



# Ovation™ Machinery Health™ Monitor for the Power Industry

## Features

- **Improves asset performance** by delivering distributed control, machinery protection and predictive condition monitoring from a single common platform
- **Simplifies fault diagnosis and analysis** through advanced high-resolution vibration data storage and plotting capabilities
- **Increases reliability** by continuously monitoring predictive vibration data that is not calculated in other systems unless they are equipped with separate, expensive software packages
- **Intensifies operational awareness** of potential issues by quickly providing alerts from a common set of HMIs
- **Enhances security** by removing links to external systems and isolating process information
- **Streamlines configuration and upgrades** by eliminating synchronization across multiple systems
- **Reduces lifecycle costs** by minimizing training, maintenance and inventory
- **Increases safety** by eliminating manual checks of machinery functions
- **Aligns with API 670 machinery protection standard** to help ensure optimal performance of the vibration protection system



## Overview

Managing and synchronizing separate systems across differing vendors can be complex and time-consuming. Although the use of multiple systems is sometimes necessary to keep your assets operating at peak efficiency; the planning, expertise and time commitment to integrate and operate two or more systems is often overwhelming for operations and maintenance personnel.

The Ovation™ Machinery Health™ Monitor is a revolutionary and robust solution for simplifying rotating asset prediction, protection and process control.

With both machinery health and protection functions now consolidated within the Ovation platform, users experience a host of benefits including easier system upgrades, improved maintenance & lifecycle processes and secure connectivity. Ovation's Machinery Health Monitor provides protection on critical plant equipment including pumps, motors, blowers, fans, steam turbines, gas turbines, generators, hydro turbines, cooling towers, gearboxes and boiler feedpumps.

## Features

### Unified Platform

Ovation's Machinery Health Monitor leverages the power of the Ovation platform through a high-performance I/O module dedicated to machinery health functions. Having native machinery protection and condition monitoring capabilities within the Ovation distributed control architecture provides several advantages:

- Increases reliability by reducing integration risks
- Improves security of information and helps to meet cybersecurity compliance obligations
- Streamlines the root cause analysis of events
- Enhances analysis and troubleshooting of rotating equipment issues through native Ovation alarming, trending, historical data collection, sequence-of-events monitoring and vibration plotting capabilities
- Improves operator efficiency with the ability to monitor and control all plant systems from the same workstation
- Simplifies configuration through a common set of standard engineering tools
- Decreases lifecycle costs and streamlines personnel training
- Expands reliability team into operations without requiring vibration analysis training
- Provides access to advanced vibration monitoring features via Emerson's AMS Machine Works application for analysts who need it

### Eliminates Integration Risks

Integrating machinery protection and control systems can require register mapping that can take up to five days to complete for 24 channels. Typical risk areas during integration include communication issues, additional testing time and the introduction of nuisance alarms. Additionally, resources aren't always available to complete what can be a complicated integration process in a timely manner. This could leave operators without important machinery health diagnostics.

The Ovation Machinery Health Monitor eliminates the risks, wasted time and increased costs associated with system integration. With installation as simple as inserting the module into a spare I/O slot, the Ovation Machinery Health Monitor removes challenges typically associated with configuring two separate systems such as Modbus integration, wiring and time synchronization. Reducing the number of configuration tasks can result in fewer failure points which translates into increased reliability.

### Enhances Security

Emerson's Ovation system uses router-based firewalls to create a demilitarized zone (DMZ). The DMZ is a barrier that isolates the control system in a measure to implement the Defense-in-Depth strategy. This strategy, where layers of protection are provided between the critical assets and the outside networks, helps to ensure security and assists utilities in complying with NERC CIP-005-01 requirements.

The native Machinery Health Monitor lies within Ovation's secure perimeter. The monitor communicates with the Ovation Controller over the passive Ovation I/O bus using a non-routable protocol. By using the Ovation I/O bus, the security perimeter stops at the module and does not extend to remote devices, providing an extra measure of information isolation and security. Additionally, use of one operating system reduces the amount of reporting and paperwork required for cybersecurity-related audits.

