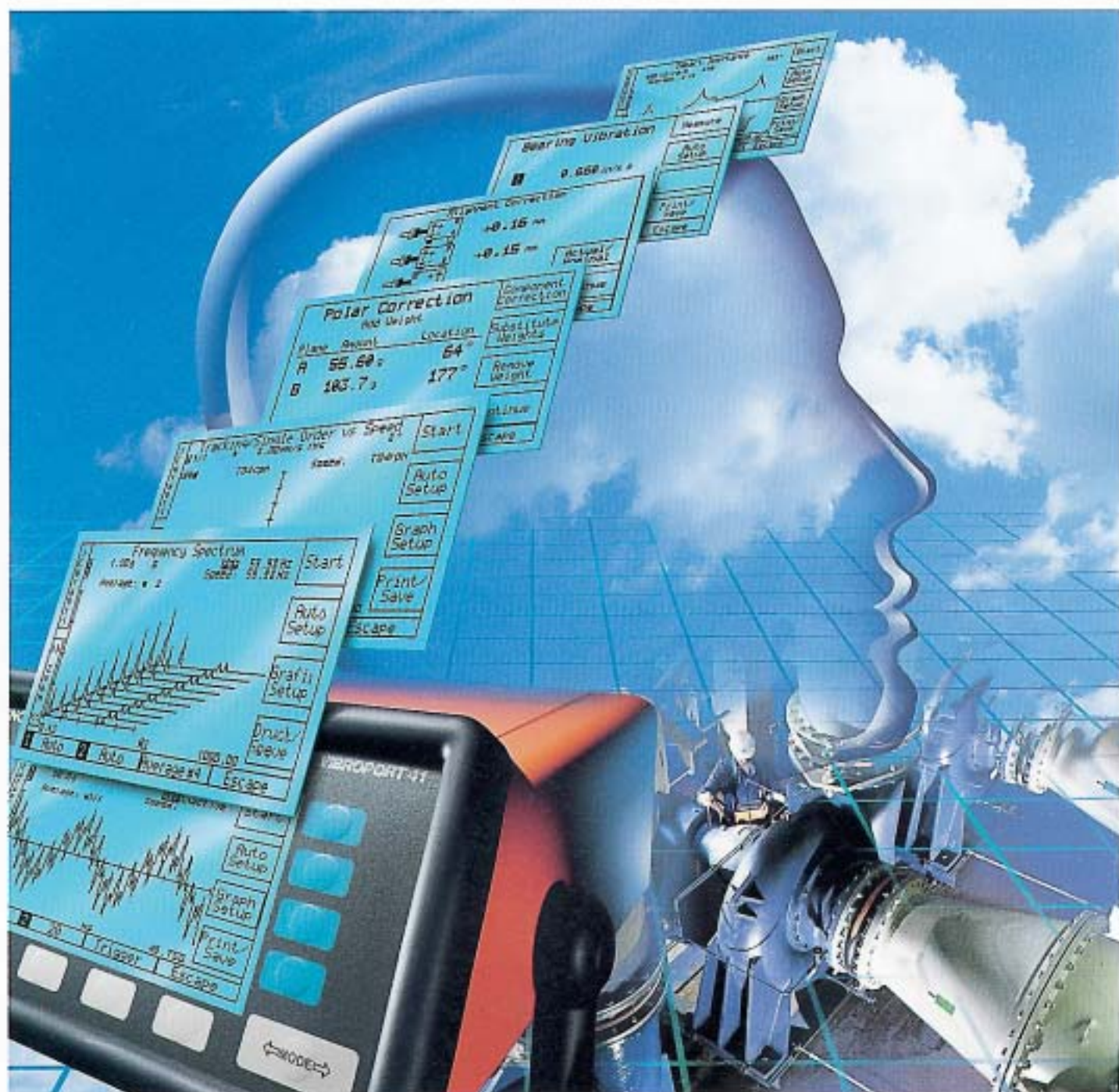




Briuel & Kjaer Vibro



## SERIES 40

Measuring Instruments with Intelligence for  
Machine Diagnosis and Field Balancing

# Economically Securing the Competitive Advantage through Machine Diagnosis and Field Balancing

The international competitiveness of many companies is significantly influenced by three factors - the quality of the products, the productivity and the cost structure.

The machines and plant equipment that are used are therefore constantly subject to higher requirements:

- operating speeds, production rates and quantities increase,
- the networking and automation of plant equipment is increasing,
- highest possible machine availability requires the use of the most modern technologies and efficient maintenance strategies.

To fulfil these requirements in the areas of research and development, manufacturing and quality control, service and machinery maintenance are gaining key rolls.

A common goal of machinery manufacturers and operators is to manufacture modern and efficient machines and to use them at the highest levels of reliability and availability.

Modern methods of machinery diagnoses and predictive machinery maintenance provide the requirements to reach these goals.

Through the consequential use of these processes the quality of the machinery is increased, the repair costs are reduced and the production losses are minimised.

## Machinery diagnoses

Machinery diagnoses enables the entire machine to be evaluated, the symptoms to be recognised through developing damage, and failure sources and damaged components to be identified. This therefore comprises of two tasks,

- the global evaluation of the condition of the machine and
- the correct identification of failures.

## The advantages of modern diagnostic processes

- disassembly of the machine is not required,
- measurements can be taken while the machine is operating,
- planning of repair procedures at an optimum time.

