GE
Measurement & Control

3500 Series
Machinery Protection System
Bently Nevada* Asset Condition Monitoring

Why Protect and Monitor?

Whether generating power, compressing and pumping fluids, or driving process equipment, the oil & gas industry relies on critical machinery every hour of every day. In these settings, machinery failure isn't just inconvenient, it can be catastrophic. While repair costs alone can be staggering, the partial or even total loss of production resulting from critical machinery failure – sometimes worth millions per day – can mean the difference between profit and loss for the entire year. With so much at stake, mechanical condition monitoring is more than just a good idea, it's a necessity.

Continuously monitoring critical asset parameters such as vibration, temperature, speed, and numerous other condition indicators is a proven method for anticipating and preventing mechanical failures – proven in tens of thousands of industrial facilities around the world by delivering tangible benefits such as:

• Improved protection from catastrophic failures

• Better machinery reliability/availability

• Fewer process interruptions

• Enhanced maintenance/outage planning

• Lower maintenance and repair costs

• Longer intervals between outages

• Reduced insurance premiums

And when it comes to protecting and monitoring critical machinery, one name has proven itself above all others: Bently Nevada* from GE Measurement & Control.

Why Bently Nevada* Condition Monitoring?

GE's Bently Nevada* machinery protection and monitoring systems span more than a dozen different models deployed during the last 40 years. Combined, they comprise the largest installed base of permanently installed transducers and monitoring channels in the world. It's a position of trust that has been earned over more than four decades of learning, refining, and improving our solutions to meet the oil & gas industry's most demanding applications. Applications that require the highest integrity. Applications where false trips or missed trips simply cannot be tolerated.

It's not just our products, it's our people. Our reputation for the highest quality, best value in the industry is born of a culture that "takes excellent care of our customers." When you choose our condition monitoring solutions, you get it all: the best people, the best products; the best service; the best solutions; and the best value.

For nearly half a century, Bently Nevada products have been world-renowned as the standard by which all others are measured. Because after all, with so much riding on your machinery, why trust anyone else?

Experience

With more than two million transducers and monitoring channels installed worldwide and more than 10,000 software solutions employed across the globe, more end users trust their machinery to Bently Nevada* continuous monitoring systems than anyone else. We are also the supplier of choice to nearly every major machinery manufacturer in the world.

Technology

Today, although our products number in the thousands, we never rest. Each year, tens of millions of dollars are invested in expanding and improving our technology with the purpose of better serving our customers. Better technology that creates better value is our passion.

Technical Support

Behind everything we deliver, you'll find our unwavering commitment to provide the best technical support to our customers. No matter where in the world you are, or what time of the day, a knowledgeable professional with technical experience is standing by 24/7 to assist you with answers to your technical questions. We also have the ability to supply many emergency parts and services after traditional working hours. Additionally, our state-of-the-art knowledge database tracks every support call, every question, and every answer, allowing our global team to deliver faster, more complete support than ever before

3500 – Simply The Best

Beginning with the 5000 Series in the 1960s, we've introduced seven successive generations of highly successful monitoring platforms. Today, that experience is embodied in the most advanced, powerful, and reliable system we have ever offered: The Bently Nevada* 3500 Series Machinery Protection System.

Certified

The 3500 is designed to fully comply with the American Petroleum Institute's Standard API 670, the world's most widely used specification for machinery protection systems. For reciprocating compressor applications, the 3500 meets API 618 requirements as well. It can also be ordered with DNV and Class NK certifications for maritime applications such as offshore platforms and ship propulsion. And, when used as part of a safety instrumented system, TÜV Functional Safety Certification can be supplied for applications requiring up to Safety Integrity Level (SIL) 3. In addition, the 3500 is approved to meet relevant Canadian Standards Association (CSA), Factory Mutual (FM), GOST, ATEX, and CE requirements.

