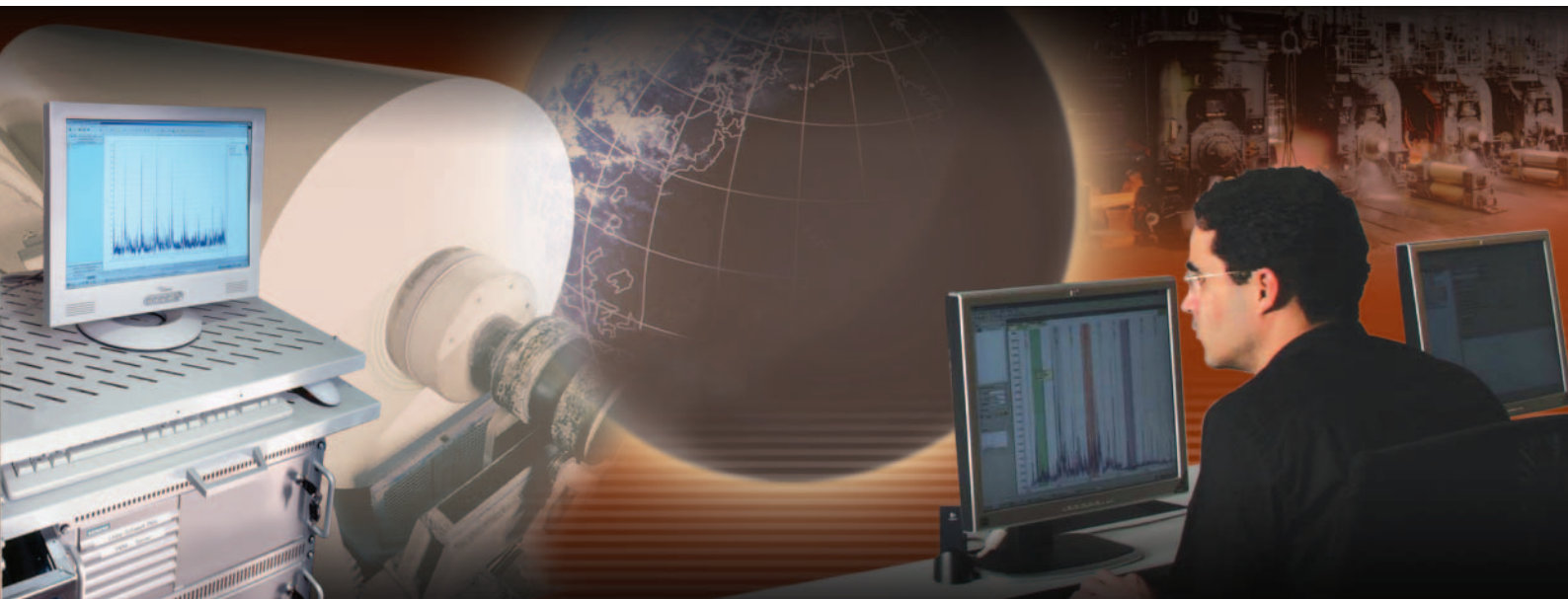


FAG



FAG VibroCheck Online monitoring system for heavy industry

Technical Product Information

SCHAEFFLER GROUP
INDUSTRIAL

Condition-based monitoring · Advantages · Area of application

Condition-based monitoring by means of vibration analysis

Until a few decades ago, the condition of most machinery was assessed in accordance with the operator's instincts. As machines have increased in complexity, this type of defect diagnosis is no longer an adequate means of assessing the condition of individual components.

For this reason, methods of measurement and evaluation were developed that allow precise assessment of the machine's condition.

Beside to process values and machine parameters such as temperature, pressure and torque, increasing use has been made of vibration analysis for machine diagnosis.

In this method, machine noise is detected using a sensor. The signals are processed and subsequently evaluated. Defects or damage affecting machine parts generally lead to additional vibrations.

