3300 System Overview

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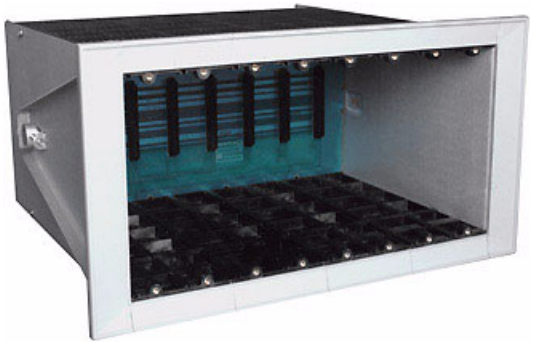
Function

The 3300 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. The system's highly modular design consists of an Instrument Rack, ac or dc Power Supply, System Monitor, and one or more monitor modules chosen to provide the required monitoring functionality. This building-block approach makes the 3300 System versatile, expandable, and cost-effective as your monitoring requirements change.

Note: For the majority of applications, Bently Nevada recommends the use of our 3500 Series Machinery Protection System as a newer and more capable product with a variety of features and functions not available with 3300. Consult your nearest Bently Nevada sales professional for more information.

System Components

Rack



Maximum flexibility includes economical expansion by physical rack growth. The 3300 rack is available in several sizes. This allows you to order exactly the size required to fit the monitors for your specific application. For example, if your application requires only two monitors, you can order a four-position (4P) rack to accommodate a Power Supply, System Monitor, and the two monitors of your choice. However, if you need to add monitors in the future, the rack size can be enlarged in the field, without soldering or use of special tools, simply by adding more rack sections and changing the backplane. Racks are available in seven panel-mount sizes ranging from 4- to 14-positions. The 8P rack is also available in a 19-inch EIA version.

The left-most rack position (position 1) is reserved for the Power Supply. The next rack position (position 2) is for the System Monitor. All other rack positions (3 - 14) are available for any combination of monitor types. The rack

depth is 424 mm (16.7 inches) and a weatherproof housing is available when required for environmental protection or for the use of purge air in hazardous area installations.

Power Supply

The 3300 Power Supply is available in both ac (3300/12) and dc (3300/14) versions for compatibility with voltage sources worldwide, and features line noise filters as standard. It resides in the left-most rack position and provides regulated power to all installed monitors and their connected transducers. The transducer supply voltage for the entire rack can be programmed within the power supply for compatibility with today's –24V proximity transducer systems as well as older systems utilizing –18V power.

System Monitor

Each rack contains one System Monitor (3300/03) installed in the second rack position. This module, as its name implies, acts to monitor the overall proper operation of itself and the other modules installed in the rack. It also provides enhanced functions such as digital interfaces for communication with external systems. However, since its circuitry is not directly in the critical monitoring path, it has no effect whatsoever on the machine protection functions of individual monitor modules, allowing these enhanced functions without compromising the reliability or integrity of the system's basic purpose: machinery protection.

Voltage supply levels that are vital for proper system operation are continuously checked by the System Monitor and annunciated via a front-panel LED. Any voltage found to be out of tolerance results in a NOT OK condition that drives the system OK relay in the power supply.

The System Monitor provides power to, and buffered/unconditioned signals from, four Keyphasor® transducers and these signals are made available via front-panel BNC connectors.

The System Monitor is also used to adjust the alarm setpoints for all monitors in the rack. An alarm reset switch works in parallel with a customer-supplied remote reset switch connected to rear terminals. Also operated by an external switch are Rack Inhibit and optional Trip Multiply with LED indication. Power-Up Inhibit is automatically controlled/activated by the System Monitor.

The System Monitor can be ordered with the following two interfaces, which can operate simultaneously and are independent of one another:

- **Serial Data Interface (SDI)**

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

  The SDI continuously scans each monitor in the rack for overall monitored values, probe gap, individual transducer OK status, channel Alert and Danger alarm status, and other statuses. This data is collected and stored temporarily in the System Monitor's memory. When data is requested via an appropriate protocol message, it is retrieved from System Monitor memory, formatted, and returned to the requesting system in a message response. Only static data is available via the SDI.

