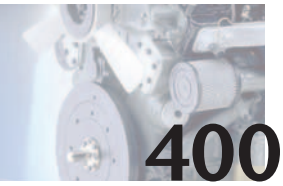
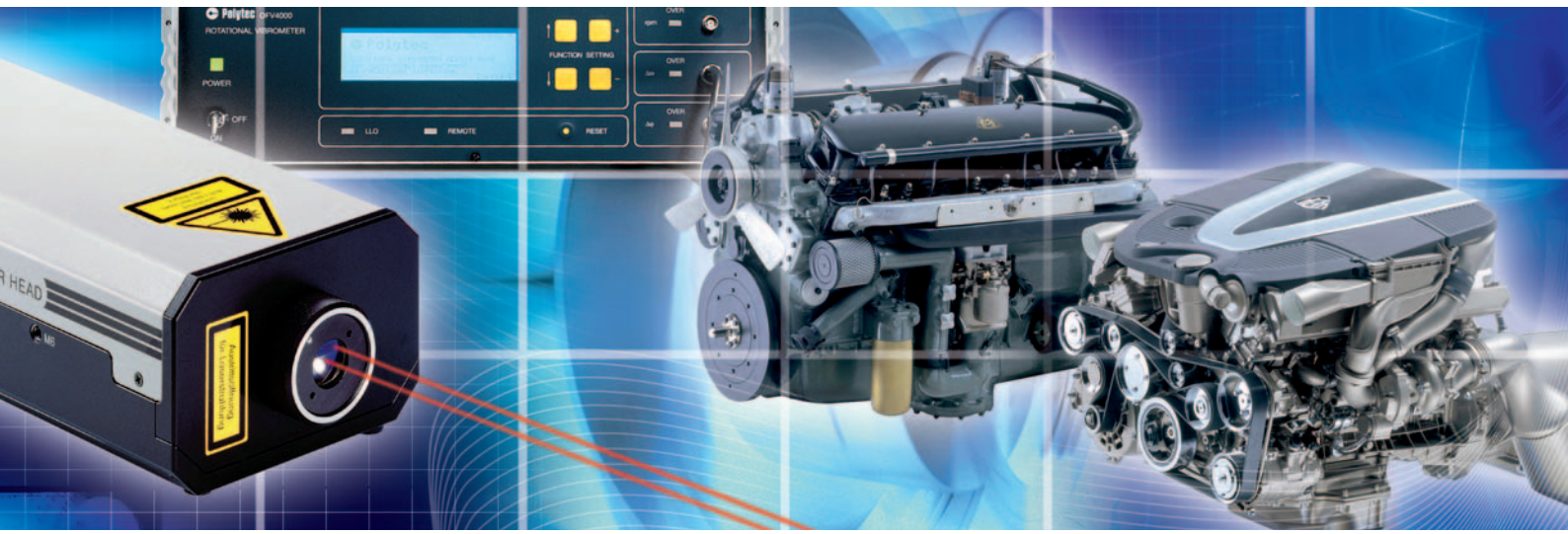
Polytec



4000 Series Rotational Vibrometer

Non-Contact Laser Measurement of Torsional and Angular Vibration

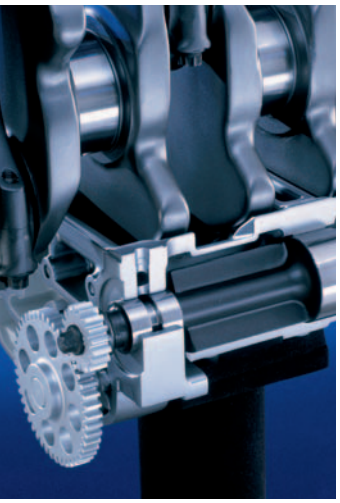


Fast
Accurate
Convenient

Rotational Vibrometer

Improvement of Rotating Parts and Structures

Polytec's rotational vibrometers are advanced non-contact angular velocity and displacement sensors, perfect for measuring rotating structures such as crankshafts, axles and pulleys. The vibrometer's large standoff distance makes repositioning the laser probe fast, safe and convenient and enables the precision measurement of operating machinery at several locations without interruption. As proof of its success, automotive design and test engineers have skillfully used rotational vibrometer data to reduce engine noise and to increase product durability.