Conventional vibration monitors normally give a total level of these vibrations that is compared with a specified limit value. Practical experience with monitoring systems has shown, however, that this method of describing the machine condition based solely on physical parameters such as peak, RMS or mean is not suitable for early detection of damage. Since each parameter comprises the total of a large number of vibrations, the damage signals must first achieve a high amplitude before they can induce a detectable change.

Furthermore, the method is not effective in the case of varying speeds.

For this reason, VibroCheck uses selective frequency monitoring. This allows detection of even minor damage or defects at an early stage since these cause an increase in the amplitude of the characteristic frequencies.

In addition, VibroCheck also uses demodulated signal analysis since this is particularly suitable for detection of shock pulses.

Advantages of VibroCheck

- VibroCheck minimises the risk of unforeseen failure of a machine element and assists in quickly rectifying the damage.
- Since the alarm is raised immediately via e-mail or SMS, this ensures very short reaction times.
- Vibration experts must no longer be present on site. By means of remote access, the data can be analysed by external service providers or by CM experts at other locations.
- Permanent availability of monitoring data ensures complete data history.
- VibroCheck automatically detects imbalance and misalignment as well as bearing and gearbox damage. At a glance, the employee can determine the location and extent of any damage in plain text and visually on the machine display system.

- Process visualisation helps the machine operators to assign alarm warnings immediately to their origins.

- Optional Web-based integration in the machine control system minimises the deluge of information sources in the machinery control room.

Area of application

The online monitoring system VibroCheck is used for continuous monitoring of functionally vital machine parts such as rolling bearings and gearboxes.

Through the high predictive accuracy and early identification of impending damage, optimum use can be made of planned stoppages, allowing a drastic reduction in downtime due to failure. Furthermore, costly secondary damage can be prevented. Through linkage to a CMMS system, it is also possible to further automate and reduce replacement part stockholding and maintenance work requirements.

VibroCheck is ideally used wherever a large number of measurement points must be monitored, such as in rolling mills, paper factories or power stations.

Design and function

Design and function

Since the complexity of machinery and plant in which VibroCheck can be used will vary considerably, it must be possible to tailor the measurement, transmission and system hardware to the individual conditions. Even the base version can monitor up to 128 sensors. This can be expanded as required up to the most complex version with 2048 sensors. This expanded version uses all the available connections in the system. Each individual application has essentially the same structure, see Figure 1. The vibration signals are detected by means of acceleration sensors that are mounted on the machine to be monitored. The signal is transmitted to the terminal boxes by means of a shielded cable. The

sensor housing is made from stainless steel and gives reliable operation even in aggressive environments up to +121 °C. Intermediate terminal boxes act as collector points for the individual sensor cables. The terminal boxes are made from stainless steel or aluminium. In each box, the signal connections for a maximum of eight sensors are combined. From this point, the signals are transmitted via a standard data cable. This minimises the cabling work and thus considerably reduces the cost. From the intermediate terminal boxes, the signals are fed to the multiplexers that can each accommodate 16 channels. Up to 8 multiplexers can be connected in series. Ideally, 2 multiplexers are always accommodated in one enclosure. The multiplexer take

measurements from the individual measurement channels on a cyclic pattern. The VibroCheck base unit is located at the beginning of the multiplexer chain. While the intermediate terminal boxes and multiplexers are located in the field, the base station is normally located in the control room. The base station comprises the two main elements, the filter assembly (VC-FILT) and the computer unit. Both units are designed as a 19" assembly and are mounted in their own enclosure. Two threads each with eight multiplexers can be connected to each base station. Each thread can accommodate 128 sensors and a station can accommodate 256. The incoming sensor signals pass through the filter assembly. At this point, the measurement signals are

