Polytec

RLV-5500
Rotational Laser Vibrometer

Non-Contact Measurement of Rotational Vibration

Rotational Vibrometer

Features

- Compact, fiber-coupled sensor head
- Precision rpm, angular velocity and angular displacement measurement
- Measures from 0 to 20,000 RPM with 10 kHz bandwidth
- Class 2, low power visible laser
- Order filters for run-up measurements
- Standard ±10 V BNC signal output

Benefits

- Quick setup and alignment
- Easily repositioned to different parts of rotating machinery
- High resolution within expanded RPM range
- Insensitive to ambient vibration
- No mounted sensors or telemetry necessary
- No added inertial mass during measurement
- Improved S/N ratio through digital demodulation and filtering
- Compatible with all standard data acquisition systems
- Integrated air wipe to cool and protect the optics

A Better Way to Measure Rotational Dynamics: Rotational vibrometers are advanced non-contact angular velocity and displacement sensors, perfect for measuring rotating structural dynamics. Controlling drivetrain rotational vibrations is crucial to designing reliable vehicles, power generation equipment and aircraft propulsion systems.

The RLV-5500 Rotational Laser Vibrometer incorporates high-performance digital decoding techniques for an improved signal/noise ratio, an expanded RPM range to 20,000 RPM and a compact measurement head. A new optical configuration reduces the sensor head size, making it easier to get close to the measurement object. For industrial environments, a robust design is combined with an integrated air purge system to cool the sensor head and prevent contamination from oil spray and dust.

Taken together, these industrial features enable difficult, on-vehicle measurements of an operating drive train under real driving conditions! As proof of the vibrometer's usefulness, automotive design and test engineers have skillfully used rotational vibrometer data to reduce engine noise and to increase product durability.

More Info: www.polytec.com/rotvib

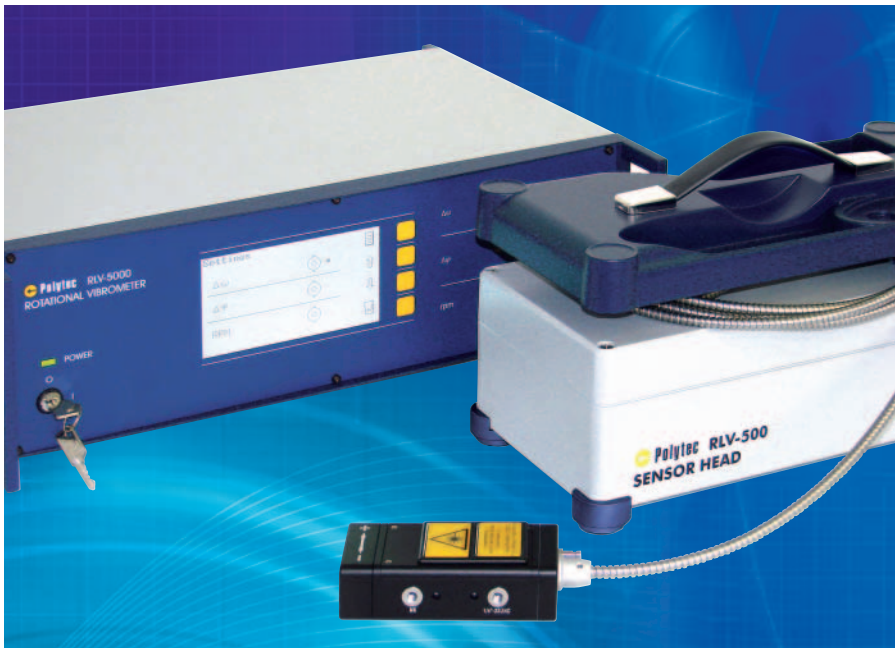
More Precision, Better Design: The Second Generation

The RLV-5500 Rotational Vibrometer is the impressive digital successor to the analog OFV-4000 that revolutionized optical measurement of rotational vibration. Since the sensor uses light as the probe, no inertial mass is added to the rotating structure and no telemetry is required to get highly accurate and reliable data. The latest digital decoding technologies reveal the smallest signal details in the vibrational spectrum previously hidden in analog device noise.

