

3500/46M Hydro Monitor

Datasheet

Bently Nevada Machinery Condition Monitoring

144408 Rev. Y



Description

The 3500/46M Hydro Monitor is a four-channel instrument that accepts input from proximity, seismic, dynamic pressure and air gap sensors. The monitor conditions the signal to provide vibration, position and both static and dynamic pressure measurements. It then compares the conditioned signals with user-programmable alarms. Hydro Radial Vibration channels combine the shaft gap movement with the NX amplitude to provide a measurement to alarm on shear-pin failure.

Using the 3500 Rack Configuration Software, you can configure the 3500/46M Hydro Monitor to perform the following functions:

- Hydro Radial Vibration
- Hydro Air Gap
- Hydro Velocity
- Hydro Acceleration
- Hydro Thrust
- Multimode Hydro RV
- Multimode Air Gap
- Multimode Hydro Velocity
- Multimode Thrust
- Multimode Acceleration
- Multimode Hydro Dynamic Pressure
- Hydro Stator End Winding (SEW)



The monitor channels are programmed in pairs. Each channel may have separate or identical configurations.



The primary purpose of the 3500/46M Hydro Monitor is to provide the following:

- Machinery protection by continuously comparing monitored parameters against configured alarm setpoints to drive alarms
- Essential machine information for operations and maintenance personnel



Hydro Velocity channels provide early warning of pending machinery problems and assist in diagnosing them. Due to the nature of high amplitude, low frequency velocity events, the Hydro Velocity channel type cannot be used for automated machinery protection.

Each channel, depending on configuration, typically conditions its input signal to generate various parameters called **static values**. You can configure **alert setpoints** for each active static value and **danger setpoints** for any two of the active static values.

You can configure multimode channels to have up to eight sets of alarm parameters including alert and danger set points and alarm time delays. Each set may be configured for a specific machine mode.

As the machine changes modes, the monitor can switch to a specific set using contacts on multimode I/O modules or software commands through a communications gateway.

Specifications

Inputs

Signal	Accepts 1 to 4 proximity, air gap, velocity or acceleration sensor signals
Power consumption	7.7 watts, typical
Multimode positive input I/O	50 k Ω
Input Impedance	
Prox/Velom I/O and Multimode Prox/Velom I/O	10 k Ω for Prox/Accel 3.5 M Ω for Velomitor

Sensitivity

Hydro Radial Vibration and Multimode Hydro RV	0.79 mV/ μ m (20 mV/mil), 3.94 mV/ μ m (100 mV/mil) or 7.87 mV/ μ m (200 mV/mil)
Hydro Air Gap and Multimode Air Gap	0.20 mV/ μ m (5 mV/mil), 0.22 mV/ μ m (5.6 mV/mil), 0.49 mV/ μ m (12.5 mV/mil) or 0.55 mV/ μ m (14 mV/mil)
Hydro Velocity and Multimode Hydro Velocity	20 mV/mm/s (508 mV/in/s)
Hydro Thrust and Multimode Thrust	3.94 mV/ μ m (100 mV/mil), 7.87 mV/ μ m (200 mV/mil) or 11.22 mV/ μ m (285 mV/mil)
Hydro Acceleration and Multimode Acceleration	1.02 mV/m/s ² (10 mV/g) or 2.55 mV/m/s ² (25 mV/g)

Hydro SEW	10.19 mV/m/s ² (100 mV/g)
Multimode Hydro Dynamic Pressure	Refer to the Bently Nevada 350300 Dynamic Pressure Sensor datasheet, document 110M4613

Outputs

Front Panel LEDs	
OK LED	Indicates when the 3500/46M Hydro Monitor is operating properly
TX/RX LED	Indicates when the 3500/46M Hydro Monitor is communicating with other modules in the 3500 Rack.
Bypass LED	Indicates when the 3500/46M Hydro Monitor is in Bypass Mode.

