Vibration Analysis & Diagnostic System

infiSYS RV-200

An analysis & diagnostic system for all rotating machinery

infiSYS

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SHINKAWA
A vibration analysis & diagnostic system that is applicable to a variety of rotating machinery, helps safe operation and to improve operational efficiency.

infiSYS RV-200 precisely keeps track of and quickly feeds back conditions of rotating machinery which are the key production assets of plants.

SHINKAWA CMS Overall Configuration

SHINKAWA's CMS is applicable to a variety of rotating machinery condition monitoring whether it is comprehensive with shaft vibration, axial position, phase mark, rotation speed etc., for large machines, or simple with only bearing vibration for small machines.

In the CMS scheme, infiSYS RV-200 positions itself as a system which analyzes vibration for phase angle and frequency component, and displays the information in the form of various analysis graphs necessary for vibration diagnostics.
**Features**

1. **For all rotating machinery**  
   Applicable to a wide range from small rotating machinery supported by rolling element bearings to large rotating machinery supported by journal bearings.

2. **High-speed and flexible system configuration**  
   While achieving high-speed data acquisition, the system can be configured with various condition monitors, including non-SHINKAWA monitors.

3. **Sophisticated data analysis with various graphs**  
   The software provides a variety of analytical graphs which are optimized for the type of machinery and condition, satisfying stringent demands of vibration analysts and other plant personnel.

4. **User-friendly operability and plotting functions**  
   Intuitive software interaction with drag & drop graph display manipulation, and graph area switching tab, etc.

**Advantages**

Helps customers improve productivity and reliability by optimizing plant operation.

- Detects abnormal symptoms from vibration characteristics or subtle changes in vibration. Reduces risks of unplanned production shutdown by taking a proactive approach.
- Advanced diagnostics reveal the causes and areas of anomalies and detailed analysis helps users practice optimum, efficient maintenance.

**Applications**

- Steam turbines  
- Gas turbines  
- Electric generators  
- Feed pumps  
- Fans  
- Blowers  
- Compressors  
- BOP machinery  
- Rotating equipment critical to your facility
infiSYS RV-200 Basic System

When used for large rotating machinery, it acquires phase mark signals and shaft vibration waveforms, processes phase analysis and frequency analysis, and then displays the information in various graphs for further analysis. For small rotating machinery, infiSYS acquires acceleration vibration waveform of casing and the information is displayed with graphs based on the frequency analysis.

infiSYS RV-200 Configuration Example (for Large Rotating Machinery)

Based on the vibration waveform detected by shaft vibration sensors, the system provides vibration monitoring and anomaly analysis for rated-speed operation, and shaft behavior analysis for critical startup/shutdown.

infiSYS RV-200 Configuration Example (for Small Rotating Machinery)

Based on the vibration detected by acceleration sensors installed on the bearing housings, the system provides trend management and abnormality diagnostics not only on overall vibration but also on vibration of each fault frequency resulting from bearing failure.
High-speed data acquisition
- Trend data every 1 sec
- Waveform data every 10 sec

The machine’s data during startup/shutdown (transient data) are acquired to a level, allowing for detailed plotting of analysis graphs. The gradual changes over time can also be analyzed in real time.

Various system configurations
- VM-7
- VM-5 (with DAQpod)
- Non-SHINKAWA monitors

The system can be configured independently of a condition monitor that is already deployed on large rotating machinery. Whether an existing SHINKAWA monitor or non-SHINKAWA monitor, data can be acquired and analyzed via DAQpod, upgrading the customer’s existing system to a current analysis-capable system.

* If the monitor is VM-7, DAQpod is not required.

Multi channel
- Maximum number of inputs 480 ch

Integrating, monitoring, and analyzing vibration data of machinery in a plant in one analysis system, the system contributes to a plant’s stable operation with early detection, analysis/diagnostics of abnormality.

Analysis data acquisition unit DAQpod
Analyzes vibration waveform signals received from a condition monitor on large rotating machinery and sends analysis data to the infiSYS View Station. When it is used for bearing vibration analysis on small rotating machinery, acceleration sensors can be directly connected for data collection.
infiSYS RV-200 offers a variety of analysis and plotting functions.

