

# 3500/45 Position Monitor

## Datasheet

Bently Nevada Machinery Condition Monitoring

14I537 Rev. H



## Description

The 3500/45 Position Monitor is a 4-channel instrument 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. The monitor conditions the input and compares the conditioned signals with user-programmable alarms.



The type of measurement and transducer input determine which I/O modules are required. [See Transducer Types for Position Measurements on page 10.](#), [See Figures and Graphs on page 12.](#), and [See I/O Modules for AC LVDTs and Rotary Potentiometers on page 14.](#)

You can program each channel using the 3500 Rack Configuration Software to perform 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



The monitor channels are programmed in pairs and can perform up to two of these functions at a time. For example, Channels 1 and 2 can perform one function while channels 3 and 4 may perform the same or a different function.



The primary purpose of the 3500/45 Position 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

Each channel, depending on configuration, typically conditions its input signal to generate various parameters called **measured variables**. You can establish **alert setpoints** for each active measured variable and **danger setpoints** for any two of the active measured variables.

## Specifications

### Inputs

Signal	Accepts from 1 to 4 signal inputs
Power consumption	7.7 watts, typical, using Position I/O,  <b>or</b> 8.5 watts typical, using AC LVDT I/O  <b>or</b> 5.6 watts typical, using Rotary Potentiometer I/O
	Input Impedance
	1 M $\Omega$ (DC LVDT inputs) 10 k $\Omega$ (Proximitor or RPT inputs) 137 k $\Omega$ (AC LVDT inputs) 200 k $\Omega$ (Rotary Potentiometer inputs)

### Sensitivity

Thrust	3.94 mV/ $\mu$ m (100 mV/mil) or 7.87 mV/ $\mu$ m (200 mV/mil)
Differential Expansion	0.394 mV/ $\mu$ m (10 mV/mil) or 0.787 mV/ $\mu$ m (20 mV/mil)
Ramp Differential Expansion	0.394 V/mm (10 mV/mil), 0.787 V/mm (20 mV/mil), 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), 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), 0.08 V/mm (1.90 V/in), 0.10 V/mm (2.50 V/in), 0.18 V/mm (4.50 V/in), 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), 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) 15.35 mV/V/mm (0.39 mV/V/mil), 9.45 mV/V/mm (0.24 mV/V/mil), 10.24 mV/V/mm (0.26 mV/V/mil), 7.48 mV/V/mm (0.19 mV/V/mil), 5.51 mV/V/mm (0.14 mV/V/mil),

	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, 70 mV/deg rotation or 50 mV/deg rotation


### Outputs

Front Panel LEDs	
OK LED	Indicates when the 3500/45 Position Monitor is operating properly.
TX/RX LED	Indicates when the 3500/45 Position Monitor is communicating with other modules in the 3500 rack.
Bypass LED	Indicates when the 3500/45 Position Monitor is in Bypass Mode.

### Transducer Power Supply

Proximitor 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.
	The monitor provides individual recorder values 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

## Signal Conditioning

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

### Thrust and Differential Expansion

Accuracy	Within ±0.33% of full-scale typical ±1% maximum
<b>Frequency Response</b>	
Direct filter	-3 dB at 1.2 Hz
Gap filter	-3 dB at 0.41 Hz

### Ramp Differential Expansion

Accuracy	<a href="#">See Ramp Differential Expansion Accuracy on page 11.</a>
<b>Frequency Response</b>	
Direct filter	-3 dB at 1.2 Hz
Gap filter	-3 dB at 0.41 Hz

### Complimentary Input Differential Expansion (CIDE)

Accuracy	Within ±0.33% of full-scale typical ±1% maximum
<b>Frequency Response</b>	
Direct filter	-3 dB at 1.2 Hz
Gap filter	-3 dB at 0.41 Hz

### Case Expansion

Accuracy	Within ±0.33% of full-scale typical ±1% maximum
<b>Frequency Response</b>	
Direct filter	-3 dB at 1.2 Hz
Gap filter	-3 dB at 0.41 Hz

## Valve Position

Accuracy	Within ±0.33% of full-scale typical ±1% maximum
<b>Frequency Response</b>	
Direct filter	-3 dB at 1.2 Hz
Gap filter	-3 dB at 0.41 Hz

## Physical

<b>Monitor Module (Main Board)</b>	
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)
<b>I/O Modules</b>	
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 the 3500 Rack Configuration Software to set alert and danger levels for the direct values measured by the monitor.  Alarms are adjustable from 0 to 100% of full-scale for each measured value. However, when the full-scale range exceeds the range of the transducer, the range of the transducer will limit the setpoint.
Accuracy of alarm setpoints	Within 0.13% of the desired value

## Alarm Time Delays



You can program alarm delays using the 3500 Rack Configuration Software from one to 60 seconds in one second intervals.