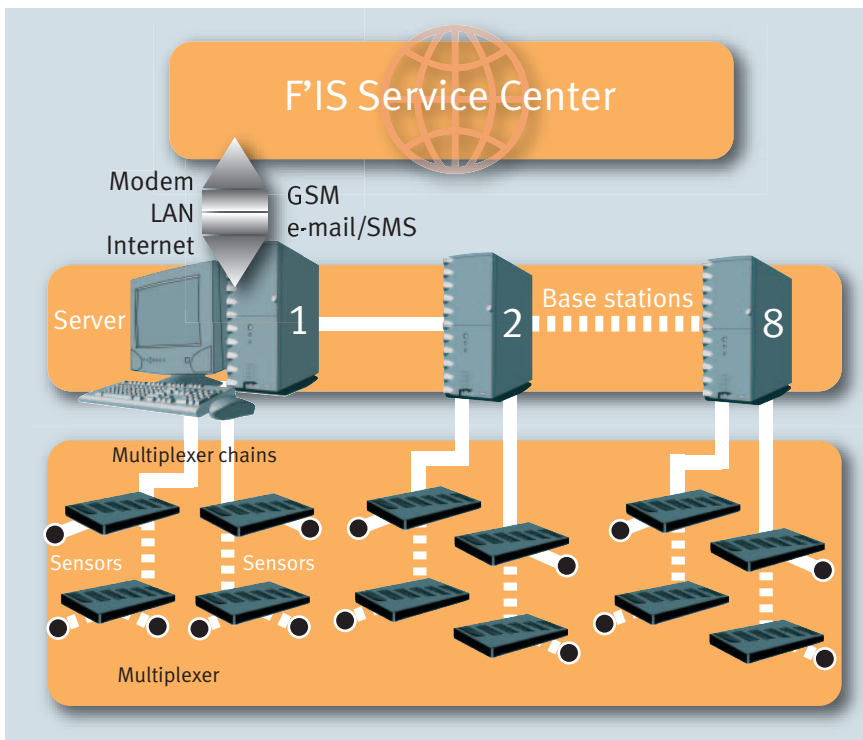


Figure 1: Structure

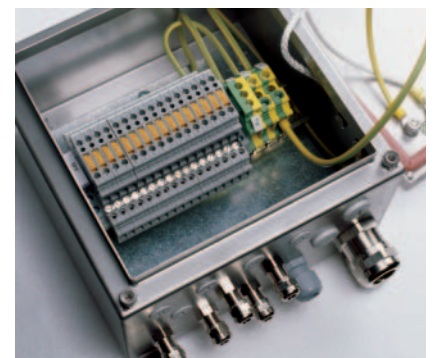


Figure 2: Intermediate terminal box

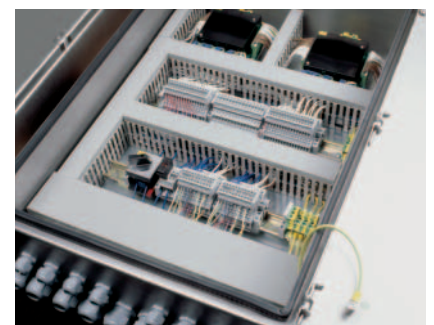


Figure 3: Multiplexer

Design and function · Filtering



Figure 4: VC base station

not only filtered but also amplified. The speed signals from the plant are also received here, either as analogue signals from the drive units or OPC from a higher level machine controller. Base stations can be operated as standalone units or in a local area network (LAN). A network drive is only necessary if the system comprises more than one base station. In each case, the first base station acts as a server PC. This is preferably located in the control room. The server provides communication with up to seven workstations that can be added to expand the system. As a result, one VibroCheck can manage up to 2 048 measurement points. Each individual base station in the field collects the data from the connected sensors. It carries out automatic monitoring of the connected sensors. As a result, cable rupture or short circuits can be immediately detected. Furthermore, software plausibility checking is carried out. In addition to the acceleration sensors, other sensors can of course also be used for the monitoring of temperature,

pressure, force, current, power etc. In each base station, the measurement results are held locally for up to 10 days in order to safeguard against data loss in the event of a network failure. The server PC calls off the data from the individual stations. The data are then analysed and stored there.