**Provides analysis and plotting functions required by vibration analysts certified in accordance with ISO 18436-2.**

*ISO18436-2: Condition monitoring and diagnostics of machines - Requirements for training and certification of personnel - Part 2: Vibration condition monitoring and diagnostics*

### Data display examples

#### Polar Plot

This shows the vibration vector at the time of critical startup/shutdown of the machine. From this plot, the user can observe the balancing condition, vibration levels and critical speed during the startup/shutdown of the machine.

Displayed data (Switchable display): 1X, 2X

This allows over-lay of current data on top of past data.

#### Polar Plot (reference superimposition and speed indication)

For easy comparison, the data set as the base line is plotted over the current or selected data. The rotation speed of multiple clicked points can be labeled on the field while the RPM (speed) button is active. At other times, the speed is displayed while the cursor is over the point.

#### Trend Plot

This plot displays short term and long term chronological changes using a line chart.

Displayed data (multiple selections are allowed): Rotation speed, GAP, OA, 0.5 X amplitude, 0.5 X phase, 1X amplitude, 1X phase, 2X amplitude, 2X phase, Not-1X amplitude, nX1 to nX4 amplitude and phase, Smax amplitude, various alarm setting values.

#### Machine Train Diagram

The 3D illustration of rotating machinery diagram displays the rotation speed as well as the location and the vibration amplitude of each measuring point.

For each machine, current values can be displayed in a list view.

#### Orbit and Waveform Plot

This plot composes signals from each X and Y sensor and displays the dynamic motion of the center of a rotating shaft.

The Orbit plot helps to identify any abnormal status including imbalance, misalignment, oil whirl and oil whip.

#### Bode Plot

This plot displays the amplitude and phase in separate graphs with rotation speed used as the horizontal axis.

From this plot, the user can see the vibration status and critical speed during the startup/shutdown of the machine.

Displayed data (Switchable display): 1X, 2X

This allows over lay of current data on top of past data.
A Speed - Vibration (S-V) trend plot shows the change in the vibration amplitude with rotation speed. The user can select multiple amplitude types from overall (OA), 0.5X, 1X, 2X, to display in the same field for understanding the critical speed or vibration condition during startup and shutdown of the rotating machinery.

Waterfall Plot
This plot is used to analyze changes in frequency components that occur over time. Cascade plot can also be displayed with width (z-axis) as rotation speed to analyze changes in frequency components in relation to changes in rotation speed.

Spectrum Plot
This plot shows the frequency analysis of the vibration data. The X-axis represents the frequency or the order; the Y-axis shows the amplitude of each frequency component. The graph identifies the frequencies and the orders to help determine the cause of the abnormal condition of the rotating machinery.

Campbell Plot (Optional)
The X-axis shows the rotation speed; the Y-axis expresses the vibration frequency; the radial lines indicate each order; the size of the circle represents the vibration amplitude. This shows the vibration level relative to the change in the rotation speed. Whether or not a sequence of vibration is accompanying a specific order or it is of a certain frequency component can be seen visually.

Full Spectrum Plot (Optional)
A spectrum plot that separately depicts the forward whirling motion and backward whirling motion of the rotating machine rotor. The X-axis is the frequency of the whirling motion (positive for forward, negative for backward), and the Y-axis is the amplitude of each frequency component or order.

Bearing Analysis (Optional)
This window collectively displays the plots necessary for rolling bearing diagnosis. The following analysis functions are available per additional specification code, “/RB1” and “/RB2”.
/ RB1 … Peak value analysis, order analysis, sideband analysis
/ RB2 … Crest factor, form factor, kurtosis, skewness, envelope.
### Case Studies

#### Unbalanced Vibration

The most common abnormal vibration is due to the mismatch between shaft center and mass center, due to manufacturing error or machine components missing. The characteristic of the vibration generates the rotation synchronous component (1X), which is sine wave or similar. Vibration becomes largest at critical speed.

![S-V Plot](image1)

![Spectrum Plot](image2)

#### Oil Whirl Vibration

Self-excited, unstable vibration typical for sleeve bearing supported rotating machinery. Possible causes include effects from the shape of the sleeve bearing, oil film characteristics, etc. Normally, this vibration appears at two or less times lower than the critical speed, and the frequency is around half the rotation synchronous frequency (0.5X).