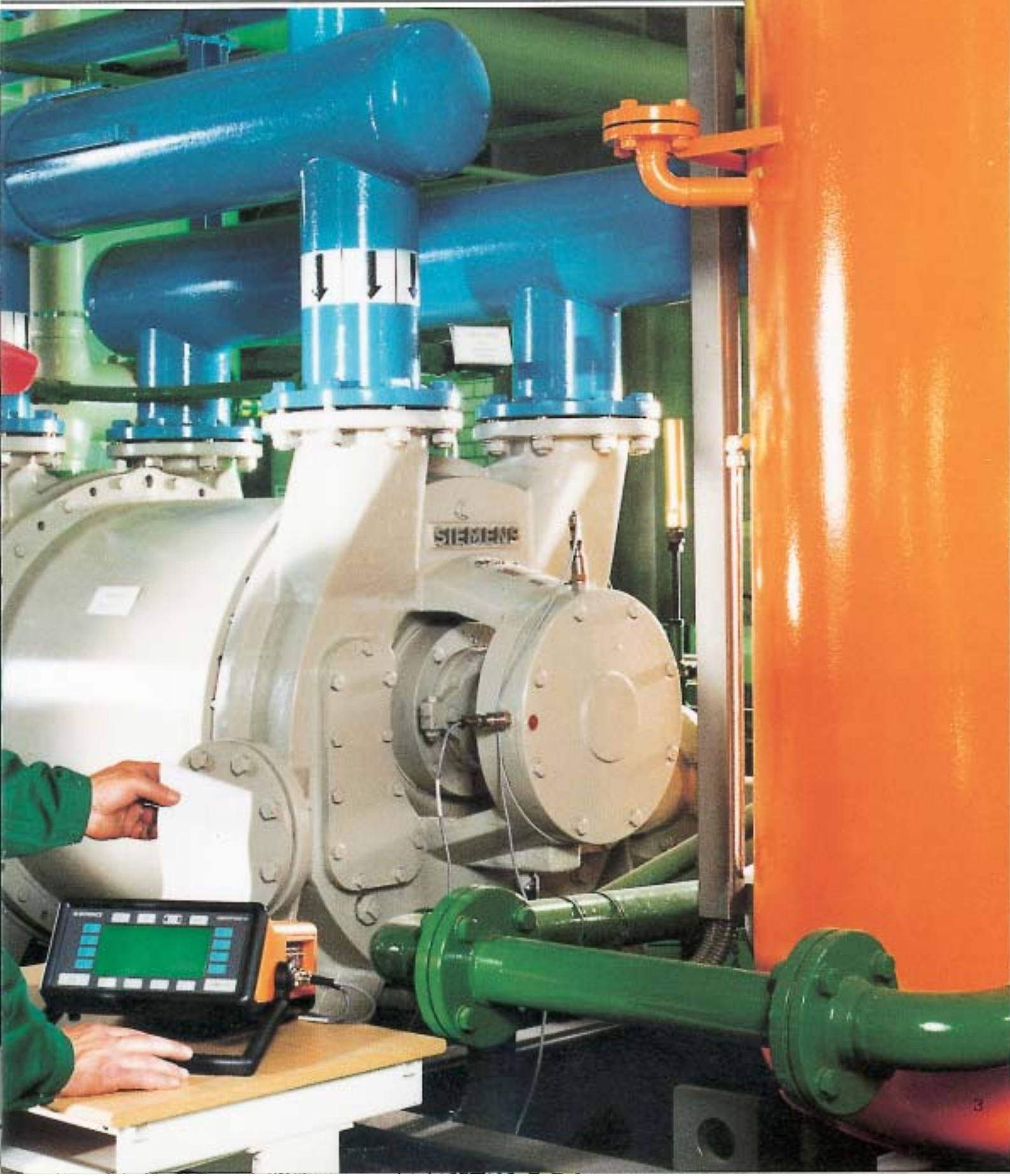
## Field balancing

Unbalance is the most common source of machinery faults. Field balancing is the most economical method to correct unbalance in a completely assembled machine.

## The advantages of field balancing:

- disassembly and transport of rotors is not required,
- mounting and operating requirements of the machine are taken into account,
- field balancing and machine diagnoses can be economically performed with one measuring instrument.





SIEMENS

# The Series 40 Measuring Instruments – Perfect Operator Comfort, Exceptional Functionality

## The concept

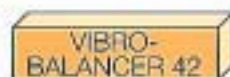
Series 40 comprises of modular, totally compatible portable measuring instruments:

- VIBROBALANCER 41**
- VIBROBALANCER 42**
- VIBROTEST 41**
- VIBROTEST 42**
- VIBROPORT 41**

The respective functionality from the areas of machinery condition evaluation, fault diagnoses and field balancing are tailored to the requirements of application and can, through options, be individually modified.

