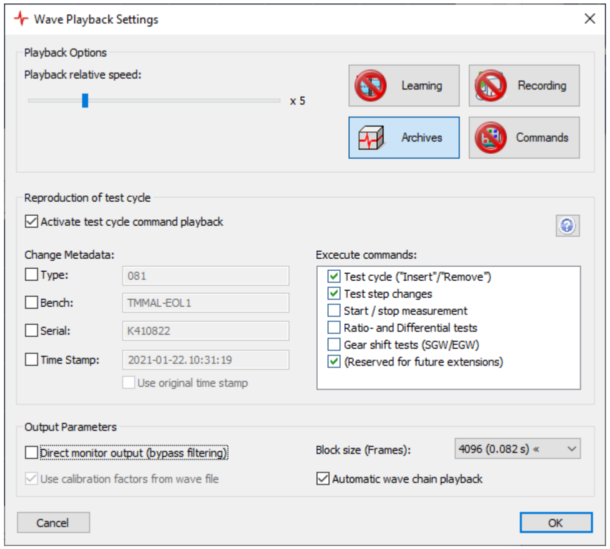
Max. recording time and max. directory size for the recording folders (see remarks below)

Recordings can be placed in separate folders for OK and nOK measurements.

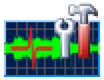
When the maximum directory size is reached for one of the folders, the oldest recordings are deleted automatically.

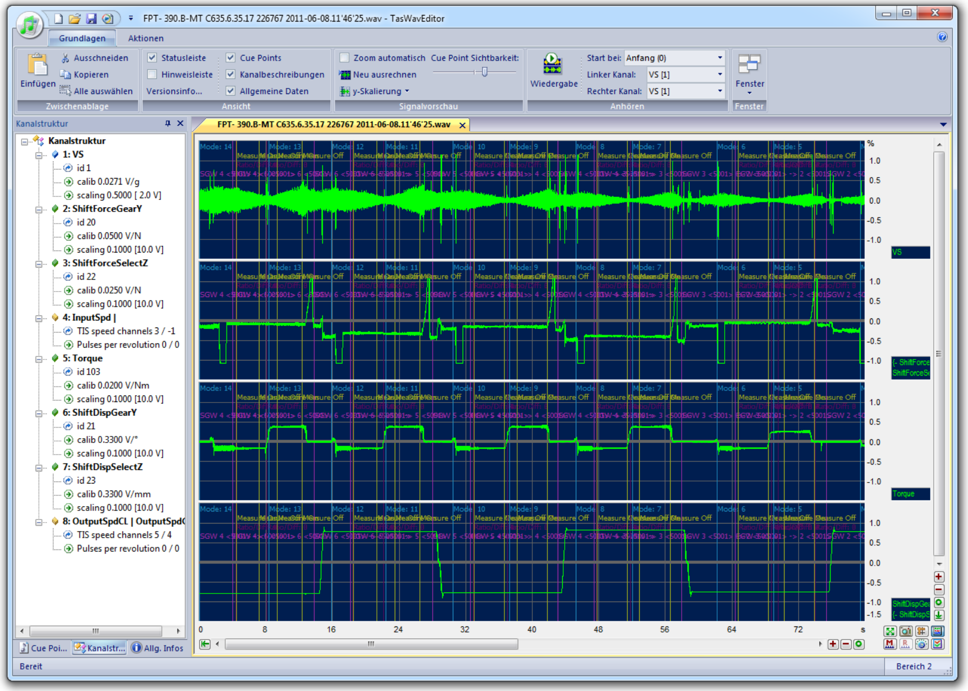
Wave Playback, TasWavEditor

TasAlyser-recorded wave files do not only contain the multichannel sensor data but also additional channel descriptions (like calibration) and data about the test sequence (called “cue points”) for test steps and so on.



This way, the test can be exactly re-played in TasAlyser. For the processing and evaluation in TasAlyser, there is no difference between a real measurement and a wave playback. (You can even use wave playback for limit learning.)



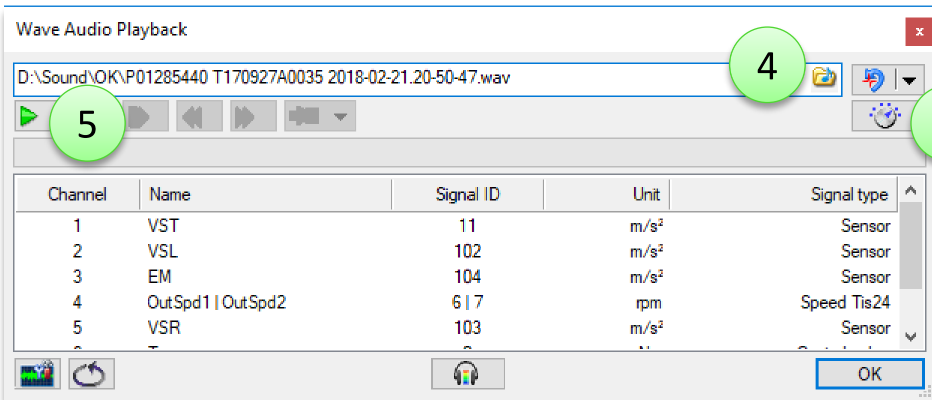


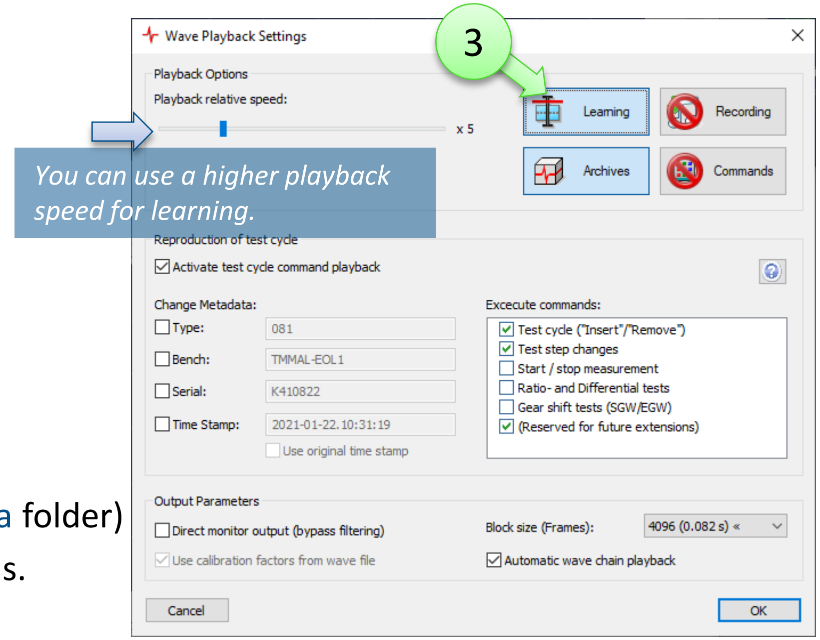
You can use TasWavEditor to examine the contents of the wave files. The TasWavEditor also shows channel information and the test run cue points and can play the sounds.

You can also load the wave files into standard audio processing software or import them into third party analysis systems.

Learning Limits from Wave Files

You can use wave recordings to learn limits.
This is for example useful if you are in a prototype or start-of-production phase where you have only a small number of transmissions available.



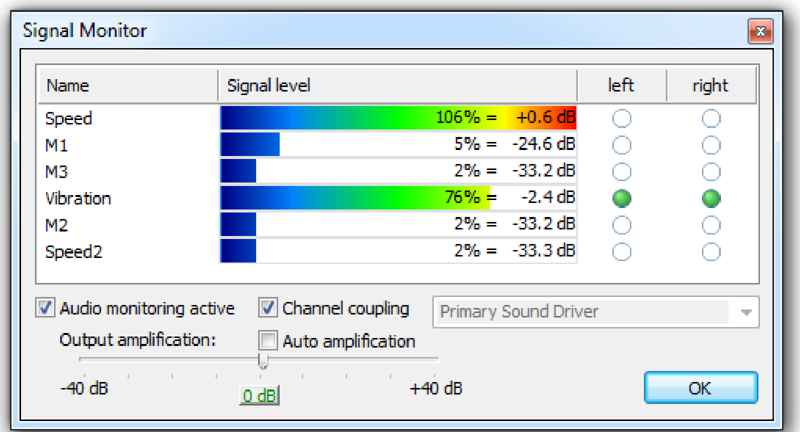


1. Initiate a new learning (for example by deleting the learn files in the C:\Discom\Measurement\MultiRot\(ProjectName)\Locals\LearnData folder)
2. Call up the wave player (F12) and from there the wave player options.
3. In the wave player options, activate the “Learning” option.
4. Use the file browser from the wave player to load all intended wave files at once (select multiple files in the file open browser).
5. Press the “Play” button. The wave player will run all selected files and limits will be learned.
6. Switch the “Learning” option back off afterwards to avoid unintended learning during later playbacks.

Signal Monitor

The signal monitor routes the data of selected sensor channels to the PC soundcard of the measurement computer.

By connecting headphones to the measurement signal, you can directly listen to (for example) the accelerometer signal.



In addition, the signal monitor shows the recording level for all sensor channels. Here you can check if all signals have enough strength or if a signal is overdriven.

Double-click in a line of the level display to switch between gain percentage and absolute sensor values. The maximum gain is changed in the TAS box settings.

The signal monitor also works when replaying a wave file, so this way you can listen to what was recorded.

Sensor Configuration Switching

In some projects, different sensor configurations are used for different tests.

Examples: different housings of models require different sensor positions, or test stand uses a turntable with two sensor sets.

In cases like these, two (or more) **Sensor Configurations** are set up in the parameter data base.

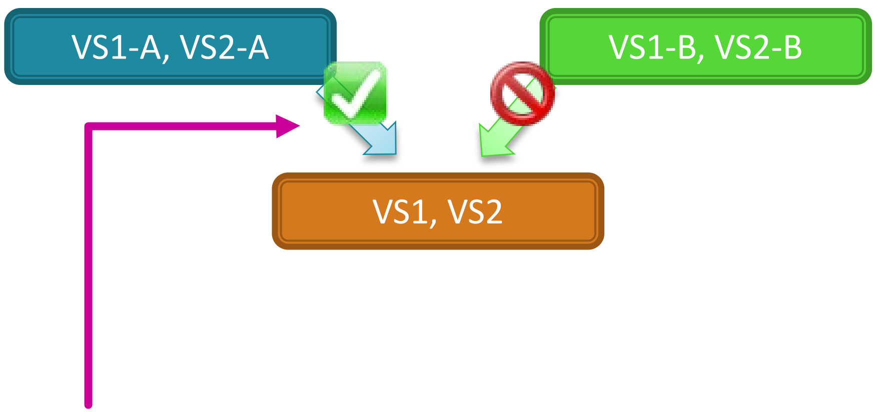
In addition, a set of 'generic' sensor names exists. These generic names are used for parametrization.

Example:

Sensor Configuration "SC-A" Sensors VS1-A, VS2-A	Sensor Configuration "SC-B" Sensors VS1-B, VS2-B	'generic' sensors for parametrization: VS1, VS2

Before the actual test run starts, TasAlyser determines which sensor configuration has to be used for the current test run and applies **Signal Routing** to switch between sensor sets.

Routing:



The sensors of the selected configuration will appear under the 'generic' names in the measurement results and in the wave files.

The not selected sensors will also be contained in the wave files, but with their original names.

(In this example, configuration A is used, and the wave file will contain the channels VS1, VS2, VS1-B and VS2-B.)

Selecting the Sensor Configuration can be done by assigning sensor configuration with base types in the parameter data base ("Test Setup"), or the test stand can send the command `SetSensorConfig`.

(In the latter case, the measurement results will automatically contain the additional information which configuration was selected.)

The Presentation/Marvis Appliction

The 'Presentation' application – renamed to 'Marvis' recently – is used to evaluate the curve data stored in result files.

Measurement Result Archives

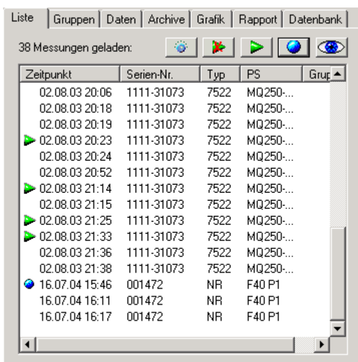
DISCOM

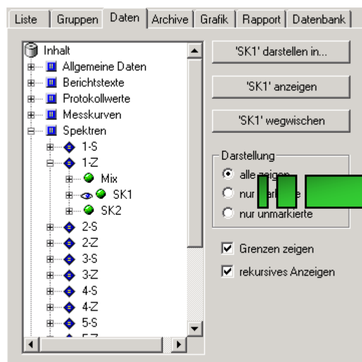
The measurement application stores all result data in an **archive file**.

