ifm electronic

Manual

efector800®

VES001

Software for
efector octavis

Version 1.6.3

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Contents

Introduction

Short description

efector octavis vibration diagnostic unit VE1001, VE1101, VE111A

- up to 5 different rolling element bearings or up to 20 individual frequencies which can be divided between 5 objects
- analysis methods FFT or enveloped FFT (H-FFT) is selectable for each object
- each of the 5 diagnostic objects has it's own limit values
- option: selectable peak / g-monitor with speed related limit values for early warning and main alarm
- can monitor fixed and variable speeds from 120...12.000 rpm
- speed input via 0...20 mA current loop or pulse input for applications with variable speed
- switching signals for early warning and main alarm
- the frequency spectrum of the vibration acceleration and velocity can be visualised and the data recorded
- the limit values can be adjusted via the speed

efector octavis vibration diagnostic unit VE1002, VE1102, VE112A

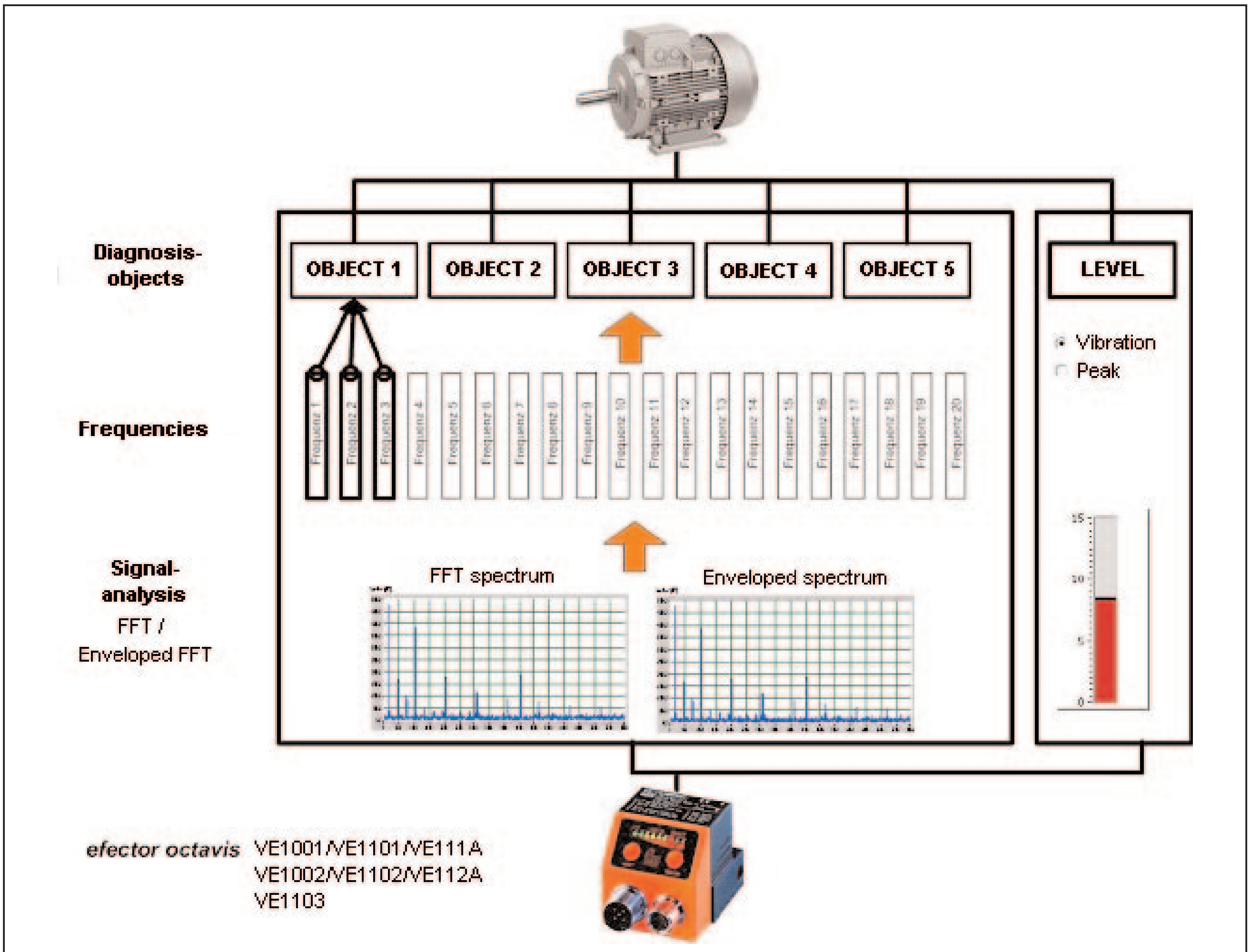
- up to 5 different rolling element bearings or up to 20 individual frequencies which can be divided between 5 objects
- analysis methods FFT or enveloped FFT (H-FFT) is selectable for each object
- each of the 5 diagnostic objects has it's own limit values
- option: selectable peak / g-monitor with speed related limit values for early warning and main alarm
- can monitor fixed and variable speeds from 12...3.500 U/min
- speed input via 0...20 mA current loop or pulse input for applications with variable speed
- switching signals for early warning and main alarm
- the frequency spectrum of the vibration acceleration and velocity can be visualised and the data recorded
- the limit values can be adjusted via the speed

efector octavis vibration diagnostic unit VE1103

- Up to 5 different rolling element bearings or up to 20 individual frequencies which can be divided between 5 objects
- analysis methods FFT
- each of the 5 diagnostic objects has it's own limit values
- option: selectable peak / g-monitor with speed related limit values for early warning and main alarm
- can monitor fixed and variable speeds from 1.500 bis 96.000 U/min

- speed input via 0...20 mA current loop or pulse input for applications with variable speed
- switching signals for early warning and main alarm
- the frequency spectrum of the vibration acceleration and velocity can be visualised and the data recorded
- the limit values can be adjusted via the speed

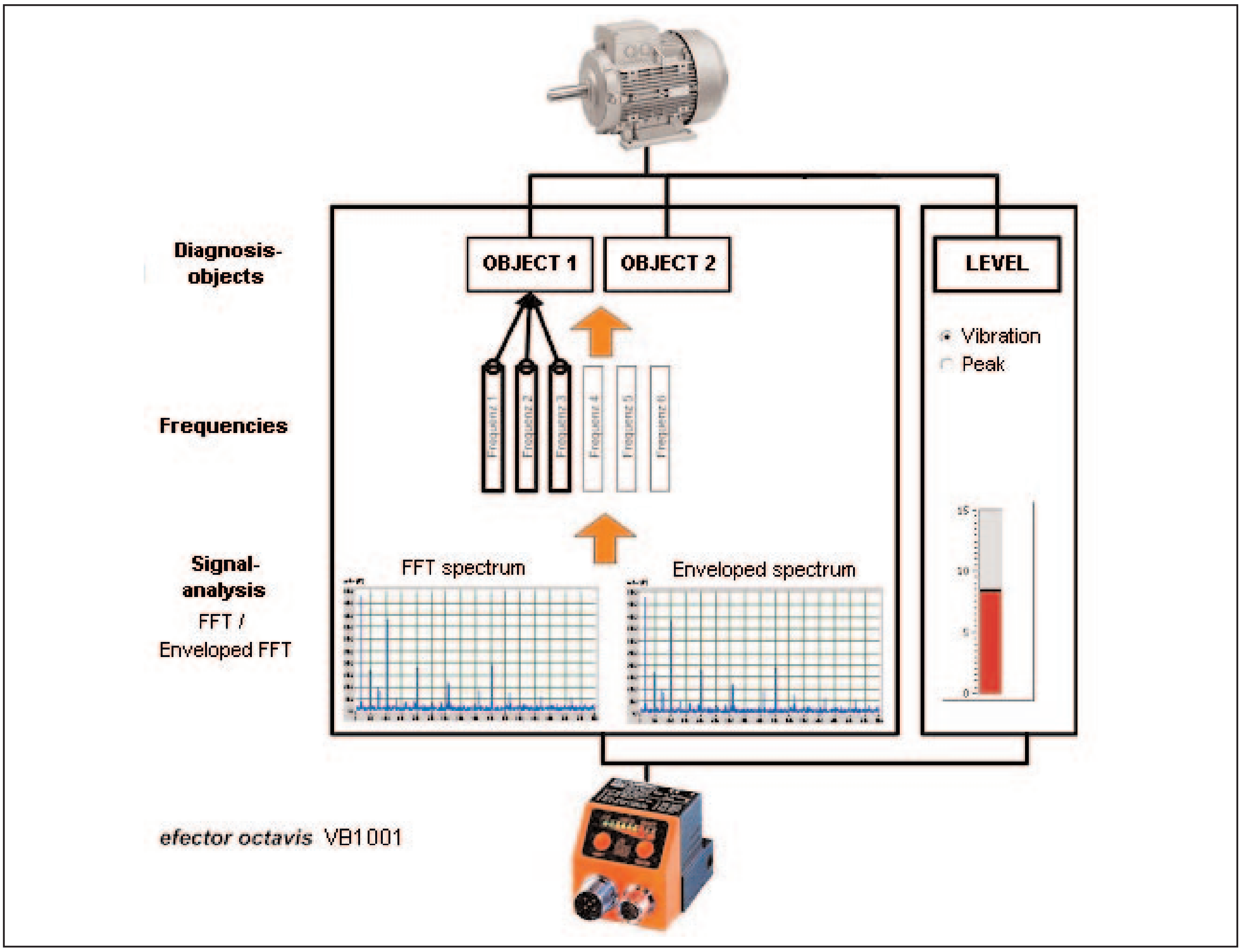
Scope (VE1xxx)



efector octavis rolling element bearing monitor VB1001

- up to 2 different rolling element bearings or up to 6 individual frequencies which can be divided between 2 objects
- analysis methods FFT or enveloped FFT (H-FFT) is selectable for each object
- each of the 2 diagnostic objects has it's own limit values
- option: selectable peak / g-monitor with own limit values for early warning and main alarm
- Can monitor fixed and variable speeds from 500...6.000 U/min
- Speed input via 0...20 mA current loop or pulse input for applications with variable speed
- Switching signals for early warning and main alarm

Scope VB1001



Important notes

Sources of interference

We wish to point out that in some cases condition monitoring in the diagnostic mode "bearing damage" can be negatively influenced by the following applications:

- Hybrid bearings; needle bearings
- Slow speeds (< 500 rpm) - High speeds (> 6.000 rpm)
- Machine tool engagement during tooling operations such as cutting, grinding, sawing and drilling etc., other external sources of noise disturbance

Before using the unit in one of the aforementioned applications please consult one of our specialists.

Pre-damaged bearings
If pre-damaged rolling element bearings are to be monitored, the limit values should be adjusted by an expert with specialist knowledge of vibration condition monitoring. Please consult one of our specialists prior to installing the unit.

Function and features

- efector octavis continually detects the vibration acceleration of an non-rotating machine surface (32,000 values/seconds). It calculates the amplitudes of the damage frequencies (inner race, outer race and rolling element) of up to 5 different diagnosis objects comprising a maximum of 20 individual frequencies (VE1XXX: 5 objects, 20 individual frequencies; VB1001: 2 objects, 6 individual frequencies). The rolling element bearings or diagnosis objects to be monitored are defined using a PC-software and are then transferred as parameter sets to the sensor via a RS232 interface (VE1101, VE1102, VE111A, VE112A: RS485 interface). The evaluation and condition monitoring of the rolling element bearing is then relative to the Teach-In value (reference value).
- efector octavis can also calculate the maximum weighted average or the maximum accerlation value. The evaluation and monitoring is then in absoloute limit values without a reference value.
- indication of early warning and main alarm: The diagnosis object or the vibration level (g-monitor) with the highest degree of damage is indicated via the switching output.
- the damage progress of the diagnosis objects is also indicated via the sensor's integrated LED display.
- efector octavis can be used with constant and variable speeds. To ensure correct diagnosis when using variable speeds the current speed has to be supplied via a 0...20 mA current loop or pulse input.
- for use with variable speeds ensure that the operational speed related to the set values remains constant for intermittent periods.
- the recommended range for the rolling element bearings in the standard mode (wizard) are shaft speeds of 500 rpm to 6,000 rpm. The maximum operating range is from 120 rpm to 12,000 rpm shaft speed (VE1001, VE1101, VE111A: 120 ... 12,000 rpm — VE1002, VE1102, VE112A: 12 ... 3,500 rpm — VE1103: 1,500 rpm ... 96,000 rpm — VB1001: 500 ... 6,000 rpm).
- the sensor is mounted via a screw fixture close to the rolling element bearing radial to the rotational axis(see installation instructions). The suitability of the mounting location when in the "rolling element bearing" monitoring mode must be checked by conducting an impulse test, in so far as the sensor is not mounted directly next to the bearing seat.

efector octavis uses own object limit values for the set spectral diagnosis objects for early warning (yellow) and main alarm (red). The alarm lmit values of the diagnosis objects are always related to the set Teach-In value and therefore describe a signal fan-out. Whereby green always corresponds to 100%.

efector octavis can also compensate differences caused by the trigger level. The diagnosis value is weighted according to the "weighted signal" curve. Each diagnosis object has individual weighted curves.

efector octavis uses broad band limit values for the monitoring of the vibration level within the time domain. Contrary to the diagnostic objects these are absolute acceleration values (unit: mg).
To compensate differences caused by the trigger level at different speeds, the vibration level is weighted according to the "weighted signal" curve.

Settings

Country settings

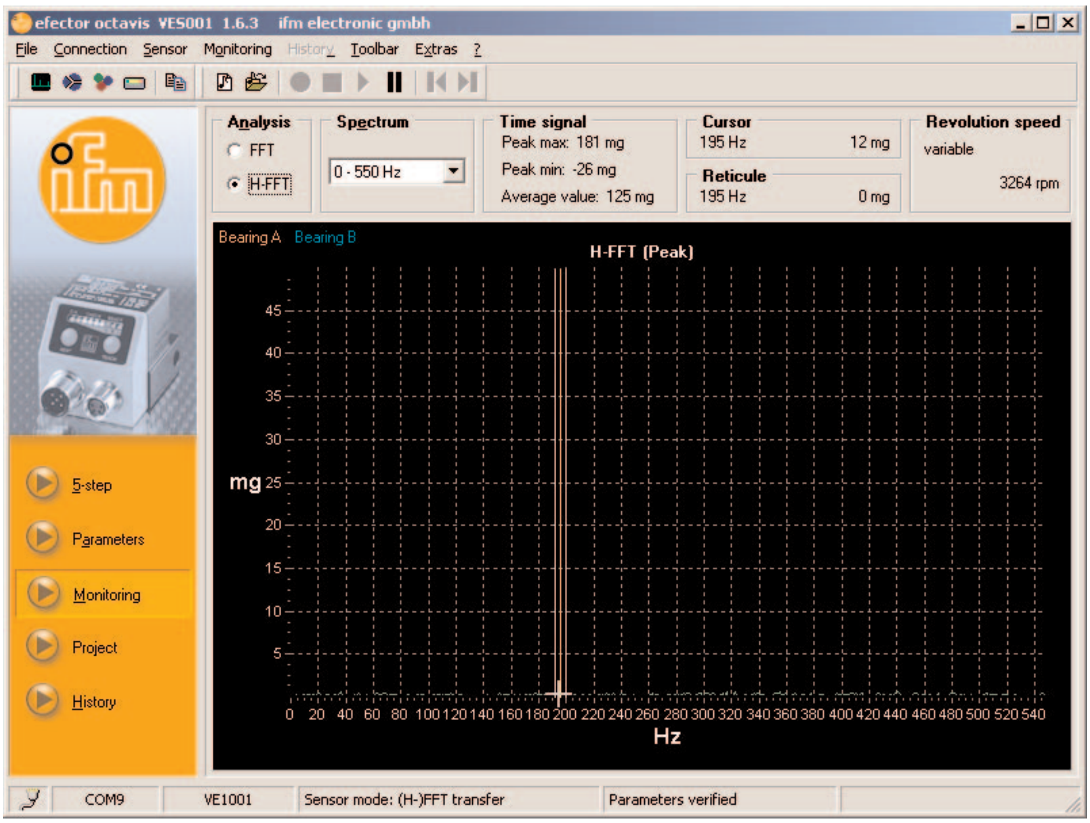
Under "Options → settings" the parameter input can be changed from the metric system (comma, mm) to the US system (decimal point, inch).
The language is selected under "File → Language".

Scan COM ports

Using "Extras" → "scan COM ports" the list of available ports is updated ("Connection" → "Interface"). This means that virtual serial ports which have been introduced subsequent to program start will be included (e.g. from USB Converter E30098).

Program settings

Menu "Extras" → "Preferences...": Please set your preferred setting for length measurement (millimeter or inch) and decimal seperator (comma or point).
The individual frequency windows pertaining to the sub-objects displayed in spectrum (Monitor) can be shown.



