3500/46M Hydro Monitor

Bently Nevada* Asset Condition Monitoring

Description

The 3500/46M Hydro Monitor is a 4-channel monitor that accepts input from proximity, seismic and air gap sensors. The monitor conditions the signal to provide various vibration and position measurements, and 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. The user can program each channel of the 3500/46M using the 3500 Rack Configuration Software to perform any of the following functions:

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

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

The purpose of the 3500/46M monitor is to provide:

1. Machinery protection by continuously comparing monitored parameters against configured alarm set points to drive alarms.
2. Essential machine management information for both operations and maintenance personnel.

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

Each channel, depending on configuration, typically conditions its input signal into various parameters called “proportional values”. The user can configure Alert set points for various active proportional values and Danger set points for up to two active proportional values.

The user can configure multimode channels to have up to eight sets of alarm parameters (Alert and Danger set points and alarm time delays). The configuration of each set can be for a specific machine mode, and the monitor can switch to a specific set as the machine changes modes. This is done via contacts on multimode I/O modules or by software commands through a communications gateway.

Specifications

Inputs

Inputs

Signal

Accepts 1 to 4 proximity, air gap, velocity or acceleration sensor signals.

Input Impedance

Prox/Velom I/O and Multimode Prox/Velom I/O

10kΩ for Prox/Accel.

3.5MΩ for Velomitor.

Multimode Positive Input I/O

50kΩ.

Power Consumption

7.7 watts, typical.

Sensitivity

Hydro Radial Vibration and Multimode Hydro RV:

0.79mV/µm (20mV/mil) or

3.94mV/µm (100mV/mil) or

7.87mV/µm (200mV/mil).

Hydro Air Gap and Multimode Air Gap

0.20mV/µm (5mV/mil) or

0.22mV/µm (5.6mV/mil) or

0.49mV/µm (12.5mV/mil) or

0.55mV/µm (14mV/mil).

Hydro Velocity and Multimode Hydro Velocity:

20mV/mm/s (508mV/in/s).

Multimode Thrust

3.94mV/µm (100mV/mil) or

7.87mV/µm (200mV/mil) or

11.22mV/µm (285mV/mil).

Multimode Acceleration

1.02mV/m/s^2 (10mV/g) or

2.55mV/m/s^2 (25mV/g) or

Hydro SEW

10.19mV/m/s^2 (100mV/g)

Outputs

Front Panel LEDs

OK LED

Indicates when the 3500/46M is operating properly.

TX/RX LED

Indicates when the 3500/46M is communicating with other modules in the 3500 rack.

Bypass LED

Indicates when the 3500/46M 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

550Ω.

Transducer Power Supply

Prox/Velom I/O and Multimode Prox/Velom I/O

-23Vdc nominal at 43 mA max.

Multimode Positive Input I/O

+23Vdc nominal at 23mA max.

Recorder

+4 to +20mA. 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 +12Vdc range across load. Load resistance is 0 to 600Ω.

Resolution

0.3662µA per bit

±0.25% error at room temperature ±0.7% error over temperature.

Update rate is 100ms or less.

Signal Conditioning

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

Hydro Radial Vibration and Multimode Hydro RV Frequency Response

Direct filter

0.25X rotor speed to 500Hz.

Rotor speed is 25 to 1,500cpm.

Gap filter

-3 dB at 0.05Hz.

Not 1X filter

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

1X and NX Vector filter

Constant Q Filter. Minimum rejection in stopband of –50dB. The N value in NX may be set between 2 and 20.

Note: 1X & NX Vector, Not 1X and Composite parameters are valid for machine speeds of 25 cpm to 1,500 cpm.

Composite

NX amplitude multiplied by the percent change in gap from its zero position. Specific for detecting “Shear Pin” failure.

Hydro Radial Vibration and Multimode Hydro RV

Direct and Gap

Within ±0.33% of full-scale typical, ±1% maximum.

1X and NX

Within ±0.33% of full-scale typical, ±1% 1X maximum.

±3% NX maximum.

Not 1X

±1% of full-scale typical.

±3% maximum.

Composite

±1% of full-scale typical.

Hydro Air Gap and Multimode Air Gap Description

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.

Note: All values except Instantaneous Air Gap are valid when the poles passing rate is between 1 and 200 poles/second.