Buffered Transducer Outputs	The front of each monitor has one coaxial connector for each channel. Each connector is short-circuit protected.
Output Impedance	550 Ω

Transducer Power Supply	
Prox/Velom I/O and Multimode Prox/Velom I/O	-23 Vdc nominal at 43 mA max
Multimode Positive Input I/O	+23 Vdc nominal at 23 mA max

Recorder	+4 to +20 mA. Output is proportional to monitor full-scale. One output is provided for each channel.
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	Monitor operation is unaffected by short circuits on recorder outputs.
Voltage Compliance (current output)	0 to +12 Vdc range across load Load resistance is 0 to 600 Ω .
Resolution	0.3662 μ A per bit $\pm 0.25\%$ error at room temperature $\pm 0.7\%$ error over temperature range Update rate 100 ms or less

Signal Conditioning



Specified at +25 °C (+77 °F) unless otherwise noted.

Hydro and Multimode Hydro Radial Vibration

Frequency Response

Direct filter	0.104 Hz to 500 Hz Rotor speed is 25 to 1,500 cpm.
Gap filter	-3 dB at 0.05 Hz
Not 1X filter	0.25 to 128 times rotor speed Constant Q notch filter Minimum rejection in stopband of -50 dB
1X and NX vector filter	Constant Q Filter Minimum rejection in stopband of -50 dB The N value in NX is selectable between 2 and 20 (for machine speeds of 25 cpm to 1,500cpm) or 2 to 50 (for machine speeds of 25 cpm to 600 cpm). 1X and NX vector, Not 1X and composite parameters are valid for machine speeds per selected NX value range.

Composite	NX amplitude multiplied by the percent change in gap from its zero position Specific for detecting Shear Pin failure
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Accuracy

Direct and Gap	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum
1X and NX	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ 1X maximum $\pm 3\%$ NX maximum
Not 1X	$\pm 1\%$ of full-scale typical $\pm 3\%$ maximum
Composite	$\pm 1\%$ of full-scale typical

Hydro Air Gap and Multimode Air Gap

Instantaneous Air Gap	Provides instantaneous gap measurements when the pole-passing rate slows to less than one pole/second
Average Air Gap	The monitor measures each pole gap and averages the values for all poles together over one revolution.
Minimum Air Gap	The minimum pole gap value in a revolution
Maximum Air Gap	The maximum pole gap value in a revolution
Min Air Gap Pole Number	The pole number detected with the minimum gap value in a revolution
Max Air Gap Pole Number	The pole number detected with the maximum gap value in a revolution All values except instantaneous Air Gap are valid when the poles passing rate is between 1 and 200 poles/second.

Accuracy	
Average Air Gap	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum
Minimum Air Gap	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum
Maximum Air Gap	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum

Hydro Velocity and Multimode Hydro Velocity

Frequency Response	
Bias	Low-pass filter Low Mode: -3dB at 0.02 Hz High Mode: -3dB at 0.07 Hz
Direct	Low Mode: 0.1875 to 343.75 Hz , -3dB High Mode: 0.75 to 1375 Hz , -3dB
1X and 2X vector filter	Constant Q Filter Minimum rejection in stopband of -51 dB Low Mode: Valid for machine speeds of 60 to $6,000\text{ cpm}$ High Mode: Valid for machine speeds of 60 to $24,600\text{ cpm}$

Filter Quality	
High-pass	4-pole (80 dB per decade, 24 dB per octave)
Low-pass	2-pole (40 dB per decade, 12 dB per octave)

Accuracy	
Direct	Within $\pm 1\%$ of full-scale typical $\pm 2\%$ maximum Exclusive of filters

1X Amplitude	Within $\pm 1\%$ of full-scale typical $\pm 2\%$ maximum Exclusive of filters
2X Amplitude	Within $\pm 1\%$ of full-scale typical $\pm 2\%$ maximum Exclusive of filters

Hydro Thrust and Multimode Thrust

Frequency Response	
Direct filter	-3dB at 1.2 Hz
Gap filter	-3dB at 0.41 Hz
Accuracy	
Direct	Within $\pm 0.33\%$ of full-scale typical $\pm 1\%$ maximum

Hydro Acceleration and Multimode Acceleration

Frequency Response	
Bias filter	Low-pass filter -3dB at 0.01 Hz
Not OK filter	Low-pass filter -3dB at 2400 Hz
1X and 2X vector filter	Constant Q Filter Minimum rejection in stopband of -51 dB Valid for machine speeds of 60 cpm to $60,000\text{ cpm}$ See Frequency Ranges - Multimode Acceleration Channel on the next page.

