

ORBIT 60 SERIES System Overview

Datasheet

Bently Nevada Machinery Condition Monitoring

137M5182 Rev. N



Plant-wide • One System

The Orbit 60 Series Protection and Condition Monitoring System provides one continuous, online monitoring system for both critical and plant-wide applications.

Cyber Secure • Data Isolation

Orbit 60 Series data isolation creates a safe industrial data environment designed to meet IEC 62443-4-2 with world class network security features and segregation of protection and condition monitoring functions.

Modular • Flexible • Scalable

The Orbit 60 Series system is deployable in any combination of rackmounted and distributed hardware. This provides for better alignment of instrumentation to the machinery application.

High Speed Process Data Integration

Next generation architecture facilitates full bi-directional communications with plant control systems over a suite of standard protocols.

Extended Field Wiring Length

With the Orbit 60 Series distributed architecture, connection of multiple chassis through Bridge modules decreases overall electrical installation costs, reduces analog ground loops and noise issues, and moves key maintenance activities further from hazardous areas.

Industry Leading System Capabilities

The Orbit 60 Series supports monitoring of one or multiple machine trains in a single deployment. One System Interface Module (SIM) defines each system and can encompass up to 68 dynamic channels.



Overview

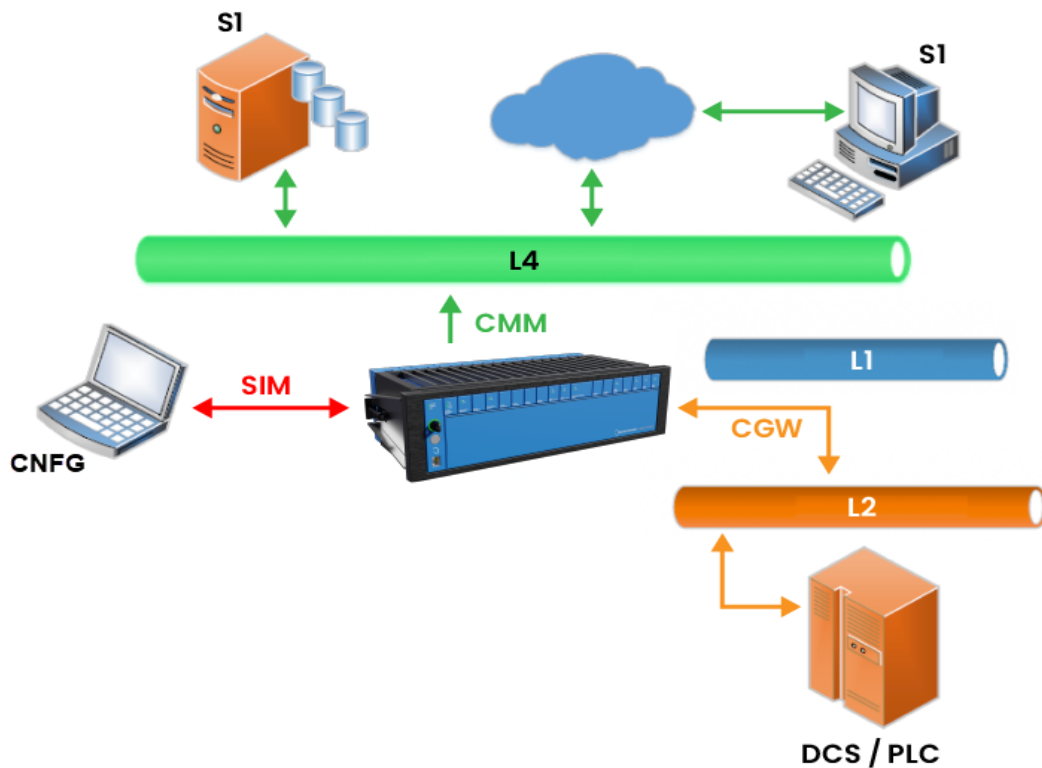
The Orbit 60 Series Protection and Condition Monitoring System provides a single platform for the continuous online monitoring of both critical and plant-wide applications. The Orbit 60 Series system is deployable in any combination of rack, bulkhead, or panel mounted hardware creating a seamless connection between chassis to make a single system.

The next table gives a general overview of the components that make up the Orbit 60 platform.

Table 1: Component Modules

System Modules	User Guide (142M9080)	Chassis	3U Chassis - 19 general purpose slots
		Power	Power Interface Module (PIM)
		Processors	System Interface Module (SIM) Protection Processing Module (PPM)
CMM	User Guide (148M9082)	SI Interface	Condition Monitoring Module (CMM)
CGW	User Guide (148M9083)	Comms	Communication Gateway (CGW) - Modbus (Ethernet) - EGD (Ethernet)
Input Modules	User Guide (137M0804) (168M9885)	Dynamic 4-channel	Negative Dynamic Input (PAV, PAS, PAA, PAD, KPH) (provides power for negatively powered transducers) Positive Voltage Transducers Dynamic Input (PVT) (provides power for positively powered transducers)
		Static 4-channel	Static Displacement Input (AC LVDT) AC and DC Linear Variable Differential Transducers
RTD/TC, Process, Discrete	User Guide (157M8568)	Static 6-channel	RTD/TC Temperature (RTD) Process Variable Isolated Discrete Input (PVD)
Output Modules	User Guide (146M5032)	Relays 8-channel	Electro Mechanical Relays (EMR). Solid State Relays (SSR)
Display and CPU	User Guide (137M0702)	Display	External Display (EXD)

Orbit 60 System Level Diagram



SIM - System Interface Module

CMM - Condition Monitoring Module

CGW - Comm Gateway Module

S1 - System 1 Server or Client

CNFG - Orbit Studio Configuration Software

DCS/PLC - Distributed Control Systems/
 Programmable Logic Controller

L1 - Unit Network

L2 - Control Network

L4 - Business Network

Figure 1: System Diagram

One System Interface Module (SIM) defines a system of up to 68 dynamic channels, accommodating multiple machine trains and supporting unrestricted synchronous Keyphasors for any channel. The Condition Monitoring Module (CMM) interfaces to the business network through a cyber-secure access port. The Communications Gateway (CGW) sends (data, status, setpoints) and receives controls (inhibit, reset, trip multiply) with control systems and plant historians.

Orbit 60 Series Chassis

You can flexibly deploy each chassis option with a public facing side (for rack or panel mounts) and a utility side (for wiring connections and bulkhead mounts). Insert modules and make all wiring connections from the utility side. Provisions for the public side of the chassis include status LEDs, configuration port, Config/Run key, and reset button.

Chassis Types



3U, 19-Slot
(Bulkhead, Rack, or Panel Mount)

The system is available as a 20 position (19 general purpose slots) single row chassis that fits a 3U 19" system format.

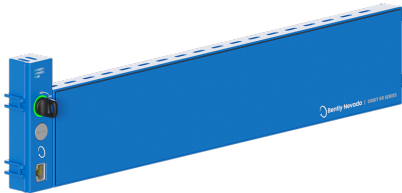
Mounting Options

- **Panel Mount Chassis** – Mounts to rectangular cutouts in panels and secures to the panel using clamps supplied with the chassis in 3U 19-inch standard configuration.
- **Rackmount Chassis** – Mounts the 3U on 19-inch EIA rails. A two-3U-unit form factor has been designed to fit within the space of a single 19-inch rackmount 3500 unit as a retrofit.
- **Bulkhead Chassis** – Typically mounts into a protective enclosure fastened to a sub panel in 3U 19-inch standard configuration. NEMA 4 and 4X weatherproof housings are available when required for environmental protection or when purge air is used.

Front Panel Options

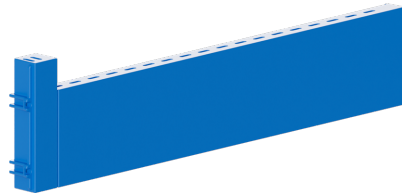
The system front panel features system status LEDs and controls. There are two variations of the front panel: a standard panel and a blank panel for the 3U form factor.

Standard Front Panel 3U



The Standard Front Panel Module is for Orbit 60 chassis that have a SIM module installed in slot two to ensure front panel functionality.

Blank Front Panel 3U



The Blank front panel is built for Orbit 60 chassis that do not have a SIM module installed, or are installed in a Bulkhead configuration.



Statuses

The Standard Front Panel Module shows the status of the power supplies and the presence and operation of the SIM Module.

Key Switch



This front panel places the system into the run or program mode of operation using the key switch. When the key is in the RUN position, the ring lights green and configuration changes cannot be made. When the key is in the PRG, or program mode, the ring lights amber and system configuration changes can be made through Ethernet connection to the SIM or front panel.

Reset

A RESET button is located on the Standard Front Panel. This is used to clear latched alarms, relays, and not OK statuses within the system.

Ethernet

An RJ45 jack provides Ethernet connection to the SIM for external display or configuration tasks from the public side of the system.

System Interface Module

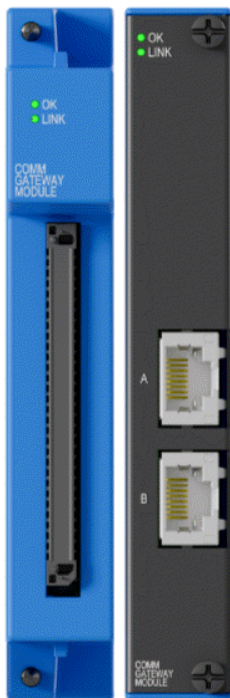


Each Orbit 60 system requires a single System Interface Module (SIM). The SIM provides the user access to manage protection configuration, local display, system-level diagnostics, system LEDs, system contacts, and the system protection fault relay. The SIM occupies one slot and must be adjacent to the Power Input Module (PIM) in the chassis.

The SIM is the access point for configuring and maintaining the system. The module communicates to the Orbit Studio configuration software and transmits the configuration to other modules in the system. The SIM provides a physical access security feature through a key-lock switch on the public side and a contact on the utility side of the SIM. Either of these controls can be used to secure the system configuration, preventing unauthorized changes.

The SIM has three independently configurable Ethernet ports. Each port can be used for system configuration, system time synchronization, temporary troubleshooting, or an external display.

For additional details, see the System Interface Module Datasheet (142M9054).



Communication Gateway Module

The Communication Gateway Module (CGW) provides information to external hosts including measurements, alarms, statuses, and system controls using standard industrial protocols. The CGW is designed for integration with process control and other automation systems.

The Communication Gateway module occupies a single slot and has two RJ-45 Ethernet ports supporting Modbus and EGD protocols.

The Comm Gateway Module includes two Ethernet ports which provide TCP/IP communications capabilities. The supported industrial protocols are:

- **Modbus TCP/IP:** Modbus over Ethernet is available for connection to HMI's, unit control systems, or other plant automation equipment. The module can only be configured as a server and supports configurable Modbus addresses within the 40000 address range.
- **Ethernet Global Data (EGD):** EGD is a GE protocol used on Mark VI and Mark VIe controllers and by GE Programmable Automation Controllers and certain 3rd party automation equipment. Version 3.04 and backward compatibility with previous versions is supported.

For additional details, see the Communication Gateway Module Datasheet (137M0700).

Protection Processing Module



The Protection Processing Module (PPM) serves as the computational engine for the Orbit 60 monitoring system. It extracts all machinery measurements for the protection system and performs alarm determinations. The PPM analyzes signals from transducers, generates measurements and statuses and publishes them to other modules for data collection and external communication. Each PPM occupies a single slot within the system.

Each PPM provides computational capacity for a large number of sensors and can support typical monitored machine trains. The PPM capacity is a function of the type of processing required on each input. If the system requires more processing than a single PPM can provide, additional PPMs can be added to the system for complex monitoring deployments. For protection systems, redundant PPMs are recommended.

The Orbit Studio Configuration Software provides a System Utilization Calculator to evaluate the remaining capacity of the PPMs in your system. If a PPM processing capacity reaches 90%, a warning indicator is displayed in Orbit Studio software, and it is recommended to add another PPM or two PPMs if the system is redundant.

For additional details, see the Protection Processing Module Datasheet (142M8515).

Condition Monitoring Module



The Condition Monitoring Module (CMM) listens to all information within the system, including all measurements, waveforms, digital transducer signals, system controls, status information, system configuration information, process data from external systems, and alarm and events logs. It only listens, with no capability to write, allowing interface to System 1 over the business networks, with no risk to the protection system.

Each module occupies two slots within the system. Placing multiple CMM modules allows the connection of two independent System 1 clients to the Orbit 60 System. Data is transferred to System 1 continuously, but in the event the connection is lost, non-volatile storage buffers historical data until the information is off-loaded to the host software. System 1 can configure the CMM module to extract additional measurements and waveforms from system sensor data. Without System 1, the customer can use the CMM module to collect data to diagnose machinery issues when an alarm event occurs in the hardware.

For additional details, see the Condition Monitoring Module Datasheet (145M9028).