Reliable

We understand that our systems are routinely used not just for indication, but to provide auto-shutdown protection. That's why – even in simplex mode – the 3500 is the most reliable monitoring system we have ever offered with extensive self-checking and fault tolerant design features. It's also why the system can be configured with various levels of redundancy, ranging from the addition of a second fully redundant power supply to complete triple modular redundant (TMR) configuration of selected or all channels - allowing even your most mission-critical applications to be addressed with confidence.
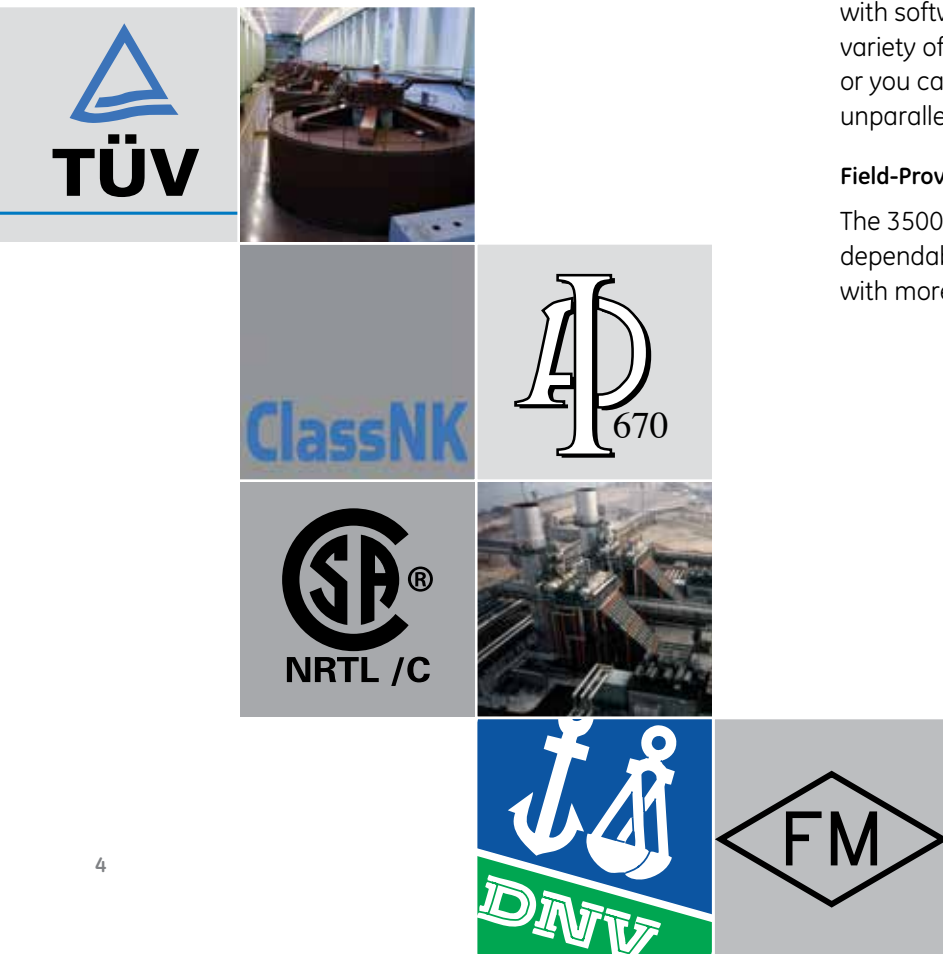
Connected

Connecting to condition monitoring and diagnostic software has never been easier. With the 3500 there are no bulky external modules, no additional wiring, and no extra rack slots required. Simply use the Ethernet port in the 3500/22M Rack Interface Module and a single network cable to communicate with our System 1* software. Connecting to plant control and automation systems is straightforward as well. Simply add a communication gateway module. You can even add multiple gateways when communication redundancy is required or when multiple systems must be supported with differing protocols.

Flexible

The 3500 Series features the industry's most extensive selection of machinery measurement parameters combined with software configuration for virtually all monitor options. A variety of locally or remotely mounted displays are available, or you can operate the 3500 without a display. The result is unparalleled flexibility to address almost any application.

Field-Proven

The 3500 Series system has proven its value and dependability with customers everywhere, year after year with more than 20,000 racks are installed globally.