Filter Quality	
High pass	4-pole (80 dB per decade, 24 dB per octave)
Low pass	4-pole (80 dB per decade, 24 dB per octave)

Direct	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum Exclusive of filters
1X Amplitude	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum Exclusive of filters
2X Amplitude	Within $\pm 0.33\%$ of full scale typical $\pm 1\%$ maximum Exclusive of filters

Hydro Stator End Winding (SEW)

Frequency Response	
Direct	5.0 Hz to 800 Hz (-3dB corners)
Bias voltage	DC to 0.05 Hz (-3dB)
Pole Pass Amplitude	2x line frequency (100 Hz or 120 Hz) Constant Q filter ($Q=20$) Minimum rejection in stop band of -60 dB
Direct Resultant	5.0 Hz to 800 Hz (-3dB corners) Resultant of both X and Y axis inputs
Pole Pass Resultant	2x line frequency (100 Hz or 120 Hz) Constant Q filter ($Q=20$) Minimum rejection in stop band of -60 dB Resultant of both X and Y axis inputs

Accuracy	
Direct	$\pm 1\%$ of Full Scale maximum
Bias voltage	$\pm 1\%$ of Full Scale maximum
Pole Pass Amplitude	$\pm 2\%$ of full-scale typical $\pm 3\%$ maximum

Direct Resultant	$\pm 1\%$ of full-scale typical $\pm 2\%$ maximum
Pole Pass Resultant	$\pm 2\%$ of full-scale typical $\pm 3\%$ maximum

Multimode Hydro Dynamic Pressure

Frequency Response	
Low mode	0.1875 Hz to 343.7500 Hz
High mode	0.75 Hz to 1375.00 Hz
Filter Quality	
High pass	4-pole (80 dB per decade, 24 dB per octave)
Low pass	4-pole (80 dB per decade, 24 dB per octave)
Accuracy	
Peak Direct amplitud	$\pm 1\%$ of Full Scale maximum
RMS Direct amplitude	$\pm 2\%$ of Full Scale maximum
Static Pressure	$\pm 0.87\%$ of Full Scale maximum

Frequency Ranges - Multimode Acceleration Channel

The following table lists the frequency ranges for the monitor under different options using the Multimode Acceleration Channel type:

Output Type	Non-Integrated (Hz)	Integrated (Hz)
RMS	10 to 30,000	10 to 20,000
Peak	3 to 30,000	3 to 20,000

Physical

Monitor Module (Main Board)

Dimensions (Height x Width x Depth)	241.3 mm x 24.4 mm x 241.8 mm (9.50 in x 0.96 in x 9.52 in)
Weight	0.91 kg (2.0 lb)

I/O Modules

Dimensions (Height x Width x Depth)	241.3 mm x 24.4 mm x 99.1 mm (9.50 in x 0.96 in x 3.90 in)
Weight	0.20 kg (0.44 lb)

Rack Space Requirements

Monitor Module	1 full-height front slot
I/O Modules	1 full-height rear slot

Alarms

Alarm setpoints	Use Rack Configuration Software to set alert levels for each value measured by the monitor and danger setpoints for any two of the values measured by the monitor. Alarms are adjustable from 0 to 100% of full-scale for each measured value except when the full-scale range exceeds the range of the transducer. In this case, the range of the transducer will limit the setpoint.
Alarm accuracy	Within 0.13% of the desired value
Hydro Radial Vibration	Direct Gap Not 1X Amplitude 1X Amplitude