Filtering

VibroCheck operates with a signal processing system that is unique worldwide: Two cascadable universal filters allow freely definable frequency responses via a filter design program. Frequencies can thus be amplified or suppressed. As a result, known machine resonances can be reduced in advance by reducing their amplitude so that the earliest stages of component damage become more easily visible and can thus be detected earlier.

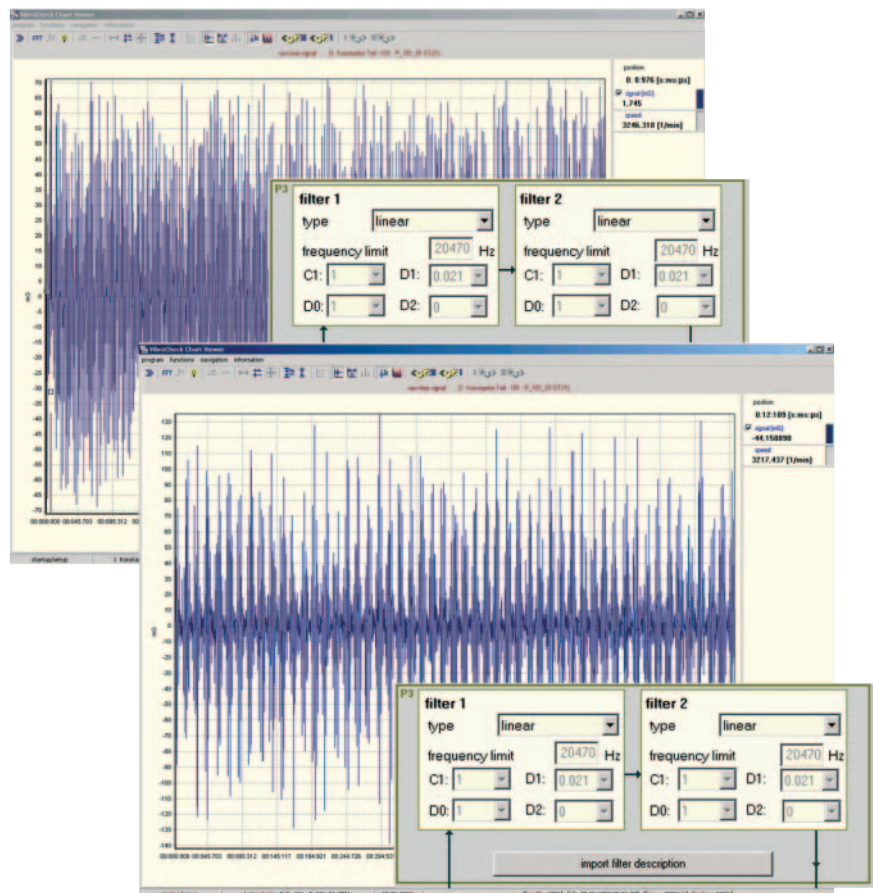


Figure 5: Filter settings

Monitoring strategy · Parameters and expert system

Monitoring strategy

VibroCheck uses three different, independent monitoring methods:

1. Global parameters
2. Spectral parameters
3. Expert system.

VibroCheck thus gives the highest possible predictive accuracy.

In addition, there is continuous self-monitoring of the system including the sensors.

Parameters and expert system

VibroCheck monitors several global parameters:

- Total RMS value of vibration velocity with firmly defined limits 10 Hz to 1 kHz (ISO 10816)
- Total RMS value of demodulated signal of vibration acceleration in freely selectable cut-off frequencies from 5 Hz to 20 kHz
- Total RMS of raw signal of vibration acceleration without filtering and demodulation

For the detection of defects such as imbalance and misalignment, VibroCheck generates spectral parameters that are managed within narrow frequency windows according to speed.

In parallel with general parameter monitoring, the user has available an automatic, rule-based expert system that can monitor up to 20 components per sensor. This allows monitoring of all rolling bearing types and tooth meshes in the vicinity of a sensor in relation to the occurrence of component-specific frequency patterns.