Hydro Air Gap and Multimode Air Gap Accuracy

Average Air Gap, Minimum Air Gap, 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 –51dB.

Low Mode: Valid for machine speeds of 60 to 6,000cpm.

High Mode: Valid for machine speeds of 60 to 24,600cpm.

Hydro Velocity and Multimode Hydro Velocity Filter Quality

High-pass

4-pole (80dB per decade, 24dB per octave).

Low-pass

2-pole (40dB per decade, 12dB per octave).

Hydro Velocity and Multimode Hydro Velocity Accuracy

Direct, 1X Amplitude, 2X Amplitude

Within ±1% of full-scale typical, ±2% maximum. Exclusive of filters.

Multimode Thrust Frequency Response

Direct filter

-3dB at 1.2Hz.

Gap filter

-3dB at 0.41Hz.

Multimode Thrust

Accuracy

Direct

Within ±0.33% of full-scale typical, ±1% maximum.

Multimode Acceleration Frequency Response

Bias filter

Low-pass filter. -3dB at 0.01Hz.

Not OK filter

Low-pass filter. -3dB at 2400Hz.

1X & 2X Vector filter

Constant Q Filter. Minimum rejection in stopband of –51dB.

Valid for machine speeds of 60cpm to 60,000cpm.

The following table represents 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	10 to 20,000

Multimode Acceleration Filter Quality

High-pass

4-pole (80dB per decade, 24dB per octave).

Low-pass

4-pole (80dB per decade, 24dB per octave).

Multimode Acceleration

Direct, 1X Amplitude, 2X Amplitude

Within ±0.33% of full scale typical, ±1% maximum. Exclusive of filters.

Hydro SEW

Frequency Response

Direct

5.0Hz to 800Hz (-3dB corners)

Bias Voltage

DC to 0.05Hz (-3dB)

Pole Pass Amplitude

2x line frequency (100Hz or 120Hz). Constant Q filter (Q=20). Minimum rejection in stop band of -60dB

Direct Resultant

5.0Hz to 800Hz (-3dB corners). Resultant of both X and Y axis inputs.

Pole Pass Resultant

2x line frequency (100Hz or 120Hz). Constant Q filter (Q=20). Minimum rejection in stop band of -60dB. 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.

Alarms

Alarm Setpoints

The user can set Alert levels for various values measured by the monitor and Danger set points for up to two of the values measured by the monitor using configuration software. Alarms are adjustable from 0 to 100% of full-scale for each measured value. The exception is when the full-scale range exceeds the range of the transducer. In this case, the range of the transducer will limit the set point of the transducer. Accuracy of alarms are to 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.

Multimode Thrust

Direct, Gap.

Multimode Acceleration

Direct, 1X Amplitude, 2X Amplitude, 1X Phase Lag, 2X Phase Lag.

Hydro SEW

Direct, Pole Pass Amplitude, Direct Resultant, Pole Pass Resultant.

Alarm Time Delays

The user can program Alarm delays using software. For multimode channels, the user can set delays for each proportional value having alarm set points. For standard channels, the user sets one alert and danger delay for the channel.

Alert

From 1 to 400 seconds, in 1 second intervals.

Danger

From 1 to 400 seconds, in 1 second intervals.

Proportional Values

Proportional values are measurements used to monitor the machine. The 3500/46M Monitor provides the following proportional values:

Hydro Radial Vibration

Direct, Gap, 1X Amplitude, 1X Phase Lag, NX Amplitude, NX Phase Lag, Not 1X Amplitude, and Composite Amplitude.

Multimode Hydro RV

Direct, Gap, 1X Amplitude, 1X Phase Lag, NX Amplitude, Not 1X Amplitude, Composite Amplitude, and 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, and Mode.

Hydro Velocity

Direct, Bias, 1X Amplitude, 1X Phase Lag, 2X Amplitude, and 2X Phase Lag.

Multimode Hydro Velocity

Direct, Bias, 1X Amplitude, 1X Phase Lag, 2X Amplitude, 2X Phase Lag and Mode.

Multimode Thrust

Direct, Gap and Mode.

Multimode Acceleration

Direct, Bias, 1X Amplitude, 1X Phase Lag, 2X Amplitude, 2X Phase Lag and Mode.

Hydro SEW

Direct, Bias Voltage, Pole Pass Amplitude, Direct Resultant, and Pole Pass Resultant.