	NX Amplitude Composite 1X Phase Lag NX Phase Lag
Multimode Hydro RV	Direct Gap Not 1X Amplitude 1X Amplitude NX Amplitude Composite 1X Phase Lag
Hydro Air Gap and Multimode Air Gap	Average Air Gap Minimum Air Gap
Hydro Velocity and Multimode Hydro Velocity	Direct 1X Amplitude 2X Amplitude 1X Phase Lag 2X Phase Lag
Hydro Thrust and Multimode Thrust	Direct Gap
Hydro Acceleration and Multimode Acceleration	Direct 1X Amplitude 2X Amplitude 1X Phase Lag 2X Phase Lag
Hydro Stator End Winding (SEW)	Direct Pole Pass Amplitude Direct Resultant Pole Pass Resultant
Multimode Hydro Dynamic Pressure	Direct Static Pressure 1X Amplitude 2X Amplitude 1X Phase Lag 2X Phase Lag

Alarm Time Delays



You can program alarm delays using **Rack Configuration Software.**

Alert	From 1 to 400 seconds in one
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	second intervals
Danger	From 1 to 400 seconds in one second intervals
Multimode channels	You can set delays for each measured value that has alarm set points.
Standard channels	You can set one alert and danger delay for the channel.

3500/46M Hydro Monitor Measured Variables

Measured variables are used to monitor the machine. The 3500/46M provides the following measured variables:

Hydro Radial Vibration	Direct Gap 1X Amplitude 1X Phase Lag NX Amplitude NX Phase Lag Not 1X Amplitude Composite Amplitude
Multimode Hydro RV	Direct Gap 1X Amplitude 1X Phase Lag NX Amplitude Not 1X Amplitude Composite Amplitude Mode
Hydro Air Gap	Average Air Gap Instantaneous Air Gap Minimum Air Gap Maximum Air Gap Minimum Air Gap Pole Number Maximum Air Gap Pole Number
Multimode Air Gap	Average Air Gap Instantaneous Air Gap Minimum Air Gap Maximum Air Gap Minimum Air Gap Pole Number Maximum Air Gap Pole Number Mode
Hydro Velocity	Direct Bias 1X Amplitude 1X Phase Lag 2X Amplitude 2X Phase Lag
Multimode	Direct

Hydro Velocity	Bias 1X Amplitude 1X Phase Lag 2X Amplitude 2X Phase Lag Mode
Hydro Thrust	Direct Gap
Multimode Thrust	Direct Gap Mode
Hydro Acceleration	Direct Bias 1X Amplitude 1X Phase Lag 2X Amplitude 2X Phase Lag
Multimode Acceleration	Direct Bias 1X Amplitude 1X Phase Lag 2X Amplitude 2X Phase Lag Mode
Hydro Stator End Winding (SEW)	Direct Bias Voltage Pole Pass Amplitude Direct Resultant Pole Pass Resultant
Multimode Hydro Dynamic Pressure	Direct Static Pressure 1X Amplitude 1X Phase Lag 2X Amplitude 2X Phase Lag Mode

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

RoHS

European Community Directive:

RoHS Directive 2011/65/EU

Maritime

ABS – Marine and Offshore Applications

DNV GL Rules for Classification – Ships, Offshore Units, and High Speed and Light Craft

Hazardous Area Approvals



For the detailed listing of country and product specific approvals, refer to the *Approvals Quick Reference Guide* (108M1756) available from Bently.com.

CSA/NRTL/C

Class I, Zone 2: AEx/Ex nA nC ic IIC T4 Gc;

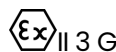
Class I, Zone 2: AEx/Ex ec nC ic IIC T4 Gc;

Class I, Division 2, Groups A, B, C, and D;

T4 @ Ta= -20°C to +65°C (-4°F to +149°F)

When installed per drawing 149243 or 149244.

ATEX/IECEx



Ex nA nC ic IIC T4 Gc

Ex ec nC ic IIC T4/T5 Gc

T4 @ Ta= -20°C to +65°C (-4°F to +149°F)

When installed per drawing 149243 or 149244.

