PRODUCT DATA

Laser Doppler Vibrometer — Type 8329
Quality Control Laser Doppler Vibrometer — Type 8335

Ometron VH300+ Laser Doppler Vibrometer Type 8329 and Ometron VH40+ Quality Control Laser Doppler Vibrometer Type 8335 are industrially engineered interferometers manufactured by the Ometron division of Image Automation Ltd.

USES

- Non-contact measurement of vibration velocity:
  - on surfaces at extreme temperatures
  - for whirling (rotational bending) of rotating shafts
  - through layers of glass
  - on targets submerged in water
  - in high radiation or magnetic fields
  - in clean rooms and wind tunnels
  - for remote vibration measurements (up to 25 m)
  - for quality control applications (Type 8335)
- Vibration measurements without mass loading on:
  - lightweight, small, or delicate structures
  - soft materials and human tissue
- Shock measurements:
  - measurements with no zero shift, ringing, leakage or mounted resonance effects
- Relative vibration measurements on board ships, in aircraft and in cars
- Absolute vibration measurements made possible by attachment of (optional) accelerometer at back plate of instrument and subtraction of the two output signals (optional hardware needed)
- Absolute calibration of accelerometers

FEATURES

- High-quality and durable die cast aluminium housing
- Rugged mechanical, electrical and optical construction
- Small form factor
- Velocity range up to 425 mm/s peak (Type 8329) and 45 mm/s peak (Type 8335)
- Frequency range from < 0.01 Hz to 25 kHz
- Dynamic range 73.5 dB (Type 8329) over full bandwidth
- Extremely high optical sensitivity ensuring problem-free measurements on even the darkest surfaces
- Measurements from 0.4 m (16 in) up to 25 m (82 ft) possible without surface treatment or retro-reflective tape
- Measurements possible beyond 25 m (82 ft) using retro-reflective tape
- Advanced Signal Drop-out Detection (Type 8335)
- Eye-safe operation (Class II laser)
- Intuitive and easy to operate with built-in bar graphs for velocity level and focus indication
- Portable, compact, “one-box” design with integrated optics and electronics
- Battery or mains operated
- 12 V DC input – mains adaptor included
- Very low levels of drop-out noise (Type 8335) in any measurement setup, ensuring fast and reliable measurement
- Traceable calibration
- Velocity proportional signal and Doppler signal output
- Highest quality diffraction limited optics for superior signal fidelity
- Anti-reflection coating to avoid laser mode change noise

Introduction

Types 8329 and 8335 are highly accurate and versatile non-contact vibration transducers for applications where it is impossible or undesirable to mount a vibration transducer onto a vibrating object, and where they can often replace an accelerometer or microphone. Ease of use and rugged construction make Types 8329 and 8335 highly suitable in both laboratory and industrial environments.

Type 8329 specifications have been carefully targeted at general Research, Development, Test and Evaluation (RDT&E) applications. The high velocity capability (in excess of 400 mm/s) makes it an extremely versatile laser-based vibration transducer, covering the vast majority of laser vibrometry applications.

Type 8335 has been optimised for quality control applications, where a higher velocity resolution and an increase in optical sensitivity have been achieved over a reduced velocity range. The increased sensitivity of Type 8335 is particularly well-suited to surfaces with low reflectivity, such as rubber and die cast metal. Type 8335 comes with built-in, sophisticated Signal Drop-out Detection. Both instruments share a common, well-proven, opto-electronic architecture meeting the needs of the most critical users.

Working Principle

Optics

Types 8329 and 8335 are based on a Michelson interferometer in which a laser beam is divided into a reference beam and a signal beam. The signal beam is directed onto a vibrating test structure, and the back-reflected light is recombined with the internal reference beam. When the test structure moves, the frequency of the signal beam is shifted, resulting in intensity modulation of the recombined beam due to interference between the reference and signal beams. One complete cycle of the intensity modulation corresponds to a surface movement of $\lambda/2 = 0.316$ mm, half the wavelength of the helium neon laser source (where λ is the wavelength of the source, 0.633 mm). The frequency of this modulation (referred to as the Doppler frequency, F_d) is given by $F_d = 2v/\lambda$, where v is the surface velocity. The recombined light is split into two paths, and a quarter-wave plate used so that the two signals are in quadrature (sine and cosine) allowing the direction of motion to be determined. This allows both the speed and direction of motion to be determined. A balanced detection scheme, with two detectors in each channel, is used for low noise and high sensitivity. Hardware implementation of this measurement principle in LDV Types 8329 and 8335 yields a rugged and environmentally tolerant instrument incorporating no perturbing acousto-optic devices (i.e., Bragg cells).