## Capabilities of the Series 40

Number of channels



### Machine evaluation

Shaft vibration  $s_{max}$

Sound

Process parameters

Temperature

BEARCON as BCU

Shaft vibration X/Y

Broad-band bearing vibration

Speed



### Fault diagnostics

Transfer function

BEARCON signature

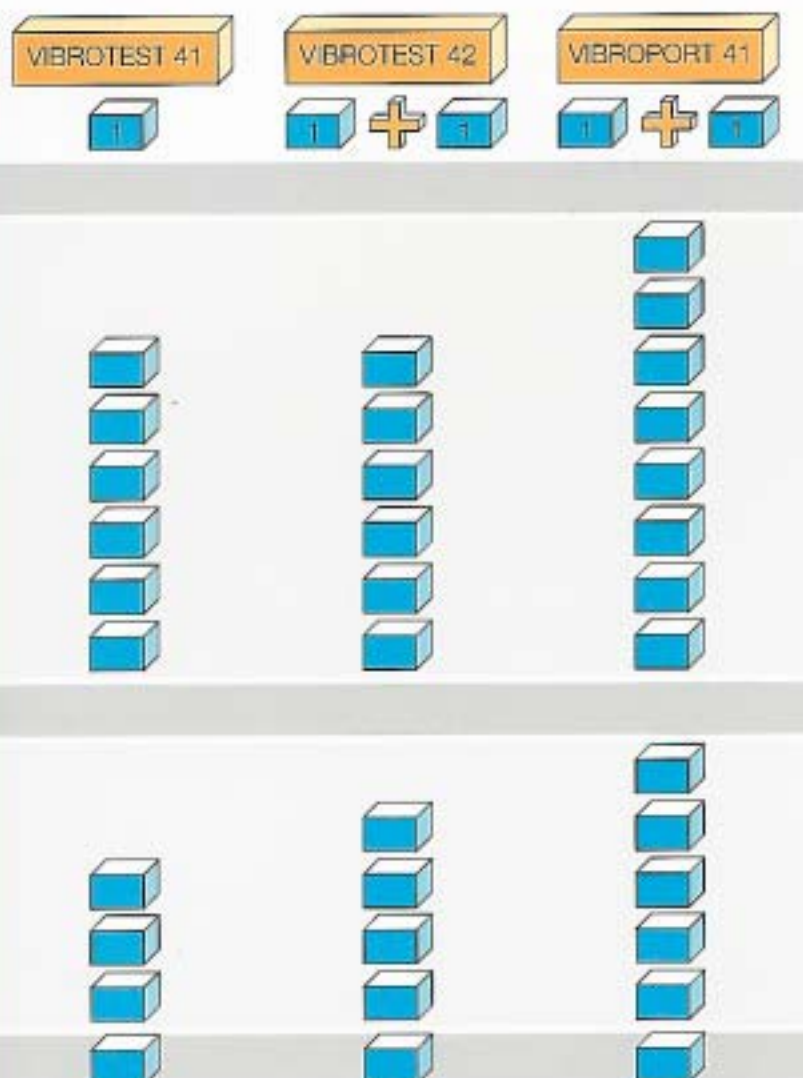
Tracking function

Oscilloscope

FFT spectrum

### Field balancing





## The important advantages at a glance

### Simple operation

- graphical capabilities and accelerated LCD display
- operator dialogues available in 3 selectable languages is standard
- storage of the individual instrument settings for all measuring functions via "Auto set-up"

- measurement data and configurations are stored when the measuring instrument is switched off.

### Extensive documentation of the results through the integrated printer

- quick protocol of the actual display
- output of the measurement values, graphics and reports in large format
- comprehensive protocols through the input of measurement point descriptions and comments via an external keyboard
- additional Centronics interface which can be directly connected to a commercially available printer (EPSON compatible)

### Large measurement data storage capacity

- up to 1.5 MByte storage (battery buffered RAM) to archive measurement data and reports

### Integrated evaluation software

- automatically calculates the balance correction weight and location during field balancing

### Connection to an external PC

- data transfer via an RS-232 interface
- archiving and individual presentation of the measurement results

### Integrated service function

- self calibration of all measurement functions
- self test

Certification in accordance with DIN/ISO 9001



# Comfortable Archiving and Individual Analysis of the Measurement Results

## The memory concept of the Series 40 measuring instruments

All of the Series 40 measuring instruments possess a large integrated memory in which, apart from the measurement values, comments and measurement point descriptions together with the instrument settings for each individual measurement are stored.

Measurement protocols are readily available with the aid of the integrated or an external printer. Of-course, the stored measurement data is also available, for example, to compare with the data of current measurement results.

The stored data, once transferred to an external PC, can also be individually evaluated using the VIBROEXPERT CM-460 software program.

## When is the transfer to a PC advantageous?

- when it is necessary to create professional measurement and service reports,
- when measurement results in line with condition orientated machinery maintenance that are stored on a regular basis are to be evaluated via trend observations,
- when the Series 40 measurement instruments are used by numerous operators or are used for numerous service customers (data security and administration),
- when measurement data is to be exchanged between the operator and various company departments,
- when existing PC measurement data presentation programs are available.

## VIBROEXPERT CM-400 works like this

### 1. Transfer of the measurement results to the PC

With the aid of the communications and database module 41, the reports which have been stored in the measuring instrument can be selected and systematically stored in the PC database. The graphical user operating system "Windows 95/98/NT/2000" supports the particularly well organised data transfer mode. In this way, measurement results for the evaluation of the condition of a machine and for failure diagnosis (refer to pages 4 and 5) can readily be transferred.





The database enables the measurement results to comfortably be stored in a four level hierarchy, namely

- plant
- machine train
- machine
- measurement point

This arrangement eases the administration of the measurement data, in particular, when a large number of measurement results are present or when a long time trend evaluation pursuant to condition orientated machinery maintenance is required.

## 2. Exporting the measurement results in standard data formats

If the presentation, evaluation and manipulation of the measurement results is to be performed using commercially available or already existing PC programs, then the measurement data stored in the databank may be exported in standard data formats such as, for example, ASCII data format.

## 3. Individual presentation and evaluation of the measurement results

The analysis modules 65/66 of the software package VIBROEXPT CM-400 offer the advantage to individually present and evaluate all the measurement results on a PC so as to for example:

- comprehensively evaluate the machine condition and identify the sources of faults
- perform comparative evaluations of numerous machines and measurement points
- enable long time trend observations of the measurement results
- graphically present and evaluate the measurement results so that these can, for example, be directly integrated into maintenance, inspection and service reports

A number of presentation and graphical functions are available for this purpose which include:

- automatic and individual scaling, cursor and zoom functions
- single and multiple presentations of measurement value trends, frequency spectrums, Bode and Nyquist diagrams, polar diagrams
- measurement value lists in accordance with different search criteria

## 4. Creation of measurement, inspection and service reports

If "Windows compatible" text operating programs are available, then the measurement results and the individually measurement value graphics can be directly integrated. Report generation is therefore substantially quicker and the graphical presentation is of a higher quality and can be easily interpreted.

## The advantages of a PC connection at a glance

- large and clearly laid out graphical presentation of the measurement results on a PC using "Windows 95"
- single, multiple and trend presentations
- tailored report presentation
- simplified data transfer between operators
- organised storage of the measurement results in a database hierarchy
- increased data security and unlimited memory
- standardised data formats

## What are the minimum requirements?

- an IBM compatible PC P200 with a 32 MByte working memory, and "Windows 95/98/NT/2000"



# Evaluating the Condition of a Machine – Quickly and Accurately Recording all Relevant Par

## The task

Prerequisite for the evaluation of machinery is the measurement of meaningful parameters to determine the condition of the machine. A qualified evaluation is made possible through comparisons of the measurement results with evaluation guidelines and standards.