Power Input Module



The Power Input Modules (PIM) always reside in a special-purposed slot located in the first slot of the chassis. This slot accommodates two PIMs for redundancy. At least one PIM must power every chassis, and every chassis requires its own PIMs and power sources. Redundant PIMs and power sources are strongly recommended.

The PIM is a half-height module that connects an external power source to the system. Each Orbit 60 Series chassis supports two stacked redundant power input modules. Failure of one power source does not affect the operation if the system uses both power inputs. The PIM employs out-of-range protection for miswiring, overvoltage, and overcurrent protection for the input power sources.

The PIMs support input voltages ranging from +21 Vdc to +32 Vdc. The most common power source comes from external DIN rail mounted AC/DC +24 Vdc output power supplies. The Instrument Common (IS) and Protective Earth \oplus connections for the system are made at the utility side of the PIM. External redundant power supplies are recommended for the system.

Removal and insertion of a single Power Input Module is supported without disrupting system operation, as long as the other PIM remains installed and connected to its input power source.

Note: The markings on the above image are for illustrative purposes only. The markings on your PIM may vary depending on its version.

For additional details, see the Power Input Module Datasheet (163M5233).

For detailed information on required Power Supply, see associated datasheet (142M8947).

Dynamic Input Modules



The primary purpose of the Dynamic Input module is to digitize the sensor signal at a rate that completely encompasses the signal content and provides transducer power for various sensors. The Orbit 60 Series Dynamic Input modules are a set of 4-channel input modules available in both negative and positive dynamic input options. The inputs are also used for speed or Keyphasor signals.



The PAV, PAS, PAA, PAD and PVT modules can be configured with up to TWO SPEED CHANNELS with a maximum speed of 12,000 rpm and maximum speed impulse rate of 12,000 cpm (200 Hz). For more than two speed channels on a single dynamic input card, speeds greater than 12,000 rpm or speed impulse frequencies greater than 12,000 cpm (200 Hz) a KPH Module is needed.

The Orbit 60 dynamic input modules are designed for use on a broad range of machine trains or individual casings where the sensor point count fits the monitor's channel count and where advanced signal processing is desired. The modules are optimized for intensive signal processing required on complex machinery such as gearboxes, planetary gearboxes, and roller element bearing (REB) machines as well as offering advanced measurement capabilities on conventional monitoring methods such as radial vibration, thrust position, and casing absolute vibration.

Negative Transducer Input Modules

The following cards work with negative-voltage external sensors offering four variants:

- **PAV** Negative Dynamic Sampler (Prox, Accel, Velom)
- **PAS** Negative Dynamic Sampler (Prox, Accel, Seismic)
- **PAA** Negative Dynamic Sampler (Prox, Accel, Aero)
- **PAD** Negative Dynamic Sampler (Prox, Accel, DC LVDT)
- **KPH** High Speed Keyphasor (Prox, Accel, Magnetic Pickup)

Positive Transducer Input Module

The Positive Voltage (PVT) input module interfaces with industry-standard third-party IEPE sensors, as well as sensors that use a 3-wire (power, common, signal) or a custom 2-wire (A/+ and B/-) positive-voltage interface.

The PVT is the preferred module to use for IEPE sensors, including the Bently Nevada Velomitor (3005xx) and IEPE accelerometers. Using the PVT modules for these sensors improves noise performance of the sensor.

- **PVT** Positive Dynamic Sampler (Prox, Accel, Velom)

The PVT module is recommended for new Velomitor installations only. Projects using the 190501 Velomitor CT or retrofits that reuse other existing Velomitor sensors should use the PAV module unless the user can verify the sensor power limits are appropriate for existing Velomiters.

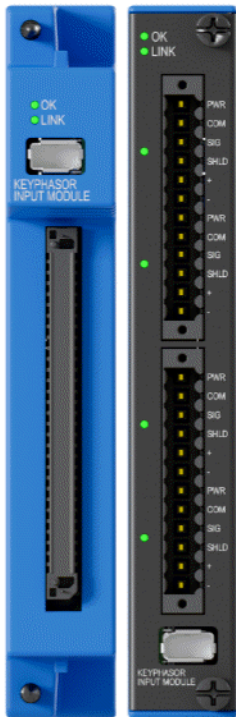
Connectors

The Dynamic Input module uses an ix Industrial connection to provide access to four buffered transducer output (BTO) connectors for each of the dynamic channels, with short circuit protection. The ix Industrial connection is available on the public and utility side of the module.



For additional details, see the Dynamic Input Modules Datasheet (137M0698).

Keyphasor Input Module



Unlike previous systems, the Orbit 60 Series system supports Keyphasor configurations for any dynamic input channel through the PAV, PAS, PAA, PAD, and PVT input modules. For high-phase accuracy applications (over 12,000 rpm) the Keyphasor Input Module must be used. The input speed limit is 120,000 rpm and can accept input speed signals up to 1,200,000 cpm (20 kHz). Each Keyphasor Input Module can accept up to four speed inputs. Input configurations to this module can also serve as Acceleration, Differential Expansion, Radial Vibration, and Thrust inputs. The Keyphasor input Module occupies a single slot.



Although the system allows the user to configure channels on the Keyphasor Input Module to serve as non-speed input types as described above, there will be a decrease in accuracy on these measurements when compared to PAV, PAS, PAA, PAD, and PVT modules. These non-speed inputs also cannot be utilized in SIL applications. The Keyphasor Input Module can only be utilized in SIL applications when configured for speed inputs.

Any channel on the module can be configured as a once-per-turn Keyphasor or a multiple-event-per-turn speed signal from a rotating shaft or gear used to provide a precision timing measurement. The Keyphasor Input Module works with the following transducers:

- Magnetic pickup
- 3-wire Prox
- 3-wire Accel

The 2-wire input connection provides a galvanically isolated, hi-impedance input which primarily supports magnetic pick-up speed sensors. The isolated input eliminates potential ground loops that can occur when speed sensors are shared between the vibration system and other instrumentation.

The Keyphasor Input Module provides a buffered transducer output for each channel. Within Orbit Studio software, each output can be configured within Orbit Studio Software to be either a true analog signal representative of the input or a conditioned/processed digital TTL signal replicating machine speed and maintaining phase with the input signal.

For additional details, see the Keyphasor Input Module Datasheet (157M8566).

AC LVDT Input Module



The Orbit 60 Series AC LVDT Input Module provides inputs to interface with four AC Linear Variable Differential Transformers for position measurements. The module's primary use is the measurement of case expansion and valve position. The AC LVDT input module occupies a single slot.

The four AC LVDT configured channels can connect to a:

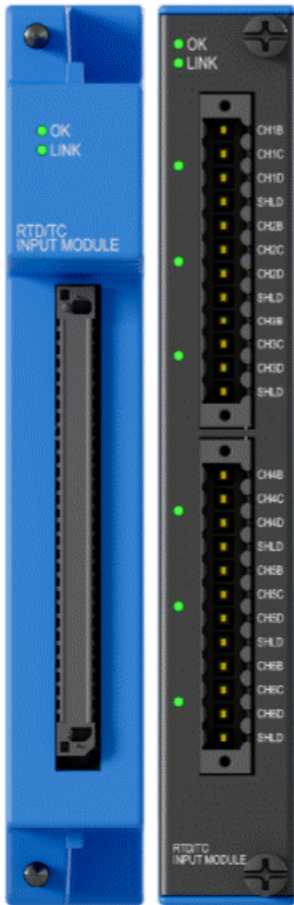
- 5-wire AC LVDT
- 6-wire AC LVDT

Note: To configure the 6-wire, 3 and 4 pins are shorted together.

The module's OK LED indicates when the module is functioning properly, and the LINK LED indicate when the module is communicating to the rest of the system. Four channel status LEDs, located on the utility side of the module, indicate that each AC LVDT sensor is connected and functioning properly.

For additional details, see the AC LVDT Input Module Datasheet (173M3153).

Temperature Input Modules



TC/RTD Temperature Module

The primary purpose of temperature modules is to interface to the temperature transducers and convert the signal into a digital representation. These modules condition and digitize the inputs at a rate that completely encompasses the signal content and allows for removal of typical noise sources.

The Orbit 60 Series TC/RTD Temperature Input Modules provide six channels of either Thermocouple (TC) or Resistive Temperature Detector (RTD) temperature input sensors.

Each channel of the Orbit 60 Series TC/RTD input module is individually configurable for sensor type and range using Orbit Studio configuration software.

The RTD/TC inputs reference the internal system ground, and for this reason, should only connect to transducers isolated at the sensing end.

Sensor Types

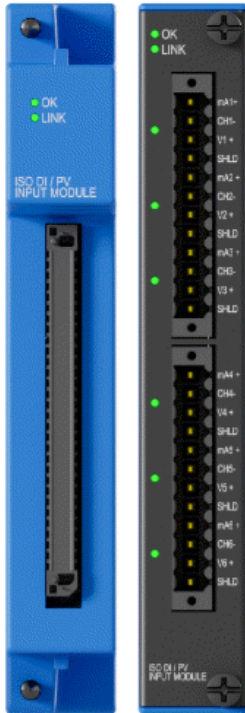
TC sensors - The thermocouple configured channels provide cold junction compensation for any J, K, E, or T Type Thermocouple.

RTD sensors - The RTD configured channels can be connected to the following:

- 3-Wire 100 Ohm Platinum 0.00392 RTD
- 3-Wire 100 Ohm Platinum 0.00385 RTD
- 3-Wire 10 Ohm Copper RTD
- 3-Wire 120 Ohm Nickel RTD

For additional details, see the Temperature Module Datasheet (137M0706).

Isolated Process Variable / Discrete Input Module (PVD)



The Orbit 60 Series Isolated Process Variable and Discrete (PVD) Input module processes machine-critical parameters such as pressure, flow, temperature, and levels that merit continuous monitoring. The module conditions and digitizes the signals so the result can be compared with user-programmable alarm setpoints. The user can program the PVD module using the Orbit Configuration software to perform current, voltage or discrete input measurements. This module provides discrete inputs for essential operational commands, such as Trip Multiply for machine start-up and Alarm Inhibit.

The monitor accepts +4 to +20 mA current inputs or any proportional voltage inputs between -10 Vdc and +10 Vdc, in addition to monitoring “dry” or “wet” contacts which can be a sensor, switch, or relay.

Primary purposes of the PVD Module:

- Continuously process input from monitored parameters to be compared against configured alarm setpoints to drive alarms for machinery protection.
- Allow provision of essential machine information, such as Trip Multiply for machine startup and Alarm Inhibit for both operations and maintenance personnel.

These modules occupy a single slot. The module OK LEDs indicate proper functioning, and the LINK LEDs indicate good system communication. Six Channel Status LEDs on the utility side of the module indicate a connected sensor in OK condition.

For additional details, see the Process Variable and Discrete Input Module Datasheet (145M9027).

Relay Modules

Relay modules may be programmed to actuate based on alarm conditions defined in other modules. Use standard logic elements (True AND, Normal AND, OR and NOT) to combine various alarms and statuses (e.g. OK statuses, Bypass, Protection State, Inhibit, Attention, Protection Fault, etc.) into relay activation conditions. Orbit Studio is used to program the voting logic.

Relays can operate as a system or group protection fault relay, if programmed to do so, especially when the protection fault relay on the SIM does not provide adequate granularity of system health - typically for multiple machines in one system.

Pairs of relays within the module function as a single Double-Pole, Double-Throw relay when appropriately configured. Both relay types are available for SIL system implementation. See Orbit 60 SIL User Guide (134M0398) for additional details and design considerations.



Electromechanical Relay (EMR)

This relay drives a load directly, or through, an interposing relay. This module takes two slots. It features **8 Epoxy Sealed, Single-Pole Double-Throw Electromechanical Relays**. This module supports an AC voltage range of 5-250 Vac for loads of 100 mA to 4 A. The module also supports DC voltages and loads of 5-30 Vdc at 4 A.

Solid State Relay (SSR)

This relay connects to an external system's discrete input for low current communication. It occupies a single slot and features **8 Solid-State Relays**. This module supports secondary voltages from 1 Vdc up to 125 Vdc and loads of 0.01 to 125 mA.

For additional details, see the Relay Modules Datasheet (137M0699).