Preamplifiers

In the preamplifier stage, the current from each pair of photodiode detectors is converted into a voltage by a wideband, low-noise amplifier in a screened environment. It is here that the optical signals are turned into electronic signals also known as “Doppler Signals”. These voltages are driven to the analogue processing board via coaxial cables.

Input Stage

The input filters remove high-frequency noise (signal components with a frequency above the maximum expected Doppler frequency for the velocity range of the instrument). The Doppler signals then pass through a dual-channel automatic gain control (AGC) circuit, which sets the amplitude to an optimum level for the mixer.

Mixer

A pair of quadrature carrier signals, which are approximations of sine and cosine waves, are produced by a digital circuit. The mixing process involves multiplying each Doppler signal by its corresponding carrier signal and summing the results. The mixer therefore implements the equation:

$$\cos(A - B) = \cos(A) * \cos(B) + \sin(A) * \sin(B)$$

A 6-pole, low-pass Butterworth filter removes any modulation due to unwanted harmonics of the carrier. This produces a frequency-modulated signal that represents the instantaneous velocity of the target, including information about the direction of motion.

Demodulator

A comparator and charge pump circuit form a frequency-to-current converter that extracts the velocity information from the FM signal. The resulting current is then converted to a voltage, the mean value of which is proportional to the velocity of the target surface.

Output Filter and Calibration

The demodulator output is low-pass filtered to remove demodulator ripple and set the maximum vibration frequency of 25 kHz. The gain and offset are adjusted to give a calibrated velocity output signal of 10 mV/mm^{-1} (Type 8329) and 100 mV/mm^{-1} (Type 8335).

