

# 2019

## Bently Nevada 3500/45 Datasheet



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# 3500/45 Position Monitor

Bently Nevada™ Asset Condition Monitoring

## Description

The 3500/45 Position Monitor is a 4-channel monitor that accepts input from proximity transducers, Rotary Position Transducers (RPTs), DC Linear Variable Differential Transformers (DC LVDTs), AC Linear Variable Differential Transformers (AC LVDTs), and rotary potentiometers.

**Note:** The type of measurement to be made and the associated transducer input will dictate which Input / Output (I/O) Module is required. See Table 1 and Figures 1 and 2.

It conditions these inputs and compares the conditioned signals with user-programmable alarms. The 3500 Configuration Software can program each channel of the 3500/45 to perform any of the following functions:

- Axial (thrust) Position
- Differential Expansion
- Standard Single Ramp Differential Expansion
- Non-standard Single Ramp Differential Expansion
- Dual Ramp Differential Expansion
- Complementary Differential Expansion
- Case Expansion
- Valve Position

**Note:** The monitor channels are programmed in pairs and can perform up to two of these functions at a time. Channels 1 and 2 can perform one function, while channels 3 and 4 perform another (or the same) function. However, only channels 3 and 4 can perform Case Expansion.

The primary purpose of the 3500/45 monitor is to provide:

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

Each channel, depending on configuration, typically conditions its input signal into various parameters called "proportional values". Alert setpoints can be configured for each active proportional value and Danger setpoints can be configured for any two of the active proportional values.



Specifications and Ordering Information  
Part Number 141537-01  
Rev. C (11/08)

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## Specifications

### Inputs

#### Signal:

Accepts 1 to 4 signal inputs.

#### Input

#### Impedance:

1M  $\Omega$  (DC LVDT inputs);  
10K  $\Omega$  (Proximitor® or RPT inputs);  
137K  $\Omega$  (AC LVDT inputs);  
200K  $\Omega$  (Rotary Potentiometer inputs).

### Power

#### Consumption:

7.7 watts, typical, using Position I/O;  
8.5 watts typical, using AC LVDT I/O; or  
5.6 watts typical, using Rotary Potentiometer I/O.

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### Sensitivity

#### Thrust:

3.937 mV/mm (100 mV/mil) or  
7.874 mV/mm (200 mV/mil).

#### Differential Expansion:

0.394 V/mm (10 mV/mil) or  
0.787 V/mm (20 mV/mil).

#### Ramp

#### Differential Expansion:

0.394 V/mm (10 mV/mil) or  
0.787 V/mm (20 mV/mil) or  
3.937 V/mm (100 mV/mil) or  
7.874 V/mm (200 mV/mil).

### Complementary

#### Input

#### Differential Expansion:

0.394 V/mm (10 mV/mil) or

0.787 V/mm (20 mV/mil) or

3.937 V/mm (100 mV/mil).

#### DC LVDT Case Expansion:

0.05 V/mm (1.25 V/in) or  
0.08 V/mm (1.90 V/in) or  
0.10 V/mm (2.50 V/in) or  
0.18 V/mm (4.50 V/in) or  
0.20 V/mm (5.00 V/in) or  
0.22 V/mm (5.70 V/in)

#### AC LVDT Case Expansion:

28.74 mV/V/mm (0.73 mV/V/mil)  
or 15.35 mV/V/mm (0.39 mV/V/mil) or 9.45 mV/V/mm (0.24 mV/V/mil)

#### AC LVDT Valve Position:

28.74 mV/V/mm (0.73 mV/V/mil)  
or 15.35 mV/V/mm (0.39 mV/V/mil) or 9.45 mV/V/mm (0.24 mV/V/mil) or 10.24 mV/V/mm (0.26 mV/V/mil) or 7.48 mV/V/mm (0.19 mV/V/mil) or 5.51 mV/V/mm (0.14 mV/V/mil) or

3.94 mV/V/mm (0.10 mV/V/mil)  
or

3.15 mV/V/mm (0.08 mV/V/mil).

