Vibration Measuring Instruments

Vibration Terminology

Important parameters relating to vibration pickups/vibrometers are described below:

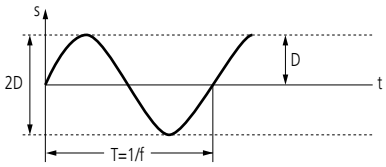
(1)Vibration frequency Unit: Hz (Hertz) Symbol: f

Refers to the number of times a vibrating object vibrates per second. The inverse of a vibration frequency is referred to as the period (T), T=1/f. Incidentally, vibration frequency is also referred to as frequency, and the motion is assumed to be sinusoidal.

When discussing vibration of a rotating object, the relation between the number of rotations (rpm: revolutions per minute) and the frequency is as follows, where rpm is a non-SI unit (SI unit: min^{-1}).

Example: 1200rpm/60s=20Hz

Frequency of an object rotating at 1200 revolutions per minute is 20Hz.



Example of notation in the catalog:
0.001 - 19.99mm$_{p\text{-}p}$

(2)Displacement Unit: m, mm, μm Symbol: D, s

Refers to the distance a vibrating object is displaced from a reference position (normally, the stationary position).

s = D sin wt

"D" is implied when displacement is simply referred to as amplitude. However, "2D" is customarily used in many cases to refer to the peak-to-peak amplitude.

Half-amplitude D, 0-p (zero-to-peak)

Full-amplitude 2D, p-p (peak-to-peak)

(3)Velocity Unit: m/s, cm/s, mm/s Symbol: V, v

Refers to the maximum speed reached by a vibrating object during the vibration cycle in the direction of motion. Defined by the rate of change in displacement per unit time. Velocity may be measured directly but is often derived from a measurement of acceleration, and may also be derived from measuring displacement with respect to time, as below.

$$v = ds/dt = d(D \sin \omega t)/dt$$

Example of notation in the catalog:
0.001 - 19.99cm/s$_{o\text{-}p}$

● Merit of velocity measurement

Velocity is a parameter widely used for equipment diagnosis and closely related to the fatigue failure of equipment structures. It is discussed in ISO standards as a parameter for specifying the severity of vibration.

(4)Acceleration Unit: m/s2, cm/s2, mm/s2 Symbol: A, a

Refers to the rate at which the velocity of an object changes per unit time. Acceleration is often measured directly and may also be derived from measuring velocity, or displacement (with respect to time) as below.

$$a = dv/dt = d^2s/dt^2 = d^2(D \sin \omega t)/dt^2$$

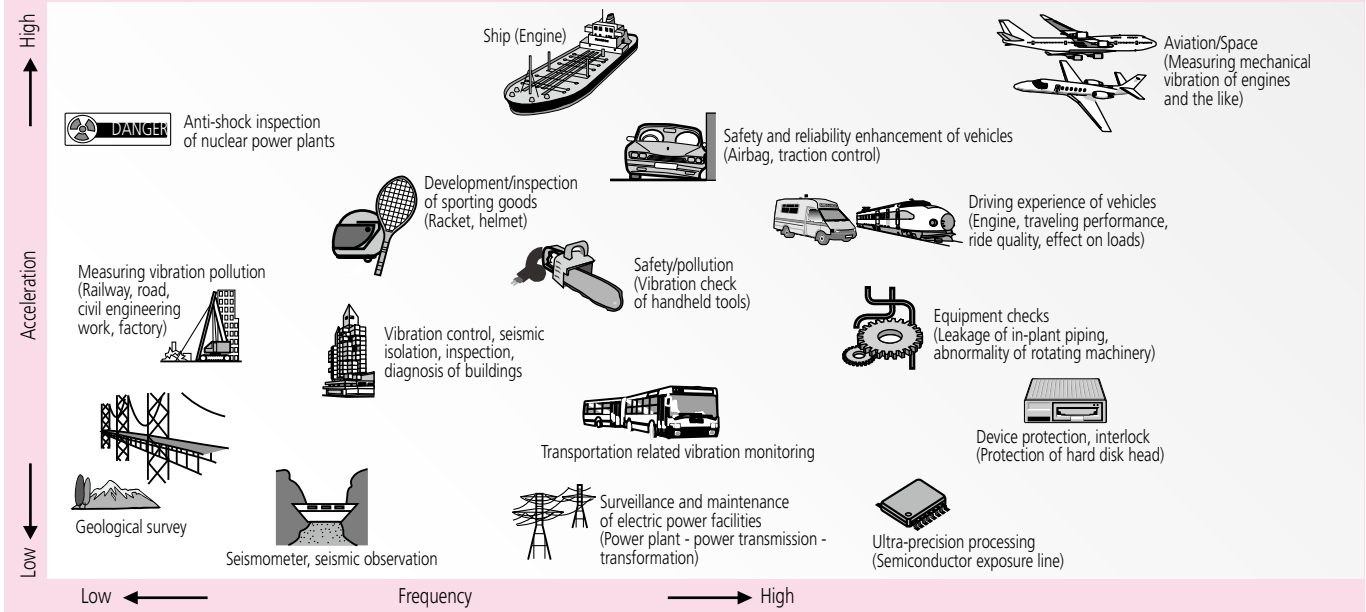
Example of notation in the catalog:
0.01-199.9 cm/s^2 $_{o\text{-}p}$

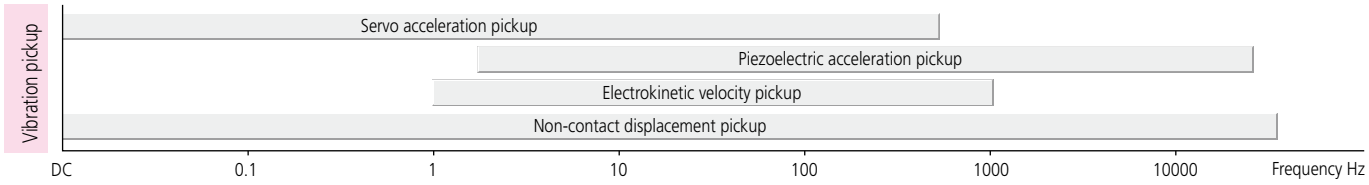
● Merit of acceleration measurement

Acceleration is regarded as a parameter effective for assessing the likelihood of dynamic fracture, and is widely used as a means of handling the fracture or breakdown especially of an object rotating at high speed.