Alert	From one to 60 seconds in one second intervals
Danger	0.1 seconds or from one to 60 seconds in 0.1 second intervals

## Measured Variables



Position measurements are used for machine protection and condition monitoring. The 3500/45 Position Monitor returns values for the following measured variables depending on configuration.

Thrust Position	Direct Gap
Differential expansion	Direct Gap
Ramp Differential Expansion	Composite Direct Gap
CIDE	Composite Direct Gap
Case expansion	Composite Direct and position
Value position	Direct and position

## Environmental Limits

Operating Temperature	When used with Internal/External Termination I/O Module: -30°C to +65°C (-22°F to +150°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% Non-condensing

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## Firmware and Software Requirements

When adding the 3500/45 Position Monitor 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
- 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, you must have 3500 Configuration Software 3.00 or greater.

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

### CSA/NRTL/C

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

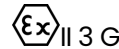
Class I, Zone 2: AEx/Ex ec nC ic IIC T4 Gc;

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 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).

## Position Monitor 3500/45 - AA-BB

### A: I/O Module Type

01	Position I/O Module with Internal Terminations (Proximitors, RPT, DC LVDT)
02	Position I/O Module with External Terminations (Proximitors, RPT, DC LVDT)
03	Discrete TMR Position I/O Module with External Terminations (Proximitors or DC LVDT)
04	Bussed TMR Position I/O Module with External Terminations (Proximitors)
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

### B: Agency Approval

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



You must order external termination blocks and cables separately for each I/O module with external termination.



When using the 3500/45 Position Monitor in a TMR application, valve position measurement are not available, and case expansion measurements are only supported for Discrete TMR.

## External Termination Blocks

132242-01	Prox/Seismic TMR I/O Bussed External Termination Block (Euro-style connectors) for Proximitors inputs
132234-01	TMR I/O Busses External Termination Block Terminal Strip connectors
125808-06	Position External Termination Block (Euro-style connectors) for Proximitors, RPT and DC LVDT inputs
125808-07	Position External Termination Block (Euro-style connectors) for Rotary Potentiometer inputs
128015-06	Position External Termination Block (Terminal Strip connectors) for Proximitors, RPT and DC LVDT 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)



## Cables

### 3500 Transducer (XDCR) to External Termination (ET) Block Cable I29525 - 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 I29529 - 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

## 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
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
125808-06	Position-Prox/DC LVDT - Euro
125808-07	Position-Rotary Pot - Euro
141208-01	Position-Prox/AC LVDT - Euro
132242-01	Prox/Seis TMR ET Block - Euro
128702-01	Recorder ET Block - Euro
128015-06	Position External Termination Block (Terminal Strip connectors) for Proximitor, RPT and DC LVDT inputs
128015-07	Position External Termination Block (Terminal Strip connectors) for Rotary Potentiometer inputs
141216-01	AC LVDT External Termination Block (Terminal Strip connectors) for AC LVDT inputs
132234-01	TMR I/O Busses External Termination Block Terminal Strip connectors
128710-01	Recorder External Termination Block (Terminal Strip connectors)