From the results of these evaluations, it can be determined whether:

- the machine can remain in service,
- analytic diagnostic procedures need to be performed to determine the source of machine fault,
- maintenance procedures need to be applied (and in such cases when),
- the machine should be immediately taken out of service to avoid machinery breakdown.

## Machine evaluation using Series 40

Series 40 can be used to measure all relevant machine condition characteristic values:

- absolute bearing vibration
- relative shaft vibration
- relative shaft vibration  $S_{max}$
- bearing condition characteristic values
- temperature
- sound
- axial position
- process parameters such as pressure, flow rates etc.

Series 40 provides the measurement results significantly quicker, reliably and accurately through the application of modern micro-processor technologies.

The ability to perform standards compliant measurements in accordance with DIN, ISO, API, BS or AFNOR is particularly noteworthy, as well as the ability to evaluate acoustic measurements in accordance with environmental guidelines.

 SCHENCK

Vibroport 41 98981648

Location: Building 900

Machine: Pump P-24

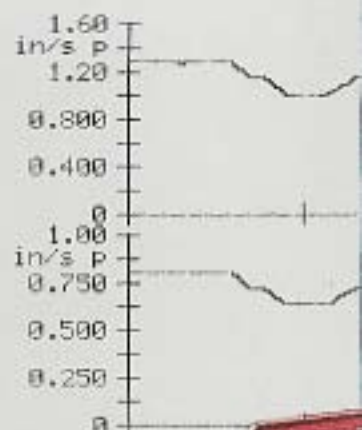
Oper. Cond.: Bearing Vibration (ft)

Notes:

Bearing MS-U

Bearing PS-U

Overall Bearing Vibration





## The features at a glance

- measurement of all machine condition characteristic values guarantees a reliable evaluation.
- measurements in accordance with industrial standards enable objective and comparable conclusions about the condition of a machine to be made.
- large format display of the results of
  - 2 channels, and
  - speed
 present extensive information in one view.
- apart from individual measurements, measurement values may continuously be recorded and presented such as in the case of
  - time functions for observations over an extended period,
  - or
  - as a function of speed during run-up and run-down procedures
- precise speed measurements through the selectable relationship of speed to reference impulses from 1:199 or 99:1 (e.g. in the case of gearing).
- display of the gap voltage used to set the operating distance of non-contacting vibration sensors.

ation vs Time



# Fault Diagnosis through Frequency Analysis – Timely Recognition of Machine Damages

## The task

If the allowable limit values for a particular machine under investigation are exceeded, then procedures to correct faults are required.

Frequency analysis of vibrations provides conclusions to the sources of faults such as the type and the extent of damage of individual machine components.

Typical faults that can readily be identified through frequency analysis include:

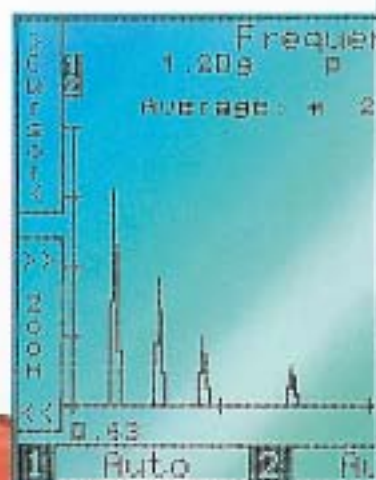
- unbalance
- misalignment and coupling errors
- bearing and gearing errors etc.

## Frequency analysis with Series 40

Frequency analysis with the aid of FFT (Fast Fourier Transformation) was further perfected in the Series 40 instruments.

High resolution, large frequency ranges, zoom functions, high dynamics and the rapid presentation of results are just a few of the significant instrument characteristics. The operator therefore possesses extensive information about the machine being investigated in the shortest time possible.

In the foreground of a detailed frequency analysis is the oscilloscope function which enables observations of the measurement point in the time domain and supports the first conclusions to the sources of faults of the machine to be determined.



## The features at a glance



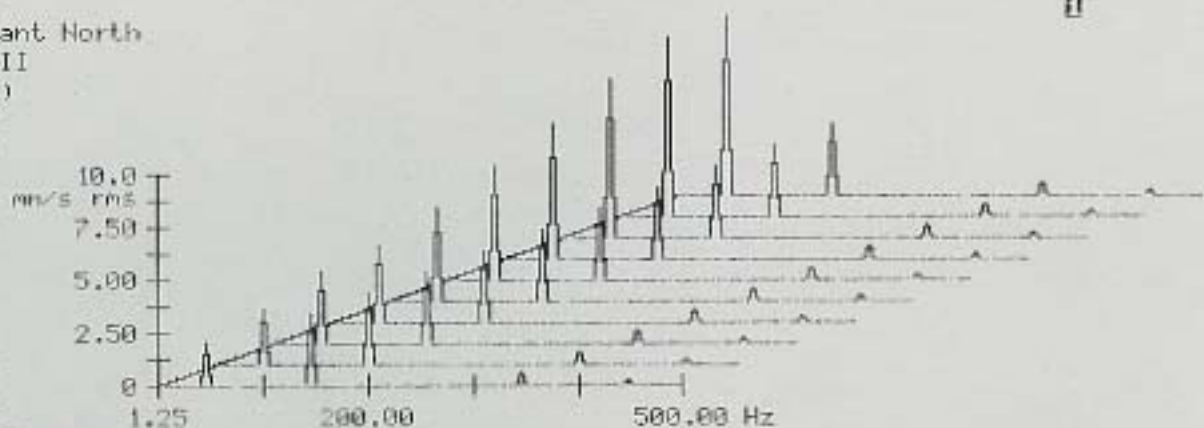
- selectable frequency range from 1Hz to 20kHz
- resolution from 200 to 3,200 lines
- dynamics from 60 dB per measurement range and 180 dB with the auto-range function
- 2 channel spectrum and difference spectrum to compare two measurement points using VIBROPORT 41
- 4 window functions to optimise the analysis procedure to the corresponding requirements
- "Single shot" individual measurements with pre-selectable triggering requirements
- synchronous averaging to subdue noise and stochastic vibration components
- cascade diagrams vers time ("Trend") or speed for the analysis of the machine response to differing operating conditions
- scaling of the frequency axis into order or rotor speed
- 16 times zoom function provides the best method to evaluate closely neighbouring vibration frequencies
- oscilloscope function to enable observations of the time functions of the measurement signal and the kinetic shaft orbit of similarly supported rotors to be evaluated
- Beacon signature (envelope analysis) for the exact analysis of the condition of a bearing