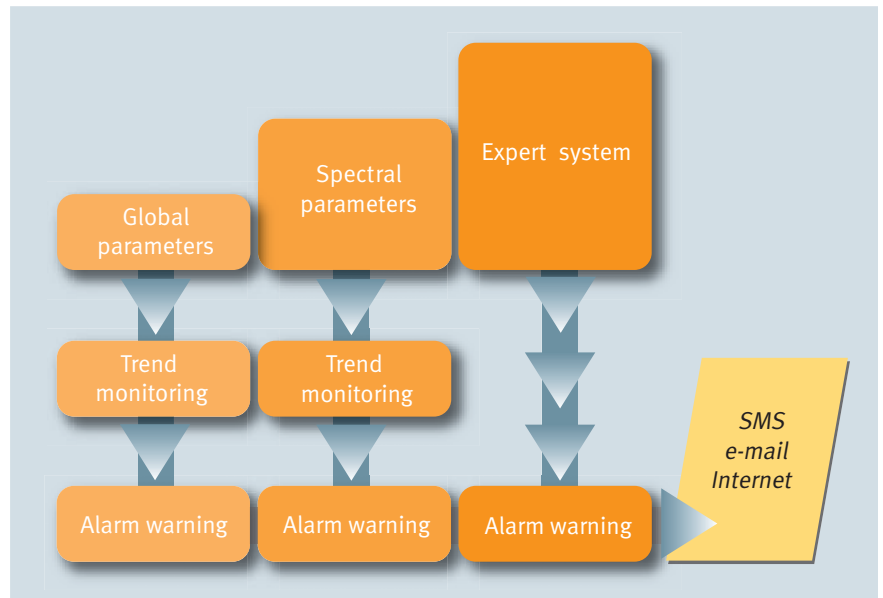


Figure 6: Monitoring strategy

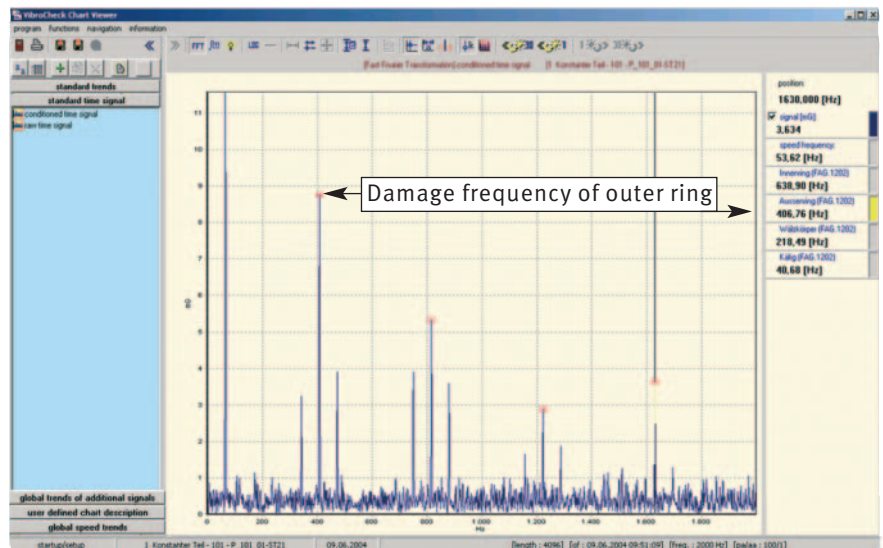


Figure 7: Expert system

Alarm limits • Visualisation

Alarm limits

For validation and adjustment of the alarm limits, process-dependent additional signals (speed, temperature, pressure, torque) are recorded that have a direct influence on the vibration signal. Up to two parameters can be used for characteristic map monitoring.

This gives reliable protection against false alarms.

