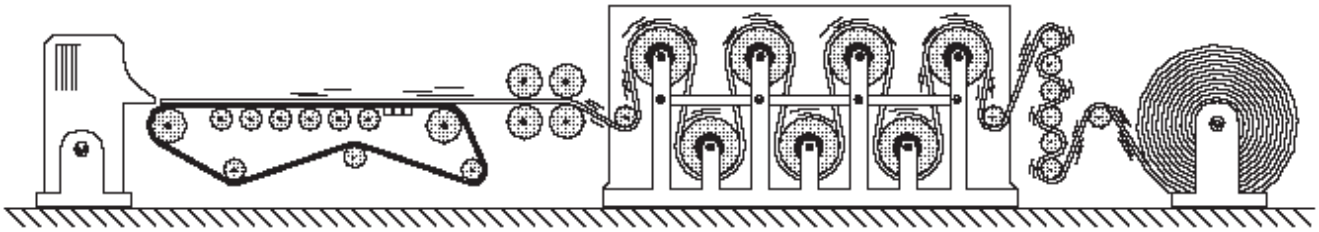
PRÜFTECHNIK AG

TechNote #21 VIBROTIP®

Condition monitoring in the paper industry with VIBROTIP®



Paper machine rolls

Why condition monitoring?

Imagine for a moment: during the middle of the night shift, the plant operator notices a radical jump in electrical current consumption of one of the dryer roll drive motors. A quick look inside the dryer cowling reveals a red-hot bearing on one of the dryer cylinders: breakdown is imminent, and the entire paper machine must be shut down immediately.

Time and cost savings

The extremely high production speeds of modern paper machines demand that deteriorating operating conditions be recognized well ahead of failure. Only then can shutdown be planned far enough in advance to maximize machine availability, instead of incurring huge production losses due to catastrophic failures: when you consider the cost of downtime incurred due to a single incidence of dryer bearing failure, a condition monitoring system can pay for itself rather quickly.

Safety aspects

Of particular importance on paper machines are plant safety considerations: permanently-installed vibration transducers can eliminate the inherent safety risks of operators having to step over barriers to take readings in precarious positions and wet, slippery, poorly-lit surroundings.

What to monitor?

Most critical is the bearing condition of the many rolls in the paper machine: if a bearing seizes, not only does production stop, but the wire fabric of the forming section can be damaged as a consequence, requiring expensive replacement.

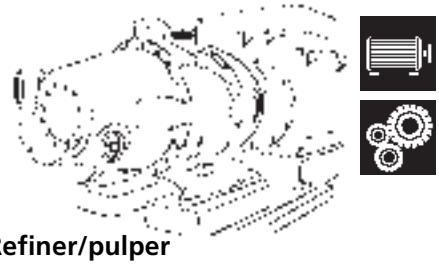
Many other aggregates outside the paper machine proper (such as supply fans, centrifuges, winders, motors and pumps) are also vitally important to uninterrupted production and therefore require monitoring as well. An entire paper mill often contains several thousand critical bearings that are suitable candidates for condition monitoring; the paper machine itself typically has 400 or more such locations.

Practical obstacles

Four main factors have stalled condition monitoring in the paper industry thus far:

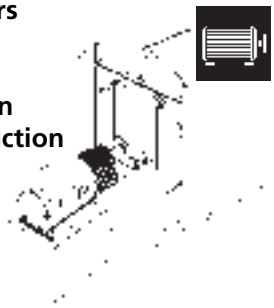
1. High initial expense
   Online monitoring systems are much too expensive to allow coverage of all critical areas.
2. Not enough vibration specialists
   Limited manpower is available for tending to complicated measurement/evaluation routines.
3. Poorly-suited measurement equipment
   The critical components of a paper machine are often located in extremely damp, high-temperature areas that cannot easily be reached (if at all) for measurement. Corrosion and temperature effects rule out use of most well-known transducers and cables.
4. System maintenance responsibility
   Conventional monitoring systems require major effort to dismantle transducers and cabling each time the paper machine is shut down for revision. This means additional work and responsibility which no one is eager to assume.

