ORBIT 60 SERIES
Protection Processor Module
Datasheet

Bently Nevada Machinery Condition Monitoring

142M8515 Rev. B

Description

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.

LED Indications	
OK	OK LED - indicates the operational status of the module.
LINK	Internal Communication LED - successful communication on the internal network.

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Protection Processor Module

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

- 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	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. 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.
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	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.

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	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. 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.

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

Protection Processor Module (PPM)	
Shaft Absolute	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.
SMAX	Measurement of the maximum excursion from an axial position.
Speed	Measurement of the rate of rotational motion.

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 ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±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 (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Integration	Option allowed
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

Acceleration Channel	
nX (Additional Variable)	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
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:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm
Amplitude Extraction (Additional Variable)	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±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 Asychronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Case Expansion Channel	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum
Position	
Units	V
Direct	in mm
Composite (Additional Variable)	
Units	in mm

Differential Expansion Channel	
General Tab Properties	
Probe Configuration	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 ±0.33% of full-scale typical ±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 ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±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 (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz

Differential Expansion Channel	
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
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:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm

Dynamic Pressure Channel	
Dynamic	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Units	psi pp psi dpp psi rms mbar pp mbar dpp mbar 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

Dynamic Pressure Channel	
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	
Low Pass Poles	1, 2, 4, 6, 8
Low Pass Corner Frequency	0.01 - 5.00 Hz

Bandpass	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
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.

Dynamic Pressure Channel	
1X and 2X (Default Variables)	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
nX (Additional Variable)	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz

Dynamic Pressure Channel	
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Order	0.1 to 100 X; with precision of 0.1 x
Minimum Speed	50 rpm
Maximum Speed	**Keyphasor source:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm
Amplitude Extraction (Additional Variable)	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz

Dynamic Pressure Channel	
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	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 Asychronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Process Variable	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum

Process Variable	
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 ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Units	mil pp µm pp
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

Radial Vibration Channel	
1X, 2X, SMAX	
1X/2X Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
SMAX Accuracy	Within ±5% of full-scale
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm

Radial Vibration Channel	
nX	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
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:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm

Radial Vibration Channel	
Amplitude Extraction	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±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	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 Asychronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Radial Vibration Channel	
Shaft Absolute - Direct	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
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 ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)

Radial Vibration Channel	
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
Eccentricity Peak to Peak / Direct	
Low Pass Poles	1
Low Pass Corner Frequency	0.41 Hz
Eccentricity Poles	1
Eccentricity Corner Frequency	15.6 Hz

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

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	KPH modules: Must be between 50 and 120,000 rpm, inclusive PAV/PAA/PAS/PAD/PVT modules: 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%

Speed Channel	
Reverse Peak Speed	
Measurement requires 2 transducers.	
Accuracy	Refer to Speed/Frequency Signal Accuracy
Top Scale	KPH modules: Must be between 50 and 120,000 rpm, inclusive PAV/PAA/PAS/PAD/PVT modules: 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

Speed Channel	
Top Scale	100 to 9,999 (rpm/min)
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	KPH modules: Must be between 50 and 120,000 rpm, inclusive PAV/PAA/PAS/PAD/PVT modules: 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

Speed Channel	
Zero Speed	
Measurement requires 2 transducers.	
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	°F °C
Temperature Range	-200C - 1370C depending on TC/RTD selection

Thrust Channel	
Position	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum
Unit	mil, mm
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 ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Unit	mil pp µm 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.

Thrust Channel	
High Pass Poles	1, 2, 4, 6, 8
High Pass Corner Frequency	0.0626 to 40,000 (must be < LPF)
Amplitude Extraction (Additional Variable)	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz
Unit	mil pp µm pp
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
nX (Additional Variable)	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz

Thrust Channel	
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Unit	mil pp µm 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
Maximum Speed	**Keyphasor source:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm

Valve Position Channel	
Valve Position - Position	
Accuracy	Within ±0.33% of full-scale typical ±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 ±0.33% of full-scale typical ±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 ±0.33% of full-scale typical ±2% maximum
Integration	Option allowed
Units	in/s pk in/s rms mm/s pk mm/s rms

Velocity Channel	
Integrated Units	mil pp µm 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 (Amplitude)	Within ±0.33% of full-scale typical ±2% maximum

Velocity Channel	
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
Integration	Option allowed
Speed Ratio	0.000000001 – 20,000 (up to 10 digits of resolution)
Minimum Speed	50 rpm
Maximum Speed	Keyphasor Source: High Speed keyphasor = 120,000 rpm Dynamic Sampled Input Module = 12,000 rpm
nX (Additional Variable)	
Accuracy (Amplitude)	Within ±0.33% of full-scale typical ±2% maximum

Velocity Channel	
Accuracy (Phase)	**Keyphasor Source:** High Speed Keyphasor Within +/-1 degree maximum up to 20 kHz Event Rate (Events Per Rev * Running Speed in RPM / 60) Dynamic Input Module Within +/-1 degree maximum up to 200 Hz Event Rate (Events Per Rev * Running Speed in RPM / 60)
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:** High Speed Keyphasor = 120,000 rpm when 0.1x ≤ n orders ≤ 12.5x 60,000 rpm, when 12.5x < n orders ≤ 25x 30,000 rpm, when 25x < n orders ≤ 50x 15,000 rpm, when 50x < n orders ≤ 100x Dynamic Input Module = 12,000 rpm
Amplitude Extraction (Additional Variable)	
Accuracy	Within ±0.33% of full-scale typical ±2% maximum

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	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 Asychronous or up to 1600X for Synchronous sampling) Bandwidth ≥ 0

Recip Impulse Acceleration Channel	
Direct	
Accuracy	Within ±0.33% of full-scale typical ±1% maximum up to 20 kHz ±2% maximum up to 40 kHz

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

Recip Piston Rod Channel	
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
Position Angle	
Accuracy	Within ±3°
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 ±3°
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

Recip Piston Rod Channel	
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 ±1 %
Units	V
Low Pass Poles	1
Low Pass Corner Frequency	0.09 Hz
Average Piston Position	
Accuracy	Within ±1 %
Units	mil µm
Low Pass Poles	1
Low Pass Corner Frequency	0.09 Hz
Instantaneous Piston Position	
Accuracy	Within ±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

Recip Piston Rod Channel	
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 ±1%
Units	V
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

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
Altitude	< 2000 m (6,562 ft) Higher altitudes are possible but are site specific applications. Contact Bently Nevada support if you require higher altitudes.

Environmental Limits	
Pollution Degree	Pollution Degree 2
Installation Category	Category II

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.

Approvals pending

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

Ⓔx 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

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.

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

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