

# 3500 ENCORE System Overview

Bently Nevada\* Asset Condition Monitoring

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## Description

The 3500 ENCORE 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:

- 3500/05E Instrument Chassis (required)
- 3500/15E Power Supplies (AC, DC low or DC high required)
- 3500/23E Transient Data Interface (required)
- 3500 Rack Configuration Software (required)
- One or more 3500/42E Vibration Monitor Modules
- One or more 3500/45E Position Monitor Modules
- One or more 3500/50E Tachometer Modules
- One or more 3500/61E Temperature Modules
- One or more 3500/67E Temperature Modules
- Internal or external intrinsic safety barriers, or galvanic isolators for hazardous area installations (optional)
- Color front panel displays

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



## System Components

### Instrumentation Chassis

The 3500 ENCORE Chassis supports 6P, 8P, 10P, 12P and 14P 3300 Rack upgrades. The chassis consists of an EMI cage, backplane, and interface modules.

The rack upgrade utilizes the existing 3300 I/O modules and the Power Input Module.

The Interface modules are installed between the old backplane and the new backplane. These are used to reduce the likelihood of damaging the old backplane during the upgrade process and as part of the shielding for the new system.

The upgraded rack provides slots for a single Power Supply and a System Monitor in the left-most rack positions that are reserved exclusively for these modules. The remaining slots in the rack can accommodate any combination of monitors. All modules plug into the chassis's new backplane and consist of a main module and an associated I/O module.

The rack depth is 424 mm (16.7 inches).

### Power Supply

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

The 3500/15E 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.



### System Monitor/Transient Data Interface

The Transient Data Interface (TDI) is the 3500 ENCORE Rack's primary interface to the configuration, display, condition and monitoring software, and to external control systems. Each rack requires one TDI, which resides in the rack slot immediately adjacent to the Power Supply slot. The TDI supports a proprietary protocol used by 3500 Configuration Software to configure the rack. TDI provides a direct interface with GE's Bently Nevada System 1\* machinery management software without the need for an external communications processor.

The TDI supports the Modicon MODBUS® protocol†.

†NOTE: The 3500 ENCORE 1.0 system will not support 3300/01 rear serial MODBUS communication. The rear 25 pin serial port is disabled with this upgrade.

This interface provides an engineered connection to process control systems, historians and other plant control and automation systems.

The TDI provides access to the current monitored values and status over this protocol.

The TDI can be configured to support the 3300 or 3500 register map. Selection of the 3300 register map will preserve the DCS programming used to access the 3300 System. Selection of the 3500 register map allows access to the additional measurements provided by the ENCORE System.

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

The TDI provides 4 front-panel LEDs as follows:



<b>RACK OK</b>	Indicates that the entire rack is operating correctly and reflects the state of the OK Relay.
<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 TDI Module does not match the physical configuration of the rack; or that a security option condition was not met.
<b>TDI OK</b>	Indicates that the TDI Module is operating correctly.
<b>TRIP MULTIPLY</b>	Indicates when the rack is in the Trip Multiply mode.

System configuration is secured by means of a keylock switch on the front of the TDI and two levels of software password protection, preventing unauthorized changes to or tampering with the configuration. The TDI can be connected to a portable computer via a front-panel Ethernet port for local changes to configuration. The TDI provides permanent system connectivity via Ethernet ports on the front and back of the rack.

The TDI 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.

### Keyphasor Inputs

The 3500 ENCORE System can accommodate up to four Keyphasor transducers per rack. The TDI provides power and termination for up to four Keyphasor transducers. Keyphasor signals from the TDI can be routed to appropriate monitor modules via the 3500 ENCORE's rack backplane for use in speed, phase, tracking filter, and other measurements.

**Notes:**

1. Many event conditions within the rack can drive the OK relay to the NOT OK state. 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 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. Measurements and statuses are displayed on a color display located on the front of the monitor. Additionally, there are status indication LEDs for each monitor allowing observation without operator interaction for convenient operation. The 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.



The 3500/42E and 3500/45E are 4 channel monitors, but while in a legacy 3300 rack only channels 1 and 2 are available. Transducer input signals are buffered and sent to front-panel coaxial connectors<sup>2</sup>. Buffered output terminals are also available on the rear of the monitors.