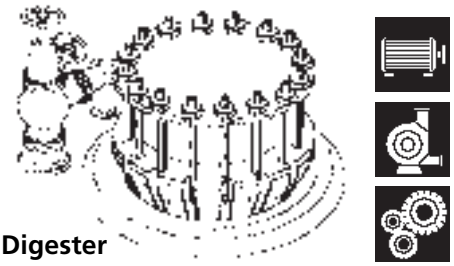
Production-critical aggregates which require condition monitoring



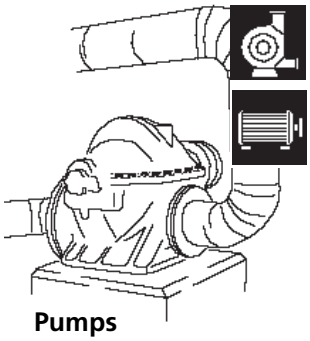
Refiner/pulper
(no redundancy)

Fans/blowers
- exhaust
- supply
- combustion
- transfer suction

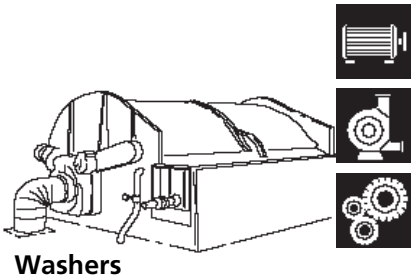




Digester



Pumps



Washers

Vaccuum
pump

Log chipper
(no redundancy)

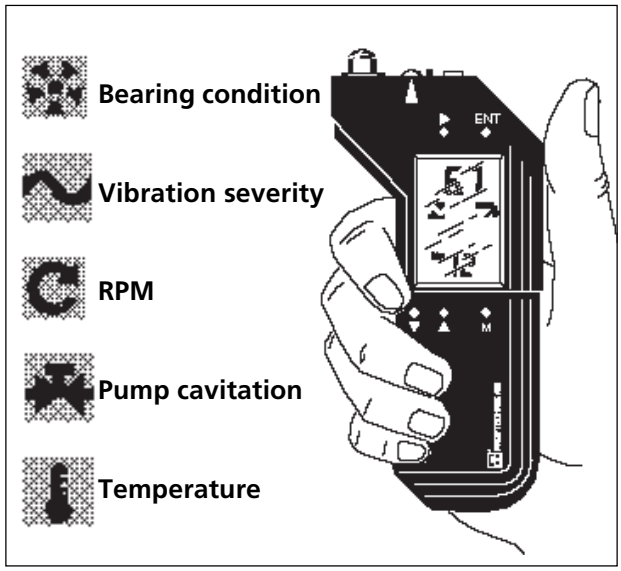
Debarking drums

Power plant/steam boiler facili-
ties
No redundancy of
- boiler feedwater pump
- fresh air supply fan
- exhaust fan

Winders
(no redundancy)
- at end of paper machine
- in conversion section

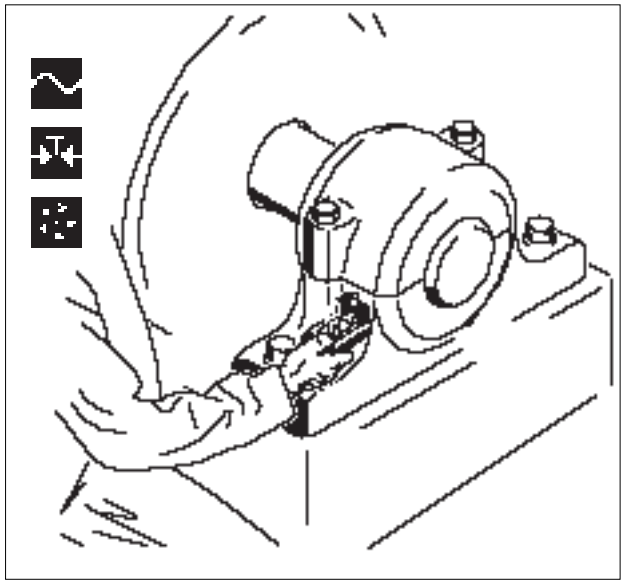
The solution: VIBROTIP®

PRÜFTECHNIK offers a complete range of components ideally suited to the stringent demands of paper machine monitoring. Vibration level alone is often not enough to judge overall operating condition of a paper machine: information regarding bearing condition, rpm, temperature or pump cavitation is often indispensable as well. Extremely robust (IP65 protected) and easy to use, VIBROTIP® is the hand-held instrument that measures all these parameters at the press of a key. Up to 1000 readings can be collected, then transferred to a PC for trend analysis with automatic notification whenever warning or alarm thresholds are exceeded.