3500 Series Measurement Capabilities

Measurements	3500/25	3500/40M	3500/42M	3500/44M	3500/45	3500/46M	3500/50	3500/53	3500/60,/65,/65	3500/62	3500/63	3500/64M	3500/70M	3500/72M	3500/77M
Phase reference	●														
Radial vibration (proximity probes)		●	●												
Radial position (proximity probes)		●	●												
Axial position (proximity probes)		●	●		●										
Eccentricity (proximity probes)		●	●												
Seismic vibration (velocity transducers/accelerometers)			●												
Shaft absolute (proximity and seismic)			●												
Aeroderivative gas turbine casing vibration				●											
Differential expansion		●	●		●										
Ramp differential expansion					●										
Complementary differential expansion					●										
Case expansion					●										
Valve position					●										
Hydro turbine/generator vibration						●									
Hydro generator air gap						●									
Machine operating state (discrete input)						●									
Rotor speed							●								
Rotor speed rate-of-change (acceleration)							●								
Rotor zero speed (turning gear engagement)							●								
Reverse rotation							●								
Overspeed								●							
Temperatur(direct/average/differential)[1]									●						
Process variable signals (4-20 mA, 1-5 vdc, etc.)										●					
Hazardous gas detection											●				
Gas turbine combustor instabilities												●			
Reciprocating compressor impulse/velocity													●		
Reciprocating compressor rod position														●	
Reciprocating compressor cylinder pressure															●

Monitor Modules

1. The 3500/60 and /61 are 6-channel monitors. The 3500/65 is a 16-channel monitor.

3500/53 Overspeed Detection Modules – can be integrated in the same rack as other machinery protection modules for maximum cost-effectiveness. Configurable for 2-out-of-3 voting and available with TÜV Functional Safety approvals.

Buffered Outputs – every dynamic input signal is conveniently available at the front panel via buffered output connectors for easy connection to portable and test instrumentation.

3500/15 Power Supply – accepts worldwide ac/dc voltages and frequencies and can be supplied fully redundant to assure uninterrupted performance.

Keylock Security – all monitor modules are software configurable via the 3500's Rack Interface Module – key lockable to prevent unauthorized tampering.

Analog Communications – all monitor module channels are available with analog 4-20 mA proportional outputs for compatibility with strip chart recorders, process control systems, and other instrumentation.

Rack Interface Module – provides configuration interface as well as single-cable connection to System 1* software via conventional wired or wireless Ethernet networks. The 3500's advanced design ensures that simultaneous data acquisition occurs for all channels in the rack.

Multiple Parameters From Each Channel – radial vibration channels can provide eight individual parameters (overall, gap, 1X amplitude/phase, 2X amplitude/phase, NOT 1X, Smax), meaning a 4-channel monitor actually provides up to 32 channels of measurements. Alarms can be set on any or all 8 parameters from each channel.

Relay Modules – software-programmable voting logic provides unmatched flexibility. 4- and 16-channel versions available along with a TMR version for 2-out-of-3 voting.

Triple Modular Redundant (TMR) Configuration – monitor and relay modules can be triplicated with 2-out-of-3 voting for addressing even the most stringent requirements. Optional TÜV Functional Safety certification available as well.

Keyphasor* Module – accepts single- and multi-event-per-turn signals from proximity probes and magnetic pickups. A standard rack can accommodate up to four Keyphasor* signals (two 3500/25 modules), and special modifications are available when more than four Keyphasor* signals are required.

Built-in Intrinsic Safety (I.S.) Barriers – I/O modules can be ordered with or without internally mounted I.S. barriers to decrease wiring, increase accuracy, and reduce installation costs when hazardous environments require intrinsically safe installation practices.

Numerous Display Options – ranging from no display (front panel status indicators only), to VGA displays, to a special LCD display that mounts directly on the front of the 3500 rack yet swings out of the way to provide access to buffered output connectors and other rack functions. Network connectivity can also be used to provide displays on any computer running System 1* software or 3500 Operator Display software.

Industry-Standard 19" Rack Size – provides more than twice the channel density of previous systems. Available in both EIA rack and bulkhead mounting versions, along with integral (standard) or external (optional) termination blocks for maximum installation flexibility. ˙

VGA Display Module – provides bargraphs, alarms, statuses, and other data to a variety of CRT or flat-panel VGA displays located within 25 feet of the rack. No programming required.

Hot-Swappable Modules – for ease of maintenance and maximum uptime, modules can be removed and reinserted without removing rack power.