Sensor functions

Test switching outputs

The function of the switching outputs 1 and 2 can be tested by manual setting (Menu "Sensor" → "Test switching ouput 1" or " Test switching output 2").

Teach values

The Teach values are set in the sensor per object and can be transferred and manually adjusted using the function "Sensor → Teach values".
If the Teach values are set manually it is not necessary to teach the sensor again. efector octavis is immediately ready for diagnosis.
The purpose of manual setting of teach values is to reuse available reference for example for machines which are identical in construction. An absolute limit value can be obtained by multiplying the Teach values with the trigger levels .

Example:
Nominal trigger level for early warning diagnosis object 1: 800 mg
Nominal trigger level for main alarm diagnosis object 1: 1600 mg
Set reference value: 80 mg

Results in a limit value setting for
Earling warning: 10 (corresponds to 800 mg = 80 mg x 10)
Main alarm: 20 (corresponds to 1600 mg = 80 mg x 20)

Read

The parameter sets are read-out from the sensor (Menu "File" → "Read from sensor" or 

Teach-In

The reference values of the set machine are measured and stored in the sensor via the Teach-In function (Menu "Sensor" → „Teach-In“) or  .Diagnosis information relates to the Teach-In value. It is therefore necessary to ensure that the Teach-In is not interrupted and conducted under typical operating conditions.

To ensure that the preset limit values can be used in the monitoring mode "Rolling element bearing" the rolling element bearings to be monitored must not be predamaged.
If the sensor is used with variable speeds, the Teach-In is conducted using a typical speed under similar operating conditions preferably using a mid-range speed. The set number of averages is also applies to the Teach-In.

Write

Writes the parameter set on the sensor (Menu "File" → "Write to sensor" or  .

Reset

Resets the contents of the sensor. All data are deleted, incl. Teach-In data (Menu "Sensor" → "Reset").

Lock Teach button

Locks the Teach button on the sensor (Menu "Sensor" → "Teach button locked").

Sensor settings

Function "Sensor" → "Password":
A password can be given to write or read / write protect the sensor.

Function "Sensor" → "Sensor settings" → "Net Mode"
For monitoring with Fieldbus-Controllers the mode "Net Mode 1" can be activated. The data protocol "Net Mode 1" automatically continues to transmit after a power failure or if the sensor ceases to operate (speed is outside the operating range).
"Net Mode 1 + LRC" is identical to "Net Mode 1" and extended by a Longitudinal Redunancy Check.

Function "Sensor" → "Sensor settings" → "History memory"
The history memory continues to store the highest object values measured within the set interval on an internal RAM after the predetermined interval has elapsed. These values can be read out later in diagram or file format.

The history can be set to save the values if the speed is outside the set operating range ("ignore" operating range) or only within the set operating range ("note" operating range).
If the speed is outside the set operating range, it is not possible to save the object values just the measured time values (peak max., average value).

These settings can be transferred directly to the sensor or when the parameter data is transferred.

Important: When connecting the sensor or reading out the parameter data the changed settings will be reset to the sensor settings.

Show Sensor Info

Reads out the serial number, Firmware version, Hardware version using „?“ → Info.

Parameter

Set diagnosis objects

The wizard input mask "set diagnosis objects" summarizes all the current set diagnosis objects. In so far as the maximum number of diagnosis objects (VE1XXX: 5 objects; VB1001: 2 objects), or subobjects (VE1XXX: max. 20 individual frequencies; VB1001: max. 6 individual frequencies) has not been exhausted and further diagnosis objects can be set.
If it is not possible to set further diagnosis objects the wizard proceeds to the g-monitor setting and project data.
If an object is selected from the list shown the wizard can be activated again for this object.

Header data

The purpose of the header data is for archiving an application. The alphanumeric inputs for

- Company
- City
- Adress
- Machine location
- Machine spec

are stored in the sensor.

Project description

The purpose of the project description is to archive project notes.

Important: The information is **not** stored in the sensor only in the parameter file.

Print parameters

The wizard function "Print parameters" provides a print out of the set parameters.

Save parameters

The functions "Save" and / or "Write" enable the parameters to be transferred to the sensor at the end of the wizard or to save the parameters in a file.

Application

Parameter

Parameter sets can be specifically set for different sensor types. The permissable input values varies according to sensor type. This is therefore included in the corresponding input box.

Speed behaviour

The operating speed is important to define speed related damage frequencies.
efector octavis can be used with fixed or variable speeds. The actual speed must be provided by either a 0...20 mA current loop or pulse input to ensure correct diagnosis of variable speed applications.

The nominal speed is used for asynchronous machines. It is important to give the nominal speed under nominal load. Deviations caused by slip are compensated by the frequency window. If the slip exceeds 5% the actual speed should be detected directly from the shaft with for example an inductive sensor.

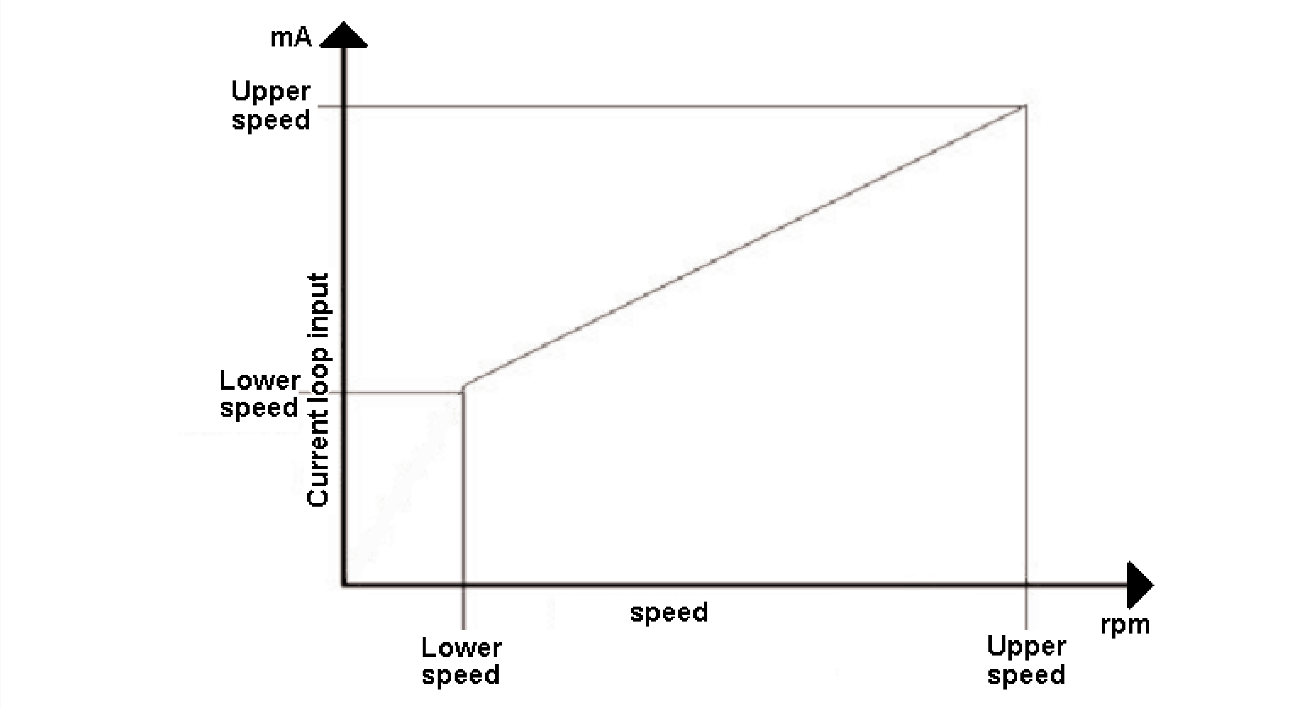
Input:
- constant operating speed
- variable operating speed

Speed Input

efector octavis has to be provided with the operating speed for speed variable applications.
Speed information can be provided by a 0...20 mA current loop or by a pulse signal (e.g. using an inductive sensor). The maximum adjustment of the current loop is 20 mA. The pulse signal has to have a signal source with a maximum switching frequency of 10,000 Hz.

Speed calibration

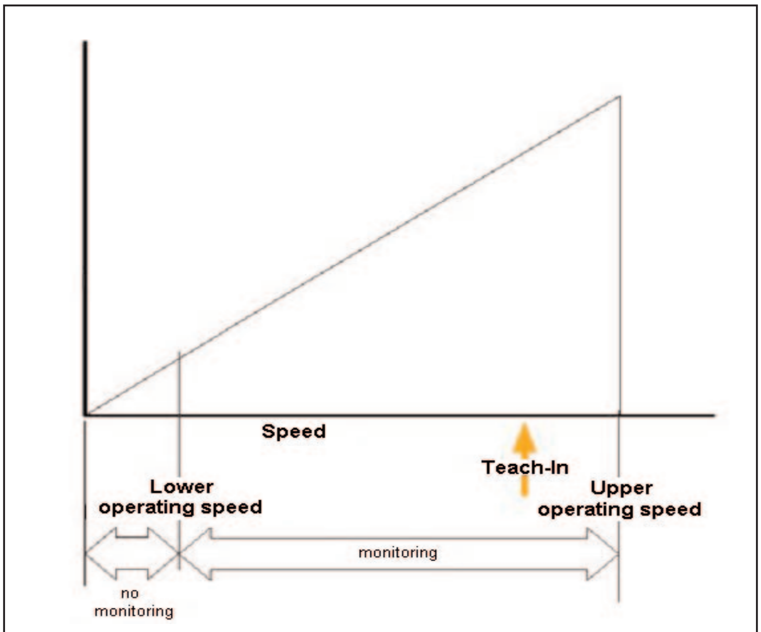
efector octavis has to be provided with the operating speed for speed variable applications. If a 0...20 mA current loop is used to provide the speed information, the speed input signal is calibrated to a user-defined lower and upper speed.



Important: The minimum speed at 20 mA calculated with the given data is 120 rpm and the maximum 13.000 rpm (VE1002/VE1102/VE112A: between 12 rpm and 4000 rpm. VE1103: between 1.500 rpm and 130.000 rpm).

Operating range

For variable speed monitoring the sensor requires the operating speed range, i.e. input of the lower and upper operating speed.



	VB1001	VE1001, VE1101, VE111A	VE1002, VE1102 VE112A	VE1103
rpm (min.) rpm (max.)	500 6000	120 12000	12 3500	1.500 96.000

Important: If the sensor has been set for variable monitoring the sensor starts measurements if the actual speed is higher than the minimum speed and lower than the maximum speed. If the speed input is not connected measurements are not possible.

Pulse per revolution

Input the pulses per revolution. The maximum pulse frequency which efector octavis can handle is 10,000 Hz. The minimum pulse band amounts to 3µs.

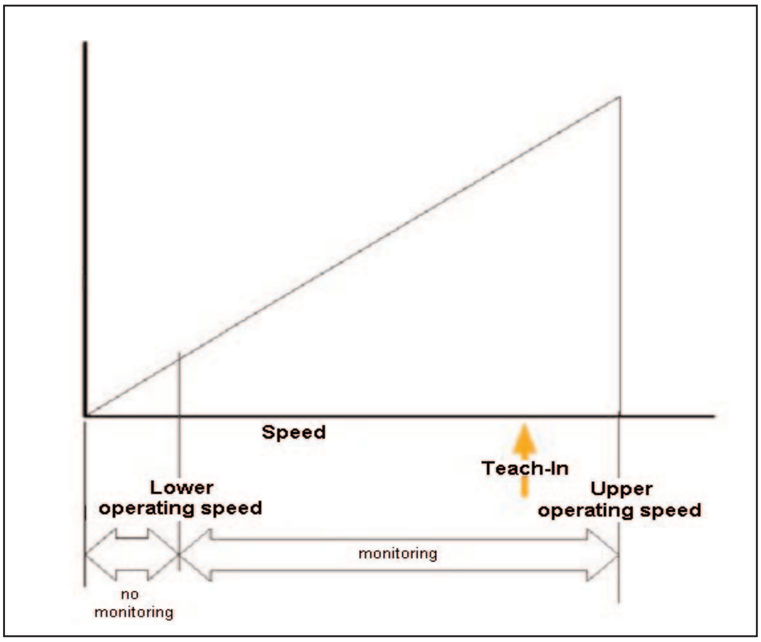
Constant speed

Number of revolutions per minute. It is only possible to define one machine speed. If the diagnosis objects (e.g. (rolling element bearings) refer to different speeds (gears) it is possible to define a transmission ratio for each diagnosis object.
For machines which are mains operated the operational speed can be considered as constant. The nominal speed is used for asynchronous machines. It is important to give the nominal speed under nominal load. Deviations caused by slip are compensated by the frequency window. If the nominal operating speed deviates more than 5% we recommend detecting the speed.

	VB1001	**VE1001, VE1101 VE111A**	**VE1002, VE1102 VE112A**	**VE1103**
rpm (min.)	500	120	12	1.500
rpm (max.)	6000	12000	3500	96.000

Teach-In speed

If the machine to be monitored operates with variable speeds, the speed for the Teach-In has to be defined so that the weighting of the reference values is taken into consideration. The Teach-In speed must be within the previously defined operating speed range and should ideally be close to the upper operating speed.



Averages Diagnosis objects

Number of individual measurements required to calculate a spectrum analysis. Each measurement amounts to 0.8 s (VB1001, VE1001, VE1101 and VE111A: corresponds to the frequency resolution of 1.25 Hz in spectrum. VE1002 and VE1102 and VE112A: 8 s, corresponds to the frequency resolution of 0.125 Hz in spectrum. VE1103: 0.064 s, corresponds to the frequency resolution of 15.625 Hz in spectrum) so long as all the frequencies are located in the same frequency band (VB1001, VE1001, VE1101 and VE111A: 0-500; 500-1500; 1500-2500.... VE1002, VE1102 and VE112A: 0-50; 50-150; 150-250...).

For setting values: 1 (=zero); 2; 4; 8; 16; 32

Recommended setting: 2

The above has no influence on the setting of the averages for the g-monitor.

Frequency window

The frequency window gives the relative search width in the frequency spectrum for each damage frequency. The frequency window systemtrically surrounds the monitored frequency. The purpose of the frequency window is to compensate for inaccuracies in the description of the frequency location (tolerance corridor).

Input values are relative in percent.

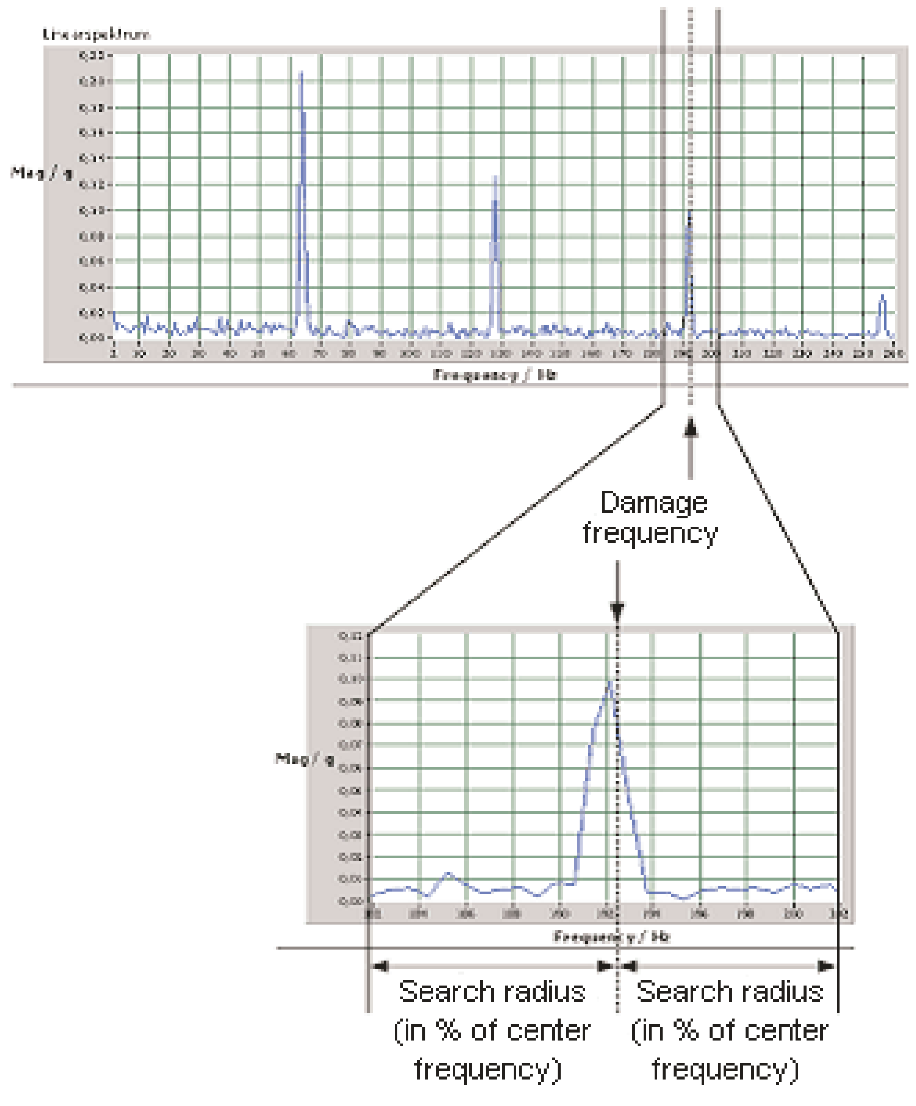
	VB1001	**VE1001, VE1101 VE111A**	**VE1002,VE1102 VE112A**	**VE1103**
Value range min.	1 %	1 %	0,1 %	1%
Value range max.	20 %	20 %	20 %	20 %

The search range setting applies to all programmed objects, as the maximum search range of the individual diagnosis objects comes into effect.