Designed for Accurate Measurements

The Polytec 4000 Series Rotational Vibrometer system is a portable, non-contact laser Doppler system for measuring angular vibrations on rotating structures. Designed to be eye-safe and simple to set-up and operate, the Rotational Vibrometer provides accurate measurements without enhancing the rotating surface with retro-reflective materials. Combining these features with the large standoff distance gives the test engineer the flexibility of setting up, making a measurement, tearing down and repositioning to other locations without stopping the machinery under test. Additionally, the large standoff distance and excellent sensitivity permit measurements on hot surfaces where it is not possible to artificially improve reflectivity. Finally, the accuracy of the data is independent of the measured rotating surface shape.

Conventional contact transducers are subject to wear and slippage, leading to unplanned maintenance. In contrast, the Polytec Rotational Vibrometer is non-contact and can be remotely located, limiting exposure to harsh conditions and reducing maintenance. Another advantage of the Polytec design is its ability to measure anywhere within the range –7,000 RPM to +11,000 RPM including directional changes, torsional transients and rotational vibrations around the rest position.

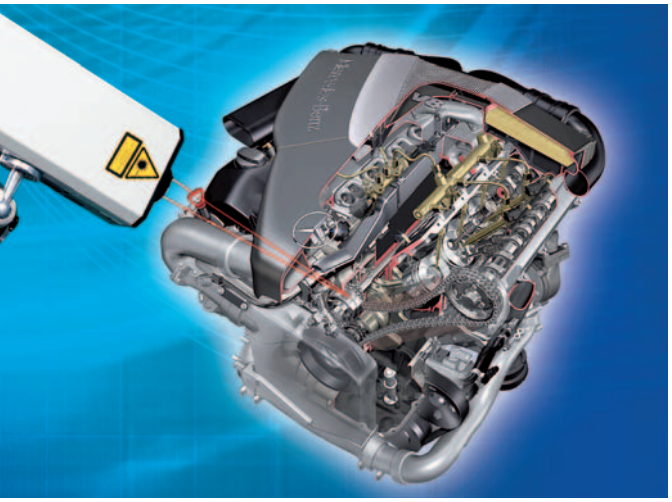
Measuring Angular Vibration

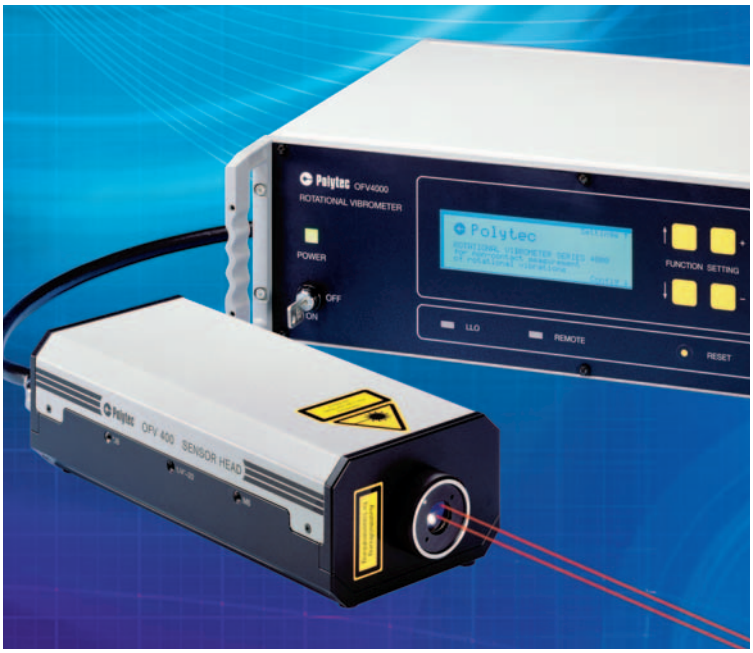
Features

- Measures angular velocity and displacement from –7,000 RPM to +11,000 RPM
- Senses direction, measures velocities and vibrations around standstill
- Portable, eye-safe class 2 visible laser
- OFV-400 Sensor Head conveniently mounts to standard tripods and customized positioners
- IEEE-488 and RS-232 interfaces for remote control and fast data transfer (RPM)
- Separate analog outputs for angular velocity and vibration amplitude (angle)

Benefits

- Wide dynamic range for high speeds, fast transients and fine resolution
- Simple set-up and easy-to-use menu-driven operation
- High efficiency optics gather sufficient light even from untreated surfaces where no contact is possible
- Eliminates down-time associated with contact methods
- Easily repositioned to different areas of rotating machinery