Input Module Sensors and Channels


Sensor Type Supported	Channel Type	Dynamic Input Module Type (4 channels)							Static Input Module Type (6 channels)	
		PAV	PAS	PAA	PAD	PVT	KPH	AC LVDT	Temp	PVD
Proximitors (3-wire)	Differential Expansion, Radial Vibration, Speed, Thrust, Recip Piston Rod	X	X	X	X	X	X			
Magnetic Pickups	Speed						X			
Accelerometer (3-wire)	Acceleration ¹ , Recip Impulse Acceleration	X	X	X	X	X ²	X			
Charge Amplifier (3-wire)	Acceleration ¹	X	X	X	X ²	X ²	X			
Interface Modules (4-wire)	Acceleration ¹			X						
High-Temp Accel (4-wire)	Acceleration ¹			X						
High-Temp Accel (3-wire)	Acceleration ¹	X	X	X	X	X ²	X			
Negative Biased Constant Current (2-wire)	Acceleration ¹	X								
IEPE Positive Constant Current (2-wire)	Acceleration ¹ , Recip Impulse Acceleration					X				
High-Temp Velocity	Velocity ¹	X	X	X		X ²				
Negative Biased Constant Current (2-wire)	Velocity ¹	X								
Velomitor® (2-wire)	Velocity ¹	X ³				X ^{2,3}				
Velomitor CT	Velocity ¹	X								
Seismoprobe (2-wire)	Velocity ¹		X							
IEPE Positive Constant Current (2-wire)	Velocity ¹	X ³				X				
Amplifier/Interface Modules	Dynamic Pressure			X						


Sensor Type Supported	Channel Type	Dynamic Input Module Type (4 channels)							Static Input Module Type (6 channels)	
		PAV	PAS	PAA	PAD	PVT	KPH	AC LVDT	Temp	PVD
Pressure Transducers	Dynamic Pressure					X				
DC LVDT	Valve Position & Case Expansion				X					
AC LVDT	Valve Position & Case Expansion							X		
3-wire RTD	Temperature								X	
TC - Type J, K, E, T	Temperature								X	
4-20 mA Transmitter, ±10 V Sensor	Process Variable									X
Dry or Wet Contact, TTL Logic	Discrete Channel									X

¹ Designates the ability to integrate these measurements to provide additional measurement types.

² These sensors can be configured using a Custom transducer configuration.

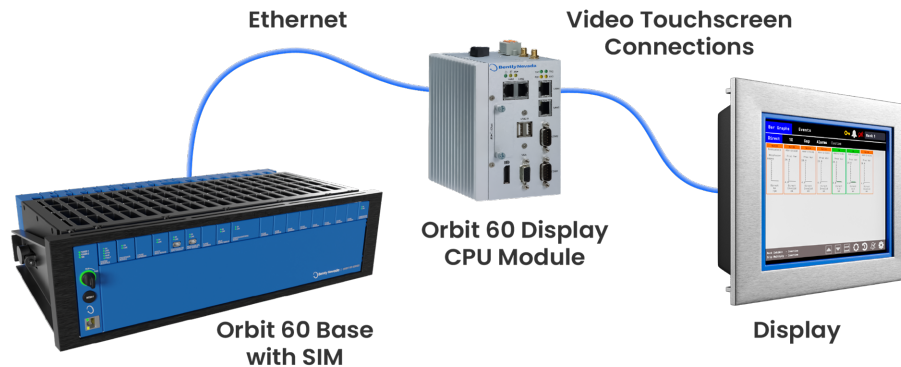
³ PVT modules are recommended for new installations only. Projects using the Velomitor CT or retrofits that reuse existing sensors should use PAV or verify sensor power limits.

 The PVT is only for positively biased sensors.

 The Velomiters® and IEPE sensors can be configured on the PAV as a custom transducer.

External Display

The external display utilizes an industrial computer connected to the SIM via Ethernet. The computer and display placement varies based on application needs. The 10.4", 15", and 21.5" VGA touchscreen displays provide excellent viewing quality for industrial applications. The 10.4" display is suitable for use in hazardous area locations across the world. The 15" display is certified for hazardous areas for North America only. The 21.5" display is intended for non-hazardous (safe) area applications only.



Display Mounting Options

You can mount the displays in a remote enclosure, panel, or rack.

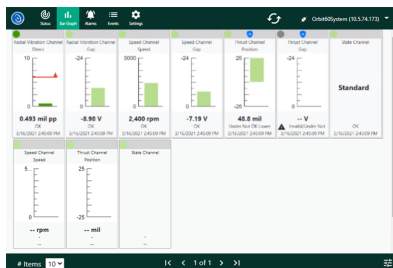
- **10.4" Display** Can be mounted in a rack, panel, and enclosure.
- **15" Display** Can be mounted in a rack, panel, and enclosure.
- **21.5" Display** Can be mounted in a rack or panel.

Bently Nevada Industrial Computer

The Orbit 60 Series Industrial Computer is certified for hazardous environments when installed in a NEMA3 or NEMA4 enclosure. The industrial computer communicates with an Orbit 60 Base SIM module to gather and output data to supported displays. The small form factor of 5.2 x 4.8 x 3.4 (132 x 122 x 87 mm) enables DIN-rail mounting.

Orbit Display Software

By default, a bar-graph screen shows all measurements. The Orbit Display software can show bar graphs, alarm lists, event lists, and statuses. Up to 12 Orbit 60 systems can be viewed on one display.



- System-event list
- Alarm-event list
- All module and channel data
- Alarm and OK status

Orbit Studio Configuration Software

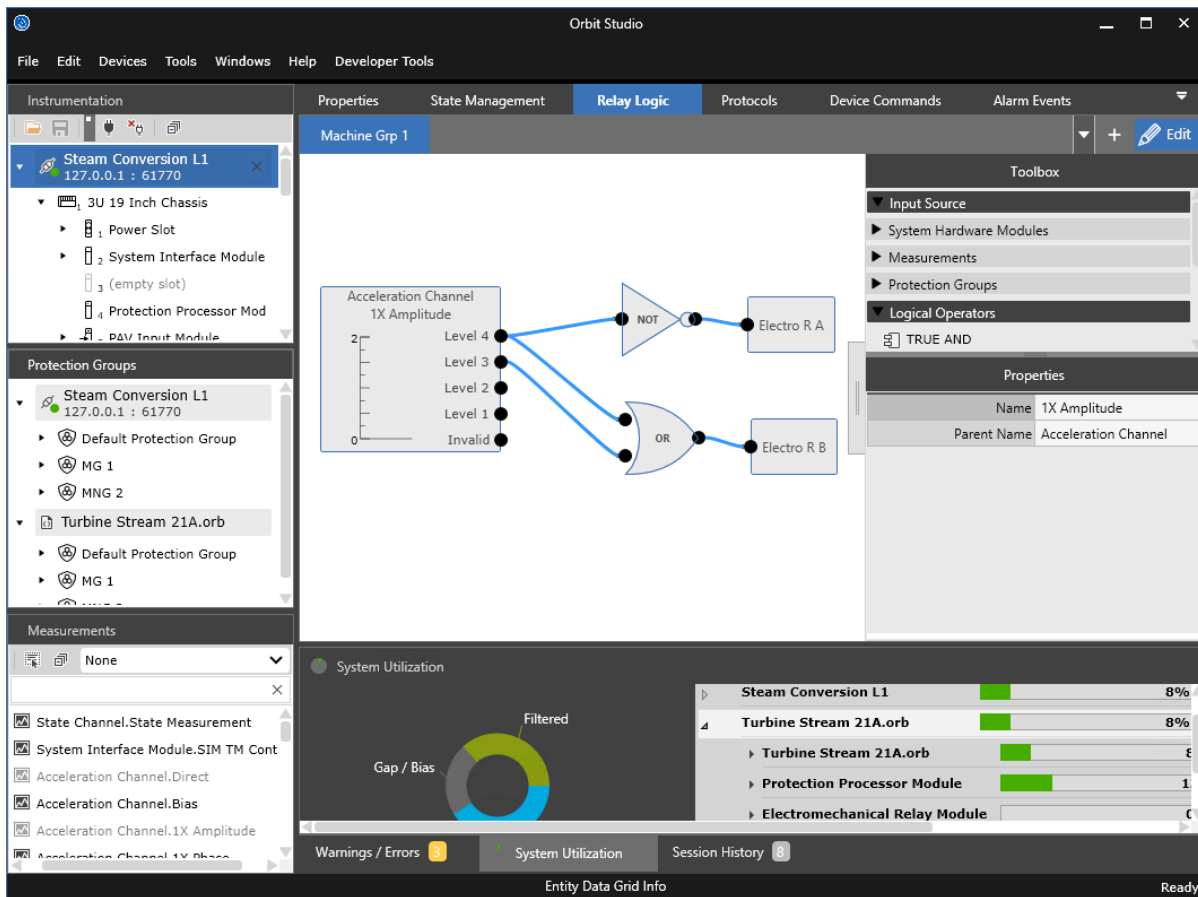
The Orbit Studio software configures Orbit 60 chassis, modules, channels, measurements, setpoints, relays, and many other aspects to protect plant assets. It is also the primary method used to verify systems. For more information, see Orbit Studio online help or Orbit Studio Configuration Software User Guide (137M0696).

Multiple Systems Configuration

You can connect multiple systems from a single Orbit Studio client session. This opens multiple offline configuration files alongside actively connected systems allowing for easy cross-referencing across systems, while enabling security through user-based permissions. You can copy and paste modules and channels across systems and configuration files, as well as send and retrieve configurations for multiple systems at once.

Graphical System and Relay Configuration

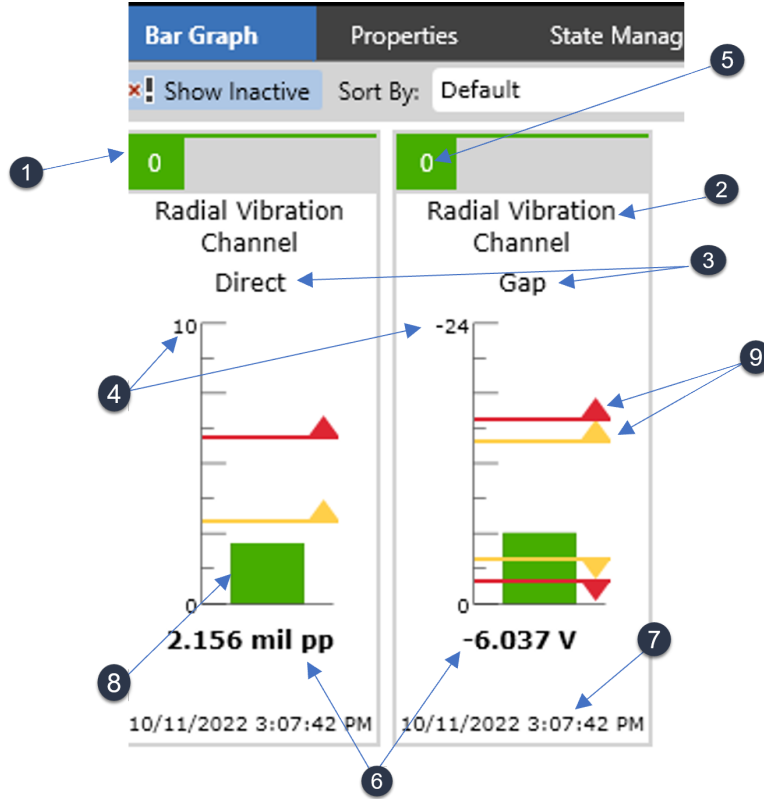
Create and manage multiple pages of relay logic by graphically configuring using drag and drop elements and connectors. You can also graphically assemble your system by dragging and dropping components from a library of modules. The resulting assembly produces a hierarchical representation of the system for access to individual channels.



Current Values and Loop Check

View current value data across all channels within a system. You can use the bar graphs and tabular lists to complete loop checks from channels throughout the system.

To configure the Orbit 60 system, refer to the Orbit Studio online help .