![S-V Plot](image3)

![Spectrum Plot](image4)

#### Misalignment Vibration

Vibration that occurs when the shaft centers of driving rotating machinery and its associated driven rotating machinery are not properly aligned. Typically the vibration includes rotation synchronous frequency component (1X) and harmonic components (2X, 3X).

![Obit & Waveform Plot](image5)

![Spectrum Plot](image6)

#### Loss of Rotor Component

When a rotor component is lost or flies off, the vibration conditions suddenly change. The typical phenomenon includes sudden changes in the amplitude and phase angle (vibration vector) of the rotation synchronous frequency component (1X).

![Polar Plot](image7)
Diagnosis Screens

Installing VM-781B infiSYS Diagnostic Software adds a diagnostic function to VM-773B infiSYS Analysis View Software or VM-774B infiSYS Remote View Software. The possible causes of the abnormal vibration are diagnosed based on the analysis and are listed from the most to the third likely to support technical engineers with their abnormal vibrations diagnostics.

Applications

The diagnostics are applicable to the following rotating machinery with rolling-element bearings or journal bearings.

- Turbines
- Electric generators
- Motors
- Blowers
- Pumps
- Compressors

Failure modes to be determined

Diagnostics with Journal Bearing

- Unbalance
- Permanent bow / Lost rotor parts
- Seal rub
- Misalignment
- Friction induced whirl
- Critical speed
- Rotor crack
- Cavitation
- Gear inaccuracy
- Vane vibration
- Nonsymmetrical rotor
- Draft core
- Steam whirl / Seal whirl
- Surging
- Oil whip
- Oil whirl
- Partial rub

Diagnostics with Rolling Bearings

- Bearing damage
- Insufficient bearing lube due to grease deterioration
- Lubricating trouble
- Insufficient tightness - Bearing
- Unequal bearing stiffness
- Unbalance
- Vane unbalance
- Cooling fin unbalance
- Coupling inaccuracy of damage
- Misalignment
- Seal or rotor rub
- Inaccurate tooth contact
- Tooth surface wear
- Electrically excited vibration
- Insufficient tightness - Casing
- Vane rub

Note: The diagnostic results are derived from collected vibration data. No responsibility can be accepted for any loss or damage that might arise from the use of the information.
infISYS RV-200 (hardware & software) has a simple user interface, that is easy and instinctively operated by most plant personnel.

Quick learning of graphic display.

Examples of easy operation

**Drag & drop**
From left to display area at right, desired plots can be displayed anywhere you want.

**Tile display**
The desired channel plot can be picked up instantly from the display window. The desired plot window opens with one click.

**Page switching tab**
Desired graph display page can be displayed simply by switching the tabs. A step to create a new page is also simple. (Up to 20 pages.)

Up to 20 pages can be created.
Pages with desired plots in desired arrangement can be created with specified tab name. Users can lock the displays as well, this allows uniformity and protection on your custom view settings.
For more efficient trend management and vibration analysis/diagnostic reporting

**infiSYS Report Software VM-783B**

By installing this software to the infiSYS View Station or Remote Station, the user will be able to output the event history, trend data and analysis graph images into report files.

**Example**

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**Easier, faster report preparation using a format template**

Using a preinstalled or customized template, the user can quickly create a report in a desired format. If it is pre-set, the system can create and print out reports at defined intervals or at the time of alarm activation.

**Communication between infiSYS Analysis View and the host network via OPC server**

**OPC Client Software VM-784B**

By adding to infiSYS Analysis View (version 1.2.0.0 or later), interactive data communication with the host system, such as DCS and PLC, will be available through an OPC server. The infiSYS RV-200 system acquires process data, such as temperature, pressure, generating power, etc. along with vibration data, and performs a variety of analyses with the information linked together. Likewise, the host system can utilize the analysis data of infiSYS Analysis View.

**Example**

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Creating a generating power (load) - vibration correlation plot (L-V plot)

An X-Y plot displays selected pairs of data acquired by infiSYS which are set as the x-axis and the y-axis. This is useful to check the relationship between the vibration and the process data, i.e., load, temperature, pressure, etc.

