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Frequently asked questions for electric motor testing with Simcenter Anovis

Introduction

What is Simcenter Anovis end-of-line testing?

Simcenter Anovis end-of-line testing solutions perform process-secure, fully automated, and highly reliable fault detection, under volume production conditions using vibration and sound measurements. Assembly errors and component defects, together with distinctive (noise-related) characteristics are detected within seconds during manufacturing. Rationalization and cost savings are realized thanks to increased automation, early detection of failures, less reworking, and fewer recalls.

Frequently Asked Questions

Which noises and phenomena can be detected by Simcenter Anovis?

- Unbalances
- Bearing noises
- Load change noises
- Excentricity, rotor noises
- Ghost orders (machine orders)
- Chatter marks
- Machining failures with influence on NVH behaviour

For certain phenomena and groups of noises special features are defined by a Siemens Digital Industries Software specialist working together with the quality engineer. The quality engineer uses analysis functions provided by Simcenter Anovis, like for example order analysis.

A highly sophisticated digital resampling approach is used for precise order analysis.

In which testing environments Simcenter Anovis can be used?

Simcenter Anovis can be used for testing of single components or assemblies. Typical test specimen are drive motors, actuators, power steering motors or electric adjustable steering columns. In any cases structure-borne noise and air-borne noise is used to acquire valuable information for quality testing of the component.

Typically, the test duration is within some seconds and can be combined with other tests to save testing time.

Is it possible to measure during revolution speed changes?

The digital resampling algorithm used by Simcenter Anovis allows signal analysis independent from the revolution speed. Typical high-speed RPM-changes can be used for measurements.

How is the overall level calculated?

The overall level is calculated according to DIN IEC 651 with or without A-weighting.

How are order levels calculated?

Order level calculation is based on angle synchronous digital resampling using quadratic turn angle interpolation and revolution speed dependent FIR reconstruction filters. The analysis can be synchronised to one or more reference shafts. The number of pulses per revolution according to the reference shaft can be non-integral.

Based on this, a high resolution order analysis is calculated using an appropriate segmentation and windowing. The averaging can be set to RMS or complex. Order levels are calculated using the results of the high resolution order analysis. The amplitude calculation takes account of the window function used.

The user can parameterize a variable number of single levels, harmonic levels, range levels and any arithmetical combination of orders. Every order level can be assessed by definable limits. The output is available as linear or logarithmic levels.

Which order resolutions and bandwidths are possible?

The acquisition bandwidth is 0 to 75.000 Hz. The lower frequency limit can be set to 0 Hz, 10 Hz, 75 Hz and 150 Hz using software adjustable analogue filters. The upper frequency limit can be set to: 1.25 kHz, 2.5 kHz, 5 kHz, 10 kHz, 20 kHz, 30 kHz, 40 kHz, 60 kHz und 75 kHz.

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The maximum order can be parameterized between 4 and 1000: any integer number between 4 and 1000 is allowed.

The order resolution can be set from 10 to 1/999 orders. It can be set to non-integral values (floating point numbers).

The maximum order multiplied by the order resolution (in FFT-lines) must not exceed 12,800.

Which window functions are supported?

All common geometric and cosine sum windows are available for FFT windowing: Boxcar, Triangle, Hann, Hamming, Nuttall, Flattop, Harris, Babic and Taylor. Additional window functions can be loaded into the system using text files with a maximum of 32,768 samples.

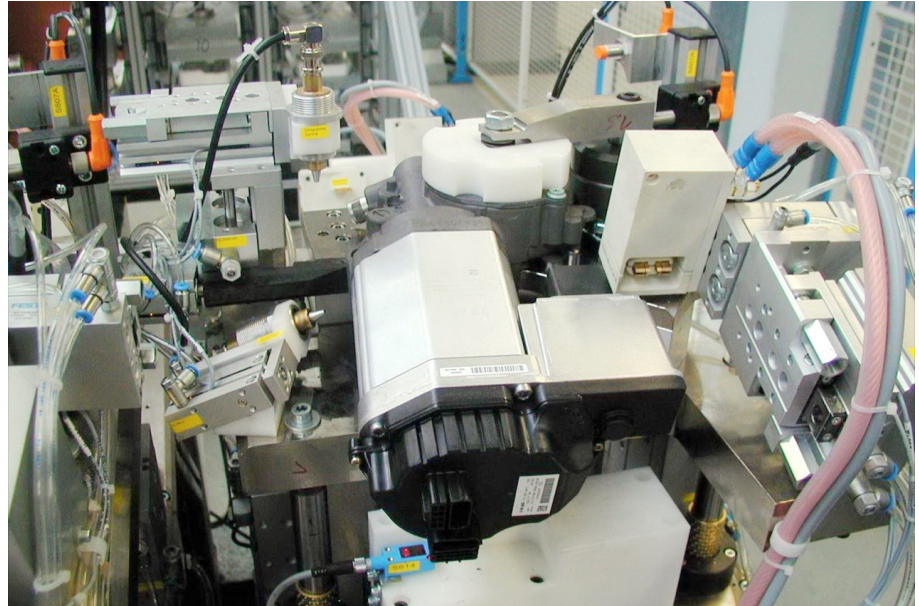### Which features can be calculated from the time signal?