VIBROTIP® is versatile

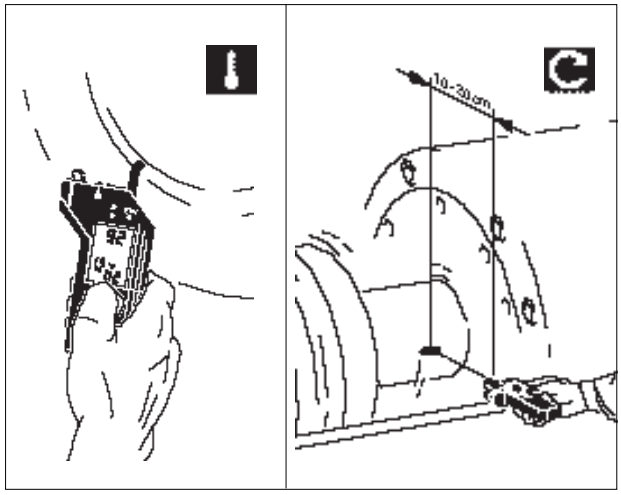
VIBROTIP® lets you take condition readings in a number of different ways, letting you take readings on the spot, from remote locations - or upgrade to total trending data reliability with VIBCODE®. These different measurement procedures are described in detail on the following pages.



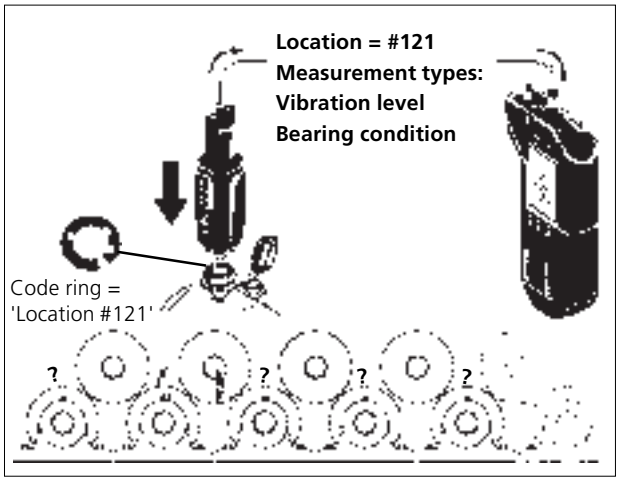
1. Hand-held readings

The heart of the system is the Tandem-Piezo® accelerometer built into VIBROTIP®. This transducer offers linear response over the entire range of machinery component operating frequencies (including the higher-range bearing frequencies), making it the ideal sensor for measuring vibration, pump cavitation and bearing conditions.

Furthermore, VIBROTIP® contains built-in RPM and temperature sensors for single-handed measurement convenience.



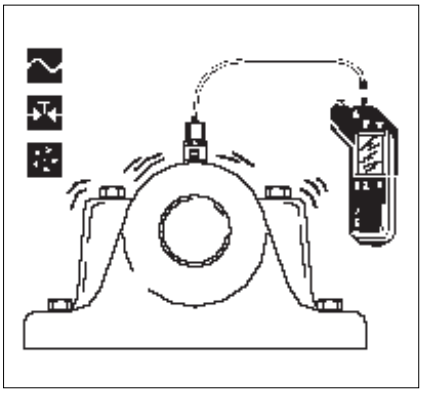
2. Data collection with VIBCODE®: Automatic location recognition!



VIBCODE® is the world's first intelligent system that makes trend monitoring simple, economical and reliable - regardless who takes the readings. Even among the thousands of measurement points in a paper mill, VIBCODE® automatically keeps track of readings for each and every location.

