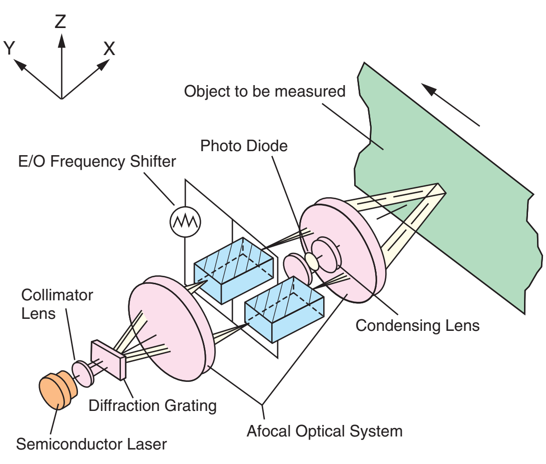
LASER DOPPLER VELOCITY SENSOR

Compact-Size, High-Precision, Low-Cost, Next-Generation Non-Contact Laser Doppler Velocimeters

Canon laser Doppler velocimeters, equipped with diffraction gratings, take advantage of an optical system (diffraction laser light Doppler method) that will not dependent on the laser wavelength. Therefore, the measurement precision is unaffected by fluctuations in the semiconductor laser wavelength due to changes in temperature. Not only are these sensors environmental stability they can be used for a wide variety of applications; since we use an E/O frequency shifter, they are capable of taking measurement from a still as well as a running state.

THEORY

The laser light emitted by a semiconductor laser is positioned so that it is a linearly polarized beam with respect to the z-axis. Then, a collimator lens makes it into a parallel light beam. The grating array direction of this parallel light beam is the direction of the y-axis, and the diffraction grating with a grating pitch d divides the beam into two light beams by a diffraction angle of q. Here, the equation $d \sin \theta = \lambda$ holds.
These two light beams pass through a first lens and are then irradiated into an E/O frequency shifter consisting of electro-optical crystals. After that, they are diffracted by a second lens before irradiated to the object moving at a velocity of V, which is being measured. The incidence angle of the two irradiated light beams is θ'.
The first and second lenses form an afocal optical system with a magnification of m, and the aberration is corrected so that $\sin \theta / \sin \theta' = m$.
The two light beams that are now modified to have a frequency difference fR by the E/O frequency shifter are then irradiated to the object to be measured, and the diffused beams coming back from the object proceed through the second lens and a condensing lens, eventually reaching the photo diode. The beat signal (i.e., the Doppler frequency) of these light beams containing the speed information obtained here is $F=2V/md+fR$, independent of the laser frequency; in addition, it is possible to measure the velocity from an object that is originally in a still state.
By signal-processing this Doppler frequency, the unit displays the velocity and sends the F/V output and pulse output.



S-100Z Optical Structure

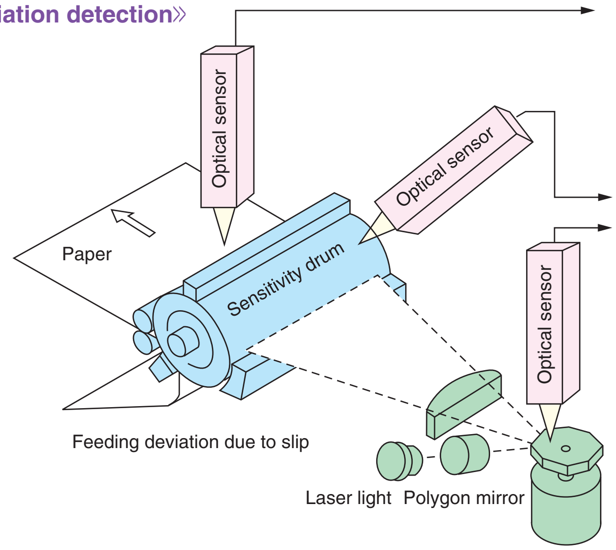
FEATURES

- Since the unit is of non-contact type, measurement can be taken with velocity irregularities, it will not place any extra load on the object whose velocity is being measured.
- By Canon's original diffraction laser-light Doppler system, the sensor unit is ultra-compact with high precision.
- The E/O frequency shifter enables the unit to measure velocities varying from -200 to 2,000mm/sec (LV-20Z).