A compact, rugged measurement head offering standoff distances from 70 to 600 mm allows a convenient set-up in confined spaces, a crucial feature for today's high-performance engine test stands. The new instrument design decouples the electronics from the optics, permitting the construction of an innovative sensor head that is small, robust and easy to handle.

Designed for Flexibility and Precision

The RLV-5500 Rotational Laser Vibrometer consists of the RLV-500 Rotation Sensor Head and the RLV-5000 Controller. The Sensor Head is also divided into two functional sections: the Laser Unit and the Compact Sensor. The Laser Unit includes a Helium-Neon laser and two high-precision interferometers for converting minute frequency changes of the reflected laser light into electrical signals. These signals are then decoded in the RLV-5000 Controller. The outputs of the decoding process are voltage signals proportional to the real-time angular velocity and – by integration – angular displacement.



RLV-500 Compact Sensor

By separating the laser and interferometers from the delivery and receiving optics, a Compact Sensor was designed that increases mounting and positioning options without sacrificing measurement precision. The Compact Sensor is connected to the Laser Unit with an industrialized, steel-sheathed optical fiber that delivers the light from the laser to the rotating structure and collects the back-scattered light needed for the measurement. The scattered light contains the information about the rotational dynamics encoded as a Doppler shifted frequency modulation of an RF carrier frequency.

The Compact Sensor is available in fixed standoff distances of 70 mm, 200 mm, 400 mm and 600 mm. It can have two different beam separations: 7.5 mm for maximum speed or 24 mm for highest sensitivity. For more details please refer to the Specification Section.

Get In and Out of Harsh Environments Quickly

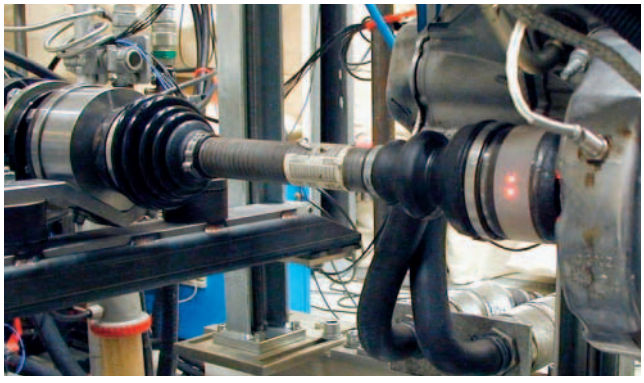
The Compact Sensor can be optimally positioned in minutes using a removable balance indicator. The Head is easily positioned in industrial environments where hot temperatures, dirt, moisture and dirt are prevalent. The Head is designed to meet the IP-67 specification for protection from heat, oil spray and dust.

RLV-5000 Controller for Signal Processing

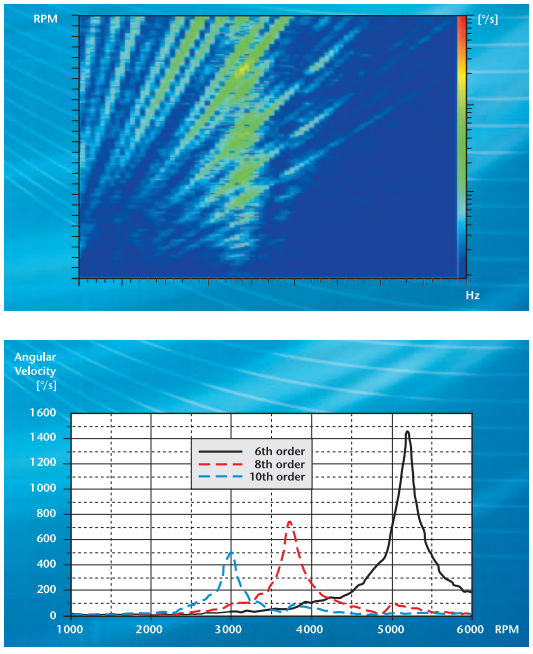
Digital Vibrometry delivers extraordinary results with precision optics to deliver clear optical signals to the detectors and powerful electronic decoding techniques to extract the rotational information from the raw signal.