  Both Modicon MODBUS® and Allen-Bradley DF1 protocols are supported and are jumper selectable via the System Monitor's SDI circuit board. Each protocol has its own unique characteristics, but the data which can be transferred over each interface is similar. Modbus® protocol can read monitor alarm set points and also allows daisy-chaining of monitor racks.

- **Dynamic Data Interface (DDI)**

  This interface provides an engineered connection to appropriate Bently Nevada online condition monitoring software without the need for an external communications processor. DDI is appropriate when transient (i.e. startup/shutdown) data collection is not required, and can be daisy-chained with other Bently Nevada communications processors using serial communications.

Monitors

Available monitor types in the 3300 System are summarized in Table 1 and the functions of each monitor are detailed in the individual datasheets as noted. Each monitor occupies a single slot in the rack, except as noted in the table. All monitors are microprocessor-based with digitally adjustable alarm setpoints for each channel. Monitors incorporate high contrast, LCD bargraph-type[1] displays with enhanced viewing angle. These provide continuous indication per channel, allowing all monitored parameters of the system to be read simultaneously and at a glance.

Status indications for each monitor and channel are provided with bright, front-panel LEDs, allowing observation without operator interaction for easy and convenient operation. Independent recorder outputs for each channel are provided on most monitors via a rear terminal strip for connection to strip chart recorders or older process control systems where a digital interface is not feasible. Transducers, where applicable, are provided with appropriate power via short-circuit-protected terminals on the rear of the monitor. OK circuitry continuously monitors the operation of each transducer and associated field wiring.

Indication on the monitor display of alarm setpoint levels and system self-test routines are standard. Associated error codes are stored in non-volatile memory and can be read from the monitor display.

Transducer input signals are buffered and sent to separate terminals at the Signal Input/Relay Module at the rear of the monitor and to front panel coaxial connectors.[2]

Table 1. Available 3300 Series Monitor Modules

Application	Monitor	Datasheet
Relative Vibration using Proximity Probes	3300/16 2-ch. XY/GAP 3300/61 2-ch. Vector[4]	141498-01 141517-01
Axial Position	3300/20 2-ch. Thrust Position	141500-01
Casing Velocity or Acceleration	3300/17 2-ch. Vibration (Aeroderivative) 3300/25 2-ch.Acceleration (peak) 3300/26 2-ch. Acceleration (rms) 3300/55 2-ch. Velocity 3300/65 Dual Probe 3300/95 Filter Module/Vibration Monitor (Aeroderivative)[3]	L3317 141501-01 141502-01 141516-01 141518-01 141523-01
Temperature	3300/30 6-ch. Temperature (TC)[3] 3300/35 6-ch. Temperature (RTD)[3] 3300/36 2-ch. Temperature (TC/RTD)	141503-01 141503-01 141504-01
Differential Expansion / Case Expansion	3300/45 2-ch. Differential Expansion 3300/46 Ramp Differential Expansion 3300/47 Complementary Input Differential Expansion 3300/48 Case Expansion	141507-01 141508-01 141509-01 141510-01
Tachometer	3300/50 Speed, Zero Speed, Rotor Acceleration 3300/52 Reverse Rotation 3300/53 Overspeed Detection	141512-01 141513-01 141514-01
Reciprocating Compressors	3300/75 8-ch. Valve Temperature[3] 3300/81 6-ch. Rod Drop[3]	141520-01 141521-01
Rolling Element Bearings	3300/54 2-ch. REBAM®	141515-01
Generic 4 to 20 mA or 1 to 5 Vdc signals	3300/39 2-ch. Process Variable	141505-01
Shaft Eccentricity	3300/40 Eccentricity	141506-01
Valve Position	3300/70 2-ch. Valve Position	141519-01
Diagnostics	3300/04 4-ch. Transducer Output Panel 3300/90 Multi-Channel Diagnostic Instrument[3,4]	141491-01 141522-01

Note:

1. Tachometer (3300/50, /52, and /53), temperature (3300/30, /35, /36, and /75), rod drop (3300/81), and diagnostic instrument (3300/90) modules utilize a 7-segment LCD instead of bargraphs for indicating measured parameters.