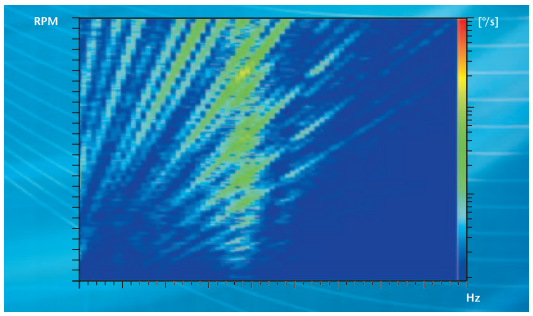
The System

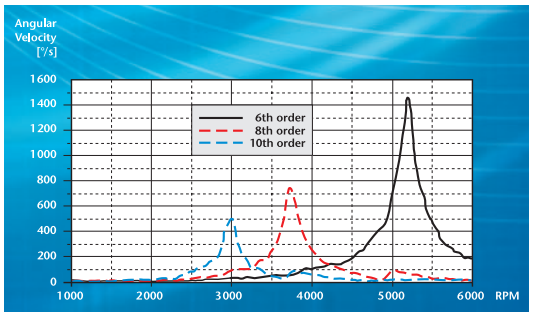
The 4000 Series Rotational Vibrometer comprises the OFV-400 Optical Sensor Head and the OFV-4000 Controller.

Polytec's long-standing experience in the development of laser vibrometers has been applied to the design of the OFV-400 Measuring Head, with a compact, dual interferometer whose high optical sensitivity enables precise measurements on untreated objects. Signals from the OFV-400 are processed by the OFV-4000 Controller/Power Supply. It provides four selectable angular velocity ranges (one of them DC-capable), three angular displacement ranges and twenty-eight selectable high and low-pass filters. There are two computer interfaces: IEEE-488 and RS-232. The controller bandwidth is large enough to handle fast transients such as sudden accelerations of a shaft during gear changes.

All instrument settings are shown on the OFV-4000's large, backlit display including signal strength from both laser beams and RPM. Three BNC jacks provide analog signal outputs including angular vibrational velocity, angular vibrational displacement and RPM. These outputs can be examined further with signal processing, such as an order tracking analyzer.

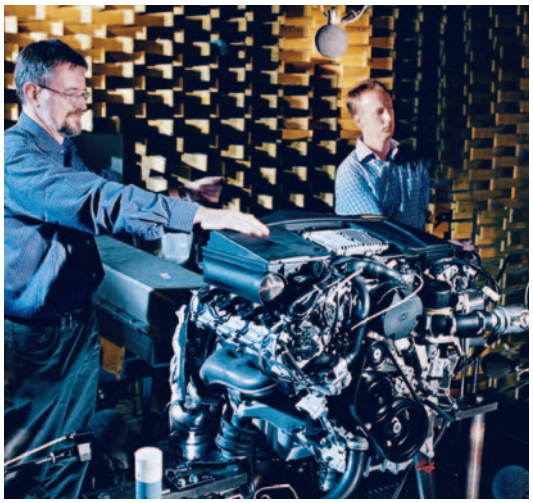
Applications





The left images show an order tracking analysis of a crankshaft. Results are completely equivalent to the output from a traditional magnetic encoder. Set-up and data acquisition were accomplished by the Rotational Vibrometer in a fraction of the time needed to install the encoder.