Example (VE1001):

Frequency window =
5%; Damage frequency = 311.5 Hz corresponds to spectral lines 249

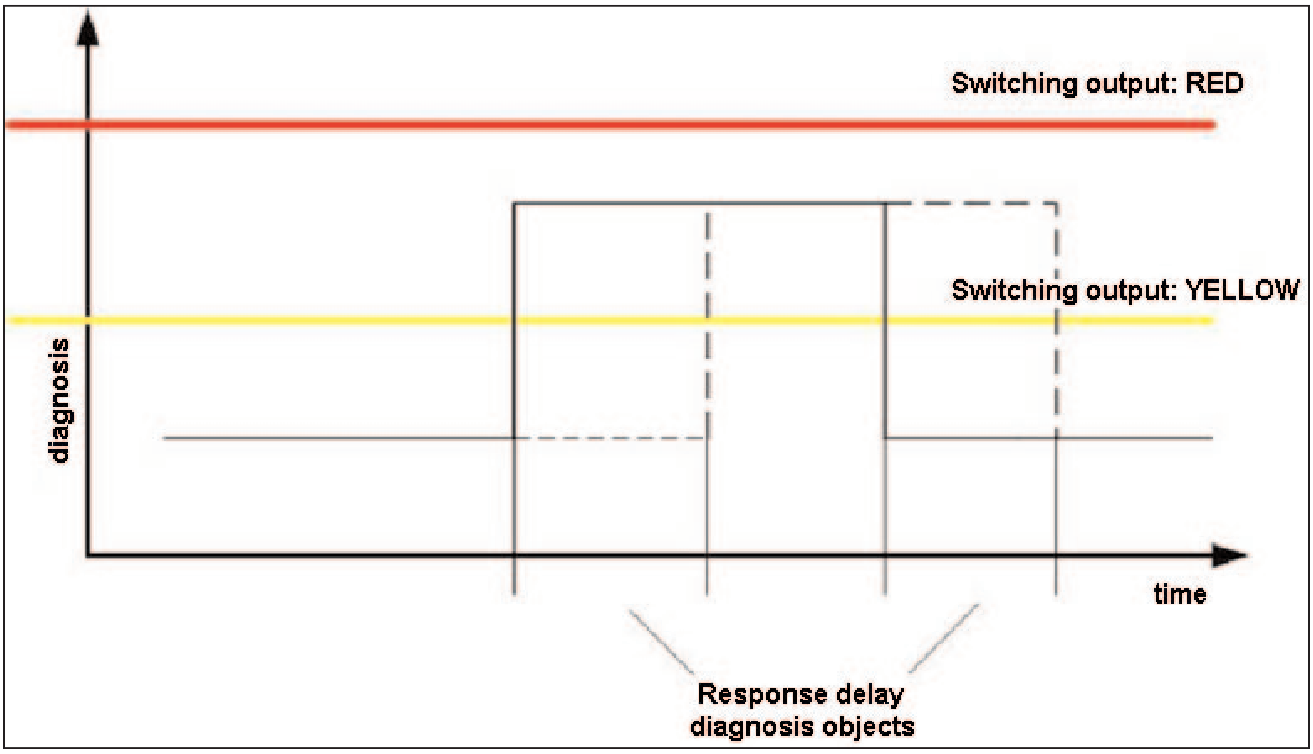
Frequency window =
spectral lines 237 to 261 corresponds to 296.25 Hz to 326.25 Hz



Diagnosis objects

Response delay - Diagnosis objects

To avoid false alarms the sensor is equipped with an response delay (hysteresis) of 5. This means that an increase in the diagnosis value is only displayed after a sustainability check confirms 5 subsequent increases. The sustainability of the displayed diagnosis is thereby guaranteed.
The response delay can be adjusted from 1 (means no delay) to 10. The total response time results from the number of averages multiplied by the set response delay.
The response delay is triggered by a deviation exceeding +/- 1 in the diagnosis level which corresponds to +/- 100 %. The function applies to both increasing and decreasing values. The set response delay has the same effect on all set Diagnosis objects. Independent of the aforegoing it is also possible to program a response delay for the g-monitor.



Switching outputs

The switching outputs can be programmed as normally closed or normally open. We recommend using normally closed (to recognise cable break).

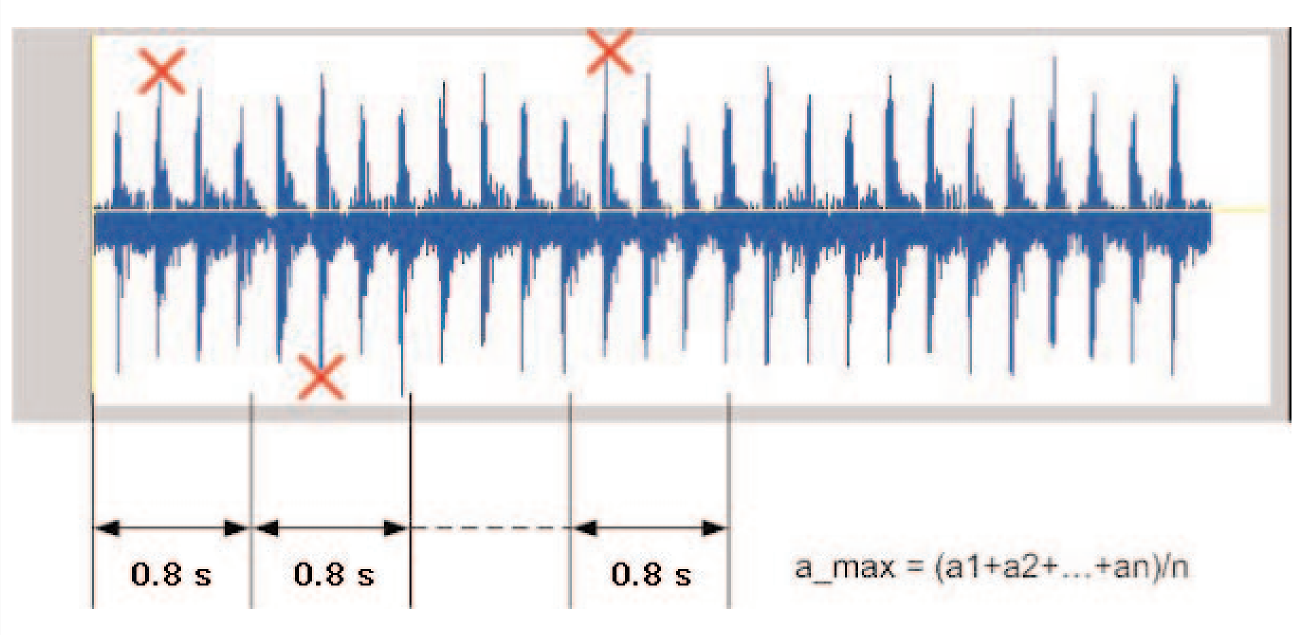
g-monitor

The purpose of the g-monitor is to offer additional vibration condition monitoring in the time domain in addition to the frequency selective (i.e. narrow band) measurement of rolling element bearings/error objects. This so-called broadband measurement makes it possible to give general information about the total system by evaluating the raw acceleration signal for maximal or medium acceleration.

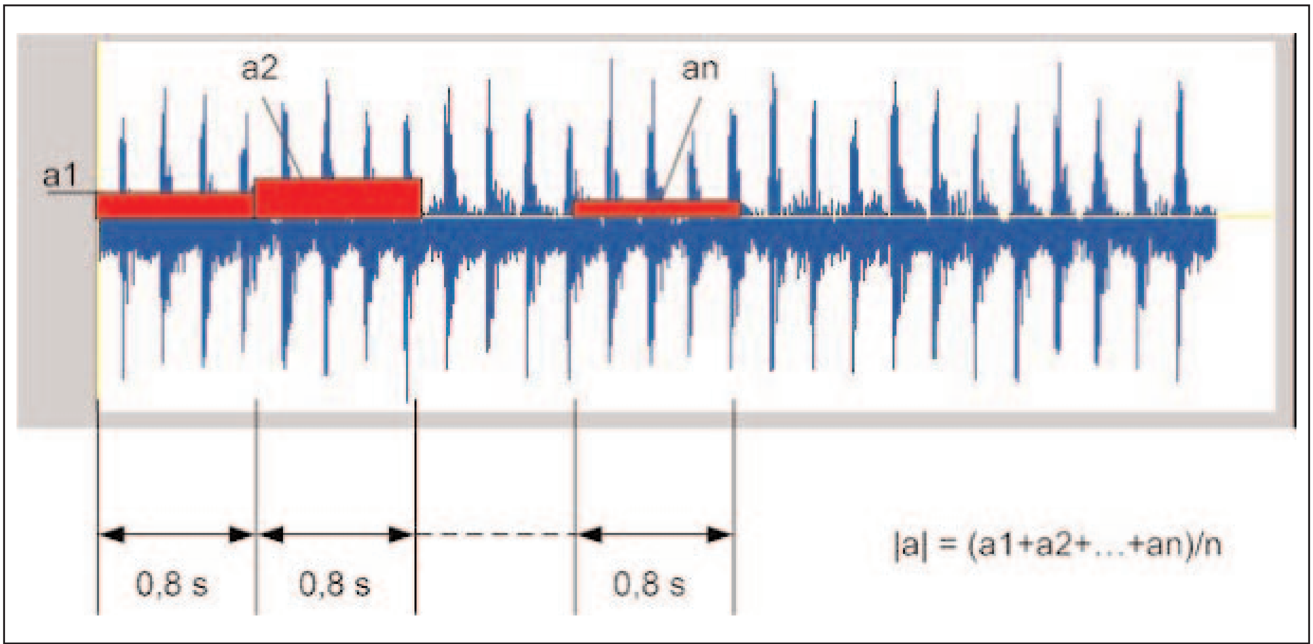
Monitoring mode

The monitoring mode determines whether the g-monitor should monitor the maximum peak (peak monitoring) or the weighted average (vibration monitoring) of the acceleration signal. Contrary to the diagnosis objects the ensuing monitoring uses absolute values.
Two alarm levels can be set as well as speed dependent signal weighting.
Response delay and the number of averages are set independendantly of the settings for the diagnosis objects.

Peak monitoring (example for VE1001, VE1101, VE111A)



Vibration monitoring (example for VE1001, VE1101, VE111A)



Switchpoints - constant

efector octavis uses own limit values to monitor the vibration level within the time domain. Contrary to the diagnosis objects the acceleration values are absolute (unit: mg).
For variable speed monitoring the vibration level to be monitored is weighted according to the "Weighted signal" curve to compensate for differences caused by the trigger level.
Two trigger levels can be defined (yellow and red) which are also used to switch the outputs.

Valid for VE1001, VE1002

yellow:
first yellow LED is lit + switching output 1 is switched
red:
first yellow LED is lit + third red LED (L) + switching output 2 is switched

Minimum: 200 mg
Maximum: 25,000 mg

Units:
1 mg = 0,001 g
1 g = 9,81 m/s² (gravitational acceleration)

Switchpoints - variable

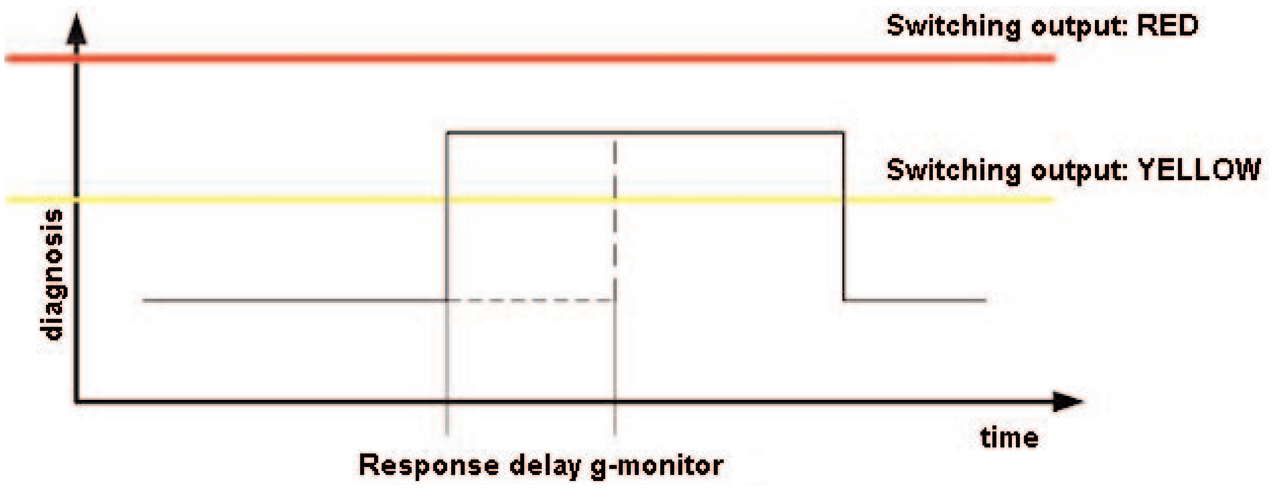
For variable speed monitoring the limit values can be set variably via the operating speed range. The curve for the early warning alarm is dragged using the left mouse button and the distance between yellow and read is entered as percentage value. Only values which result in trigger levels below 25,000 mg are accepted.
The exact values are displayed for the defined Teach-In speed.

Averages g-monitor

Independent of the averages set for the diagnosis objects it is also possible to set averages within the time domain.
Number of individual measurements required to calculate a diagnosis value. The measurement intervals to calculate the weighted averages and the maximum peak amount to 0.8 s (VE1002, VE1102 and VE112A: 8 s. VE1103: 0.064 s).

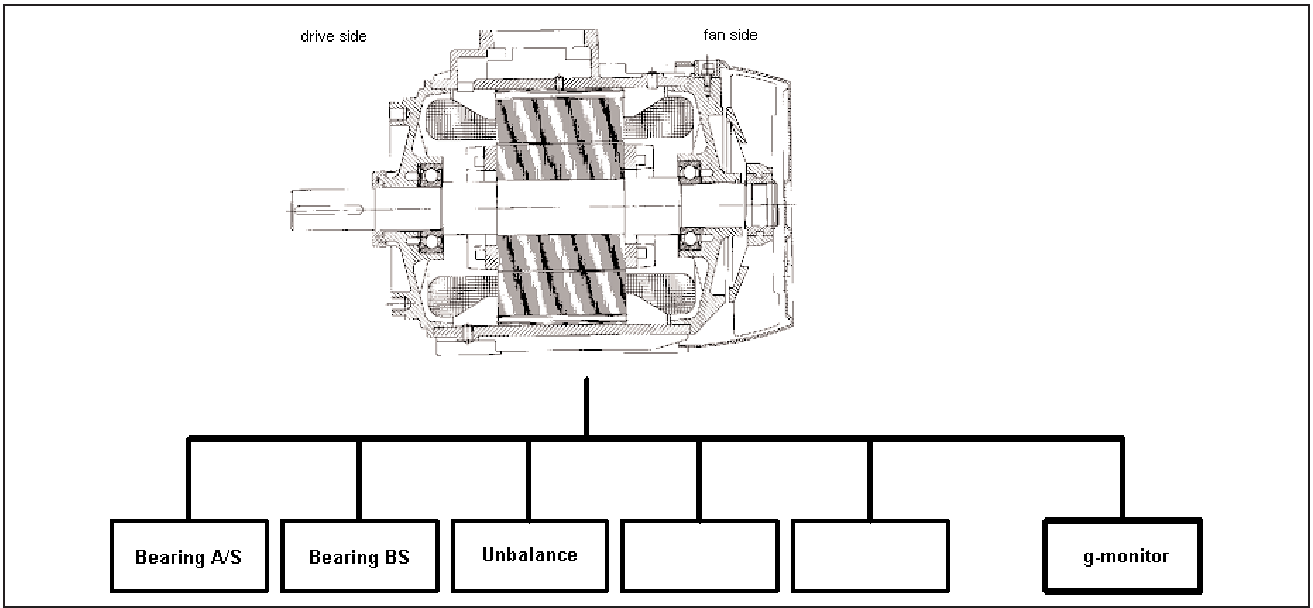
Response delay - g-monitor

Independent of the settings for the spectral diagnosis objects it is also possible to program a separate response delay for the g-monitor.
To avoid false alarms the sensor is equipped with an response delay of 5. This means that the g-monitor signal level is only displayed after a sustainability check confirms 5 subsequent increases. The relevance of the displayed values is thereby guaranteed.
The response delay can be adjusted from 1 (corresponds to zero delay) to 10. The total response time results from the number of averages multiplied by the set response delay.



