3500/45 Position Monitor
Datasheet

Bently Nevada Machinery Condition Monitoring

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 11; see Figures and Graphs on page 14; and see I/O Modules for AC LVDTs on page 16.)

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

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> ✎ 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.

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Specifications

Inputs

Signal	Accepts from 1 to 4 signal inputs
Power consumption	7.7 Watts, typical, using Position I/O, **or** 8.5 Watts typical, using AC LVDT I/O **or** 5.6 Watts typical, using Rotary Potentiometer I/O
Input Impedance	1 MΩ (DC LVDT inputs) 10 kΩ (Proximitor or RPT inputs) 137 kΩ (AC LVDT inputs) 200 kΩ (Rotary Potentiometer inputs)

Sensitivity

Thrust	3.94 mV/μm (100 mV/mil) or 7.87 mV/μm (200 mV/mil)
Differential Expansion	0.394 mV/μm (10 mV/mil) or 0.787 mV/μm (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.

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| 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 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

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
Frequency Response	
Direct filter	–3 dB at 1.2 Hz
Gap filter	–3 dB at 0.41 Hz

Ramp Differential Expansion

Accuracy	See Ramp Differential Expansion Accuracy on page 13.
Frequency Response	
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
Frequency Response	
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 |

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Frequency Response	
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
Frequency Response	
Direct filter	–3 dB at 1.2 Hz
Gap filter	–3 dB at 0.41 Hz

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 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

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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: -30ºC to +65ºC (-22ºF to +150ºF)
Storage Temperature	-40ºC to +85ºC (-40ºF to +185ºF)
Humidity	95% Non-condensing

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.

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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

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

Hazardous Area Approvals

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

For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

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

⟨Ex⟩ II 3 G
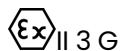
Ex nA nC ic IIC T4 Gc
Ex ec nC ic IIC T4 Gc

T4 @ Ta= -20°C to +65°C
(-4°F to +149°F)
When installed per drawing 149243 or 149244.

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Ordering Information

> For the detailed listing of country and product-specific approvals, refer to the *Approvals Quick Reference Guide (108M1756)*.
>
> For additional technical documentation, please log in to bntechsupport.com and access the Bently Nevada Media Library.

Position Monitor
3500/45-AA-BB

A: I/O Module Type

01	Position I/O Module with Internal Terminations (Proximitor, RPT, DC LVDT)
02	Position I/O Module with External Terminations (Proximitor, RPT, DC LVDT)
05	AC LVDT Position I/O Module with Internal Terminations
06	AC LVDT Position I/O Module with External Terminations

B: Agency Approval

00	None
01	cNRTLus (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.

External Termination Blocks

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
141208-01	AC LVDT External Termination Block (Euro-style 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) to External Termination (ET) Block Cable 129525-AAAA-BB

A: I/O Cable Length	
0005	5 feet (1.5 meters)
0007	7 feet (2.1 meters)
0010	10 feet (3.0 meters)
0025	25 feet (7.6 meters)
0050	50 feet (15.2 meters)
0100	100 feet (30.5 meters)

B: Assembly Instructions	
01	Not assembled
02	Assembled

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

A: I/O Cable Length	
0005	5 feet (1.5 meters)
0007	7 feet (2.1 meters)
0010	10 feet (3.0 meters)
0025	25 feet (7.6 meters)
0050	50 feet (15.2 meters)
0100	100 feet (30.5 meters)

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
125808-06	Position-Prox/DC LVDT-Euro
141208-01	Position-Prox/AC LVDT-Euro
128702-01	Recorder ET Block-Euro
128015-06	Position External Termination Block (Terminal Strip connectors) for Proximitor, RPT and DC LVDT inputs
128710-01	Recorder External Termination Block (Terminal Strip connectors)
166M4363	Connector Header Push-in-Spring Type (Alternative for PN 00580441)

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166M2389	Connector Header Push-in-Spring Type (Alternative for PN 00580434)
166M2388	Connector Header Push-in-Spring Type (Alternative for PN 00580432)
166M2379	Connector Header Push-in-Spring Type (Alternative for PN 00580443)

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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)

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Measurement	Transducer Type		
	AC LVDTs	Rotary Potentiometer	Rotary Position Transducer
Valve Position	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	100° FS 200° FS 300° FS