**SCHENCK**

Vibroport 41 g0001648

Location: Power Plant North  
 Machine: Turbine II  
 Meas. Cond.: FFT f(t)

## FFT vs Time



Speed: 58.05 Hz

# Fault Diagnosis through the Analysis of Dynamic Targeted Correction of the Machine Design

## The task

The analysis of the dynamic behaviour supports the diagnostic fundamentals to optimally design and operate machines. The results of the analysis enables conclusions to be made about:

- the useable speed range
- resonance frequencies
- dynamic stiffness of the actual machine and its foundations
- vibration modes

This method enables, for example, design orientated problem areas of machines and their construction to be identified. The analysis of the dynamic behaviour can be viewed as a supplement to frequency analysis. This is particularly useful in the case when problems that occur with machines during variable operating conditions (speed ranges) are to be determined.

A predominant measurement requirement is in the evaluation of the transfer function of individual machine components or the systems machine foundations. The transfer function is defined as the relationship of the system response (vibrations) of the machine to imposed excitation forces.

## Analysis of the dynamic response

The transfer functions can be determined through two methods:

- with the aid of tracking filter analysis after a run-up or run-down of a machine - the unbalance of the rotor provides the excitation force.
- with the aid of a vibration exciter - as the excitation force, whereby in this case either an impulse hammer or a dynamic vibration exciter is used.

## Tracking function

The fundamental vibrations and the harmonics are measured during a run-up or run-down in ratios from 1:99 to 99:1!

An extremely narrow band tracking filter with a band width of 0.25-Hz guarantees a high separation accuracy for the analysis and thereby enables unambiguous identification of the sources of faults in the machine.



# Behaviour –

## Transfer function with VIBROPORT 41

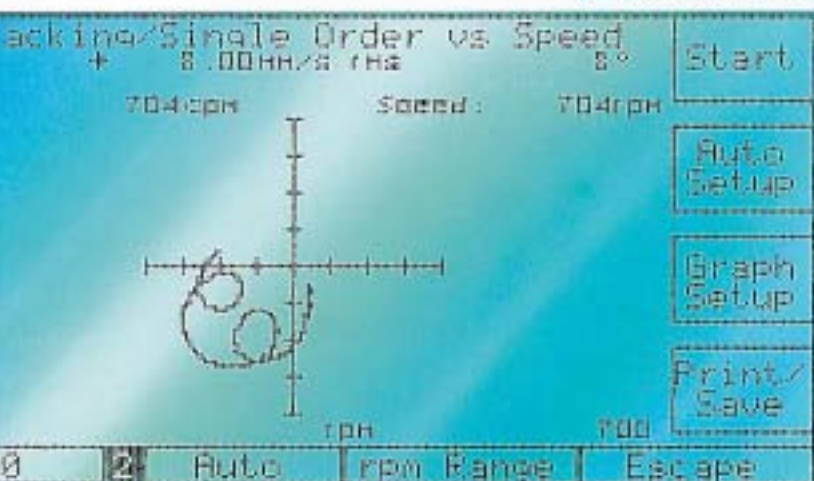
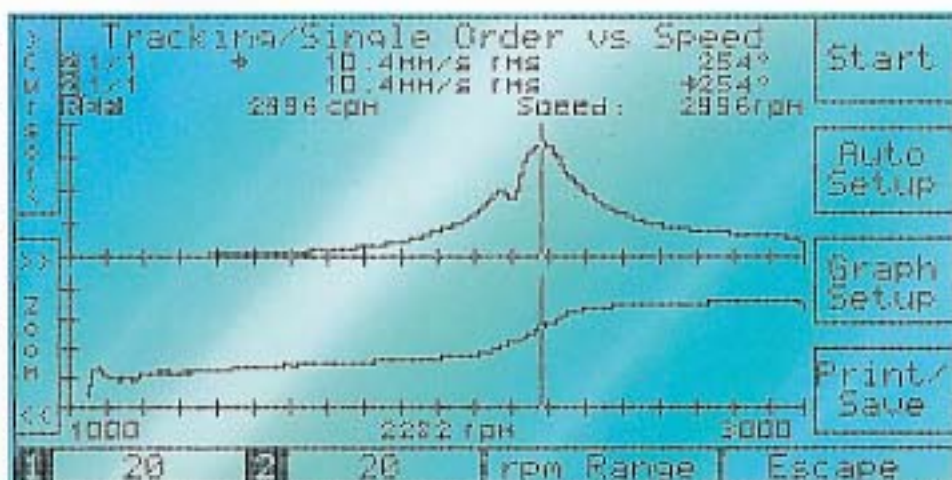
A calibrated 2 channel measurement of the transfer function is required when system characteristic values of the machine under investigation are to be determined from the measurement results. The imposed excitation force is measured by channel 1 of the VIBROPORT 41 and the vibration response of the machine is measured by channel 2. VIBROPORT 41 automatically calculates the transfer function between both channels and displays these in the form of a spectrum plot, Bode diagram or Nyquist diagram.

With the aid of an impulse hammer or an external vibration exciter, the VIBROPORT 41 can be adapted to every measurement task.

Large frequency ranges, high resolution, selectable window functions and short calculation times are further important aspects that make this instrument unsurpassable in the areas of maintenance, research and development and service.