#### Rotary Potentiometer Valve Position:

41 mV/degree rotation.

#### Rotary Position Transducer (RPT) Valve Position:

140 mV/deg rotation or  
70 mV/deg rotation or  
50 mV/deg rotation.

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**Outputs****Front Panel LEDs:****OK LED**

Indicates when the 3500/45 is operating properly.

**TX/RX LED**

Indicates when the 3500/45 is communicating with other modules in the 3500 rack.

**Bypass LED**

Indicates when the 3500/45 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. When using DC LVDTs, channels 3 and 4 are level shifted by -10 Vdc. When using AC LVDT's, all channels are a DC representation of the AC signals returned by the LVDT.

**Output Impedance**

550  $\Omega$ .

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**Transducer Power Supply:****Proximitors or RPT**

-24 Vdc.

**DC LVDT**

+15 Vdc.

**AC LVDT**

2.3Vrms 3400Hz sine wave.

**Rotary Potentiometer**

-12.38 Vdc.

**Recorder**

+4 to +20 mA. Values are proportional to monitor full-scale. Individual recorder values are provided for each channel except Ramp and CIDE. 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  $\Omega$ .

**Resolution**

0.3662  $\mu$ A per bit  $\pm$  0.25% error at room temperature  $\pm$  0.7% error over temperature range; update rate 100 ms or less.

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**Signal Conditioning**

Specified at +25  $^{\circ}$ C (+77  $^{\circ}$ F).

**Thrust and Differential Expansion****Frequency Response***Direct Filter:*

-3 dB at 1.2 Hz.

*Gap Filter:*

-3 dB at 0.41 Hz.

*Accuracy*

Within  $\pm$  0.33% of full-scale typical,  $\pm$  1% maximum.

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**Ramp Differential Expansion****Frequency Response***Direct Filter:*

-3 dB at 1.2 Hz.

*Gap Filter:*

-3 dB at 0.41 Hz.

**Accuracy:**

See Table 2 which represents the accuracy of the composite proportional value as a function of the channel configuration.

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**Complimentary Input Differential Expansion (CIDE)**

**Frequency Response**

**Direct Filter:**

-3 dB at 1.2 Hz.

**Gap Filter:**

-3 dB at 0.41 Hz.

**Accuracy:**

Within  $\pm 0.33\%$  of full-scale typical,  $\pm 1\%$  maximum.

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**Case Expansion**

**Frequency Response**

**Direct Filter:**

-3 dB at 1.2 Hz.

**Position Filter:**

-3 dB at 0.41 Hz.

**Accuracy:**

Within  $\pm 0.33\%$  of full-scale typical,  $\pm 1\%$  maximum.

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**Valve Position**

**Frequency Response**

**Direct Filter:**

-3 dB at 1.2 Hz.

**Position Filter:**

-3 dB at 0.41 Hz.

**Accuracy:**

Within  $\pm 0.33\%$  of full-scale typical,  $\pm 1\%$  maximum.

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**Alarms**

**Alarm Setpoints:**

Alert levels can be set for each value measured by the monitor. In addition Danger setpoints can be set for any two of the values measured by the monitor. All alarm setpoints are set using software configuration. Alarms are adjustable and can normally be set from 0 to 100% of full-scale for each measured value. However, some setpoint limits are based on transducer type. In some cases the combination of full-scale range and zero position voltage can cause the full-scale or bottom scale voltage to exceed the setpoint limit. In this case the setpoint range is restricted and does not include the entire measurement range. Accuracy of alarms are within 0.13% of the desired value.

**Alarm Time Delays:**

Alarm delays can be programmed using software, and can be set as follows:

**Alert:**

From 1 to 60 seconds in 1 second intervals.

**Danger:**

(?) seconds or from 1 to 60 seconds in 1-second intervals.

