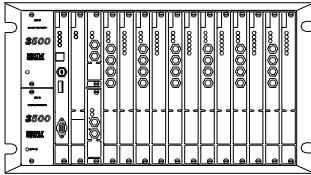


# 3500 System Datasheet

## Bently Nevada\* Asset Condition Monitoring

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### Description

The 3500 System provides continuous, online monitoring suitable for machinery protection applications, and is designed to fully meet the requirements of the American Petroleum Institute's API 670 standard for such systems. It represents our most capable and flexible system in a traditional rack-based design, and represents numerous features and advantages not provided in other systems. The system's highly modular design consists of:

- 3500/05 Instrument Rack (required)
- One or two 3500/15 Power Supplies (required)
- 3500/22M Transient Data Interface or 3500/20 Rack Interface Module (required)
- One or two 3500/25 Keyphasor\* Modules (optional)
- 3500 Rack Configuration Software (required)
- One or more 3500/XX Monitor Modules (required)
- One or more 3500/32 4-channel relay modules or 3500/33 16-channel relay modules)
- One or more 3500/92 Communication Gateway Modules (optional)
- 3500/93, 3500/94, or 3500/95 display OR 3500 Operator Display Software running on a compatible PC (optional)
- Internal or external intrinsic safety barriers, or galvanic isolators for hazardous area installations (optional)

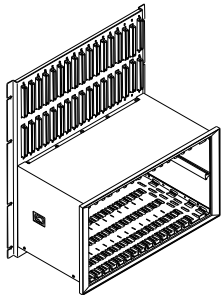
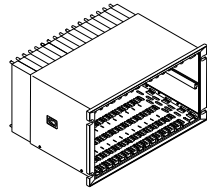
These are described in more detail in the following section and in the individual datasheets for each system component.



## System Components

### Rack

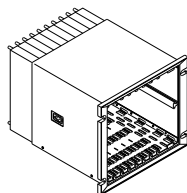
The full-size 3500 Rack is available in 19" EIA rail-mount, panel-cutout-mount, and bulkhead-mount versions. The rack provides slots for two Power Supplies and a Rack Interface Module in the left-most rack positions that are reserved exclusively for these modules. The remaining 14 slots in the rack can accommodate any combination of monitor, display, relay, Keyphasor module, and communications gateway modules. All modules plug into the rack's backplane and consist of a main module and an associated I/O module. The I/O module installs at the rear of the rack for panel-mount systems, and above the main module for bulkhead-mount systems.



The rack depth is 349 mm (13.75 inches) and NEMA 4 and 4X weatherproof housings are available when required for environmental protection or when purge air is used.

A mini-rack (12" wide instead of 19") is also available and features 7 available monitor

slots instead of 14. Like its larger counterpart, the left-most slots are reserved for the Power Supply or Supplies and Rack Interface Module. The mini-rack may be mounted in a panel cutout or, using an optional adapter plate, on 19" EIA mounting rails. Bulkhead mounting is not available.



**Note:** The use of internal barriers adds 74 mm (3 inches) to the rack depth. The bulkhead-mount version of the rack is 267 mm (10.5 inches) deep. Actual dimensions of all rack types can be found in our document number 129766.

### Power Supply

The 3500/15 Power Supply can be ordered for ac or dc input power, providing compatibility with voltage sources worldwide. Line noise filters are standard.

The 3500 Rack can operate from a single supply, or dual Power Supplies can provide redundancy for situations which cannot tolerate power interruption. Dual supplies reside in the upper and lower positions of the left-most rack slot. Redundant Power Supplies can use with separate voltage sources. For example, the primary (bottom) supply can be operate with 120 Vac power while the backup (upper) supply can be powered from an uninterruptible 24 Vdc source.



Each Power Supply can individually provide power to the entire rack and its modules. When redundant supplies are used, one supply acts as primary power for the rack while the other acts as a backup, ready to instantly and automatically operate as the primary rack supply without interrupting rack functions should the primary supply fail.

The 3500/15 Power Supply module has self-monitoring functions that allow it to determine if all its output voltages are within specifications. The module annunciates this via a green "Supply OK" LED on the Power Supply's front panel.