Selection Guide to Vibration Transducers (Pickups)

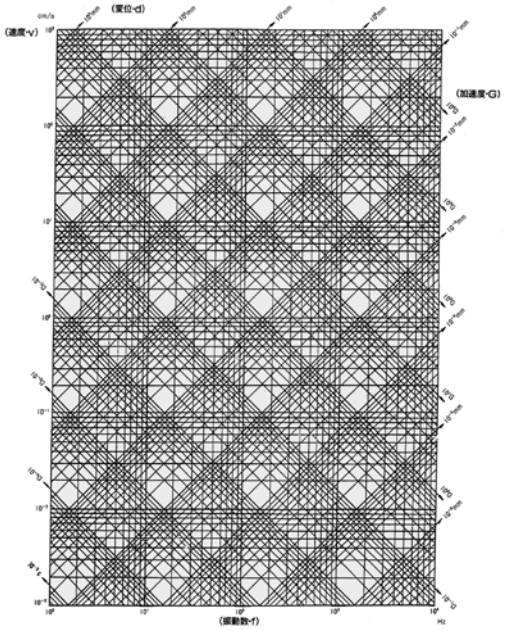
Acceleration pickup applications — from everyday to aerospace —





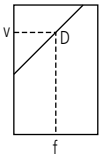
Seismogram Chart

Illustration of usage

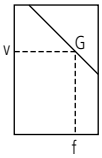


D: Displacement (mm) at half amplitude
v: Velocity (cm/s)
g: Acceleration (stated as a fraction of g_o, the 'standard acceleration of gravity' at the Earth's surface)
f: Frequency (Hz)
ft: Frequency (Hz) determined by a given displacement and acceleration

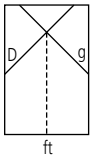
● Relation between v-f-D



● Relation between v-f-g



● Relation between D-g-ft



* The seismogram chart allows the magnitude of any one parameter to be determined from the magnitudes of two other parameters.

Selection Guide to Vibration Pickups and Model of Vibrometers

Field of application	Purpose	Specification requirements	Recommended type
Industrial machinery Machine tools	Operating conditions monitoring abnormality Vibration observation Equipment diagnosis Evaluation of bearings	For measuring the vibration induced by rotating/reciprocating motions through the use of gears and rolling bearings and its wide vibration range of harmonics. A vibration pickup is required of a size that does not affect the frequency characteristics of an object to be measured. High frequency characteristics (10 kHz) are required.	Piezoelectric acceleration pickup/vibrometer
High-speed rotating machinery Internal combustion engines		For measuring the unbalance and coupling abnormality resulting from the rotating motion through the use of a sliding bearing.	Electrokinetic velocity pickup/vibrometer
Power plant turbine Generator peripherals/accessories	Abnormal vibration observation	For monitoring vibrations in the normal state. For non-contact measurement of rotating shafts. For measuring vibrations of a casing. For measuring relatively low frequency in terms of velocity and displacement.	Non-contact displacement pickup/vibrometer
			Mainly electrokinetic velocity pickup/ vibrometer
Transportation machinery Automobile/ship/aircraft	Safety evaluation Riding quality evaluation	For measuring low-velocity vibrations.	Servo acceleration pickup/vibrometer
			Electrokinetic velocity pickup (compact type)/ vibrometer
		For measuring high frequencies and noise levels.	Piezoelectric acceleration pickup (extra compact type)/vibrometer
Large-scale structures	Dynamic stiffness evaluation Anti-earthquake design data	For measuring in a low frequency range while putting the priority to the sensitivity over the magnitude of the output.	Servo acceleration pickup/vibrometer
Building structures	Environmental measurement Seismic diagnosis (earthquake resistance diagnosis)		
Ground disturbance	Seismic observation Vibration pollution research Machinery foundation research	For measuring mainly in the low frequency range below 50Hz where precision measurement of vibration levels to lower than a few Gals is required. (m/s^2=100Gal)	Electrokinetic velocity pickup/vibrometer
			Servo acceleration pickup/vibrometer
Various vibration testing	Research and development Dynamic stiffness/frequency characteristics evaluation	If a pickup for the entire range of frequency is required, select multiple pickups according to the purpose. For the purpose of motion control of equipment.	Piezoelectric acceleration pickup/vibrometer
			Electrokinetic velocity pickup/vibrometer
			Servo acceleration pickup/vibrometer

	Pickup	Portable vibrometer (Ground noise meter)	Vibration monitoring machine
Servo	V405, 407	AVT-103/104	AVR-145L
Piezoelectric	V311TE, TB, SB, TF, V301SS, TA, TB, SB, TC, TD, V331TB	AVT-CZ, AVT-3000DZ, AHV-1000AZ	AVR-145Z
Electrokinetic	V238J, V231, V233, V237L, V240V, V242T, U1-FH, U1-FH-S, U1-FMA, V235B, V241 251M, 2516, V251GV (H), (L1), (L2)	AVT-B2, AHV-1000BU, AHV-11A	AVR-145, 150
Non-contact	V462B-8, MX	—	AVR-145X