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**Proportional Values**

Proportional values are position measurements used to monitor the machine. The Position Monitor returns the following proportional values depending on configuration:

**Thrust Position:**

Direct, Gap.

<b>Differential Expansion:</b>	Direct, Gap.	<b>EN61000-6-2</b> <i>Electrostatic Discharge</i>	
<b>Ramp Differential Expansion:</b>	Composite, Direct, Gap.	<i>Radiated Susceptibility</i>	EN 61000-4-2, Criteria B
<b>CIDE:</b>	Composite, Direct, Gap.	<i>Conducted Susceptibility</i>	EN61000-4-3, Criteria A
<b>Case Expansion:</b>	Composite, Direct and Position.	<i>Radiated Susceptibility</i>	EN61000-4-6, Criteria A
<b>Valve Position:</b>	Direct and Position.	<i>Conducted Susceptibility</i>	ENV 50140, Criteria A
<hr/>			
<b>Environmental Limits</b>			
<b>Operating Temperature:</b>	-30 °C to +65 °C (-22 °F to +150 °F)	<i>Electrical Fast Transient</i>	ENV 50141, Criteria A
<b>Storage Temperature:</b>	-40 °C to +85°C (-40 °F to +185 °F).	<i>Surge Capability</i>	EN 61000-4-4, Criteria B
<b>Humidity:</b>	95%, non-condensing.	<i>Magnetic Field</i>	EN 61000-4-5, Criteria B
<hr/>			
<b>CE Mark Directives</b>			
<b>EMC Directives</b>		<i>Power Supply Dip</i>	EN 61000-4-11, Criteria B
<b>Declaration of Conformity</b>	134036/EN61000-6-4	<i>Radio Telephone</i>	ENV 50204, Criteria B
<b>Radiated Emissions</b>	EN 55011, Class A	<b>CE Mark Low-Voltage Directives</b>	
<b>Conducted Emissions</b>	EN 55011, Class A	<b>Declaration of Conformity</b>	
		134036	
		<b>Safety Requirements</b>	
		EN6101001	

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## 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)

### Certification Number

CSA 150268-1002151 (LR  
26744)

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## 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 Modules:

#### Dimensions (Height x Width x Depth)

241.2 mm x 24.4 mm x 99.1 mm  
(9.50 in x 0.96 in x 3.90 in).

### Weight

0.45 kg (1.0 lb.).

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## Rack Space Requirements

### Monitor Module:

1 full-height front slot.

### I/O Modules:

1 full-height rear slot.

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## Ordering Information

### Position Monitor 3500/45-AXX-BXX

#### A: I/O Module

- 01** Position I/O Module with Internal Terminations (Proximito, RPT, DC LVDT)
- 02** Position I/O Module with External Terminations (Proximito, RPT, DC LVDT)
- 03** Discrete TMR Position I/O Module with External Terminations (Proximito or DC LVDT)
- 04** Bussed TMR Position I/O Module with External Terminations (Proximito)
- 05** AC LVDT Position I/O Module with Internal Terminations
- 06** AC LVDT Position I/O Module with External Terminations
- 07** Rotary Potentiometer Position I/O Module with Internal Terminations
- 08** Rotary Potentiometer Position I/O Module with External Terminations

#### Notes:

- 1.** When ordering I/O Modules with External Terminations the External Termination Blocks and Cables must be ordered separately for each I/O Module.
- 2.** When using the 3500/45 in a TMR application Valve Position measurements are not available and Case Expansion measurements are only supported for Discrete TMR.

#### B: Agency Approval Option

- 00** None
- 01** CSA/NRTL/C (Class 1, Div 2)

**Note:** If the 3500/45 is added to an existing 3500 System the following firmware and software versions (or later) are required:  
3500/20 RIM Firmware rev. G  
3500 Configuration Software 2.41 and  
3500 Data Acquisition 2.20  
3500 Operator Display 1.20  
3500/93 Display Interface Module  
135799-01  
Firmware rev G

For Valve Position using RPT must have 3500 Configuration Software 3.00 or greater

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## External Termination Blocks

132242-01

Prox/Seismic TMR I/O Bussed External Termination Block (Euro Style connectors) for Proximitor inputs.