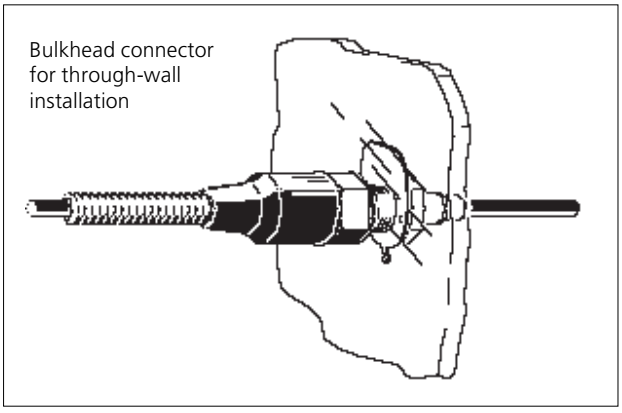
The measurement stud is encoded with its own unique location number. A patented probe locks onto the stud, allowing VIBROTIP® to recognize each location and to take the appropriate measurement(s) fully automatically. Any operator can collect accurate data at the press of a single key: this enhances trending reliability and eliminates repeat measurements due to mixups.

3. With permanently-installed transducers



The same multi-function vibration transducer is also available in a permanently mounted version which attaches to VIBROTIP® via cable (available in high temperature version as well). The accelerometer's built-in current line drive amplifier* allows reliable, linear signal conduction over the inherently long distances involved with paper machines - even up to 1 km - while minimizing the effect of ground loops or induced interference.

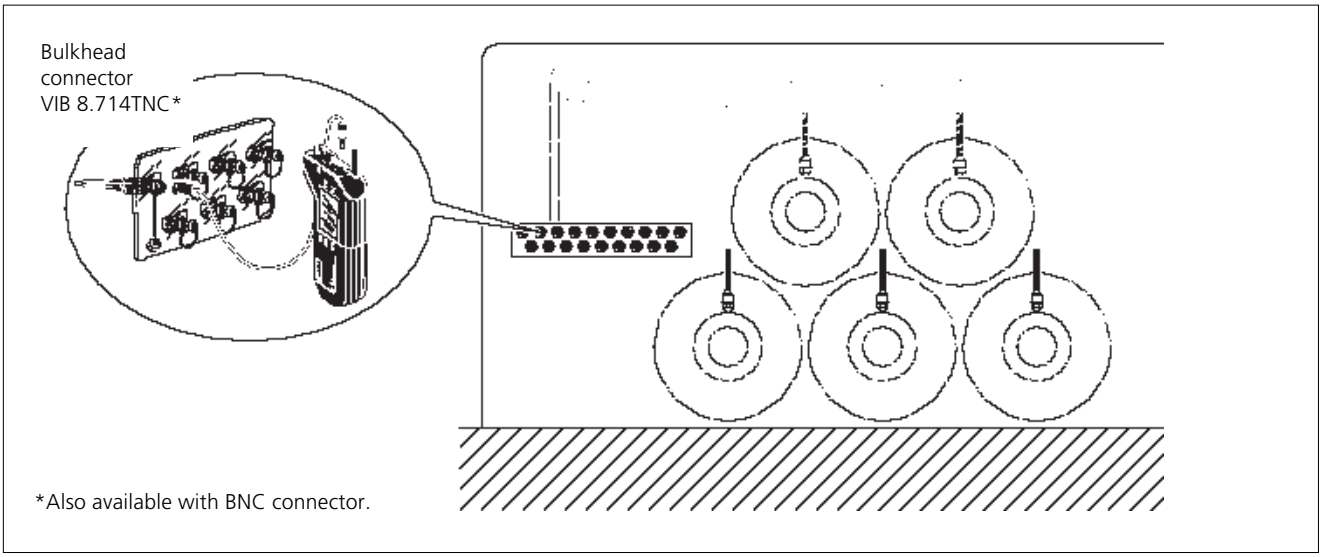
The entire signal conduction path is protected from environmental moisture by rubber glands and flexible metal conduits, with bulkhead connectors available for through-wall installations.



*The term 'line drive amplifier' was originally used by Brüel & Kjær (Nærum, Denmark) for this type of circuit. We use the same term for sake of familiarity although there are technical differences between the B&K system and the PRÜFTECHNIK system. Technical Note #18 of this series describes the advantages of PRÜFTECHNIK accelerometers in detail.