## Transducer Types for Position Measurements

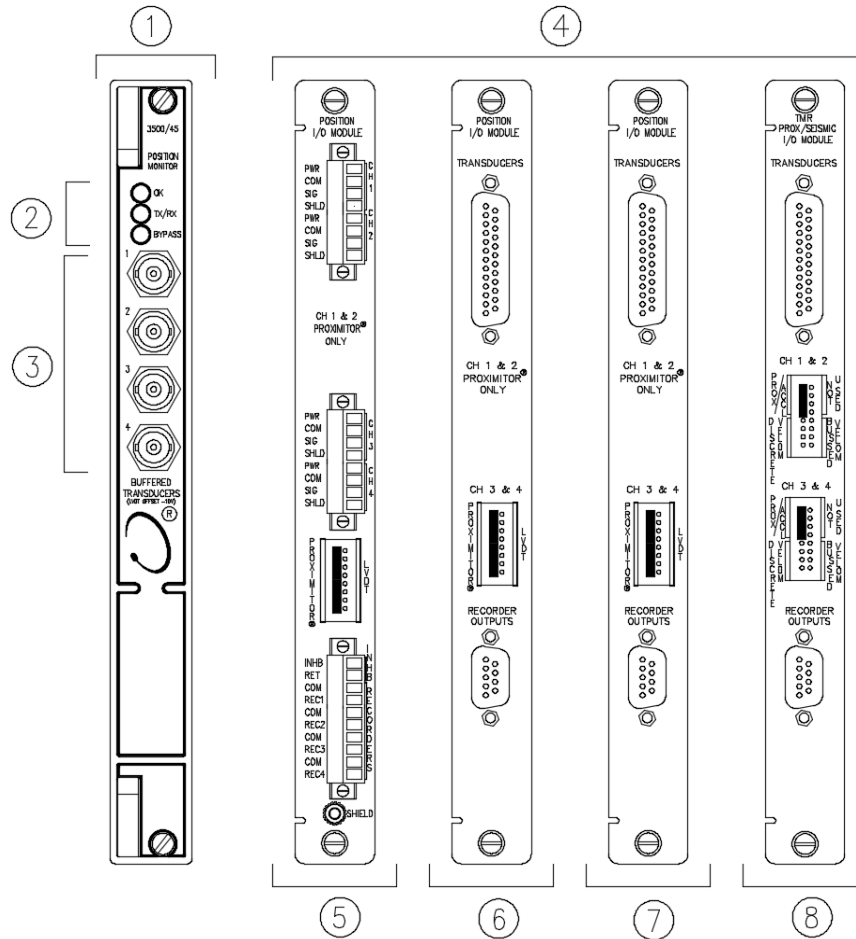
The following table lists transducer types for each position measurement:

Measurement	Transducer Type		
Thrust	Proximitors		
	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	
Differential Expansion	Proximitors		
	25 mm Extended Range 35 mm Extended Range 50 mm Extended Range		
Ramp Differential Expansion	Proximitors For Ramp and Flat Channels		Proximitors For Flat Channel
	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		3300XL 8 mm 3300 8 mm 7200 5 mm 7200 8 mm
Complementary Input Differential Expansion	Proximitors		
	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
Case Expansion (Channels 3 and 4 only)	DC LVDTs		AC LVDTs
	25 mm (1 in) 50 mm (2 in) 101 mm (4 in)		25 mm (1 in) 50 mm (2 in) 101 mm (4 in)
Valve Position	AC LVDTs		Rotary Potentiometer
	25 mm (1 in) 50 mm (2 in) 101 mm (4 in) 152 mm (6 in) 03 mm (8 in) 254 mm (10 in) 304 mm (12 in) 508 mm (20 in)		50° FS rotation to 300° FS rotation
			Rotary Position Transducer
			100° FS 200° FS 300° FS