## The features at a glance

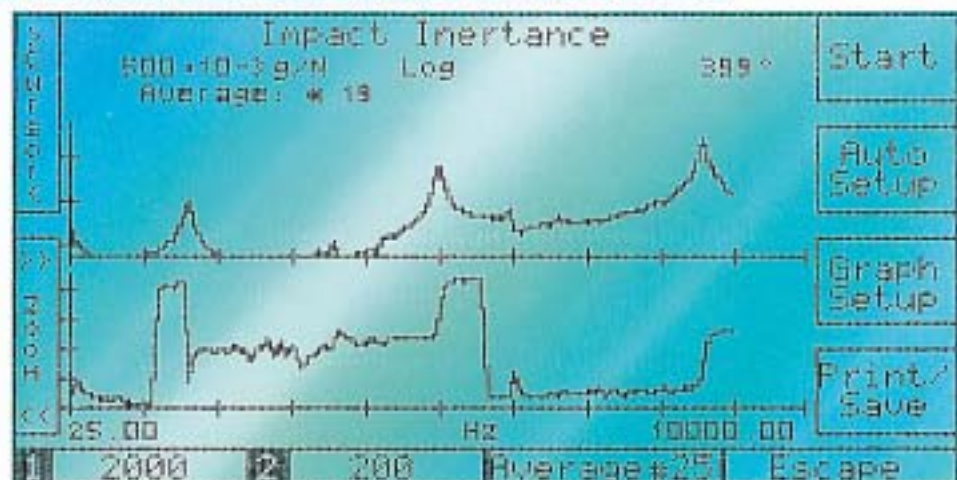
- a tracking filter with a bandwidth of up to 0.25 Hz enables pin point analysis
- frequency ranges in convenient steps from 1 Hz to 20 kHz



- simultaneous measurement of amplitude and phase of dual order in 2 parallel measurement channels reduces the time required
- dynamic display in the form of an:
  - amplitude and phase diagram
  - Nyquist diagram
  - Orbit

displays the response of the machine during the actual measurement

- calibrated 2 channel measurement of the transfer function
- excitation through an impulse hammer or an external vibration signal
- transfer functions from 1Hz to 20kHz (in pre-set steps) with 400 line resolution, dynamics > 60 dB and 0.036 s calculation time (400 line) provide extremely precise results in the shortest time possible.



# Field Balancing – Professionally Correcting Unbalance

## The task

Unbalance in rotors excites vibrations that lead to damage in the bearings, foundations or in the rotating components themselves. If unacceptable vibrations due to unbalance are identified during machine diagnosis, then it is generally a requirement that these damaging influences are quickly and economically reduced.

## The solution is called field balancing

During field balancing, the unbalance of a rotor is measured and corrected to acceptable limits while the rotor is assembled in the machine and operating in its normal condition. Disassembly is therefore not required.

## Special tools available for field balancing

- the actual unbalance is presented and can be observed in either numerical or vector diagram form.
- through the application of a photoelectric phase reference sensor changes in speed can automatically be tracked.
- polar and components correction locations can automatically be calculated.
- balance correction components can readily be either moved apart or brought together to a convenient and optimised location thereby minimising the amount of correction weight required.
- rotor runout is automatically determined and compensated through the use of non-contact eddy-current sensors.

## Field balancing using Series 40

- the operator is dialogue guided through the whole balancing procedure and can obtain a balancing protocol if required.
- balancing can be performed in either 1 or 2 planes i.e. static as well as dynamic balancing.
- rotors of almost any size and weight can be balanced.
- fluctuations in the rotor speed and vibration from other sources do not influence the results.
- the integrated software automatically calculates the required balance correction weight and its location.
- repeatedly balancing the same rotor, is significantly simplified since the data of up to 99 rotors (each with 2 balancing planes) together with the instrument settings can be permanently stored.

Polar Correction			Component Correction
Add Weight			
Plane	Amount	Location	Substitute Weights
A	55.60 g	64°	Remove Weight
B	103.7 g	177°	Continue
Help			Escape



## 1 PLANE BALANCING

⚠ Bearing MSU

### INITIAL RUN # 1

SCHENCK May/28/98 12:11pm

⚠ 0.199 in/s p 135°

Speed: 1493 rpm

### TEST RUN 1 # 1

Trial Weight in Plane A:  
18.00 oz Location 90° attached

SCHENCK May/28/98 12:13pm

⚠ 0.149 in/s p 40°

Speed: 1492 rpm



### CORRECTION

7.7 oz Location 54°

### CHECK RUN # 1

SCHENCK May/28/98 12:19pm

⚠ 0.022 in/s p 356°

Speed: 1492 rpm

Balancing finished

# Series 40 Technical Data

## Vibration measurement

### Measurement channels

- 1 plus speed (Single channel units)
- 2 plus speed (Dual channel units)

### Frequency range

- 1 ... 20 kHz

### Measurement values

- vibration acceleration
- vibration velocity
- vibration displacement
- rolling-element bearing condition (not VIBROBALANCER 41)

### Signal detection types

- rms
- peak true/calculated
- peak-peak true/calculated
- $S_{max}$  (only VIBROPORT 41)
- BCU (rolling-element bearing condition value)

### Measurement range

- 0.000001 ... 2,000
- end values
- 0.002/0.02/0.2/2/20/200/2,000

### Dynamics

- 60 dB per measurement range
- 180 dB with autoranging

### Accuracy

- $\pm 1$  % of the measured value or
- $\pm 0.1$  % of the full scale value

### Broad-band measurement

- 1/3/10 Hz... 1/5/10 kHz and
- 10 Hz ... 1 kHz ISO
- 10 ... 60 kHz BCU
- measurement time: typically 0.5 s

### FFT (except VIBROBALANCER)

- Resolution:
- 200/400/800/1,600/3,200 lines

### Frequency range:

- 1 Hz ... 100/200/500 Hz
- 1 Hz ... 1/2/5/10/20 kHz

### Averages:

- 0 ... 99, synchronous with the reference signal, asynchronous in the frequency domain