1. Overall Health
2. Channel Name
3. Measurement
4. Full Scale Range
5. Alert Level
6. Measurement Value
7. System Time
8. Measurement Health
9. Alarm Levels

Figure 1: Bar graph Verification Screen for 1 RV Channel

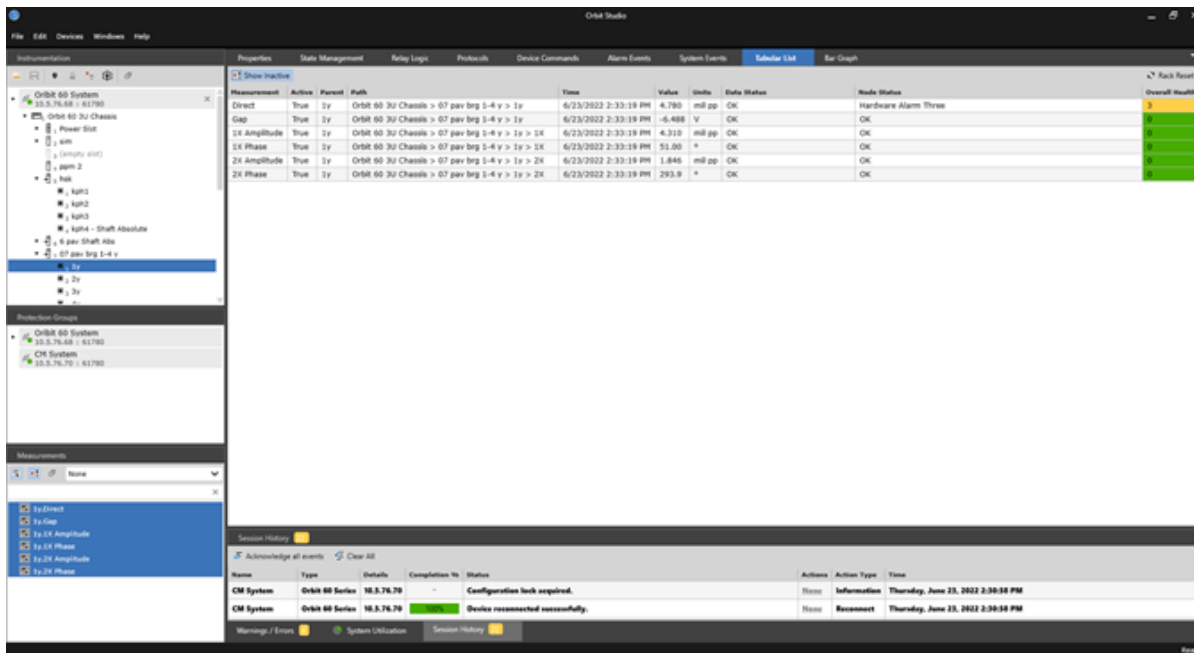
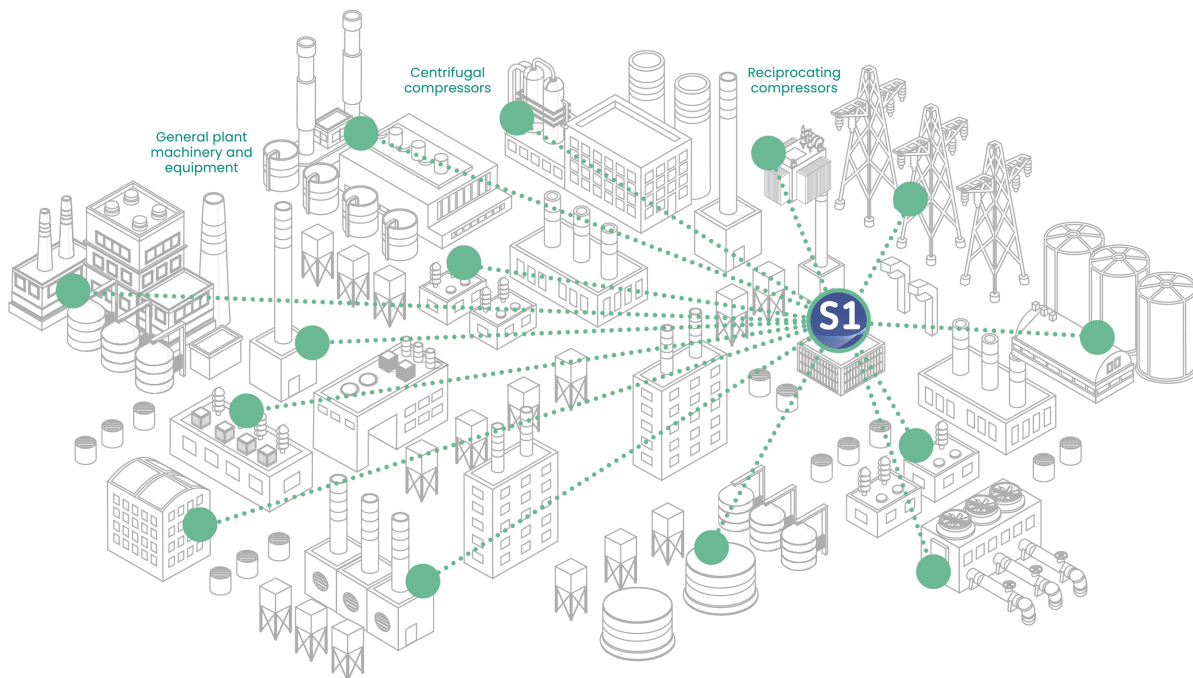


Figure 2: Tabular List Verification Screen for 1 RV Channel

System 1 Integration

Offering plant-wide condition monitoring insights to reduce risk, increase productivity, and minimize unplanned downtime, System 1 streamlines decision-making processes by bringing machine data into a single platform, providing clarity and context to your operations and enterprise. Harnessing the power of Bently Nevada's decades of machinery research and advanced diagnostics expertise, this powerful tool is a key component of successful digital transformation in any industrial facility. By combining its Connectivity, Analytics, and Visualization capabilities, System 1 is the premier Edge historian and condition monitoring platform among industrial operators.

Take full advantage of System 1 Condition Monitoring Software in conjunction with Orbit 60 Series for complete monitoring and advanced diagnostics for all machine types, including roller-element bearings. Use the Orbit 60 Series Condition Monitoring Module (CMM) for a read-only access point to provide a cyber-secure approach for obtaining data through the business network or other systems.



Bently Nevada has a rich heritage in helping customers solve industrial maintenance challenges that is over 60 years strong. Through user research in 25 countries with more than 500 end users, we have studied our customers' team dynamics, site processes, and technology suites to determine how System 1 can best support plant-wide machinery management. The resulting platform is the most comprehensive and user-intuitive condition monitoring solution ever developed.

System 1 Support for Orbit Channels and Measurements


The Orbit 60 Condition Monitoring Module (CMM) interfaces with System 1. Data is transferred from Orbit 60 to System 1 continuously.

- You can view Orbit 60 alarms and system health events in System 1.
- When a measurement triggers an alarm in Orbit 60, the alarm and system events are visible in System 1.

- Alarm and transient data configured in System 1 Data Collection States and Points are also applied to Orbit measurements.
- Orbit measurements can be used to configure triggers for state events (Start up/Shutdown, Running, Slow Roll, or Machine Off) in System 1.
- You can use replication, OPC/DA (data access), and OPC/UA (unified architecture) to export Orbit channels and measurements from System 1.
- System 1 Audit files contain Orbit channels and measurements.



Specifications


Orbit 60 System


Full-Load Chassis	
Power Consumption	
3U 19" full load	Typical: 120 Watts Maximum: 180 Watts
<div style="border: 1px solid black; padding: 5px; background-color: #e6f2e6;">  <p>The Orbit 60 Series system was qualified with the power supplies listed in Accessory section of this datasheet. Use of a reduced wattage power supply may result in changed behavior under fault conditions.</p> </div>	
Max Current	
3U Current Draw:	8.6 Amps Max
Characteristics	
Voltage Input	+21 to +32 Vdc
Current Draw	8.6 Amps max
Maximum	8.6 Amps
Out of Range Protection	An undervoltage does not harm the PIM. An overvoltage causes the fuse to open.
Chassis Loading	No minimum chassis loading is required.
Outputs	
OK LED	Indicates the module is functioning properly.
LINK LED	Indicates the module is successfully communicating on the internal network.
Weight	
3U 19" Chassis	32 lbs (14.5 kg)


System Physical Dimensions	
3U Standard Chassis (19")	
Width	19" (48.26 cm) - with bezel 18.87" (47.93 cm) - panel mount without bezel 17.53" (44.53 cm) - rackmount without bezel
Height	5.2" (13.21 cm) - with bezel
Depth	9.67" (24.56 cm)
Single Wide Module	
Width	0.8" (2.03 cm)
Height	5.2" (13.21 cm)
Depth	9.67" (24.56 cm)
Double Wide Module	
Width	1.64" (4.17 cm)
Height	5.2" (13.21 cm)
Depth	9.67" (24.56 cm)

Environmental Limits (All Modules)

Environmental Limits	
Chassis Operating Temperature Range (indoor use only)	3U Chassis: -30°C to +70°C (-22°F to 158°F) 
Module Temperature Rating Certification	-30°C to +70°C (-22°F to 158°F)  When using a Bridge module, temperatures over 58°C (136°F) require forced air convection with a minimum airspeed of 0.5 m/s.
Storage Temperature Range	-40°C to +85°C (-40°F to 185°F)
Relative Humidity	0% to 95% rH non-condensing operating and storage
Vibration	Without Isolators: 0 g to 0.35 g @ 57-500 Hz With Isolators: 0 g to 5 g @ 57-500 Hz
Shock	2" Incline Drop

Environmental Limits	
Altitude	< 2000 m (6,562 ft)  Higher altitudes are possible but are site specific applications. Contact Bently Nevada support if you require higher altitudes.
Pollution Degree	Pollution Degree 2
Installation Category	Category II

 Verify that temperature ratings on the wiring cables match the operating temperature range.

 **CAUTION**

LOCATION TEMPERATURE AND HUMIDITY

If you install the hardware in a location where temperatures may exceed 40° C (104° F) or in excessive humidity, you should consider supplying environmental controls. High temperatures will reduce the operational life of the system.

System Interface Module

System Interface Module (SIM)	
Power Consumption	
Typical	7.6 Watts
Maximum	10.9 Watts
System Contacts	
4 contacts on utility or rear side	Trip Multiply
	Alarm Inhibit
	System Reset
	Configuration Lock
Voltage In	24 V max
Current rating	<1 mA to 125 mA
Protection Fault Relay	
Relay Type	Solid State, Single-Pole, Double Throw
Voltage	1 Vdc to 125 Vdc
Current	0.01 to 125 mA
Communications	
1 Ethernet port - public side 2 Ethernet ports - utility side	Independent Ethernet ports 1000/100/10 Base-T Auto-negotiation
Connector	RJ-45
Supported Connections	NTP time sources Orbit Config - System configuration Orbit Display - Local system display
Cable Length	100 meters (328 feet) max

System Interface Module (SIM)
Cyber Security
<ul style="list-style-type: none"> - Aligned to the IEC 62443-4-2 standard. - Encrypted communications using latest TLS standards. - PKI implemented signed firmware images to facilitate secure boot and trusted firmware updates. - Device identity management uses certificates for trusted connections. - Configure user, roles and rights account management. - Uses physical Run/Program control

System Interface Module (SIM)	
Controls and Contacts	
RST Reset Contact or Button	Used to clear all latched alarms and NOT OK statuses across the system. LED indicates reset contact closed. 1
SAI System Alarm Inhibit Contact	Used to inhibit all alarms within the system. LED indicates the state of the alarming functions within the system.
TM Trip Multiply Contact	Used to place the system in Trip Multiply. LED indicates that the system is in Trip Multiply mode.

System Interface Module (SIM)	
<p>LOCK Configuration Lock Contact or Key</p>	<p>PRG - Allows configuration changes to be made to the system. Amber LED indicates the system is in Program mode.</p> <p>RUN - Locks the system, blocking configuration changes. Green LED indicates the system is in Run mode. ²</p>
<p>NO, ARM, NC Protection Fault Relay</p>	<p>NO, ARM, and NC contacts are all used to wire the output to an external receiver. A green LED indicates that all the protection functions within the system are operational. Red indicates the protection path is faulted and the Protection Fault Relay is in a tripped state (not energized).</p>

¹ Performed by either closing the contact on the module or pressing the button on the front panel.

² Performed by either closing the contact on the module or setting the key on the front to the RUN setting on the front panel.

Communications Gateway

Communications Gateway (CGW)	
Power Consumption	
Maximum	10.2 Watts
Typical	6.8 Watts
Data Communications	
2 Ethernet ports - utility or rear side	Independent Ethernet ports 1000/100/10 Base-T Auto-negotiation
Connector	RJ-45
Cable Length	100 meters (328 feet) max
Updated Rate	
Modbus	50 ms
EDG	20 ms
LEDs	
Module OK LED	Indicates when the module is functioning properly
System Communication LED	Indicates when the module is communicating to the rest of the system
Physical Characteristics	
Required Rack Space	1 Slot

Protection Processor Module

Protection Processor Module (PPM)	
Power Consumption	
Typical	6.1 Watts
Maximum	9.7 Watts

Protection Processor Module (PPM)	
Channel Types	
<ul style="list-style-type: none"> • Acceleration • Case Expansion • Differential Expansion • Dynamic Pressure • Process Variable • Radial Vibration • Recip Impulse Acceleration • Recip Piston Rod • Speed • Temperature • Thrust • Valve Position • Velocity 	
Measurements and Signal Processing	
1X/2X/nX Amplitude and Phase	In a complex vibration signal, notations for signal components having frequencies equal to fractions of rotative speed. Also called subharmonic and subsynchronous.
Amplitude Extraction	Amplitude Extraction measurements can be based on synchronous or asynchronous sampling.

Protection Processor Module (PPM)	
Average Piston Position	<p>This trended variable measures the average of the physical distance between the face of the proximity probe tip and the observed rod with respect to the zero position multiplied by the average correction factor. This measurement is computed over the full rotation of the compressor crankshaft.</p> <p>The system computes average piston position from a configured reference value (zero position) extrapolated from the measurement of the piston rod movement to piston movement inside the cylinder.</p>
Bandpass	Adjustable lowpass and highpass corners based on the frequency range of the transducer.
Bias	Applicable to Acceleration and Velocity sensor inputs. The DC voltage used by the system as a bias for the transducer. Can be used as a diagnostic tool for evaluating system integrity. Note: The bias voltage measurement contains no information about the condition of the machinery being monitored. It is provided only for monitoring system diagnostics.