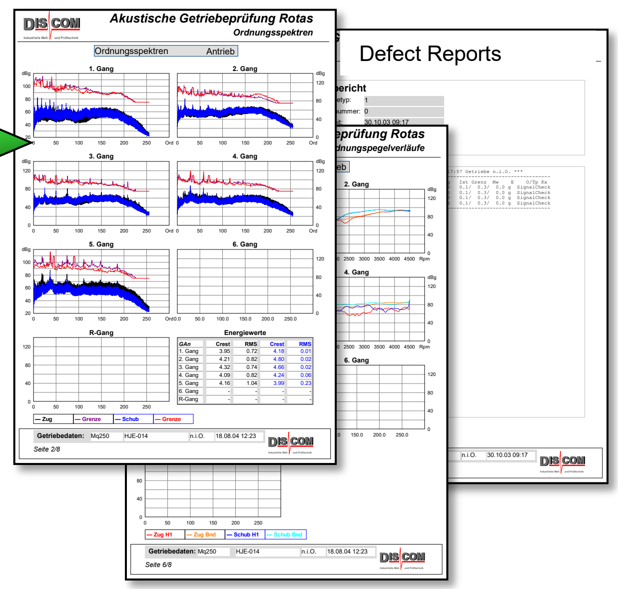
These archive files are inserted into the **Result data base** by the **Collector Service**.

The result data can be evaluated using **Web.Pal** or the **Presentation** (Marvis) application.

The Presentation application can load archive files and results from the data base in parallel.



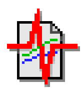




Display of measurements and results in Presentation can be done automatically by so-called Rapports. With rapports, standardized multi-page reports can be produced easily.

Measurement Archive Evaluation: Marvis

Marvis or “Presentation application” is used for displaying and evaluation of the data contained in measurement archives and the result data base. With Presentation, evaluation can be done interactively as well as automatic production of complete reports.



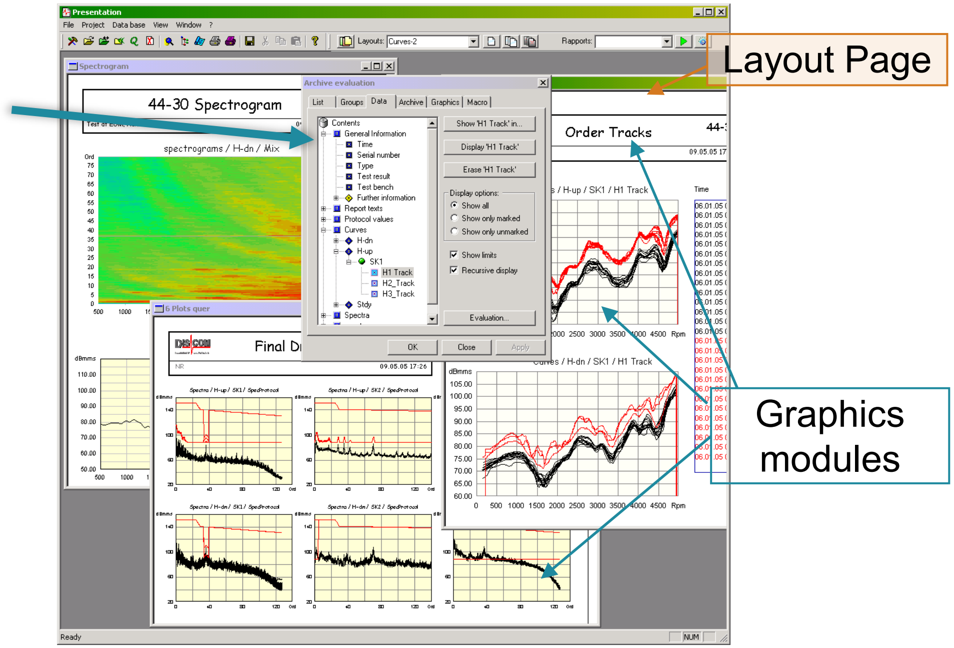
Presentation

You can load many measurements at a time and produce stray bands or A/B comparisons. The Presentation‘s graphics can be directly imported into Microsoft Office (like Powerpoint). Measurement data can be exported to Excel.

Presentation is handled using a tabbed control window with categories for different tasks.

The data is displayed on layout pages. Each page corresponds to a printable sheet of paper and can be designed individually. You can use as many pages as you want.

The elements within a layout page are called graphics modules. There are many kinds of graphics modules, like curve plots, text boxes, bar charts or colored lists.



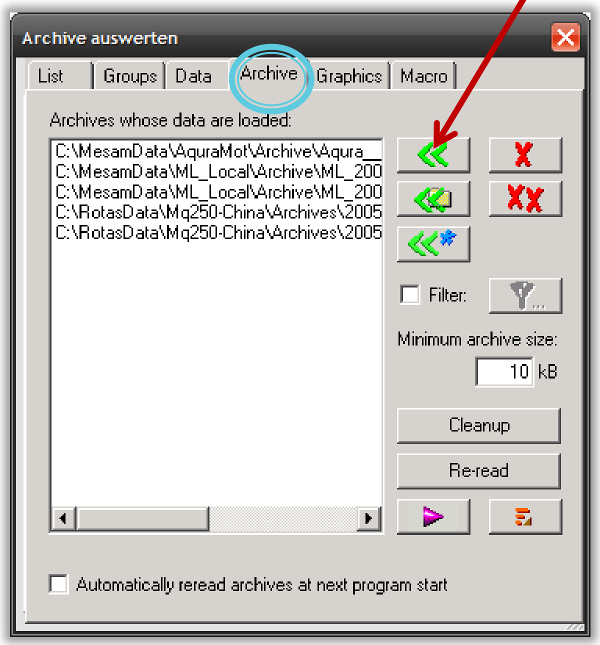
All layout pages, display settings etc. are stored in files within one folder, the Presentation Project folder. One of these files is the project base file which you load into Presentation to use that project.

Using the Presentation App

You can load measurements into Presentation either by querying the result data base or by loading archive files.
Use the “**Q**” button on the toolbar to get measurements from the result data base:

In order to load an archive file, press the “file open” button in the toolbar or the “**<<**“ button in the “Archive” category of the control window:

Or just drag the archive files from Windows file explorer and drop them into the Presentation window.

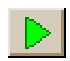


Un-Load Archives:

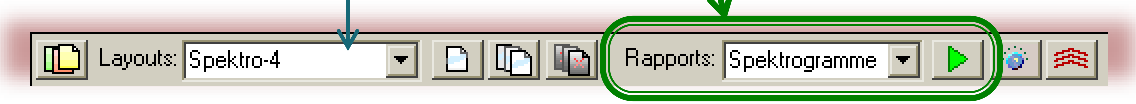
The ***X*** buttons unload one or all archives.

The ***X*** button in the toolbar unloads all loaded measurements and cleans all graphics.

After one or more measurements have been loaded, select a Rapport from the list in the right toolbar and start it with the button



Select a layout page from this list to pop up the window:



The List of Measurements

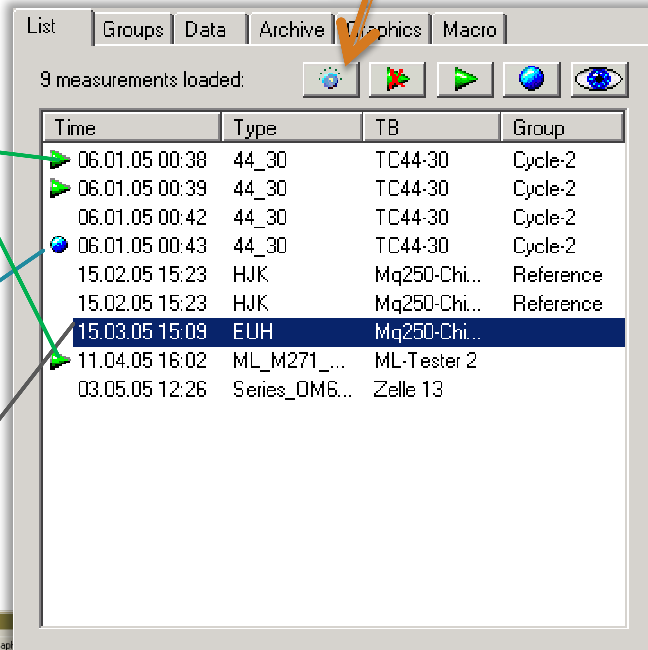
In the List section of the control window, you can see all loaded measurements.

List column settings
(select the list columns)

Marked measurements (multiple measurements can be marked)

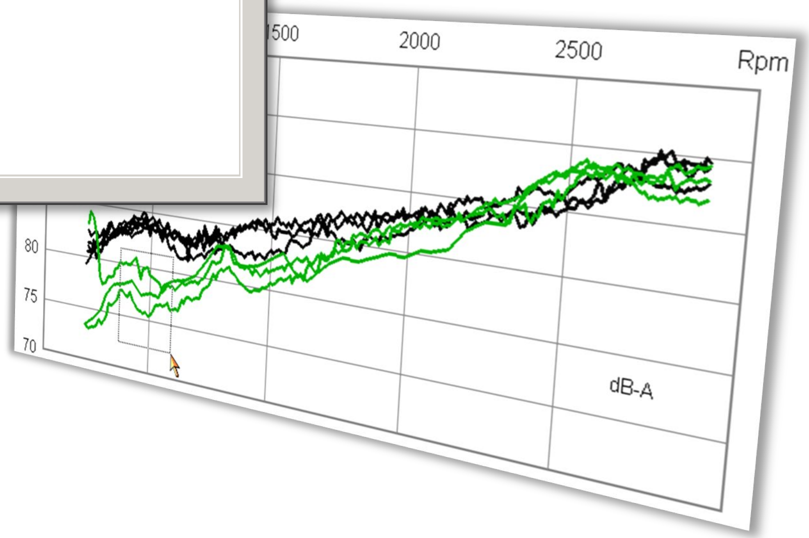
Highlighted measurement (only one measurement can be highlighted)

Selected measurement (select list lines in the normal Windows fashion)

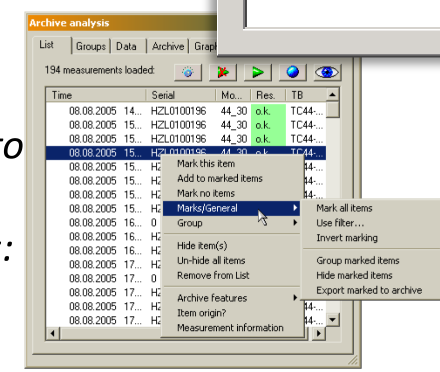


When you mark or highlight measurements in the list, the according curves are re-drawn colored.

Or select curves (shift+click+drag rectangle) to mark them.