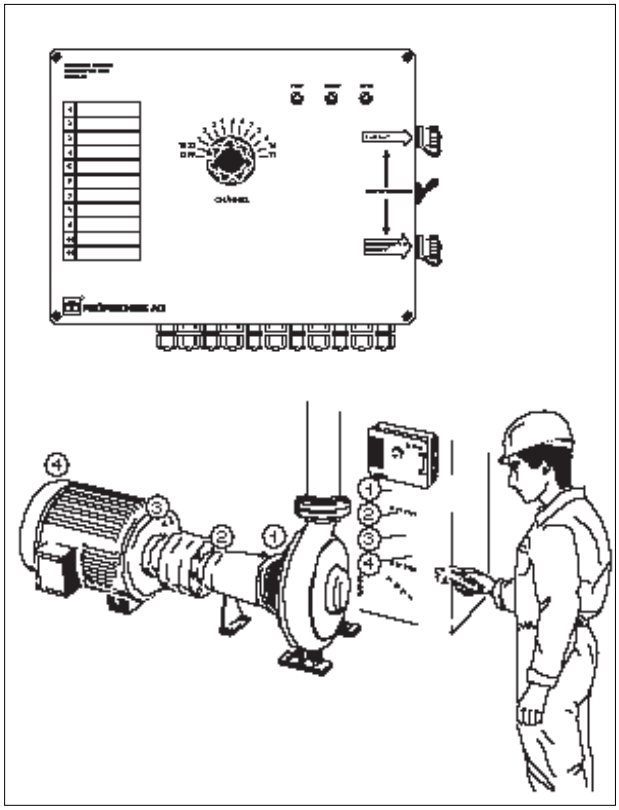
4. Central data collection

A cable to the VIBROTIP® allows remote connection to each measurement point in turn for quick and easy data collection from a central location. The illustration below shows how VIBROTIP® collects condition data at a conveniently-located panel of sensor jacks.



*Also available with BNC connector.

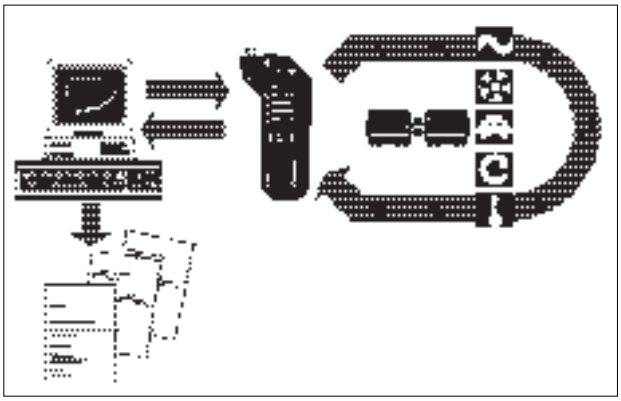
The VIB 8.530 sensor connection box may also be used to switch the VIBROTIP® input signal among 11 different sensor locations.



TIPTREND® transforms raw data into useful information

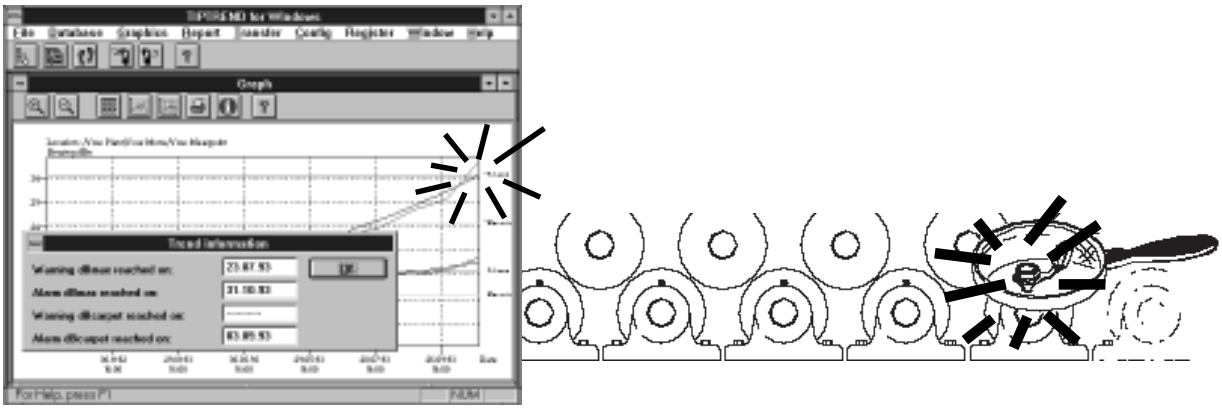
The real benefit of condition monitoring lies in measurement trending, which allows early recognition of trouble spots and can even predict when they will seriously threaten continued operation.