Fig. 1 *Optical principle of Types 8329 and 8335 LDVs*

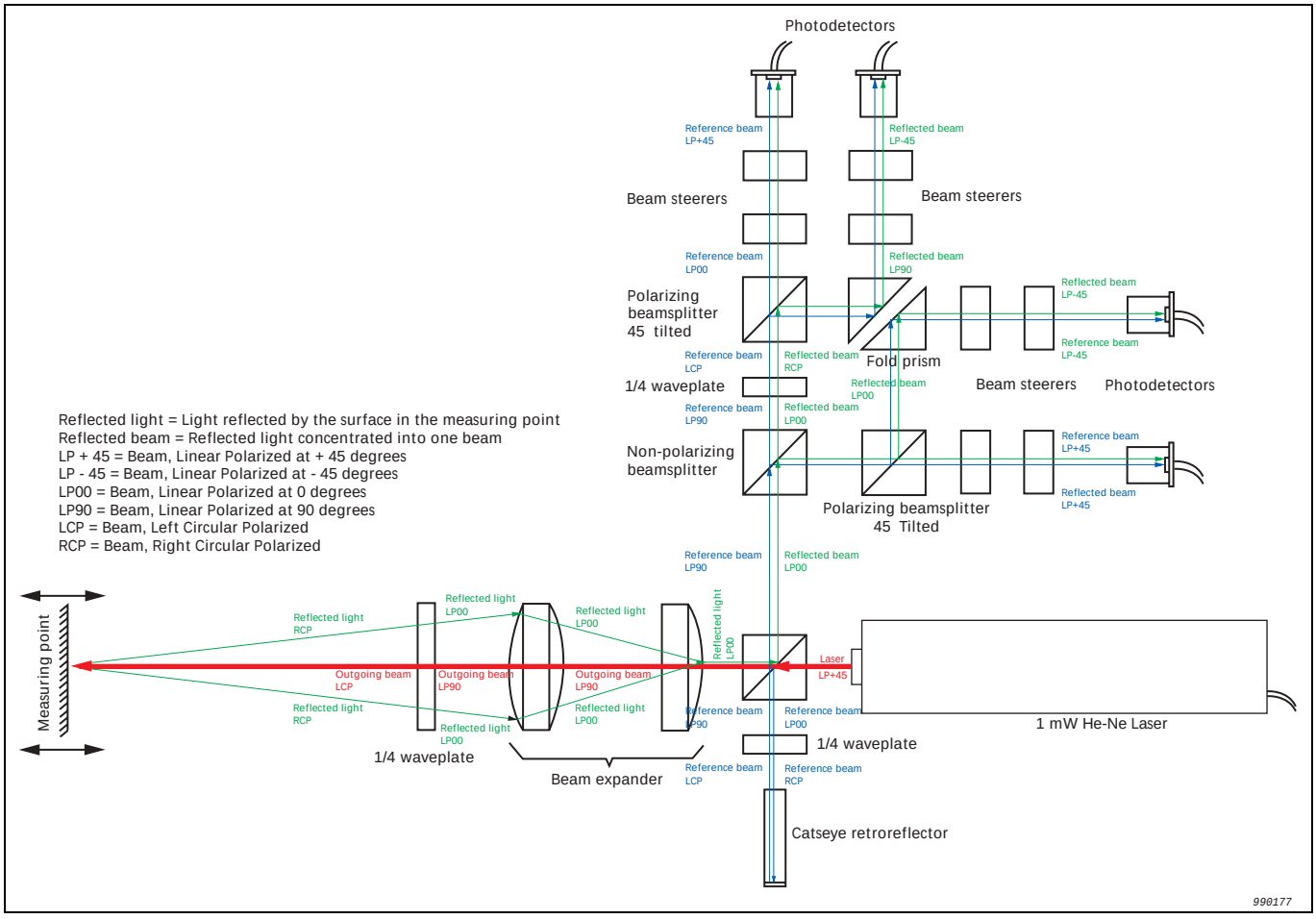
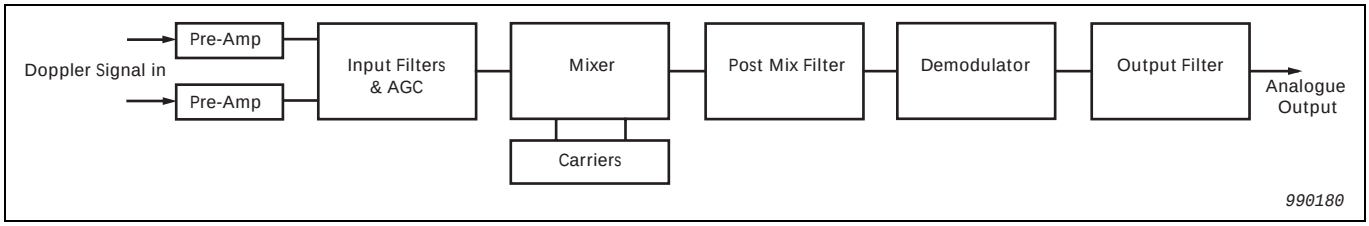


Fig. 2 *Block diagram of Types 8329 and 8335 LDVs electronics*



Type 8329 and 8335 LDV Nomogram

The nomogram in Fig. 3 describes the ranges of acceleration, velocity, displacement and frequency for a quick indication of whether Types 8329 and 8335 are suitable for the application.