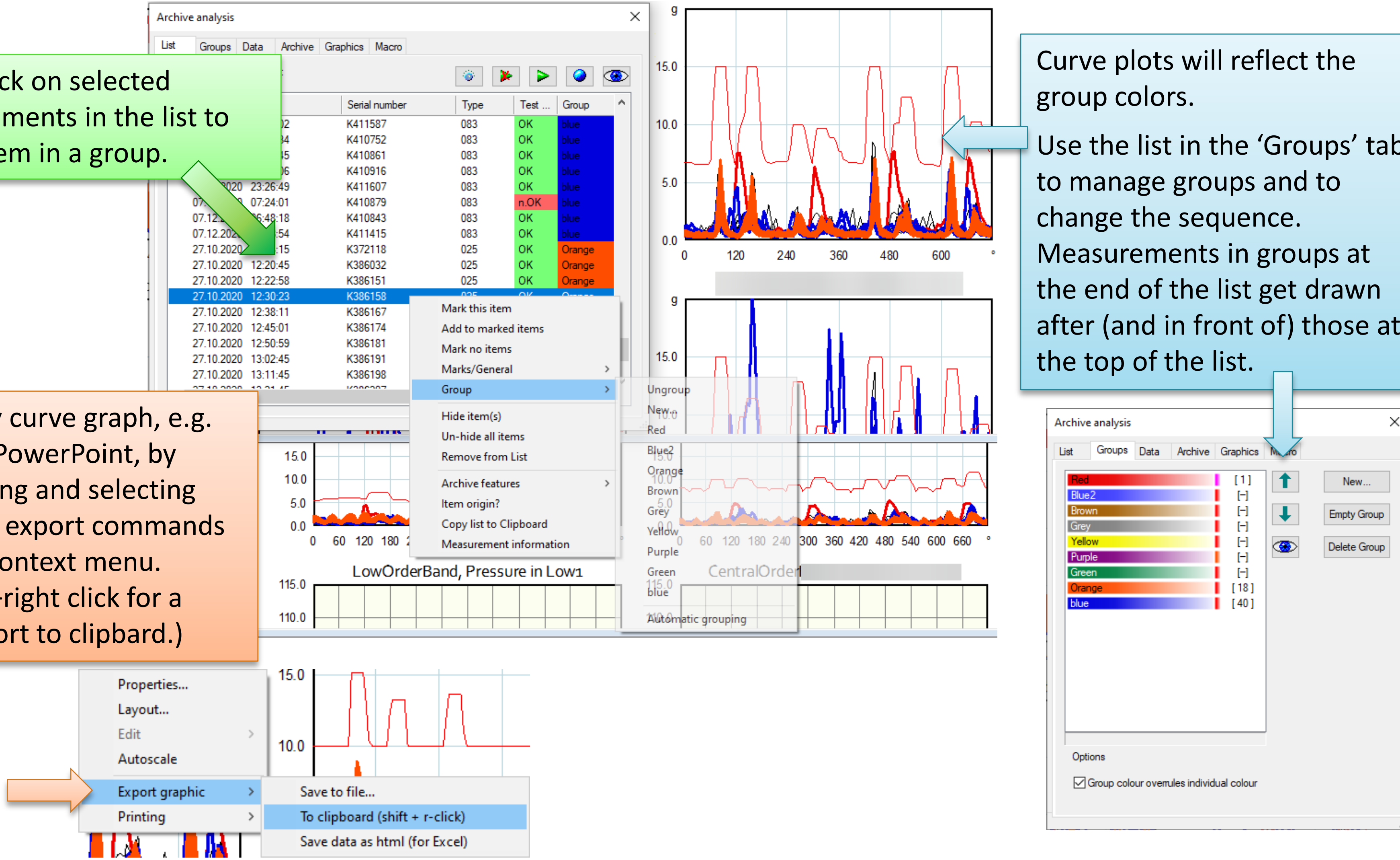
Right-click on a measurement in the list to call up a context menu with additional functions:



Groups of Measurements

Use ‘Groups’ to analyse the differences between batches of measurements.

Right-Click on selected measurements in the list to place them in a group.



Curve plots will reflect the group colors.

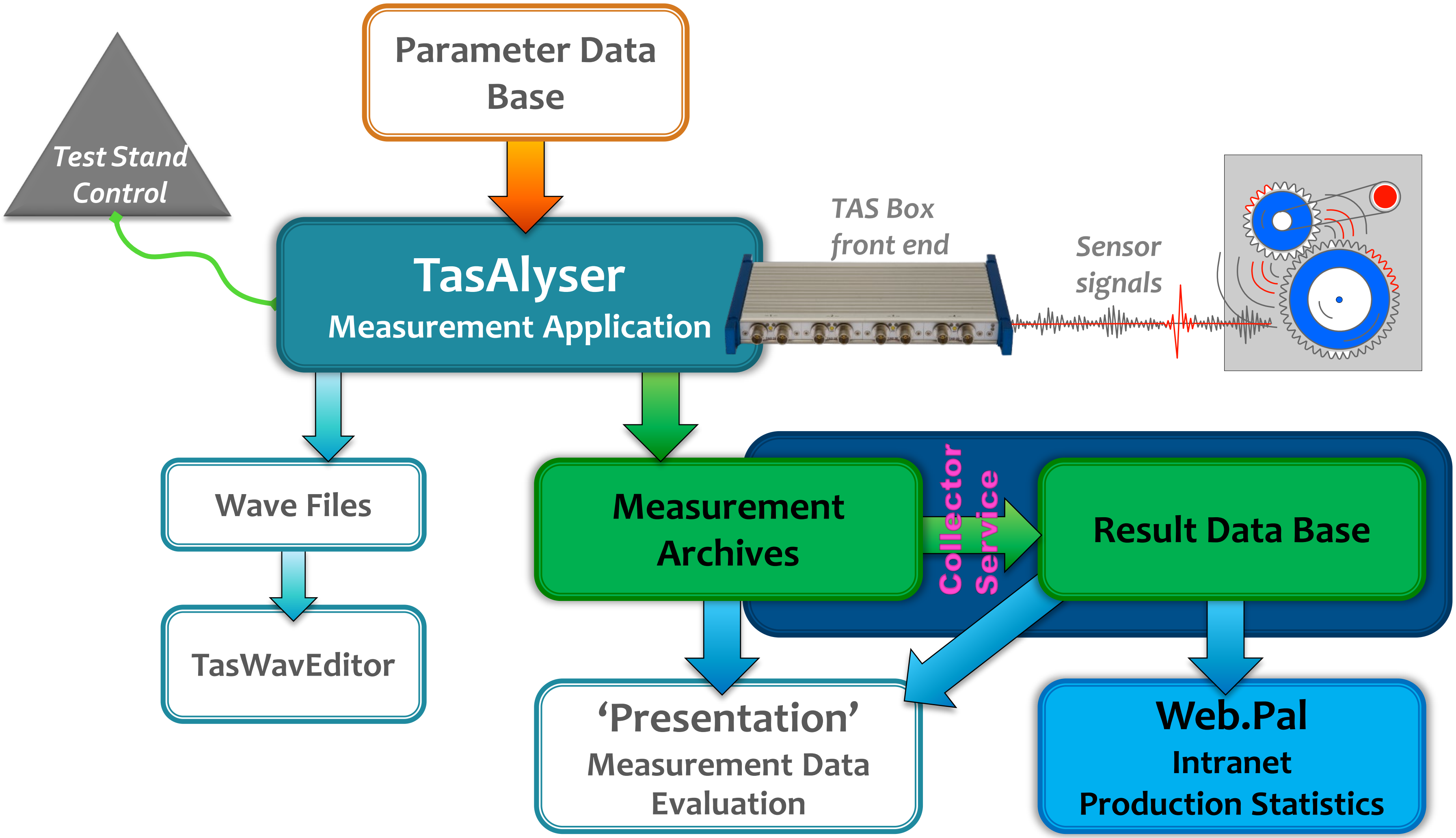
Use the list in the ‘Groups’ tab to manage groups and to change the sequence. Measurements in groups at the end of the list get drawn after (and in front of) those at the top of the list.

Export any curve graph, e.g. for use in PowerPoint, by right-clicking and selecting one of the export commands from the context menu. (Use shift+right click for a direct export to clipboard.)

RESULT DATABASE AND COLLECTOR SERVICE

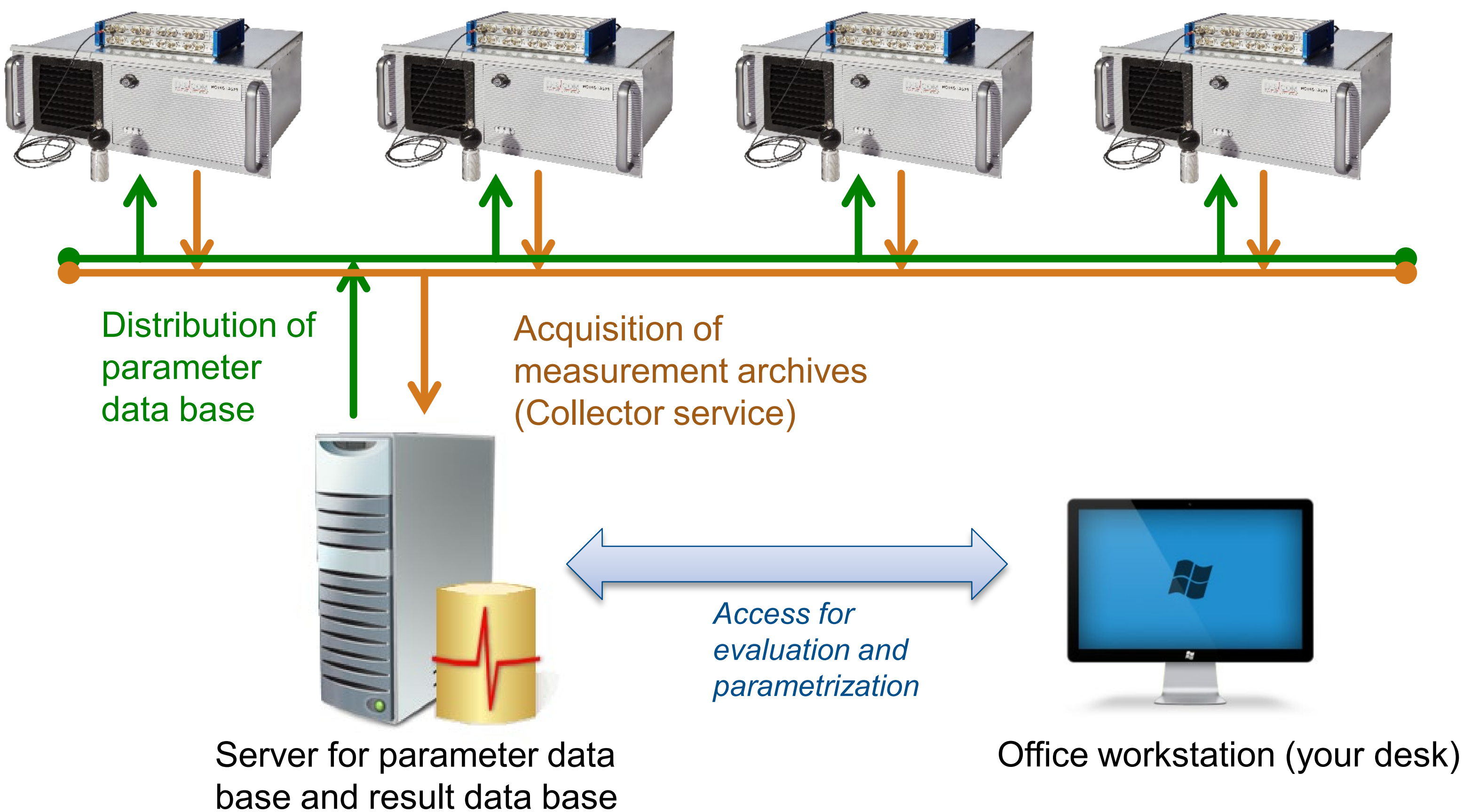
The result database is filled with information from the measurement archive files. This is the task of the Collector Service.