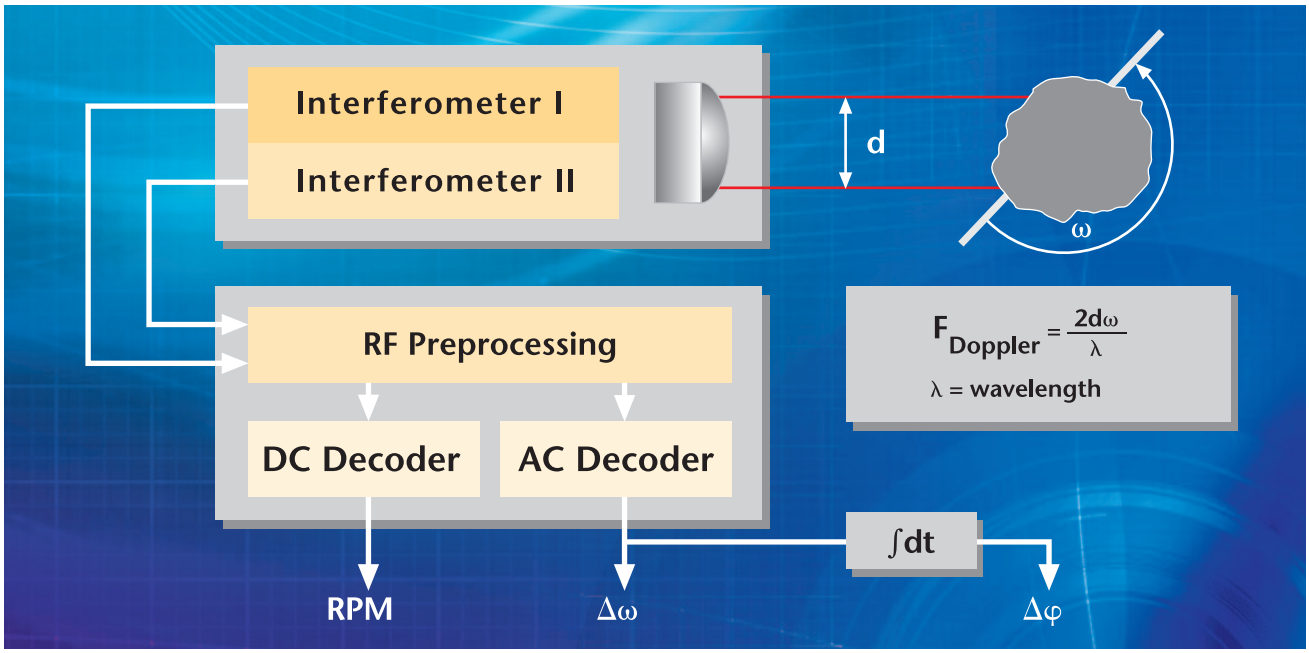
Right image:
Measurement on a rotary printing press



Polytec's rotational vibrometers measure torsional or angular vibrations, without contact, on arbitrarily shaped structures including engine crankshafts, vehicle axles, marine driveshafts, electrical generator shafts and rotating parts in lithographic machines, printers & photocopiers. Automotive engineers use the rotational vibrometer to develop torsional vibration dampers that reduce engine noise and increase product durability. Faults in gearboxes, compressors and generators cause torsional vibrations at certain system specific frequencies. Measurements are made to:

- Reduce noise and vibration
- Study rotational fatigue
- Improve the precision and quality of tool-making machines
- Monitor and trouble shoot power plant and production machinery
- Speed up adjustment of torsional vibration dampers in vehicle drive shafts
- Study run-up and run-down of machines (order tracking and Campbell plots)

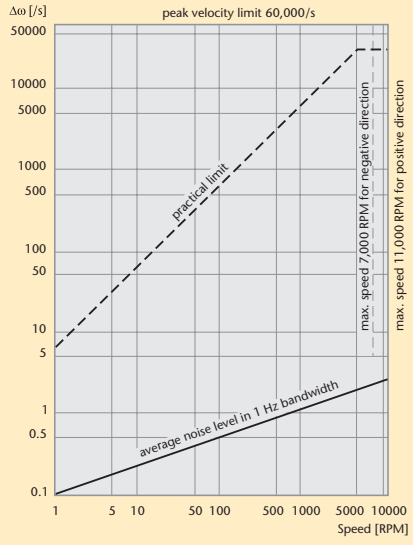
Principle of Operation



Advancing Measurements by Light

The 4000 Series Rotational Vibrometer uses two parallel laser beams which exit the OFV-400 front lens and strike the rotating surface. Each back-scattered laser beam is Doppler shifted in frequency by the surface velocity vector in the beam direction.

Operating Range of the Rotational Vibrometer



This velocity is made up of rotational and lateral components. Raw velocity information from each beam is independently sent to the OFV-4000 for processing. Using a simple geometric relationship, the difference of the two velocity components is a direct measure for the pure rotational velocity of the object and eliminates lateral vibrations.

The advantage of Polytec's dual interferometer approach lies in optical gain that is orders of magnitude higher than designs using only one interferometer operating in an optically differential mode. The resulting high optical sensitivity allows measurements on poorly reflecting surfaces, thereby increasing the range of applications and ease of use. For measuring positive and negative rotations as well as vibrations around zero RPM, a Bragg cell is incorporated into the dual interferometer. The Bragg cell produces a constant angular velocity offset by frequency shifting the laser beams.

