3500 System Overview

Function
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 Bently Nevada’s 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 Relay Modules or 3500/34 TMR Relay Modules (optional)
- 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 BNC 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 may provide redundancy for situations in which power interruption cannot be tolerated. Dual supplies reside in the upper and lower positions of the left-most rack slot. Redundant Power Supplies can be energized with different voltage sources. For example, the primary (bottom) supply can be energized with 120 Vac power while the backup (upper) supply can be energized from an uninterruptible 24 Vdc source.

Each Power Supply is individually capable of providing power to the entire rack and its modules. When redundant supplies are used, one 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 should the other module fail, without interrupting rack functions. 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. One TDI or RIM is required for each rack and it resides in the rack slot immediately adjacent to the Power Supply slot. The TDI and RIM support a proprietary protocol used by 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 Bently Nevada's System 1® machinery management software without the need for an external communications processor. The RIM requires an external communications processors, such as TDXnet™, TDIX, or DDIX to interface to Data Manager® condition monitoring software.

The System OK relay1 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 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.
Four front-panel LEDs are provided on the TDI and RIM as follows:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>Indicates that the Rack Interface Module and its I/O modules are operating correctly.</td>
</tr>
<tr>
<td>TX/RX</td>
<td>Flashes at the rate that communications between the RIM and other rack modules are occurring.</td>
</tr>
<tr>
<td>TM</td>
<td>Indicates when the rack is in the Trip Multiply mode.</td>
</tr>
<tr>
<td>CONFIG OK</td>
<td>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.</td>
</tr>
</tbody>
</table>

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 or tampering. 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. TDI permanent system connectivity is accomplished 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.

A 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 for remote activation of 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).

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.

Monitors

Available monitor types in the 3500 System are summarized in Table 1. Each monitor occupies a single slot in the rack. All monitors are microprocessor-based with digitally adjustable Alert and Danger setpoints for each channel. Alarms can be configured 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 older process control systems where a digital interface is not feasible. 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. Buffered output terminals are also available upon request on the rear of the TDI/RIM’s I/O module.
### Table 1 – Available 3500 Series Monitor Modules

<table>
<thead>
<tr>
<th>Monitor Type</th>
<th>Channels Types</th>
<th>Number of Channels</th>
</tr>
</thead>
</table>
| 3500/40M     | • Radial Vibration  
• Axial (Thrust) Position  
• Eccentricity  
• Differential Expansion³ | Four⁴,⁵ |
| 3500/42M     | Same as 3500/40M, with the following additional channel types:  
• Acceleration⁶  
• Velocity⁵  
• Enhanced Acceleration⁶  
• Enhanced Velocity⁵  
• Circular Acceptance Region⁷  
• Shaft Absolute | Four⁴,⁵ |
| 3500/44M     | • Special Aeroderivative Gas Turbine Monitoring Functions³ | Four |
| 3500/45      | • Axial (Thrust) Position  
• Differential Expansion  
• Standard Single Ramp Differential Expansion  
• Non-Standard Single Ramp Differential Expansion  
• Dual Ramp Differential Expansion  
• Complementary Differential Expansion  
• Case Expansion⁵  
• Valve Position | Four⁵ |
| 3500/46M     | • Hydro Radial Vibration¹⁰  
• Hydro Stator-Mounted Air Gap | Four⁵ |
| 3500/50      | • Standard Tachometer  
• Rotor Acceleration Tachometer  
• Zero-Speed Tachometer | Two¹¹,¹² |
| 3500/53      | • Overspeed Tachometer | One¹³ |
| 3500/60/61²⁴  
3500/62/63²⁴ | • Temperature  
• Differential Temperature  
• Process Variables¹⁵  
• Hazardous Gas Detection | Six |
| 3500/64      | • Dynamic Pressure¹⁶ | Four |
| 3500/70M     | • Recip Impulse / Velocity | Four |
| 3500/72M     | • Reciprocating Compressor Rod Drop / Rod Position / Hyper compressor | Four⁵ |
| 3500/77M     | • Reciprocating Compressor Cylinder Pressure, including:  
- Suction Pressure  
- Maximum Pressure  
- Minimum Pressure  
- Compression Ratio  
- Peak Rod Compression  
- Peak Rod Tension  
- Degree of Rod Reversal | Four |

**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. Front-panel buffered output connectors are not provided on the 3500/60, /61, /62, or /63 monitor types.

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 Bently Nevada sales professional.
8. Contact the factory or your local Bently Nevada 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 3500/50 is not intended for use in overspeed protection applications. Use the 3500/53 instead.

12. When configured for zero speed functionality, both channels of the 3500/50 module are required, making it a single-channel monitor.

13. The 3500/53 is a single channel module, intended for use as part of a 2-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

The 3500/32 Relay Module provides four 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.

### Keyphasor® Inputs

The 3500 System can accommodate up to four Keyphasor® transducers per rack by installing two 3500/25 Keyphasor® modules in a rack. Each 3500/25 is a half-height module that provides power and termination for up to two Keyphasor® transducers each. When two or fewer Keyphasor® transducers are needed, 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 backbone 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.
Communications Gateway

By installing an appropriate Communications Gateway module in the rack, selected status and current value data can be transferred digitally to process control systems, historians, plant computers, and other relevant systems. The Communication Gateway modules support a variety of industry-standard protocols and multiple Communications Gateway modules can be installed in a rack when redundant communications are required with the same system, or when the system must support multiple communication protocols simultaneously.

The modules do not interfere with the 3500 System’s normal operations or machinery protection functions, ensuring 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 Ethernet is used for connecting 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.