132234-01

TMR I/O Busses External Termination Block (Terminal Strip connectors).

125808-06

Position External Termination Block (Euro Style connectors) for Proximitor, RPT and DC LVDT inputs.

128015-06

Position External Termination Block (Terminal Strip connectors) for Proximitor, RPT and DC LVDT inputs.

125808-07

Position External Termination Block (Euro Style connectors) for Rotary Potentiometer inputs.

128015-07

Position External Termination Block (Terminal Strip connectors) for Rotary Potentiometer inputs.

141208-01

AC LVDT External Termination Block (Euro Style connectors) for AC LVDT inputs.

141216-01

AC LVDT External Termination Block (Terminal Strip connectors) for AC LVDT inputs.

128702-01

Recorder External Termination Block (Euro Style connectors).

128710-01

Recorder External Termination Block (Terminal Strip connectors).

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## Cables

### 3500 Transducer (XDCR) Signal to External Termination (ET) Block Cable

129525 -AXXXX-BXX

A: Cable Length

0005	5 feet (1.5 metres)
0007	7 feet (2.1 metres)
0010	10 feet (3 metres)
0025	25 feet (7.5 metres)
0050	50 feet (15 metres)
0100	100 feet (30.5 metres)

B: Assembly Instructions

01	Not Assembled
02	Assembled

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### 3500 Recorder Output to External Termination (ET) Block Cable

129529-AXXXX-BXX

A: Cable Length

0005	5 feet (1.5 metres)
0007	7 feet (2.1 metres)
0010	10 feet (3 metres)
0025	25 feet (7.5 metres)
0050	50 feet (15 metres)
0100	100 feet (30.5 metres)

B: Assembly Instructions

01	Not Assembled
02	Assembled

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## Spares

176449-04

3500/45 Position Monitor

135137-01

Position I/O Module with Internal Terminations for use with Proximitors, RPTs or DC LVDTs.

135145-01

Position I/O Module with External Terminations for use with Proximitors, RPTs or DC LVDTs.



135145-01

Discrete TMR I/O Module with External Terminations for use with Proximitys, RPTs or DC LVDTs.

126632-01

Bussed TMR I/O Module with External Terminations for use with Proximitys only.

139554-01

AC LVDT Position I/O Module with Internal Terminations for use with AC LVDTs.

139567-01

AC LVDT Position I/O Module with External Terminations for use with AC LVDTs.

139978-01

Rotary Potentiometer Position I/O Module with Internal Terminations for use with Rotary Potentiometers.

139991-01

Rotary Potentiometer Position I/O Module with External Terminations for use with Rotary Potentiometers.

135545-01

Position Monitor Manual

00530843

I/O Module four-pin connector shunt.