## Simplifies Configuration and Upgrades

Ovation's Developer Studio is a comprehensive set of software applications that manage configuration of the entire Ovation system. The fully integrated advanced suite of Developer Studio tools is used to create and maintain Ovation drop types, control strategies, process graphics, point records, and system-wide configurations including security.

Engineers familiar with the Ovation system can easily configure and maintain the module through a dedicated tool within the Developer Studio. Unlike traditional machinery protection systems, the Ovation Machinery Health Monitor's logic is contained within standard Ovation control sheets for quick and easy in-house maintenance as opposed to waiting for an expensive service call.

Ovation's control building tool includes SAMA formatted drawing capabilities tailored specifically for creating and editing logic. Users are automatically supplied with online and offline documentation of control strategies that keeps information up-to-date for easier system management. Updates to the module are made to the control sheets and loaded into the Controller for processing.

Unlike conventional machinery protection racks, the Ovation Machinery Health Monitor is embedded within the Ovation architecture. Similar to standard Ovation I/O modules, the monitor is a modular, plugin component that inserts into the I/O base and communicates directly to the Ovation Controller rather than data link communication used by traditional racks.

Implementing machinery health monitoring functions into a standard Ovation I/O base simplifies future upgrades and eliminates risks associated with synchronizing new versions across multiple systems. The integration, configuration, troubleshooting and testing of a separate machinery health system is no longer necessary. Additionally, the monitor is 'hot swappable' allowing it to be removed and replaced without disrupting system operation.

## Reduces Lifecycle Costs

Operators can easily monitor diagnostics and manage alerts for all plant assets from a common platform. Intuitive diagnostics in the form of illuminated colored status indicators, audible alarms and status graphics enables quick determination of where an issue may reside. The embedded machinery health alarm and status information provide details about the issue as opposed to a simple "high vibration" alert like other systems. Diagnostics for process and system alerts are readily available; eliminating the time wasted browsing between multiple systems to obtain statuses.

The consolidated architecture of the Ovation Machinery Health Monitor reduces hardware maintenance, inventory and networking equipment. The module is powered by Ovation's redundant primary power and auxiliary power infrastructure; so additional power supplies are not necessary.

With a single point of contact for automation and machinery health, getting expert technical support from Emerson is quick and easy, helping to keep the Ovation system running smoothly and reliably.

## Increases Safety

The vibration monitoring function within the Ovation Machinery Health Monitor eliminates the need for a separate vibration monitoring strategy. With online monitoring available from Ovation HMIs, operators no longer need to manually check machinery function in the plant. This decreases the expense and safety hazards associated with walk-around programs.

The module includes built-in condition monitoring that immediately notifies operators of developing equipment problems, as opposed to time-delayed activation associated with a traditional protection system. Real-time alerts allow for cost-effective maintenance planning which increases safety and provides an opportunity to avoid forced outages, derates and runbacks.

## API Standard 670

The American Petroleum Institute's (API's) Standard 670 for Machinery Protection Systems is a purchasing guideline that does not provide product certification. Vibration protection systems can declare compliance with the API 670 standard, provided any variances from the standard are stated and the end user considers the variances acceptable.

It is the end user's responsibility to determine the appropriate level of shutdown protection required for their rotating machinery and select the best vibration protection system that meets their needs. Emerson's Ovation Machinery Health Monitor aligns with the intent of the API 670 standard, but like most vibration protection systems, does so with minor variances.

## Scalable Functionality

The Ovation Machinery Health Monitor is one hardware base capable of protecting and monitoring the health of both turbomachinery and balance-of-plant equipment. For critical turbomachinery needs, the Ovation Machinery Health Monitor delivers standard machinery protection while providing machinery health parameters that can be targeted to both operators and maintenance as needed.

Vibration peak, phase and band-pass parameters provide operators early indicators of imbalance, misalignment, looseness, shaft cracks, bearing fluid instabilities and mechanical wear issues where immediate action must be taken. Detailed waveform, spectrum, orbit and machinery health parameters are available within the Ovation system for maintenance planning. Emerson's PeakVue technology provides an early indication of developing mechanical wear issues on rolling element bearings and gearbox applications. Data delivered through the Ovation system allows operators to plan more effectively and avoid unplanned downtime, runbacks, derates and forced outages.