Also, a display of process data in a bar graph or a trend plot will become available.
Support for Analysis Communication Redundancy

Communication between the infiSYS View Station and VM-7 can be provided with redundancy. This prevents loss of data due to disconnection, hub failure or communication failure due to noise on the primary line. When communication failure is detected, infiSYS Analysis View automatically switches to the secondary line and continues communicating with the VM-7 monitor.

A LAN card must be added on the infiSYS View Station for secondary communication.

VM-742B Network Communication Modules, both with analysis function and of supported versions, must be installed in Slot C1 and Slot C2.

Process Data Input Function

To incorporate process data, including temperature, power, etc., into the infiSYS View Station, the user can either provide analog signals to DAQpod, or digitally communicate with DCS via the OPC server.

With VM-7, analog signal types are voltage and current; with DAQpod, analog signals are limited to voltage.

For digital communication, refer to page 10, “OPC Client Software”.

*1 For data interaction with DCS via the OPC server, installation of VM-784B OPC Client Software to the infiSYS View Station is required. (For the support version of this function, please refer to the separate “Updated Information”.)
SHINKAWA is employing global thinking to create a business with a worldwide network currently comprising over 50 bases around the world.

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## System Specifications

<table>
<thead>
<tr>
<th>Maximum number of connections</th>
<th>20 units* (VM-7, DAQpod)</th>
<th>* DP-2000H is composed of 2 systems, therefore counted as two units in this calculation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum number of measuring points</td>
<td>480 points*</td>
<td>* Actual number of points measurable may be limited due to system configuration.</td>
</tr>
<tr>
<td>Number of FFT lines</td>
<td>VM-7 : 800 lines</td>
<td>DAQpod : 400 / 800 / 1600 lines</td>
</tr>
<tr>
<td>Short Term / Long Term data saving feature</td>
<td>Short Term data saving period</td>
<td>Can be set to any length between 1 day and 31 days.</td>
</tr>
<tr>
<td></td>
<td>Short Term data saving interval</td>
<td>Trend data : 1 sec (critical mode), 10 sec (BOP mode)</td>
</tr>
<tr>
<td></td>
<td>Waveform data : 10 sec / 20 sec / 30 sec / 1 min / 2 min / 3 min / 5 min / 10 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long Term data saving period</td>
<td>1 yr / 2 yrs / 3 yrs / 4 yrs / 5 yrs</td>
</tr>
<tr>
<td></td>
<td>Long Term data saving interval</td>
<td>10 min / 20 min / 60 min / 120 min</td>
</tr>
<tr>
<td>Alarm data saving feature (Applicable to critical mode only)</td>
<td>Time range of the data to be saved</td>
<td>Trend data : 24 hours of data before and after the alarm occurred.</td>
</tr>
<tr>
<td></td>
<td>Data saving interval</td>
<td>Waveform data : 24 hours of data before and after the alarm occurred.</td>
</tr>
<tr>
<td></td>
<td>Type of alarm</td>
<td>Trend data : Every 1 sec</td>
</tr>
<tr>
<td></td>
<td>High speed acquisition</td>
<td>Waveform data : Based on the normal waveform data saving interval.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OA amplitude, 1X amplitude / phase, 2X amplitude / phase, rotation speed, process data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trend data : Taken at intervals of 0.1 sec from 20 sec before the alarm until 10 sec after the alarm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waveform data : Taken at the selected intervals (minimum 10 sec) from 60 sec before the alarm until 60 sec after the alarm.</td>
</tr>
<tr>
<td>Transient data saving function</td>
<td>Data saving period</td>
<td>Trend data : 1 sec (critical mode), 10 sec (BOP mode)</td>
</tr>
<tr>
<td></td>
<td>Startup period : From [Specified number of revolutions] to [specified number of revolutions] + N minutes (can be set to any time between 0 - 60 minutes) (Example : 100 rpm to 2,950 rpm + 20 minutes)</td>
<td>Waveform data : Based on the Δt setting or Δrpm setting</td>
</tr>
<tr>
<td></td>
<td>Shutdown period : From [Specified number of revolutions] to [specified number of revolutions] (Example : 2,950 rpm to 100 rpm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data saving interval</td>
<td>Trend data : 1 sec (critical mode), 10 sec (BOP mode)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waveform data : Based on the Δt setting or Δrpm setting</td>
</tr>
<tr>
<td>Number of histories</td>
<td>Number of transient histories per measuring point 100 to 1,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of alarm histories per measuring point 100 to 1,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of event histories per hardware item 1,000 to 10,000</td>
<td></td>
</tr>
<tr>
<td>Data display function</td>
<td>Displayable graphs : Trend Plot, Long Term Trend Plot, Bar Graph, Spectrum Plot, Waveform Plot, Orbit &amp; Waveform Plot, Waterfall Plot, Polar Plot, Shaft Centerline Plot, X-Y Plot, S-V Plot, Bode Plot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Optional plots : Cascade Plot, Full Spectrum Plot, Full Waterfall Plot, Full Cascade Plot, Campbell Plot) Analysis (Optional) : Peak analysis, order analysis, side band analysis, crest factor, form factor, kurtosis, skewness, envelope, runout (slow roll vector) List view : List of Current Values, List of Alarm Setting Values, Event History, Machine Train (maximum 24)</td>
<td></td>
</tr>
</tbody>
</table>