Discom Result Database Overview



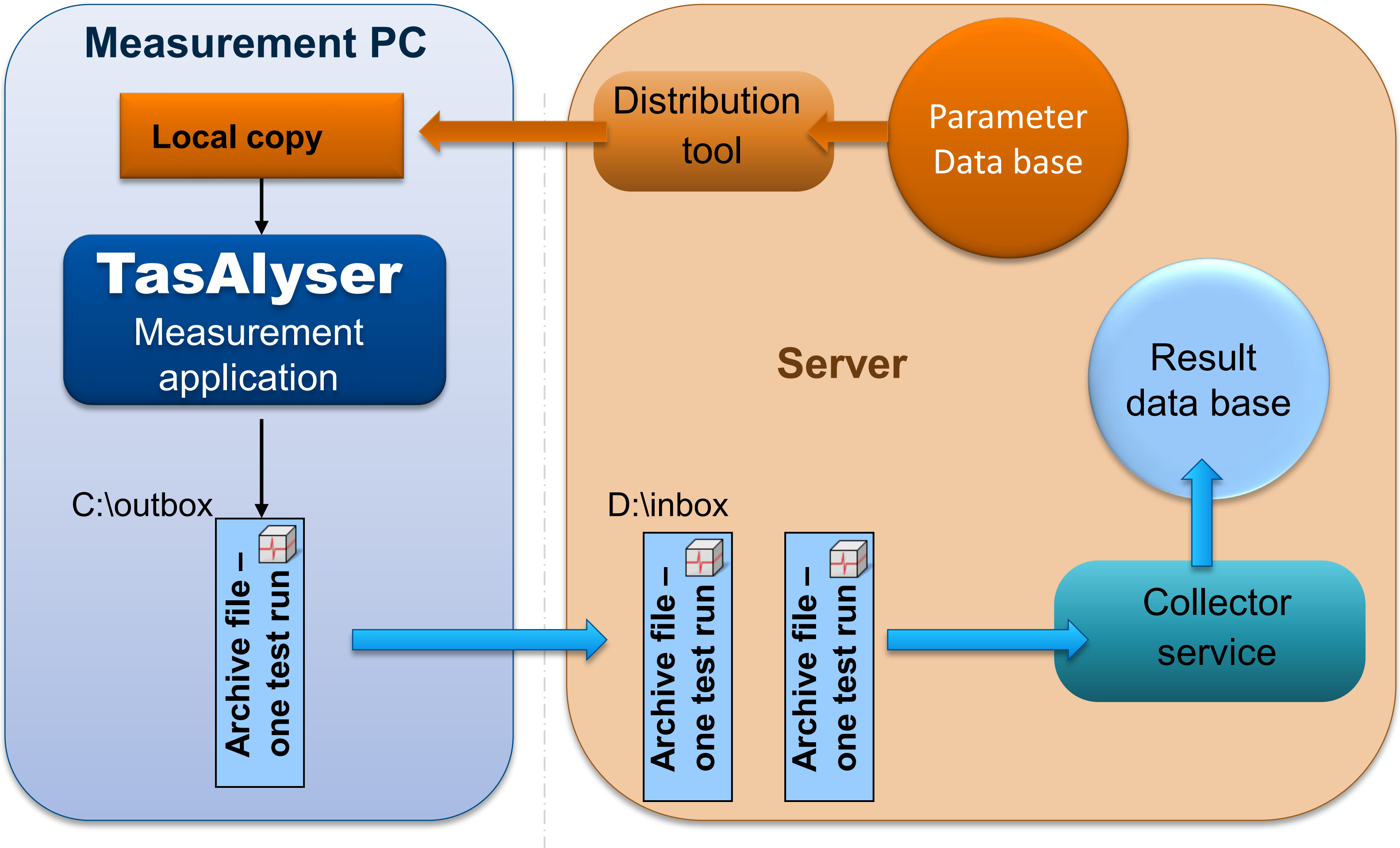
Working with multiple test stands

The result database and the parameter database master copy reside on a central server. Results are collected from the test stands to the server, and the parameter database is distributed from there to the test stands. Usually you access the server via Web.Pal and remote desktop from your office workstation.



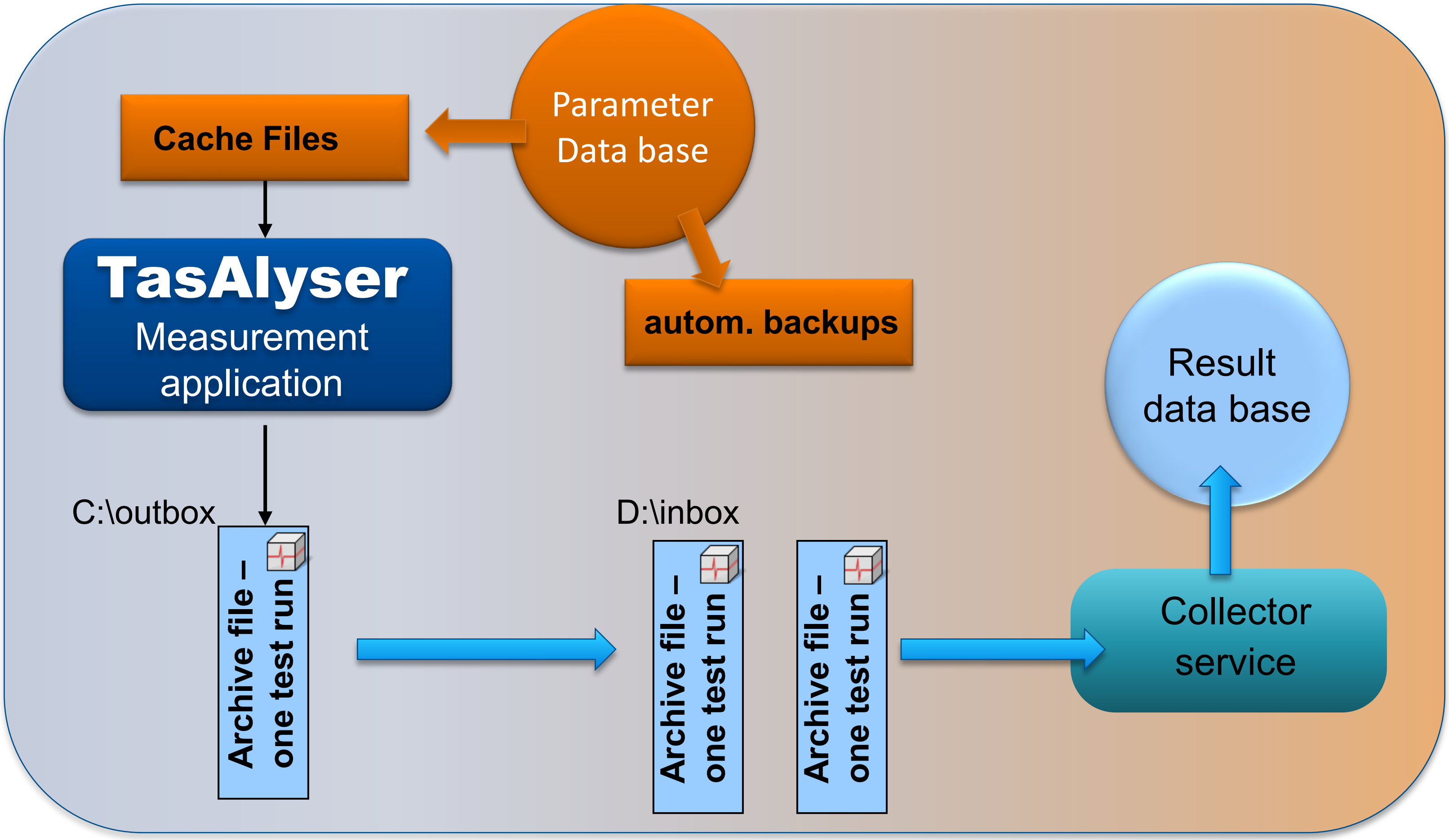
Network exchange with a server

Information exchange between measurement PCs and server uses shared folders and file transfer. The Collector Service retrieves the result files from the test stands, moves them to the local inbox folder and then inserts them into the result database.



Local Result and Parameter Databases

If no dedicated server is available, the result data base and Web.Pal service can also be hosted on the measurement PC.

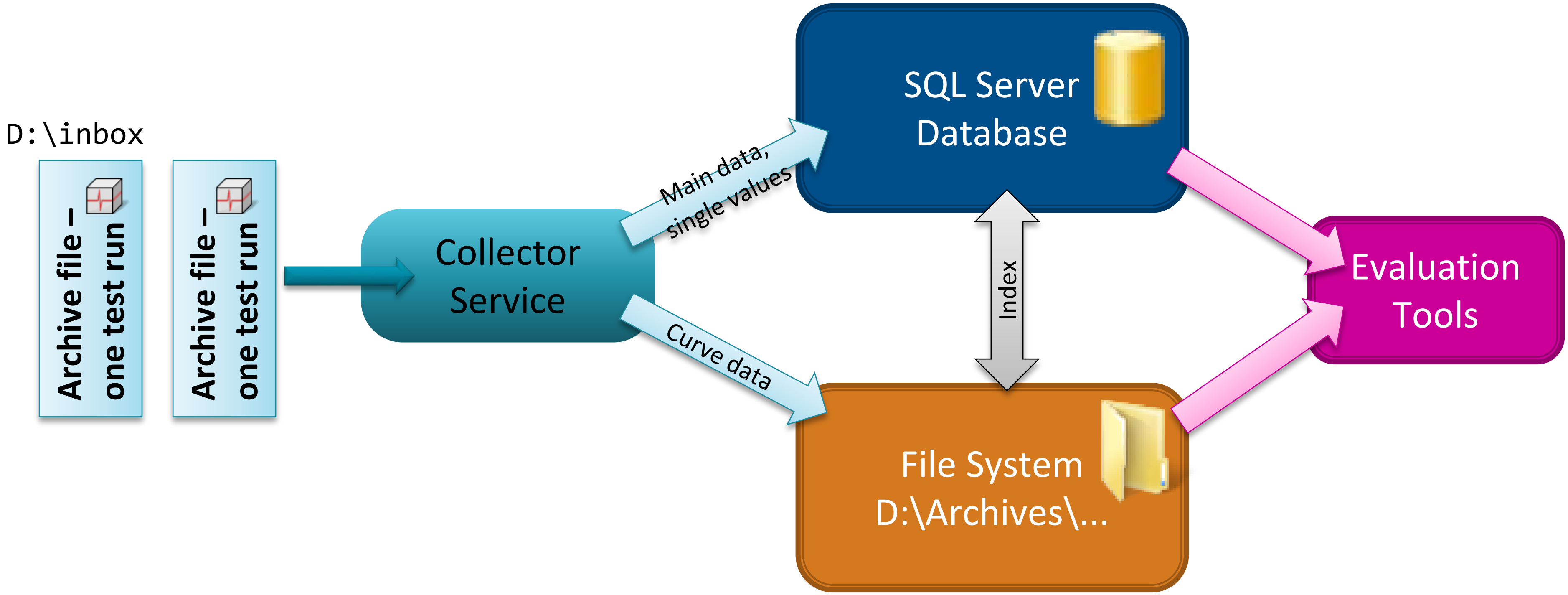


If a network connection is available, results and Web.Pal can still be accessed from within the company network.

Result Database + File System

The result database contains for each test run all general information (serial number, time stamp, result, defect messages etc.) and all single value measurement data.

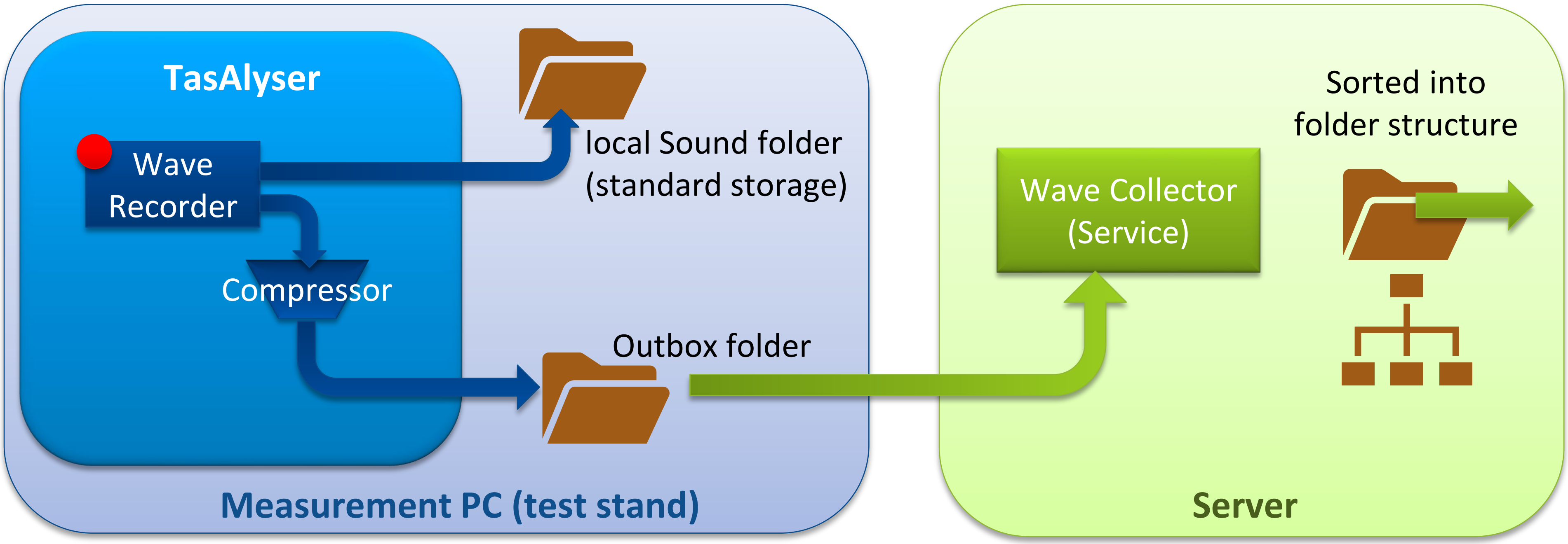
Curve data (spectra, order tracks) and spectrogram data are stored in files in rdt format, which are sorted into week folders and daily files. The database contains an index into these files, so that any specific curve can be found and loaded directly.