VIBROTIP® readings are transferred via cable to a PC for automatic evaluation, graphic depiction, reporting and storage by the TIPTREND® program.



Points out trouble spots

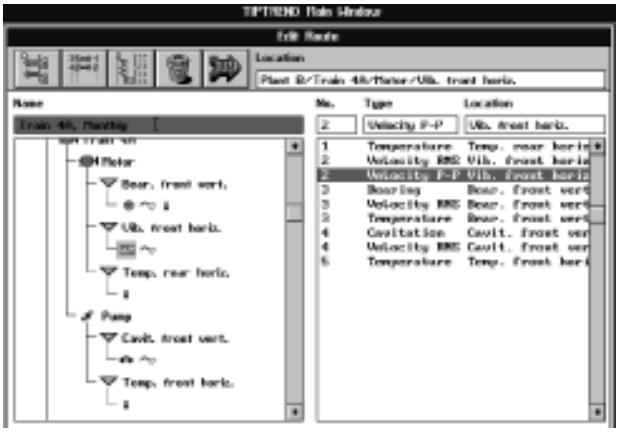
TIPTREND® software evaluates VIBROTIP® readings and automatically points out exactly where and when further attention is needed, so that no effort is wasted on bookkeeping for 'healthy' measurement locations. TIPTREND® runs under MS-Windows™ on any ordinary PC, making operation simple: 'point' to the desired location in the graphic overview to produce a clear graph of measurement readings over time. Set your own warning and alarm limits, then let TIPTREND® notify you of violations after every measurement round. The program also generates downtime reports, measurement path listings and other productivity-enhancing documentation.



Automated measurement paths

VIBROTIP® may be programmed with up to 1,000 desired measurement locations and types using TIP-TREND® software for MS Windows™. Only two keys are then needed to take a reading and store it under the proper location number. VIBROTIP® then automatically moves on to the next location.

An FFT analyzer (such as VIBROSPECT® FFT) may be used for taking diagnostic readings when conditions warrant. In addition, this configuration supports fully-automated computerized data collection systems (please consult your PRÜFTECHNIK representative for further information).



Cable considerations

Depending upon the measurement surroundings, the type of cable used and the way it is installed can significantly affect measurement results. For example, high temperatures (above 80°C / 176°F). can influence the measurement signal, as can electrical current flowing nearby. Therefore, avoid letting the cable run near large motors, transformers or electrical wiring, if possible. High-temperature cable 90093 (withstands temperatures up to 125°C / 257°F) should be used whenever ambient temperatures exceed 80°C / 176°F.

Also consider how the cable path can affect future machine service jobs: for example, cables to cylinder bearing locations should be laid from the back (drive side) of the paper machine to the front in such a way that they do not interfere with replacement of the wire fabric or rolls. Also be careful to leave enough slack in the cable to allow the transducer to move freely if the measurement site is expected to move (for example, in the winder section or during replacement of the roll or forming wire).

Line drivers exhibit particularly remarkable properties when long cables are used. With a standard RG58 coaxial cable, the high frequency loss over 1kilometer is negligible:

@ 10kHz : 0.5dB loss
@ 20kHz : 1.3dB loss

Measurement considerations

The low rotational speeds encountered on paper machine rotors (especially large drying section rolls) can result in low overall reading levels of shock pulse measurements of bearing condition. Therefore, the overall trend development over time is much more important to observe than the absolute value of the reading (which may be as low as 5 dB_{sv} for a bearing in good condition).

ISO standards for categorization of vibration severity as 'good,' 'acceptable' and 'unacceptable' do not apply to frequencies below 10 Hz, so here again, trend observation is the most important criterion for evaluating the machine operating condition.

Carbon sealing rings on the steam inlets of drying rolls can produce extremely high-amplitude vibration at frequencies in the range of shock pulse readings, resulting in vastly inflated reading levels. The source of disturbance must then be eliminated at the steam inlets in order to obtain usable shock pulse values.