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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

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Figures and Graphs

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
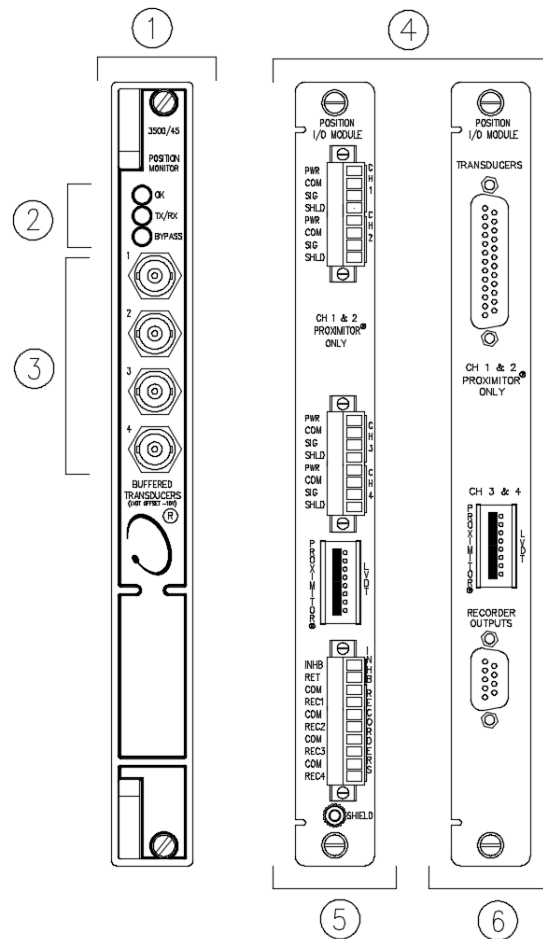
1. Front View of 3500/45 Position Monitor
2. Status LEDs
3. Buffered Transducer Outputs
4. Rear Views of I/O Modules with Proximitors, Rotary Position Tranducers or DC LVDTs.
5. Position I/O Module, Internal Termination, for Use with Proximitors, Rotary Position Transducers, or DC LVDTs
6. Position I/O Module, External Termination, for Use with Proximitors, Rotary Position Transducers, or DC LVDTs

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Figure 2: Side View of I/O Modules

The I/O modules with internal or external terminations have the same jumpers.
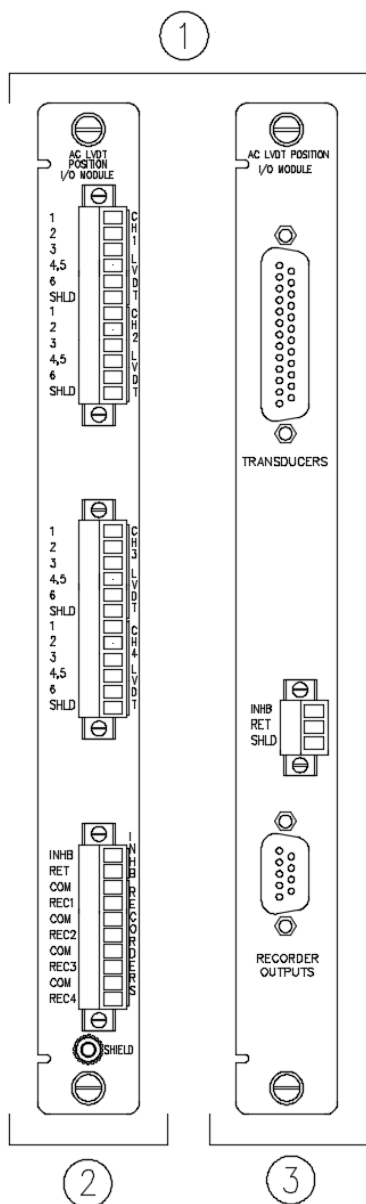
1. Rear Views of I/O Modules Used with AC LVDTs
2. Position I/O Module, Internal Termination, for Use with AC LVDTs
3. Position I/O Module, External Termination, for Use with AC LVDTs