2. Buffered outputs are not provided on the 3300/30, /35, /36, or /75 temperature monitors, or the 3300/70 valve position indicator.

3. These modules occupy two rack slots.

4. No longer available for new systems; supplied for spare parts requirements only.

Relays

Relays are provided integral to the rack and are available in both epoxy-sealed and hermetically-sealed versions. All relays have arc suppressors installed as standard. The type and quantity of alarm relays are specified with each monitor module ordered, and are included on the monitor's Signal Input / Relay Module. Dual-channel monitors can be ordered with a pair of relays shared between the channels, or with quad relays, which provides individual alert/danger contacts for each channel. Relays can be programmed for normally energized or de-energized as well as latching or non-latching operation.

A common system OK relay is also supplied in addition to any alert/danger relays in the rack. This relay is located in the power supply input module and is connected via the System Monitor to the OK circuits of all monitors in the rack. These circuits monitor the operating condition of transducers. Transducer failures or field wiring faults will be annunciated by the OK relay, which is a single-pole, double throw (SPDT) relay, normally energized, providing added capability of annunciation in the event of primary power loss.

Four common relay buses exist in the rack's backplane, allowing relays in one monitor module to be driven by alarm conditions in other modules when individual relays for each monitor or channel are not required. Refer to the 3300 Relay datasheet (p/n 141511-01) for additional details.

Safety Barriers

For applications where the transducers are located in a hazardous area, the 3300 System can be used with zener safety barriers. However, 3300 is the first system offered by Bently Nevada with an option for *internal* safety barriers on many monitor modules. This option saves cost over external barriers because it requires no extra cabinet space and no additional wiring. It improves safety because the connections are pre-wired, eliminating the opportunity for errors introduced with additional external wiring connections between monitor and barriers. This option also improves quality because, unlike external barriers, no special monitor scale factor calibration is necessary to compensate for voltage drop across the barrier.

Applications

The 3300 System is intended for continuous, permanent monitoring of rotating and reciprocating machinery in a variety of industries, and is suitable for auto-shutdown machinery protection applications. Machine types addressed by the 3300 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 requirements can often be addressed through modifications to a standard monitor type, through our custom products engineering capabilities. Contact your local Bently Nevada sales professional for further information.

Features

Digital and Analog Communications

Digital communication capabilities are provided via the System Monitor for connection to plant process control and automation equipment, as well as Bently Nevada's online condition monitoring software. Refer to the section on the System Monitor above, or its datasheet, for additional information. The 3300 System also provides pre-engineered Data

Manager® static/dynamic ports for connection to an appropriate Bently Nevada external communications processor when required.

Analog facilities for connection to plant control and automation equipment are also provided via relays and recorder outputs (4 to 20 mA, 1 to 5 Vdc, and 0 to -10 Vdc).

Timed OK/Channel Defeat

Monitors utilizing proximity probe and seismic transducer inputs are designed to enhance system reliability by providing enhanced protection against false trips. A special proprietary circuit minimizes the possibility of false alarms caused by a defective transducer, its associated interconnect wiring, or transducer power supply. This circuit is standard on all Bently Nevada vibration monitors.

Power-Up Inhibit

This unique function minimizes false alarms due to transient power surge or loss and subsequent reapplication of power. Alarms are inhibited for two seconds after power has stabilized, then Timed OK/Channel Defeat, if selected, becomes active.

Rack Inhibit -- Activated by a customer-supplied external contact closure, this function places all monitors in bypass, disables alarms, zero-scales all outputs, and de-energizes the system OK relay.

Self Tests

With three levels of self-testing, the 3300 System actually *monitors itself*. Power-up, cyclic, and user-invoked self tests are included in every monitor module, maximizing proper operation and increasing operator confidence in the system. Errors are indicated by rapidly flashing OK LED and the error type is stored in non-volatile memory where it can be recalled on the LCD upon request to assist in troubleshooting. Errors must be deliberately cleared from the monitor's memory after the fault is remedied. This prevents monitor errors from being accidentally overlooked.