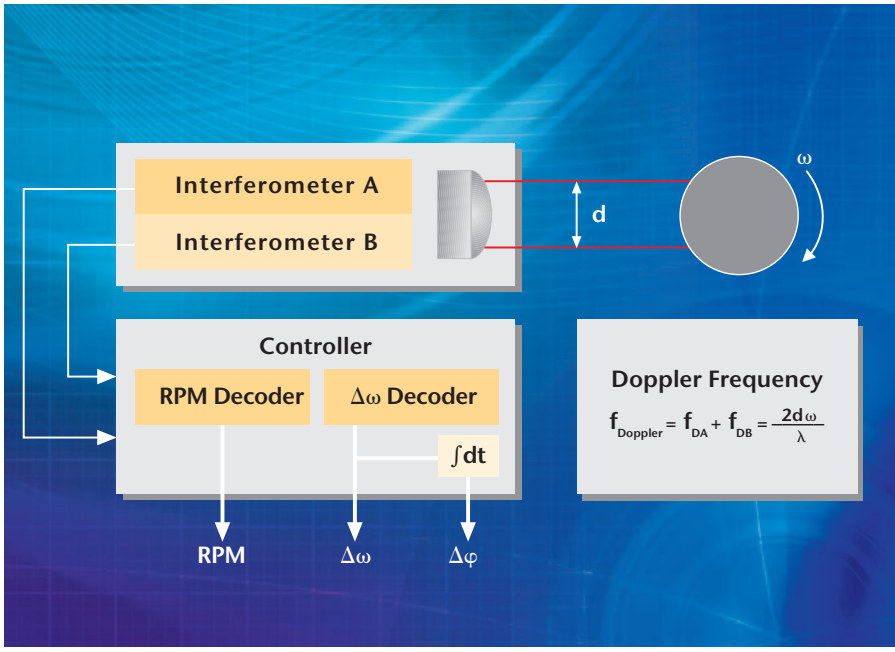
The RLV-5000 Controller provides basic measurement features that allow a perfect adaptation to the measurement task. The signal processing electronics and power supply are incorporated in a 19” rack-mount, industrial housing. High-pass, low-pass and band-pass filters adapt the bandwidth to the required ranges, getting rid of ambient noise.

Order-filters were designed for precision tracking of specified orders. Special RPM filters are available to allow applications ranging from high-speed run-ups up to 40,000 RPM/s to monitoring constant running shafts with slight variations of the rotation close to DC. These filters are accessed intuitively in a clearly structured menu-driven user interface. Special configuration settings are easily stored in user-defined configuration files.



Advancing Measurements by Light





The image shows an order tracking analysis of a crankshaft. Results are equivalent to the output from a magnetic encoder but free from added inertial mass. Set-up, data acquisition and tear-down were accomplished by the Rotational Vibrometer in a fraction of the time needed to install the encoder.

Flexibility to Solve Your Application

Polytec's rotational vibrometers measure rotational 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 for:

- Reduction of noise and vibration
- Studies of rotational fatigue
- Monitoring and trouble shooting production machinery
- Simplifying adjustment of torsional vibration dampers in vehicle drive shafts
- Order tracking analysis
- Testing auxiliary equipment for combustion engines

Principle of Operation

The Rotational Laser Vibrometer uses two parallel laser beams which exit the front lens of the Compact Sensor Head and strike the rotating surface. Each back-scattered laser beam is Doppler-shifted in frequency by the surface velocity vector in the beam direction. This velocity is made up of rotational and lateral components. Raw velocity information from each beam is independently sent to the RLV-5500 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.