00580434

Connector Header, Internal Termination I/O, 8 position, green

00580432

Connector Header, Internal Termination I/O, 10 position, green

00580443

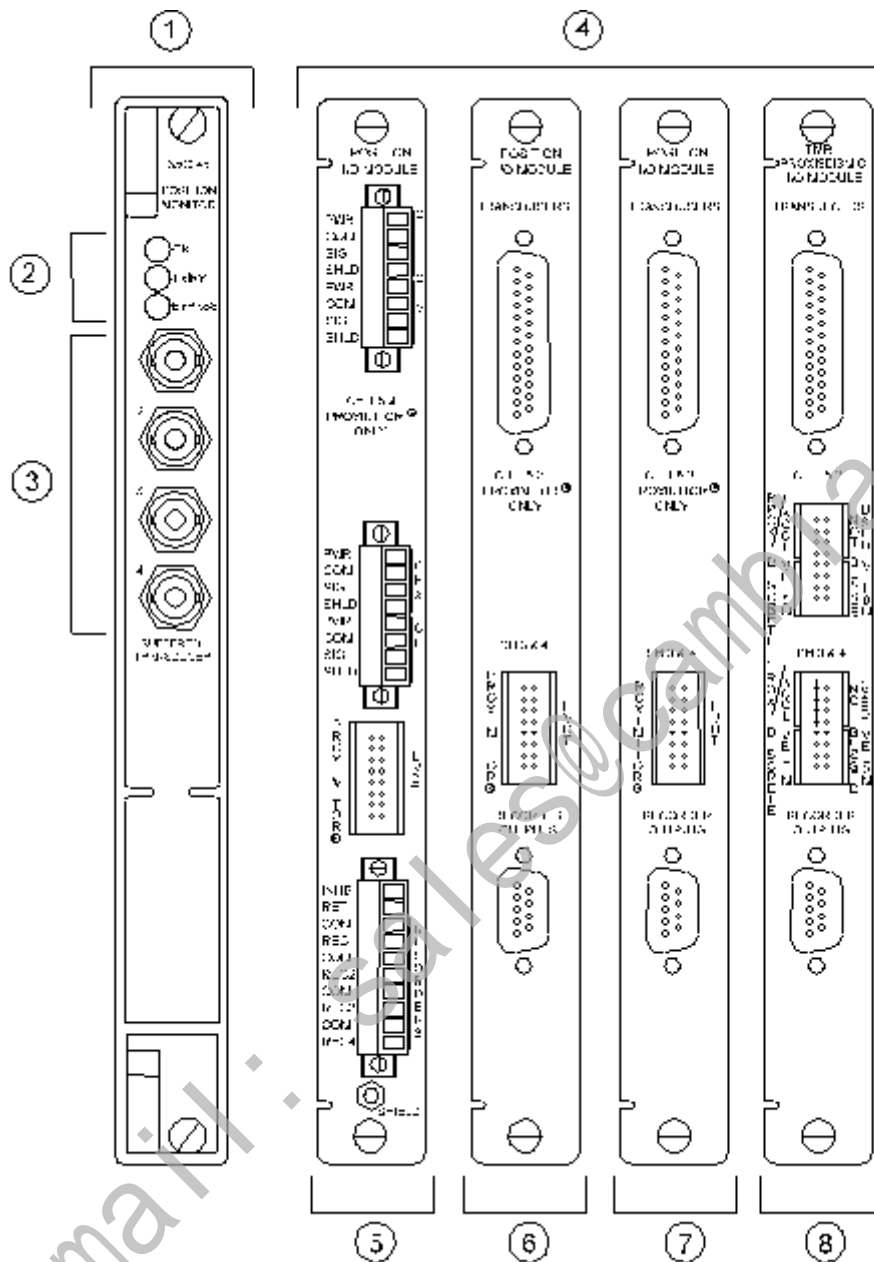
Connector Header, Internal Termination I/O, 12 position, green