### Rack Interface Module/Transient Data Interface

The Transient Data Interface (TDI) or the Rack Interface Module (RIM) are the 3500 Rack's primary interfaces to the configuration, display, and condition monitoring software. Each rack requires one TDI or RIM, which resides in the rack slot immediately adjacent to the Power Supply slot. The TDI and RIM support a proprietary protocol used by both the 3500 Configuration Software to configure the rack and the 3500 Operator Display Software to retrieve rack data and statuses. TDI provides a direct interface with GE's Bently Nevada System 1\* machinery management software without the need for an external communications processor. The RIM requires an external communications processor, such as TDISecure to interface to System 1 condition monitoring software.

The System OK relay<sup>1</sup> is located within the TDI/RIM's I/O module. It is driven by NOT OK conditions within the TDI/RIM itself and within other modules in the rack.

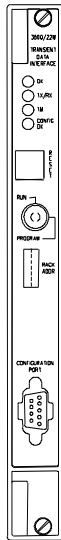
The TDI and RIM supply "self monitoring" functions both for themselves and for the rack, in addition to those provided by the individual monitor, relay, communications, and other modules. While the TDI

and RIM provide certain functions common to the entire rack, neither is part of the critical monitoring path and has no effect on the proper, normal operation of the overall 3500 System or its machinery protection functions.

The TDI and RIM provide 4 front-panel LEDs as follows:

<b>OK</b>	Indicates that the Rack Interface Module and its I/O modules are operating correctly.
<b>TX/RX</b>	Flashes at the rate that communications between the RIM and other rack modules are occurring.
<b>TM</b>	Indicates when the rack is in the Trip Multiply mode.
<b>CONFIG OK</b>	Indicates that any module in the rack is not configured or has a configuration error; that the stored configuration of the Rack Interface Module does not match the physical configuration of the rack; or that a security option condition was not met.

System configuration is secured by means of a keylock switch on the front of the TDI/RIM and two levels of software password protection, preventing unauthorized changes to or tampering with the configuration. Both the TDI and the RIM can be connected to a portable computer via a front-panel serial communications port for local changes to configuration. The RIM can also be permanently connected to a configuration workstation via a rear panel serial communications port, or to a remote computer via an optional modem I/O module. The TDI provides permanent system connectivity via Ethernet ports. The TDI/RIM provides a front-panel DIP switch that permits the user to assign a unique rack address when multiple 3500 racks are networked with one another.



The TDI/RIM provides a system reset switch on the front panel, allowing the user to clear any latched alarms in the system as well as latched NOT OK conditions. An I/O module provides a set of rear-panel connections as well, allowing users to remotely activate this switch.

For Triple Modular Redundant (TMR) applications, the 3500 System requires a TMR version of the TDI/RIM (refer to the TMR section of this datasheet for additional information)<sup>2</sup>.

**Notes:**

1. Dozens of possible event conditions within the rack can drive the NOT OK relay. For this reason, it is not intended for use as part of a machinery auto-shutdown circuit and should be used for general annunciation purposes only.

2. New TMR systems are no longer available. This information is being included for information purposes for those that already have these systems installed.

**Monitors**

Table 1 summarizes available monitor types in the 3500 System. Each monitor occupies a single slot in the rack. All monitors are microprocessor-based and offer digitally adjustable Alert and Danger setpoints for each channel<sup>1</sup>. Users can configure alarms for latching or non-latching operation. Status indications for each monitor and channel are provided with bright, front-panel LEDs, allowing observation without operator interaction for easy and convenient operation. Most monitors provide independent 4 to 20 mA proportional outputs for each channel of the I/O module for connection to strip chart recorders or for older process control systems that do not support a digital interface. Where applicable, the monitor's I/O modules provide transducers with appropriate power via short-circuit-protected terminals. OK detection routines within each monitor continuously check the integrity of each transducer and the associated field wiring. Transducer input signals are buffered and sent to front-panel coaxial connectors<sup>2</sup>. Buffered output terminals are also available upon request on the rear of the TDI/RIM's I/O module.