The following features can be calculated from the time synchronous or from the angle synchronous time signal: Minimum, maximum, linear average (DC component), effective value (true RMS), averaged power, DC power, variance (AC component), standard deviation, absolute peak value, crest factor.

Any arithmetical combination can be calculated from these features and compared against lower and upper limits.

The time signals can be filtered using freely programmable high pass, low pass and band pass filters. Highly sophisticated filter functions can be introduced to the system by means of filter coefficient tables.

Especially for analysis of recurring pulsed signals (e.g. valve clearance noises) angle synchronous averaged time signals, power signals and envelope analysis functions are available.

Analysis functions relating to different reference shafts can be calculated simultaneously.

Which features can be calculated from the spectrum?

Linear or A-weighted frequency analysis can be performed. The analysis is FFT based and supports FFT lengths between 64 and 32.768. Overlap is adjustable between 0 and 99 percent.

The following types of analysis are possible (calculated simultaneously):

- 3rd octave spectra
- Frequency sonagram vs. RPM
- Frequency level tracks vs. RPM as single level, harmonic level or range level; assessment via tolerance curves.
- Averaged spectra over freely definable trigger ranges or free-run linear or exponential averaged; assessment via tolerance curves.
- Averaged cepstra over freely definable trigger ranges or free-run linear or exponential averaged; assessment via tolerance curves.
- Frequency levels over freely definable trigger ranges or free-run (linear, exponential) as single level, harmonic level, and range level, overall level or user definable level. Any arithmetical combination of these levels is also possible.

Which units are supported by Simcenter Anovis?

The acquired signals immediately are converted into physical units by calibration modules. Simcenter Anovis in general processes data scaled in real physical values.

All common used physical units, like way, velocity, acceleration, pressure, sound pressure, temperature, force, torque etc. are pre-defined. Additionally the user can define any other physical unit and can use this for calibration.

A differentiator module is available to, for example, convert velocity (e.g. measured by a laser Doppler vibrometers) into acceleration.

How many signal channels are possible with Simcenter Anovis?

One signal recording device (SRD) supports up to 14 high bandwidth signal channels. The number of channels that can be activated at the same time

depends on the selected bandwidth: 75 and 60 kHz for 2 channels; 40 and 30 kHz for 4 channels; 20 kHz for 8 channels; 10 kHz or less for 14 channels. Every signal input has an integrated anti-aliasing filter, a switchable ICP-power supply, and an adjustable pre-amplifier with programmable sensitivity between 10 mV and 10 V.

A maximum of 14 high-resolution tacho channels with 20 MHz bandwidth is possible. Each tacho input can trigger on rising, falling or both edges of the input signal. The trigger level can be set between 100 mV and 12 V.

Up to 56 operational data inputs are available for acquisition of slowly changing signals (temperature, torque etc.). The bandwidth of these channels is 1.25 kHz and the sensitivity can be set by software to 1 V or 10 V.

Furthermore, the Simcenter Anovis-SRD can be equipped with 4-to-1 multiplexers.

All inputs of one Simcenter Anovis-SRD are sample synchronous.

Which signal outputs are supported by Simcenter Anovis?

The communication to the master control system is encapsulated within a customer specific software module called "Test Bench Control (TeCo)". This makes easy adoption of Simcenter Anovis to a wide range of test bench systems possible without changing the base system. This is crucial for software quality management. All communication interfaces which are available on Windows NT, 2000 or XP can be handled by Simcenter Anovis.

Industry proven interfaces using RS232, TCP/IP, UDP/IP, Named Pipe and Digital-IO (PLC) are optionally available.

Additional the common field busses can be supported, e.g. PROFIBUS.

Which sensors can be used with Simcenter Anovis?