Wave Collector

Normally, the wave recordings of the test runs stay on the measurement PCs in the designated Sound folders. The combined storages space of all test stands is in may instances larger than the available server space, and not moving the wave files to the server keeps network traffic low.

Nevertheless, there are situations where it is desirable to have all wave files on the server. This can be achieved by externally moving the files, or by using the Discom wave collector.



The Wave Compressor in TasAlyser creates (optionally reduced) copies of the wave recordings which are then transferred to the server.

CALIBRATION

Sensor and A/D converter calibration ensures the stability and reliability of the measurement results

Calibration

The TasAlyser measurement application includes a semi-automatic **calibration function**.

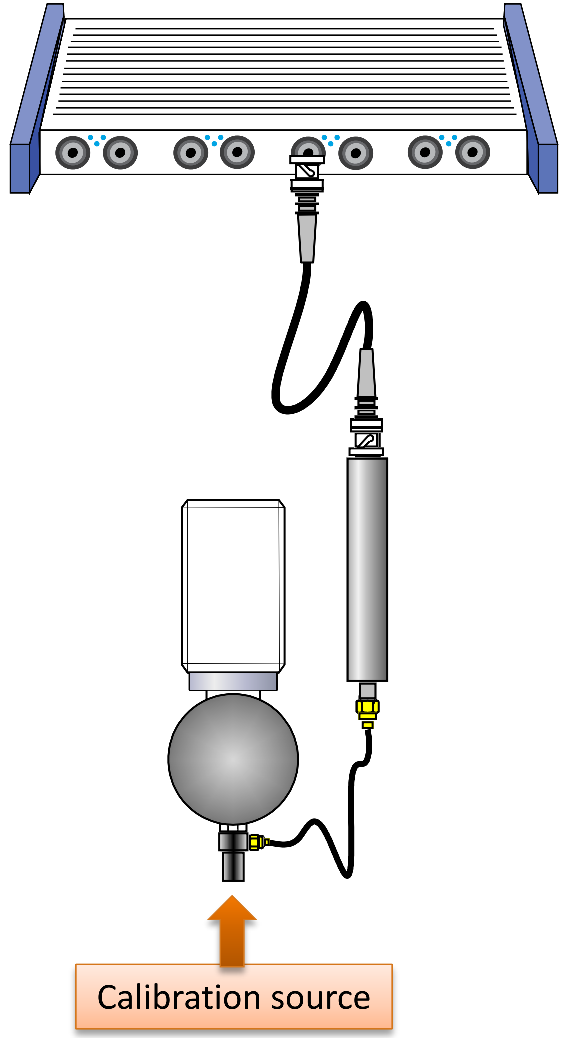
Calibration applies to the complete measurement chain including sensor, amplifier and A/D converter.

The result is the **calibration factor**, which converts a voltage detected by the A/D converter into a physical value (e.g. in m/s^2 or g) which is measured by the attached sensor.

To calculate the calibration factor, a calibration signal of known quantity is necessary. This signal is generated by a **calibration source**, for example a handheld shaker which produces a vibration with exactly 9.81 m/s^2 peak.

The properties of the calibration source have to be entered into the measurement system, so the calibration function knows the reference value and can calculate the factor.

To perform the actual calibration, the calibration control function is started and then the calibration source applied to the sensor. The measurement system will detect automatically the presence of a valid signal and calculate the calibration factor.



Calibration Step by Step

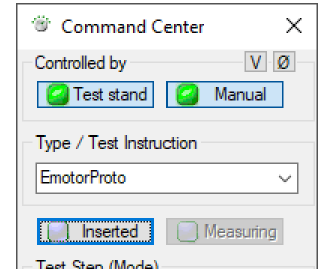
The calibration procedure consists of the following steps:

1. Start A/D converters (initiate a “test run”)
2. Adjust input sensitivity if necessary
3. Open calibration control window and start calibration
4. Press calibration signal source against all sensors, one by one
5. Check and apply new calibration factors
6. Stop A/D converters (cancel “test run”)
7. Restore changed input sensitivities (if applicable)
8. Save new settings
9. Project Backup

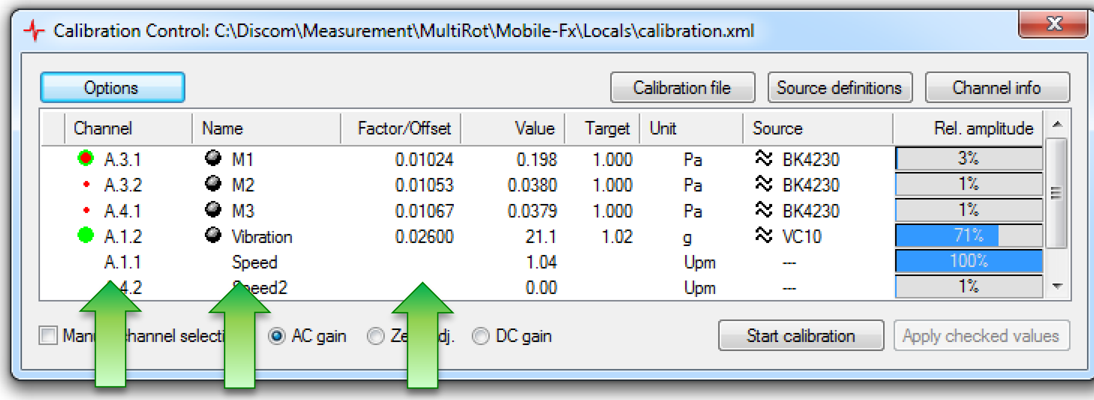
Details about the steps are described on the following pages.

Opening Calibration Control

To perform the calibration, the A/D converters in the TAS box front end must be active. Therefore, manually initiate a test run using the button [Inserted] in the *command center* window or by pressing F5 on the keyboard. (TasAlyser has to load the parameter data base information to know the signal names and properties.)



Then, open calibration control from the *Favorites* window.



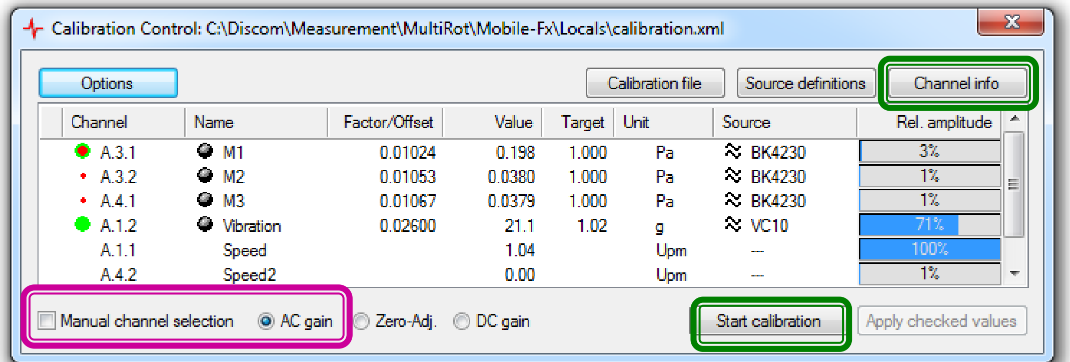
Calibration control shows the TAS box input channels, the assigned signal names and the current calibration factors.

For each sensor you have to specify the calibration signal source (column “Source”) and describe what signal that source provides.
During project setup, according source definitions are prepared and assigned. Changes are only necessary if you switch to a different calibration source.

For details about how to set up calibration signal sources, please read page “Source Definitions”.

Performing calibration

Open the calibration control window and press **Start calibration**. From now on, calibration control “listens” on all sensor channels for a calibration signal.



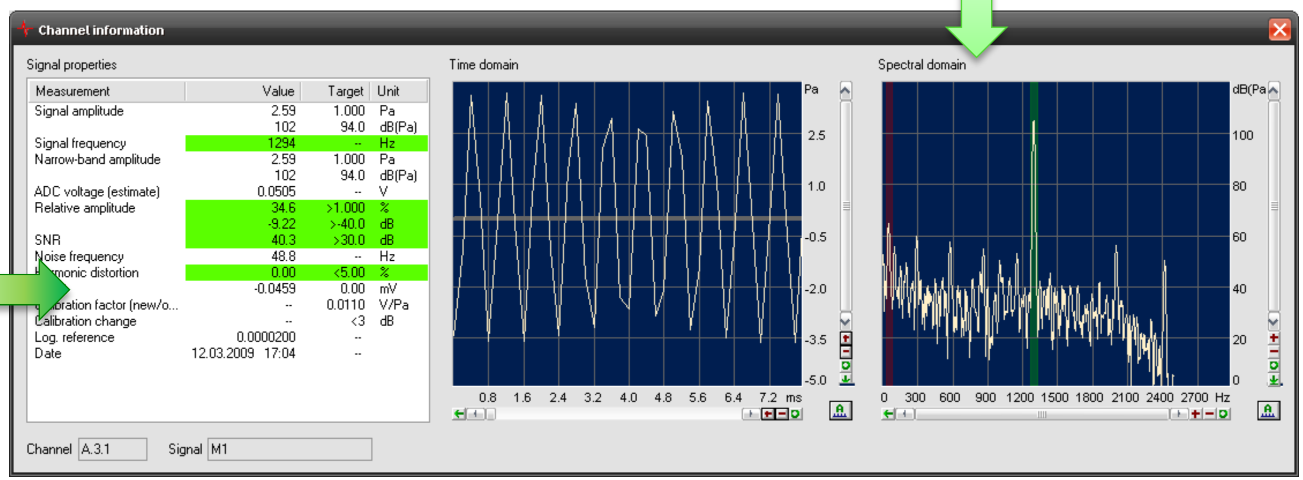
“Manual channel selection” must be switched off to enable automatic signal detection.

Press **Channel info** to see the signal and spectrum. Calibration control automatically selects the strongest signal source.

In the spectrum the detected calibration signal and the strongest noise source are marked.

Press the calibrator source (e.g. shaker) to the sensor. When calibration control detects a “clear” signal, all lines in the channel information table will change to green.

If the signal is stable long enough, a new calibration factor is calculated and then shown in the list in calibration control window.

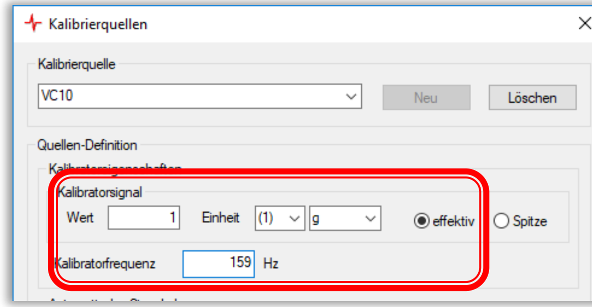


In the Channel Info display you can check whether you have a proper calibration signal. If not, check the sensor and cable connections!

Typical Accelerometer Calibration

The typical calibration sources for accelerometers produce a signal of 1 g (9.81 m/s²) RMS at a frequency of 159.2 Hz.

