Vibration Analyzer VA-12

VIBRATION ANALYZER

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

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

Piezoelectric Accelerometer
PV-57I (with integrated preamplifier)

Magnet attachment (supplied)
Vibration Meter Mode

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

FFT Analyzer Mode

- Real-time analysis frequency 20 kHz
- Time waveform display and spectrum display with up to 3,200 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

Menu Mode

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

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 1,000 data sets per store name are supported (max. 100 store names).

System Diagram

Piezoelectric Accelerometer PV-571 (supplied)
(Curled Accelerometer Cable VP-51K1) (supplied)
(PV-901/41/971 (With magnet attachment))
(PV-85/90B etc.)

AC adapter NC-99

SD card (supplied)
Displacement / Acceleration / Velocity

Simultaneous Measurement of Three Components

Vibration explained

Mechanical vibrations can be represented as a complex combination of a spring and weight, as shown in the illustration on the right. The basic physical quantities that define vibration are displacement, velocity, and acceleration. By measuring each of these values, the vibration condition can be assessed.

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:

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

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.

**Maintenance Management of Machine Equipment**
Periodic vibration measurement serves to detect problems.

**Using an absolute evaluation standard**
ISO 10816-1 (JIS B 0906 Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non-Rotating Parts)
This is an absolute reference that can be used to judge whether measured vibration data are normal or not. The vibration velocity RMS values are used.

(Definition of classes)
- **Class I**: Small motors from 0 to 15 kW
- **Class II**: Motors from 15 to 75 kW, machinery equipment up to 300 kW mounted on a rigid base
- **Class III**: Large machinery equipment mounted on a rigid base
- **Class IV**: Large machinery equipment mounted on a flexible base

<table>
<thead>
<tr>
<th>Class boundary value (m/s)</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
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**Using a relative evaluation standard (trend management)**
Using the normal condition as a reference, threshold values for caution and hazard conditions are set.

![Trend management diagram](image)

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.
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.

Vibration amplitudes are shown for each frequency. The time waveform is divided into constant intervals, and FFT analysis* is performed for these intervals. A sine wave will have only one line spectrum, but complex machine vibrations will show peaks at various frequencies. FFT (Fast Fourier Transform) analysis is a type of frequency analysis that is particularly suited to analyzing machine vibrations.

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.
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.
Specifications

Standard compliance
CE marking (EMC Directive 2004/108/EC)
Chinese RoHS (export model for China only)
WEEE Directive

Input section

Number of measurement channels
1

Connector type
BNC, CCLD 18 V 2 mA. (CCLD28 V 4 mA available as factory option)

Input range
At sensitivity 0.100 to 0.999 mV/nV/mA (ms)
ACC (Acceleration)
10, 1.5, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 (ms)
VEL (Velocity)
316.1, 10, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 (ms/m) (ms)
DISP (Displacement)
1.89, 2.83, 8.94, 28.9, 89.4, 283, 894 mm (Eq.p)

At sensitivity 1.00 to 9.999 mV/nV/mA (ms)
ACC (Acceleration)
1.3, 1.0, 3.16, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 (ms)
VEL (Velocity)
316, 10, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 (ms/m) (ms)
DISP (Displacement)
0.089, 0.283, 0.884, 2.83, 8.94, 28.9, 89.4 mm (Eq.p)

At sensitivity 10.00 to 99.999 mV/nV/mA (ms)
ACC (Acceleration)
0.1, 0.316, 1.0, 3.16, 1.0, 316, 1.0, 316, 1.0, 316, 1.0 (ms)
VEL (Velocity)
0.316, 1.0, 3.16, 1.0, 316, 1.0, 316, 1.0, 316, 1.0 (ms/m) (ms)
DISP (Displacement)
0.0089, 0.0283, 0.0884, 0.283, 0.884, 2.83, 8.94 mm (Eq.p)

Measurement range
using PP-07, High-pass filter 3 Hz, Low-pass filter 20 kHz
ACC (Accuracy) 0.2% to 1.41 mV (ms) Continuous measurement, 1 Hz to 5 kHz
Instantaneous measurement 700 mV
maximum acceleration 700 mV
VEL (Velocity) 0.2 to 1.41 mm (ms) at 15.91 kHz
DISP (Displacement) 0.02 to 400 mm (Eq.p) at 3.18 kHz
Measurement frequency range (electrical characteristics)
ACC (Acceleration) 1 Hz to 20 kHz
VEL (Velocity) 3 Hz to 3 kHz
DISP (Displacement) 3 Hz to 500 Hz
Resonate exist 1 kHz to 20 kHz