Generally every sensor can be used, which produces output voltages between 10 mV and 10 V and has useful signal bandwidth.

Special techniques are integrated for laser Doppler vibrometers (spike detection and elimination) and ICP-sensors (integrated ICP power supply with shorted and open connection monitoring).

Which classification techniques are possible?

For electric motor inspection Simcenter Anovis provides assessment of single levels against single level limits and assessment of measurement curves against tolerance curves. Additionally, the user can define limits and tolerance curves based on statistical considerations.

Fault detection is done by definition of special features like sideband energy measures to detect rotor or gear defects.

Simcenter Anovis "Chameleon" is also available; this is a self-adapting classifier, which only needs unlabelled production data for adaptation and which takes process changes into account.

How are limits for assessment defined?

Usually limit values and limit curves are defined on the base of statistical evaluation of production data. In some cases data from known faulty parts is available. For this task Simcenter Anovis provides the following analysis functions for limit definition:

- On- and off-line-statistics viewers for statistical evaluation of single feature values.
- Analysis viewers for statistical evaluation of measurement curves and for definition of tolerance curves.
- Off-line functionality to define new features.
- Sonagram analysis functions to generate sonagram sections.

How is a test run defined?

Typically, Simcenter Anovis acts as a slave of the test bench system. This means that Simcenter Anovis will receive information about the device under test (type, modification ...) for the test run, as well as control commands (start/stop, phase information ...). The assessed measurement results will be sent back to the test bench master. At the test bench Simcenter Anovis usually works in a fully automated way, without need of user interaction.

Specific test set-ups can be defined for different types of measurement objects. Each set-up is stored as an individual file and can be loaded on demand.

The definition and parameterisation of test set-ups can be carried out by trained personnel (or by the supplier). Special set-ups are constructed from a wide range of available signal processing modules named "Flowlets". Flowlets are interconnected, attributed to test phases and individually parameterized.

The definition of a specific test run can be done by phase information sent from the test bench control or by triggers calculated from any signal and/or any revolution speed.

Measurement set-ups can be modified on a standard office PC with installed Simcenter Anovis software. Set-ups can be updated via LAN. The test bench control automatically uses the new set-up.

Which visualisation techniques are available?

Any one-, two- or three-dimensional data generated by Simcenter Anovis can be visualised using freely configurable viewers. This can be done independently from their calculation. Simcenter Anovis-viewers can be created and configured by mouse-click. The following types of viewers are available: Tables, numbers, alarm fields, level meters, bitmaps, curve viewers and sonagrams. The user can define for every application which data is presented in which combination. Viewer configurations are saved to and re-loaded from file.

Meta information such as trigger range, phase, parameters, physical units etc. is displayed in addition to the actual viewer data. The viewer may use this meta information e.g. for scaling.

The user can analyse data displayed in a certain viewer using zoom, cursors, harmonic cursors, cursor zoom, measurement-value-dependent cursors, hyperbolic cursors and several dynamic markers.

How are the measurement channels calibrated?

Each signal or operational data input can be calibrated independently. Calibration can be carried out manually or automatically using power or single tone calibration techniques. Calibration parameters can be freely chosen. A calibration history is automatically created by Simcenter Anovis. Calibration can be controlled from the test bench.

Does Simcenter Digital Industries Software support calibration services?

Simcenter Digital Industries Software can supply calibration hardware that relates to the sensors we deliver.

Can Simcenter Anovis save raw signal data?

Yes, it is possible to save raw signal data.

For automated storage of signal data at the test bench, the user can define the percentage of "go" and "no-go" measurements that should be automatically saved by the system.

Storage of raw signal data is conducted by Simcenter Anovis at the end of the test run and does not interfere with the test run itself. Saved raw signal data files can be used as follows:

For off-line analysis with Simcenter Anovis: Using the Simcenter Anovis off-line mode, raw signal files can be processed on any lab or office PC. There is no difference in data analysis between on-line mode at the test bench and off-line mode at the lab or office PC. All meta information supplied by the signal recording device and from the test bench control (like trigger information, calibration values etc.) are included in the raw signal file. Using this method, measurement set-ups can be modified and tested as if they were running on the test bench PC. After parameterisation the set-ups can be transmitted directly to the test benches and used immediately as a tested measurement set-up.

Simcenter Anovis supports file lists to process a high number of raw signal files at a single mouse click.

Off-line analysis using MATLAB: Simcenter Anovis raw signal files are stored in MATLAB 4 format. The definition of this format is open and can also be processed directly by later MATLAB versions. The open file format allows conversion into any other file format.