## Available 3500 Series Monitor Modules

Monitor Type	Channels Types	Number of Channels
3500/40M	<ul style="list-style-type: none"> <li>• Radial Vibration</li> <li>• Axial (Thrust) Position</li> <li>• Eccentricity</li> <li>• Differential Expansion<sup>3</sup></li> </ul>	Four <sup>4,5</sup>
3500/42M	<p>Same as 3500/40M, with the following additional channel types:</p> <ul style="list-style-type: none"> <li>• Acceleration<sup>6</sup></li> <li>• Velocity<sup>6</sup></li> <li>• Enhanced Acceleration<sup>6</sup></li> <li>• Enhanced Velocity<sup>6</sup></li> <li>• Circular Acceptance<sup>7</sup></li> <li>• Shaft Absolute</li> </ul>	Four <sup>4,5</sup>
3500/44M	<ul style="list-style-type: none"> <li>• Special Aeroderivative Gas Turbine Monitoring Functions<sup>8</sup></li> </ul>	Four
3500/45	<ul style="list-style-type: none"> <li>• Axial (Thrust) Position</li> <li>• Differential Expansion</li> <li>• Standard Single Ramp Differential Expansion</li> <li>• Non-Standard Single Ramp Differential Expansion</li> <li>• Dual Ramp Differential Expansion</li> <li>• Complementary Differential Expansion</li> <li>• Case Expansion<sup>9</sup></li> <li>• Valve Position</li> </ul>	Four <sup>5</sup>
3500/46M	<ul style="list-style-type: none"> <li>• Hydro Radial Vibration<sup>10</sup></li> <li>• Hydro Stator-Mounted Air Gap</li> <li>• Hydro Acceleration</li> <li>• Hydro Thrust</li> <li>• Hydro Velocity</li> <li>• Stator End Winding</li> <li>• Multimode Functionality</li> </ul>	Four <sup>5</sup>
3500/50M	<ul style="list-style-type: none"> <li>• Standard Tachometer</li> <li>• Rotor Acceleration Tachometer</li> <li>• Zero-Speed Tachometer</li> <li>• Reverse Rotation</li> </ul>	Two <sup>11,12</sup>
3500/53	<ul style="list-style-type: none"> <li>• Overspeed Tachometer</li> </ul>	One <sup>13</sup>

Monitor Type	Channels Types	Number of Channels
3500/60 <sup>2,14</sup> and 3500/61 <sup>2,14</sup>	<ul style="list-style-type: none"> <li>• Temperature</li> <li>• Differential Temperature</li> </ul>	Six
3500/62 <sup>2,14</sup>	<ul style="list-style-type: none"> <li>• Process Variables<sup>15</sup></li> </ul>	Six
3500/63 <sup>2</sup>	<ul style="list-style-type: none"> <li>• Hazardous Gas Detection</li> </ul> <p><b>NOTE: The 3500/63 is no longer available.</b></p>	Six
3500/64	<ul style="list-style-type: none"> <li>• Dynamic Pressure<sup>16</sup></li> </ul>	Four
3500/70M	<ul style="list-style-type: none"> <li>• Recip Impulse / Velocity</li> </ul>	Four
3500/72M	<ul style="list-style-type: none"> <li>• Reciprocating Compressor Rod Drop / Rod Position / Hyper compressor</li> </ul>	Four <sup>5</sup>
3500/77M	<ul style="list-style-type: none"> <li>• Reciprocating Compressor Cylinder Pressure, including: <ul style="list-style-type: none"> <li>- Suction Pressure</li> <li>- Maximum Pressure</li> <li>- Minimum Pressure</li> <li>- Compression Ratio</li> <li>- Peak Rod Compression</li> <li>- Peak Rod Tension</li> <li>- Degree of Rod Reversal</li> </ul> </li> </ul>	Four
3500/82	<p>Motor Stator Insulation Monitor</p> <ul style="list-style-type: none"> <li>• Leakage Current (each phase)</li> <li>• Line Voltage (each phase)</li> <li>• Temperature (up to three channels)</li> </ul>	Nine