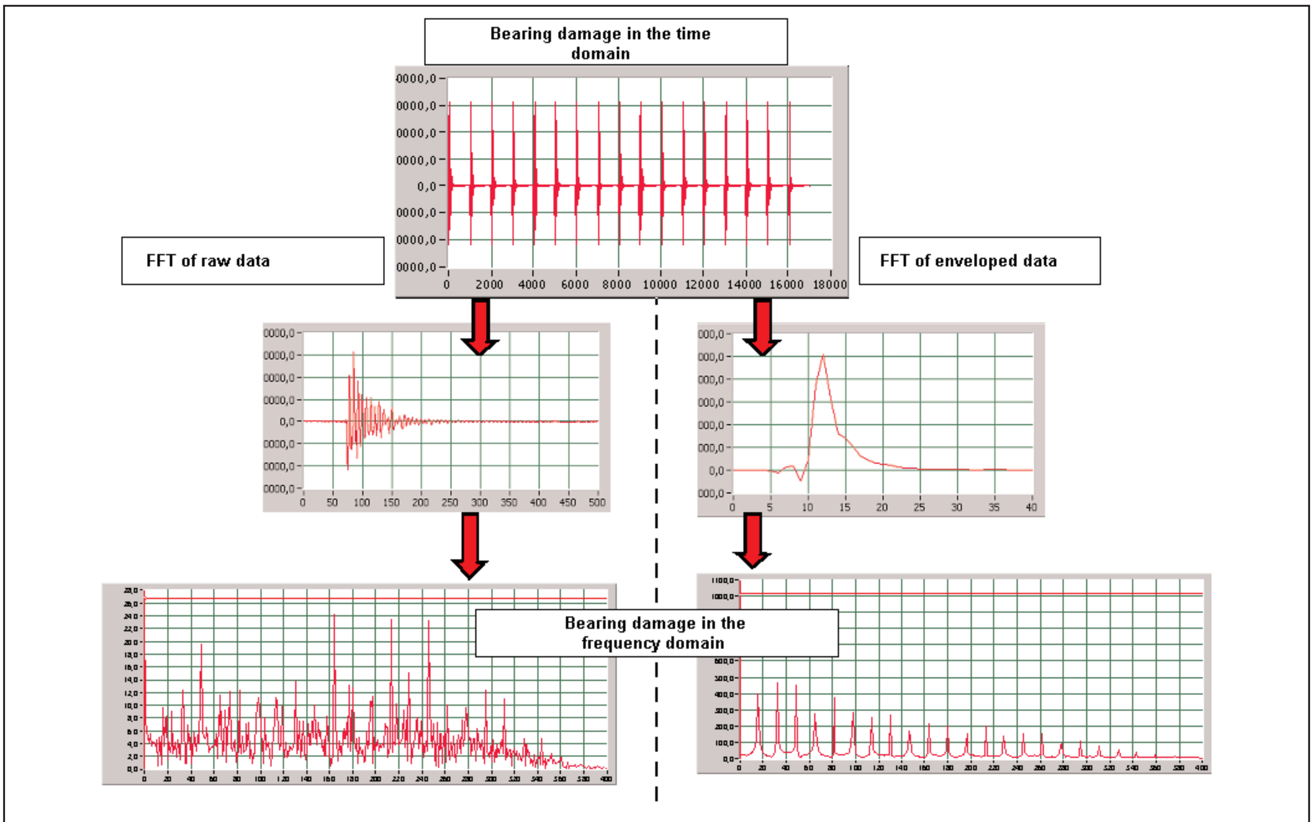
Diagnosis objects
The machine diagnosis carried out by efector octavis is automatically built-up by defining a machine model via so-called diagnosis objects.
efector octavis can monitor up to 5 different diagnosis objects simultaneously (VE1XXX: 5 objects. VB1001: 2 objects). A diagnosis object comprises a group of symptomatic frequencies which are defined by so-called frequency factors. The rotational frequency multiplied by the frequency factor results in the actual damage frequency. The constant speed monitoring the damage frequency thus remains constant.
The method of analysis is assigned to a diagnosis object depending on the type of damage. For example for unbalance applications the FFT method is used and for rolling element bearings the H-FFT method.

efector octavis monitors an e-motor as follows:



Analysis method

The purpose of the signal analysis is to generate informative characteristics from the raw acceleration data. efector octavis uses fast frequency analysis methods (Fast Fourier Transformation = FFT). The analysis method differentiates between calculating the linear spectrum from the raw acceleration data (FFT) and the envelope of the acceleration data (H-FFT). The selected method of analysis can be assigned individually to each diagnosis object. For example unbalance and rolling element bearing damage can be monitored in one sensor.



The linear spectrum of VB1001-, VE1001-, VE1101- and VE111A-sensors has a frequency resolution of 1.25 Hz in the total frequency range from 1.25...7.500 Hz. The linear spectrum of VE1002-, VE1102- and VE112A-sensors has a frequency resultion of 0.125 Hz in the total frequency range from 0.125...750 Hz. The linear spectrum of VE1103 has a frequency resolution of 15.625 Hz in the total frequency range from 15,625...13.125 Hz. The windowing is conducted via the Hanning-Window.

Applications for FFT:
Evaluating harmonic signals e.g. unbalance, cavitation, resonance, alignment errors.

Applications for H-FFT:
Evaluating high frequency peak-shaped signals e.g. rolling element bearings.

Diagnosis-type
By selecting the diagnosis type "rolling element bearing" or "unbalance" the settings for rolling element bearing diagnosis or for the recognition of unbalance are automatically selected. This simplifies the parameter setting process.
By selecting "Other" it is possible to set parameters for any machine damage if it is characterised by assigned symptomatic frequencies/fundamental frequency factors.

Rolling element bearing
The parameter setting "Rolling element bearing" determines the rolling element bearing condition from the amplitudes of the ball pass frequencies:

- Inner race
- Outer race
- Rolling elements

It is possible to make use of the rolling element bearing database or to enter own bearing data.

Unbalance
The parameter setting "Unbalance" determines the machine condition using the amplitudes at rotational frequency.

Other
The parameters can be set for any machine damage under the damage type "Other", by entering the damage frequencies (fundamental frequencies per diagnosis object).

Transmission ratio

Gear transmission measuring speed/object speed

The transmission ratio give the differences in speed between the motor shaft and the shaft upon which the bearing (or object) to be monitored is located, in so far as the given speed relates to the motor shaft and the shafts are connected via gears.

(measuring speed/object speed) < 1 => Increase in speed relating to the motor
(measuring speed/object speed) > 1 => Decrease in speed relating to the motor

Important:
The subject damage frequency (fundamental frequency) divided by the gear transmission ratio (quotient measuring speed/object speed) must be below 50.

Description

Enter an alphanumeric description for the diagnosis ojbect to be monitored.

Damage frequencies

Enter the damage frequencies (subobjects) which are to be assigned to a particular type of machine damage (object). A maximum of 20 individual frequencies can be defined which can be assigned to a maximum of 5 diagnosis objects (VE1xxx: 20 frequencies, 5 objects. VB1001: 6 frequencies, 2 objects). The characteristic data for the object is calculated using the summation of the individual amplitudes at the given frequency.

The frequencies are described using the so-called fundamental frequency analysis. Hereby the required frequency from a fundamental frequency is multiplied by the current rotational frequency.

The fundamental frequency is a multiplication of the rotational frequency. The damage frequency is calculated as follows:

Damage frequency = fundamental frequency x rotational frequency.

Example:
Fundamental frequency = 6.23, rotational frequency = 50 Hz
=> damage frequency = 311.5 Hz

The fundamental frequency always relates to the corresponding frequency of the set error object. If different speeds are used between the objects then the corresponding gear reduction has to be taken into consideration.

Frequency window

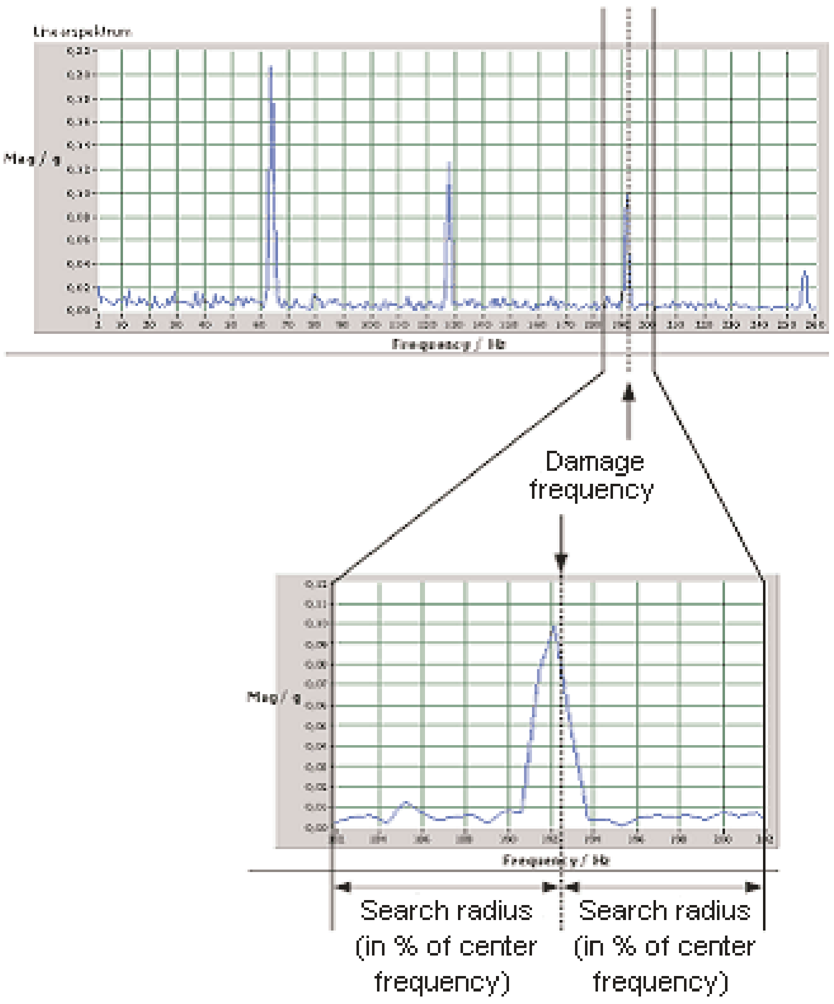
The frequency window gives the relative search range in the frequency spectrum for each damage frequency. The frequency window symmetrically surrounds the monitored frequency. The purpose of the frequency window is to compensate for inaccuracies in the description of the frequency location (tolerance corridor).

Input values are relative in percent.

	VB1001	**VE1001, VE1101 VE111A**	**VE1002,VE1102 VE112A**	**VE1103**
Value range min.	1 %	1 %	0,1 %	1%
Value range max.	20 %	20 %	20 %	20 %

The frequency window setting applies to all programmed objects, as the maximum search range of the individual diagnosis objects comes into effect.

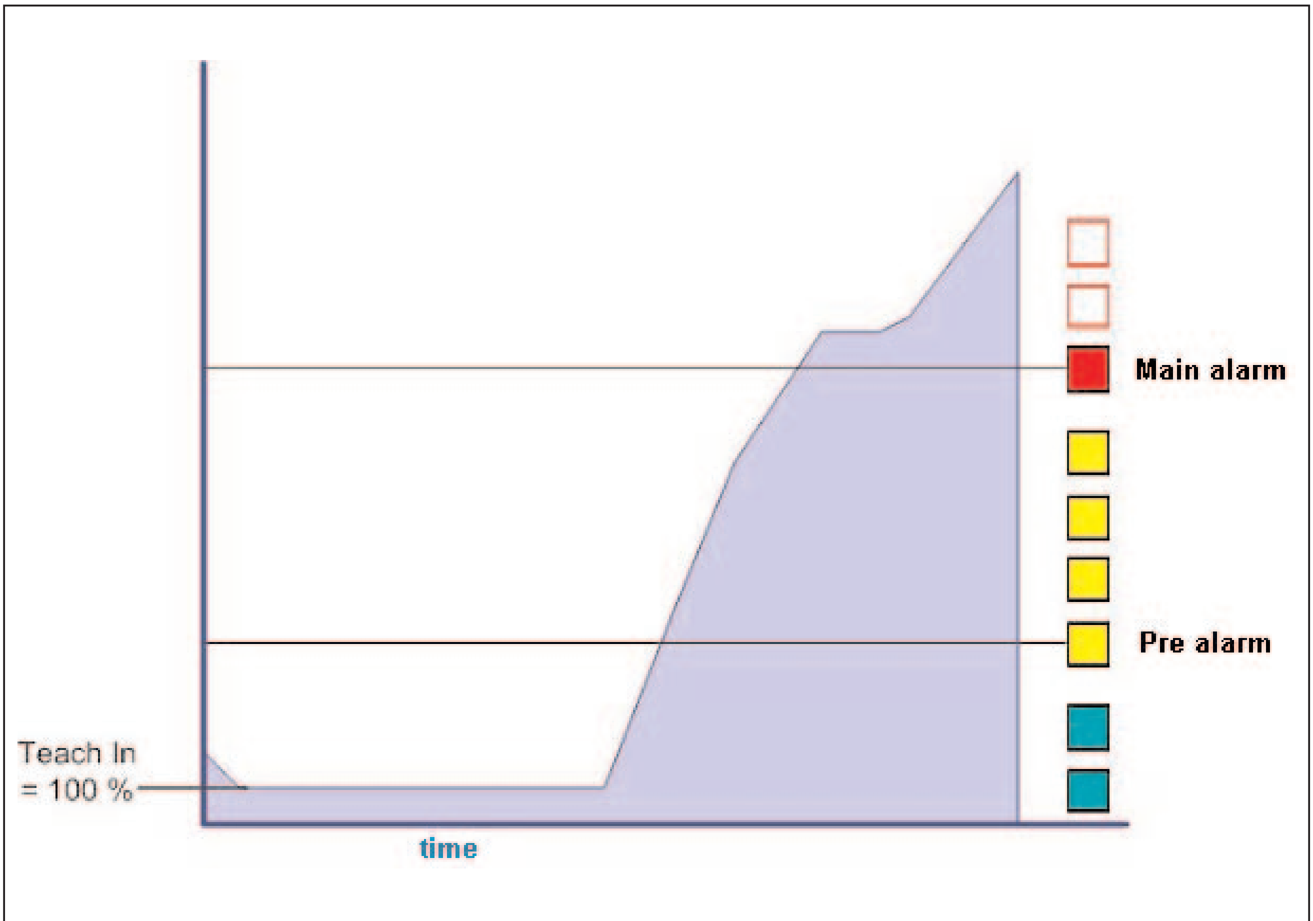
Example (VE1001):
Frequency window = 5 %; Damage frequency = 311.5 Hz corresponds to spectal lines 249
Frequency window = spectral lines 237 to 261 corresponds to 296.25 Hz to 326.25 Hz



Limit values - diagnosis objects

efector octavis uses own object limit values for the set spectral diagnosis objects for early warning (yellow) and main alarm (red). The alarm limit values of the diagnosis objects are always related to the set Teach-In value and therefore describe a signal fan-out. Whereby green always corresponds to 100%.
Value range early warning: 2;3;4;...;20 (in whole numbers) corresponds to: 200%; 300%; etc.
Value range main alarm: 6; 7; 8;.....; 99 (in whole numbers, which have to be 4 more than the set yellow-value in order to obtain intermediate values with whole numbers for the yellow LEDs.)
For variable speed monitoring efector octavis can also compensate differences caused by the trigger level. The diagnosis value is weighted according to the "weighted signal" curve. Each diagnosis object has individual weighted curves.

If the diagnosis-type "Rolling element bearing" is selected the limit values and weighted signal curve are automatically set.



Speed ratio

The speed ratio measures the mechanical transmission of peak pulse sequences pertaining to rolling element bearing damage.
The speed ratio can be measured with a connected sensor using an impulse test. It is important hereby that the sensor is mounted in the designated location and as close as possible to the subject bearing. The transmission can be entered manually off-line. The unit is mg / N, i.e. acceleration per force.