Ordering Considerations

The 3500/46M Hydro Monitor requires the following or later revisions of these firmware and software products:

Application	3500/46M Firmware Version	3500/01 Software Version	3500/02 Software Version	3500/03 Software Version
Hydro Radial Vibration	2.02	2.70	2.21	1.22
Hydro Air Gap	2.09	3.40	2.30	1.30
Hydro Velocity	2.10	3.70	2.50	1.50
Hydro Acceleration	2.40	4.40		
Hydro Thrust	2.40	4.40		
Multimode Hydro RV	2.40	3.80	2.51	1.51
Multimode Air Gap	2.40	3.80	2.51	1.51
Multimode Hydro Velocity	2.40	3.80	2.51	1.51
Multimode Thrust	2.40	3.80	2.51	1.51
Multimode Acceleration	2.40	3.80	2.51	1.51
Hydro Stator End Winding (SEW)	4.10	3.93	2.52	1.52
Multimode Hydro Dynamic Pressure	4.21	5.20		

Application	3500/46M Hardware	3500/22 Firmware	3500/92 Firmware	System 1
Multimode applications using hardware contacts to change monitor modes	Revision S Multimode I/O Modules			
Multimode applications using software commands to change monitor modes		1.32	1.16	
Multimode applications incorporating the 3500/94 display		1.60	2.30	
Applications requiring full multimode support from System 1 software		1.32		6.0

Other Requirements and Restrictions

A multimode recorder ET block must be used with an external termination multimode I/O module. To connect these components, you must use a signal cable, part number 129525. The ET block provides recorder outputs and mode inputs.



External Termination Blocks cannot be used with Internal Termination I/O Modules.

When ordering I/O modules with External Terminations, the External Termination Blocks and cables must be ordered separately.

Ordering Information



For the detailed listing of country and product specific approvals, refer to the *Approvals Quick Reference Guide* (108M1756) available from [Bently.com](https://www.bentley.com).

Hydro Monitor 3500/46 – AA-BB

A: I/O Module Type

01	Prox/Velom I/O Module with Internal Terminations
02	Prox/Velom I/O Module with External Terminations
03	Multimode Prox/Velom I/O Module with Internal Terminations
04	Multimode Prox/Velom I/O Module with External Terminations
05	Multimode Positive Input I/O Module with Internal Terminations
06	Multimode Positive Input I/O Module with External Terminations

B: Hazardous Area Approval Option

00	None
01	CSA/NRTL/C (Class 1, Division 2)
02	ATEX/IECEX/CSA (Class 1, Zone 2)

External Termination Blocks

125808-08	Prox/Velom External Termination Block Euro Style connectors
125808-11	Multimode Prox/Velom External Termination Block Euro Style connectors
125808-12	Multimode Positive Input External Termination Block Euro Style connectors

125808-13	Multimode Recorder Output and Mode Input External Termination Block Euro Style connectors
128702-01	Recorder External Termination Block Euro Style connectors
128015-08	Prox/Velom External Termination Block Terminal Strip Connectors
128015-11	Multimode Prox/Velom External Termination Block Terminal Strip connectors
128015-12	Multimode Positive Input External Termination Block Terminal Strip connectors
128015-13	Multimode Recorder Output and Mode Input External Termination Block Terminal Strip connectors
128710-01	Recorder External ET Block Terminal Strip connectors

Cables

3500 Transducer (XDCR) to External Termination (ET) Block Cable 129525 – AAAA-BB

A: I/O Cable Length

0005	5 feet (1.5 metres)
0007	7 feet (2.1 metres)
0010	10 feet (3.0 metres)
0025	25 feet (7.6 metres)
0050	50 feet (15.2 metres)
0100	100 feet (30.5 metres)

B: Assembly Instructions

01	Not Assembled
02	Assembled

3500 Recorder Output to External Termination (ET) Block Cable (Non-Multimode) 129529 - AAAA-BB

A: I/O Cable Length

0005	5 feet (1.5 metres)
0007	7 feet (2.1 metres)
0010	10 feet (3.0 metres)
0025	25 feet (7.6 metres)
0050	50 feet (15.2 metres)
0100	100 feet (30.5 metres)

