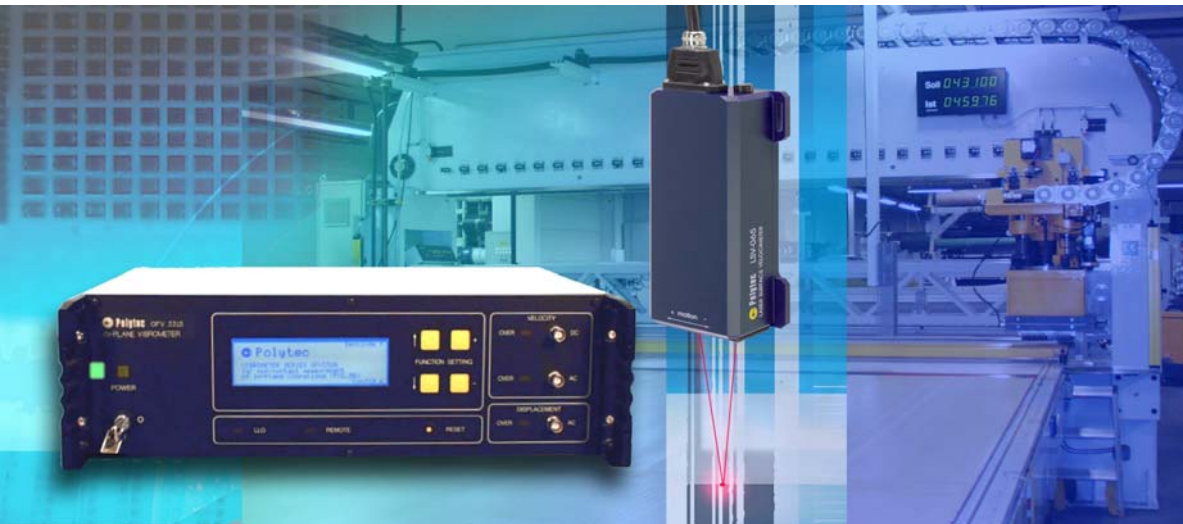


Polytec *In-Plane Vibrometer*



POLYTEC LASER VIBROMETERS

- Single Point Vibrometers
- Differential Vibrometers
- Rotational Vibrometer
- In-Plane Vibrometer
- 3D Vibrometers
- Microscope Systems
- Scanning Vibrometers

MEASURING IN-PLANE VIBRATION

An in-plane laser vibrometer is designed to measure the velocity of a surface moving in a plane perpendicular to the bisector of the two converging laser probes. The frequency shift (Doppler Effect) of the back-scattered laser light is used to determine the velocity. Signal processing separates the continuous motion (DC, average velocity) from the vibration (AC) component. Non contact, load-free velocity measurement is essential to study and develop tape drives, ultrasonic knives and scalpels, photocopiers, printers, belt drives and other moving parts where slippage, vibration and mass-loading can be a problem.

System Description

The In-Plane Vibrometer consists of a laser measurement head that probes the object under study and a separate controller that provides the user interface, power to the head and signal processing of the raw heterodyne output.

The standard **LSV-065-306F Measurement Head** emits a pair of converging laser beams to differentially sense the in-plane vibrations. These probe beams are positioned symmetrically about the orthogonal to the examination point on the object's surface. Depending on measurement bandwidth requirements, the LSV-065-306F can be paired with either the **low frequency OFV-3310** or the **high frequency OFV-3320 Controller**. Each controller is assembled in a 19" housing, linked to the measurement head via a control cable, has analog FM demodulation electronics to extract the signal from the carrier, and uses a micro-processor to calculate and display the DC velocity.

Key Features

- Measures in-plane velocities, including stopping and reversals
- Large standoff, small spot size laser probe
- Velocities from -40 m/s to +50 m/s (DC) and 100 m/s_{p-p} (AC)
- Frequency range 0 - 50 kHz (OFV-3310) or 0.5 Hz - 250 kHz (OFV-3320)

Key Benefits

- Powerful tool for diagnosing slippage and vibration problems
- Zero-mass loading does not disturb sensitive measurements
- Proven technology used on photocopier transfer carriages, servo drives, and reciprocating stages

Measurement Principle

Differential laser Doppler velocimetry is commonly used to measure fluid and gas flow. Polytec has incorporated the same principle in the LSV-065-306F measurement head but applied it specifically to measure moving surfaces.

Within the measurement head, the output of a diode laser is split into two beams. These probe beams exit the head, converge and overlap with a known angle, φ , on the moving surface to be measured. The overlapping of the two beams results in a three-dimensional region (measurement volume) which contains an interference pattern that is composed of parallel light and dark fringes.

The surface to be measured cuts the central portion of the measurement volume, revealing and scattering the fringe pattern. The fringe spacing, δx , depends only on the beam intersect half-angle, φ , and the laser wavelength, λ . Wavelength stabilization, product design and manufacturing are very important to keeping these two variables constant.