Note: The system and hardware specifications in this document are just overviews. For details, please refer to the specification sheets of the infiSYS RV-200 System and other related products.
## Hardware Specifications

### For DAQpod

| Number of inputs (number of channels) | AP-2000H* (19" rack) | Maximum number of vibration channels = [48 ch - (number of phase marker channels)]<sup>x2</sup> systems  
Number of phase marker channels = [0, 4, 8, 12, 16 ch]  

| AP-2000D* (19" rack) | Maximum number of vibration channels  
= 48 ch - (number of phase marker channels)  
Number of phase marker channels = 0, 4, 8, 12, 16 ch  

| DP-2000 (24 ch box) | Maximum number of vibration channels  
= 24 ch - (number of phase marker channels)  
Number of phase marker channels = 0, 4, 8 ch  

| Number of frequency analysis lines | 400 / 800 / 1600 lines  

| Trend data | Rotation speed, OA amplitude, GAP, 0.5X amplitude / phase, 1X amplitude / phase, 2X amplitude / phase, Not-1X amplitude, nX1 to nX4 amplitude/phase, Smax amplitude, §X or higher amplitude, IR / OR / BS vibration.  

| Data collection interval | Trend data collection interval  
Every 1 sec (every 0.1 sec during alarm high speed acquisition mode)  
Waveform data collection interval  
During normal operation : Every 10 / 20 / 30 sec, 1 / 2 / 3 / 5 / 10 min  
During transient : Δt setting : Trend every 1 sec (fixed)  
Waveform every 10 sec (fixed) : Δrpm setting : From Δ1 rpm to Δ100 rpm (1 rpm increments)  

| Network Interface | Ethernet 100 Base-TX  
| Power supply voltage | AP-2000H / D (19" rack ) : Rated voltage 100-240VAC  
DP-2000 (24 ch box) : Rated voltage 24 VDC  

| Dimensions | AP-2000H / D (19" rack ) : 482 (W) x 132.5 (H) x 444 (D) mm  
DP-2000 (24 ch box) : 96 (W) x 224 (H) x 165 (D) mm  

### For VM-7 (Analysis board installed)

| Number of inputs (number of channels) | Phase marker channels : Rack common 4ch, vibration module specific 1 ch/module  
vibration channels : 44 ch  

| Number of frequency analysis lines | 800 lines  

| Trend data | Rotation speed, OA amplitude, GAP, 0.5X amplitude / phase, 1X amplitude / phase, 2X amplitude / phase, Not-1X amplitude, nX1 to nX4 amplitude/phase, Smax amplitude.  

| Data collection interval | Trend data collection interval  
Every 1 sec (Process data : Every 10 sec)  
Waveform data collection interval  
During normal operation : Every 10 / 20 / 30 sec, 1 / 2 / 3 / 5 / 10 min  
During transient : Δt setting : Trend every 1 sec (fixed)  
Waveform every 10 sec (fixed) : Δrpm setting : From Δ1 rpm to Δ100 rpm (1 rpm increments)  

| Network Interface | Ethernet 100 Base-TX  
| Power supply voltage | Supports power supply redundancy with VM-75□B Power Supply Module  
Rated voltage 100-240 VAC / 50-60 Hz, 24 VDC, 110-220 VDC