Portable vibration analyzer for Equipment Diagnosis and On-site Measurements
Vibration Meter VA-12 With FFT analysis function

**Piezoelectric Accelerometer PV-57I** (with integrated preamplifier)

**Magnet attachment (supplied)**

**Compact & Lightweight**

**Vibration Analyzer VA-12**

**Major Application Fields**

- **Product Development**: Vibration measurement at various stages of product development
- **Quality Assurance**: Pre-shipment testing, post-installation operation checks
- **Maintenance**: Startup testing after periodic maintenance and servicing
- **Simple Diagnosis**: Daily routine checks and monitoring of unusual vibration conditions
- **Precision Diagnosis**: Measurement of problem vibrations and detection of fault sources
**Vibration Meter Mode**

- Allows simultaneous measurement of acceleration, velocity, displacement, and acceleration crest factor.

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**FFT Analyzer Mode**

- Real-time analysis frequency 20 kHz
- Time waveform display and spectrum display with up to 3200 spectral lines. Envelope processing also supported.
- Vibration waveform data recording function (10 seconds at analysis frequency 20 kHz)
- Data stored in WAVE file format on memory card (SD card).
- Timer controlled automatic measurement.

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**Menu Mode**

The crisp color TFT display (240 x 320 dots) is easy to read, whether outdoors, indoors, or in a dark location.

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**System Diagram**

- USB A - Mini B cable
- SD card (supplied)
- USB port allows use of unit as removable disk
- SD cards used as memory media
- Measurement data and setting data can be stored as a set on memory cards. Up to 1000 data sets per store name are supported (max. 100 store names).

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- USB port allows use of unit as removable disk
- SD card slot
- Trigger input connector
- AC adapter connector
- SD cards used as memory media
- AC adapter NC-99

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- Piezoelectric Accelerometer PV-571I (supplied) (With magnet attachment)
- Curled Accelerometer Cable VP-51K1 (supplied) (Length 50 to 100 cm)
- Piezoelectric Accelerometer PV-91C/97I (1000 MHz operation)
- Accelerometer Cable VP-51 series
- BNC Adapter VP-52C
- Charge Converter VP-40
- SD card (supplied)
- Computer
Simultaneous Measurement of Three Components

Displacement / Acceleration / Velocity

Usage of displacement, velocity, and acceleration

Displacement explained
The movement distance (travel) from a reference point is called displacement. For example, if a car travels a distance of 100 meters, the displacement value is 100 m. When considering vibrations, the movement distance of the vibrating object from the stationary rest position is the displacement, which changes between positive and negative values.

Velocity explained
This quantity expresses the amount of change per unit of time. It is related to the vibration energy. For example, if a car travels a distance of 100 meters in 10 seconds, the velocity is the distance (100 m) divided by the time (10 s), i.e., 10 m/s. When considering vibrations, the displacement magnitude and direction change over a short span of time, and the velocity therefore is not usually constant. The following relationship exists:

\[ \text{Velocity} = \text{displacement} \times 2 \pi \times \text{vibration frequency} \]

Acceleration explained
Acceleration is the change in velocity per unit of time. It is proportional to the impact force or other external force. For example, if a car traveling at a velocity of 10 m/s changes to a velocity of 30 m/s over a period of 2 seconds, the acceleration is the change in velocity (20 m/s) divided by the time (2 s), i.e., 10 m/s². When considering vibrations, the velocity and direction change over a short span of time, and the acceleration therefore is not usually constant. The following relationship exists:

\[ \text{Acceleration} = \text{velocity} \times 2 \pi \times \text{vibration frequency} \]

Values used to express vibration magnitude

- Peak value: Maximum value of single-sided amplitude
- RMS value: Root mean square of instantaneous value
- P-P value: Peak-to-peak value
- Maximum difference between highest and lowest value
- Equivalent peak value: RMS value multiplied by \( \sqrt{2} \)
- Equivalent P-P value: RMS value multiplied by \( 2\sqrt{2} \)

Unit: μm, mm, etc.

Unit: m/s, m/s², etc.

Usage of displacement, velocity, and acceleration

Displacement
- Measurement of vibrations in a low frequency range (below 200 Hz)
- Cases where displacement as such is critical
- Assessment of wear and damage related to static deformation, such as the effects of tensile force or compression
- Assessment of contact risks and machining precision

Velocity
- Measurement of vibrations in a medium frequency range (10 Hz to 1 kHz)
- Detection of imbalance, misalignment, bolt loosening, rattle and play etc.
- Assessment of vibration severity (ISO 10816, JIS B 0906)
- Assessment of metal fatigue

Acceleration
- Measurement of vibrations in a high frequency range (above 1 kHz)
- Detection of bearing and gear defects etc.
Vibration Meter Mode Applications

Simple Diagnosis

Vibration magnitude
Measuring the magnitude of vibrations is a useful diagnostic technique for ascertaining that machinery is operating normally and checking for signs of possible problems.

For example, when vibrations exceeding the reference value in the velocity range (up to 1000 Hz) are detected, the presence of an imbalance, misalignment, or loosening condition can be suspected, whereas vibrations in the acceleration range (1 kHz to about 12 to 15 kHz) point to possible bearing or gear problems.