email: sales@cambridge

**Table 1: Transducer Type Based on Position Measurement**

Measurement	Transducer Type	
<b>Thrust</b>	<b>Proximitys:</b>	
	3300XL 8 mm 3300 8 mm 3300 5 mm 3300 16 mm HTPS 7200 5 mm 7200 8 mm 7200 11 mm	3300XL 11mm 7200 14 mm 3000 (-18V) 3000 (-24V) 3300 RAM
<b>Differential Expansion</b>	<b>Proximitys:</b>	
	25 mm Extended Range 35 mm Extended Range 50 mm Extended Range	
<b>Ramp Differential Expansion</b>	<b>Proximitys (for ramp channel):</b>	<b>Proximitys (for flat channel):</b>
	3300XL 11mm 7200 11 mm 7200 14 mm 3300 16 mm HTPS 25 mm Extended Range 35 mm Extended Range 50 mm Extended Range 50 mm DE Transducer	All of those for ramp and: 3300XL 8 mm 3300 8 mm 7200 5 mm 7200 8 mm
<b>Complementary Input Differential Expansion</b>	<b>Proximitys:</b>	
	3300XL 11mm 7200 11 mm 7200 14 mm 3300 16 mm HTPS 25 mm Extended Range	35 mm Extended Range 50 mm Extended Range 50 mm DE Transducer
<b>Case Expansion (Channels 3 and 4 only)</b>	<b>DC LVDTs:</b>	<b>AC LVDTs:</b>
	25 mm (1 in) 50 mm (2 in) 101 mm (4 in)	25 mm (1 in) 50 mm (2 in) 101 mm (4 in)
<b>Valve Position</b>	<b>AC LVDTs:</b>	<b>Rotary Potentiometer:</b>
	25 mm (1 in) 50 mm (2 in) 101 mm (4 in) 152 mm (6 in) 203 mm (8 in) 254 mm (10 in) 304 mm (12 in) 508 mm (20 in)	50° FS rotation to 300° FS rotation
		<b>Rotary Position Transducer:</b>
		100° FS 200° FS 300° FS