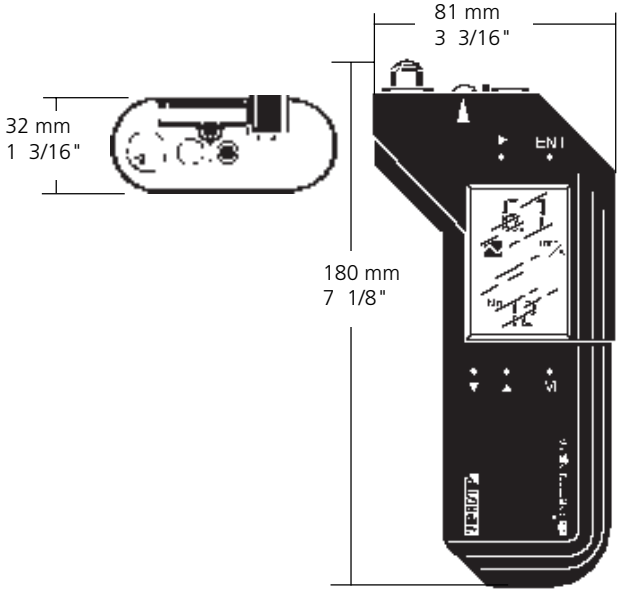
Despite these special circumstances, VIBROTIP® offers an extremely simple and reliable method to realize the advantages of condition monitoring for preventive maintenance.

Monitoring components

VIBROTIP® instrument	VIB 8.650
QuickMount industrial accelerometer	VIB 8.513
Coaxial cable RG 58	90005-x*
Protective conduit	VIB 8.716-x*
Rubber gland	VIB 8.727
Bulkhead connector (specify BNC or TNC)	VIB 8.714
Connection box	VIB 8.530-N
VIBCODE transducer	VIB 8.660
VIBCODE measurement stud	
M8 thread	VIB 8.680 SET
UNC thread	VIB 8.690 SET
TIPTREND for Windows™ PC software	VIB 8.611

*specify x meters length

See the VIBROTIP® sales leaflet and the Accessory Catalog VIB 9.459G (available free of charge) for additional details on these and other components.



VIBROTIP® technical data

Vibration

Sensor built in; external Tandem-Piezo® sensor available

Measurement units	mm/s, in/s (selectable) RMS or peak-to-peak or 0-to-peak
Frequency range	10 Hz - 1 kHz
Measurement range	0 - 100 mm/s / 0 - 4 in./s v_{eff}
Resolution	0.1 mm/s, 0.001 in./s
Accuracy	±5% (DIN 45666)

Bearing diagnosis

Sensor built in;	external Tandem-Piezo® sensor available
Measurement units	dB_{SV}, $dB_{N.}$ carpet value, maximum value
Range	-9 - 90 dB_{SV}
Resolution	1 dB_{SV}

Cavitation

Sensor built in; external Tandem-Piezo® sensor available

Measurement units	dB_C
Range	-9 - 90 dB_C
Resolution	1 dB_C

Temperature

Sensor built in; external & replacement probes available

Accuracy	±3%
Measurement units	°C, °F (selectable)
Measurement range	
Internal probe	-30° - 270° C / -22° - 518° F
External probe (NiCrNi)	-30° - 500° C / -22° - 932° F

Tachometer

Sensor built in	
Measurement units	rpm
Resolution	1 rpm
Range	60 - 30,000 rpm
Max. distance	1 m / 39"

Data collector

Capacity	1000 points (or 400 per function), including time and date for each point
Transfer functions	Import or download
Routing	Up to 1000 points may be set

General characteristics

Interface	RS-232C (9600 Baud)
Battery operation	1x IEC 6LR61 (9V)
Lithium	20 hrs.
Alkaline	10 hrs.
Rechargeable	3 hrs.
Display	LCD (5 x 10 mm / 3/16" x 3/8" digits)
Hold function	yes
Intrinsic safety	EEx ib IIC T4 (optional)
Coal mining safety	EEx ib I (optional)
Protection	IP 65 (water- and dustproof) Chemical protection
Operating temperature	0° - 60° C / 32° - 140° F
Automatic shutoff	yes
Shock resistance	2 m / 6 ft. drop test
Dimensions	see illustration
Weight incl. battery	300 g / 10 oz.

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ISO 9001

Productive maintenance technology