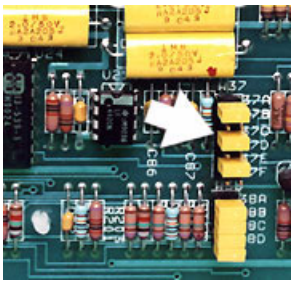
Fault Tolerance

Firmware programmable options and alarm setpoints are stored in non-volatile memory where they are protected from memory loss or corruption using the 3300 System's fault tolerant programming techniques. The result is an extremely reliable system, well-suited for machinery protection applications where neither false trips nor missed trips can be tolerated.

Trip Multiply (TM)

This feature is available on vibration monitors only. An external, customer-supplied signal that shorts or opens terminals on the back of the power supply sends a signal to monitors with the trip multiply option installed. This increases the alarm setpoints in the affected monitors by a pre-set factor of 2 or 3. TM must be specified at time of ordering in order to allow the components required to perform this critical task to be integrally tested with the entire system. Once activated, TM operates only on monitors in the rack with this option chosen. Trip Multiply does not affect the meter display or the recorder outputs.

Programmability



It is not always possible when placing your order to determine the exact monitor options needed for a particular application. Prior to the introduction of the 3300 System, it was difficult to change monitor system options after installation. 3300 overcomes this problem via plug-in jumpers and, on selected monitors, convenient firmware programming so that options can be changed easily and reliably in the field. The plug-in jumpers are simply repositioned on the moni-

tor's circuit boards according to the legend on the monitor's protective side cover. The monitor's microprocessor continually checks the jumper locations and sets the monitor options accordingly.

Those monitors featuring firmware-programmable options allow easy selection or change via the front panel controls, without the need for special tools or programming modules. Controls to enable firmware programming are located behind the front panel in order to prevent unauthorized tampering of these options.

Programmable options for monitor modules vary depending on the monitor type chosen, and are listed on the individual monitor datasheets (refer to Table 1). Typical programmable options are summarized below.

Typical Programmable Options for 3300 Series Monitor Modules

Danger (or Alarm 2) Bypass

The Danger (or Alarm 2) relay drive can be bypassed and the red bypass LED on the front panel will be ON whenever the monitor is in this condition. This feature allows maintenance on the monitor and its associated field wiring. The function is activated via a tamper-proof switch behind the monitor front panel. A jumper on the circuit board of the monitor can be programmed to prevent unauthorized use by disabling the bypass switch.

Note: *If the Danger (or Alarm 2) relay is connected to a common relay bus, other monitors in the rack can still activate the Danger relay, even though the monitor is in Danger Bypass.*

Channel Bypass

A channel can be bypassed via a tamperproof switch located behind the monitor front panel. This deactivates a channel which, for whatever reason (unused, maintenance being performed, etc.), should be removed from the system monitoring loop. The channel's front panel display, recorder output, and relay drive will be bypassed. The red bypass LED will be ON whenever the channel is in this condition and the monitor will default to OR voting. After this function is activated, the normal system OK operation will be restored for the remaining active channels in the rack.

Danger Voting Logic (vibration)

AND logic is "two-out-of-two" voting logic. OR voting logic is "one-out-of-two" which allows either channel to independently generate a monitor alarm (Alert or Danger). The 3300 System allows either OR or AND voting logic.

For dual-channel vibration monitors, AND Danger voting logic allows either channel to independently generate an Alert alarm, but requires both channels to detect a Danger alarm condition before the Danger relay will activate.

AND voting logic with two independent transducers is required by the API 670 standard, and recommended, for thrust position measurements. For vibration, in general, AND voting is appropriate when the two channels represent exactly the same measurement variable (transducer redundancy) and when it is likely that a transducer fault will produce a false monitor alarm (see Timed/OK Channel Defeat). OR voting logic is appropriate when the two channels do not represent exactly the same measurement variable.

The most common types of transducer and field wiring faults (short and open circuits) generate signals which are not likely to produce false alarms in a vibration monitor. Thus, it is generally not necessary to use AND voting logic for the purpose of transducer redundancy.