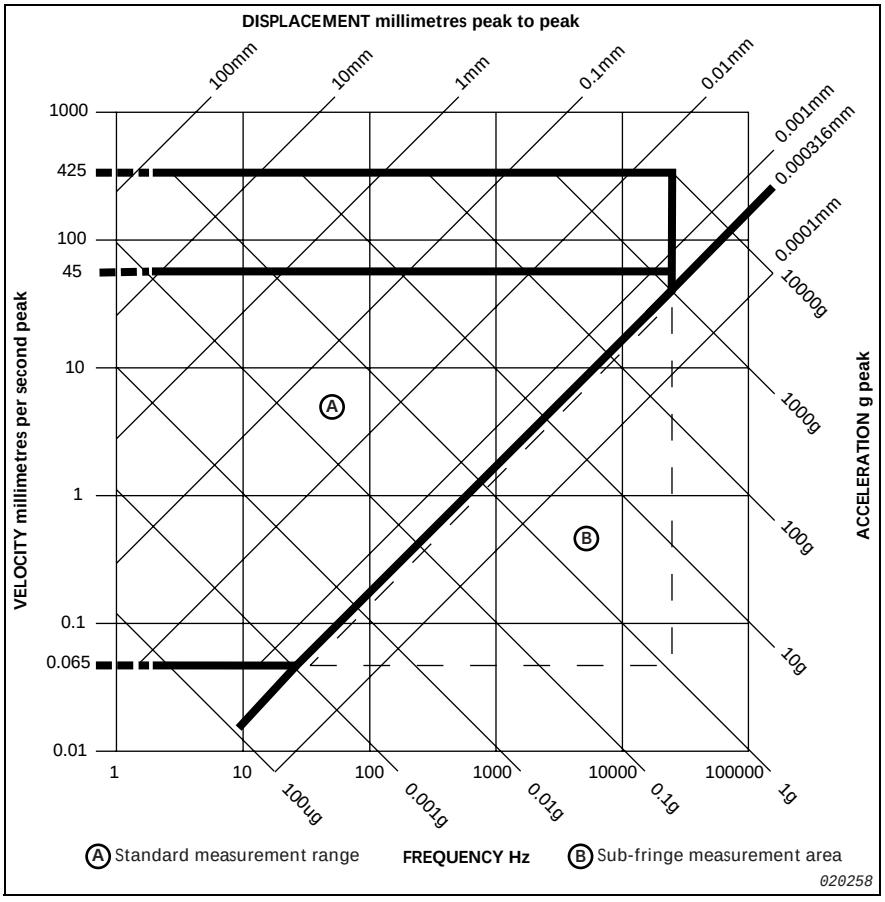


Fig. 3
Nomogram of working ranges for Types 8329 and 8335 LDVs. The 425 mm/s limit is for Type 8329 and the 45 mm/s for Type 8335. The area defined by A is accessible regardless of the application whereas the area defined by B is only accessible when a superimposed "carrier" within standard measurement range A is present. This superimposed signal can be of any type – random or deterministic – originating either because Types 8329 and 8335 vibrate and/or because the test object vibrates

For applications outside the area defined by the thick lines, please contact your local Brüel & Kjær representative for alternative solutions.

Basic Battery Kit (Option)

The Type 8329/8335 LDV can be hand held by an operator wearing the belt from the optional Basic Battery Kit ZG 0420. It should be observed, however, that the Type 8329/8335 LDV measures the relative velocity between the sensor unit and the object under investigation. Any movement by the operator will be superimposed on the velocity signal of the object. In addition, it is difficult for an operator to keep the laser beam fixed on one point on the vibrating surface. If possible, a fixed mounting on, e.g., a tripod is preferred. However, this is usually not a problem above 10 Hz and with higher velocity values.

Tripod (Option)

The Type 8329/8335 LDV has two mounting points, at the bottom and side of the sensor unit, each having a ¼″ hole with Whitworth thread, a widespread standard used for camera tripods. Type 8329/8335 can be mounted on the Brüel & Kjær Tripod UA 0989.

Mirror Kit (Option)

Mirror Kit UA 1554 is available for when there is no direct line of sight from the Type 8329/8335 LDV to the target surface. The mirrors are supplied with mounting magnets.

Applications

Environmental Applications
- Analysing traffic sound absorption by plants
- Quality testing of sound-deadening materials

Nuclear Applications
- Vibration analysis in a contaminated environment measured at long distance

Telecommunication Applications
- Analysis of vibration, caused by wind load, of parabolic antennas on towers

Industrial Applications
- Vibration analysis of car body panels, components and braking systems
- Vibration analysis of household appliances
- Loudspeaker testing
- Quality control of
  – machined metal castings
  – television tubes
  – hard disk or CD-ROM drives
- Lateral and axial vibration measurements on rotating components (e.g., on rotating machinery
- Hot exhaust systems

Research Applications
- Vibration analysis of models under investigation within a wind tunnel

- General non-contact vibration studies

Calibration Applications
- Transducer calibration

Compliance with Standards

CE, C-Tick	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand
Safety	Electrical Safety: IEC 950. Laser Safety: 21 CFR 1040.10 and 21 CFR 1040.11 (similar to EN 60825–1)
EMC Emission	EN 61000–6–3: Generic emission standard for residential, commercial and light industrial environments. CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
EMC Immunity	EN 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments.
Temperature	IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat. Operating Temperature: 5 to 35°C (41 to 95°F)
Humidity	IEC 60068–2–78: Damp Heat: Operating: up to 80% RH (non-condensing)
Mechanical	IEC 60068–2–6: Test Fc Vibration (sinusoidal), operating: 2 g peak, 10–150 Hz, 1 octave/minute, 10 sweep cycles on each axis