### Window functions:

- Flat top, Hanning, Exponential, Rectangular

### Cascade diagram $f(t)$ :

- 10 spectra
- $t = 1 \dots 1,000$  s

### Cascade diagram $f(n)$ :

- 10 spectra
- 60 ... 1,200,000 rpm

### Difference spectrum (not VIBROTEST 41)

### Order display (not VIBROTEST 41)

### Cursor

- Zoom: 1 ... 16 times, central to the cursor position or the screen centre

### Display of the measurement results:

- Frequency axis and amplitude axis in linear and logarithmic scales
- Measurement value list of the 10 largest peaks in the spectrum
- Measurement time: typically 0.2 s

### Oscilloscope

- (except VIBROBALANCER 41/42)

### Resolution: 200 points

### Time domain:

- selectable (3 ms ... 10 s)

### Averaging: 0 ... 99

### Continuous measurement

- Single measurements with triggering by the measurement signal or the reference signal pre-trigger 10%

### Cursor

- Orbit (VIBROPORT 41/VIBROTEST 42)

### Order tracking analysis

- (except VIBROBALANCER 41/42)

### Bandwidth:

- 0.25/0.75/2.5/7.5/25 Hz

### Orders: 1:99 ... 99:1

- Amplitude and phase diagram, Nyquist diagram, vector diagram

### Cursor

- Zoom: 1 ... 3 times, central to

- the cursor position or the screen centre

- Measurement time: typically 0.5 s

### Transfer function (VIBROPORT 41)

- Excitation via an impulse hammer or an external vibration generator

- Resolution: 400 lines

### Frequency range:

- 1 Hz ... 100/200/500 Hz
- 1 Hz ... 1/2/5/10/20 kHz

- Averages: 0 ... 99 only with background noise excitation

- Window functions: Flat top, Hanning, Exponential and Rectangular

- Amplitude and phase diagram, Nyquist diagram

### Cursor

- Zoom: 1 ... 2 times, central to the cursor position or screen centre
- Selectable linear/log scales

## Process parameter measurement

### Temperature

- (except VIBROBALANCER 41)

- with resistance thermometer PT 100

### Measurement range:

- 200 ... +850 °C, units °C or °F

- Measurement time: typically 2 s

### Axial position (except VIBROBALANCER 41, VIBROTEST 41)

- with vibration displacement sensor
- voltage supply -24 V/30 mA

### Measurement range:

- 0.01 ... 200 mm or mils

### Further measurement parameters (except VIBROBALANCER 41)

- Input: 0 ...  $\pm 20$  V or 0/ $\pm 4$  ...  $\pm 40$  mA
- Measurement range: 0.01 ... 20 eu, standardised to voltage/current values

- Accuracy: typically  $\pm 1$  % of the measurement value or  $\pm 0.1$  % of the full scale value

- Measurement time: typically 2 s

## Sound measurement VIBROPORT 41

- Measurement type
  - dB (lin)
  - dB (A) 10 Hz ... 12 kHz
- Measurement range: 30...130 dB(A)
- Accuracy:
  - according to IEC 651, class 1
- Measurement time: typically 0.5 s

## Measurement vs. time f(t) and vs. speed t(n)

- Number of values: 600
- Time basis: 1/3/10/30/100 s
- Speed range: 60 ... 1,200,000 rpm
- Measurement parameters
  - Vibration
  - Rolling-element bearing condition (BCU)
  - Temperature
  - Axial position (except VIBRO-BALANCER 41/VIBROTEST 41)
  - Process parameters
  - Sound (VIBROPORT 41)
- Display
  - Diagram with cursor and zoom
  - 1 ... 3 times

## Dialogue languages

- Versions
  - German + English + French, selectable (further languages available upon request)
- Selection
  - within the version via dialogue, further versions through module exchange
- Special functions
  - Date: DD/MM/YY or MMM/DD/YY or YY/MM/DD
  - Time: 24 hour or am/pm
  - Screen back light: illumination duration 30 ... 600 s
  - Instrument settings with \*Auto set-up\*: storage of the individual instrument settings for all measurement functions
  - Service: automatic self test of the instrument and battery

## Display

- LCD, super twisted, illuminating, 256 x 128 pixel, 125 x 65 mm (4.9 x 2.6 inch)

## Hardware

- Memory
  - EEPROM for original auto set-up and rotor data
  - EEPROM for the operating system and language versions

## Processor

- 68070
- 16/32 bit
- 80 C 652 for instruments with in-built printer
- Additional DSP (VIBROPORT 41)
- A/D converter: 12 bit/8 ms

## Measurement parameters sensor input

- 2 measurement channels each for:
  - Vibration acceleration sensors
  - Vibration velocity sensors
  - Vibration displacement sensors
- Force sensor (only one channel)
- Microphone
- Temperature sensor (only one channel)
- DC 0 ...  $\pm 20$  V or 0/ $\pm 4$  ... 40 mA (only one channel)

## Manual sensitivity setting

- Frequency linearization for Brüel & Kjær Vibro vibration velocity sensors. Each channel: 1 tuchel socket with current supply-24 V/30 mA and 1BNC socket

## Input reference

- 1 reference input for: photoelectric reference sensor, vibration displacement sensor or any input signal
- Frequency multiplier:
  - Speed: reference 1:199 ... 99:1
- 1 tuchel socket with -24 V/30 mA and +5 V/30 mA
- 1 BNC socket

## Interfaces

- 1 RS-232 to connect to a computer. 19,200 Baud and connection of a handheld keyboard
- 1 CENTRONICS for the direct connection of an external printer type EPSON/compatible

## Battery operation

- Rechargeable Pb battery, installation without special tools
- Operation time: typically approx. 6.5 hours (approx. 2.5 hours with continuous measurement)

## Power supply operation

- 76 ... 264 VAC, 48 ... 400 Hz
- 10.5 ... 32 VDC

## Printer

- Thermal printer, graphics capability
- Paper width 110 mm

## Operating temperature range

- 0 ... +40 °C, printer function (32 ... 104° F)
- 0 ... +50 °C, display function (32 ... 122° F)
- 0 ... +70 °C, measurement function (32 ... 158° F)