If the sensor is mounted directly on the bearing seat then an impulse test is not required. The manual input typically amounts to10 mg / N.

Signal weighting - diagnosis object

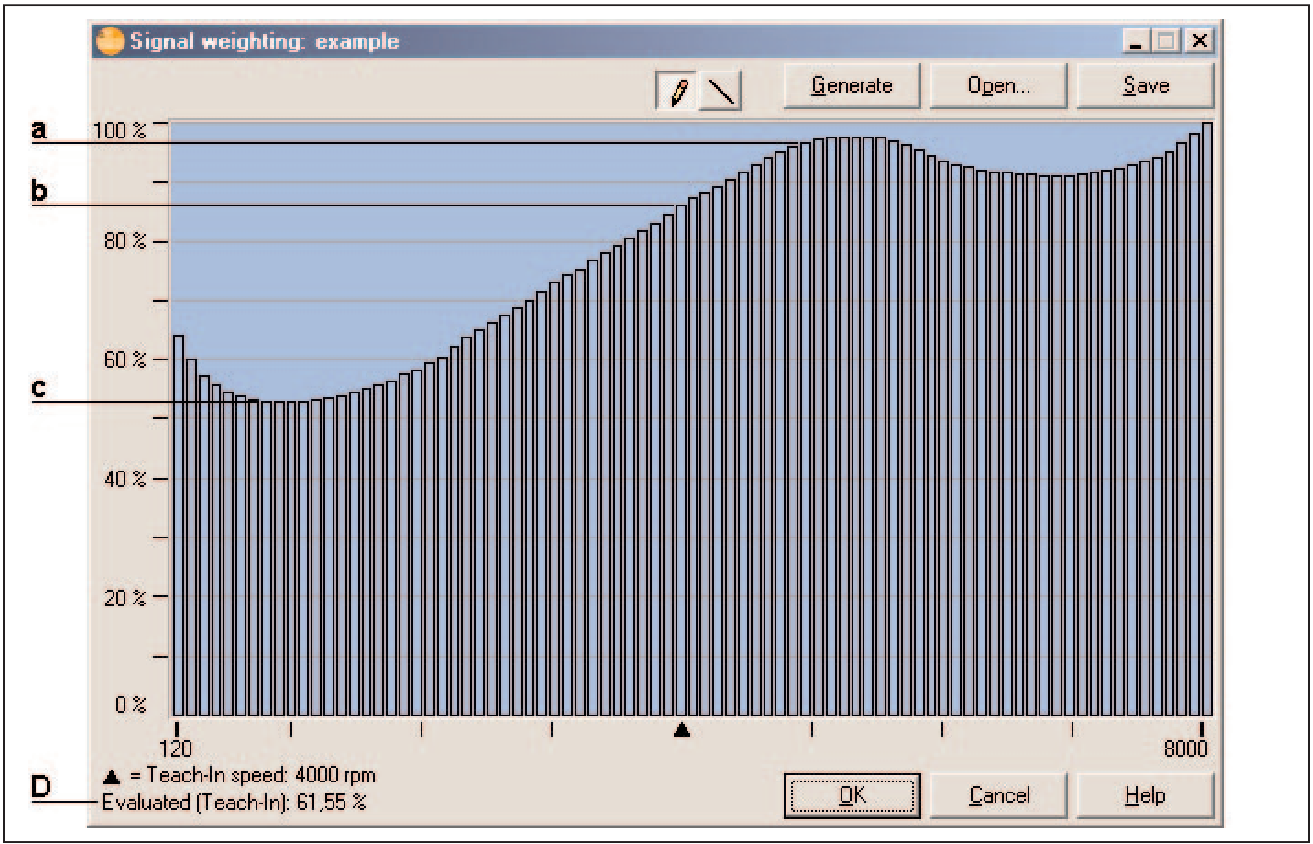
For variable speed monitoring it is possible to correct the limit values independently of the speed. The values displayed indicate how the variables of a constant damage change with speed. During evaluation and calculation the sensor takes this change into account. This correction makes a speed related weighting of the actual measured values.

The Teach value as well as the measured value are weighted using the signal weighting table (see example given below) - the Teach value using the Teach-In speed, the measured value using the measured speed. It is imperative to keep to the Teach-In speed during the Teach-In.

It is possible to use ready defined curves or to produce/load own curves.
When setting parameters in the "Rolling element bearing damage" mode, preconfigured parameter sets can be used. This can be changed again if required.

Also indicated is the extent to which the Teach-In value is adjusted in the signal-weighted diagram shown in the "subobjects" and "objects" mode (D = (c / b) x 100 %).

Example



The following formula is valid:

$$\textbf{Damage level (or limit value)} = \frac{\textbf{measured value in mg / signal weighting at measured speed (a)}}{\textbf{Teach-In value in mg / signal weighting at Teach-In speed (b)}}$$

Determine the damage level (300 mg at 5000 rpm, Teach-In 65 mg) taking the signal weighting into consideration:

$$X = \frac{300\ \text{mg} / 97\ \%}{65\ \text{mg} / 86\ \%} = 4{,}09$$

The required Teach value can also be determined in the same way in order to exceed the yellow limit values (4) at given values (300mg at 5000 rpm):

$$4 = \frac{300\ \text{mg} / 97\ \%}{x\ \text{mg} / 86\ \%}$$

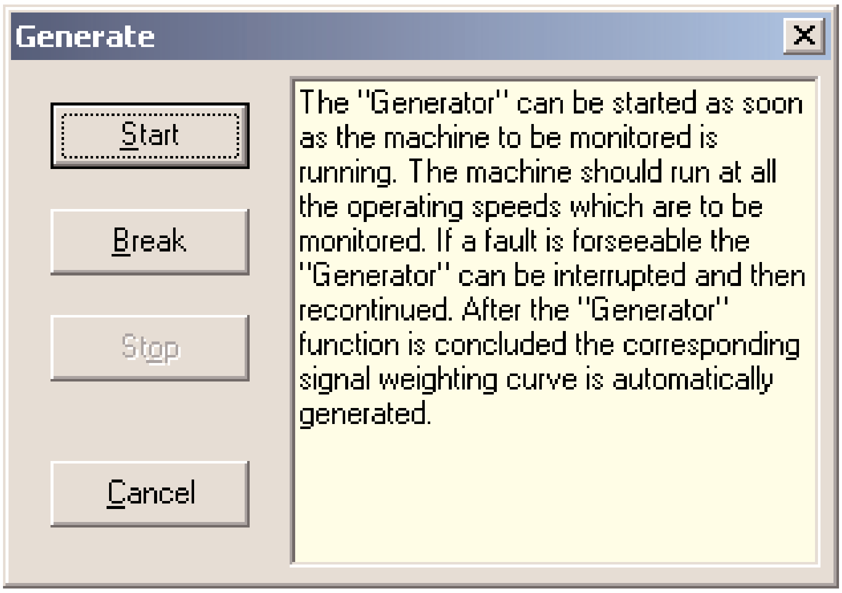
solved according to X (Teach-In value)

$$X = 66{,}5\ \text{mg}$$

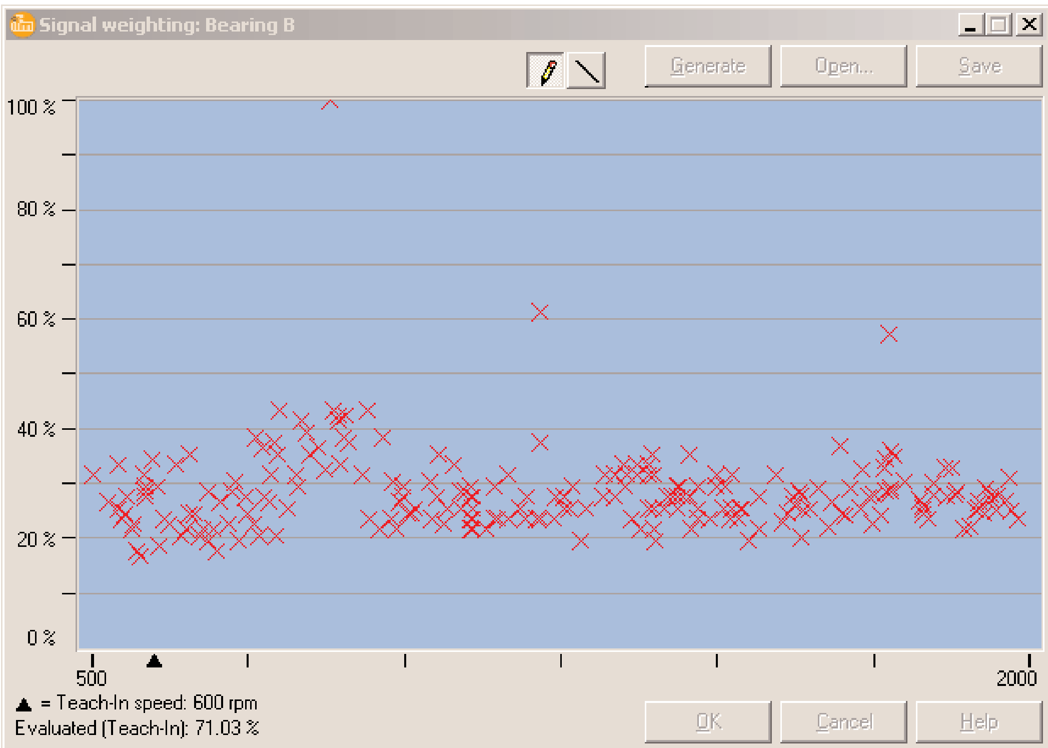
Generate signal weighting

A signal weighting table can be created using the sensor. The machine should run through all the operating speeds for the diagnosis object under normal conditions (without damage). The values measured are collected in a table which can be used to calculate the reference values for the corresponding speed ranges. In this case the rule of thumb applies that the more measurements available the better the detection of deviations..

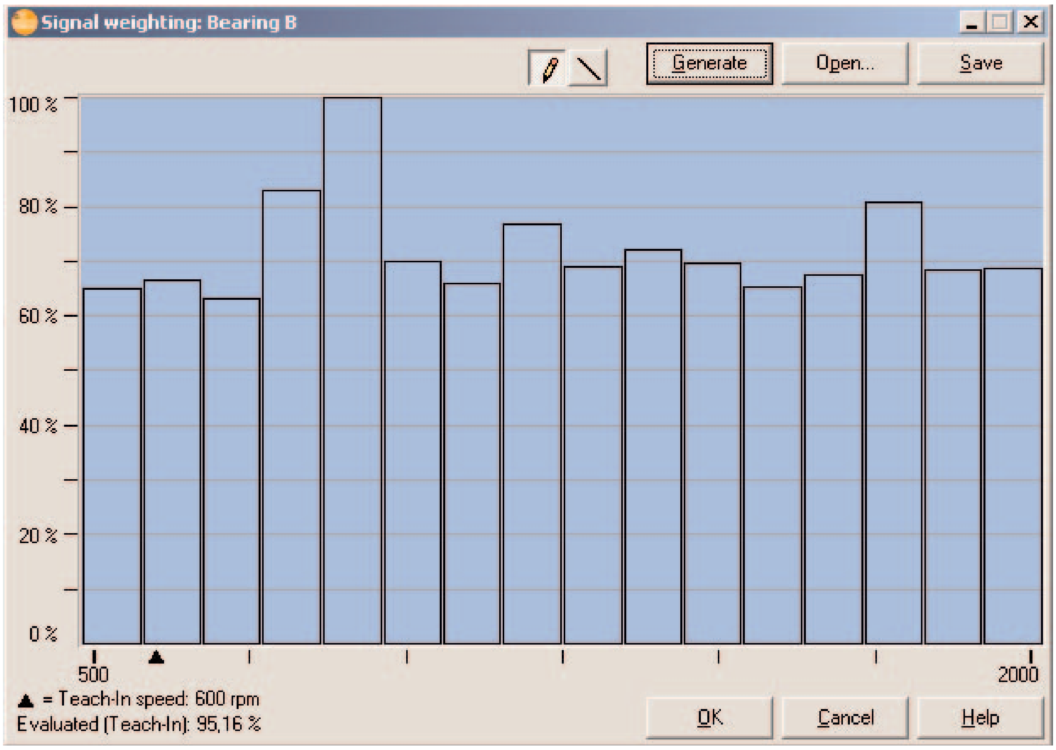
The generator starts as soon as the machine starts up.



The individual measured values are shown as red crosses in the display field. For foreseeable breakdowns the generator can be interrupted and then continued.



After completion the corresponding signal weighting curve is created.



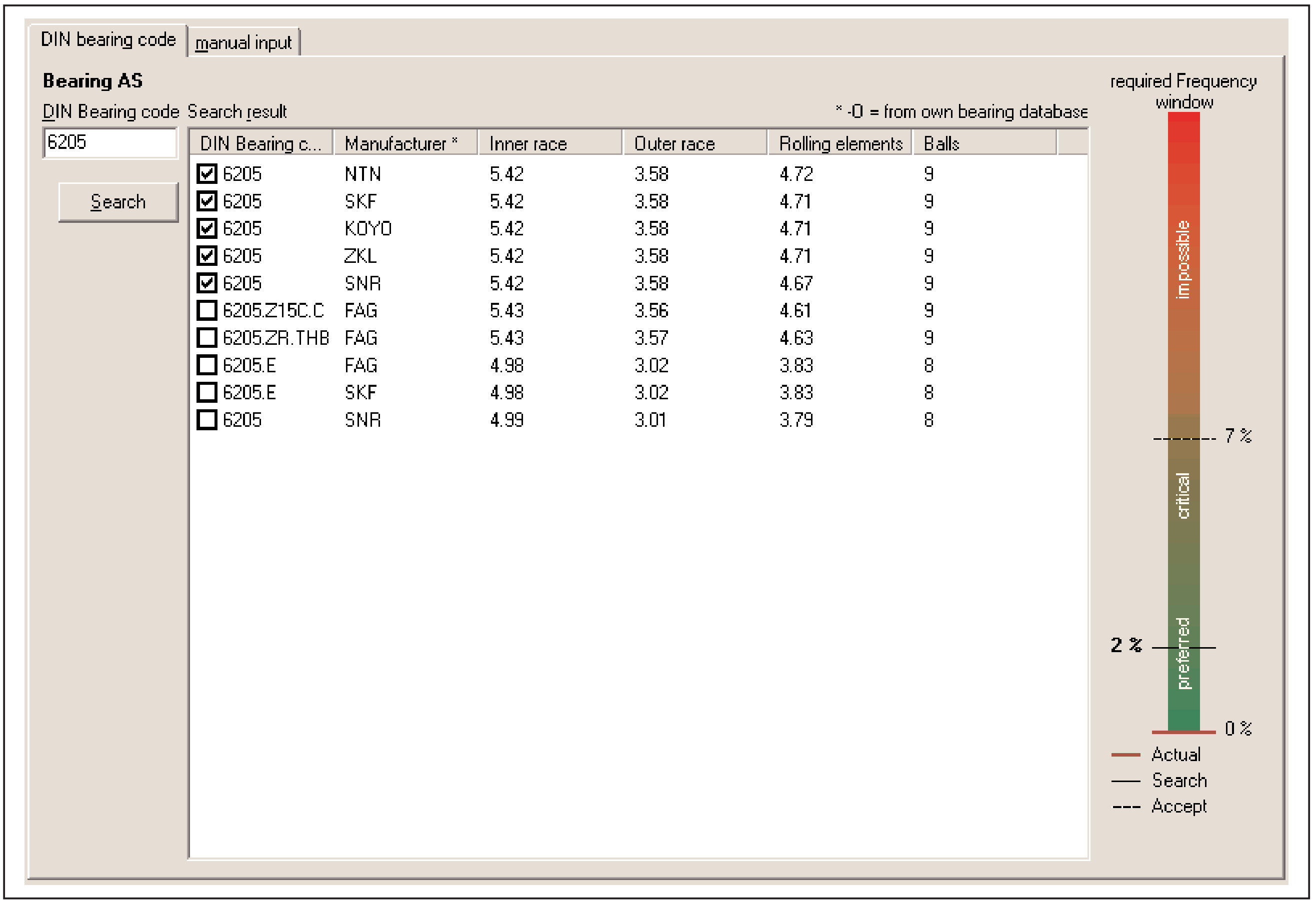
Subsequently the values can be changed manually (plot the required values at the corresponding level using the mouse).

Conflict check

The purpose of the conflict check is to ensure that the parameter sets are complete and compatible.