Protection Processor Module (PPM)	
Case Expansion	<p>A measurement of the axial position of the machine casing relative to a fixed reference, usually the foundation. The measurement is typically made with a Linear Variable Differential Transformer installed on the foundation at the opposite end of the machine from the point where the casing is attached to the foundation. Changes in casing axial position are the result of thermal expansion and contraction of the casing during startup and shutdown.</p>

Protection Processor Module (PPM)	
Complimentary Input DE (Composite of Differential Expansion Channel measurements)	Complementary Input Differential Expansion (CIDE) is a method of measuring Differential Expansion. Two proximity probes are mounted and gapped so that the measurement range is twice the range of a single proximity probe. One probe is in its linear range during the first half of the measurement range and the second probe is in range during the second half of the measurement range. The monitor is configured so that it will switch from one probe to the other probe when the gap voltages are at the switch point. The switch point is termed the Cross Over Voltage. The monitor uses the Direct static value from each probe to determine the overall expansion value. The overall expansion value is termed the Composite static value and it is the value used for machine protection and machinery management information.
Crank Angle	This trended variable measures the point in the crankshaft rotation where the maximum position magnitude occurs.

Protection Processor Module (PPM)	
Differential Expansion	The measurement of the axial position of the rotor with respect to the machine casing at some distance from the thrust bearing. Changes in axial position relative to the casing affect axial clearances and are usually the result of thermal expansion during startup and shutdown. The measurement is typically made with a proximity probe transducer mounted to the machine casing and observing an axial surface (e.g., collar) of the rotor.
Direct	Data or a signal which represents the original transducer signal without significant filtering. Sometimes called unfiltered, raw, all pass, or overall data or signal. Bently Nevada signal processing does some filtering to create "direct" data, but it still contains broadband frequency information.

Protection Processor Module (PPM)	
Dual Ramp (Composite)	Dual Ramp Differential Expansion is a method of measuring Differential Expansion and is a subset of a number of measurement methods, generally termed Ramp Differential Expansion, which make use of ramps to measure axial position. Two proximity probes observe different ramps. The two ramp sections must be mirror images with the same ramp angle. The two probes mount on the same side of the rotor and in the same axial plane. The monitor uses the direct static values from both channels to measure axial position and compensate for the effect of radial movement. The compensated result is termed the Composite static value and is the primary value used for machine protection and machinery management information.
Eccentricity	The radial displacement of the rotor journal centerline from the geometric center of a fluid lubricated bearing. Eccentricity is measured while the turbine is on slow roll (1 to 240 RPM below the speed at which the rotor becomes dynamic and rises in the bearing on the oil wedge) and requires special circuitry to detect the peak- to-peak motion of the shaft.

Protection Processor Module (PPM)	
Gap	The physical distance between the face of a proximity probe tip and the observed surface. The distance can be expressed in terms of displacement (mils, micrometres), or in terms of voltage (millivolts). Standard polarity convention dictates that a decreasing gap results in an increasing (less negative) output signal.
Instantaneous Piston Position	This trended variable measures the position of the rod with respect to the zero position times the correction factor when the rod is in its stroke position described by the configured trigger angle position. The system computes the instantaneous piston position from the configured reference value (zero position) extrapolated from the measurement of the piston rod movement to piston movement inside the cylinder.
Instantaneous Probe Gap	This trended variable measures the voltage representing the physical distance between the face of the proximity probe tip and the observed rod when it is in its stroke position described by the configured trigger angle position.

Protection Processor Module (PPM)	
Integration/RMS	Available for Velocity and Acceleration channels to be applied to Direct, Bandpass, 1X, 2X, nX an SMAX measurements.
Non-Standard Single Ramp DE (Composite)	Nonstandard Single Ramp Differential Expansion is a method of measuring Differential Expansion and is a subset of a number of measurement methods, generally termed Ramp Differential Expansion, which make use of ramps to measure axial position. Two proximity probes observe the same ramp. The two probes are mounted on opposite sides of the rotor (180 degrees apart). The monitor uses the direct static values from both channels to measure axial position and compensate for the effect of radial movement. The compensated result is termed the Composite static value and is the primary value used for machine protection and machinery management information.
Number of Reverse Rotation	Valid when the machine is spinning backwards and has exceeded the reverse speed setpoint, counting revolutions.

Protection Processor Module (PPM)	
Position	Position has a variety of applications. For the Thrust and Differential Expansion it is the change in axial direction with respect to a fixed reference. Also used in Case Expansion to measure case growth and Valve Position to measure how open or closed a valve is.
Position Angle	<p>This trended variable measures the angle made by the vector representation of the maximum position magnitude referenced from the top of the piston rod in a clockwise direction when viewed from the crank end towards the cylinder. The top of piston rod is identified as 0° position angle.</p> <p>Position Angle provides an indication of the direction of rod movement relative to bore center. For a single vertical probe, this position angle will be 0° when piston rod is above bore center, or 180° when piston rod is below bore center.</p>


Protection Processor Module (PPM)	
Position Magnitude	<p>This trended variable measures the maximum displacement of piston rod relative to the calculated hot bore center reference.</p> <p>The cylinder bore geometric center is calculated based on piston material, expected operating temperatures, and measured bottom and top piston to cylinder wall clearances.</p>
Process Variable	<p>The Process Variable Channel accepts current and voltage proportional inputs from a transmitter for the purpose of monitoring process variables (temperature, pressure, flow, etc.).</p>
Reverse Peak Speed	<p>Valid when the machine is spinning backwards and has exceeded the reverse speed setpoint, storing the highest achieved reverse speed.</p>
Reverse Speed	<p>Valid when the machine is spinning backwards. This measurement behaves like a typical speed measurement.</p>
Rotor Acceleration	<p>Rotor acceleration is a ramp rate of a rotor (in rpm / min) as its speed increases from zero rpm to the machine's running speed value.</p>

Protection Processor Module (PPM)	
Shaft Absolute	<p>Shaft Absolute vibration is the measurement of the shaft motion referenced to free space. It is measured using a vector summation of shaft relative motion and bearing seismic motion. A proximity sensor and an integrated velocity sensor must be mounted at the same location. Shaft Absolute Direct and 1X measurements are available on Radial Vibration channels.</p>
SMAX	<p>Measurement of the maximum excursion from an axial position.</p>
Speed	<p>Measurement of the rate of rotational motion.</p>

Protection Processor Module (PPM)	
Standard Single Ramp DE (Composite)	Standard Single Ramp Differential Expansion is a method of measuring Differential Expansion and is a subset of a number of measurement methods, generally termed Ramp Differential Expansion, which make use of ramps to measure axial position. One proximity probe, termed the ramp transducer, observes a ramp and the other probe, termed the flat transducer, observes the shaft. The two probes are mounted on the same side of the rotor and in the same axial plane. The ramp transducer measures axial position and the flat transducer measures radial position. The monitor uses the flat channel Direct static value to compensate the ramp channel Direct static value for the effect of radial movement. The compensated result is termed the Composite static value and is the primary value used for machine protection and machinery management information.
Valve Position	Measurement of the percentage open or closed of a valve.

Protection Processor Module (PPM)	
Zero Speed	A channel whose transducer is used to monitor the shaft rotational speed of a large rotor machine in revolutions per minute (under 100 rpm) below which the turning gear engagement can safely occur. Continuous shaft rotation during machine shutdown is imperative to prevent shaft bow that could lead to possible machine damage during startup. The channel receives a signal from a transducer whose output frequency is proportional to the speed of a rotor.
Alarming	
Alarm Time Delays	100 ms to 60 sec for vibration and position measurements. 1 sec to 60 sec for speed measurements.
Setpoints	Four setpoint levels available at a each measurement.
Protection States	Up to 32 Protection States that be controlled by Discrete contacts or configurable measurement ranges. Alarm setpoints are adjustable for different Protection States.

Acceleration Channel	
Direct/Bandpass	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Integration	Option allowed
Units	g pk g rms m/s ² pk m/s ² rms
Integrated Units	in/s pk in/s rms mm/s pk mm/s rms
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.0626 - 40,000 Hz Must be greater than high pass frequency and below Upper Transducer Frequency Response.
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	User can set values below the low pass frequency. Range of 0.0625 to 39,999

 Frequency response of the transducer needs to be considered.

Bias	
Units	V
Low Pass Poles	1, 2, 4, 6, 8

Acceleration Channel	
Low Pass Corner Frequency	0.01 - 5.00 Hz
1X and 2X (Default Variables)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Integration	Option allowed
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

nX (Additional Variable)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40kHz
Integration	Option allowed
Order	0.1 to 100 X; with precision of 0.1 x
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm

Acceleration Channel

Maximum Speed	Keyphasor source: <u>High Speed Keyphasor =</u> 120,000 rpm when $0.1x \leq n \text{ orders} \leq 12.5x$ 60,000 rpm, when $12.5x < n \text{ orders} \leq 25x$ 30,000 rpm, when $25x < n \text{ orders} \leq 50x$ 15,000 rpm, when $50x < n \text{ orders} \leq 100x$ <u>Dynamic Input Module =</u> 12,000 rpm
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Amplitude Extraction (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Integration	Option allowed
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Spectral Lines	100, 200, 400, 800, 1600, 3200
Frequency Span (Asynchronous)	10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 40000 Hz
Samples Per Rev (Synchronous)	8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096
Number Of Revs (Synchronous)	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024
Number of Averages	Up to 128
Minimum Speed	50 rpm

Acceleration Channel

Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
Center Frequency and Bandwidth	Configurable over the supported spectral range (up to 40 kHz for Asynchronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Case Expansion Channel

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
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Position

Units	V
Direct	in mm

Composite (Additional Variable)

Units	in mm
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Differential Expansion Channel	
General Tab Properties	
Probe Configuration	<ol style="list-style-type: none"> 1. Single Channel Differential Expansion 2. Standard Single Ramp Differential Expansion Flat Section 3. Standard Single Ramp Differential Expansion Ramp Section 4. Dual Ramp 5. Non-Standard Single Ramp Differential Expansion 6. Complementary Input Differential Expansion

 The desired Probe Configuration can be set for the Differential Expansion Channel.

Options 2-6 require the channel to also have a Composite Trended Variable added per Channel pair.


Position and Composite (Additional Variable)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 2\%$ maximum
Units	in mm
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5 Hz
Gap	
Units	V

Differential Expansion Channel	
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5 Hz
Bandpass (Additional Variable)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Unit	in mm
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.0626 - 40,000 Hz Must be greater than high pass frequency and below Upper Transducer Frequency Response.
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	0.0626 to 40,000 (must be < LPF)
nX (Additional Variable)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Integration	Option allowed
Order	0.1 to 100 X; with precision of 0.1 x
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)

Differential Expansion Channel	
Minimum Speed	50 rpm
Maximum Speed	<p>Keyphasor source:</p> <p><u>High Speed Keyphasor =</u></p> <p>120,000 rpm when $0.1x \leq n \text{ orders} \leq 12.5x$</p> <p>60,000 rpm, when $12.5x < n \text{ orders} \leq 25x$</p> <p>30,000 rpm, when $25x < n \text{ orders} \leq 50x$</p> <p>15,000 rpm, when $50x < n \text{ orders} \leq 100x$</p> <p><u>Dynamic Input Module =</u></p> <p>12,000 rpm</p>

Dynamic Pressure Channel	
Dynamic	
Accuracy	<p>Within $\pm 0.33\%$ of full-scale typical</p> <p>$\pm 1\%$ maximum up to 20 kHz</p> <p>$\pm 2\%$ maximum up to 40 kHz</p>
Units	<p>psi pp</p> <p>psi dpp</p> <p>psi rms</p> <p>mbar pp</p> <p>mbar dpp</p> <p>mbar rms</p>
Low Pass Poles	1, 2, 4, 6, 8

Dynamic Pressure Channel	
Low Pass Corner Frequency	<p>0.0626 – 40,000 Hz</p> <p>Must be greater than high pass frequency and below Upper Transducer Frequency Response.</p>
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	<p>User can set values below the low pass frequency.</p> <p>Range of .0625 to 39,999</p>

 Frequency response of the transducer needs to be considered.

Bias	
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 – 5.00 Hz

Bandpass	
Accuracy	<p>Within $\pm 0.33\%$ of full-scale typical</p> <p>$\pm 1\%$ maximum up to 20 kHz</p> <p>$\pm 2\%$ maximum up to 40 kHz"</p>
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	<p>0.0626 – 40,000 Hz</p> <p>Must be greater than high pass frequency and below Upper Transducer Frequency Response.</p>
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	<p>User can set values below the low pass frequency.</p> <p>Range of 0.0625 to 39,999</p>

Dynamic Pressure Channel



Frequency response of the transducer needs to be considered.