## Ramp Differential Expansion Accuracy

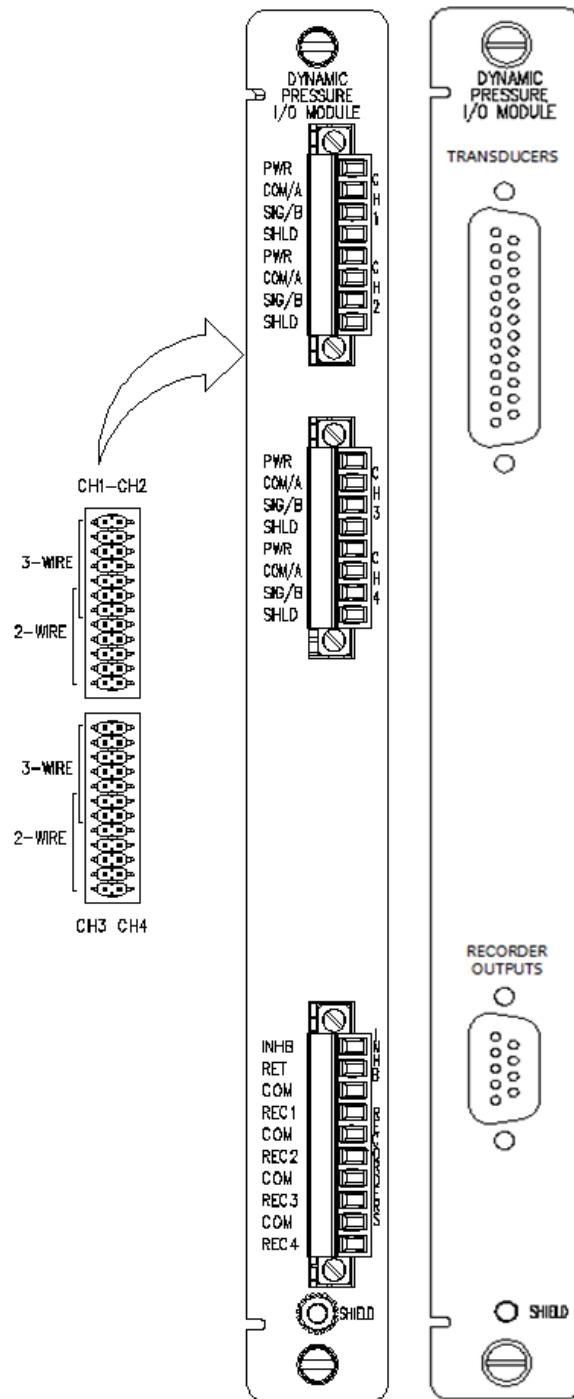
Maximum Tolerance in Percent of Full-Scale	Channel Pair Type and Configuration Parameters		
	Standard Single Ramp Differential Expansion	Nonstandard Signal Ramp Differential Expansion	Dual Ramp Differential Expansion
±1.0	Ramp angles 4 - 45 degrees Greater than 3 Vdc full-scale span Same model transducers on each channel	Ramp angles 4 - 70 degrees Greater than 3 Vdc full-scale span	Ramp angles 4 - 70 degrees Greater than 3 Vdc full-scale span
±1.25	Ramp angles 4 - 70 degrees Greater than 3 Vdc full-scale span Same model transducer on both channels	N/A	N/A
±1.5	Ramp angles 4 - 70 degrees Greater than 3 Vdc full-scale span Different model transducer on each channel	N/A	N/A
±2.0	Ramp angles 4 - 70 degrees Less than 3 Vdc full-scale span Same or Different model transducer on each channel	Ramp angles 4 - 70 degree Less than 3 Vdc full-scale span	Ramp angles 4 - 70 degrees Less than 3 Vdc full-scale span