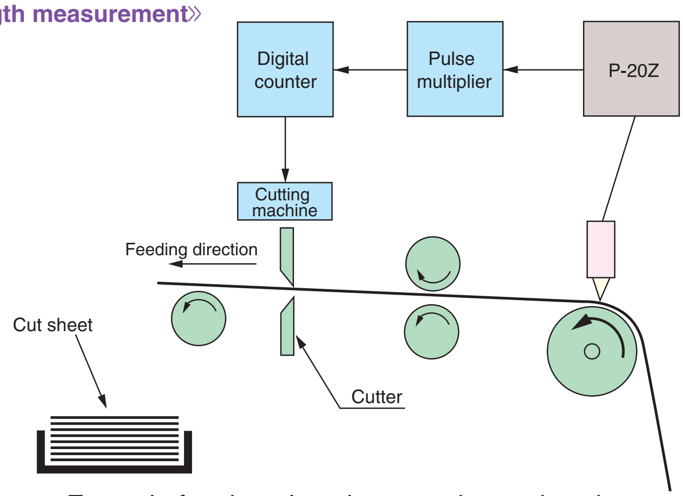
APPLICATION EXAMPLES

- OA Equipment
  - ·Detection of the speed of copying paper & speed irregularities
  - ·Detection of rotation irregularities of photo-conductor drums
  - ·Detection of the displacement of printer paper
- AV Equipment
  - ·Detection of speed irregularities of magnetic tapes
  - ·Detection of rotation irregularities of magnetic heads
- Manufacturing Equipment
  - ·Detection of rotation and motion irregularities in each driving part of manufacturing machinery
  - ·Detection of uneven stitch length (speed irregularities)
  - ·Detection of the displacement of machine tool work

《Example for speed deviation detection》



《Example for length measurement》



Example for sheet length measuring and cutting system.

LASER DOPPLER VELOCITY SENSOR

LV-20Z , LV-50Z

Laser Doppler Velocimeter enables non-contact measurement from zero speed

- **Contact-free measuring of movement speeds, movement distances, speed irregularities, and rotation irregularities.**
- **Enables wide speed range measurement from still state.**
- **Automatic gain control (AGC), Automatic Doppler frequency following function are equipped.**

SPECIFICATIONS

COMPONENT

■Optical sensor	S-100Z
■Signal processing unit	P-20Z / P-50Z

ELECTRICAL SPECIFICATIONS

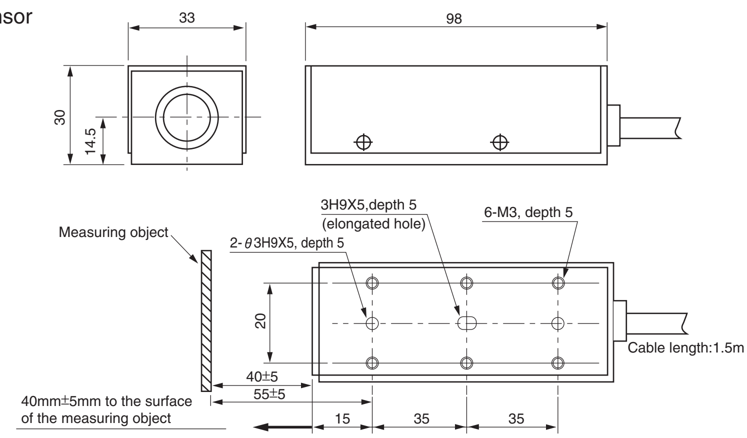
■Measurement method	Diffraction laser doppler method
■Light source	Semiconductor laser (680nm)
■Focal Length	40mm
■Depth of focus	±5mm
■Laser spot size	2.4 x 0.1mm (at focal point)
■Measurement Range	LV-20Z: -200 to 2,000mm/sec. LV-50Z: -50 to 5,000mm/sec.
■Resolution	LV-20Z: 2.5μm/pulse max. LV-50Z: 5μm/pulse max.
■Speed irregularity measurement range	±10% from center of measured speed
■Frequency irregularity response	0~300Hz
■Measurable object surface	A scatter surface of 20% or more (Measurement may not be made for blasted metal surfaces or measuring objects with high directivity.)
■Output Signal	
1. F/V output (analog output)	Analog voltage output approximately proportional to the speed. The output voltage can be selected with the RANGE switch.
a. Output voltage	-0.6 to 7.5V (in case of range 4)
b. Accuracy	less than ±1% of full scale
c. LPF cutoff frequency	300 Hz (-3 dB)
2. A phase, B phase output	Rectangle wave signal, Line driver output
Resolution	LV-20Z: 2.5, 5, 10, 20, 40, 80, 160, 320μm LV-50Z: 5, 10, 20, 40, 80, 160, 320, 640μm
3. Doppler output	Frequency output proportional to the speed. The frequency is given by: F=Fo+V/2.5 [μm] F: Doppler frequency [KHz] Fo: Optical shift frequency [KHz] V: Speed [mm/sec]
a. Output frequency range	LV-20Z: 120 to 1,000KHz LV-50Z: 180 to 2,200KHz
b. Measuring certainty	< 100mm/sec.: ±0.2mm/sec. > 100mm/sec.: ±0.2%
c. Output level	CMOS output (0 to 5V square wave)
4. Optical shift frequency output	Fo = 200 [KHz]
5. UP/DOWN output	One pulse is output for each movement by Δd in positive/negative direction.
6. Alarm output	5V output when DC level error, velocity error, or some other conditions.
■Speed indication	5 digits with minus sign (range:mm/sec, m/min)
■Power supply	AC100-240V 3A
■Dimensions (L x W x Hmm)	Optical sensor: 33 x 98 x 30mm Signal processing unit: 235 x 290 x 115mm