Specifications – Laser Doppler Vibrometer Type 8329, Quality Control Laser Doppler Vibrometer Type 8335

Dynamic

Velocity Range:
Type 8329: 65 µm/s to 425 mm/s (16.7 in/s) peak
Type 8335: 65 µm/s to 45 mm/s (1.77 in/s) peak
Typical Lowest Residual Noise Floor[1]: <0.1 $\mu ms^{-1}/\sqrt{Hz}$
Typical Average Residual Noise Floor: <0.4 $\mu ms^{-1}/\sqrt{Hz}$ @ the midband of 12.5 kHz
Frequency Range: < 0.01 Hz to 25 kHz
Working Distance: From 0.4 m (16 in) up to 25 m (82 ft) without surface treatment. Above 25 m (82 ft) on retro-reflective surfaces
Spatial Resolution: Approx. dia. 1 mm (0.04 in) at 10 m (33 ft) working distance
Accuracy of Output Signal: Better than 1% at analogue output
Velocity Output Sensitivity:
Type 8329: 10 mV/mms^{-1} (256 mV/ins^{-1})
Type 8335: 100 mV/mms^{-1} (2.56 V/ins^{-1})
Polarity: Positive analogue velocity signal when the test surface is moving towards Types 8329 and 8335 and negative analogue velocity signal when the test surface is moving away

Physical

Displays: LED bars for velocity and focus
Controls: Focus ring, trigger button (Type 8329), lens shutter
Signal Output Connectors: Analogue velocity (±4.25 V), Laser Doppler (× 2), Trigger (Type 8329), Signal Strength Indicator (Type 8335 only)
Laser: He-Ne continuous wave laser, <1 mW output power, 632.8 nm (red light). Life expectancy if LDV is used daily for min. 15 minutes >10000 hours
Laser Safety Class: Class II
Dimensions: 75 × 175 × 350 mm (3 × 6.9 × 13.8 in)
Weight: 3.7 kg (8.2 lb.)

Electrical

110 – 230 V, 50 – 60 Hz, mains supply using the power supply included with Types 8329 and 8335 – 12 V DC, 1.2 A, 15 VA supply

Environmental

Operating Temperature[2]: +5 to +35ºC (+41 to +95ºF)
Operating Relative Humidity: Up to 80% (non-condensing)
Operating Altitude: Up to 2200 m (7200 ft)

[1] Residual noise is a function of electronic noise and Doppler break-through noise, combining to form a frequency-dependent noise floor. Typical lowest residual noise floor is the noise floor at frequencies where only electric noise dominates, i.e., "typical best case" when making real measurements. Typical average residual noise floor is the noise floor at frequencies where frequency-dependent Doppler break-through noise dominates, i.e., "typical worst case". Both of these values presuppose a correctly performing setup.

[2] Types 8329 and 8335 can, with care, be used to obtain measurements even outside this range. The HeNe laser power supply incorporates over-temperature sensors, and automatically shuts down when overheating is detected (at around 45°C). This should be avoided where possible, but does not in itself cause any damage. The instrument should be switched off and allowed to cool down; then it will operate normally again. All the electronic components in Types 8329 and 8335 are rated to temperatures higher than that of the HeNe laser. However, there are potential temperature stability issues with the optics in going beyond the stated maximum operating temperature range. The performance of the frequency-to-voltage converter inside Types 8329 and 8335 will not be affected, so accuracy will not be impaired, but dynamic range will be reduced.

Ordering Information

Types 8329 and 8335 Laser Doppler Vibrometer
Include the following items:
Main Sensor Unit
Lens Cap
Power Supply 110 – 230 V, 50 – 60 Hz
MainsCable
BNC–BNC Cable
Shipping Case with Pressure Release Valve
User Manual
Laser Safety Inspection and Test Report
Allen Key
EC Declaration of Conformity
Certificate of Traceable Calibration

Optional Accessories

ZG 0420	Basic Battery Kit including Battery Belt with NiCd battery giving up to 4 hours continuous operation and Battery Cable for Types 8329 and 8335
UA 1554	Mirror Kit including high-reflectivity 75 × 75 mm mirrors with metallic bases, extension rods, magnets, knuckle joint, plastic carrying case that fits in the shipping case of Types 8329 and 8335)
UA 0989	Tripod
QA 0137	Retro-reflective Tape (Roll)
WE 0147	Watertight Case
WA 1516	Absorptive Filter Set

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