1X and 2X (Default Variables)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40kHz
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

nX (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Order	0.1 to 100 X; with precision of 0.1 x
Minimum Speed	50 rpm

Dynamic Pressure Channel

Maximum Speed	Keyphasor source: <u>High Speed Keyphasor =</u> 120,000 rpm when $0.1x \leq n \text{ orders} \leq 12.5x$ 60,000 rpm, when $12.5x < n \text{ orders} \leq 25x$ 30,000 rpm, when $25x < n \text{ orders} \leq 50x$ 15,000 rpm, when $50x < n \text{ orders} \leq 100x$ <u>Dynamic Input Module =</u> 12,000 rpm
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Amplitude Extraction (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Spectral Lines	100, 200, 400, 800, 1600, 3200
Frequency Span (Asynchronous)	10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 40000 Hz
Samples Per Rev (Synchronous)	8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096
Number Of Revs (Synchronous)	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024
Number of Averages	Up to 128
Minimum Speed	50 rpm

Dynamic Pressure Channel	
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
Center Frequency and Bandwidth	Configurable over the supported spectral range (up to 40 kHz for Asynchronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Process Variable	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
Input Options	4 - 20 mA 1 - 5 V 0 - 10 V -10 - 10 V
Output Options	Custom units accepted. Upper and Lower Limits must be within 100,000 units of each other.

Radial Vibration Channel	
Direct/Bandpass	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Units	mil pp μm pp

Radial Vibration Channel	
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.1 - 40,000 Hz; increments of 0.1 Hz (should be greater than 10 times High Pass Frequency)
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	0.1 - 40,000 Hz; increments of 0.1 Hz (should be less than 1/10 of Low Pass Frequency)
Gap	
Units	V
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5.00 Hz
1X, 2X, SMAX	
1X/2X Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz"
SMAX Accuracy	Within $\pm 5\%$ of full-scale
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm

Radial Vibration Channel	
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
nX	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz"
Order	0.1 to 100x; increments of 0.1x
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor source: <u>High Speed Keyphasor =</u> 120,000 rpm when $0.1x \leq n \text{ orders} \leq 12.5x$ 60,000 rpm, when $12.5x < n \text{ orders} \leq 25x$ 30,000 rpm, when $25x < n \text{ orders} \leq 50x$ 15,000 rpm, when $50x < n \text{ orders} \leq 100x$ <u>Dynamic Input Module =</u> 12,000 rpm

Radial Vibration Channel	
Amplitude Extraction	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Samples Per Rev (Sync.)	8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096
Number Of Revs (Sync.)	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024
Frequency Span (Async.)	10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 40000 Hz
Spectral Lines	100, 200, 400, 800, 1600, 3200
Number of Averages	Up to 128
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
Center Frequency and Bandwidth	Configurable over the supported spectral range (up to 40 kHz for Asynchronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Radial Vibration Channel

Shaft Absolute - Direct

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.0626 - 40,000 Hz; increments of 0.1 Hz (should be greater than 10 times High Pass Frequency)
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	User can set values below the low pass frequency. Range of .0625 to 39,999

Shaft Absolute - 1X

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz"
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

Eccentricity Peak to Peak / Direct

Low Pass Poles	1
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Radial Vibration Channel


Low Pass Corner Frequency	0.41 Hz
Eccentricity Poles	1
Eccentricity Corner Frequency	15.6 Hz

Speed Channel	
Speed	
Speed/Frequency Signal Accuracy	<p><u>KPH modules:</u></p> <p>0.017 to 100 rpm: ±0.1 rpm</p> <p>101 to 10,000 rpm: ±100 rpm</p> <p>10,001 to 120,000 rpm: ±0.01% of actual rotational speed</p> <p><u>PAV/PAA/PAS/PAD/PVT modules:</u></p> <p>1 to 100 ppm: ±0.1 rpm</p> <p>101 to 5000 ppm: ±1 rpm (within 3 seconds)</p> <p>5001 to 12,000 ppm: ±15 rpm (within 3 seconds)</p> <p><u>Definitions</u></p> <p>ppm = Pulses Per Minute</p> <p>ppm = EPR * RPM</p> <p>EPR = Events Per Revolution</p> <p>“Within 3 seconds” = At higher ppms, the system requires time to settle to the designated accuracy specifications</p>
Top Scale	<p><u>KPH modules:</u></p> <p>Must be between 50 and 120,000 rpm, inclusive</p> <p><u>PAV/PAA/PAS/PAD/PVT modules:</u></p> <p>Must be between 50 and 12,000 rpm, inclusive</p>

Speed Channel	
Units	rpm cpm Hz
Gap	
Low Pass Corner Frequency	0.01 – 5Hz
Low Pass Poles	1, 2, 4, 6, 8
Reverse Speed	
Accuracy	Refer to Speed/Frequency Signal Accuracy
Top Scale	<p><u>KPH modules:</u></p> <p>Must be between 50 and 120,000 rpm, inclusive</p> <p><u>PAV/PAA/PAS/PAD/PVT modules:</u></p> <p>Must be between 50 and 12,000 rpm, inclusive</p>
Units	rpm cpm Hz
Speed Ratio	0.00005 – 20,000 (up to 10 digits of resolution)
Speed Hysteresis	0 to 10
% Difference	1 to 10%

Speed Channel

Reverse Peak Speed

 Measurement requires 2 transducers.

Accuracy	Refer to Speed/Frequency Signal Accuracy
Top Scale	<u>KPH modules:</u> Must be between 50 and 120,000 rpm, inclusive <u>PAV/PAA/PAS/PAD/PVT modules:</u> Must be between 50 and 12,000 rpm, inclusive
Units	rpm cpm Hz
Speed Ratio	0.00005 – 20,000 (up to 10 digits of resolution)
Speed Hysteresis	0 to 10
% Difference	1 to 10%

Number of Reverse Rotations

Top Scale	Bottom Scale < Top Scale < = 20,000
Speed Ratio	0.00005 to 20,000 (must support up to 10 digits of precision)
Speed Hysteresis	0 to 10
% Difference	1 to 10%

Rotor Acceleration

Accuracy	±20 rpm/min
Top Scale	100 to 9,999 (rpm/min)


Speed Channel

Bottom Scale	-9,999 to -100 (rpm/min)
Unit	rpm/min cpm/min Hz/min (rpm/min)
Speed Ratio	0.00005 – 20,000 (up to 10 digits of resolution)
Minimum Speed	1 to 120,000

Peak Speed

Accuracy	Refer to Speed/Frequency Signal Accuracy
Top Scale	<u>KPH modules:</u> Must be between 50 and 120,000 rpm, inclusive <u>PAV/PAA/PAS/PAD/PVT modules:</u> Must be between 50 and 12,000 rpm, inclusive
Units	rpm cpm Hz
Speed Ratio	0.00005 – 20,000 (up to 10 digits of resolution)
Clamp Signal Below 1 rpm	Option allowed
Minimum Speed	1 to 120,000

Zero Speed

 Measurement requires 2 transducers.

Speed Channel	
Accuracy	Refer to Speed/Frequency Signal Accuracy
Top Scale	10.0 to 99.9 rpm
Units	rpm cpm Hz
Second Transducer Source	Lists all available speed channels configured in system
Speed Ratio	0.00005 – 20,000 (up to 10 digits of resolution)
Clamp Signal Below 1 rpm	Option allowed
% Difference	1 to 10%

Temperature Channel	
Direct	
Accuracy	Within ± 1 degree typical ± 3 degrees maximum
Units	$^{\circ}\text{F}$ $^{\circ}\text{C}$
Temperature Range	-200C - 1370C depending on TC/RTD selection

Thrust Channel	
Position	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
Unit	mil, mm

Thrust Channel	
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 – 5Hz
Gap	
Unit	V
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01-5Hz
Bandpass (Additional Variable)	
Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Unit	mil pp $\mu\text{m pp}$
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.0626 – 40,000 Hz Must be greater than high pass frequency and below Upper Transducer Frequency Response.
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	0.0626 to 40,000 (must be < LPF)

Thrust Channel

Amplitude Extraction (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Unit	mil pp $\mu\text{m pp}$
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

nX (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
Unit	mil pp $\mu\text{m pp}$
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Order	0.1 to 100 X; with precision of 0.1x
Minimum Speed	50 rpm

Thrust Channel

Maximum Speed	Keyphasor source: <u>High Speed Keyphasor =</u> 120,000 rpm when $0.1x \leq n \text{ orders} \leq 12.5x$ 60,000 rpm, when $12.5x < n \text{ orders} \leq 25x$ 30,000 rpm, when $25x < n \text{ orders} \leq 50x$ 15,000 rpm, when $50x < n \text{ orders} \leq 100x$ <u>Dynamic Input Module =</u> 12,000 rpm
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Spectral Band (Additional Variable)

Unit	mil pp $\mu\text{m pp}$
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

Valve Position Channel

Valve Position - Position

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
Units	% Open % Closed
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5.00 Hz

Valve Position - Direct (Default)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
Units	V
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5.00 Hz


Velocity Channel

Direct/Bandpass

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 2\%$ maximum
Integration	Option allowed
Units	in/s pk in/s rms mm/s pk mm/s rms

Velocity Channel

Integrated Units	mil pp $\mu\text{m pp}$
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.0626 - 40,000 Hz Must be greater than high pass frequency and below Upper Transducer Frequency Response.
High Pass Corner Frequency	User can set values below the low pass frequency. Range of .0625 to 39,999

 Frequency response of the transducer needs to be considered.

Bias

Units	V
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5.00 Hz

1X and 2X

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 2\%$ maximum
Integration	Option allowed
Speed Ratio	0.000000001 - 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm

Velocity Channel	
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

nX (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 2\%$ maximum
Integration	Option allowed
Order	0.1 to 100 X; with precision of 0.1 x
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor source: <u>High Speed Keyphasor =</u> 120,000 rpm when $0.1x \leq n$ orders $\leq 12.5x$ 60,000 rpm, when $12.5x < n$ orders $\leq 25x$ 30,000 rpm, when $25x < n$ orders $\leq 50x$ 15,000 rpm, when $50x < n$ orders $\leq 100x$ <u>Dynamic Input Module =</u> 12,000 rpm

Amplitude Extraction (Additional Variable)

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 2\%$ maximum
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Velocity Channel	
Integration	Option allowed
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Spectral Lines	100, 200, 400, 800, 1600, 3200
Frequency Span (Asynchronous)	10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 40000 Hz
Samples Per Rev (Synchronous)	8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096
Number Of Revs (Synchronous)	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024
Number of Averages	Up to 128
Minimum Speed	50 rpm
Maximum Speed	<u>Keyphasor Source:</u> High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
Center Frequency and Bandwidth	Configurable over the supported spectral range (up to 40 kHz for Asynchronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Recip Impulse Acceleration Channel

Direct

Accuracy	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum up to 20 kHz $\pm 2\%$ maximum up to 40 kHz
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Recip Impulse Acceleration Channel	
Integration	Not allowed
Units	g pk g rms m/s ² pk m/s ² rms
Low Pass Poles	4
Low Pass Corner Frequency	30 to 40,000 Hz when subunit is not RMS 40 to 40,000 Hz when subunit is RMS Low Pass Corner Frequency must be greater than or equal to (High Pass Corner Frequency * 4). Low Pass Corner Frequency must be greater than High Pass Corner Frequency. Bently Nevada recommends Low Pass Corner Frequency to be less than or equal to Upper Frequency Response.
High Pass Poles	4
High Pass Corner Frequency	3 to 3,000 Hz when subunit is not RMS 10 to 3,000 Hz when subunit is RMS
Bias	
Units	V
Low Pass Poles	1
Low Pass Corner Frequency	0.01 - 5.00 Hz

Recip Piston Rod Channel	
Peak-Peak Displacement	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Integration	Not allowed
Units	mil pp µm pp
Low Pass Poles	2
Low Pass Corner Frequency	600 Hz
High Pass Poles	2
High Pass Corner Frequency	1 Hz
Position Magnitude	
Accuracy	Within ±1 % of the lowest configurable full-scale range
Integration	Not allowed
Units	mil µm
Speed Ratio	0.00005 to 20,000 (up to 10 digits of resolution)
Minimum Speed	If (50 / Speed Ratio < 1): 1 Otherwise: 50 / MultiEventRatio
Max Speed	When Keyphasor source is a High Speed Keyphasor: 120,000 rpm When Keyphasor source is a Dynamic Sampled Input Module: 12,000 rpm