Crest factor
The crest factor (C.F.) is an indication of the impact characteristics of a waveform. It is determined by the ratio between the RMS and peak values. Higher crest factor values indicate a stronger impact quality. The crest factor of acceleration measurements is useful for detecting the early stages of bearing damage.

\[ \text{Crest factor} = \frac{\text{Peak value}}{\text{RMS value}} \]

The vibration waveform of a bearing with a fault in the initial stage is shown in the example below. Compared to the waveform of a normal bearing, the crest factor is higher.

Normal bearing
(Peak value / RMS value = crest factor is small)

Bearing with spot damage
(Peak value / RMS value = crest factor is large)

Maintenance Management of Machine Equipment

By periodically measuring the vibration magnitude and comparing the results to a reference value, the equipment condition (normal or potential problem) can be diagnosed.

Using an absolute evaluation standard
ISO 10816 series (Evaluation of machine vibration by measurements on non-rotating parts).

According to ISO 10816-1:1995 / Amd. 1:2009, evaluation criteria for mechanical vibration over a specified range are to be decided by agreement between the supplier and the user of the machine, and boundary values for evaluation are to be determined in consideration of the measurement position and the support rigidity of the machine etc.

**Reference value**
- A: Newly installed machinery will normally be within this range.
- B: Long-term continuous operation allowed.
- C: Long-term continuous operation not allowed, but limited-term operation allowed.
- D: High risk of injury. Operation not allowed.

Using a relative evaluation standard (trend management)
Using the normal condition as a reference, threshold values for caution and hazard conditions are set. When the caution level is exceeded, monitoring is reinforced, and detailed diagnosis is performed when the hazard level is exceeded. A commonly used factor for setting the levels is as follows: caution level = 2 to 3 times the normal value, hazard level = 2 to 3 times the caution value.

After deciding on the vibration measurement location, measurement direction, and measurement frequency, a time series graph is commonly used for trend management, comprising measurement values and other data.
The Need for Frequency Analysis

Machinery usually comprises a variety of vibration sources such as motors, gears, bearings, fans, etc. When devising measures to minimize vibrations and when trying to locate the causes of problematic vibrations, measuring only the magnitude of vibrations often will not provide enough information. It is also necessary to perform frequency analysis, in order to determine which types of vibrations exist and what their levels are. As shown in the illustration, the locations where vibrations occur will affect the vibration frequency. Frequency analysis makes it possible to pinpoint vibration sources with greater accuracy.

FFT Analyzer Mode Applications

Product Quality Control

When testing products on manufacturing lines for unusual vibrations, frequency analysis can be very helpful. For example, when targeting a specific frequency, it can be determined whether there are vibration components in the adjacent frequency range. Using the frequency spectrum with a known good product as reference, comparative analysis can be applied to pass / fail evaluation.
Precision Diagnosis of Rotating Machinery

Precision diagnosis is used to determine the cause of problems as well as the extent, location etc.

Bearing Problems

Bearing problems will cause a significant increase in acceleration values. As seen in the example, envelope analysis shows the peaks at equal intervals. When the size, number of rolling elements, axis rotation speed and other parameters are known, the primary frequency of the lined-up peaks will provide information about the problem location.

Misalignment

When there is a misalignment, large vibration components that are an integral multiple of the rotation speed will appear in the axis direction. The type of bearing joint affects the multiplication factor. In the example shown here, there are large vibration components with a factor of 3.

Imbalance

When there is an imbalance, large vibration components at a frequency equal to the rotation speed will appear in the circumferential direction. Vibrations of other frequencies will be largely absent. The vibration amplitude is proportional to the imbalance magnitude. At higher rotation speeds, the vibration amplitude is proportional to the square of the rotation frequency.

Measuring the Resonance Frequency of a Structure

When an external force at a frequency close to the resonance frequency is applied to a structure, strong vibration will occur. This can lead to breakdown of machinery, product quality degradation, and other problems. In order to guard against such risks, measuring the resonance frequency is very important.

In the example shown at right, multiple resonance frequencies at 8 Hz, 98 Hz etc. exist. To measure the resolution frequency, the structure is struck with a hammer or similar and the resulting vibrations are subject to frequency analysis.
This product is environment-friendly. It does not include toxic chemicals on our policy.

Specifications

<table>
<thead>
<tr>
<th>Standard compliance</th>
<th>CE marking, Chinese RoHS (export model for China only), WEEE Directive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input section</td>
<td>Number of measurement channels = 1</td>
</tr>
<tr>
<td>Connector type etc.</td>
<td>BNC, CCLD 18 V 2 mA, CCLD24 V 4 mA (available as factory option)</td>
</tr>
<tr>
<td>Sensor</td>
<td>Piezoelectric Accelerometer PV-571 (supplied)</td>
</tr>
</tbody>
</table>

Input range

- At sensitivity 1.000 to 0.9999 mV/m/s
  - ACC (acceleration): 10, 31.6, 100, 1,000, 10,000 mV/m/s
  - VEL (Velocity): 1, 31.6, 100, 1,000, 10,000 mm/s
  - DISP (Displacement): 0.89, 2.83, 8.94 mm (±0.5 m/s)