## Figures and Graphs



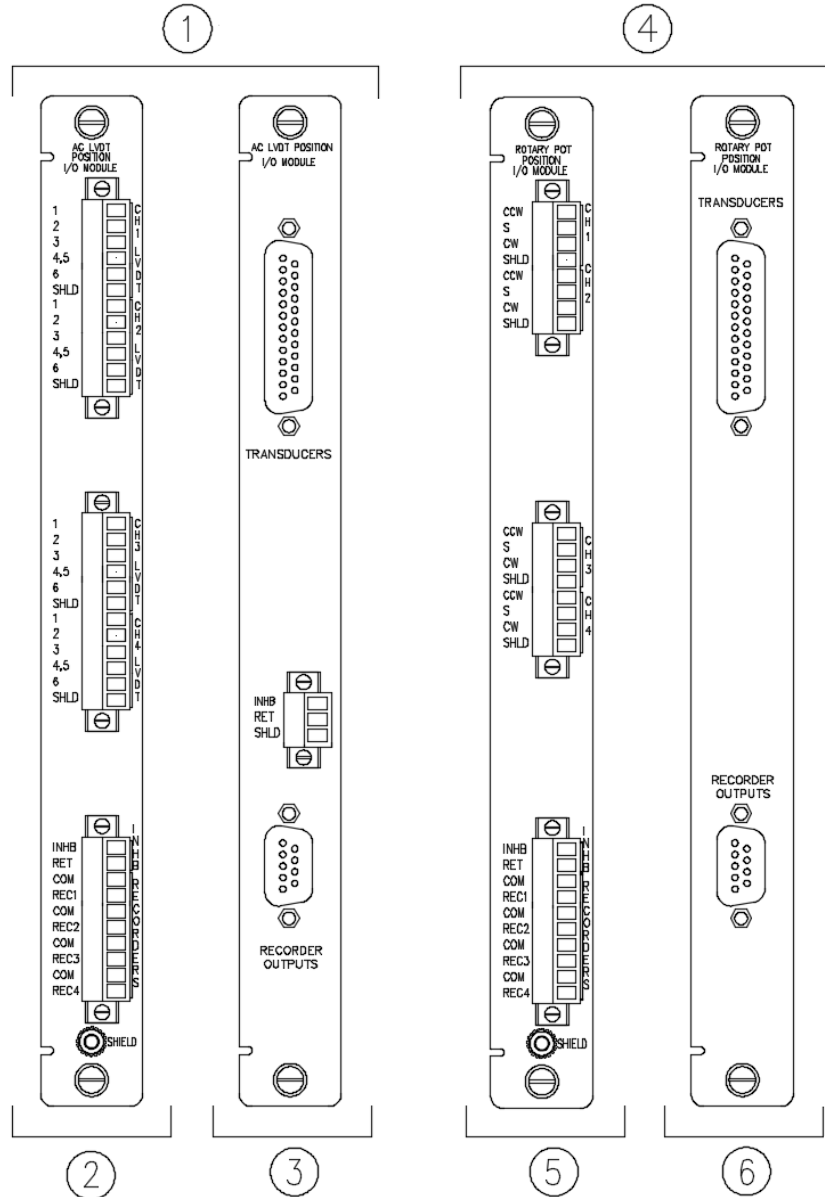
1. Front View of 3500/45 Position Monitor
2. Status LEDs
3. Buffered Transducer Outputs
4. Rear Views of I/O Modules with Proximitors, Rotary Position Transducers or DC LVDTs.
5. Position I/O Module, Internal Termination, for Use with Proximitors, Rotary Position Transducers, or DC LVDTs
6. Position 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 1: Front and Rear Views of 3500/45 Position Monitor and I/O modules for use with Proximitor, Rotary Position Transducer and DC LVDT I/Os**



**Figure 2: Side View of I/O Modules**

The I/O modules with internal or external terminations have the same jumpers.



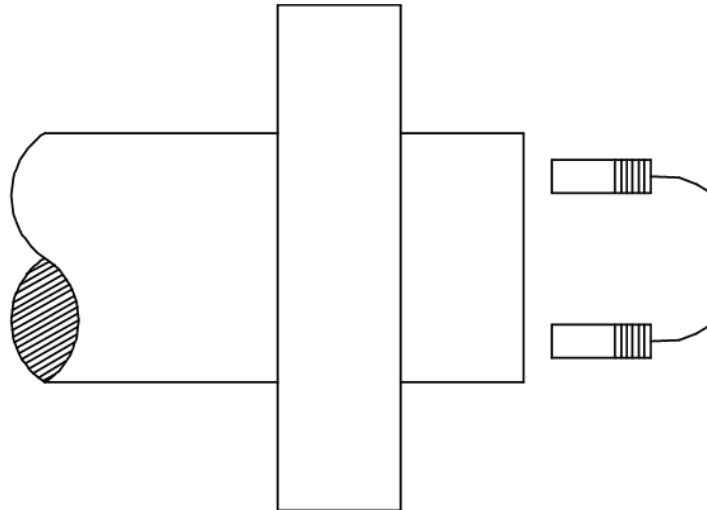
1. Rear Views of I/O Modules Used with AC LVDTs
2. Position I/O Module, Internal Termination, for Use with AC LVDTs
3. Position I/O Module, External Termination, for Use with AC LVDTs
4. Rear Views of I/O Modules Used with Rotary Potentiometers
5. Position I/O Module, Internal Termination, for Use with Rotary Potentiometers
6. Position I/O Module, External Termination, for Use with Rotary Potentiometers