For more information about how a Rotational Vibrometer works please visit our vibrometer university website:

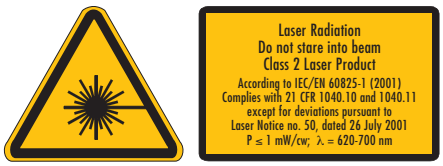
www.polytec.com/usa/vib-university

Technical Data

Metrological Properties	
Rotations per Minute	
Measurement range	–7,000 RPM ... +11,000 RPM
Accuracy	±1 % (or ±5 RPM)
DC signal output	1 V/1000 RPM
Data transfer	Via interfaces; up to 500 samples/s
Time constant switch	Time constant switch slow/fast for detection of machine run-up characteristic
Angular Velocity	
Angular velocity ($\Delta\omega$) ranges	4 Velocity ranges: 100 °/s; 1,000 °/s; 10,000 °/s and 60,000 °/s (full scale range)
Analog output	±10 V
Frequency range	0.5 Hz ... 10 kHz (0 ... 10 kHz @ 60,000 °/s)
Linearity error	<0.25 %
Filters	High- and low-pass filters, 4th order, wide range of cut-off frequencies
Angular Displacement	
Angular displacement ($\Delta\varphi$) ranges	3 Angle ranges: 0.1° / 1° / 10° (full scale range)
Analog output	Nom. ±10 V
Frequency range	1 Hz ... 10 kHz
Linearity error	<0.5 %

Operating range diagram: see page 5

Optics	
Laser type	Helium-Neon (Red HeNe)
Laser output	633 nm, <1 mW per beam, Class 2
Separation of measurement beams	8 mm
Operating distance	400 mm ±50 mm (200 mm or 600 mm optional)



General Properties, Housing and Power		
System	Dual interferometer system with frequency shift (Heterodyne Detection)	
Components	OFV-4000 Controller	OFV-400 Sensor Head
Dimensions [L x W x H]	450 mm x 360 mm x 145 mm (17.7 in x 14.2 in x 5.7 in) 19" housing, rack mountable	320 mm x 120 mm x 78 mm (12.6 in x 4.7 in x 3.1 in)
Weight	11 kg	3.7 kg
Display	Large 4-digit LCD display	LED bar graph for balance
Operating temperature	+5 °C ... +40 °C (41 °F ... 104 °F)	
Relative humidity	<80 %, non-condensing	
Optics mounting	Multiple mounting positions	
Mains voltage	100 V / 115 V / 230 V	
Power consumption	max. 150 VA	
Interfaces	IEEE interface and RS-232 computer interface	
Outputs	3 separate BNC output sockets	

Compliance with Standards	
Electrical safety	IEC/EN 61010
EMC	IEC/EN 61326; Emission: FCC Class B, IEC/EN 61000-3-2 and 61000-3-3 Immunity: IEC/EN 61000-4-2 to 61000-4-6 and IEC/EN 61000-4-11
Laser safety	IEC/EN 60825-1 (CFR 1040.10, CFR 1040.11)

For more information please contact your local Polytec sales engineer or visit our website **www.polytec.com/usa/rotvib**

Polytec GmbH (Germany)
Polytec-Platz 1-7
76337 Waldbronn
Tel. + 49 (0) 7243 604-0
Fax + 49 (0) 7243 69944
info@polytec.de

Polytec-PI, S.A. (France)
32 rue Délizy
93694 Pantin
Tel. + 33 (0) 1 48 10 39 34
Fax + 33 (0) 1 48 10 09 66
info@polytec-pi.fr

Lambda Photometrics Ltd. (Great Britain)
Lambda House, Batford Mill
Harpenden, Herts AL5 5BZ
Tel. + 44 (0) 1582 764334
Fax + 44 (0) 1582 712084
info@lambdaphoto.co.uk

Polytec KK (Japan)
Hakusan High Tech Park
1-18-2 Hakusan, Midori-ku
Yokohama-shi, 226-0006
Kanagawa-ken
Tel. +81 (0) 45 938-4960
Fax +81 (0) 45 938-4961
info@polytec.co.jp

Polytec, Inc. (USA)
North American Headquarters
1342 Bell Avenue, Suite 3-A
Tustin, CA 92780
Tel. +1 714 850 1835
Fax +1 714 850 1831
info@polytec.com

Midwest Office
3915 Research Park Dr.,
Suite A-12
Ann Arbor, MI 48108
Tel. +1 734 662 4900
Fax +1 734 662 4451

East Coast Office
25 South Street, Suite A
Hopkinton, MA 01748
Tel. +1 508 544 1224
Fax +1 508 544 1225