Filters

Prefilters
High-pass filter 1 Hz (accuracy only), 316 Hz, 1 kHz (+/- 10% point, cutoff slope -18 dB/oct)
Low-pass filter 1 kHz, 5 kHz, 20 kHz (+/- 10% point, cutoff slope -18 dB/oct)
Acceleration envelope curve filter
High-pass filter 1 kHz (+/- 10% point), cutoff slope -18 dB/oct

Inherent noise
High pass filter 3 Hz, Low-pass filter 20 kHz, basic range setting
ACC (Accuracy) 0.01 mV (ms) or less
VEL (Velocity) 0.1 mm (ms) or less
DISP (Displacement) 0.01 mm (Eq.p) or less
A/D conversion 24 bit, ADJ principle, 5.12 kHz
Dynamic range
Maximum 110 dB (Acceleration)

Vibration meter mode
ACC (Acceleration) m/s², rms value, vibration peak value, Crest factor
VEL (Velocity) m/s, rms value
DISP (Displacement) mm, Eq.p

FFT mode
Time waveform, spectrum, Acceleration envelope curve

Analysis points 0, 12, 1, 2, 24, 4, 9, 18, 36, 192 (3600 lines)
Time window functions
Rectangular, Hanning, flat-top
Processing
Linear average, maximum, exponential averaging instantaneous value
Frequency span 100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz

Display

Spectrum
Top 10 list, graph display (excluding DC)

Zoom
X axis: x1, x2, x4, x8, x16
Y axis: x2, N = 0 to 10 (x1 to x1024)

Overlay display
With stored data in spectrum mode

Time waveform
Graph display

Zoom
X axis: x1, x2, x4, x8, x16
Y axis: x2, N = 0 to 1.4 (x1 to x16 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
Slope
> V- Trigger operation
Free-run
Processing always carried out, regardless of trigger condition
Repeat
Processing carried out whenever trigger occurs
Single
Processing carried out only when trigger occurs
Time
Data are stored according to the setting of Trigger Start Time, Store Interval, Store number.

Pretrigger Processing starts from data 1/8 frame time ahead
Display
Color TFT LCD, 240 x 320 dots, with backlight
Japanese display, English display, Time display

Warning indication
LED lights up in red to indicate overload

Memory

Memory media 80 cards (max. 2 GB)
Store files Sets of measurement values and parameters can be stored on memory card
1 000 data saved as one store name. Max. number of store names: 100
Parameter setting memory Parameter settings can be stored on memory card
Wave files Up to 5 parameter sets can be stored in unit
Vibration waveforms recorded during FFT processing available when using a computer

BMP files Screen capture can be saved as BMP files

Recall function Settings are removed when power is turned off and can be restored at next power on

Resume function Settings are removed when power is turned off and can be restored at next power on

Input/output section

Trigger input connector TTL level, BNC mini plug, 2.5 mm dia. for CEC-24
USB port Removable disk function Allows use of memory card inserted in unit as removable storage device (removable storage device class)

Power

DC12 V (1 to 15 V)
AC adapter NC-988, eight 6C2 RB (size AA) batteries (size batteries, normal operation, back light off)
Battery life Approx. 12 hours
Current consumption 1.45 mA (normal operation, back light on)
Ambient temperature and humidity conditions for use
-10 to +50 °C, 90% RH or less (no condensation)
Dimensions, weight
214 x 105 x 86 (W x D x H) mm; Mass Approx. 850 g (incl. batteries, with protective cover, PP-07 connected)

Supplied accessories
Peizo-electric Accelerometer PP-07, Curved cable, Magnet attachment
EC RB (size AA) battery x 8, SD card, Protective cover, Shoulder belt.

Option

Name
Waveshape Analysis Software CAT-WAVE
VA-12 Comparator System CAT-VA12-CMP01
Placeous accelerometer Various
BNC Adapter Vc-05C
Charge converter VP-AD
SD-CARD 512 MB SD-512M
SD-CARD 2 GB SD-2G
BNC mini plug Cable OCD-04
AC Adapter NC-986

# Only RION supplied cards for assured operation

Option

Waveshape Analysis Software
CAT-WAVE allows post-processing using stored waveform file data from VA-12

Option

VA-12 Comparator System
CAT-VA12-CMP01

For power spectrums that are measured by using VA-12, up to five conditions are established to determine whether the product is acceptable.

* Specifications subject to change without notice.

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