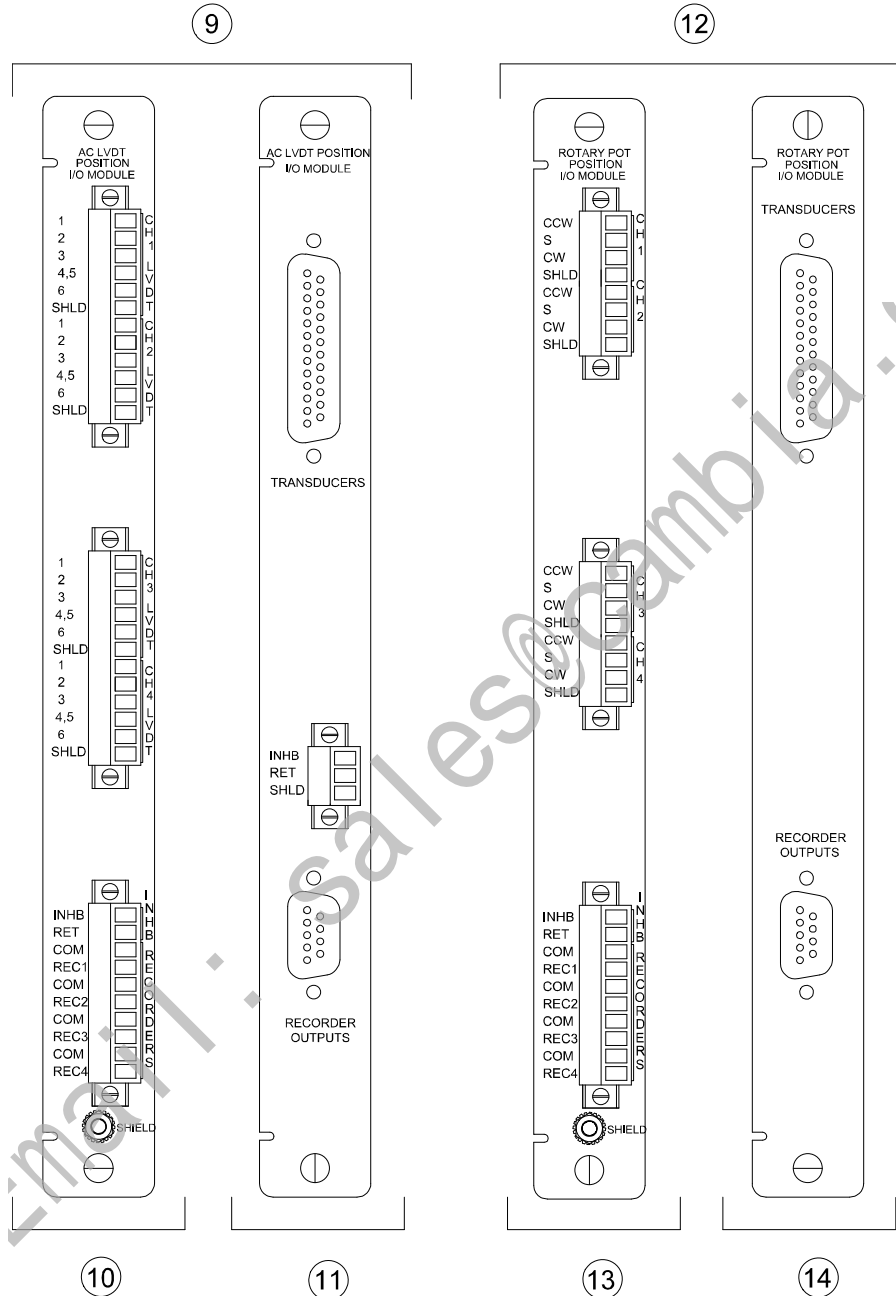
## Field wiring diagrams



**Figure 1: Front view Position Monitor and rear view of I/Os for use with Proximitor®, Rotary Position Transducer and DC LVDT I/Os.**

- 1) Front view of monitor.
- 2) Status LEDs.
- 3) Buffered Transducer Outputs: Provide an unfiltered output for each of the four transducers. All are short circuit protected. Channels 3 and 4 are level shifted by  $-10V$  when using DC LVDTs. When using AC LVDTs, all channels are a DC representation based on the signal processing of two secondary outputs from each AC LVDT.
- 4) Rear views of the various I/O modules used with Proximitors, Rotary Position Transducers, or DC LVDTs.

- 5) Position I/O Module, Internal Termination, for use with Proximitors, Rotary Position Transducers, or DC LVDTs.
- 6) Position I/O Module, External Termination, for use with Proximitors, Rotary Position Transducers, or DC LVDTs.
- 7) Position I/O Module, TMR Discrete, External Termination, for use with Proximitors or DC LVDTs.
- 8) Prox/Seismic I/O Module, TMR Bussed, External Termination for use with Proximitors.



**Figure 2: Rear view of I/Os for use with AC LVDTs and Rotary Potentiometers**

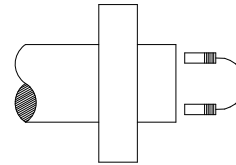
- 9) Rear views of the various I/O modules used with AC LVDTs.
- 10) Position I/O Module, Internal Termination, for use with AC LVDTs.
- 11) Position I/O Module, External Termination, for use with AC LVDTs.
- 12) Rear views of the various I/O modules used with Rotary Potentiometers.

- 13) Position I/O Module, Internal Termination, for use with Rotary Potentiometers.  
 14) Position I/O Module, External Termination, for use with Rotary Potentiometers.

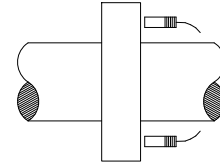
**Table 2: Ramp Differential Expansion Accuracy**

	Channel Pair Type and Configuration Parameters		
Maximum Tolerance in percent of full-scale	Standard Single Ramp Differential Expansion	Nonstandard Signal Ramp Differential Expansion	Dual Ramp Differential Expansion
±1.0	<ul style="list-style-type: none"> <li>Ramp angles 4 - 45 degrees.</li> <li>Greater than 3 Vdc full-scale span.</li> <li>Same model transducers on each channel.</li> </ul>	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Greater than 3 Vdc full-scale span.</li> </ul>	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Greater than 3 Vdc full-scale span.</li> </ul>
±1.25	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Greater than 3 Vdc full-scale span.</li> <li>Same model transducer on both channels.</li> </ul>	Not Applicable	Not Applicable
±1.5	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Greater than 3 Vdc full-scale span.</li> <li>Different model transducer on each channel.</li> </ul>	Not Applicable	Not Applicable
±2.0	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Less than 3 Vdc full-scale span.</li> <li>Same or Different model transducer on each channel.</li> </ul>	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees</li> <li>Less than 3 Vdc full-scale span.</li> </ul>	<ul style="list-style-type: none"> <li>Ramp angles 4 - 70 degrees.</li> <li>Less than 3 Vdc full-scale span.</li> </ul>