Environmental Limits

Operating Temperature

-30 °C to +65 °C (-22 °F to +150 °F).

Storage Temperature

-40 °C to +85 °C (-40 °F to +185 °F).

Humidity

95%, noncondensing.

CE Mark Directives

Declaration of Conformity

134036

EMC Directives

EN61000-6-4

Radiated Emissions

EN 55011, Class A

Conducted Emissions

EN 55011, Class A

EN6100-6-2

Electrostatic Discharge

EN 61000-4-2, Criteria B

Radiated Susceptibility

EN61000-4-3, Criteria A

Conducted Susceptibility

EN61000-4-6, Criteria A

Radiated Susceptibility

ENV 50140, Criteria A

Conducted Susceptibility

ENV 50141, Criteria A

Electrical Fast Transient

EN 61000-4-4, Criteria B

Surge Capability

EN 61000-4-5, Criteria B

Magnetic Field

EN 61000-4-8, Criteria A

Power Supply Dip

EN 61000-4-11, Criteria B

Radio Telephone

ENV 50204, Criteria B

Low Voltage Directives

EN 61010-1

Safety Requirements

Hazardous Area Approvals

CSA/NRTL/C
Approval Option (01)

Class I, Div. 2

Groups A, B, C, D

T4 @ Ta = -20 °C to +65 °C

(-4 °F to +150 °F)

Approval Option (02)

When used with I/O module ordering options without internal barriers:

A/Ex nC[L] IIC
Class I, Zone 2
Class I, Div 2, Groups A,B,C,D
T4 @ Ta = -20 °C to +65 °C
(-4 °F to +150 °F)

ATEX
Approval Option (02)

For Selected Ordering Options with ATEX/CSA agency approvals:

II 3/(3) G

Ex nC[L] IIC
T4 @ Ta = -20 °C to +65 °C
(-4 °F to +150 °F)

Brazil
Approval Option (02)

For Selected Ordering Options with ATEX/North American agency approvals:

BR-Ex nC [nL] IIC T4
T4 @ Ta = -20 °C to +65 °C
(-4 °F to +150 °F)

For further certification and approvals information please visit the following website:

www.ge-mcs.com/bently

Physical

Monitor Module

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 Module

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.

Ordering Considerations

General

The 3500/46M Module requires the following (or later) firmware, and software revisions:

Hydro Radial Vibration Applications

3500/46M Module Firmware – Version 2.02

3500/01 Software – Version 2.70

3500/02 Software – Version 2.21

3500/03 Software – Version 1.22

Hydro Air Gap Applications

3500/46M Module Firmware – Version 2.09

3500/01 Software – Version 3.40

3500/02 Software – Version 2.30

3500/03 Software – Version 1.30

Hydro Velocity Applications

3500/46M Module Firmware – Version 2.10

3500/01 Software – Version 3.70

3500/02 Software – Version 2.50

3500/03 Software – Version 1.50

Multimode Applications

For Hydro RV, Air Gap, Hydro Velocity, Thrust, and Acceleration applications:

3500/46M Module Firmware – Version 2.40

3500/01 Software – Version 3.80

3500/02 Software – Version 2.51

3500/03 Software – Version 1.51

Multimode applications that will use hardware contacts to change monitor modes require:

3500/46M Module Hardware – Revision S Multimode I/O modules.

Multimode applications that will use software commands to change monitor modes require:

3500/22 Module Firmware – Version 1.32

3500/92 Module Firmware – Version 1.16

Multimode applications incorporating the 3500/94 Display require:

3500/22 Module Firmware – Version 1.60

3500/94 Module Firmware – Version 2.30

Applications that require full multimode support from System1 require:

System1® Software – Version 6.0

3500/22 Module Firmware – Version 1.32

A multimode recorder ET block must be used with an external termination multimode I/O module, and a 129525 signal cable is used to connect these components. 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.