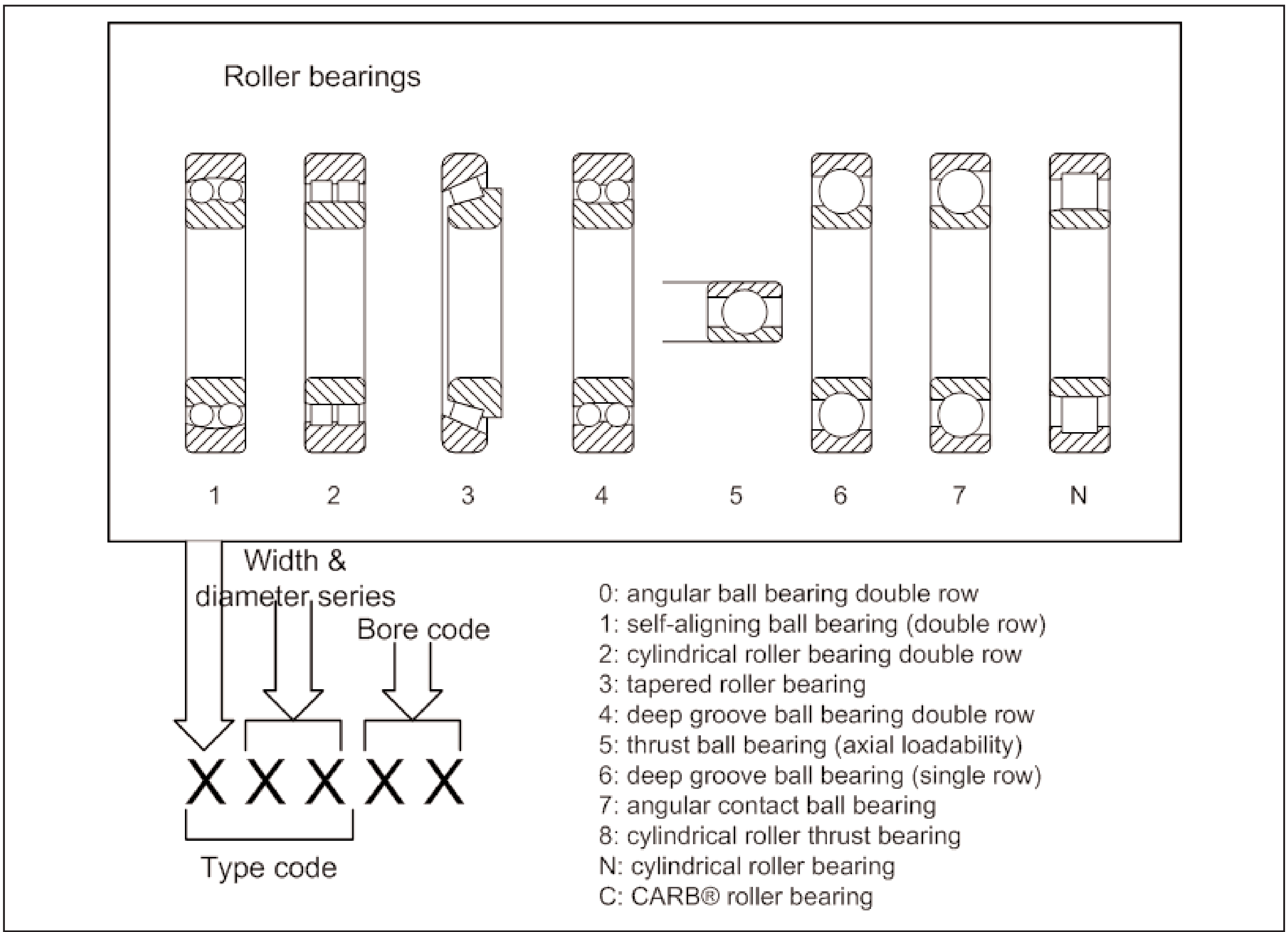
Rolling element bearing database

The rolling element database contains the most common rolling element bearings from different manufacturers.
They can be defined by entering the bearing's short description.
The bearings listed in the user-defined database can be included and displayed (Function: Extras → Setting → Rolling element database → Search). The extension -O is then added to the manufacturers' description.



Short description (=DIN)
Each standard rolling element bearing has a short description according to DIN 623 with which it can be clearly assigned to a particular group of bearings. Not only that but geometric data can also be identified from the description. The ball pass frequencies are also described.

Suffixes and prefixes normally do not have any influence of the ball pass frequencies. Only the suffix "E" usually indicates a reduced number of rolling elements and is therefore relevant for the ball pass frequency.
Differences between the manufacturers are on the whole marginal. Bearing descriptions with more than five digits are special constructions. In this case you should consult the manufacturers' database.



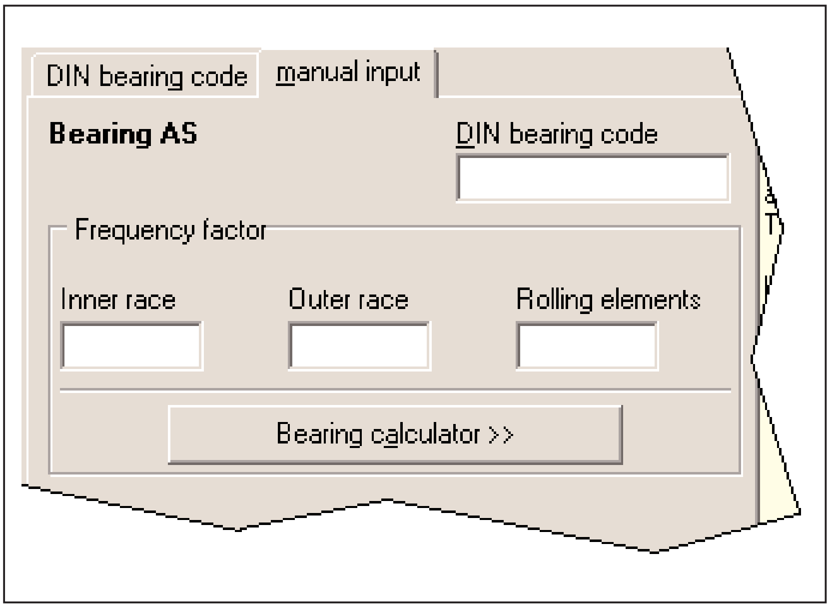
The last two digits define the inner diameter of the bearing multiplied by 5:

Example:
Bearing 6(0)212:
Inner diameter = 12 x 5 = 60 mm

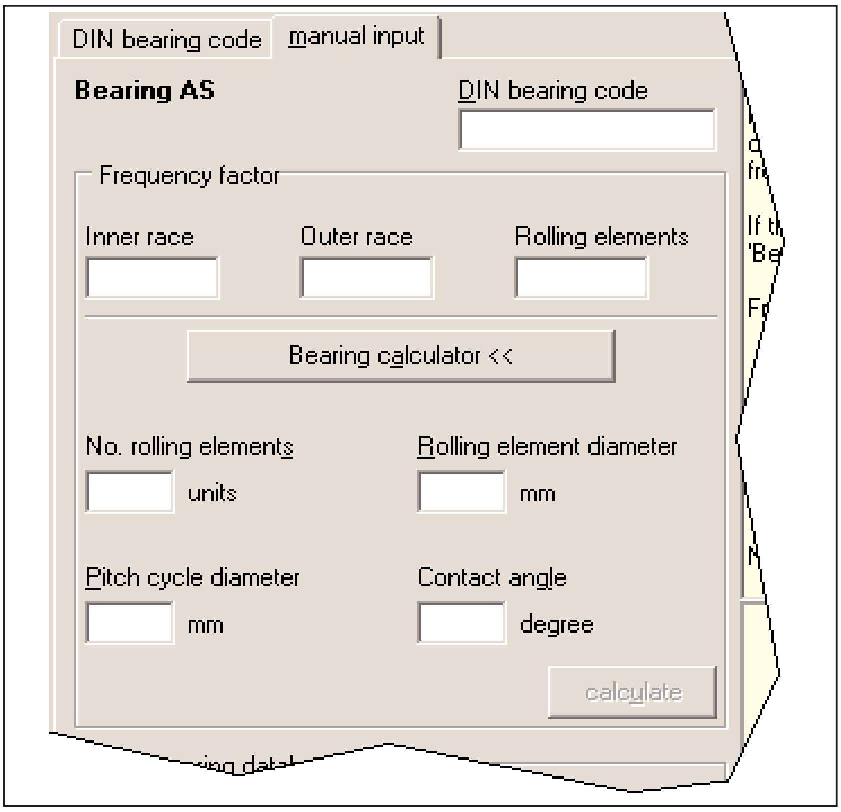
Important:
The data pertaining to the different bearings is a service offered free of charge. We cannot guarantee the correctness of the data. If in doubt or if the required rolling element bearing is not available please contact the bearing manufacturer.

Create user-defined rolling element data

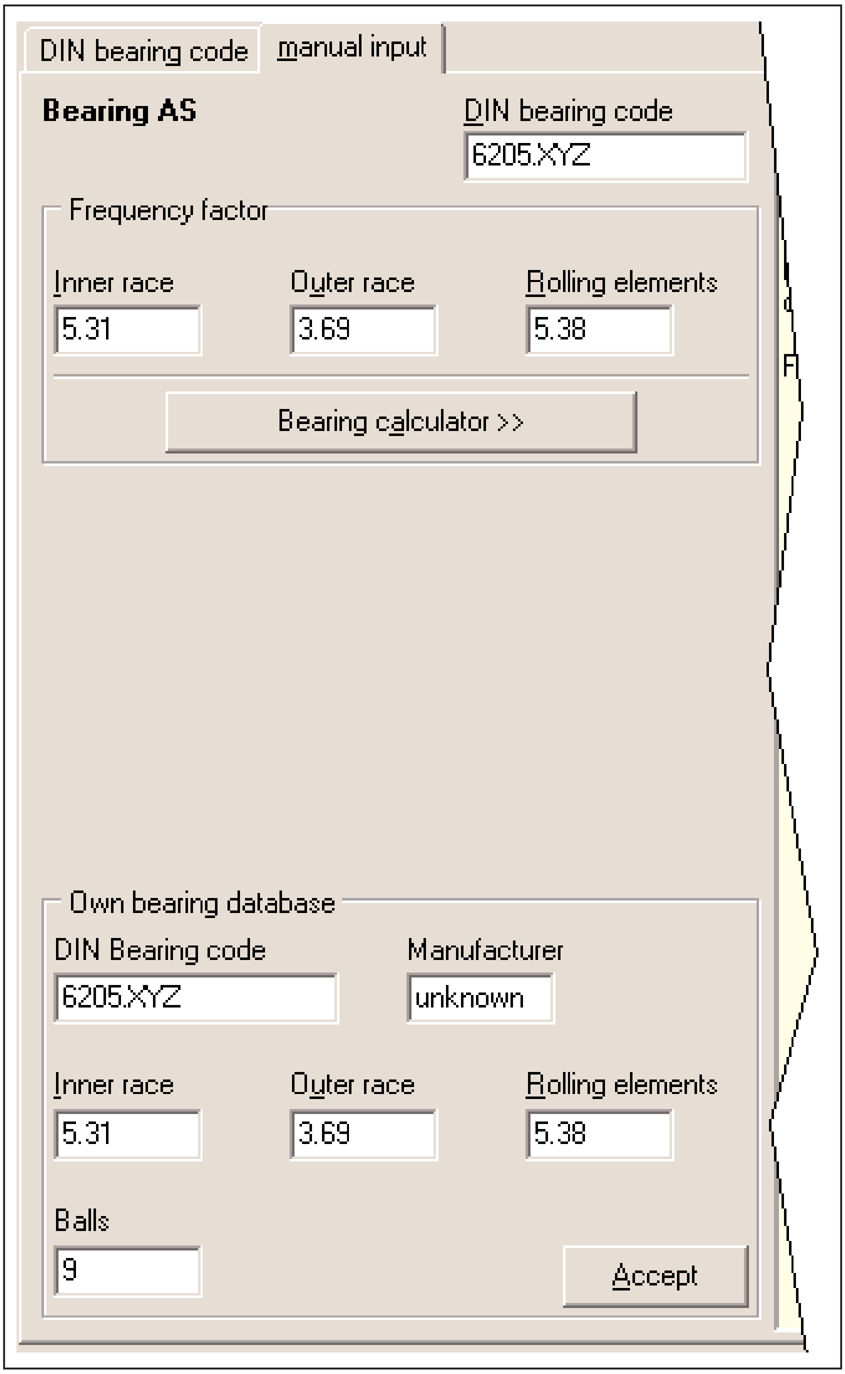
As an alternative to using the rolling element bearing database the ball pass frequencies can be input manually by entering the fundamental frequencies (multiplier with rotational frequency) for the inner race, outer race and rolling elements.



The rolling element bearing calculator can be used to calculate the fundamental frequencies if the bearing geometry is known.



Bearing data can be stored in the user-defined database. This information is included and displayed when using the "rolling element database" (The extension -O is added to the manufacturers' description.



Database settings

In order to optimize the search speed and to avoid double entries in the search results, the search function in the bearing database can be limited to search the database provided on the CD or to search the "own bearing database".

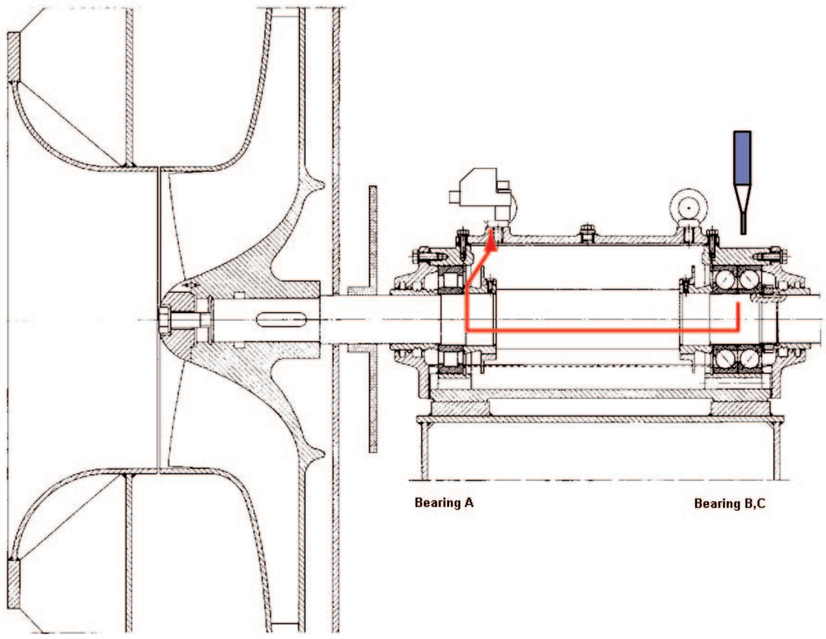
The path for "own bearing database" can be entered again in order reintegrate previously stored bearing databases or to include bearing databases from colleagues.

Impulse test

The impulse test measures the signal transmission from the object to be measured to the mounting location of the sensor. The suitability of the mounting location can thereby be determined (signal path / mounting test) and also if the limit value parameters can be set automatically (signal path/diagnosis object).

The impulse test is initiated using the Start button. Prior to emitting a pulse the background noise (baseline) of the machine is measured.
Subsequently the structure is excited on the relevant bearing seat using the pulse generator (article no. E 30082) and each of the three pulse responses are measured at the designated mounting location.
The results of the impulse test are only valid if the distance between the baseline measurement and the test results are sufficient and the measuring values deviations do not exceed 40%.
If the baseline measurement is too strong we recommend repeating the measurements when the machine is not in operation.

A minimum result of 5 mg /N is required to reliably monitor rolling element bearings.



Teach-value

The Teach-value of the diagnosis object is generally set using the sensor "Teach-In".
Teach values, which have been calculated or which are available from identical reference equipment, can be transferred to the parameter set and /or written on to the sensor.
If "0" is entered the sensor retains its Teach values.

