

# 3500/46M Hydro Monitor

## Datasheet

Bently Nevada Machinery Condition Monitoring

144408 Rev. AA



## 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 kΩ

#### Input Impedance

Prox/Velom I/O and Multimode Prox/Velom I/O	10 kΩ for Prox/Accel 3.5 MΩ for Velomitor
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### Sensitivity

Hydro Radial Vibration and Multimode Hydro RV	0.79 mV/μm (20 mV/mil), 3.94 mV/μm (100 mV/mil) or 7.87 mV/μm (200 mV/mil)
Hydro Air Gap and Multimode Air Gap	0.20 mV/μm (5 mV/mil), 0.22 mV/μm (5.6 mV/mil), 0.49 mV/μm (12.5 mV/mil) or 0.55 mV/μm (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/μm (100 mV/mil), 7.87 mV/μm (200 mV/mil) or 11.22 mV/μm (285 mV/mil)
Hydro Acceleration and Multimode Acceleration	1.02 mV/m/s <sup>2</sup> (10 mV/g) or 2.55 mV/m/s <sup>2</sup> (25 mV/g)

Hydro SEW	10.19 mV/m/s <sup>2</sup> (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.  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 μA per bit ±0.25% error at room temperature  ±0.7% error over temperature range  Update rate 100 ms or less

IX 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). IX and NX vector, Not IX 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

Accuracy	
Direct and Gap	Within ±0.33% of full-scale typical ±1% maximum
IX and NX	Within ±0.33% of full-scale typical ±1% IX maximum ±3% NX maximum
Not IX	±1% of full-scale typical ±3% maximum
Composite	±1% of full-scale typical

## 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 IX filter	0.25 to 128 times rotor speed Constant Q notch filter Minimum rejection in stopband of -50 dB

## 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 ±0.33% of full scale typical ±1% maximum
Minimum Air Gap	Within ±0.33% of full scale typical ±1% maximum
Maximum Air Gap	Within ±0.33% of full scale typical ±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 cpm High Mode: Valid for machine speeds of 60 to 24,600 cpm
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**Filter Quality**

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

**Accuracy**

Direct	Within ±1% of full-scale typical ±2% maximum Exclusive of filters
1X Amplitude	Within ±1% of full-scale typical ±2% maximum Exclusive of filters
2X Amplitude	Within ±1% of full-scale typical ±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 ±0.33% of full-scale typical ±1% maximum
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## 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 cpm  <a href="#">See Frequency Ranges - Multimode Acceleration Channel on the next page.</a>

### Filter Quality

High pass	4-pole (80 dB per decade, 24dB per octave)
Low pass	4-pole (80 dB per decade, 24dB per octave)
Direct	Within ±0.33% of full scale typical ±1% maximum Exclusive of filters
1X Amplitude	Within ±0.33% of full scale typical ±1% maximum Exclusive of filters
2X Amplitude	Within ±0.33% of full scale typical ±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	±1% of Full Scale maximum
Bias voltage	±1% of Full Scale maximum
Pole Pass Amplitude	±2% of full-scale typical ±3% maximum
Direct Resultant	±1% of full-scale typical ±2% maximum
Pole Pass Resultant	±2% of full-scale typical ±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 amplitude	±1% of Full Scale maximum
RMS Direct amplitude	±2% of Full Scale maximum
Static Pressure	±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 24.8 mm (9.50 in x 0.96 in x 0.97 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 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 Hydro Velocity	Direct 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 (Approvals Pending)

### 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

### Cyber Security

Designed to meet IEC 62443

### Maritime

DNV GL rules for classification – Ships, offshore units, and high speed and light

craft

ABS Rules for Condition of Classification, Part 1

- Steel Vessels Rules
- Offshore Units and Structures

### Functional Safety

SIL 2

### 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](http://Bently.com).

### cNRTLus

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

II 3 G

Ex nA nC ic IIC T4 Gc  
Ex ec nC ic IIC T4 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](http://Bently.com).

### Hydro Monitor 3500/46 - AA-BB

#### A: I/O Module Type

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

#### B: Hazardous Area Approval Option

<b>00</b>	None
<b>01</b>	cNRTLus (Class 1, Division 2)
<b>02</b>	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

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

#### B: Assembly Instructions

<b>01</b>	Not Assembled
<b>02</b>	Assembled

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

**A: I/O Cable Length**

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

**B: Assembly Instructions**

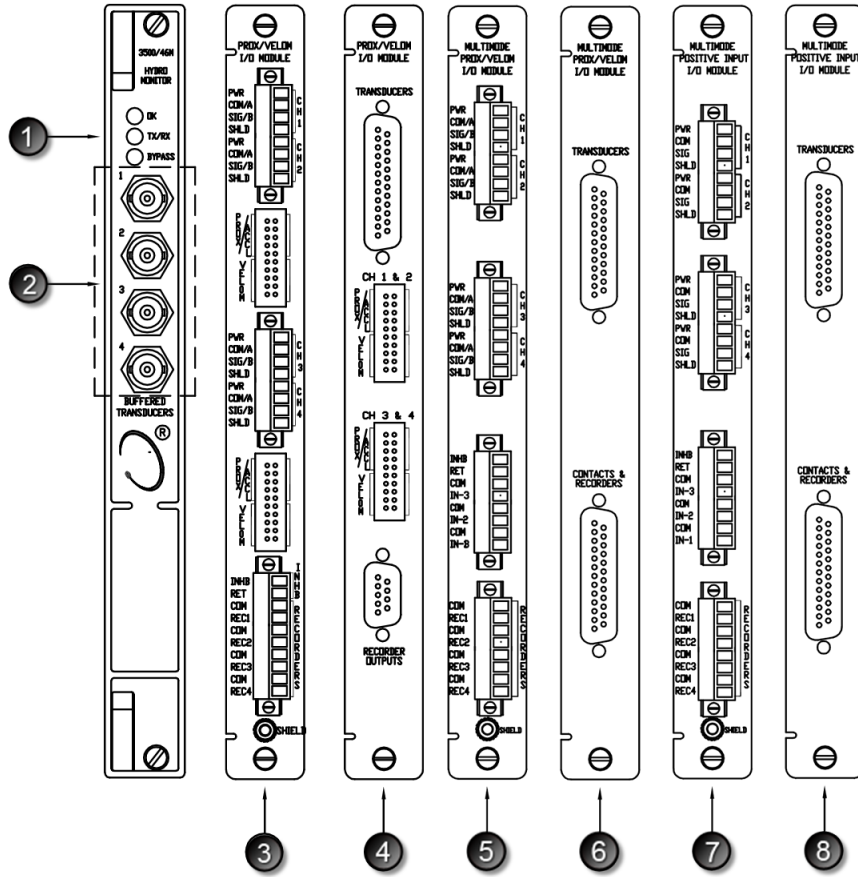
<b>01</b>	Not Assembled
<b>02</b>	Assembled

169715-02	Multimode Positive Input I/O Module with External 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
166M2389	Connector header Push-in-spring type (Alternative for PN 00580434)
166M2388	Connector header Push-in-spring type (Alternative for PN 00580432)

**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

## 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**

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