

## Technical Specifications

Electrical Specifications				
<b>Output type</b>	Analog voltage proportional to vibration velocity in L, R, T laser beam and cartesian coordinate x,y,z direction			
<b>Frequency response</b>	<b>CLV-3220</b>	<b>CLV-3230</b>		
	(CLV-M020.B decoder)	(CLV-M030.B decoder)		
	0.5 Hz to 50 kHz (±0.5 dB)	0.5 Hz to 250 kHz (+0.3/-1 dB)		
<b>Measurement ranges</b>	3			
<b>Peak velocity (mm/s)</b>	±50	±250	±1,250	
<b>Scaling factor(mm/s/V)</b>	5	25	125	
<b>Analog velocity output</b>	±10 V, output impedance 50 Ω, BNC connector			
<b>Maximum acceleration</b>	40,000 g for CLV-M020.B decoder 200,000 g for CLV-M030.B decoder			
<b>Spurious free dynamic range (SFDR)</b>	> 70 dB (f < 20 kHz),			
	> 60 dB (f ≥ 20 kHz)			
v <sub>x</sub> , v <sub>y</sub> and v <sub>z</sub> outputs				
<b>Velocity resolution<sup>(1)</sup> (μm/s):</b> (5 mm/s/V range)	f=160 mm lens		f=310 mm lens	
<b>Direction of Vibration<sup>(2)</sup></b>	x, y	z	x, y	z
<b>10 Hz ≤ f &lt; 20 kHz</b>	< 1	< 0.2	< 2	< 0.2
<b>20 kHz ≤ f ≤ 200 kHz</b>	< 3	< 0.5	< 5	< 0.5
<b>Output filter</b>	High-pass filter 10 Hz (-3dB), switchable			
Optics				
<b>Measurement spot size</b>	80 μm for f=160 mm lens, 160 μm for f=310mm lens			
<b>Nominal standoff distance</b>	145 mm ± 1.5 mm with f=160mm lens 302 mm ± 3.0 mm with f=310mm lens			
<b>Laser output</b>	Helium-Neon (HeNe), 633nm (visible, red)			
<b>Total laser power exiting front lens</b>	< 3 mW			
<b>Laser safety class</b>	III R (III A) (Meets ANSI Z136.1)			
Housing and Power				
<b>Controller</b>	19" Rack format. 6HE 350 mm deep, 450 mm wide, 290 mm high			
<b>Optics</b>	276 mm long, 100 mm wide, 96.5 mm high			
<b>Weight</b>	Controller: 24 kg, Optics: 4 kg			
<b>Connection cable</b>	Length 3 m, minimum bending radius 80 mm			
<b>Optics mounting</b>	English and metric threaded holes in base			
<b>Power requirements</b>	100 – 240 V AC, ±10 %; 50-60 Hz, max. 150 W			
Compliance with Standards				
<b>Electrical safety</b>	EN 60950 (IEC 950), EN 61010 (IEC 1010)			
<b>EMC</b>	Emission: EN 50081-2 (FCC Class A) Immunity: EN 61000-6-2 (IEC 61000-6-2)			
<b>Laser safety</b>	EN 60825-1 (CFR 1040.10, CFR 1040.11)			
<b>CE</b>	Mark (EMC, laser safety, LVD)			

<sup>(1)</sup> The resolution is defined as the signal amplitude (rms) at which the signal-to-noise ratio is 0dB in a 10 Hz spectral bandwidth (RBW), measured from 3M Scotchlite® Tape.

<sup>(2)</sup> See figure on page 2 for definition of directions according to 3D-LV sensor head.

The information contained in this publication is subject to change without notice.

# 3D-LV Compact 3D Laser Vibrometer

## Introduction

Polytec's -3D LV non-contact vibration sensor simultaneously measures all three linear velocity components at a point on a vibrating structure. The system comprises a three-channel CLV controller unit coupled to an optical sensor containing three independent CLV optical systems, all focused to the same measurement point approximately 145 mm (or 302 mm) from the front lens. The individual vibration components lying along the three respective laser beams are available as analog outputs. Most importantly, a geometry-calculation module generates true  $v_x$ ,  $v_y$  and  $v_z$  analog outputs in real time, and can process vibration frequencies as high as 250kHz.

Using 3D-LV, Polytec customers can now make non-contact, tri-axial measurements with total simplicity. Users of conventional, single-axis laser vibrometers will especially appreciate the convenience no longer having to make three separate measurements and then manually calculating  $v_x$ ,  $v_y$  and  $v_z$ .

Users of tri-axial accelerometers will be pleased to finally make non-loading 3-axis measurements. A small overall measurement spot diameter of only 80 μm, (a much smaller footprint than any accelerometer), allows measurement of smaller components. And, of course, with a bandwidth of 250kHz, all three components of a high frequency vibration can now be measured accurately in one shot.

3D-LV enjoys the same advantages as the other laser vibrometer products in the Polytec family. It gathers enough light from poorly reflecting surfaces such that little or no reflective enhancement is needed. Its wide dynamic range, excellent bandwidth and low noise enable use in many advanced applications. And, of course, customers enjoy the benefits of Polytec's world-wide service & applications support network.