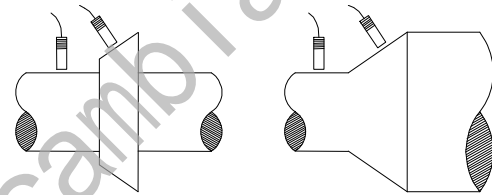
**Figure 3:**  
**Thrust Position:** The axial position of the rotor with respect to the thrust bearing or some fixed reference



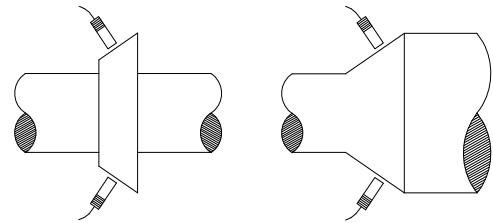
**Figure 4: Differential Expansion:** Shaft growth relative to the machine case.



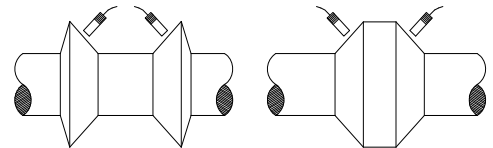
**Figure 5:**  
**Standard Single Ramp Differential Expansion**



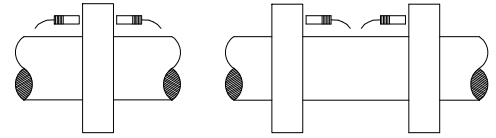
**Figure 6:**  
**Nonstandard Single Ramp Differential Expansion**



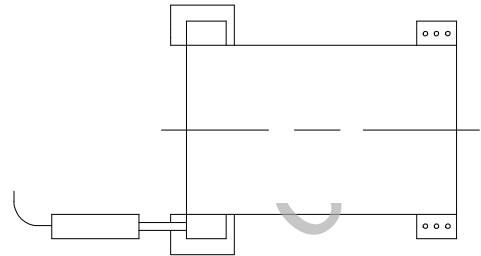
**Figure 7:**  
**Dual Ramp Differential Expansion**



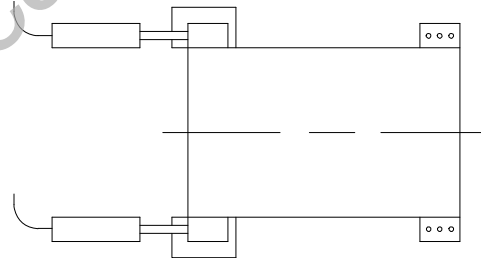
**Figure 7: Complementary Input Differential Expansion (CIDE):** A differential expansion measurement that uses a combination of two probes to increase the measurement range to twice the range of a single probe.



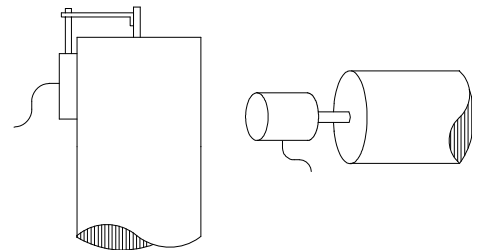
**Figure 8: Single Case Expansion:** The Measurement of the machine casing growth relative to its foundation.



**Figure 9: Dual Case Expansion**



**Figure 10: Valve Position:** The relative measurement of the position of a process inlet valve stem based on its full stroke, or the relative measurement of the rotational position of a cam shaft based on its full rotation.



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