$$\delta x = \frac{\lambda}{2 \sin \varphi} = \text{const.}$$

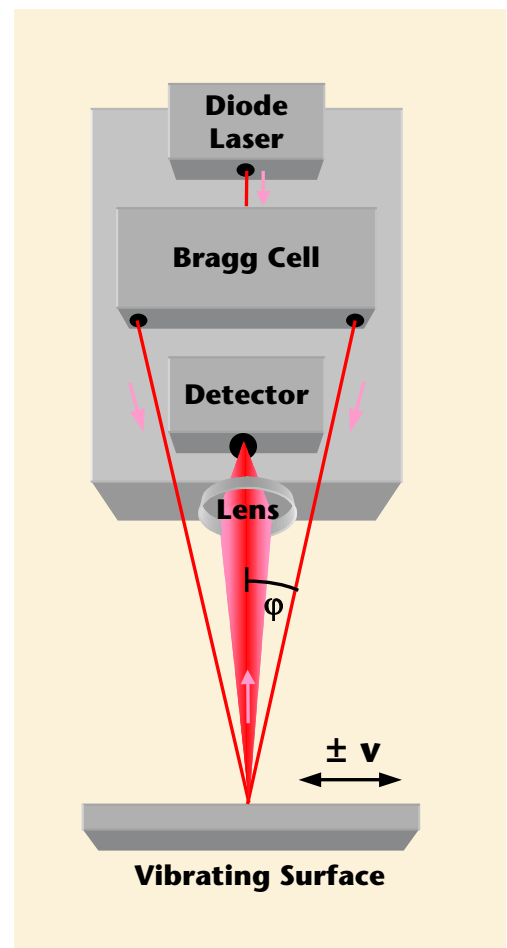
Diffusely scattered light from the fringe pattern is collected by a lens centered on the bisector and focused onto a detector. Because of the periodic nature of the fringe pattern and changing scattering properties across the surface, the detected light will be intensity modulated at a frequency, f_m , proportional to the surface velocity, v , perpendicular to the fringe pattern.

After frequency demodulation performed in the controller unit, the resulting measurement signal will have a DC frequency component proportional to the average speed and an AC component corresponding to the variations around that velocity.

As described, the measurement head could not distinguish the direction of motion of the surface. A velocity to the left would produce the same modulation frequency as a velocity to the right. To resolve the sign of the velocity, Polytec has slightly shifted the frequencies of the two laser probes. This frequency offset, generated by a Bragg cell,

causes a moving fringe pattern through the measuring volume and across the surface being measured.

A stationary surface, swept by the moving fringe pattern, has a modulation frequency at the detector determined by the frequency difference between the two probes. This carrier frequency determines the zero velocity position. Velocities are shifted above or below the carrier depending on the sign of the velocity relative to the sweep direction.



Heterodyne demodulation of the carrier frequency and subsequent signal processing in the controller delivers an AC signal representing dynamic velocity fluctuations and a DC signal representing the average velocity. The frequency range in question can be selected by finely adjustable filters. The analog AC and DC signals are available on the front panel of the OFV-3310 controller. The high-frequency OFV-3320 controller only provides the AC component at its output.

In-Plane Vibrometer Technical Data

LSV-065-306F Sensor Head	
Laser type/wavelength	Diode laser, nom. 670 nm/ <10 mW (visible)
Laser protection class	III B
Characteristics	
Stand-off distance	300 mm
Nominal fringe spacing	4.04 μm
Depth of field	± 2 mm
Diameter of focal volume	150 μm
General Specifications	
Protective housing type	IP 65 (with cable connector fixed)
Operating temperature	± 0 °C ... +45 °C (32 °F ... 113 °F)
Storage temperature	-10 °C ... +65 °C (14 °F ... 149 °F)
Maximum air humidity	100 %, without condensation
Dimensions (W x L x H)	120 mm x 240 mm x 65 mm
Weight	2 kg
Cable	5 m interconnecting cable between optical head and controller



OFV-3310 Controller



LSV-065 Sensor Head

OFV-3310 and OFV-3320 Controller	
General Specifications	
Mains voltage	100/115/230 volt, 50/60 Hz
Power consumption	Max. 150 VA
Dimensions (W x L x H)	450 mm x 355 mm x 135 mm
Operating temperature	+5 °C ... +40 °C (41 °F ... 104 °F)
Maximum air humidity	80 %, without condensation
Weight	11 kg

In-Plane Vibrometer Technical Data

OFV-3310 and OFV-3320 Controller (continued)		
Characteristics		
Controller	OFV-3310 universal In-Plane Vibrometer Controller	OFV-3320 high speed, high frequency AC In-Plane Vibrometer Controller
Frequency range	0 Hz (DC) ... 50 kHz	0.5 Hz ... 250 kHz
Processing scheme	Analog frequency demodulation	Analog frequency demodulation
Measurement ranges	AC velocity in 4 ranges: - 0.025 m s ⁻¹ /V - 0.1 m s ⁻¹ /V - 0.5 m s ⁻¹ /V - 5 m s ⁻¹ /V DC velocity: -40 m/s ... +50 m/s (slope: 5 m/s per V)	AC velocity in 4 ranges: - 0.05 m s ⁻¹ /V - 0.25 m s ⁻¹ /V - 1.25 m s ⁻¹ /V - 10 m s ⁻¹ /V
Resolution	< 25 μm/s in a 10 Hz spectral bandwidth (AC, 0.025 m s ⁻¹ /V)	< 50 μm/s (0.05 m s ⁻¹ /V)
Acceleration	Max. acceleration: 5 * 10 ⁶ m/s ² (Tracking Filter: FAST)	Peak acceleration: 1.5 * 10 ⁸ m/s ² (@ 100 m s ⁻¹ / 250 kHz)
Signal output DC velocity	Voltage swing: +10 V	not available
Signal output AC velocity	Voltage swing: ±10 V Calibration accuracy: ±2.5% of RMS reading	Voltage swing: ±10 V Calibration accuracy: ±2.5 % of RMS reading
Filters	High-pass: 1 Hz ... 255 Hz (28 settings) Low-pass: 200 Hz ... 51 kHz (28 settings)	High-pass: 1 Hz ... 255 Hz (28 settings) Low-pass: 200 Hz ... 51 kHz (28 settings)
Interfaces	RS-232 and IEEE-488	RS-232 and IEEE-488

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