Displays

The 3500 System provides the most flexible display options ever offered by Bently Nevada, 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.

Table 2 – 3500 Display Options

<table>
<thead>
<tr>
<th>Display Type</th>
<th>Mounting Options</th>
<th>Capabilities</th>
<th>Meets API</th>
</tr>
</thead>
<tbody>
<tr>
<td>3500/93 LCD Display</td>
<td>Face Mounting¹ – 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.</td>
<td>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.</td>
<td>Yes, when properly configured</td>
</tr>
<tr>
<td></td>
<td>19-inch EIA Rack Mounting – The display is mounted on 19-inch EIA rails and located up to 100 feet away from the 3500 System².</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Panel Mounting – The display is mounted in a panel cutout located in the same cabinet or up to 100 feet away from the 3500 System².</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Independent Mounting – 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 System².</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display Type</td>
<td>Mounting Options</td>
<td>Capabilities</td>
<td>Meets API 670</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>3500/94 VGA Display</td>
<td>Panel Mounting – The display is mounted in a panel cutout located in the same cabinet or up to 25 feet away from the 3500 System³.</td>
<td>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.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>19-inch EIA Rack Mounting – The display is mounted on 19-inch EIA rails and located up to 25 feet away from the 3500 System³.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shelf Mounting – The display is mounted on a shelf or tabletop and located up to 25 feet away from the 3500 System³.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3500/95 User Interface Workstation</td>
<td>Panel Mounting – The display is mounted in a panel cutout located in the same cabinet or up to 4000 feet away from the 3500 System³.</td>
<td>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. Other software, such as 3500 Configuration or 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.</td>
<td>No</td>
</tr>
<tr>
<td>Desktop or Laptop Computer</td>
<td>Panel Mounting – The display is mounted in a panel cutout located in the same cabinet or up to 4000 feet away from the 3500 System³.</td>
<td>This display option is simply a compatible desktop or laptop computer running 3500 Operator Display Software, and 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.</td>
<td>No</td>
</tr>
<tr>
<td>Process Control System</td>
<td></td>
<td>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.</td>
<td>No</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>The 3500 can operate as a &quot;blind&quot; 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.</td>
<td>No</td>
</tr>
</tbody>
</table>

Notes:

1. For this mounting option only, the Display Interface Module (DIM) must be installed in 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. 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.
Communications Gateway

By installing an appropriate Communications Gateway module in the rack, selected status and current value data can be transferred digitally to process control systems, historians, plant computers, and other relevant systems. The Communication Gateway modules support a variety of industry-standard protocols and multiple Communications Gateway modules can be installed in a rack when redundant communications are required with the same system, or when the system must support multiple communication protocols simultaneously.

The modules do not interfere with the 3500 System’s normal operations or machinery protection functions, ensuring 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 Ethernet is used for connecting 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.

Displays

The 3500 System provides the most flexible display options ever offered by Bently Nevada, 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.

<table>
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<tr>
<th>Display Type</th>
<th>Mounting Options</th>
<th>Capabilities</th>
<th>Meets API 670</th>
</tr>
</thead>
<tbody>
<tr>
<td>3500/93 LCD Display</td>
<td>Face Mounting ¹ – 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.</td>
<td>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.</td>
<td>Yes, when properly configured</td>
</tr>
<tr>
<td></td>
<td>19-inch EIA Rack Mounting – The display is mounted on 19-inch EIA rails and located up to 100 feet away from the 3500 System².</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Panel Mounting – The display is mounted in a panel cutout located in the same cabinet or up to 100 feet away from the 3500 System².</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Independent Mounting – 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 System².</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ For reference only
² For reference only
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 it saves cost, requires no extra cabinet space, and needs no additional wiring. It improves 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, no special monitor scale factor calibration is necessary 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.

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

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 TDXnet, TDIX, or DDIX
- 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.

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) 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.

Highly Flexible Display Options

Displays can range from local mounting directly on the rack’s front panel, to remote mounting 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 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.

<table>
<thead>
<tr>
<th>Transducer type and scale factor</th>
<th>Normal thrust direction toward or away from probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm delays</td>
<td>Trip Multiply factor</td>
</tr>
<tr>
<td>Transducer OK limits</td>
<td>Filter corners</td>
</tr>
<tr>
<td>Full scale value</td>
<td>Integration (velocity to displacement, acceleration to velocity)</td>
</tr>
<tr>
<td>Engineering Units</td>
<td>Recorder output clamping value</td>
</tr>
<tr>
<td>Alarm Setpoints</td>
<td>Timed OK / Channel Defeat enabled-disabled</td>
</tr>
<tr>
<td>Latching/non-latching alarms</td>
<td>Proportional value assigned to recorder output</td>
</tr>
</tbody>
</table>
platforms, compressor or pump stations, emergency generators, and other locations where on-site access to the instrumentation is inconvenient or impractical.

**Tamper-resistant Design**

3500’s combination of two levels of password protection and a keylock for configuration changes means the system can’t be adjusted, changed, or configured except by those authorized to do so. Management of change can be documented and controlled much more easily, and the 3500 rack contains any configuration changes in the system’s event list.

**Alarm/Event Lists**

3500 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.

**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.

**API 670 Compliance**

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

**Hot Insertion**

All modules and Power Supplies (when redundant supplies are used) can be removed or inserted with the rack 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.

**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.

**Enhanced Data**

Even without condition monitoring software installed, 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.

**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.

**Specifications**

Consult individual datasheets for each module type.

**Ordering Information**

Consult individual datasheets for each module type.