Monitoring

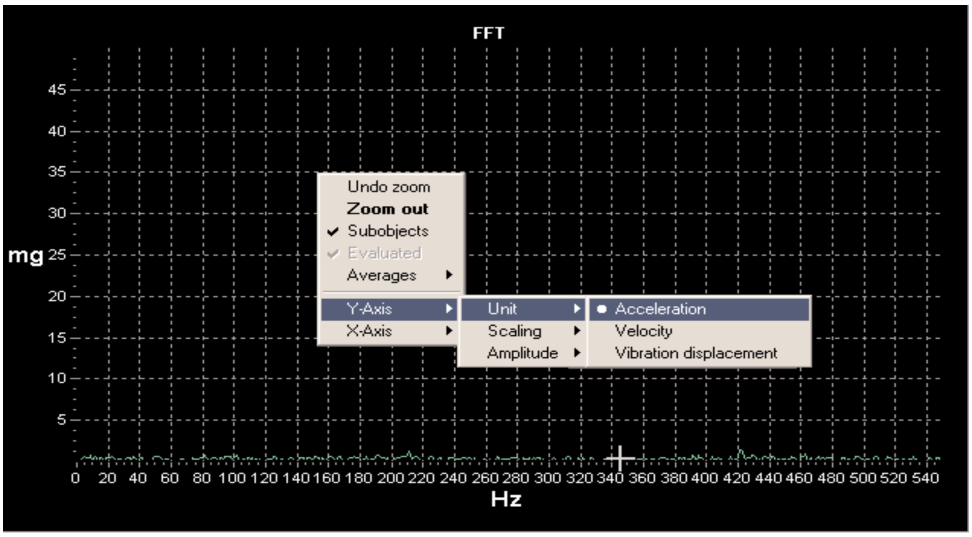
Spectrum monitoring

Considers the linear spectrum and the raw time signal as well as the envelope modulated time signal. The amplitudes are given in "mg-peak". The total frequency range can be displayed in 7 different areas (VE1103: 1 area). In addition the maximum and minimum acceleration as well as the weighted averge of the acceleration per time interval are displayed. A spectrum is measured at 0.8 s intervals which corresponds to a spectral resolution of 1.25 Hz (VE1002, VE1102 and VE112A: 8 seconds, 0.125 Hz. VE1103: 0.064 seconds, 15.625 Hz). The windowing takes place via a Hanning-window.

Changing the display from FFT to H-FFT. The cursor relates to the set damage frequency in the sensor. If alterations are made to these values then the settings in the sensor have to be changed. Use the function "Program settings" to select display of the frequency range for the corresponding damage frequency.

Using the right mouse button you can select between acceleration (mg) velocity (mm/s) or vibration displacement (µ). The amplitude values can also be indicated as Peak (basic setting, basis for sensor calculator) or as RMS. The frequency unit of the X-axis can be changed from Hz to CPM (counts per minute). To zoom into the diagram draw a rectangle by keeping the left mouse button pressed and moving the mouse from top left to bottom. To zoom out use the context menu (right mouse button).

The averages (1, 2, 4, 8, 16, 32) can also be simulated using context menu.



Maximum and minimum acceleration as well as average sum per time interval are also displayed.

Important: The monitoring of diagnosis objects is deactived in the spectral mode, which means switching outputs cannot be switched. Do not interrupt the cable connection between the sensor and PC in spectral mode, as otherwise the sensor would remain in the spectral mode and monitoring would not be possible.

Subobjects

In the subobject-mode the damage relevant frequency groups with amplitudes and the found frequencies per object are displayed. The spectral evaluation can be made from the raw signal or from the modulated envelope curve time signal. The settings in the sensor are valid. If the analysis method is to be changed then the sensor parameters have to be adjusted accordingly. New values are measured every 0.8 s (VE1002, VE1102 and VE112A: 8 s. VE1103: 0.064 s).
The diagram corresponds to a frequency factor analysis.
The maximum and the minimum acceleration as well as the weighted acceleration average per time interval are displayed.
Using the right mouse button you can select between acceleration (mg) velocity (mm/s) or vibration displacement (µ). It is also possible to include or exclude the signal weighting of the subobjects.

The averages(1, 2, 4, 8, 16, 32) can also be simulated using context menu.

Objects

In the object mode the weighted and the non-weighted characteristic values are shown for each set object. The relevant reference value from the Teach-In are shown additionally as blue bars provided that a Teach-In has already been conducted.
The evaluation can be selected from the raw signal or from the demodulated time signal. The settings in the sensor are valid. If the method of analysis is changed then sensor parameters have to be changed as well. As soon as new values have been calculated (according to the number of set "averages") a new value is then shown. (see "averages")
The object values can be displayed with or without signal weighting. (Select using right mouse button).

Damage level

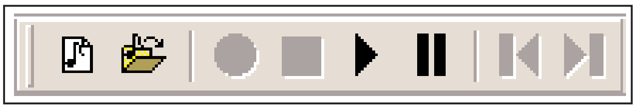
In the condition or damage level mode the weighted and averaged condition characteristic values are displayed per set object. The reference values are the Teach-In values.
The evaluation can be selected as either from the raw signal or from the demodulated time signal. The settings in the sensor are valid. A new value is displayed according to the number of set averages (see averages).

The limit values indicated correspond to the set limit values in the sensor and correlate to the LED display on the sensor.

If the g-monitor and the diagnosis objects have different averages, the data from the g-monitor and the diagnosis objects according to the number of averages, which are set for the diagnosis objects are displayed anew. The set parameters are valid for monitoring.

Record data

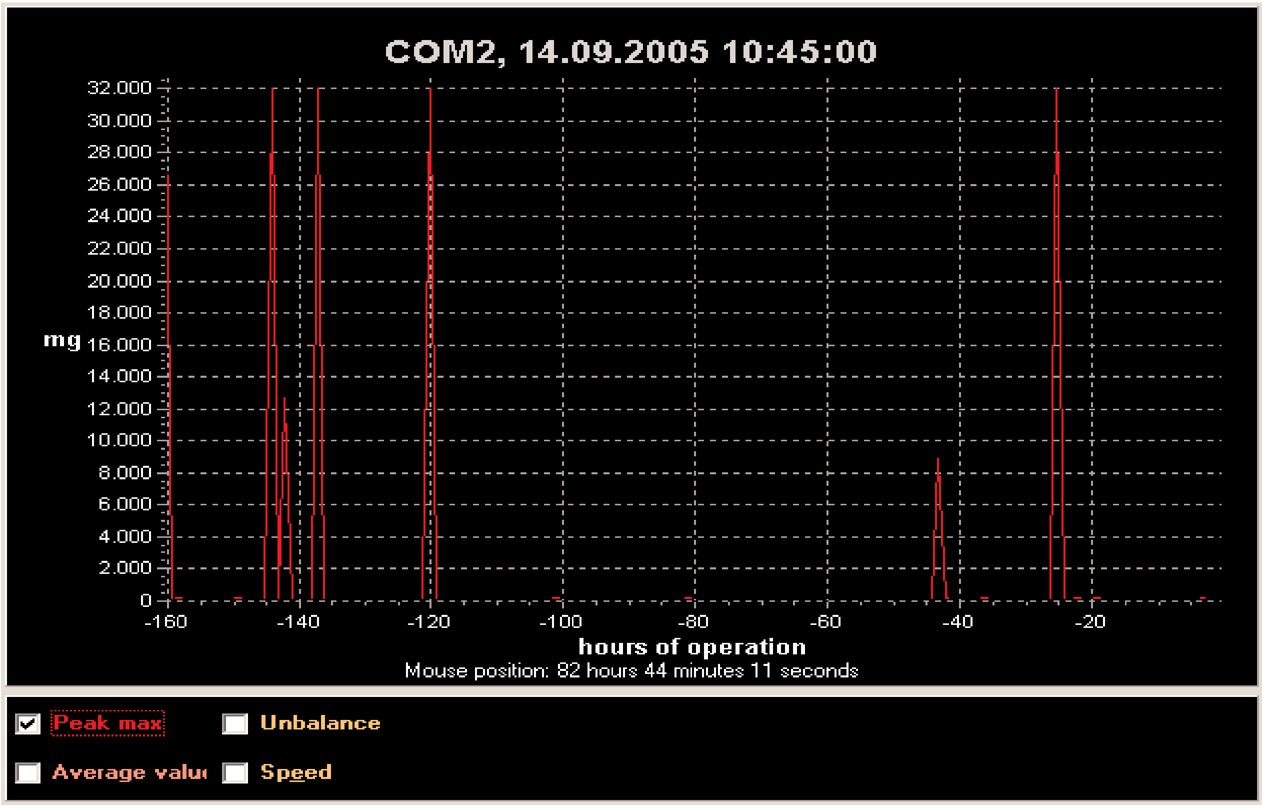
According to the diagnosis depth (linear spectrum-damage frequency-diagnosis object-damage level) the corresponding data displayed can be stored continually (data streaming) and consequently displayed again. efector octavis can thus be used as a measuring instrument.



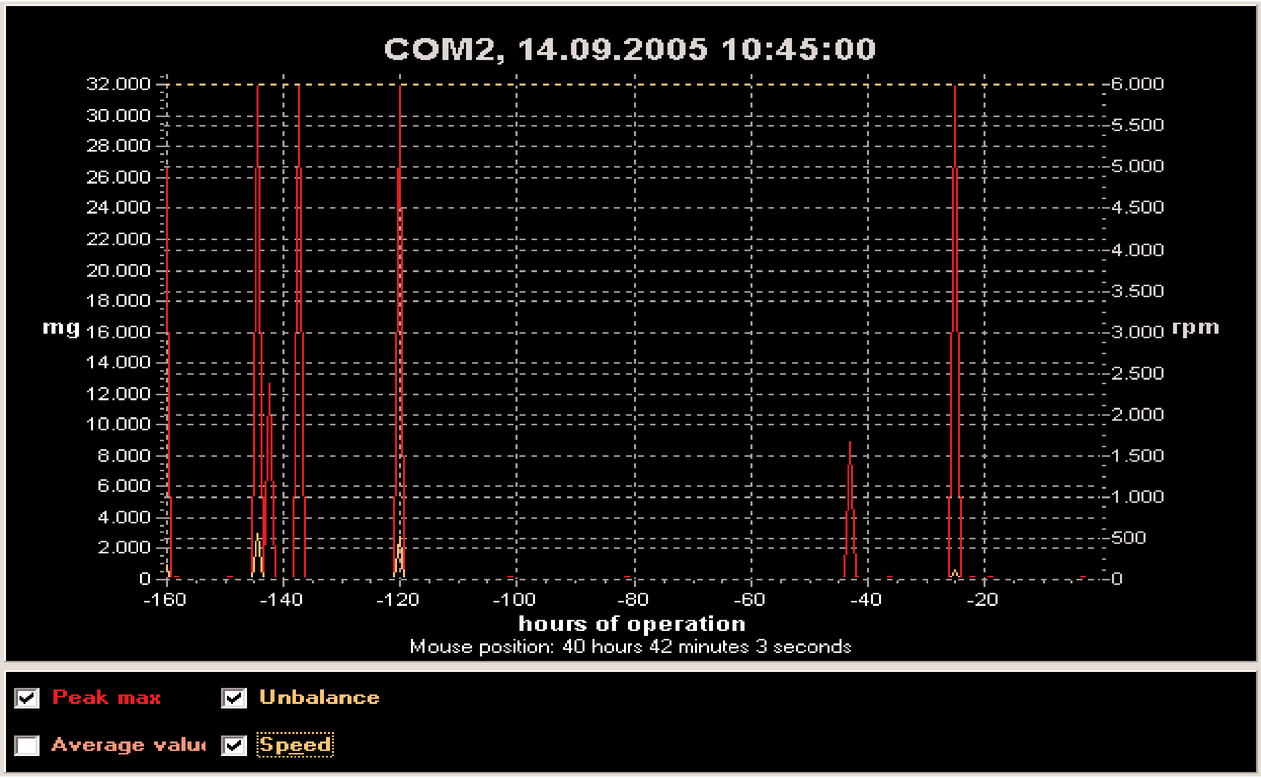
To record or play a measurement the file has to be opened. The file has to be opened prior to recording. The data can be recorded or visualized using the function "data recording" or "play".

History

After the predetermined interval has elapsed the sensor continues to store the highest object values measured per diagnosis object together with the corresponding speed on the internal RAM. The list of data stored as history can be read out of the sensor (function "History"→" Read out from sensor / history or )



The display can be extended to show more values (use tick-box). The corresponding speeds can also be shown (dotted line, scaling-axis right).

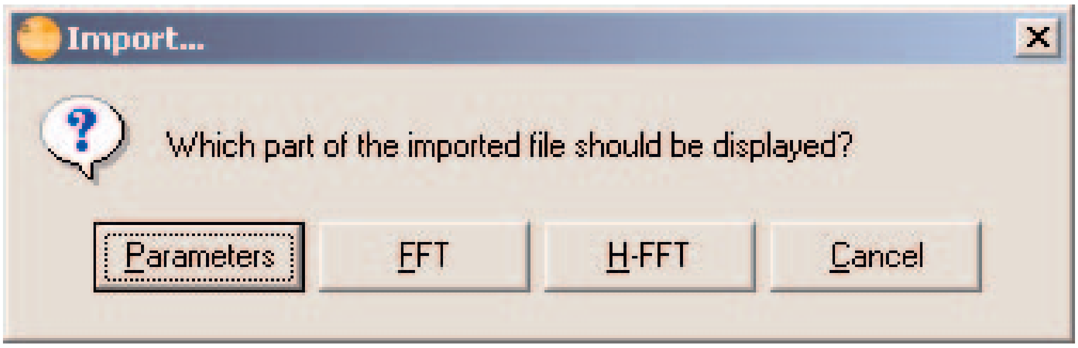


The history data also inlcudes the read-out time and can be stored as "CSV- or "XML" file formats (function "History → store / History or ). The file can be reopened later (function "History" → "open.../ History" or ).

Others

Import reference file

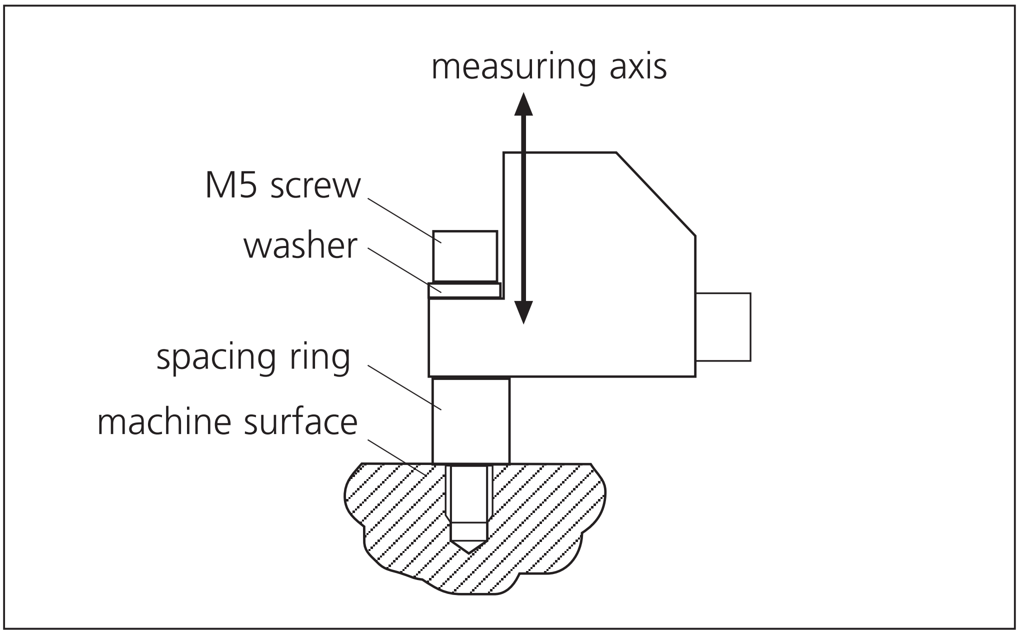
The contents of reference files (*dat) can be shown using the function "File → Import....". Three file contents can be selected.