### Available 3500 ENCORE Series Monitor Modules

Monitor Type	Channels Types	Number of Channels
3500/42E <sup>1</sup>	<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> <li>● Acceleration</li> <li>● Velocity</li> <li>● Shaft Absolute</li> </ul>	Four <sup>4,5</sup>
3500/45E <sup>1</sup>	<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</li> <li>● Valve Position</li> </ul>	Four <sup>5</sup>
3500/50E	<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>6,7</sup>
3500/61E <sup>2</sup>	<ul style="list-style-type: none"> <li>● Temperature</li> </ul>	Six
3500/67E	<ul style="list-style-type: none"> <li>● Temperature</li> </ul>	Two

**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 measurements 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. 3500/61E and /67E monitor types do not provide front-panel buffered output connectors. It also requires two slots due to the legacy I/O modules in the 3300 rack.

3. Only standard differential expansion capabilities provided. For ramp differential expansion and complementary input differential expansion, use the 3500/45E Position Monitor instead.

4. The 3500/42E provides individual 4 to 20 mA proportional outputs for each channel.

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. When in a legacy 3300 rack only channels 1 and 2 can be used for the 3500/42E and 3500/45E.

6. The 3500/50E is not intended for use in overspeed protection applications. Use the 3500/53 instead.

7. Zero speed functionality requires both channels of the 3500/50E module, making it a single-channel monitor.

8. Velocity 1X phase and Shaft Absolute 1X phase are disabled in 3500 ENCORE due to the pre-filtering that is done in the I/O module.

## Intrinsic Safety Barriers or Galvanic Isolators

For applications where the transducers are located in a hazardous area, the 3500 ENCORE System can be used with internal or external intrinsic safety barriers. The ENCORE system makes use of any existing barriers connected to the 3300 rack.

## Applications

The 3500 ENCORE System is intended for continuous, permanent monitoring of rotating machinery in a variety of industries. Machine types addressed by the 3500 ENCORE System include but are not limited to:

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

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.

## Features

### Digital and Analog Communications

The 3500 ENCORE 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 RS-232, RS-422, RS-485 or Ethernet.
- 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:** Relays are strongly recommended as the appropriate way to interconnect the 3500 ENCORE 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.

### Software Configurable

Virtually every aspect of the 3500 ENCORE's operation is software configurable, resulting in the most flexible Bently Nevada monitoring system ever offered. The flexibility of the system simplifies spare parts management. Unlike previous systems, a single 3500 ENCORE 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 ENCORE 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

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## Remote Accessibility

Modem, WAN, or LAN connections allow the user to remotely configure a 3500 ENCORE 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 ENCORE 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. 3500 ENCORE rack records any configuration changes in the system's event list.

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## Alarm/Event Lists

The 3500 ENCORE System goes well beyond the capabilities of previous systems which simply identify the first alarm to occur in the rack via "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 retains the lists, which provide a description of each alarm or event and a corresponding date/time stamp. These lists are available to 3500 Configuration SW and System 1 machinery management software.

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## Time Synchronization

The system's real-time clock can be synchronized with external clocks, via the MODBUS interface or via connected Bentley Nevada software. The 3500 ENCORE'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

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, tachometer and casing vibration.

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## Hot Insertion

All of the ENCORE modules 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.

**Note:** To remove the legacy I/O modules power must be removed from the rack.

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## Enhanced Data

Even without condition monitoring software, the 3500 ENCORE 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 3500/42E 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.

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## Specifications

Consult individual datasheets for each module type.

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## Support for Legacy Parts

Power Input Modules (PIM) for the 3300/10 and /11 Power Supplies do not support serial Modbus communication. These PIMs are currently lifecycle phase 4 and only repair is supported.

Power Input Modules for the 3300/12 and 3300/14 Power Supplies and most 3300 Signal Input Modules (SIM) and Signal Input Relay Modules (SIRM) are lifecycle phase 3. New factory spare parts are available as well as repair.

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## Ordering Information

Chassis ordering information is shown below. For ordering information for each module consult the module data sheets.

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**Product Description****3500/05E – AXX – BXX – CXX****A: Rack Size**

- 01** 6P Retrofit Rack
- 02** 8P Retrofit Rack
- 03** 10P Retrofit Rack
- 04** 12P Retrofit Rack
- 05** 14P Retrofit Rack

**B: Power Supply Type**

- 01** AC
- 02** Low Voltage DC
- 03** High Voltage DC

**C: Agency Approvals**

- 00** None
- 01** CSA/NRTL/C (Class 1, Div 2)

Note: For installation as a retrofit monitor for a 3300 System, Agency Approval Option C01 should be ordered only if the existing 3300 System has the same type of approvals. Installation of a retrofit monitor in a system without approvals will invalidate the approvals of the monitor.

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