Recip Piston Rod Channel	
Position Angle	
Accuracy	Within $\pm 3^\circ$
Integration	Not allowed
Units	Degrees
Speed Ratio	0.00005 to 20,000 (up to 10 digits of resolution)
Minimum Speed	If (50 / Speed Ratio < 1): 1 Otherwise: 50 / MultiEventRatio
Max Speed	When Keyphasor source is a High Speed Keyphasor: 120,000 rpm When Keyphasor source is a Dynamic Sampled Input Module: 12,000 rpm
Crank Angle	
Accuracy	Within $\pm 3^\circ$
Integration	Not allowed
Units	Degrees
Speed Ratio	0.00005 to 20,000 (up to 10 digits of resolution)
Minimum Speed	If (50 / Speed Ratio < 1): 1 Otherwise: 50 / MultiEventRatio
Max Speed	When Keyphasor source is a High Speed Keyphasor: 120,000 rpm When Keyphasor source is a Dynamic Sampled Input Module: 12,000 rpm
Gap	
Accuracy	Within $\pm 1\%$
Units	V

Recip Piston Rod Channel	
Low Pass Poles	1
Low Pass Corner Frequency	0.09 Hz
Average Piston Position	
Accuracy	Within $\pm 1\%$
Units	mil μm
Low Pass Poles	1
Low Pass Corner Frequency	0.09 Hz
Instantaneous Piston Position	
Accuracy	Within $\pm 1\%$
Units	mil μm
Speed Ratio	0.00005 to 20,000 (up to 10 digits of resolution)
Minimum Speed	If (50 / Speed Ratio < 1): 1 Otherwise: 50 / MultiEventRatio
Max Speed	When Keyphasor source is a High Speed Keyphasor: 120,000 rpm When Keyphasor source is a Dynamic Sampled Input Module: 12,000 rpm
Instantaneous Probe Gap	
Accuracy	Within $\pm 1\%$
Units	V
Speed Ratio	0.00005 to 20,000 (up to 10 digits of resolution)

Recip Piston Rod Channel	
Minimum Speed	If (50 / Speed Ratio < 1): 1 Otherwise: 50 / MultiEventRatio
Max Speed	When Keyphasor source is a High Speed Keyphasor: 120,000 rpm When Keyphasor source is a Dynamic Sampled Input Module: 12,000 rpm

Condition Monitoring Module

Condition Monitoring Module (CMM)	
Power Consumption	
Maximum	14.2 W
Typical	10.5 W
Data Communications	
2 Ethernet ports - utility or rear side	Independent Ethernet ports 1000/100/10 Base-T Auto-negotiation
Connector	RJ-45
Cable Length	100 meters (328 feet) max
LEDs	
Module OK LED	Indicates when the module is functioning properly
LINK LED	indicates when the module is communicating to the rest of the system
Physical	
Required Rack Space	2 Slots

Power Input Module

Power Input Module (PIM)	
Electrical	
Voltage Input	+21 to +32 Vdc
Current Draw	
3U 19" full load	7.1 Amps @ 24 Vdc
Out of Range Protection	An undervoltage does not harm the PIM. An overvoltage causes the fuse to open.
Physical	
Width	0.8" (2.03 cm)
Height	5.2" (13.21 cm)
Depth	9.67" (24.56 cm)

Dynamic Input Modules


Dynamic Input Modules	
PAV	(-) (Prox, Accel, Velom)
PAS	(-) (Prox, Accel, Seismic)
PAA	(-) (Prox, Accel, Aero)
PAD	(-) (Prox, Accel, DC LVDT)
PVT	(+) (Prox, Accel, Velom)
Speed and Keyphasor	
Speed Range	1 - 12,000 rpm
Power Consumption	
Maximum	11 W
Typical (All Modules)	7.5 W


Dynamic Input Modules	
Accuracy and Frequency Response	
PAV	Prox/Accel (3-wire) 0-40 kHz 1% of Full Scale Velom (2-wire) 5 Hz - 20 kHz 1% of Full Scale 20-40 kHz 2% of Full Scale
PAS	Prox/Accel (3-wire) 0-40 kHz 1% of Full Scale Seismic (2-wire) 5 Hz - 20 kHz 1% of Full Scale 20-40 kHz 2% of Full Scale
PAA	Prox/Accel (3-wire) 0-40 kHz 1% of Full Scale Aero (4-wire) 5 Hz - 20 kHz 1% of Full Scale 20-40 kHz 2% of Full Scale
PAD	Prox/Accel (3-wire) 0-40 kHz 1% of Full Scale DC LVDT (4-wire) 5 Hz - 20 kHz 1% of Full Scale 20-40 kHz 2% of Full Scale
PVT	Prox/Accel (3-wire) 0-40 kHz 1% of Full Scale Velom (2-wire) 5 Hz - 20 kHz 1% of Full Scale 20-40 kHz 2% of Full Scale

Dynamic Input Modules	
Dynamic Inputs	
Analog Input	See Input Module Sensors and Channels on page 16.
Channels Supported	4 Dynamic Inputs
Sampling Rate	102.4 kHz
Input Interface Impedance (Typical)	
PAV	Prox/Accel (3-wire) 10 k Ω
PAS	Prox/Accel (3-wire) 10 k Ω Seismic (2-wire) 10 k Ω
PAA	Prox/Accel (3-wire) 10 k Ω Aero (4-wire) 100 k Ω
PAD	Prox/Accel (3-wire) 10 k Ω DC LVDT (4-wire) 1 M Ω
PVT	Prox/Accel (3-wire) 10 k Ω
Input Interface Signal Range [V]	
PAV	Prox/Accel (3-wire) Min. -22, Max. 0 Velom (2-wire) Min. -24, Max. -2

Dynamic Input Modules	
PAS	Prox/Accel (3-wire) Min. -22, Max. 0 Seismic (2-wire) Min. -14, Max. 0
PAA	Prox/Accel (3-wire) Min. -22, Max. 0 Aero (4-wire) Min. -22, Max. 0
PAD	Prox/Accel (3-wire) Min. -22, Max. 0 DC LVDT (4-wire) Min. -10, Max. 10
PVT	Prox/Accel (3-wire) Min. 0, Max. 24 Velom (2-wire) Min. 2, Max. 24

Outputs	
BTO Accuracy	AC > 0 to < 10 kHz, ±1% of input signal 10 kHz to < 20 kHz, ±2% of input signal 20 kHz to < 30 kHz, ±4% of input signal 30 kHz to ≤ 40 kHz, ±6% of input signal DC ±100 mV over voltage range of Input Module
BTO Output Impedance	500 Ω

Dynamic Input Modules	
BTO Connector	


 This is a true analog signal from the input, not digital to analog reconstitution of the input signal. Some Transducers have an offset BTO bias.


Transducer Power	
PAV	Prox/Accel (3-wire) -24 VDC, Max. 40 mA Velom (2-wire) 3.3 mA (Constant current)
PAS	Prox/Accel (3-wire) -24 VDC, Max. 40 mA
PAA	Prox/Accel (3-wire) -24 VDC, Max. 40 mA Aero (4-wire) -24 VDC, Max. 40 mA
PAD	Prox/Accel (3-wire) -24 VDC, Max. 40 mA DC LVDT (4-wire) -10 to 10 VDC, max. 40 mA
PVT	Prox/Accel (3-wire) 24 VDC, Max. 33 mA Velom (2-wire) 9.5 mA (Typical)

Dynamic Input Modules	
LEDs	
Channel Status LED (Rear Utility side only)	1 per input channel indicates when the connected sensor is in an OK condition
Module OK LED	Indicates when the module is functioning properly
System Communication LED	indicates when the module is communicating to the rest of the system
Physical	
Required Rack Space	1 Slot

Keyphasor Input Module

Keyphasor Module Inputs (KPH)	
Inputs	
Analog Input	<ul style="list-style-type: none"> • Proximitor (3-wire) • Accelerometer (3-wire) • Proximitor Keyphasor (3-wire) • Magnetic Speed Pickups
Signal Conditioning	
Speed / Frequency Signal Ranges	Input range of 1 to 120,000 cpm (0.017 to 2 kHz).
Non-Speed Dynamic Input Specifications	
Analog Input	See Input Module Sensors and Channels on page 16.
Channels Supported	4 Dynamic Inputs
Sampling Rate	102.4 kHz

Keyphasor Module Inputs (KPH)	
Accuracy and Frequency Response	
KPH	Prox/Accel (3-wire) 0-40 kHz 2% of Full Scale
Outputs	
Analog Buffered Transducer (BTO)	Short circuit protected output signal available through BTO connector on public and utility side.
BTO Accuracy	<p>AC</p> <p>> 0 to < 10 kHz, ±1% of input signal</p> <p>10 kHz to < 20 kHz, ±2% of input signal</p> <p>20 kHz to < 30 kHz, ±4% of input signal</p> <p>30 kHz to ≤ 40 kHz, ±6% of input signal</p> <p>DC</p> <p>±100 mV over voltage range of Input Module</p>
BTO Output Impedance	500 Ω
BTO Connector	

 When configured as an analog output, this is a true analog signal from the input and not a digital to analog reconstitution of the input signal. When configured as a processed output, this is a 5 V or 3.3 V compatible TTL signal with the same machine speed and phase as the input signal. Some Transducers have an offset BTO bias.


Keyphasor Module Inputs (KPH)	
Keyphasor Transducer Power Supply	-24 Vdc, 40 mA maximum per channel.
LEDs	
Channel Status LED (Rear Utility side only)	1 per input channel indicates when the connector sensor is in an OK condition
Module OK LED	Indicates when the module is functioning properly
LINK LED	indicates when the module is communicating to the rest of the system
Physical	
Required Rack Space	1 Slot

AC LVDT

Module Inputs	
Channels	4 differential AC signals from AC LVDT
Power Consumption	5.7 W typical, 10 W maximum

TC/RTD Temperature

Temperature	
Thermocouple (TC) Temperature	
Thermocouple	Type J, K, E, T
Channel Supported	6
RTD Temperature	
RTD Type	Pt100 (385), Pt100 (392), Ni120, Cu10

Temperature	
	Platinum RTD's with 0.00385 alphas are the worldwide industrial standard and are recommended for all applications.

Power Consumption	
Maximum	6 W
Typical	3 W
LEDs	
Channel Status LED (Rear Utility Side)	1 per unit channel indicates when the connected sensor is in an OK condition
Module OK LED	Indicates when the module is functioning properly
System Communication LED	Indicates when the module is communicating to the rest of the system
Physical Characteristics	
Required Rack Space	1 Slot

Isolated Process Variable / Discrete Input (PVD)

Isolated PV / Discrete Input (PVD)	
Power Consumption	
Typical	4.5 W
Maximum	6.5 W
Characteristics	
Channels	6
Isolation	500 V Channel to System and 250 V Channel to Channel isolation

Isolated PV / Discrete Input (PVD)	
Process Variable 4–20 mA Input	
Process Variable Input (Current)	4 to 20 mA
Process Variable Input (Voltage)	-10 to 10 Vdc 0 to 10 Vdc 2 to 10 Vdc 0 to 5 Vdc 1 to 5 Vdc -10 to 0 Vdc
Discrete Input	
Discrete Input	Dry Contact, Internally Wetted Wetted Contact, 0 to 10 Vdc

Electromagnetic Relay (EMR)

Electromagnetic Relay (EMR)	
Power Consumption	
Typical	6 watts
Maximum	11 watts
Characteristics	
Type	Electromechanical Single-Pole, Double-Throw
Number of Relay Outputs	8
Environmental	Epoxy Sealed
Operation	Each relay is configurable for Normally De-Energized or Normally Energized
Contact Rating for Standard Systems	
Minimum Switched Current	100 mA

Electromagnetic Relay (EMR)	
DC Maximum Switched Current	4 A @ 30 Vdc
DC Minimum Switched Voltage	5 Vdc
DC Maximum Switched Voltage	30 Vdc
AC Maximum Switched Voltage	250 Vrms
AC Maximum Switched Current	4 A
Maximum Switched Power	180 W or 1800 VA

Contact Rating for Hazardous Area Systems	
Maximum Switched Current	4 A
DC Maximum Switched Voltage	30 Vdc
AC Maximum Switched Voltage	160 Vrms

Solid State Relay (SSR)

Solid State Relay (SSR)	
Power Consumption	
Typical	5 watts
Maximum	9 watts
Characteristics	
Type	Solid State Single-Pole, Double-Throw
Number of Relay Outputs	8
Environmental	Plastic Encapsulated

Solid State Relay (SSR)

Arc Suppressor	150 Vdc, installed standard
Maximum Cycling Rate	1 Hz
Operation	Each relay is configurable for Normally De-Energized or Normally Energized
Switching Properties	Limited to non-inductive loads

Contact Rating for Standard Systems

Current Range	0.0 1-125 mA
DC Maximum Switched Current	125 mA @ 125 Vdc
Voltage Range	1-125 Vdc
Maximum Switched Power	650 mW

Contact Rating for Hazardous Area Systems

Current Range	0.0 1-125 mA
Voltage Range	1-50 Vdc

10.4" Hazardous Area Display

10.4" Hazardous Area Display

Part Number	120M8155-01
Warranty	1 Year

Features

Video Interface	VGA
Touch Screen Type	Resistive Touch Screen
Cable Interface	Serial
Control Settings	Front panel button

10.4" Hazardous Area Display

Mounting Styles	Panel Mount, 19" EIA Rack Mount, and Independent Mount
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Power