## Dimensions

- Instrument:
  - approx. 240 x 305 x 135 mm (9.5 x 12 x 5.3 inch)

## Weight

- Measuring instrument approx. 3.6 kg (7.9 lb)
- Soft case with measuring instrument and standard accessories:
  - VIBROBALANCER 41 / VIBROTEST 41 approx. 8.3 kg (18.3 lb)
  - VIBROBALANCER 42 / VIBROTEST 42 / VIBROPORT 41 approx. 9.0 kg (19.8 lb)

# Scope of Delivery and Ordering Codes

## Standard Delivery



### Standard delivery

Instrument with dialog in English, French and German softcase and documentation

with built-in printer

Power unit AC-521

Battery AC-520

Accelerometer AS-020 with accessories

Reference Sensor P-84 with accessories

Thermal paper roll AC-523



# Options for the Series 40 Measuring Instruments

## Option 402

- Additional vibration acceleration sensor AS-020
- Operation frequency range:  
1 ... 15,000 Hz
- Operating temperature range:  
-50 ... +121°C (-58 ... +250°F)
- Scope of delivery:  
1 vibration acceleration sensor AS-020  
1 connection cable AC-162,  
5 m long (16.4 ft)  
1 magnet AC-273  
1 probe AC-272  
1 threaded stud  
Weight: 1 kg (2.2 lb)

## Option 403

- Vibration velocity sensor VS-080
- Operating frequency range:  
1 ... 2,000 Hz
- Operating temperature range:  
-40 ... +100°C (-40 ... +212°F)
- Scope of delivery:  
1 vibration velocity sensor VS-080  
1 cable AC-183/5, 5 m long (16.4 ft)  
1 magnet AC-273  
1 probe AC-171  
1 threaded stud AC-350  
Weight: 1 kg (2.2 lb)

## Option 404

- Vibration displacement sensor with integrated oscillator
- Operating frequency range:  
1 ... 10,000 Hz
- Operating temperature range:  
0 ... +125°C (+32 ... +257°F)

- Linear displacement measurement range: 105 mm (0.06 in)  
Sensor length: 70 mm (2.75 in)  
Thread: M10 x 1
- Scope of delivery:  
1 vibration displacement sensor VIBRONECS IN 085/3/070/00/0  
1 cable AC-425, 5 m long (16.4 ft)  
Weight: 0.3 kg (0.76 lb)

## Option 405

- Temperature sensor VIBOTHERM 41 (not for use with VIBROBALANCER 41)
- Temperature resistant element PT 100
- Operating temperature range:  
-20...+200°C (-4 ... +392°F)  
(continuous operation)  
-50 ... +260°C (-58 ... +500°F)  
(10 min. operation)
- Scope of delivery:  
VIBROTHERM 41 with connection cable 1.5 m long (5 ft)  
Weight: 0.2 kg (0.4 lb)

## Option 406

- Photoelectric reference sensor
- Option 406-1  
1 reference sensor, P-84
- Option 406-2  
1 cable AC-185/5 m (16.4 ft) long
- Option 406-3  
1 magnetic stand AC-525
- Option 406-4  
1 reflex tape AC-526, 5 m (16.4 ft) roll

## Option 408

- External keyboard KEYBOARD 41
- Used to enter comments, descriptions in measurement protocols

- Scope of delivery: 1 KEYBOARD 41 with a 25 pole RS-232 connection cable
- Weight: 0.5 kg (1.1 lb)

## Option 410

- PC Software VIBROEXPERT CM-400
- Basic module for SERIES 40 Module 41
- Communications and database module for data transfer from the measuring instrument to the PC, and to archive data in the database and to export measurement data in standard data formats
- Scope of delivery:  
1 software package module 41 with selectable languages German, English, French  
1 connection cable with adapter for PC  
1 software security key  
1 documentation  
please order language for documentation English or French or German

- Analysis modules:  
(only in combination with basic module 41)
- Module 65: Overall values  
For trend analysis of all overall values and prognosis function
- Module 66: Spectra analysis  
For analysis of single-, multiple-spectra, cascade diagrams, Cepstrum analysis and Bearcon Signature (envelope detection), FFT-Marker functionality.

- For presentation and analysis of oscilloscope, tracking and transfer function.

## Options for Series 40

### Option 412

- Additional extension cables

- Option 412-1

- 1 cable AC-185/5 m long (16.4 ft) for options 402, 404, 405

- Option 412-2

- 1 cable AC-185/20 m (65 ft) long for options 402, 404, 405, 406

- Option 412-3

- 1 cable AC-183/5 m (16.4 ft) long for option 403

- Option 412-4

- 1 cable AC-185/20 m (65 ft) long for option 403

- Option 412-5

- 1 cable AC-199/5 m (65 ft) long for option 409

### Option 413

- Additional rechargeable battery

- Scope of delivery:

- 1 battery AC-520

- Weight: 0.7 kg (1.5 lb)

### Option 414

- Paper rolls for the in-built thermal printer

- Scope of delivery:

- 10 replacement rolls AC-523

- Weight: 2 kg (4.4 lb)

### Option 415

- Seminar handbooks

- Option 415-1

- Seminar handbook C40, Machinery Diagnostics

- Option 415-2

- Seminar handbook C41, Field Balancing

### Option 451 for VIBROPORT 41

- Accessories to determine the transfer functions of mechanical systems

- Option 451-3

- Impulse hammer with integrated force sensor and in-built charge amplifier, AC-529

- Frequency range with a steel impact tip: 4.5 kHz (-10dB)

- Hammer mass 500 g (1.1 lb), additional mass 250 g (0.55 lb)

- Scope of delivery:

- 1 impulse hammer

- 3 hammer tips

- 1 connection cable

- 1 documentation

- 1 carrying case

- Weight: 4.5 kg (9.9 lb)

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