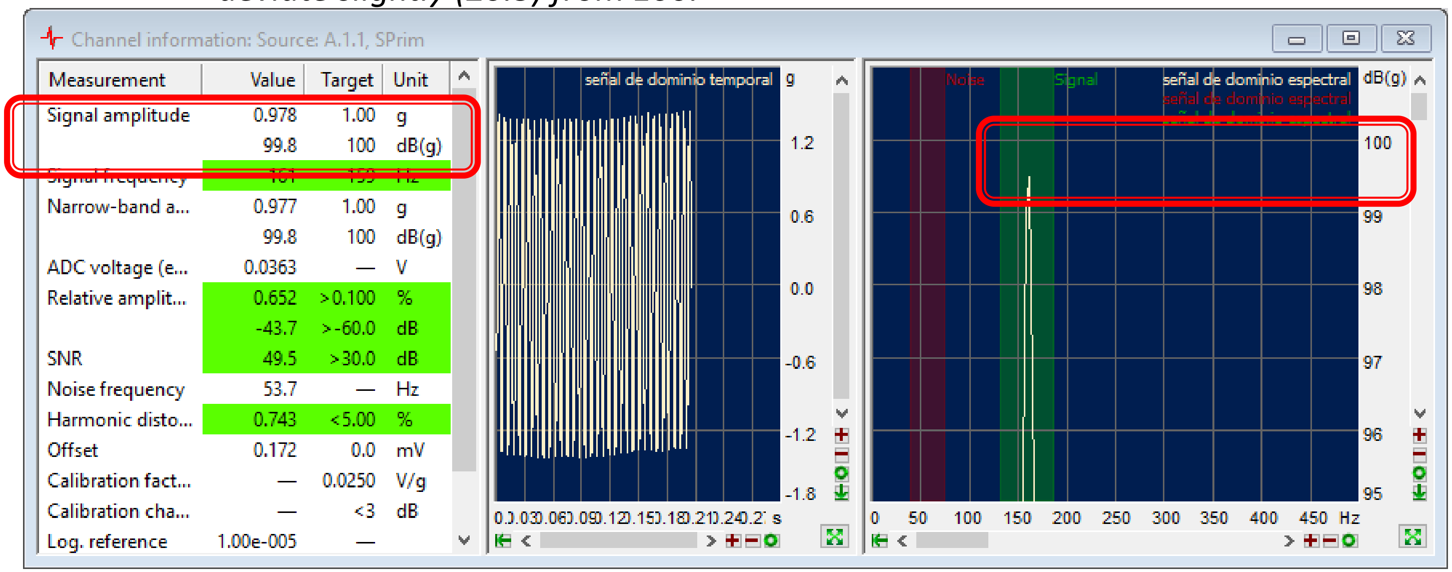
You can read these signal properties in the calibration source definition:



159.16 = 1000/2π

For such sources and the logarithmic reference of 10^{-5}g (standard value), the calibration signal corresponds to exactly 100 dB. You can read this value in the table in the [Channel information] window:

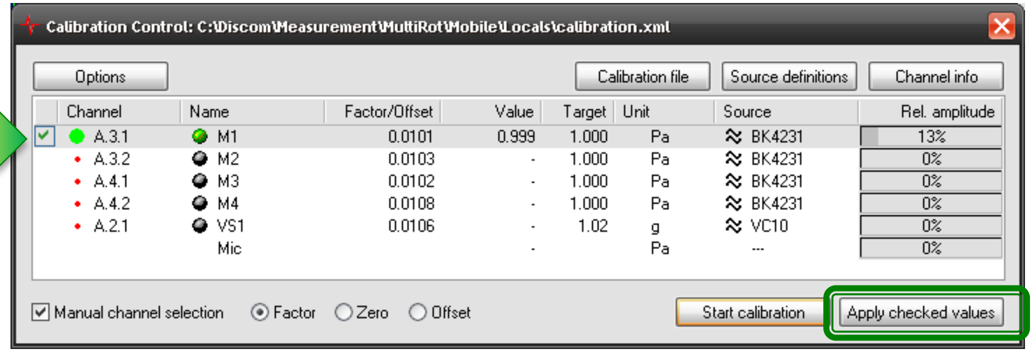
The actual measured value may deviate slightly (±0.3) from 100.



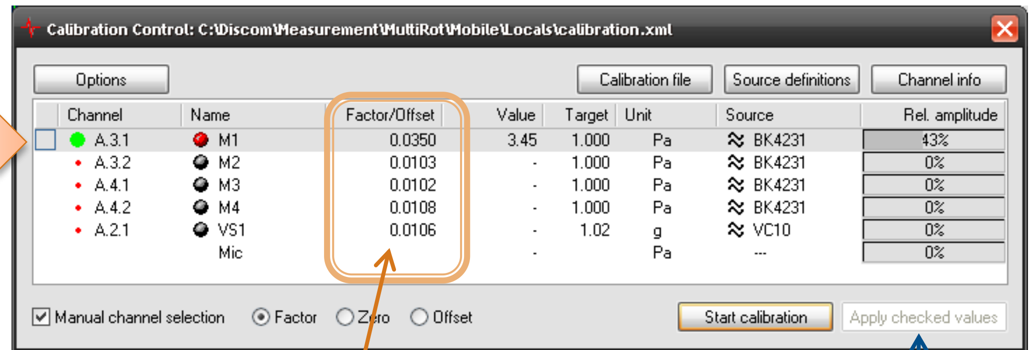
The peak in the spectrum will typically show a lower value than displayed in the table. The reason is the limited spectral resolution of the spectrum shown in the scope window and does not reduce calibration precision.

Applying a new calibration

When for a sensor channel the calibration was completed successfully, a green check mark appears in front of that line and the new factor is displayed.



If the new factor deviates from the previous one so much that a difference in the measurement results of more than 3 dB has to be expected,
no check mark will appear. You still can set the check manually.



When you are done, press the **Apply selected values** button to activate the new values.

You can enter calibration factors manually. Just click into the according filed in the **Factor/Offset** column and enter the desired value. Set the check mark and press the **Apply checked values** button.

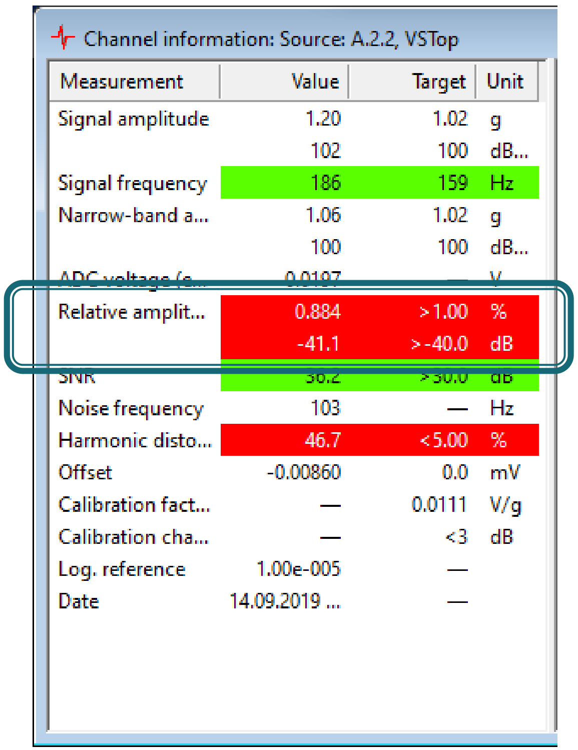
The typical calibration factor of KS91D Sensor (BKS03 with amplifier) is about 0,025 V/g

Adjusting Input Sensitivity

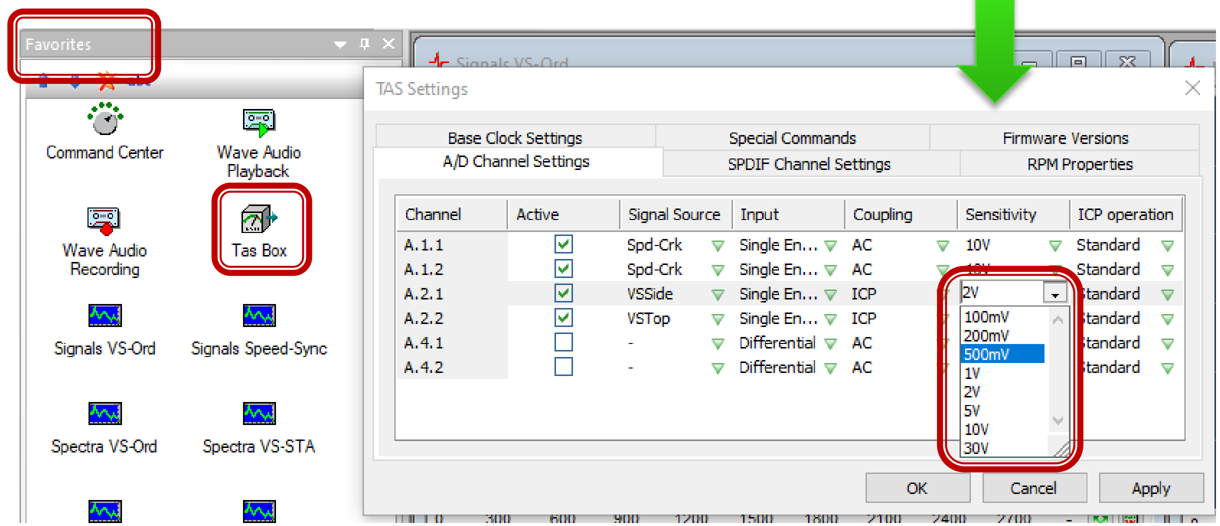
The Calibration function will only accept a proper and clear calibration signal.

To ensure this, several signal properties are checked, e.g. signal-to-noise ratio, harmonic distortion and relative amplitude.

When you get a red lines for the “relative amplitude” in the Channel Info window, one possible reason is that with the current Tas Box input settings, the signal from the calibrator unit is too weak. The Tas Box is typically configured for much stronger (“louder”) input signals than the calibrator unit provides, therefore the relative amplitude is too low for calibration.



The solution is to temporarily change the input sensitivity of the Tas Box channel(s) to a lower value like 500mV.



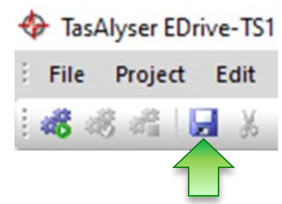
Do not forget to set the Sensitivity back to it’s original value after calibration.

Finalizing Calibration

When [Apply checked values] is pressed in calibration control, the new calibration factors take effect immediately. Additionally, a report documenting the changes is created (see page “Calibration Reports”).

When you are done with calibrating, restore the input channel sensitivity settings to the original values (if you had to change them; see page “Adjusting Input Sensitivity”).

Close the calibration control and channel info windows. Then, press the “Save” button of TasAlyser main window, or call the Save command from menu File.

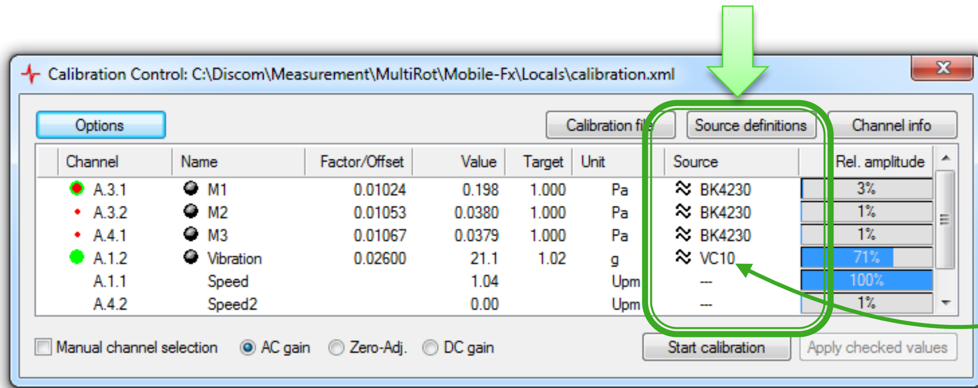


Cancel the “test run” by pressing F8 or switching off the [Inserted] button in Command Center window. There is also an according button in the TasAlyser tool bar (red symbol, third from left).

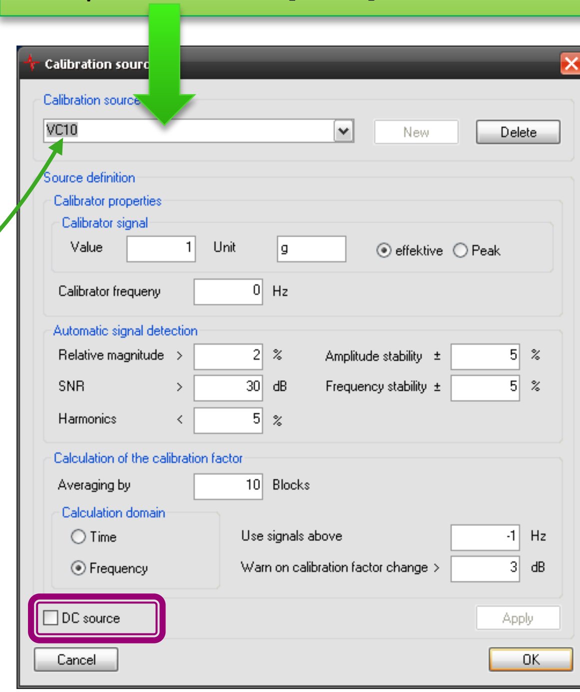
We recommend to create a measurement project backup after calibration. On the measurement PC desktop, you will find a folder “Rotas for Experts” and within the “Tas Backup Tool” (also called “Software Maintenance Tool”). Start it and simply press the [Perform Project Backup] button.