Voltage	24 Vdc nominal voltage range 10 to 28 Vdc
Operating Current	Less than 500 mA

Physical Characteristics

Dimensions	15.25 x 9.8 x 1.93 in (387.4 x 248.9 x 49 mm)
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Environmental Limits - Indoor Use Only

IP Rating	Designed for IP54 ingress protection against dust and water spray to the front only.
Operating Temperature	-20 to 65°C (-4 to 149°F)

Standards and Certifications

Refer to External Display Datasheet (154M8401)

15" Hazardous Area Display

15" Hazardous Location Display	
Part Number	102M8950
Warranty	1 Year
Features	
Video Interface	VGA and DVI-D
Touch Screen Type	5-Wire Resistive Touch Screen
Touch Screen Interface	Serial and USB-B
Control Settings	Front panel button
Mounting Styles	Panel Mount and 19" EIA Rack Mount
Power	
Voltage	24 Vdc nominal voltage range 12 to 24 Vdc
Operating Current	~100 mA
Physical Characteristics	
Dimensions	16.61 x 13.31 x 2.68 in (422 x 338 x 68 mm)
Environmental Limits - Indoor Use Only	
IP Rating	IP65 ingress protection against dust and water spray compliant to the front only.
Operating Temperature	-20 to 60°C (-4 to 140°F)
Standards and Certifications	
Refer to External Display Datasheet (154M8401)	

21.5" Industrial Display

21.5" Industrial Display	
Part Number	150M1466
Warranty	1 Year
Features	
Video Interface	VGA and DVI-D
Touch Screen Type	Projected Capacitive Touch Screen
Touch Screen Interface	USB-B and Serial
Control Settings	Control buttons on rear panel
Mounting Styles	Panel Mount and 19" EIA Rack Mount
Power	
Voltage	24 Vdc nominal voltage range 22 to 26 Vdc
Operating Current	≈ 200 mA
Physical Characteristics	
Dimensions	21.98 x 13.77 x 1.88 in (558.4 x 349.8 x 47.7 mm)
Environmental Limits - Indoor Use Only	
IP Rating	IP66 ingress protection against dust and water spray compliant to the front only.
Operating Temperature	-30 to 70°C (-22 to 158°F)
Storage Temperature	-40 to 75°C (-40 to 167°F)
Ambient Relative Humidity	10 to 90% non-condensing

21.5" Industrial Display

Standards and Certifications

Refer to External Display Datasheet
 (154M8401)

Industrial Computer for Display

CPU Module

CPU	Intel Atom processor E3845 (quad-core, 1M cache, 1.91 GHz)
System Memory	4 GB
Storage	SD 3.0 (SDHC/SDXC) 128 GB
Display	Intel HD Graphics 4000
Peripherals	
USB	2 – USB-A 2.0
VGA	Resolution up to 1920 x 1200 pixels at 75 Hz HDDB-15F port
DisplayPort	Resolution up to 2560 x 1600 pixels at 60 Hz receptacle
Ethernet	4 – Auto-sensing 10/100/1000 Mbps RJ45 ports Magnetic Isolation Protection 1.5 kV
Serial	2 – RS-232/422/485 DB9M ports
Power	
Voltage	12/24 Vdc (11.4 to 36 Vdc)
Power	Less than 30 W (nominal)
Physical Characteristics	
Weight	1.75 kg (3.86 lbs.)
Dimensions	132 x 122 x 87 mm (5.20 x 4.81 x 3.43 in.)

CPU Module

Environmental Limits – Indoor Use Only

Operating Temperature	-40 to 70°C (-40 to 158°F)
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Standards and Certifications

Refer to External Display Datasheet
 (154M8401)

Compliance and Certifications

FCC

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

EMC

European Community Directive:

EMC Directive 2014/30/EU

Standards:

EN 61000-6-2; Immunity for Industrial Environments
EN 61000-6-4; Emissions for Industrial Environments

Electrical Safety

European Community Directive:

LV Directive 2014/35/EU

Standards:

EN 61010-1;
EN 61010-2-201;

RoHS

European Community Directive:

RoHS Directive 2011/65/EU

Cyber Security

Designed to meet IEC 62443-4-2

*Maritime

ABS Rules for Condition of Classification, Part 1

- Steel Vessels Rules
- Offshore Units and Structures

* Approvals pending

Functional Safety

SIL 2

See the SIL User Guide (134M0398) for details regarding SIL implementation.

Hazardous Area Approvals



For the detailed listing of country and product-specific approvals, refer to the [Approvals Quick Reference Guide \(108M1756\)](#).

For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

cNRTLus

Class I, Zone 2: AEx/Ex ec nC IIC T4 Gc;
Class I, Zone 2: AEx/Ex nA nC IIC T4 Gc;
Class I, Division 2, Groups A, B, C, D T4;
Class I, Division 2, Groups A, B, C, D T4 (N.I.);

T4 @ Ta= -30°C to +70°C (-22°F to +158°F)

ATEX/IECEx



II 3 G
Ex ec nC IIC T4 Gc
Ex nA nC IIC T4 Gc

T4 @ Ta= -30°C to +70°C (-22°F to +158°F)

Ordering Information

60R_SYSTEM - Packaged Chassis

To begin your order, contact your sales representative.

Ordering Option	Description
A - Chassis Type	
01	Rackmount Chassis
02	Panel Mount Chassis
03	Bulkhead Mount Chassis
B - Power Input	
02	Dual DC Power Input Modules
C - Display	
00	No Display
D - Agency Approvals	
00	None
01	CSA/NRTL/C (CLASS 1 DIV 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
E - Functional Safety System	
NO	Standard System
YES	Functional Safety System

All chassis orders will include the following modules:

- PIM
- SIM
- PPM
- CMM

System Interface Module

Ordering Option	Description
60R/SIM01-AAA-B • System Interface Module	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL



For an Orbit 60 safety system, SIL certification for the SIM is not required.

Communications Gateway Module

Ordering Option	Description
60R/CGW01-AAA-B • RJ-45 Ethernet Comm Gateway	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL

Protection Processor Module

Ordering Option	Description
60R/PPM01-AAA-B • Protection Processor Module	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

Condition Monitoring Module

Ordering Option	Description
60R/CMM01-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL

Two PIM modules are included with the Orbit 60 Chassis.

3U Power Input Module

Ordering Option	Description
60R/PIM01-AAA-B • Power Input Module	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL

PAV (Prox/Accel/Vel) Module

Ordering Option	Description
60R/INP01-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

PAA (Prox/Accel/Aero) Module

Ordering Option	Description
60R/INP02-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area

Ordering Option	Description
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

PAS (Prox/Accel/Seismic) Module

Ordering Option	Description
60R/INP03-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

PAD (Prox/Accel/DCLVDT) Module

Ordering Option	Description
60R/INP04-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)

Ordering Option	Description
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

PVT (Prox/Accel/Velom)

Ordering Option	Description
60R/INP05-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
2	SIL 2

Keyphasor Input Module

Ordering Option	Description
60R/INP06-AAA-B	
AAA – Hazardous Area Certifications	
00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL

Ordering Option	Description
2	SIL 2

AC LVDT Input Module

Ordering Option	Description
60R/INP10-AAA-B	

AAA – Hazardous Area Certifications

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals

B – SIL Level

0	No SIL
2	SIL 2

RTD / TC Temperature Module

Ordering Option	Description
60R/INP07	

AA – Hazardous Area Certifications

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XX	Country Specific Approvals

B – SIL Level

0	No SIL
2	SIL 2

Isolated Process Variable / Discrete Input Module (PVD)

Ordering Option	Description
60R/INP09	

AAA – Hazardous Area Certifications

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals

B – SIL Level

0	No SIL
2	SIL 2

Electromechanical Relay Module

Ordering Option	Description
60R/RLY01-AAA-B	

AAA – Hazardous Area Certifications

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals

B – SIL Level

0	No SIL
1	SIL 1

Solid State Relay Module

Ordering Option	Description
60R/RLY02-AAA-B	

AAA – Hazardous Area Certifications

00	No Hazardous Area
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Ordering Option	Description
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals
B – SIL Level	
0	No SIL
1	SIL 1

External Display

Bently Nevada offers three display systems with different resolution, capabilities, mounting options, accessories, and certifications. Not all options are available for all displays.

60X/EXDAA-BB-CC	
AA – Display	
01	10.4" Hazardous Area Display
02	15" Hazardous Area Display
04	21.5" Display
BB – Agency Approvals	
00	No Approval Certifications
01	CSA/NRTL/C (Class 1 DIV 2) (only available for the 60X/EXD01 10.4 in display and 60X/EXD02 15 in display)
02	Multi (CSA, ATEX, IECEx) (only available for the 60X/EXD01 10.4 in display)
CC – Mounting Options	
01	19" Rack Mount Panel
02	Panel Mount Kit
03	Remote Stainless-Steel Enclosure (Select a pole or wall mount option separately as an accessory as needed.)

60X/EXDAA-BB-CC	
04	Independent Mount (only available for the 60X/EXD01 10.4 in display)

Industrial Computer for Display

60X/CMP01-AA	
AA – Agency Approvals	
00	No Approval Certifications
01	CSA/NRTL/C (Class 1 DIV 2)
02	Multi (CSA, ATEX, IECEx)
Includes DIN Mounting Kit, 24 Vdc 90-Watt DIN Mountable Power Supply, USB Mouse, 24 Vdc Power Cable, 10' (3 m) Ethernet Cable. A 20' Ethernet cable accessory is available.	

Accessories

Part Number	Description
Dongles and Cables	
60X/BTC01	Buffered Transducer Breakout Kit

External Barriers

Part Number	Description
175502	3-pin Transducer Barrier
177241	2-pin Velomitor Barrier
175990 or 170M3559	Thermocouple Barrier
170M3559	RTD Barrier

External Galvanic Isolators

Part Number	Description
103M7134	3-pin Transducer Isolator

Part Number	Description
103M7134	2-pin Transducer Isolator
154M1361	Thermocouple Isolator
103M7138	RTD Isolator

Configuration Software

Part Number	Description
60X/CFG	Orbit Studio Configuration Software

AC/DC Industrial Power Supply

Ordering Option	Description
60X/XPS01-AAA • 240 Watt AC/DC Industrial Power Supply	

AAA – Agency Approvals

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals

60X/XPS02-AAA • 480 Watt AC/DC Industrial Power Supply

AAA – Agency Approvals

00	No Hazardous Area
01	CSA/NRTL/C (Class I, Div 2)
02	Multi (CSA, ATEX, IECEx)
XXX	Country Specific Approvals

Miscellaneous

Part Number	Description
144M5033-01	System Key
60R/BLK01	Blank: Module slot blank cover

Glossary of Terms

Accel	Acceleration	PAV	Prox, Accel, Velom
Aero	Aeroderivative	PIM	Power Input Module
API	American Petroleum Institute	PLC	Programmable Logic Controller
BRG	Bridge	PPM	Protection Processing Module
BTO	Buffered Transducer Output	Prox	Proximity
CE	Case Expansion	PVD	Isolated Process Variable, Discrete Input
CGW	Communication Gateway Module	PVT	Positive Voltage Transducer
CIDE	Complementary Input Differential Expansion	REB	Roller Element Bearing
CMM	Condition Monitoring Module	REC	Recorder Outputs
COM	Common	RMC	Remote Monitoring Center
DCM	Distributed Condition Monitoring	RST	Reset
DCS	Distributed Control Systems	RTD	Resistance Temperature Detector
DR(DE)	Dual Ramp (Differential Expansion)	SAI	System Alarm Inhibit
EGD	Ethernet Global Data	SCDE	Single Channel Differential Expansion
ESD	Emergency Shutdown Device	SHLD	Shield
EIA	Energy Information Administration	SIL	Safety Integrity Level
EMR	electromechanical Relay	SIM	System Interface Module
HAZLOC	Hazardous Location	SSR	Solid State Relay
HTVAS	High Temperature Velocity/Accel Sensor	SSRDE	Standard Single Ramp Differential Expansion
I/O	Input/Output	SW	Software
IEPE	Integrated Electronics Piezo-Electric	TC	Thermocouple
ITC	Isolated Thermocouple	TLS	Transport Layer Security
KPH	High Speed Keyphasor	RTD/TC	Resistance Temp Detector / Thermocouple
LVDT	Linear Variable Differential Transformer	TCP/IP	Transmission Control Protocol Internet Protocol
NC	Normally Closed	TM	Trip Multiply
NEMA	National Electrical Manufacturers Association	OEM	Original Equipment Manufacturer
NO	Normally Opened	Velom	Velomitor
NSSRDE	Non-Standard Single Ramp Differential Expansion		
NTP	Network Time Protocol		
OEM	Original Equipment Manufacturer		
PAA	Prox, Accel, Aero		
PAD	Prox, Accel, Displacement Module		
PAS	Prox, Accel, Seismic		

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