False trips are addressed through features such as integrated two-out-of-three (2oo3) voting logic, dynamic trip setpoints and sensor health monitoring.

Other available functions include thrust monitoring, differential expansion and eccentricity. These integrated features increase decision accuracy by leveraging the power of the existing Ovation process variables.

Predictive information built into Ovation gives operators a clear view of all process information to quickly assess and analyze an asset's health. This capability enables immediate operator action to avoid unnecessary impact to machine health or to lessen the progression of failure in context with production goals.

## Ovation Machine Works

Ovation's Machine Works application provides operators with diagnostic plots for vibration analysis including waveform, spectrum and orbit plots. Ovation Machine Works information is viewed from Ovation HMIs along with other standard operator displays such as point information, trends and signal diagrams.

## AMS Machine Works

Emerson's AMS Machine Works application enhances the Ovation Machine Works vibration condition monitoring capabilities with the ability to store waveform, spectrum and orbit snapshots. Additionally, AMS Machine Works provides high-resolution storage of the vibration waveform as well as advanced vibration plotting capabilities. A firewall, DMZ or data diode can be provided for hardware-enforced, one-way communication from the Ovation system to the AMS Machine Works application located on-site or at a remote operations or diagnostics center.

## Architecture

At its core, the Ovation Machinery Health Monitor has two separate processes. The protection and machinery health parameters are internally separate and isolated. This architecture provides the peace of mind and robustness for machinery protection while delivering machinery health performance to help users manage plants assets with confidence.

The Ovation Machinery Health Monitor simplifies the monitoring tasks to the core functions of vibration signal conditioning, sampling and sending parameters to the Ovation system. The monitor includes hardware and self-checking instrumentation and is hot swappable. Optional buffered outputs are available. The Ovation Machinery Health Monitor is inserted directly into the standard Ovation I/O base and utilizes the built-in passive I/O bus communications to an Ovation Controller. It is separate and independent from other process I/O, handling the unique requirements of machinery health monitoring while leveraging the infrastructure of Ovation.

Each monitor has eight signal input channels that accept any of the following vibration sensor types:

- Piezo accelerometers
- Eddy current sensors
- Piezo ICP velocity sensors
- Piezo dynamic pressure
- Moving coil velocity sensors
- LVDT
- Generic user defined AC input
- Generic user defined DC input

Two channels (channels 7 and 8) support all the sensors listed above as well as the following tachometer inputs:

- Eddy current tachometers
- Passive magnetic tachometers
- Hall effect tachometers
- TTL pulse
- Encoder
- Tachometer sharing via a daisy chain from module to module (does not consume a signal input channel)

## Logic Expansion

Machinery protection logic has access to the power and redundancy readily available within the Ovation Controller and is no longer limited to the logic capabilities of a traditional machinery protection rack. The monitor communicates over a passive I/O base to a secure, reliable, mission-critical, redundant Controller with "bumpless" automatic fail-over for monitoring system robustness. Because Ovation Controllers are designed to handle more than 1000 control sheets, adding machinery monitoring is a simple setpoint comparison and relay output addition.

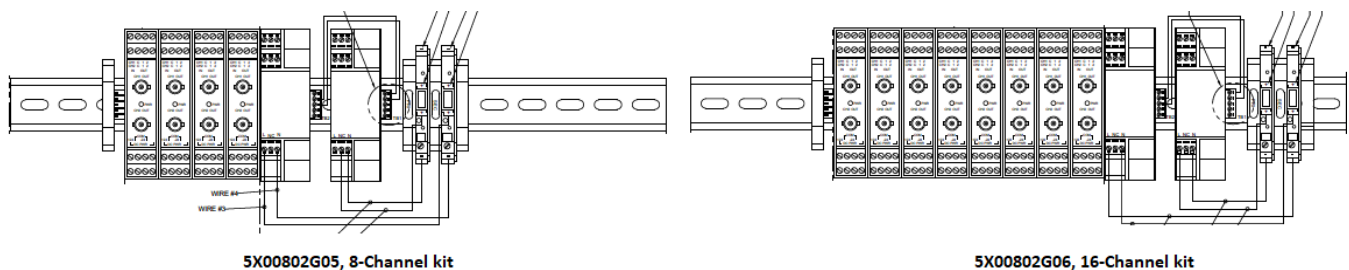
## Requirements

- Ovation Machinery Health Monitor requires Ovation 3.5.1 or higher
- Emerson AMS Machine Works requires Ovation 3.6 or higher
- Ovation IOIC Group 3
- Local or extended I/O placement
- Remote I/O placement when paired with an Ovation remote node interface
- Spare I/O slot