Source Definitions

To perform calibration, you first need the external source of your calibration signal.
In the **calibration control** window, you create an according **source definition** and then assign it to the appropriate **sensor channels**:



To create a new source definition, enter the desired name into the list text field and press button [New].



Each sensor which needs a calibration factor also needs an appropriate source definition (using the correct unit). Therefore, you also have to create and assign source definitions for signals like torque, force, or position, where the calibration factor is not measured but directly entered as a number from a data sheet.

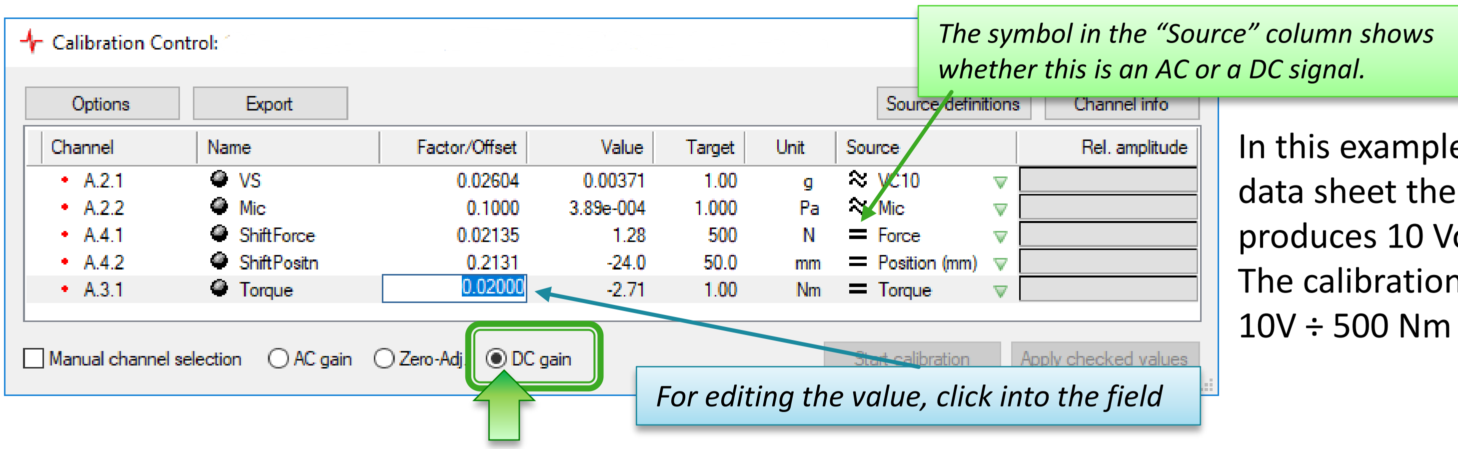
The source definition has to be set up and selected only once, at the first calibration (or when the source is changed).

For DC signals like Torque, you have to create a "DC source" definition (see "Calibration for DC Sources" on next page).

Calibration for DC Sources

Noise sensors like accelerometers, microphones or laser vibrometers generate oscillating voltage (AC signals). Other sensors, for example for torque or force, generate DC voltage signals. For this type of sensors, a **DC Calibration** must be done.

Switch to DC Gain below the list in the calibration control window. Now you can enter the calibration factors for DC signal sources:



In this example, according to the data sheet the torque sensor produces 10 Volts at 500 Nm. The calibration factor calculates as 10V ÷ 500 Nm = 0.02 V/Nm.

Although you may be copying the calibration factor directly from the data sheet of your sensor and entering it into the list, you still have to define and assign a valid calibration source.

After entering the values, press the button [**Apply checked values**] in the same way as you do after normal (AC) calibration.

DC Offset Calibration

The A/D converters in the Tas Box have a hardware related voltage offset: even if the input signal is zero, there is a small internal voltage producing a non-zero output value.

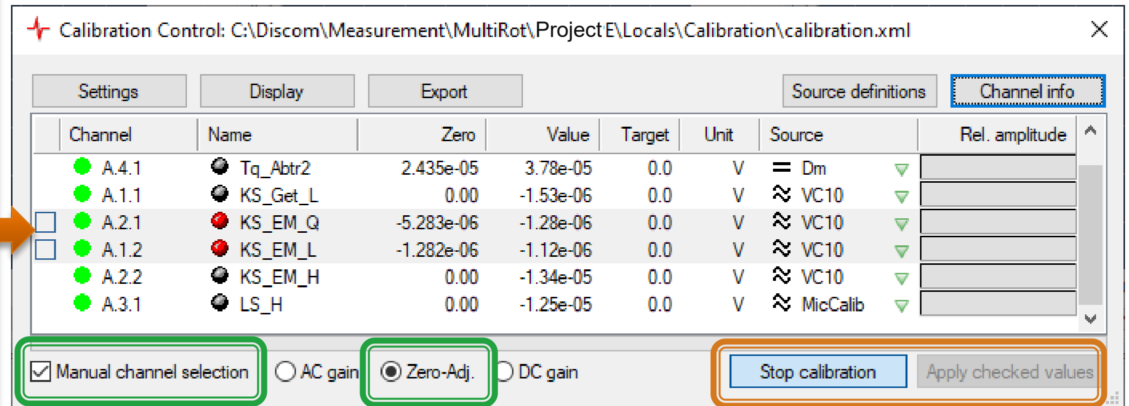
This offset can be compensated with DC offset calibration.

In Calibration Control, below the channel list, switch to “Zero-Adjustment” and activate “Manual channel selection”.

Then press [Start Calibration] button.

Click into the list rows for the sensors you want to calibrate, one by one, and each time wait a moment until the bullet mark turns red and the value in column “Zero” is updated.

Finally, press [Stop calibration], set check marks into all boxes in front of the according list rows, and press [Apply checked values].



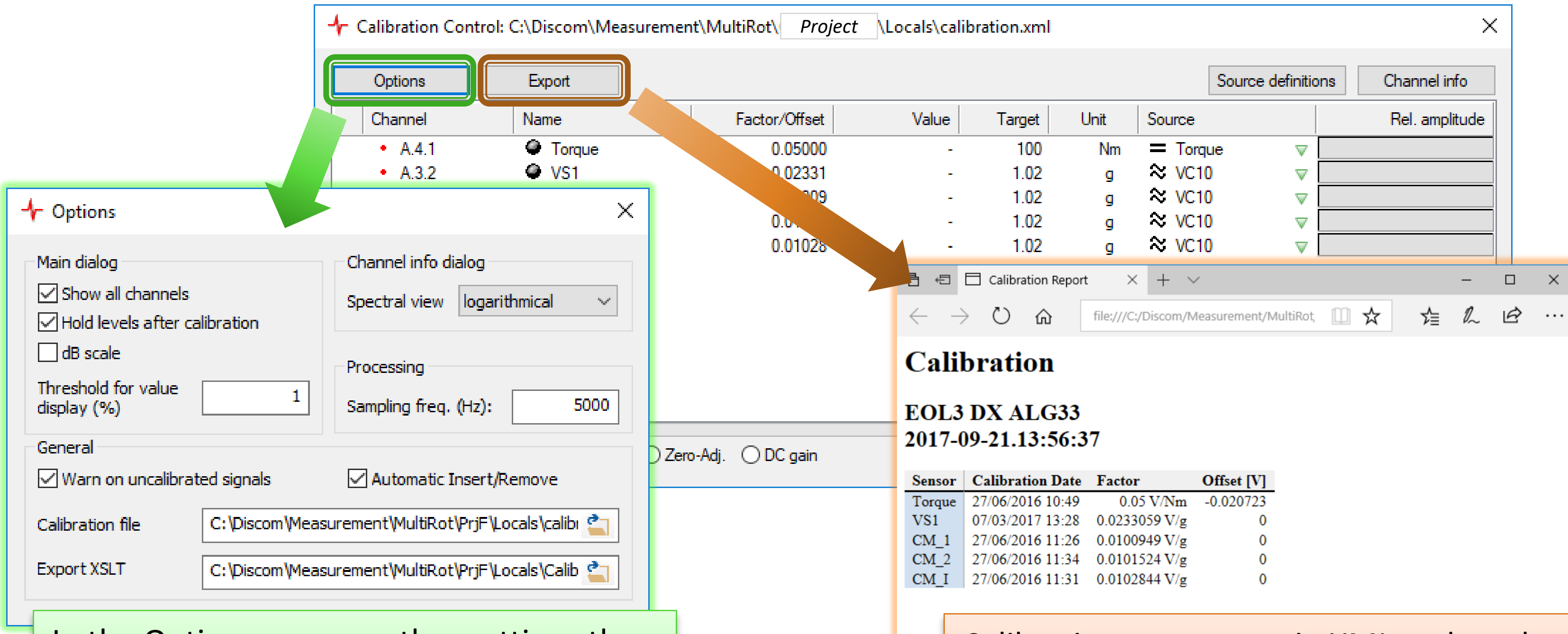
Remember to switch off “Manual channel selection” before starting a normal vibration sensor calibration.

For noise sensors like accelerometers or microphones the DC offset does not influence the results. Vibrations are analyzed for their changes (frequencies), not their absolute values. Nevertheless, a DC offset calibration can be done also for these channels.

For sensors where the absolute value is used (like torque, force, position), a DC offset calibration is recommended.

Calibration Reports

Use the “Export” function to create a formatted report about the current calibration factors. Each time when you [Apply checked values], a report is created automatically.



In the Options, among other settings the location of the calibration file and the Export folder can be specified.

Calibration reports are in XML and can be viewed in web browsers.
An according style sheet for generating a formatted output is created automatically.

Default storage location of the exported reports:

C:\Discom\Measurement\MultiRot\(Projektordner)\Locals\Calibration

PROJECT BACKUP AND FOLDER STRUCTURE

Use the “Tas Backup Tool” to easily create backups of all settings including learned limits and calibration data

Tas Backup Tool

The **Tas Backup Tool** assists you in creating project backups.

It is located in the "Rotas for Experts" folder on the measurement computer's desktop. Use it to

- Create a backup copy of the measurement project including all settings and learned limits
- Create a backup of the software executables (TasAlyser etc.)
- Schedule automatic backups

Usage:

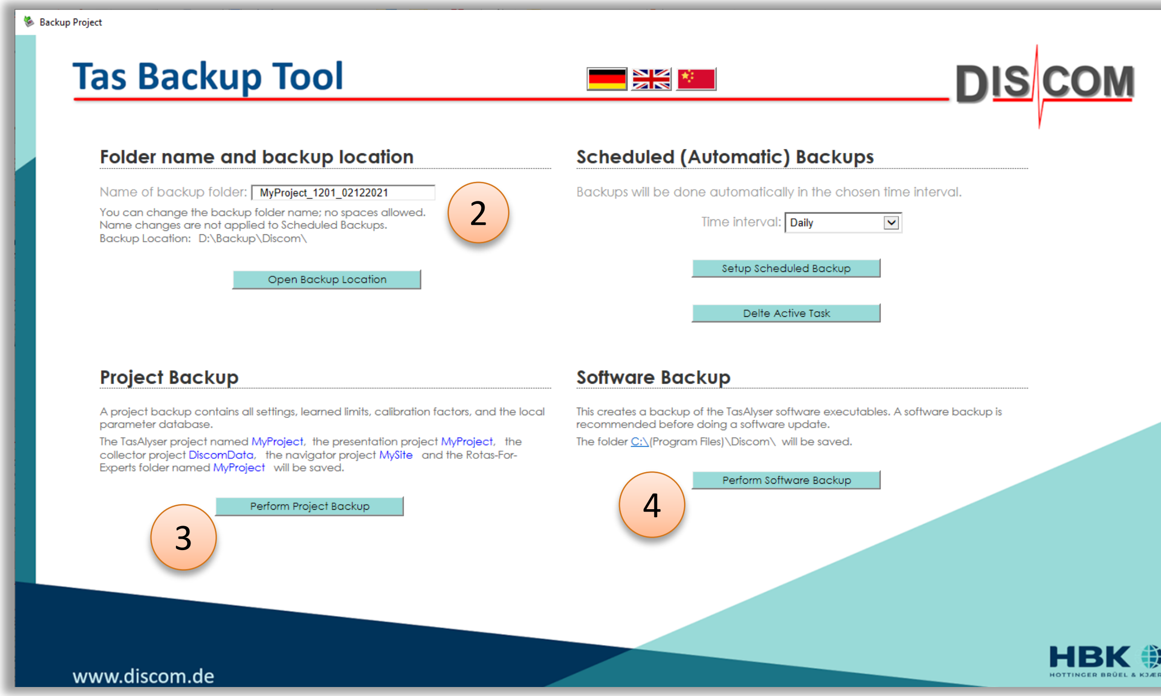
(1) Start Tas Backup Tool from *Rotas for Experts* folder.