**Table 1**

**Notes:**

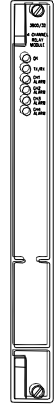
1. In addition to the direct measurement made by the monitor, many channel types provide an enhanced data set consisting of a variety of proportional values that will depend on the monitor type and its configuration. For example, for a radial vibration channel this includes the basic overall (direct) vibration amplitude as well as gap voltage, 1X filtered amplitude, 1X filtered phase, 2X filtered amplitude, 2X filtered phase, NOT 1X amplitude, and Smax. These additional proportional values are provided for each channel, and ALERT alarm setpoints can be established on each proportional value, as desired. DANGER alarm setpoints can be established on any two proportional values returned from each channel.
2. 3500/60, /62, and /63 monitor types do not provide front-panel buffered output connectors.
3. Only standard differential expansion capabilities provided. For ramp differential expansion and complementary input differential expansion, use the 3500/45 Position Monitor instead.
4. The 3500/42M provides individual 4 to 20 mA proportional outputs for each channel. The 3500/40M does not provide 4 to 20 mA outputs.
5. The monitor channels are programmed in pairs and can perform up to two of these functions at a time. Channels 1 and 2 can perform one function, while channels 3 and 4 perform another (or the same) function.
6. Channels configured for velocity or acceleration provide only direct amplitude. Channels configured for Velocity II or Acceleration II provide 1X amplitude/phase and 2X amplitude/phase in addition to direct amplitude.
7. Any vibration channel can be configured for conventional "pie-shaped" acceptance region alarms. When configured for circular acceptance regions, circular, rather than pie-shaped, acceptance region alarms can be enabled. Refer to the 3500/42M Operations/Maintenance Manual for additional information, or contact your nearest sales professional.
8. Contact the factory or your local sales professional for details.
9. Only channels 3 and 4 can be used for Case Expansion measurements.
10. The 3500/46M provides frequency response characteristics suitable for use on machines with very slow rotational speeds, such as hydraulic turbine/generator sets, which often operate at speeds of 100 RPM or lower. Also, special signal conditioning and tracking filtering is provided, allowing detection of rough load zone operation, shear pin failure, and other hydro-specific conditions.
11. The 3500/50M is not intended for use in overspeed protection applications. Use the 3500/53 instead.
12. Both Zero Speed and Reverse Rotation channel types require both channels of the 3500/50 module, making it a single-channel monitor in these configurations.
13. The 3500/53 is a single channel module, intended for use as part of a 1-out-of-2 or 2-out-of-3 (recommended) overspeed detection system.
14. The 3500/60 and 3500/61 provide identical functions except the 3500/60 does not provide 4 to 20 mA proportional outputs. When these outputs are required, use the 3500/61.
15. The 3500/62 is designed to accept static proportional signals such as 4 to 20 mA, 1 to 5 Vdc, or any static proportional signal between -10 and +10 Vdc. When dynamic signals (i.e., those where waveform information is required) are used, a 3500/40M or 3500/42M can often be programmed as a custom channel type to such signals, making the 3500 system compatible with virtually any

static or dynamic signal from pressure, level, temperature, vibration, flow, position, speed, or other transducers. Consult the factory or your local Bently Nevada sales professional for more information.

16. The 3500/64M is primarily intended for monitoring combustor pressure pulsation instabilities ("humming") in gas turbines.

**Relays<sup>1</sup>**

The 3500/32 Relay Module provides four double-pole, double throw (DPDT) relays that can actuate based on alarm conditions within 3500 monitor modules. The configuration software allows the user to program various combinations of alarms, ranging from an individual channel's ALERT or DANGER status, to highly complex Boolean expressions that combine two or more channel statuses to provide special AND or OR voting. By adding the desired number of relay modules, the user can provide individual contacts for each channel, alarm type, and group of channels for global alarm annunciation.



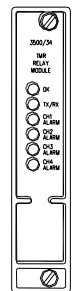
The 3300/33 16-Channel Relay Module is a full-height module that provides 16 relay outputs. Any number of 16-Channel Relay Modules can be placed in any of the slots to the right of the Rack Interface Module. Each output of the 16-Channel Relay Module can be independently programmed to perform needed voting logic.

Each relay utilized on the 16-Channel Relay Module includes "Alarm Drive Logic". Programming for the Alarm Drive Logic uses AND and OR logic, and can use alarming inputs (Alert and Danger statuses), Not OK, or individual PPLs from any monitor channel or any combination of monitor channels in the rack. Users program this Alarm Drive using the 3500 Rack Configuration Software to meet the specific needs of the application.

**Note:** The 3500/34 Module is no longer available for new installations. The following is provided for information purposes only.

The 3500/34 TMR Relay Module works in conjunction with a special TMR Rack Interface Module and three monitor modules to provide 2-out-of-3 voting for inputs.

Relays are epoxy-sealed and installed arc suppressors are standard. Users can program relays for either normally energized or normally de-energized operation.



The 3500 Rack also supplies a common system OK relay<sup>2</sup> in addition to any alarm relays in the rack. This relay is located in the TDI/RIM's I/O module and is connected to the OK circuits of all modules in the rack. These circuits monitor the operating condition of each module. Any fault in the module, its transducers, or associated transducer field wiring will be annunciated by the OK relay. This relay is a single-pole, double-throw (SPDT) type and is normally energized, providing added capability of annunciation in the event of primary power loss.