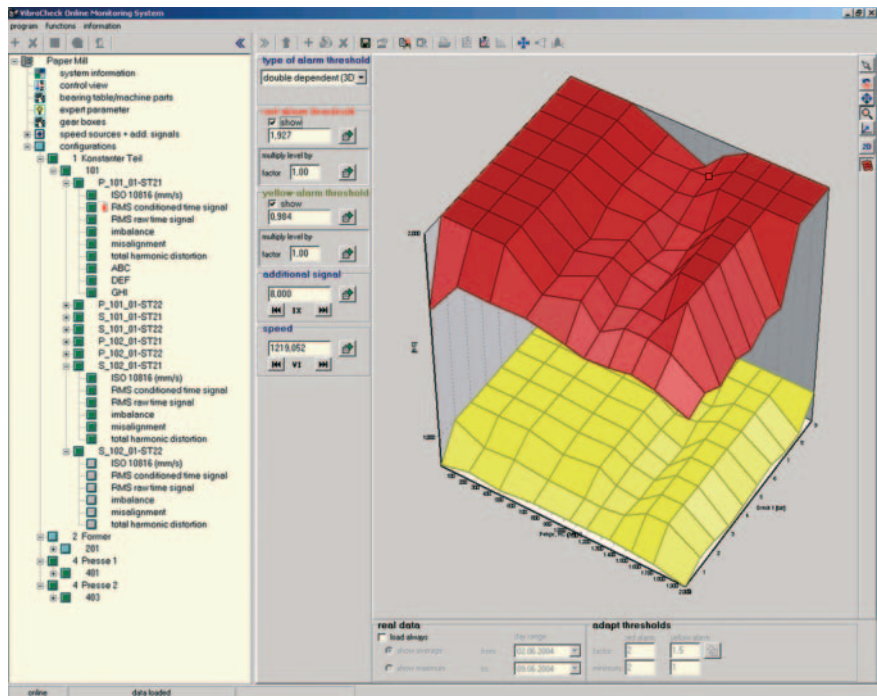


Figure 8: Alarm limit generation

Visualisation

The visualisation for each individual machine, which is specifically tailored to the customer's requirements, gives a user interface that allows rapid overview of the condition of the machine. By means of a plant layout split into several levels, the user can move from a complete overview to each individual measurement point. Attention is drawn to an alarm by means of a colour change on the sensor icon.

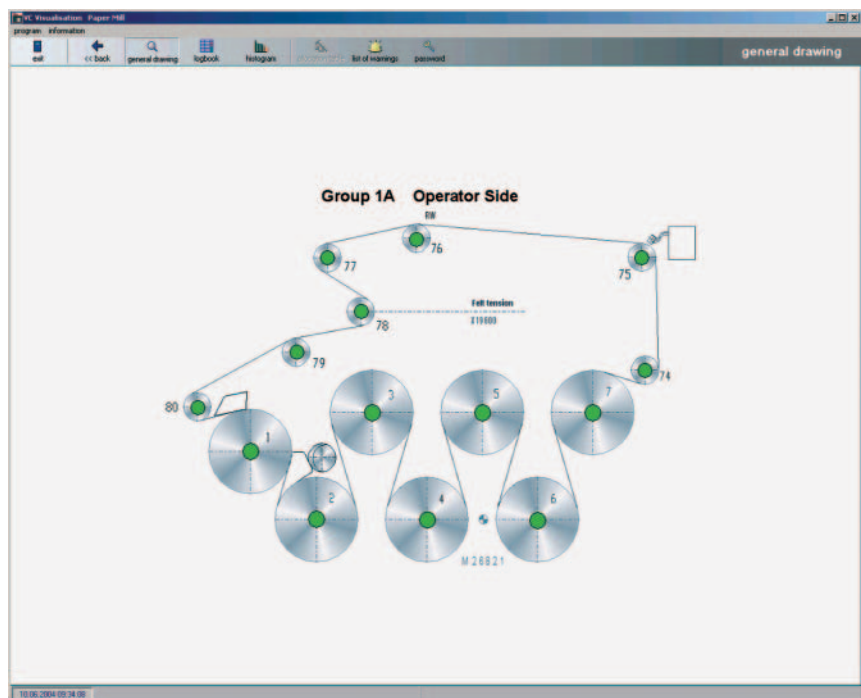


Figure 9: Customer-specific visualisation

History · Histogram · Remote diagnosis · Device variants

History

The history gives the user an overview of all events and data related to the individual measurement point. This provides seamless documentation of the service life, frequencies of failure and any modifications made for each individual component monitored.