A significant 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. For measuring positive and negative rotations as well as vibrations centered around zero RPM, a Bragg cell is incorporated into the dual interferometer. The Bragg cell produces a constant angular velocity offset by frequency shifting thelaser beams.

Find more information on **www.polytec.com/vib-university**

Accessories

To make an application more convenient, a range of positioning and optical accessories can be added to the RLV-5500 to improve usability and adapt it to specific measurement conditions. Please refer to the table of accessories, contact your local Polytec sales/application engineer for more detailed information, or visit **www.polytec.com/rotvib**.

RLV-5500 Technical Specifications

Metrological Properties

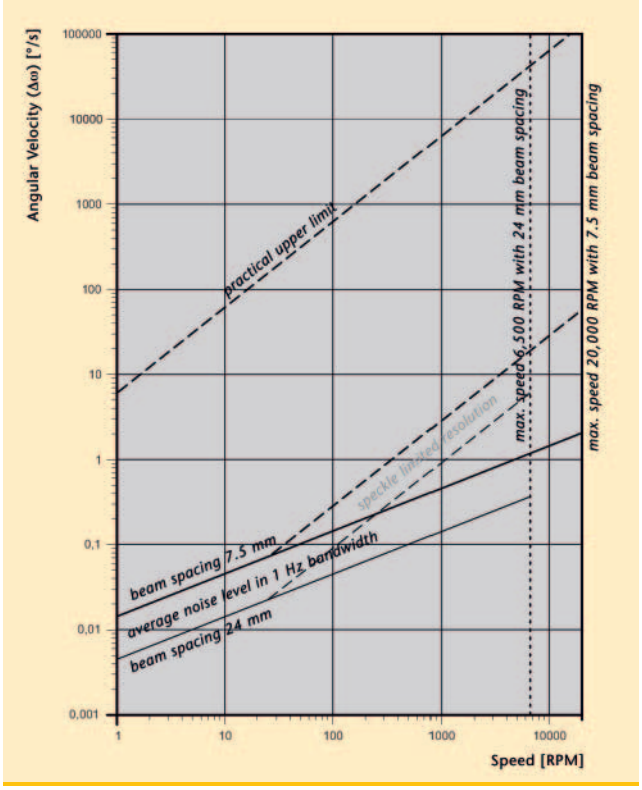
Rotations per Minute		
Version	7.5 mm beam separation	24 mm beam separation
Measurement range	–8,000 RPM ... +20,000 RPM	–2,500 RPM ... +6,500 RPM
Analog output	–4 V ...+10 V	–2.5 V ...+6.5 V
Calibration error	< 0.3 %	
Filter settings	DC; slow/medium/fast response	

Angular Velocity (Δω)								
Version	7.5 mm beam separation				24 mm beam separation			
Measurement ranges (°/s/V)	10	100	1,000	12,000	10	100	1,000	6,000
Peak analog output (V)	±10	±10	±10	+10/–4	±10	±10	±10	+6.5/–2.5
Frequency range (kHz)	0.001 ... 10			0 ... 10	0.001 ... 10			0 ... 10
Measurement error	<1 % (at f = 1 kHz)							
Noise properties	See diagram							
Filters	High and low-pass filters, order and variable band-pass filters							

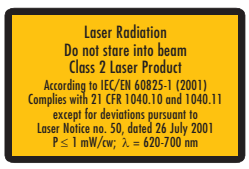
Angular Displacement (Δφ)			
Measurement ranges	0.01 °/V	0.1 °/V	1 °/V
Peak analog output	±10 V	±10 V	±10 V
Lower frequency limit f_u	1 Hz ... 100 Hz [1]	1 Hz ... 10 Hz [1]	1 Hz
Measurement error	<2 % (f = 5 · f_u ... 8 kHz); <10 % (f = f_u ... 10 kHz)		
Filters	High and low-pass filters, order and variable band-pass filters		