Digital Communications – the 3500/92 Communications Gateway supports Modbus® and Modbus/TCP protocols via serial (RS232/422/485) or Ethernet links for digital communications with PLCs, DCSs, and other instrument and automation platforms. Multiple gateways can be installed in a single rack for link redundancy or when multiple protocols are needed.

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System 1* Connectivity

Protecting your critical machinery with the 3500 is an important step. But there's more to effective asset management than just protection. The 3500 system also serves as a fully functional gateway to GE's powerful System 1* software, allowing totally proactive condition monitoring and in-depth diagnostics.

System 1* software links portable data collection instruments, permanent monitoring systems, manually input data, and data from process control and automation systems into an integrated condition monitoring environment.

Connecting to System 1* software has never been easier, thanks to the 3500's design which completely integrates all data capture and communication functions into the rack. Simply provide an Ethernet network connection from your System 1* server computer to the 3500/22M Rack Interface Module and use our convenient software configuration capabilities to enable the appropriate channels in the rack. That's it. No external boxes or wiring to worry about, no separate signal conditioning or interface devices.

So move beyond just protecting your machinery and start proactively managing it as well. With the 3500, we've made it easier than ever.

M2 Technology

Although all 3500 monitor modules can communicate with System 1* software to supply status and value data, an M^{2*} symbol on the faceplate (and an M in the part number) designate modules capable of supplying high-bandwidth dynamic waveform data as well. It is this dynamic data that allows you to more effectively diagnose and manage your machinery assets by providing a precise picture of mechanical condition with every shaft revolution. When you see M^{2*}, it signifies this enhanced "Machinery Management" functionality.

Decision Support

The combination of the 3500, System 1* software, and Decision Support capabilities provides your critical machinery with one of today's most advanced technology to proactively detect and avoid problems.

Decision Support is System 1* software's unique ability to automatically audit its collected data against user embedded rules and knowledge, detect mechanical or thermodynamic problems, and generate Actionable Information* advisories. Building your own rules is simple and requires no special programming skills – just drag and drop logical and mathematical operators into any sequence of conditions that correspond to a particular malfunction.

When a specific malfunction or condition is detected, System 1* software alerts plant personnel that there is a problem, how severe it is, and what to do about it – in real time. The Actionable Information* messages used to notify plant personnel are fully configurable, reflecting your specific operating practices and procedures. Supported notification methods include cell phone, pager, PDA, email, computer and process control system pop-up windows, and even conventional analog annunciator panels.

Applications

The table on page 5 summarizes the enormous selection of measurement types available in the3500. This allows it to be applied to an extremely wide-range of rotating and reciprocating machinery in many industries. Below are just a few of the more common applications that can be easily addressed by the 3500 System.

If your specific machine doesn't appear on the list, just ask us. Chances are, our applications engineers have already developed a solution that's right for you. And, with our extensive custom applications capabilities, we can easily modify off-the-shelf 3500 solutions to handle your nonstandard applications and signal processing requirements.

• Steam turbines

• Hydraulic turbines

• Industrial gas turbines

• Aeroderivative gas turbines

• Reciprocating compressors

• Centrifugal compressors

• Axial compressors

• Screw compressors

• Gears

• Turbo-expanders

• Horizontal and vertical centrifugal pumps

• Reciprocating pumps

• Electric motors

• Generators

• Fans

• Blowers

• Agitators

• Mixers

• Centrifuges

• Pulp refiners

• Ball mills

• Crushers/pulverizers

• Extruders

• Pelletizers

• Cooling tower/heat exchanger fans

Service and Support

As the people who design and manufacture the 3500 system as well as the entire portfolio of Bently Nevada* asset condition monitoring products, there's nobody better equipped than GE Measurement & Control to professionally install and support these products. We have successfully completed over 30,000 installation, repair, machinery diagnostic, balancing, alignment, and system commissioning projects worldwide. We are everywhere you are with hundreds of locally available, factory-trained sales and service professionals in convenient locations around the world – knowledgeable people that speak your language.

Service and support includes:

- Complete pre-wired, pre-tested cabinet packages for your 3500 racks and associated instrumentation

- Transducer and monitor system installation

- System integration services for connection of Bently Nevada* monitoring systems to third-party control and automation systems

- Complete project management scope

- Product verification and repair

- Training, including product operation, product maintenance, and machinery diagnostics

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