B: Assembly Instructions

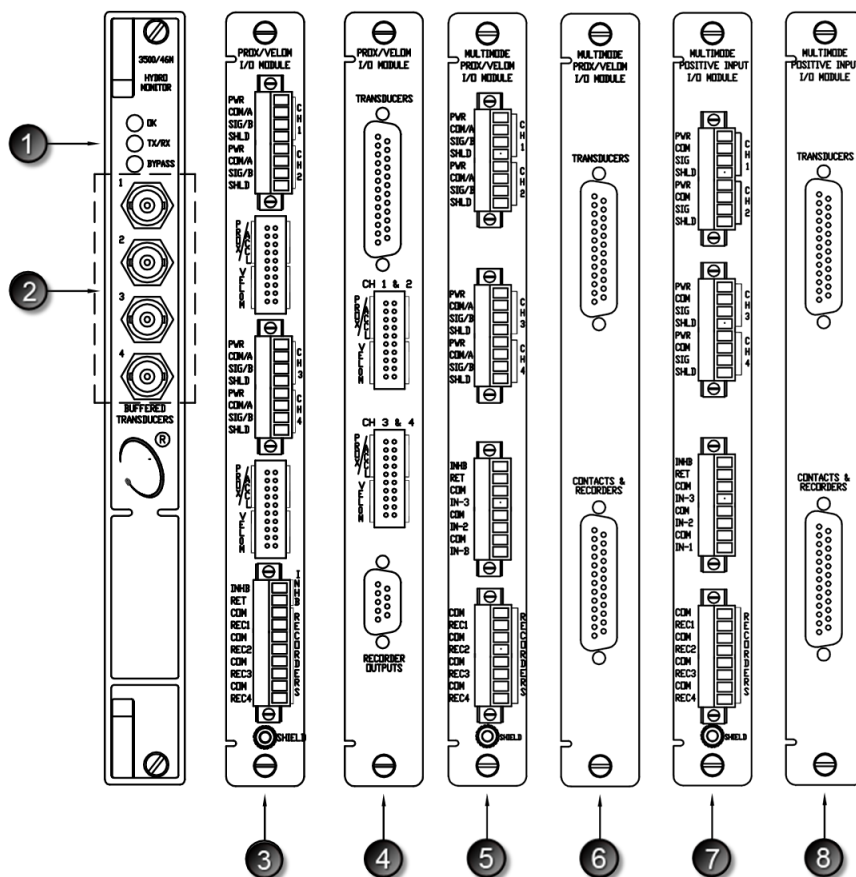
01	Not Assembled
02	Assembled

	Terminations
00561941	Prox/Velom and Multimode Prox/Velom I/O Module ten-pin connector shunt
00580434	Euro Style connector header 8 pin For use on I/O modules with internal terminations
00580432	Euro Style connector header 10 pin For use on I/O modules with internal terminations

Spares

176449-06	3500/46M Hydro Monitor
144403-01	3500/46M Hydro Monitor User Guide
140471-01	Prox/Velom I/O Module with Internal Terminations
140482-01	Prox/Velom I/O Module with External Terminations
169459-01	Multimode Prox/Velom I/O Module with Internal Terminations
169459-02	Multimode Prox/Velom I/O Module with External Terminations
169715-01	Multimode Positive Input I/O Module with Internal Terminations
169715-02	Multimode Positive Input I/O Module with External

Graphs and Figures



1. Status LEDs
2. Buffered Transducer Outputs
3. Prox/Velom I/O Module with Internal Terminations
4. Prox/Velom I/O Module with External Terminations
5. Multimode Prox/Velom I/O Module with Internal Terminations
6. Multimode Prox/Velom I/O Module with External Terminations
7. Multimode Positive Input I/O Module with Internal Terminations
8. Multimode Positive Input I/O Module with External Terminations

Figure 1: Front and Rear Views of the 3500/46M Hydro Monitor