**Notes:**

1. Although not a required component of the 3500 System, we strongly recommend relays as the appropriate way to interconnect the 3500 System in auto-shutdown applications. Analog (e.g. 4 to 20 mA) and digital (e.g. Modbus®) connections are intended for operator annunciation and trending purposes and do not provide the fault tolerance or integrity necessary for highly reliable machinery shutdown purposes.
2. Dozens of possible event conditions within the rack can drive the NOT OK relay. For this reason, it is not intended for use as part of a machinery auto-shutdown circuit and should be used for general annunciation purposes only.

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## Keyphasor Inputs

The 3500 System can accommodate up to four<sup>1</sup> Keyphasor transducers per rack by installing two 3500/25 Keyphasor modules in a rack<sup>2</sup>. Each 3500/25 is a half-height module that provides power and termination for up to two Keyphasor transducers each. When applications require Keyphasor transducers, simply install a single 3500/25 module. Keyphasor signals from the 3500/25 module(s) can be routed to appropriate monitor modules via the 3500's rack backplane for use in speed, phase, tracking filter, and other measurements.

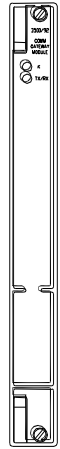
**Notes:**

1. When more than four Keyphasor transducers must be used in a single rack, contact the factory for details regarding special modifications available.
  2. When two 3500/25 modules are used, they must be installed in the same rack slot, one above the other.
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## Communications Gateway

With an appropriate Communications Gateway module in the rack, installations can digitally transfer selected status and current value data to process control systems, historians, plant computers, and other relevant systems. The Communication Gateway modules support a variety of industry-standard protocols and users can install multiple Communications Gateway modules in a rack when the system requires redundant communications or must support multiple communication protocols simultaneously. The modules do not interfere with the 3500 System's normal operations or machinery protection functions, ensuring that the monitoring system integrity is always maintained, even in the unlikely event of a Communications Gateway module failure.



The Communications Gateway supports both Ethernet and serial communications media, allowing a variety of wired and wireless topologies. Communications are bi-directional, allowing selected data to be sent to and retrieved from the 3500 System. In addition, when installations use Ethernet to connect the Communications Gateway to process control or other systems, multiple computers running 3500 Configuration Software and/or 3500 Operator Display Software can reside on the same network. This eliminates the need for separate connections between the software and the RIM.

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## Displays

The 3500 System provides the most flexible display options ever offered by the Bently Nevada product line as summarized in Table 2. Multiple displays can be combined as needed to meet specific requirements for local and remote indication of rack statuses, measurements, and alarms.

## 3500 Display Options

Display Type	Mounting Options	Capabilities	Meets API 670
3500/93 LCD Display	<b>Face Mounting<sup>1</sup></b> – The display installs directly over the front panel of any 3500 rack using a special hinged support. This permits access to the rack's buffered output connectors and user-interface buttons and switches without disconnecting or disabling the display.	Provides status and indication of all monitored parameters within the 3500 rack via dedicated LEDs and ½ VGA (640 x 200) monochrome display. Bargraph, text, and other displays are available, based on configuration.  CSA approved for use in Class I Div 2 hazardous areas.	Yes, when properly configured
	<b>19-inch EIA Rack Mounting</b> – The display is mounted on 19-inch EIA rails and located up to 100 feet away from the 3500 System <sup>2</sup> .		
	<b>Panel Mounting</b> – The display is mounted in a panel cutout located in the same cabinet or up to 100 feet away from the 3500 System <sup>2</sup> .		
	<b>Independent Mounting</b> – The display is mounted in a NEMA 4X enclosure flush against a wall or panel, and located up to 100 feet away from the 3500 System <sup>2</sup> .		
3500/94 VGA Display	<b>Panel Mounting</b> – The display is mounted in a panel cutout located in the same cabinet or up to 25 feet away from the 3500 System <sup>3</sup> .	VGA module occupies one rack slot and can drive any compatible touchscreen VGA (640 x 480 color) display, without the need for special configuration (uses configuration within 3500 rack to create pre-formatted screens automatically). Provides bargraph, text, and other display types. This display option is recommended for most applications.  When used with an optional display router, up to four 3500 racks can share a single display; however, this option does not meet API 670 requirements of a dedicated display for each rack.  CSA approved for use in Class I Div. 2 hazardous areas when ordered with the R. S. Power Station option.	Yes
	<b>19-inch EIA Rack Mounting</b> – The display is mounted on 19-inch EIA rails and located up to 25 feet away from the 3500 System <sup>3</sup> .		
	<b>Shelf Mounting</b> – The display is mounted on a shelf or tabletop and located up to 25 feet away from the 3500 System <sup>3</sup> .		
3500/95 User Interface Workstation	<b>Panel Mounting</b> – The display is mounted in a panel cutout located in the same cabinet or up to 4000 feet away from the 3500 System <sup>4</sup> .	This display option is an industrial panel-mounted computer running 3500 Operator Display Software. A single 3500/95 can display information from multiple 3500 racks. Software, such as 3500 Configuration or other Bently Nevada condition monitoring software, can also reside on this computer. The computer is CSA approved for use in Class I Div 2 hazardous areas.	No
Desktop or Laptop Computer		This display option is a compatible desktop or laptop computer running 3500 Operator Display Software that is permanently connected to the rack via the RIM using serial communications or via a Communications Gateway module using Ethernet.  Where a permanent display is not required, connection can be made to the RIM using a laptop and serial cable, or via optional phone modem.	No
Process Control System		In this display option, a Communications Gateway module in the rack provides status and current value information to a process control system, plant computer, or other human machine interface using one of the 3500 System's supported protocols. Alternatively, hardwired 4 to 20 mA proportional outputs and relay contacts can be used in lieu of a digital interface to older control or automation systems.	No
None		The 3500 can operate as a "blind" system with only local LED status annunciation as provided on the rack. Temporary display capabilities can be obtained by connecting a laptop computer to the rack using the RIM's serial port or modem. 3500 Configuration and/or 3500 Operator Display Software must be loaded on the computer.	No