Hydro SEW Applications

3500/46M Module Firmware – Revision 4.10

3500/01 Software – Version 3.93

3500/02 Software – Version 2.52

3500/03 Software – Version 1.52

Ordering Information

Hydro Monitor

3500/46-AXX-BXX

A: I/O Module Type

0 1	Prox/Velom I/O Module with Internal Terminations
0 2	Prox/Velom I/O Module with External Terminations
0 3	Multimode Prox/Velom I/O Module with Internal Terminations
0 4	Multimode Prox/Velom I/O Module with External Terminations
0 5	Multimode Positive Input I/O Module with Internal Terminations
0 6	Multimode Positive Input I/O Module with External Terminations

B: Agency Approval Option

0 0	None
0 1	CSA/NRTL/C
0 2	ATEX/CSA (Class 1, Zone 2)

Note: Agency Approval Option B 02 is only available with Ordering Options A 01, A 03, A 04, A 05, and A 06.

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 Termination Block (Terminal Strip connectors).

External Termination Cables

Transducer (XCDR) to External Termination (ET) Block Cable

129525-AXXXX-BXX

A: Cable Length

0 0 0 5 5 feet (1.5 metres)
0 0 0 7 7 feet (2.1 metres)
0 0 1 0 10 feet (3 metres)
0 0 2 5 25 feet (7.5 metres)
0 0 5 0 50 feet (15 metres)
0 1 0 0 100 feet (30.5 metres)

B: Assembly Instructions

0 1 Not assembled.
0 2 Assembled.

Recorder Output to External Termination (ET) Block Cable (Non-Multimode)

129529-AXXXX-BXX

A: Cable Length

0 0 0 5 5 feet (1.5 metres)
0 0 0 7 7 feet (2.1 metres)
0 0 1 0 10 feet (3 metres)
0 0 2 5 25 feet (7.5 metres)
0 0 5 0 50 feet (15 metres)
0 1 0 0 100 feet (30.5 metres)

B: Assembly Instructions

0 1 Not assembled.
0 2 Assembled.

Spares

176449-06

3500/46M Hydro Monitor.

144403-01

3500/46M Monitor Manual.

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 Terminations.

00561941

Prox/Velom and Multimode Prox/Velom I/O Module ten-pin connector shunt.

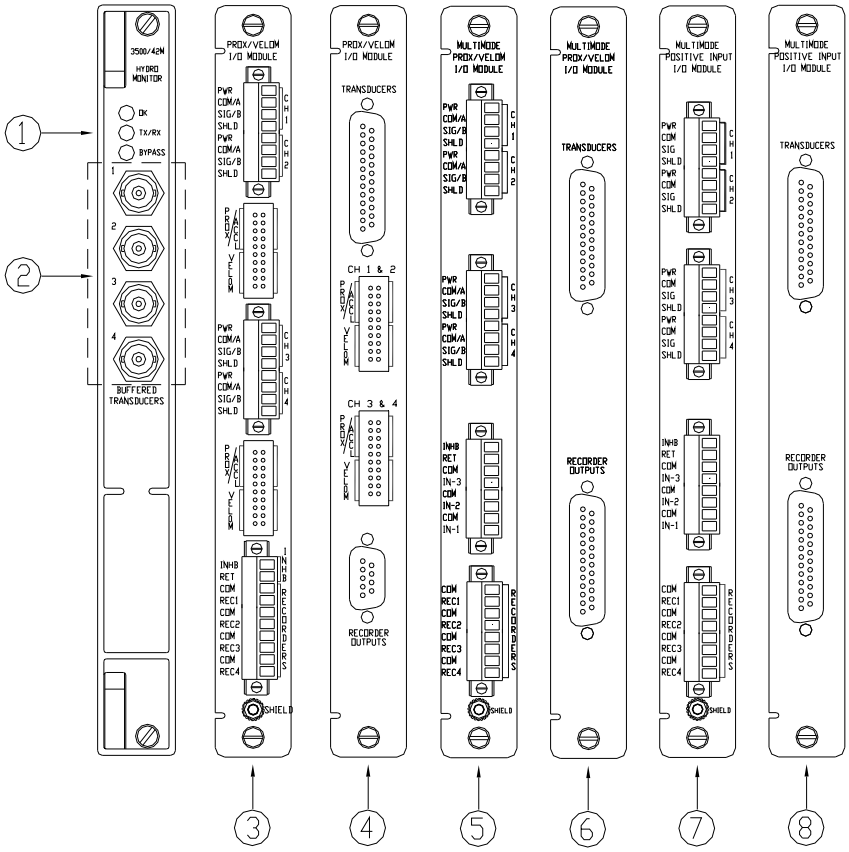
00580434

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.

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 view of the Hydro Monitor

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