Environmental Conditions

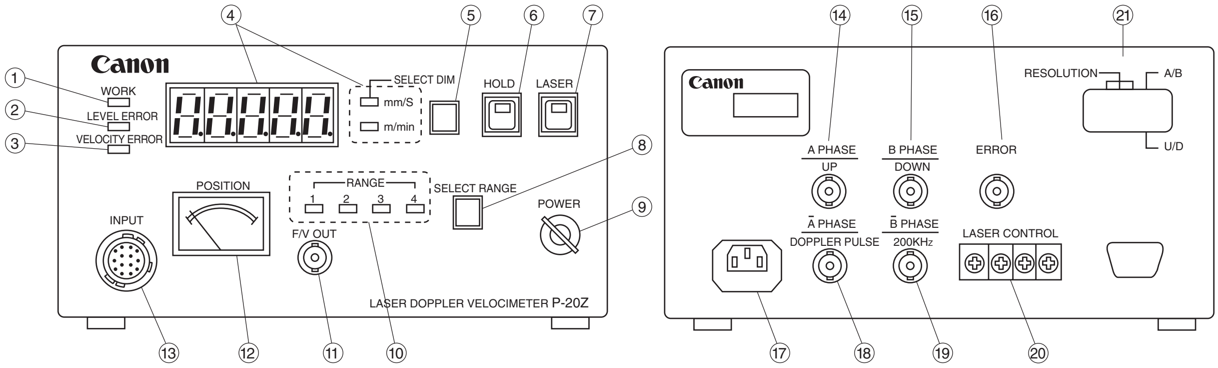
■Operating temperature	0 to 45˚C
■Storage temperature	-30 to 60˚C
■Humidity	80% RH or less (no condensation of moisture)

EXTERNAL DIMENSIONS

●Optical sensor



● Signal processing unit

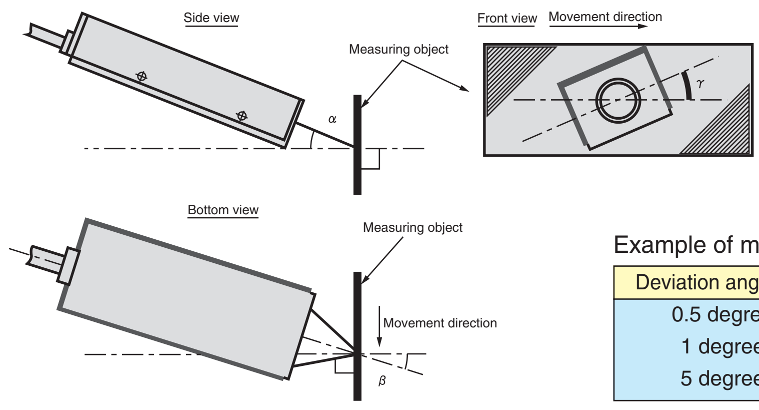


①	Work indication LED (green)
②	Level Error indication LED (red)
③	Velocity Error indication LED (red)
④	Speed indication
⑤	SELECT DIM
⑥	HOLD switch
⑦	LASER switch
⑧	SELECT RANGE switch
⑨	POWER switch
⑩	RANGE indication LED (green)
⑪	F/V OUT connector (BNC)
⑫	POSITION meter
⑬	INPUT connector

	Default setting	DIP SW ➡ OFF
⑭	A+ phase output connector	UP connector (BNC)
⑮	B+ phase output connector	DOWN connector (BNC)
⑯	ERROR connector (BNC)	
⑰	Power supply input connector	
⑱	A- phase output connector	DOPPLER PULSE connector (BNC)
⑲	B- phase output connector	200 KHz connector (BNC)
⑳	LASER CONTROL	
㉑	DIP SW	

Optical Sensor Installation Method

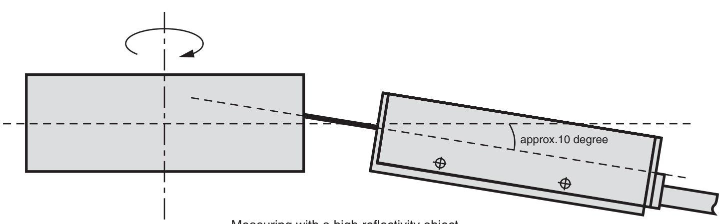
1. The measuring accuracy according to the installation is not influenced by the angle α shown in following figure.
2. The angle β causes an error of 1-cos β.
3. The deviation angle between the bottom surface and the movement direction causes an error of 1-cos γ.
4. When the bottom surface and the positioning holes are used as reference.
5. Install positioning pins as shown in the figure in the mounting surface set up parallel to the speed direction. After positioning with the positioning holes in the bottom surface of the body, affix the body with screws."
6. Pay attention to the angle β and γ, use the bottom surface and the positioning holes as reference for installation.



Example of mounting deviations and error.

Deviation angle β (γ)	Error
0.5 degrees	0.003%
1 degrees	0.015%
5 degrees	0.38%

Measuring with a High Reflectivity Object



Measuring with a high reflectivity object.