Raw signal files can be converted into WAV-files by Simcenter Anovis. The WAV-files can be used to listen to the recorded data.

Does Simcenter Anovis support data formats of other analysis systems?

The WAV-files generated from the Simcenter Anovis raw data files store the tacho information in the LSB of the audio samples.

The Simcenter Anovis raw data files are stored in MATLAB 4 format. The definition of this file format is open; therefore a converter of Simcenter Anovis raw signals into any other data format can be implemented easily.

Raw data files can be exported to and imported from ASAM-ATFX.

What about statistics?

All measurement results can be statistically analysed by Simcenter Anovis. For one-dimensional data, this can be achieved using special on-line and off-line statistics viewers. Statistics viewers display measurement values as curves and histograms with statistical measures. Off-line statistic viewers allow analysis of single measurements using a class editor.

Two-dimensional data can be analysed using special analysis viewers that also include a class editor. All statistics and analysis viewers can be coupled to use one class database. Defined reference lists and tolerance curves can be saved as files for further use.

Every statistics viewer and analysis viewer includes the analysis tools mentioned previously (cursors, markers, etc.).

Does Simcenter Digital Industries Software offer training?

Yes, we offer training lessons to instruct the user in our handling and analysis concepts, the algorithms we use, trouble shooting etc.

Dependent upon content, duration and goal we offer special training courses for:

- Maintenance personnel (1 day)
- Test bench technicians (1-2 days)
- Vibration analysis experts (3 days)
- Individual training as requested

We offer support for production start-up, i.e. we carry out the initial set-up of a test bench at production start together with the customer. During this period we transfer a lot of knowledge about Simcenter Anovis and vibrational analysis techniques.

What about service?

Special service contracts can be defined individually.

For critical applications we recommend a set of spare parts to make maintenance as effective as possible.

Manual or automatic calibration should be carried out at regular intervals.

How does smt support Simcenter Anovis users?

We assist our customers in every task concerning Simcenter Anovis and the measurement itself.

Typically, we support our customers by phone, assisting them to analyse data and to define new measurement set-ups. Simcenter Anovis supports remote maintenance.

We are a service provider for productive customers.

Does Simcenter Anovis support report generation?

Yes, Simcenter Anovis supports generation of statistical and analysis reports.

Any viewer content can be imported into other applications (like Microsoft Word or Microsoft Excel) using the clipboard.

Microsoft Word macros and document templates are available to automate report generation.

Measurement values and curves can be exported by clipboard to Microsoft Excel for further processing.

Are there additional special features?

Yes, it is worth mentioning the following system features:

- Flexible configuration of measurement set-ups and viewer configurations by mouse-click
- Highly flexible trigger definitions
- Modular signal processing modules (flowlets) that can be expanded easily and independently from other software modules.
- Revolution speed gradient monitoring
- MATLAB interface

Is it necessary to by the whole system even if only a small set of functions is needed?

No. The user only buys what is needed. We offer two possibilities for test bench applications:

- Simcenter Anovis.2 full version: The "analyser" supports visualisation of measurement curves. Simcenter Anovis does the classification; therefore highly sophisticated classification techniques are included.
- Simcenter Anovis-lite: The "intelligent sensor" generates measurement curves and transfers them to a master system. The master system carries out visualization and classification of the measurement results. Simcenter Anovis-lite has no user interface, so the customer does not need to know about any special Simcenter Anovis system concepts. Simcenter Anovis-lite does not include visualisation, analysis parameterisation and off-line functionality and is therefore our basic economy-price system.

Are QM-tasks beside the production line test benches supported?

Yes. Basing on the Simcenter Anovis system we provide solutions for quality control beside the production line test benches:

- For the quality lab to generate statistics and reports or to set up and off-line test new measurement methods
- For mobile measurements in the car (mobile system)

Are we first users of Simcenter Anovis?

No. Several hundred production lines are now using Simcenter Anovis-systems, continuously and around the clock.

Simcenter Anovis is an innovative noise and vibration measurement system which has been successfully introduced into the industrial environment. The SRD hardware has been developed for industrial operation.

Simcenter Anovis is continuously being enhanced, particularly with regard to the analysis techniques and the tools that are needed by quality technicians and engineers in their daily tasks.

Can we reach our goals with Simcenter Anovis?

It would be a pleasure for us to help you to solve your specific measurement or testing task – by working together we can succeed!