**Table 2**

**Notes:**

1. For this mounting option only, the Display Interface Module (DIM) must occupy slot 15 (right-most slot) of the rack.
2. With the use of a special external power supply, the display can be located up to 1219 metres (4000 feet) from the 3500 System.
3. It is recommended that the display be located within 7.6 metres (25 feet) of the 3500 rack as the video driver circuit is optimized for this range. Lengths above 25 feet will degrade the picture quality. When an extension is necessary, a special KVM Extender is available. However, even with the KVM Extender, there will be some reduction in picture quality. Typically, the picture image will still be acceptable. The KVM Extender must be used indoors, and it is not rated for use in hazardous areas.
4. Distances greater than 4000 feet are supported when Ethernet, rather than serial communications, is used between the rack and the 3500/95 display. Wireless Ethernet can also be used.

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### Intrinsic Safety Barriers or Galvanic Isolators

For applications where the transducers are located in a hazardous area, the 3500 System can be used with internal or external intrinsic safety barriers. However, the 3500 option for internal safety barriers is generally preferable to external barriers because this option saves cost, requires no extra cabinet space, and needs no additional wiring. Internal barriers improve safety because the connections are pre-wired, reducing the possibility for errors introduced by wiring additional external connections between monitors and barriers. Internal barriers also improve quality because, unlike external barriers, they require no special monitor scale factor calibration to compensate for voltage drop across the barrier. For additional information on 3500 internal barriers, refer to datasheet 141495-01.

For those that prefer the use of galvanic isolators to address intrinsic safety requirements, pre-engineered external galvanic isolators and an appropriate housing are available. For additional information on 3500 galvanic isolators, refer to datasheet 141714-01.

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### Applications

The 3500 System is intended for continuous, permanent monitoring of rotating and reciprocating machinery in a variety of industries. It is specifically designed for use in auto-shutdown machinery protection applications that require extremely high reliability and availability. Machine types addressed by the 3500 System include but are not limited to:

- Industrial gas and steam turbines in power generation and mechanical drive service
- Aeroderivative gas turbines in power generation and mechanical drive service

- Hydraulic (Hydro) turbines in power generation service
- Compressors (air/process gas, radial/axial, centrifugal/positive displacement)
- Turbo Expanders
- Electric motors and generators
- Exciters
- Gear boxes
- Pumps (centrifugal and positive displacement)
- Fans
- Blowers
- Reciprocating compressors
- Extruders and pelletizers

In addition, GE's Bently Nevada Custom Products engineering, can often address special requirements for custom configuration of an existing monitor type or modifications to a standard monitor type. Contact your local sales professional for further information.