For XY applications (two probes per bearing), the radial transducers cannot actually be considered redundant because they do not measure exactly the same variable. Shaft radial vibration is almost never the same in both measurement directions. In fact, our research and field experience have shown that machine damage can occur due to excessive vibra-

tion in one plane while the vibration in the orthogonal plane remains below the alarm setpoint levels. Therefore, AND voting logic for XY vibration monitors is not only unnecessary from the electrical viewpoint, it is technically inappropriate from the mechanical viewpoint.

Common Relays Groups of monitors driving a common relay module are programmable. Alert and Danger drive signals from any monitor can be programmed to drive common Alert or Danger relays at another location in the rack. Four relay busses are available (two Alert and two Danger), so a maximum of two groups of monitors, each with a common relay module, is possible. Certain combinations are not recommended. Unless specified upon ordering, monitoring racks are shipped from the factory with a default relay configuration. The first monitor in the rack must always have a relay module assigned to it. Refer to the 3300 Relay datasheet (p/n 141511-01) for additional details.

High- and Low-Pass Filtering Monitors with seismic transducer inputs (velocity, acceleration) have filtering capabilities. Each channel can be programmed individually for high- and low-pass corner frequencies.

First Out A flashing alarm LED identifies the first channel in the monitor rack that caused an alarm condition since the last power-up or reset. This function can be programmed separately for Alert and Danger alarms.

Frequency Response Proximity probe vibration monitors can be optioned for a frequency response of 4 to 4000 Hz (240 to 240,000 cpm) or 1 to 600 Hz (60 to 36,000 cpm).

Full-Scale Range Full-scale ranges must be selected at the time of ordering, but can easily be changed in the field. Gap measurement may be programmed to display in either voltage or engineering units.

After reprogramming the monitor full-scale ranges, the meter scale must be changed and the monitor requires recalibration. High-quality laser-printed spare meter scales are provided in the manual.

Gap Alarm Selected monitors, such as the 3300/16 and 3300/61, provide adjustable Alert alarms when the transducer gap voltage exceeds alarm setpoints for 6 seconds. Over and Under alarm setpoints are available for each channel. The Gap alarms can be disabled, via a plug-in jumper, without the red bypass LED being activated.

Signal Integration Monitors with seismic transducer inputs (velocity, acceleration) have integration capability. Each channel can be integrated independently, before or after filtering.

Recorder Outputs A linear analog output for use with chart recorders or other analog instruments is programmable for 4 to 20 mA, 1 to 5 Vdc, or 0 to -10 Vdc. This feature is especially useful if it is unknown at the time of the ordering what type of instruments will be connected later.

Recorder Clamping Only available with the 4 to 20 mA recorder option on selected monitor types. This option sets the recorder output to clamp to 2 mA or 4 mA when a NOT OK condition is detected. When the 2mA option is selected, it allows the process control or automation system to differentiate a NOT OK condition (2mA) from a bottom-of-full-scale condition (4 mA).

Relays, Latching/ Non-Latching Programmable separately for Alert and Danger alarms. Latching alarms are cleared using the RESET switch on the System Monitor. Non-latching alarms are automatically cleared when the monitor

no longer detects an alarm condition.

Many 3300 monitors feature latching OK option. The OK relay is reset with the RESET switch on the System Monitor. If the non-latching OK option is selected, the OK relay will automatically reset when the transducer fault clears. When Timed OK/Channel Defeat is used, the OK operation must be non-latching to allow automatic resetting of the OK relay.

Relays, Normally Energized/De-Energized

The normal condition of a relay corresponds to the non-alarm condition. Normally energized relays require rack power to hold the relay in a non-alarm condition. Removing the relay's monitor(s) does not cause the relay to change state. There is no extra cost and no extra tools or parts are required to change relay operation in the field.

Upscale Toward/ Away

Programmable option for monitors that measure position. It defines the direction of the analog meter indication corresponding to a shaft movement considered to be in normal direction. This option can be selected per channel. It provides maximum flexibility when defining probe locations and is especially useful if exact probe locations (orientations) are not known at the time the order is placed.

Specifications

Consult individual datasheets for each system component type.

Ordering Information

Consult individual datasheets for each system component type.