[1] Dependent on selected angular velocity range

Operating Range of the Rotational Vibrometer



Optics	
Laser type	Helium-Neon
Laser output	633 nm (red), <1 mW per beam, Class 2
Beam separation	7.5 mm or 24 mm (±0.3 mm, fixed configuration)
Stand-off distance	70 mm, 200 mm, 400 mm or 600 mm (fixed configuration)
Balance	Removable balance indicator at the sensor head. Additional balance indicator in the controller display
Signal level display	Removable optical display at both the Sensor Head and Controller, for both measurement beams



RLV-5500 Technical Specifications

RLV-500 Compact Sensor Versions				
Stand-off distance	70 mm	200 mm	400 mm	600 mm
Beam spacing 24 mm	RLV-500-124	RLV-500-224	RLV-500-424	RLV-500-624
Beam spacing 7.5 mm	RLV-500-175	RLV-500-275	RLV-500-475	RLV-500-675

General Properties, Housing and Power			
System	Dual interferometer system with heterodyne detection		
Components	RLV-5000 Controller (19" rack-mountable housing)	RLV-500 Rotational Sensor Head	
		Laser Unit	Compact Sensor
Dimensions [L x W x H]	45 mm x 360 mm x 150 mm (17.7 in x 14.2 in x 5.9 in)	330 mm x 170 mm x 175 mm (13 in x 6.7 in x 6.9 in)	115 mm x 56 mm x 35.5 mm (4.5 in x 2.2 in x 1.4 in)
Weight	9 kg (19.8 lbs)	8 kg (17.6 lbs)	0.5 kg (1.1 lbs)
Housing protection	IP-21	IP-67 (IP-64 with signal indicator)	IP-67
Cable length		3 m from Laser Unit to Compact Sensor	
Operating temperature	+5 °C ... +40 °C (41 °F ... 104 °F)	+5 °C ... +40 °C (41 °F ... 104 °F)	+5 °C ... +50 °C (41 °F ... 122 °F)
Storage temperature	–10 °C ... +65 °C (14 °F ... 149 °F)		
Relative humidity	<80 %, non-condensing		
Mains voltage	100 ... 240 VAC ± 10 %, 50/60 Hz		
Power consumption	max. 100 VA		
Tracking filter	1 per channel with "slow" and "fast" option		
Analog outputs (BNC)	• RPM • Angular velocity • Angular displacement		
Digital output	RPM, digital signal (binary value) via RS-232		
Measurement surface preparation	Not required in "High Sensitivity Mode". The signal-to-noise ratio will be generally improved by using reflective tape VIB-A-TAPE. Refer to the "Accessories" section.		

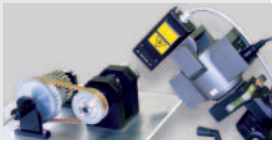
Accessories	
RLV-A-530	90° Deflection unit for measurements at positions difficult to reach
RLV-A-540 (included)	Air nozzle for improved protection against oil mist and dust
VIB-A-TAPE	Retroreflective adhesive tape for surface preparation; width 10 mm, length 4.5 m
VIB-A-T04	Heavy-duty tripod with tip/tilt head
VIB-A-T05	Heavy-duty tripod with geared tip/tilt head
A-PTT-9015	Remote controlled motorized tip-tilt stage
A-PTT-C015	15 m extension cable for A-PTT-9015
A-CBA-A003	Counterbalanced extension for tripods

Compliance with Standards	
Electrical safety	IEC/EN 61010-1:2002-08
EMC	IEC/EN 61326-1:2006-10; 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 60825-1:2003-10 (CFR 1040.10, CFR 1040.11)

RLV-A-530 Deflection Unit

RLV-A-540 Air Nozzle

A-PTT-9015 Motorized Stage on VIB-A-T04 Tripod



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

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