## Features

- Simultaneous measurement of 3 vibration velocity components
- True  $v_x$ ,  $v_y$  and  $v_z$  output
- 2 different frequency ranges available: 0.5 Hz to 50 kHz and 0.5 Hz to 250 kHz
- For velocities up to 1.25 m/s
- 3 velocity ranges for high resolution
- Compact and ruggedized sensor head
- 2 different stand-off distances available
- Modular electronics design
- Optional motorized test stand

## The System Optical Sensor



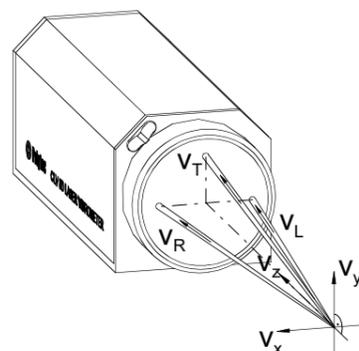
The 3D-LV optical sensor contains the optical components of three independent CLV-700 sensors. Each output laser beam is inclined at a 12° angle (f=160 mm lens version) with respect to the surface, but from three slightly different directions. A 12° angle is small enough to allow the sensors to collect enough back-

scattered light to make a high-quality measurement, but still large enough for good sensitivity to the in-plane vibration components. Furthermore, the narrow cone angle allows the beams to pass through small holes or windows in wind tunnels or environmental test chambers. For even narrower cone angle applications, a f=310mm front lens may be fitted in combination with a 310mm version of the geometry module.

## Signal Outputs

The 3D-LV provides separate analog outputs for the vibration velocity in direction of the three laser beams  $v_L$ ,  $v_R$  and  $v_T$ . If geometry calculation is performed by software these raw outputs can be directly connected to a 3 channel data acquisition board.

The geometry calculation module generates three additional analog outputs of the cartesian velocity components  $v_x$ ,  $v_y$  and  $v_z$  in real time.



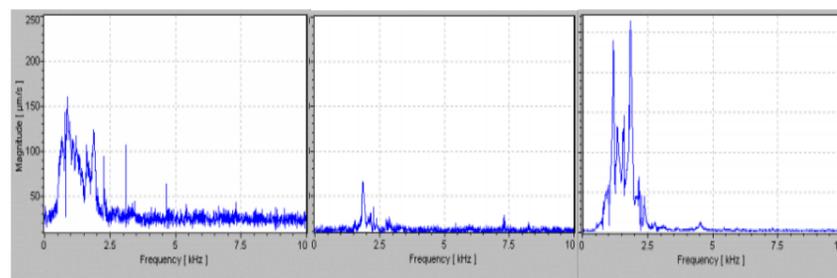
## Performance considerations

A conventional laser vibrometer is usually operated perpendicular to a surface and strictly measures  $v_z$ . Because a laser vibrometer measures the component of vibration lying along the laser beam, it is natural that all three 3D-LV laser beams (L, R and T) will be more sensitive to  $v_z$  than  $v_x$  &  $v_y$ . In fact, because the measurement laser beams are predominately aligned in the z-direction, a vibration in the z-direction will produce a five-times-higher Doppler shift than a vibration with the same amplitude lying in the x- or y-directions. Furthermore, since for many applications, the out-of-plane component  $v_z$  of surface vibration is usually much larger than the in-plane components  $v_x$  and  $v_y$ , it follows that the analog outputs  $v_x$  and  $v_y$  will usually display smaller vibration signals and higher noise than  $v_z$ .

With the angle  $\theta$  set to approximately  $12^\circ$ , the z- and x-components are given by:

$$v_z = (v_L + v_R) / 1.96 \quad \text{and} \quad v_x = (v_R - v_L) / 0.42$$

These relationships show that, even if the resultant velocities  $v_z$  and  $v_x$  are the same, the higher amplification required to correctly calculate the components will generate roughly 5 times the noise level at the  $v_x$  analog output than  $v_z$ .



Vibration velocity measurement on harddisc drive suspension:  $v_x$ ,  $v_y$ ,  $v_z$  (left to right)

Measurements on various test surfaces have shown the noise floor at the  $v_z$  output to be 10 to 12dB lower than  $v_x$  or  $v_y$ . With a "perfect" surface such as 3M Scotchlite retro-reflective tape,  $v_x$  and  $v_y$  have a noise floor of better than  $1 \mu\text{m}/\text{sec}$  measured in a 10Hz resolution bandwidth.  $v_z$  is better than  $0.5 \mu\text{m}/\text{sec}$ .

## Hardware

The controller unit is divided into upper and lower sections. The lower section contains three CLV laser modules (CLV-810) plus the master power supply module. The upper section generates the three analog velocity outputs  $v_x$ ,  $v_y$  and  $v_z$  in addition to the "raw" outputs  $v_L$ ,  $v_R$  and  $v_T$ .

Doppler signal demodulation is performed by a combination of three input modules (type CLV-M200) and three velocity decoding modules (type CLV-M020.B for 50 kHz version or CLV-M030.B for 250 kHz version) chosen according to the bandwidth demanded by the application. A master control knob on one of the three velocity modules controls the velocity range-setting for all three channels. The other two modules are run in slave or "remote" mode. Each input module generates an LED bar proportional to gathered light.

A single output module conditions the raw Doppler signals from the three laser beams and outputs  $v_L$ ,  $v_R$  and  $v_T$ . The single geometry module performs an analog calculation and outputs the true  $v_x$ ,  $v_y$  and  $v_z$  components.

A switchable 10 Hz-high-pass filter is provided for cutting off low-frequency vibrations.

A motorized test stand (model CLV-Z-018) is available for fine positioning of the 3D-LV head in z-direction. The test stand can be used with both  $f=160 \text{ mm}$  and  $f=310 \text{ mm}$  front lenses. Speed of the movement is controlled in 3 different ranges.



3D-LV sensor head mounted on motorized test stand (CLV-Z-018)