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### Features

#### Digital and Analog Communications

The 3500 System features separate, concurrent digital communication capabilities for connection to:

- System 1 machinery management software using Bently Nevada proprietary protocols via Ethernet connections
- Process control and other plant automation systems using industry-standard protocols via the 3500's Communications Gateway module
- Bently Nevada condition monitoring systems via pre-engineered Data Manager ports which interface to an appropriate external communications processor such as TDISecure
- 3500 Configuration and Display software

In addition, analog (4 to 20 mA and relay) outputs are available for connection to older plant controls that cannot support digital interfaces.

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**Note:** Although not a required component of the 3500 System, relays are strongly recommended as the appropriate way to interconnect the 3500 System in auto-shutdown applications. Analog (e.g. 4 to 20 mA) and digital (e.g. Modbus<sup>®</sup>) connections are intended for operator annunciation and trending purposes and do not provide the fault tolerance or integrity necessary for highly reliable machinery shutdown purposes.

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#### Highly Flexible Display Options

Displays can range from local units mounted directly on the rack's front panel, to remote displays using wireless communications, to completely blind monitoring systems with an as-needed HMI (Human Machine Interface) connection for configuration and



information. Multiple displays can be connected concurrently without degrading system performance or interrupting basic machinery protection functions.

### Software Configurable

Virtually every aspect of the 3500's operation is software configurable, resulting in the most flexible Bently Nevada monitoring system ever offered and in easier spare parts management. Unlike previous systems, a single 3500 module type can be configured for a variety of functions rather than for just a single function. The following list represents just part of the 3500's numerous configurable options.

Transducer type and scale factor	Normal thrust direction toward or away from probe
Alarm delays	Trip Multiply factor
Transducer OK limits	Filter corners
Full scale value	Integration (velocity to displacement, acceleration to velocity)
Engineering Units	Recorder output clamping value
Alarm Setpoints	Timed OK / Channel Defeat enabled/disabled
Latching/non-latching alarms	Proportional value assigned to recorder output
Normally energized or de-energized relays	Relay voting logic

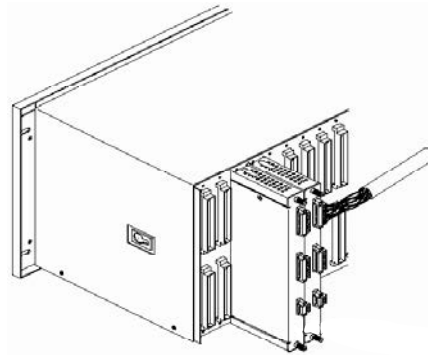
### Density

The 3500 System can easily fit twice as many channels into the same rack space as previous monitoring systems. This results in lower installation costs by saving valuable cabinet space and spreading common components, such as displays, communications gateways, and power supplies, across more channels for lower per-channel costs.

### Internal and External Terminations

Previous monitoring systems have always incorporated field wiring connections on the back of the rack. The 3500 System offers this conventional approach with our internal termination option. However, the 3500 system now offers an innovative external termination option that allows field wiring to go to external terminal blocks. These blocks can be mounted where access is more convenient, such as on a cabinet wall, and less congested than on the back of each monitor module. The external terminal block then connects to the monitor's I/O module

using a single pre-engineered cable, resulting in neater, more easily serviceable installations.



Conventional internal terminations are shown above, where field wiring terminates directly to connections on 3500 I/O modules.

### Higher Integrity / Fault Tolerance

The 3500 System is the first system offered in the Bently Nevada product line that the user can configure with varying levels of redundancy. This ranges from simplex modules to dual power supplies to redundant relay modules with wide ranging and flexible logical operator options for configuring complex relay logic as desired. The 3500 System also offers a variety of SIL 1 and SIL 2 certifications for various 3500 monitors suitable for use as components in safety instrumented systems subject to functional safety certification.

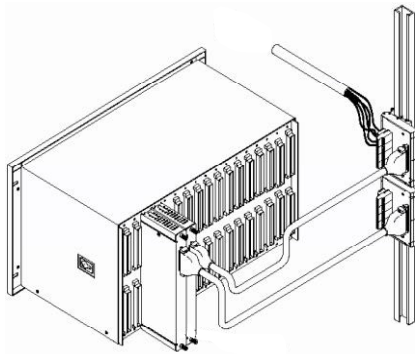
Even without redundancy, the 3500 system represents the most reliable monitoring system we have ever offered. It incorporates numerous self-monitoring functions that can identify faults in the monitor modules and their connected transducers, annunciate and identify problems via appropriate error codes, and suppress channel operation automatically when a failure could compromise correct operation of the system.