Histogram

The histogram display is intended to give the user a rapid, complete overview of the condition of a machine or machine part. The use of the histogram is useful in two respects. It can be used to determine representative alarm limits and, in conjunction with the trend of a parameter, to assess the development in the condition of the component.

Communication and remote diagnosis

Base stations can be operated as standalone units or in a local area network (LAN). A network drive is only necessary if the system comprises more than one base station.

VibroCheck offers tools that allow remote monitoring of plant. Data transfer between plant and the diagnostic computer is established using the TCP/IP protocol. As a result, the system can be remotely managed. In the same way, remote diagnosis is made possible where the situation is unclear.

In addition to alerting the F'IS Diagnosis Center, alarms can be sent via e-mail or SMS directly to the maintenance personnel and/or the operator's own diagnosis facility.

Device variants/modular concept

Where bearing locations that cannot be accessed online are to be monitored temporarily, mobile acceleration sensors with a magnetic foot and extension cable can be connected to the otherwise unused channels of the base station.

Technical data

Description/Function	Data
Operating systems supported for installation	<ul style="list-style-type: none"> • Windows NT 4.0 (from SP4) • Windows 2000 Professional • Windows XP Professional
Operating systems supported for user interface	<ul style="list-style-type: none"> • Windows 95 • Windows 98 • Windows NT 4.0 (from SP4) • Windows 2000 • Windows XP
Maximum number of connectable (physical) acceleration signals	<ul style="list-style-type: none"> • 2 048
of which	
per multiplexer thread	<ul style="list-style-type: none"> • 128
per station (computer unit)	<ul style="list-style-type: none"> • 256
Sample rate	<ul style="list-style-type: none"> • Standard: 51,2 kHz (20 kHz × 2,56) • Higher rates are possible depending on the measurement data acquisition card used
Length of individual time signals	<ul style="list-style-type: none"> • Standard: 8 192 samples • Longer lengths are possible depending on the measurement data acquisition card used
VC-FILT	<ul style="list-style-type: none"> • 2 universal filters; user-defined and predefined filter function: High-pass, low-pass, band-pass, band rejection • CutOff: 5 Hz to 20 kHz in 5 Hz steps
Signal resolution	<ul style="list-style-type: none"> • Depending on measurement data acquisition card, 12 or 16 Bit • Additional 48 amplification steps before A/D conversion
Supported measurement data acquisition cards	<ul style="list-style-type: none"> • ME 2000 • ME 1400 • ME foXX • OPC Client Interface

Technical data

Sensors		Data
Ordering designation for Europe SENSOR-C002-01S0-00MILM8 SENSOR-C002-01S1-5M-OEM8 SENSOR-C002-01S1-7M-OEM8 SENSOR-C002-01S1-12M-OEM8 SENSOR-C002-01S1-20M-OEM8 SENSOR-C002-01S1-30M-OEM8 Other sensors available by agreement	Ordering designation for countries outside Europe FIS.SENSOR:HW.C02.MIL FIS.SENSOR:HW.C02.5M FIS.SENSOR:HW.C02.7M FIS.SENSOR:HW.C02.12M FIS.SENSOR:HW.C02.20M FIS.SENSOR:HW.C02.30M	<ul style="list-style-type: none"> • Acceleration sensor with integrated polyurethane cable • In lengths 5 m, 7 m, 12 m, 20 m, 30 m • Lateral sensor output • 100 mV/g • 0,4 Hz to 11 kHz • -30 °C to +121 °C
Dimensions		W × H × D [mm]
VC-FILT (Filter unit)		19 inch rack, 3 HE
VC computer unit		19 inch rack, 4 HE
Enclosure for VC		600 × 2 000 × 800
Multiplexer enclosure		400 × 400 × 220
Intermediate terminal box		200 × 200 × 80

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