(2) Optionally change backup name.
The backup is created as a sub-folder of D:\Backup\Discom.

(3) Press [**Perform Project Backup**] if you want to save the current settings, learned limits, parameter database, Presentation project etc.

(4) Press [**Perform Software Backup**] to copy the software executables. This is only needed before installing a new software version.

(5) Done. Close the Backup Tool.



To **restore** a backup: locate the according folder
`D:\Backup\Discom\(Date-Time of backup)\Discom`
and copy it back to C:\Discom.

Tas Backup Tool (previous version)

Before 2022, the **Backup Tool** (also called “**Software Maintenance Tool**”) had a different appearance, but mainly the same functions:

- Create a backup copy of the measurement project including all settings and learned limits
- Create a backup of the software executables (TasAlyser etc.)

Usage:

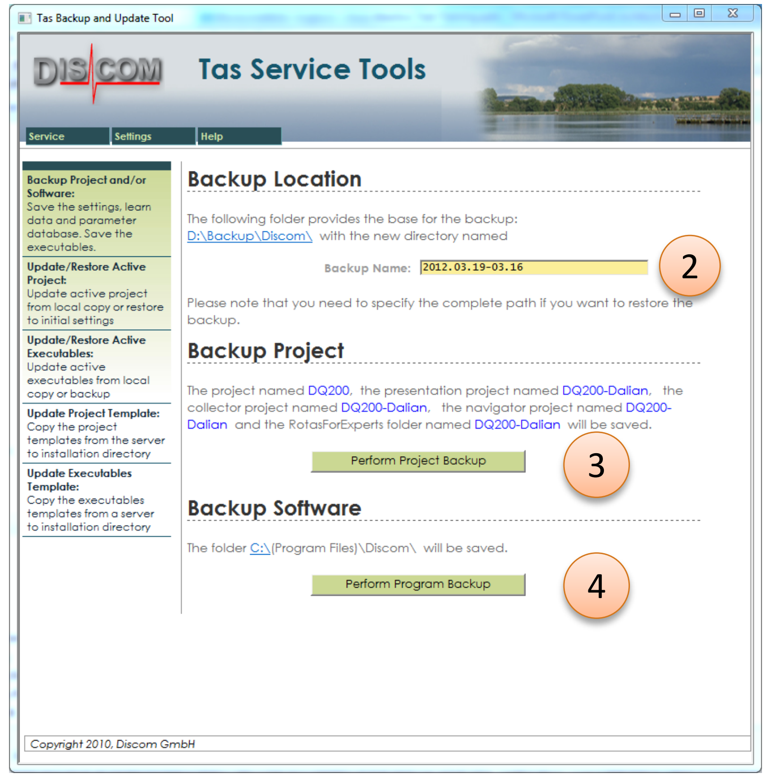
(1) Start Tas Backup Tool (or “Software Maintenance Tool”) from Rotas for Experts folder.

(2) Optionally change backup name. The backup is created as a sub-folder of D:\Backup\Discom.

(3) Press [**Perform Project Backup**] if you want to save the current settings, learned limits, parameter database, Presentation project etc.

(4) Press [**Perform Program Backup**] to copy the software executables. This is only needed before installing a new software version.

(5) Done. Close the Backup Tool.



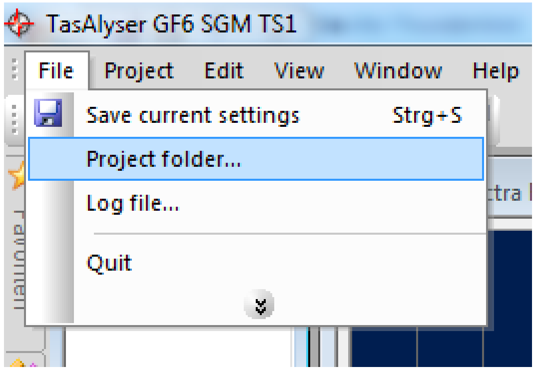
To **restore** a backup: locate the according folder
`D:\Backup\Discom\(`*`Date-Time of backup`*`)\Discom`
and copy it back to C:\Discom.

Projects, Project Folder

Similar to using the Excel *application* to open an Excel *spreadsheet*, the TasAlyser *application* loads a **measurement project**.

The TasAlyser application is installed in **`C:\Program Files (x86)\Discom`**,

The projects are located within **`C:\Discom\Measurement\MultiRot`**.



Each project has it's own project folder.

You can very easily open a Windows file explorer for your project folder by using the according command from the File menu.

The project folder contains all information and settings for your project, including the parameter data base, but no test results or measurement data.

To make a simple backup of a project, just duplicate the project folder. The easiest way to do this is using the Tas Backup Tool (Software Maintenance Tool).

The Presentation project folders are located in **`C:\Discom\Analysis\Presentations`**. You can make duplicates of these folders – as a backup, or to transfer the project to a different computer (like your desktop workstation).

Content of Project Folder

The project folder has the same structure for all projects.
In special cases, additional sub-folders may be present.

`C:\Discom\Measurement\MultiRot\(Projectname)`

`Application`	Contains the system configuration and the program settings file.
`Locals`	Contains files and settings which apply only to this computer/test stand. (In a production line with multiple test stands, the project folders of all measurement computers are identical except for the Locals folder.)
`CacheData`	Parameter database cache. Contents have to be deleted manually in some rare cases.
`LearnData`	Learned mean values for all measurement values; one file per base type. Learn files may be delete to enforce a complete new learning.
`(Files)`	The calibration file, the Tas box settings file and the `Locals.sea` file which holds the test stand name.
`ParamDb`	Here the parameter data base is located. In a sub-folder the automatic backups of the parameter data base are stored.
`TempArchives`	Intermediate storage location for measurement archives on their way to the result data base server.

If you want to have a backup copy of the parameter data base only, you just need to copy the data base file "`(Projectname)-Qdb.mdb`" located in the `ParamDb` folder.

More Discom Folders

On a standard measurement computer you will find the following folders which are used by the Rotas system:

System partition C:

`C:\Discom\`	With sub-folders Analysis and Measurement. Shared for transferring the parameter data base from the server.
`C:\Program Files (x86)\Discom\`	Installation folder for all Discom software components.
`C:\Outbox`	Intermediate storage location for measurement archives on their way to the result data base server. Shared for the Collector service.

Data partition D:

`D:\Sound\`	In this folder the wave recordings are stored. Usually has reading share so you can retrieve recordings via network.
`D:\Backup\`	For backups generated using the "TasBackupTool"
`D:\Discom-Installation\`	Installation packages and tools

If there is a local result data base on the measurement PC, you will also find the server folders described on the next page.

Discom Folders on a Server

On a server, you will normally find the basic version of the project folder which holds the master copy of the parameter data base.
On the data partition there are additional folders for the result data base.

System partition C:

- `C:\Discom\` — Same as on a measurement system. Contains master copy of parameter data base
- `C:\Program Files (x86)\Discom\` — Installation folder for all Discom software components.

Data partition D:

- `D:\Inbox` — Intermediate storage location for measurement archives on their way into the result data base.
- `D:\Archives\` — Final storage location for measurement archives (week directories, day files)
- `D:\Database\` — Storage location of result data base (SQL database file)
- `D:\Backup\` — For backup copies made with "TasBackupTool"
- `D:\Documentation\` — General and computer specific documentation
- `D:\Discom-Installation\` — Source for installation of Discom software and additional tools. Shared as "Discom-Installation"

REMOTE SUPPORT

We are always here to help you.

Calling for Help

If you have problems with your measurement projects or if you need help with noise phenomena, please contact us.

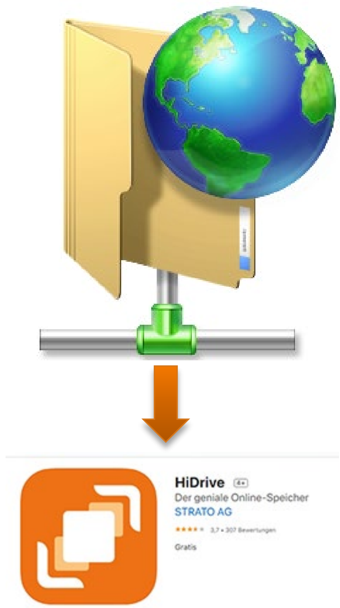
If possible, prepare to send to us these files:

- ✓ Project folder (C:\Discom\Measurement\MultiRot\(Project name)

  Use the Backup Tool to create a project backup. Then compress the backup folder (from D:\Backup\Discom) using Zip or better 7zip.

- ✓ Archive files (from single test runs or a complete day)
- ✓ Wave files of problematic measurement(s) *and from normal measurements*

  Archives and wave files should be compressed, too.



https://www.strato.de/cloud-speicher/

Discom has a cloud storage space where you can upload the data to your dedicated, protected customer folder. Please ask us for the access link.

The most efficient help tool: **Remote Access**
(Discom uses *TeamViewer*)

Software Download

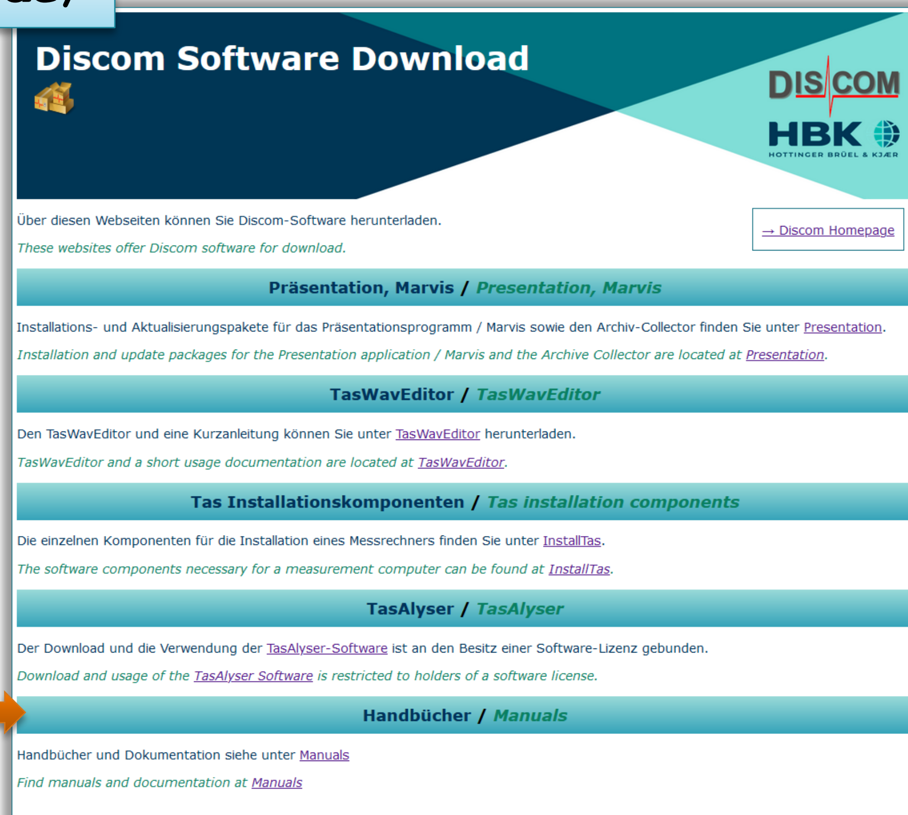
DISCOM

You can install the evaluation tools *Presentation* and *TasWavEditor* on your workstation PC or laptop and use them for analysis of data copied from measurement PC or server.

(The purchase of analysis PCs and TAS box hardware includes a site license for these analysis programs.)

You can download these applications, manuals and documentation from

https://download.discom.de/



Download manuals and data sheets from here:

Thank you for participating!

www.discom.de