The 3500 System stores configuration in two separate locations in each module's non-volatile memory. This redundancy allows the module to ensure that memory has not been corrupted by comparing configuration information for agreement and flagging any anomalies. The use of redundant, non-volatile memory also allows the user to program the module ahead of time for spare parts, and ensures that, in the event a redundant power supply is not used, monitor configuration is not lost when power is interrupted and monitoring functions can resume immediately upon reapplication of rack power.

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## Skid Mounting

In many cases, the 3500 rack can be mounted on or near the machine skid or local control panel, keeping cable runs between the 3500 rack and the machine shorter and less costly. Wired and wireless communications and display options permit the installation to make a single Ethernet connection between the control room and 3500 rack. This also permits installations to distribute display and other information needed, whether to a process control system or to an engineer's desktop computer. The result is a machinery protection system with significantly lower installation costs than those that must be mounted in only control room environments. Optional NEMA 4 and NEMA 4X weatherproof housings are available when installations require field mounting of the 3500 System.



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## Remote Accessibility

Modem, WAN, or LAN connections allow the user to remotely configure a 3500 system and even assess the system when an instrument problem arises. Users can implement simple changes, such as to an alarm setpoint or a filter corner, without traveling to site. This is ideal for such installations as offshore platforms, compressor or pump stations, emergency generators, and other locations where on-site access to the instrumentation is inconvenient or impractical.

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## Tamper-resistant Design

The 3500 System's two levels of password protection combined with a keylock for configuration changes ensures the system can't be adjusted, changed, or configured except by those authorized to do so. Users can document and control management of change much more easily, and the 3500 rack records any configuration changes in the system's event list.

Bently Nevada also offers Achilles Communication Certification Level 1 certified solutions as well as full engineered and hardened network architectures when required to meet cyber security needs.

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## Alarm/Event Lists

The 3500 System goes well beyond the capabilities of previous systems to simply identify the first alarm to occur in the rack via a "First Out" feature. Extensive alarm and event lists retain the 1000 most recent alarm and 400 most recent system events (configuration changes, errors, etc.). The system's TDI/RIM retains the lists, which provide a description of each alarm or event and a corresponding date/time stamp. These lists are available to 3500 displays, 3500 Operator Display Software, and the Communications Gateway module for export to process control, historian, or other plant systems.

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## Time Synchronization

The system's real-time clock can be synchronized with external clocks, via the Communications Gateway or via connected Bently Nevada software. The 3500's alarm and event lists then provide time/date stamps that are synchronized with alarms and events in other process and automation equipment. This reduces or eliminates the need for elaborate, hardwired "Sequence of Event" recorders.

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## API 670 Compliance

When configured properly, supplied with the correct number of relay modules, and provided with an appropriate optional display, the 3500 System fully complies with the latest edition of the American Petroleum Institute (API) Standard 670 for Machinery Protection Systems, covering shaft-relative vibration, axial position, temperature, reciprocating compressor rod drop, tachometer, overspeed detection, and casing vibration.

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## Hot Insertion

All modules and Power Supplies (when redundant supplies are used) can be removed or inserted when the rack is under power. This facilitates easier maintenance and system expansion without

interruption of machinery protection functions or system operation.

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**Note:** Before removing an I/O module, the front-panel portion of the module must first be removed. This removes power from the slot so that the I/O module can then be safely removed without powering down the rack.

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### More Flexible Mounting Options

In addition to conventional 19-inch rail and panel-cutout mounting options, the 3500 System introduces a new bulkhead mounting option, allowing the rack to be mounted on a wall or other location where rear access to the rack is not available.

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### Enhanced Data

Even without condition monitoring software, the 3500 System is able to provide more measurements from each transducer channel. For example, in addition to direct (unfiltered) vibration amplitude for a radial proximity probe channel, the 3500 monitor can return gap voltage, 1X amplitude and phase, 2X amplitude and phase, NOT 1X amplitude, and Smax amplitude (when XY transducers are present). Thus,

a single radial vibration channel can actually return 8 conditioned parameters (termed proportional values) for a total of 32 in a single 4-channel monitor module. This is particularly valuable when machinery protection strategies require alarms on these proportional values. Activation or use of these proportional values has no impact on rack density, and does not consume additional channels in the monitor.

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**Note:** ALERT alarm setpoints can be established on *each* proportional value, as desired. DANGER alarm setpoints can be established on *any two* proportional values returned from each channel.

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### Specifications

Consult individual datasheets for each module type.

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### Ordering Information

Consult individual datasheets for each module type.

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