- At sensitivity 1.00 to 9999 mV/m/s
  - ACC (acceleration): 0.1, 0.316, 1.0, 10, 100 mV/m/s
  - VEL (Velocity): 0.1, 0.316, 1.0, 10, 100 mm/s
  - DISP (Displacement): 0.089, 0.283, 0.894 mm (±0.5 m/s)

Measurement range

- High-pass filter 3 Hz, Low-pass filter 20 kHz
- Instantaneous maximum acceleration: 700 mV/s
- VEL (Velocity): 0.2 to 14.14 m/s (rms) Continuous measurement, 1 Hz to 5 kHz
- DISP (Displacement): 0.02 to 40.0 mm (Eq-p at 5.19 kHz)

Frequencies

- Measurement frequency range: 1 Hz to 20 kHz
- Filters: Prefilters, High-pass filter: 1 kHz (±10 % point), cutoff slope: -18 dB/oct
- Low-pass filter: 1 kHz, 3 Hz, 5 kHz, 10 kHz, 20 kHz (±10 % point), cutoff slope: -18 dB/oct

Inherent noise

- High-pass filter 3 Hz, Low-pass filter 20 kHz: Least range setting
- ACC (acceleration): 0.01 m/s² (rms) or less
- VEL (Velocity): 0.1 mm/s (rms) or less
- DISP (Displacement): 0.01 mm (±0.5 m/s) or less

A/D conversion

- 24-bit (16-bit 12-bit)
- Dynamic range: Maximum 110 dB (Acceleration)

Vibration meter mode

- ACC (acceleration) m/s² rms value, waveform peak value, crest factor
- VEL (Velocity) mm/s rms value
- DISP (Displacement) mm Eq-p

FREQUENCY MODE

- Waveform, spectrum, Acceleration envelope curve

ANALYSIS POINTS

- 512, 1224, 2448, 4896, 8192 (3200 lines)

Time area functions

- Rectangular, Hanning, Flat-top

Processing

- Minimum average maximum exponential averaging, instantaneous value

Display

- Spectrum: Top 10 list, graph display (excluding DC)
- Zoom: X: 1x, 2x, 4x, 8x, 16x,
  Y: 2x, 4x, 8x, 16x
- Y axis: P2.N = 0 to 10 (1 to 1024)
- Overlay display with stored data in spectrum mode
- Time waveform: Graph display
- Zoom: X: 1x, 2x, 4x, 8x, 16x, 32x,
  Y: 2x, 4x, 8x, 16x, 32x,
- Y axis: P2.N = 0 to 14 (1 to 16 384)

Trigger

- Trigger source: External signal
- Triggers at falling edge of signal at external trigger input
- Input level: Triggered when time waveform crosses a preset level
- Trigger level can be set in steps of 1/8 of full scale on in-rising amplitude
- Slope: +/- trigger operation

Option

- Name: Waveform Analysis Software
- Model: AS-70

Specifications

- Processing: software data 1/8 frame time ahead
- Display: Color TFT LCD, 240 x 320 dots, backlight
- Japanese display, English display, Time display
- Warning indication: LED lights up in red to indicate overload

Memory

- Memory media: SD cards (max. 2 GB)
- Store files: data, measurement values and parameters can be stored on memory card
  - 1000 data saved as one store name. Max. number of store names: 100
- Parameter setting: memory
- Parameter settings can be stored on memory card
- Wave data: Up to 10 seconds per file (frequency range 20 kHz)
- Vibration waveform recorded during FFT processing available when using a computer.
- BMP files: Screen capture can be saved as BMP files.
- Recall function: Measurement data can be read from memory card and displayed on screen
- Resume function: Settings can be recalculated when power is turned off, or files can be restored from text files

Input/output section

- Trigger input connector: TTL level, BNC mini plus plug: 2.5 mm dia. (for CC-24)
- USB port: Removable memory card inserted in unit as removable storage device (removable storage device class)
- Power: DC12 V (11 to 15 V)
- AC/DC adapter NC-959, eight IEC R6 (size AA) batteries (222, normal operation, backlight off)
- Battery life: Approx. 12 hours
- Power consumption: Approx. 10 VA (in case of AC 100 V (NC-999) )
- Ambient temperature and humidity conditions for use
- Accelerometer: -20°C to +70°C, 90% RH or less
- Weight: 2.13 kg (H x 105 W x 30 D mm), Mass Approx 850 g (incl. batteries, with protective cover, PV-571 connected)
- Supplied accessories: Piezoelectric Accelerometer PV-571, Cabled cable, Magnet attachment SC R6 (size AA) battery x 8, SD card, Protective case, Shoulder belt

Option

- Name: Waveform Analysis Software
- Model: AS-70
- Piezoelectric accelerometer
- Various
- BNC Adapter: VP-D2C
- Charge converter: VP-40
- SD CARD 32 MB:
  - MC-911S1
  - MC-20SSS
- BNC mini plus Cable: CC-24
- AC Adapter: NC-999

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