**Figure 3: I/O Modules for AC LVDTs and Rotary Potentiometers**

## Thrust and Valve Positions

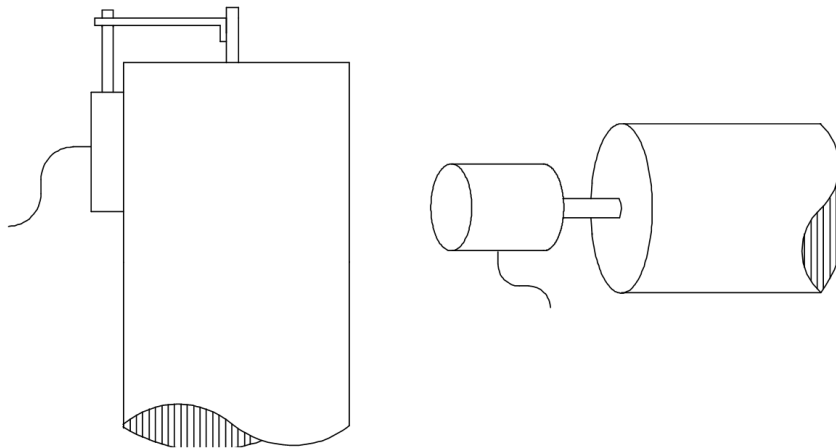
### Thrust Position

The following picture depicts the axial position of the rotor with respect to the thrust bearing or some fixed reference:



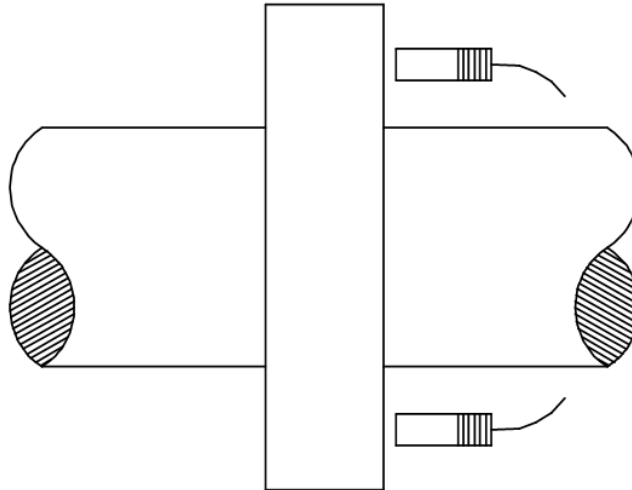
### Valve Position

The following picture depicts 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:

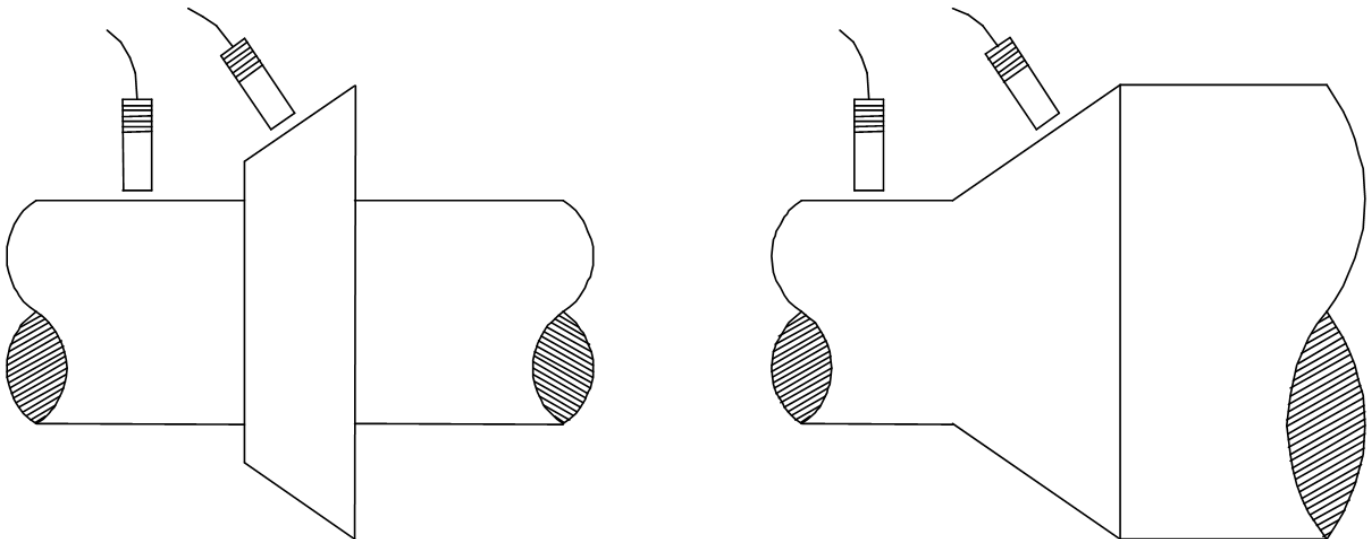


### Differential Expansion

The following picture depicts shaft growth relative to the machine case:

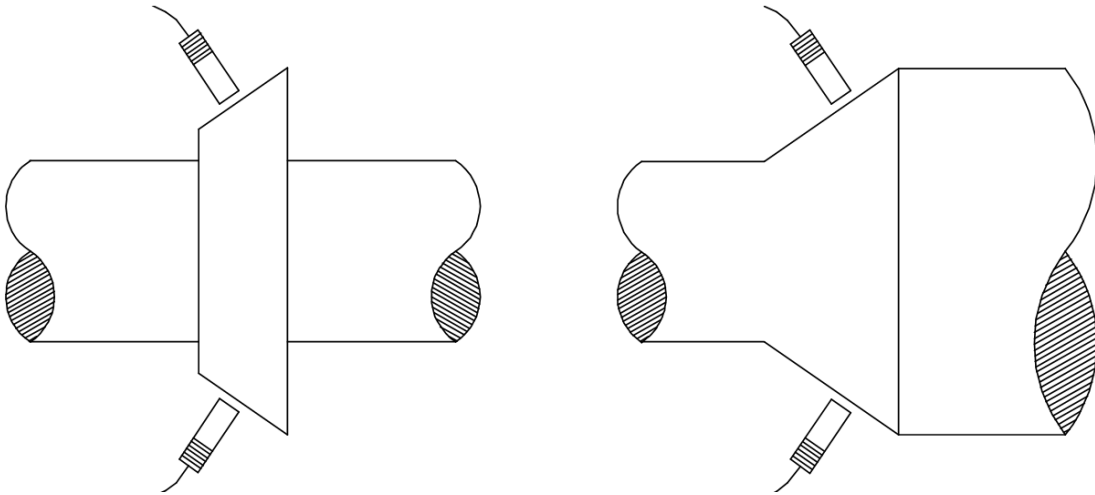


The following picture depicts standard single ramp differential expansion:

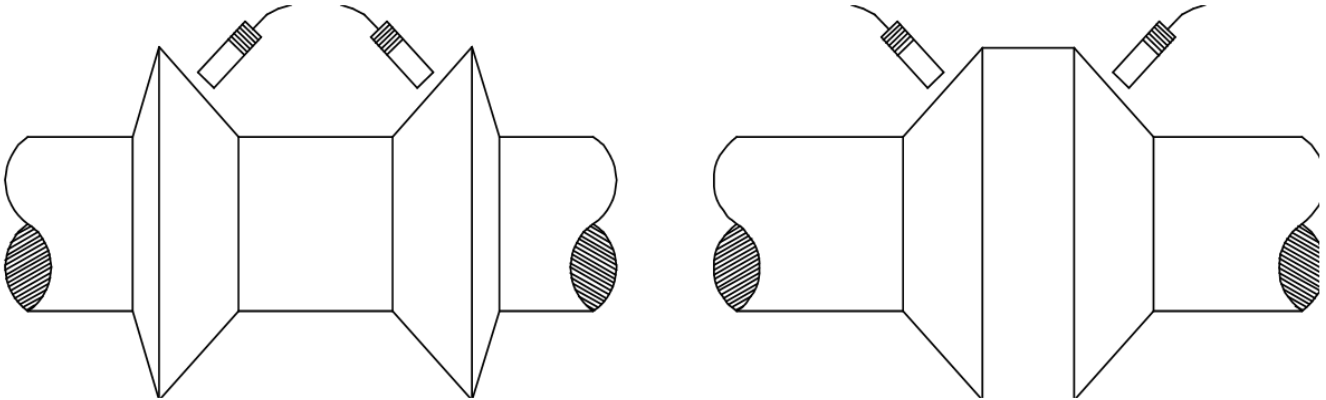




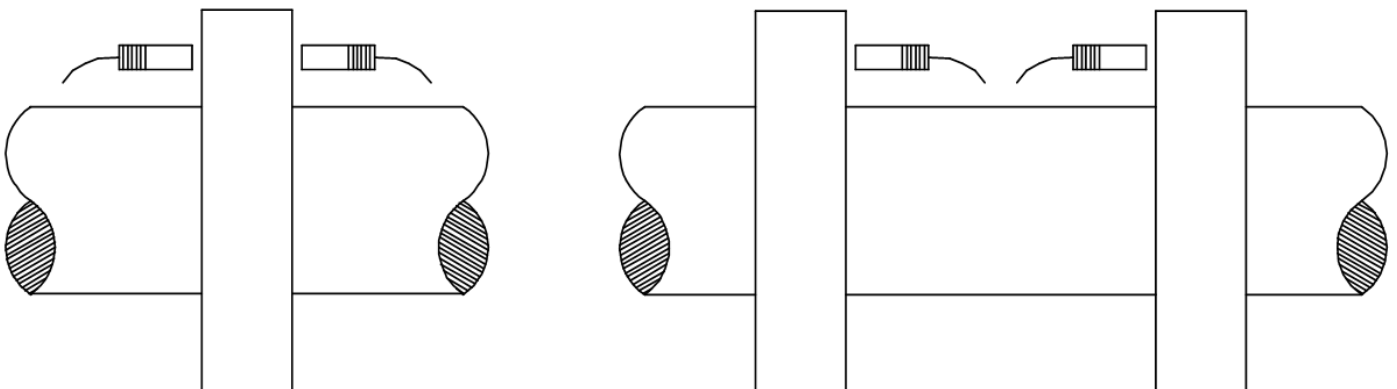
The following picture depicts non-standard single ramp differential expansion:



The following picture depicts a dual ramp differential expansion:

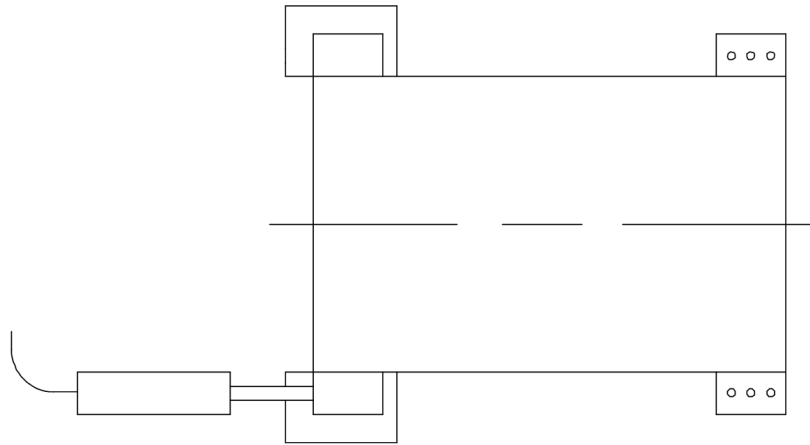


The following image depicts a complementary input differential expansion (CIDE) which uses a combination of two probes to increase the measurement range to twice the range of a single probe:

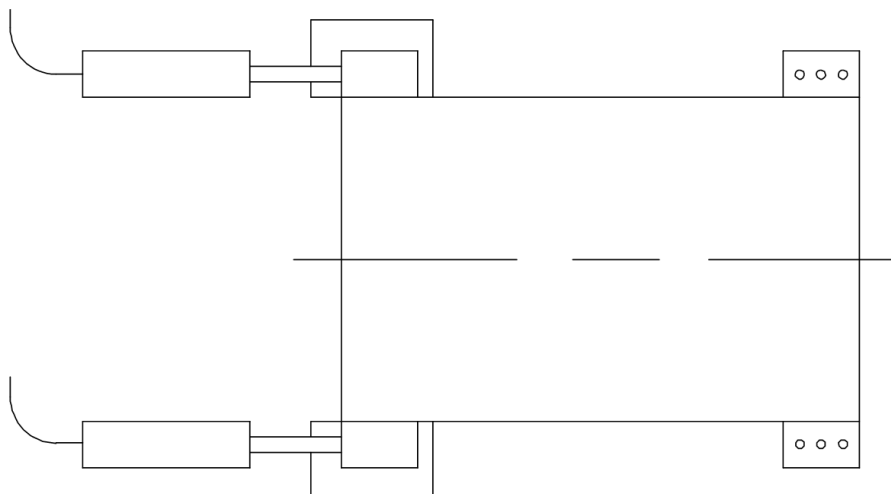


## Case Expansion

The following picture depicts a single case expansion which is the measurement of the machine casing growth relative to its foundation:



The following picture depicts a dual case expansion:



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1631 Bently Parkway South, Minden, Nevada USA 89423  
Phone: 1.775.782.3611 or 1.800.227.5514 (US only)  
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