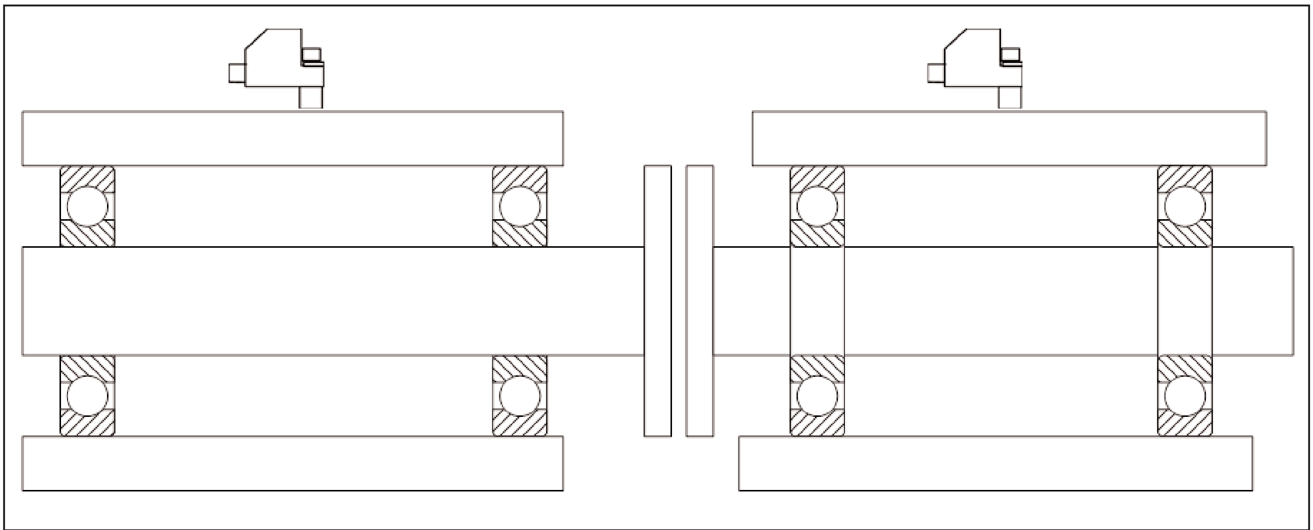
Mounting

efector octavis is mounted using a screw fixture on the machine surface.
Following mounting rules should be adhered to:

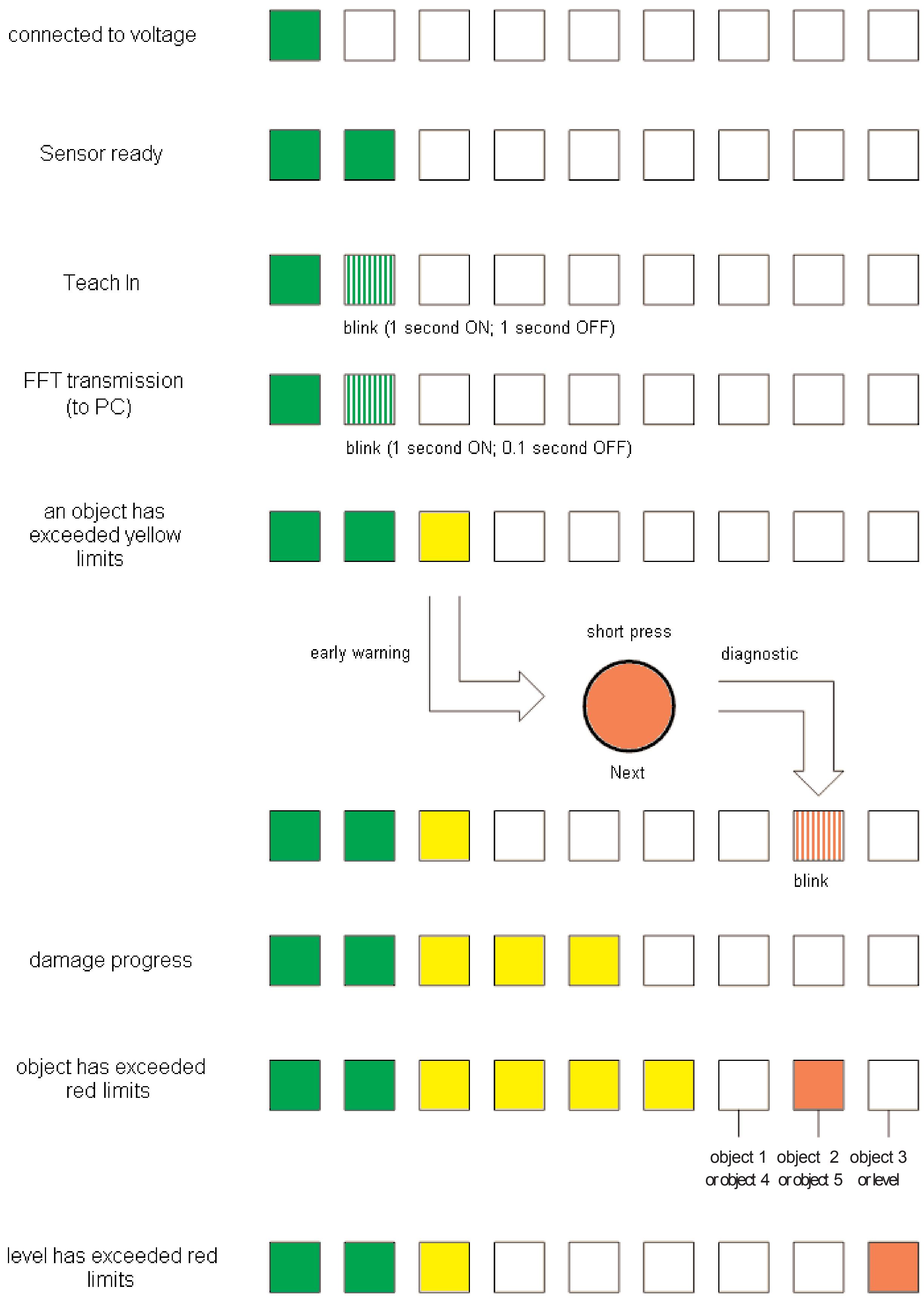
- Mounting only on massive housing
- All set diagnosis objects type "Rolling element bearings" have to have sufficient signal strenth. Transmission constant > 5 mg / N
- For all diagnosis objects set under "Other" please ensure that the damage frequencies are measurable on the location of mounting
- Mounting is radial to the rotation axis and close to the rolling element bearing
- The spacing ring is used for thermal isolation



If the machines are seperated by couplings we strongly recommend using one sensor per machine.



No LEDs on VE1101, VE1102, VE1103, VE111A, VE112A



Lexicon

Spectral lines

The calculated frequency spectrum comprises discrete frequency lines the so-called spectral lines. efector octavis has a standard frequency resolution of 1.25 Hz in the spectrum. The distance between the spectral lines is thus 1.25 Hz. (VE1002, VE1102 and VE112A: 0.125 Hz. VE1103: 15.625 Hz).

Net Mode 1

Parameters of the Com interface: 57600 baud, 8 data bits, 1 start bit, 1 stop bit, no parity.

The data string to be received is limited by a start string and a stop string (StartP and StopPe).

The data string is subdivided into 39 16-bit integer numbers (incl. sign). Every integer number carries a parameter value or measured value. Using the formulas and constants listed below in the data string structure table, the expected values can be determined on the basis of the parameter values and measured values.

Data string structure table:

Position		Variable	To determine
1		Px	Max. peak
2		Pn	Min. peak
3		Mw	Average value
4		EMw	Average value
5		A1	Diagnosis object 1
6		A2	Diagnosis object 2
...	...	...	
9		A5	Diagnosis object 5
10		E1	Diagnosis object 1
11		E2	Diagnosis object 2
...	...	...	
14		E5	Diagnosis object 5
15		M	Averages
16		N	Rotational speed
17		T1	Teach value (Diagnosis object 1)
18		T2	Teach value (Diagnosis object 2)
...	...	...	
21		T5	Teach value (Diagnosis object 5)
22		ET1	Teach value (Diagnosis object 1)
23		ET2	Teach value (Diagnosis object 2)
...	...	...	
26		ET5	Teach value (Diagnosis object 5)
27		K1	Weighting (Diagnosis object 1)
28		K2	Weighting (Diagnosis object 2)
...	...	...	
31		K5	Weighting (Diagnosis object 5)
32		D	Dummy
33		D	Dummy
34		KT1	Weighting (Teach value diagnosis object 1)
35		KT2	Weighting (Teach value diagnosis object 2)
...	...	...	
38		KT5	Weighting (Teach value diagnosis object 5)
39		NT	Speed behaviour

Calculation:

Rotational speed	= N * 1.5 rpm (VE1103: = N * 1,5 * 15,625 rpm)
Peak-Max	= Px * 1,990049751 mg
Peak-Min	= Pn * 1,990049751 mg
Average value (actual)	= ((Mw * (2^{EMw})) / 15500) * 1,406965173957 mg
Average value	= ((Mw * (2^{EMw})) / 15500) * 1,990049751 mg
Number of averages	= M + 1
Speed behaviour	NT = 1 => constant
	NT = 2 => variable (pulse counter)
	NT = 3 => variable (current loop)

	Sum of subobjects (non-weighted)	**weighted**
Diagnosis object 1	(A1 * 2^E1) / (8,625 * (M + 1) mg	Sum of subobjects * (K1 / 65535) mg
Diagnosis object 2	(A2 * 2^E2) / (8,625 * (M + 1) mg	Sum of subobjects * (K2 / 65535) mg
... ...	...	
Diagnosis object 5	(A5 * 2^E5) / (8,625 * (M + 1) mg	Sum of subobjects * (K5 / 65535) mg
	Teach value (non-weighted)	**weighted**
Diagnosis object 1	(T1 * 2^(ET1 - 5)) / 8,625 mg	Teach value * (KT1 / 65535) mg
Diagnosis object 2	(T2 * 2^(ET2 - 5)) / 8,625 mg	Teach value * (KT2 / 65535) mg
... ...	...	
Diagnosis object 5	(T5 * 2^(ET5 - 5)) / 8,625 mg	Teach value * (KT5 / 65535) mg

Important:
Weighted sums (K1 - K5; KT1 - KT5) are interpreted as integer without (arithmetic) signs (0 - 65535). Sensors configured with constant speeds (speed behaviour: NT = 1) are not weighted. In the latter case the non-weighted object sums apply.

Example:
For reasons of clarity the transmitted and received characters are shown as ASCII characters in the following example. Characters which cannot be represented are shown as hexadecimal numbersh in curly brackets.

‚StartP{00h}Zÿ÷wA{00h}{05h}{00h}Q{00h}/…{00h}{00h}{00h}{00h}{00h}{00h}…{00h}{00h}{00h}{00h}{02h}T{00h}{09h}{00h}{09h}…{00h}{00h}{00h}{05h}{00h}{05h}…{00h}{02h}ò¹ÿÿ… {00h}{00h}ÿÿÿÿê{0Dh}ÿÿ…{00h}{01h}{00h}{01h}StopPe'

Data string

16-bit number	Var.	Value	Formula	Result
{00h} Z	Px	90	90 * 1,990049751	**179,10 mg**
ÿ ÷	Pn	-9	-9 * 1,990049751	**-17,91 mg**
w A	Mw	30529		
{00h} {05h}	EMw	5	$((30529 * (2^{5})) / 15500) * 1,406965173957$	**88,68 mg**
{00h} Q	A1	81		
{00h} /	A2	47		
… …	…			
{00h} {00h}	A5	0		
{00h} {00h}	E1	0	$(81 * 2^{0}) / (8,625 * 1)$	**9,39 mg**
{00h} {00h}	E2	0	$(47 * 2^{0}) / (8,625 * 1)$	**5,45 mg**
… …	…		…	
{00h} {00h}	E5	0	$(0 * 2^{0}) / (8,625 * 1)$	**0 mg**
{00h} {00h}	M	0	0 + 1	**1**
{02h} T	N	596	596 * 1,5	**894 rpm**
{00h} {09h}	T1	9		
{00h} {09h}	T2	9		
…	…	…	…	…
{00h} {00h}	T5	0		
{00h} {05h}	ET1	5	$(9 * 2^{(5 - 5)}) / 8,625$	**1,04 mg**
{00h} {05h}	ET2	5	$(9 * 2^{(5 - 5)}) / 8,625$	**1,04 mg**
…	…	…	…	…
{00h} {02h}	ET5	2	$(9 * 2^{(2 - 5)}) / 8,625$	**0,13 mg**
ò ¹	K1	62137	$(81 * 2^{0}) / 8,625 * (62137 / 65535)$	**8,90 mg**
ÿ ÿ	K2	65535	$(47 * 2^{0}) / 8,625 * (65535 / 65535)$	**5,45 mg**
…	…	…	…	…
{00h} {00h}	K5	0	$(0 * 2^{0}) / 8,625 * (0 / 65535)$	**0 mg**
ÿ ÿ	D	65535		
ÿ ÿ	D	65535		
ê {0Dh}	KT1	59917	$(9 * 2^{(5 - 5)}) / 8,625 * (59917 / 65535)$	**0,95 mg**
ÿ ÿ	KT2	65535	$(9 * 2^{(5 - 5)}) / 8,625 * (65535 / 65535)$	**8,90 mg**
… …	…	…	…	
{00h} {01h}	KT5	1	$(9 * 2^{(2 - 5)}) / 8,625 * (1 / 65535)$	**0 mg**
{00h} {01h}	NT	1		**constant**

Reference file

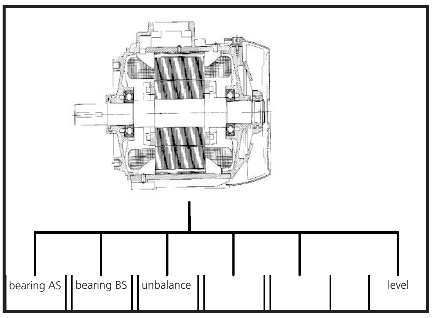
Reference files consist of two parts:

1. Parameter set
2. Spectral-recordings:
   - a) FFT
     - 0...550 Hz (or 0...55 Hz),
     - 500...1550 Hz (or 50...155 Hz),
     - ...
     - 5500...6550 Hz (or 550...655 Hz)
   - b) H-FFT
     - 5500...6550 Hz (or 550...655 Hz),
     - 4500...5550 Hz (or 450...555 Hz),
     - ...
   - 0...550 Hz (or 0...55 Hz).

Important: The complete spectrum can only be collected using staggered recordings. It is therefore of an advantage to keep the speed as constant as possible when recording the reference data.

Start set-up

Please note

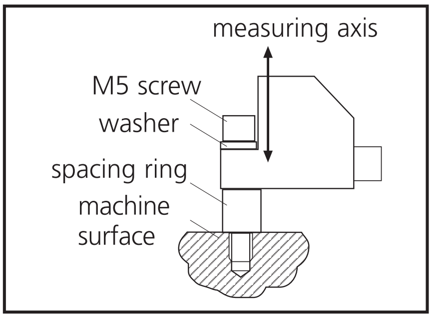


1 Define application
What is to be monitored?
FDefine fault tree starting from the machine structure

Operational speed constant or variable?
If variable, how can information about rotational speed be provided?
• Pulse detection
• 0...20mA current loop

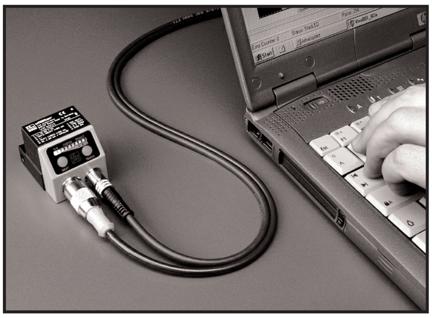
Rolling element bearings can only be differentiated with different damage frequencies, otherwise they can be combined in one diagnosis object.

In case of fluctuations of the operating speed > 5% due to the load it is recommendable to detect the speed at the shaft.



2 Select mounting place
• Mounting only in massive housing
• Mounting vertical to the machine surface
• Check signal path with impulse test
Take into account measuring axis
• Ensure no coupling between sensor and object

Transmission of mechanical vibrations has to be guaranteed.
The mounting location has to be suitable for screw fixtures.
The result of the impulse test must be > 5mg/N.

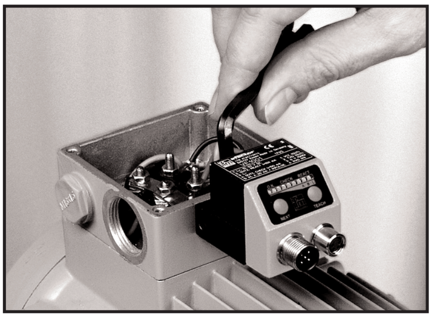


3 Set parameters
Setting of the parameter values in the operating software using the wizard function (parameter → wizard)
The parameter sets can be created online or offline

Ensure correct bearing designation (or manufacturer).
Ensure the correct nominal speed (observe number of pole pairs in case of multipole motors).

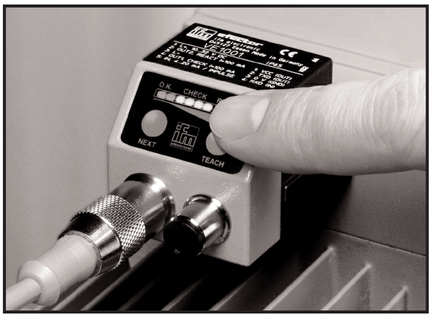
4 Transfer parameters to the sensor
The completed parameters are transferred to the sensor via the RS232 interface. When using VE1101, VE1102, VE111A or VE112A this is done via an RS485 interface or using the USB/RS485 converter E30098.

Only completed parameter sets can be transferred to the sensor.



5 Mounting the sensor
The efector octavis is fixed to the machine surface by means of a screw. It has to be connected electrically via the M12 connector

Screw fixture with a tightening torque of 7 Nm. The electrical connection may only be made by a specialist.
When determining the speed details check the current loop.



6 Teach-In
The Teach-In finishes the parameter setting. By pressing a button the reference condition of the rolling element bearing vibrations are measured (when using VE1101, VE1102, VE111A or VE112A this is only possible via the software). The subsequent diagnosis relates to these data

Prerequisites for the reference run:
• Machine not pre-damaged
• Nominal performance at nominal speed (with variable operation take into account the set Teach-In speed).

If the Teach-In values are known, they can also be entered manually.

7 Record reference run

For the documentation of a later damage it is helpful to record a reference run.

Set-up finished