## Buffered BNC Outputs

Ovation Machinery Health Monitor has optional buffered BNC outputs. Buffered outputs allow external analyzers, usually portable vibration analyzers, to access dynamic sensor data. The buffered outputs can also be connected to other permanently-installed vibration monitoring systems.

Emerson uses a third-party isolator, the 5X00802 Signal Buffer Kit, to provide safe isolation to the Ovation Machinery Health Monitor module. This kit comes in two versions and either includes 8 or 16 channels per kit, plus power supplies in a DIN-rail mounted, pre-assembled package. Each buffered output module channel in the Emerson kit provides high impedance isolation and 2 independent active buffered lines out, including a line with a BNC connection for use with a portable vibration analyzer. The buffered output kit can be mounted near the Ovation Machinery Health Monitor modules, or near the equipment being monitored for more convenient access.



Ovation Machinery Health Monitor Specifications	
<b>Number of channels</b>	8
<b>Tachometer channels</b>	2 (of the 8 channels per module)
<b>Sensor support</b>	Piezo accelerometers Piezo ICP velocity Piezo dynamic pressure Electro-dynamic velocity Eddy current displacement sensor <ul style="list-style-type: none"> <li>▪ AC vibration</li> <li>▪ DC displacement</li> </ul> LVDT (some require available external converter) 4-20 mA (requires external resistor) Other AC/DC output transmitters (within the power and input range of the module)

Ovation Machinery Health Monitor Specifications	
<b>Tachometer support</b>	Eddy current displacement Passive electro-magnetic Hall effect tachometer N pulse/rev shaft encoder TTL pulse
<b>Sensor Power</b> <i>(channels may be individually programmed)</i>	Constant current Programmable 0 mA – 20 mA (may also be used to lift current for electro-dynamic (passive) velocity sensors) Constant voltage <ul style="list-style-type: none"> <li>▪ +24V @20mA, short circuit protected</li> <li>▪ -24V @20mA, short circuit protected</li> </ul>
<b>Input range</b> <i>(channels may be individually programmed)</i>	<ul style="list-style-type: none"> <li>▪ 0 to +24V</li> <li>▪ -24V to +24V</li> <li>▪ -12V to +12V</li> <li>▪ 0 to -24V</li> <li>▪ DC to 20KHz</li> </ul>
<b>Machinery protection and turbine supervisory instrumentation parameters</b>	<ul style="list-style-type: none"> <li>▪ Root mean square (RMS), Peak (Pk) and Peak-to-Peak (Pk-Pk)</li> <li>▪ Relative shaft vibration</li> <li>▪ Absolute shaft vibration</li> <li>▪ Eddy current DC gap voltage</li> <li>▪ Bearing case vibration</li> <li>▪ Accelerometer bias voltage</li> <li>▪ Axial thrust position</li> </ul> <ul style="list-style-type: none"> <li>▪ Shaft eccentricity</li> <li>▪ Speed</li> <li>▪ Zero speed</li> <li>▪ Phase</li> <li>▪ Differential expansion</li> <li>▪ Case expansion</li> </ul>
<b>Embedded machinery health parameters</b>	<ul style="list-style-type: none"> <li>▪ nX peak and phase where n = 0.5 and 1-5</li> <li>▪ Peak and phase for looseness 3X-8X band and for fluid instability 0.3X-.49X band</li> <li>▪ PeakVue value</li> <li>▪ Waveform</li> <li>▪ Spectrum</li> <li>▪ Orbits</li> </ul>
<b>Advanced condition monitoring</b>	Please refer to the <a href="#">Emerson AMS Machine Works data sheet</a>
<b>Emerson part number</b>	5X00717G01

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