Figure 3: I/O Modules for AC LVDTs

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:
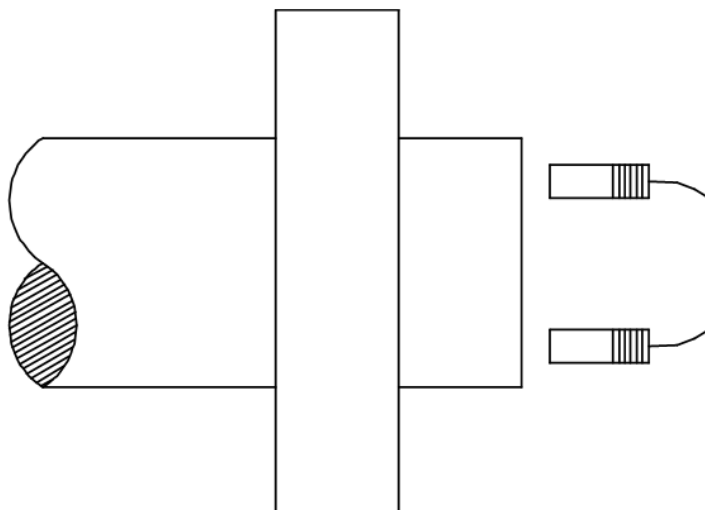
Valve Position

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:
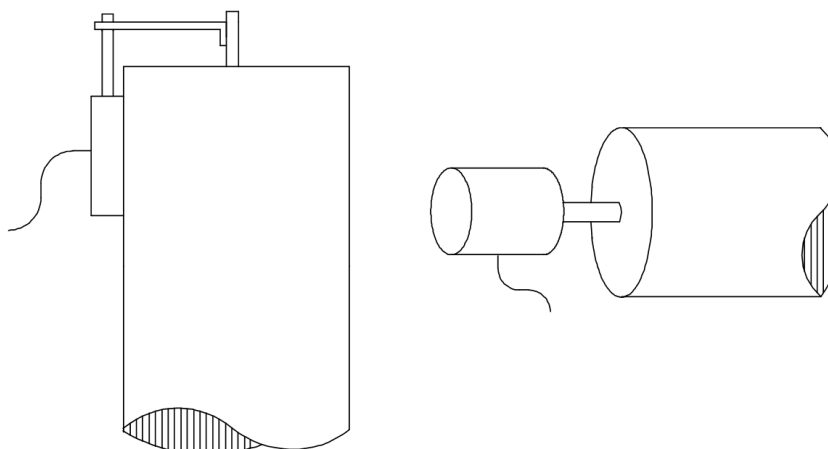
Differential Expansion

The following picture depicts shaft growth relative to the machine case:
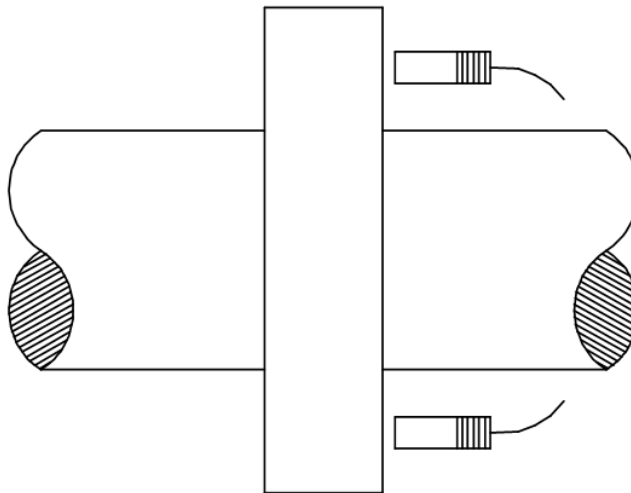
The following picture depicts standard single ramp differential expansion:

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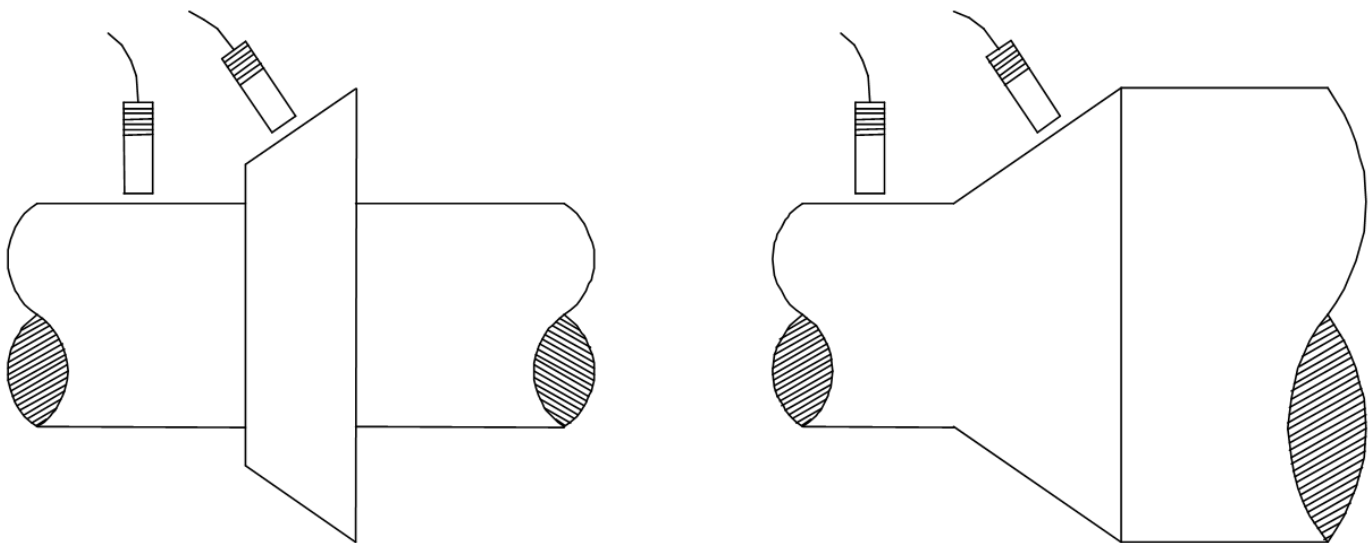
The following picture depicts non-standard single ramp differential expansion:
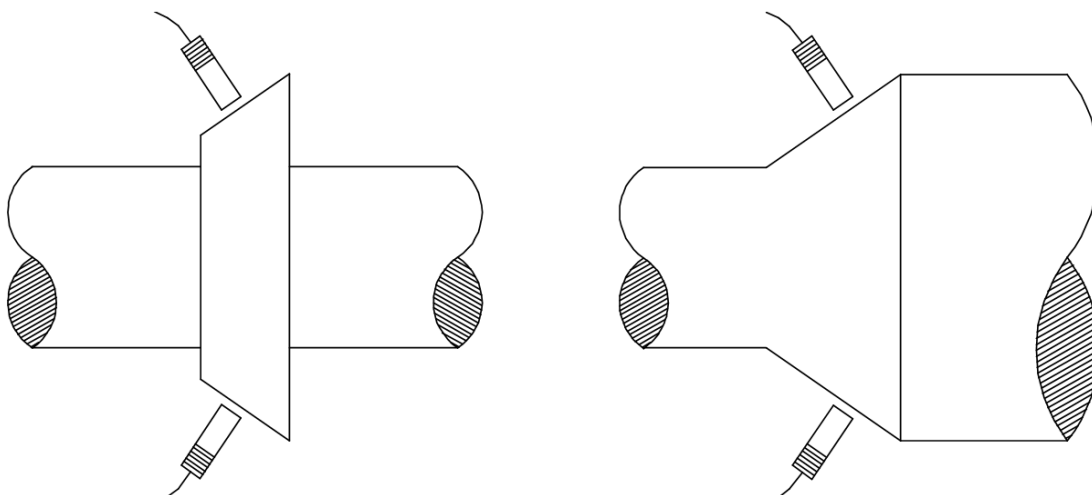
The following picture depicts a dual ramp differential expansion:
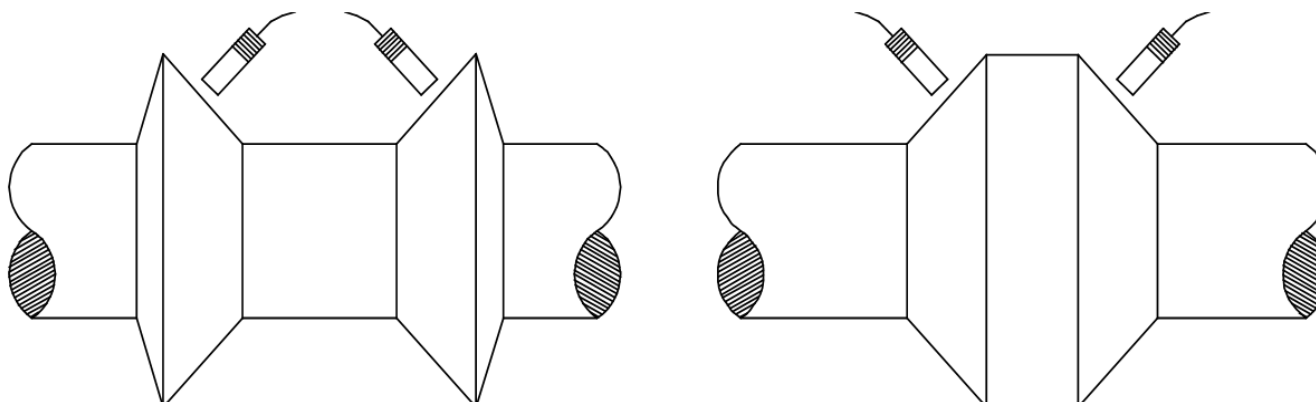
The following image depicts a complementary input differential expansion (CIDE) which uses a combination of two probes to increase the measurement range to twice the range of a single proble:

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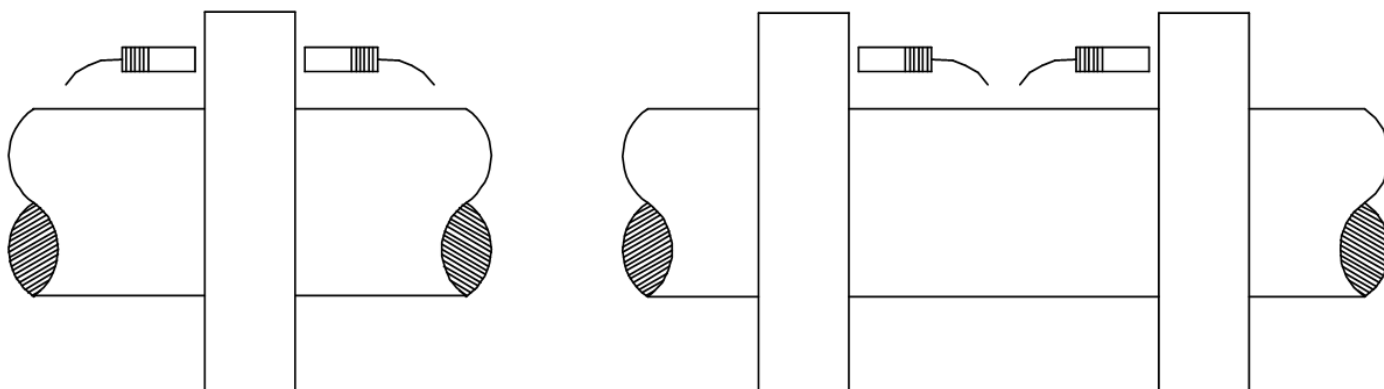
Case Expansion

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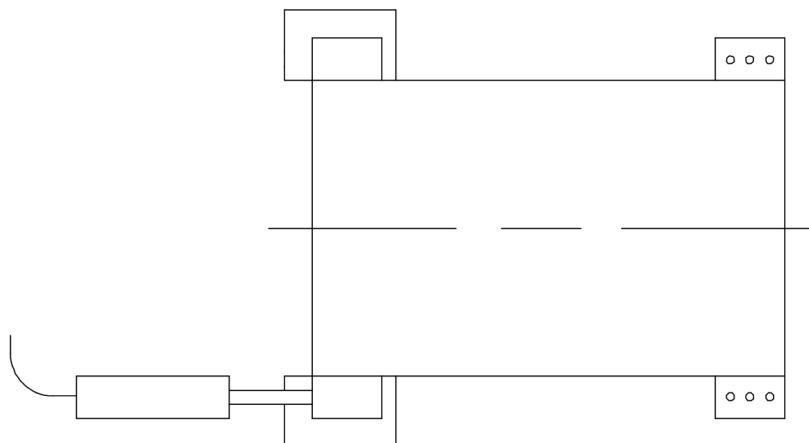
The following picture depicts a dual case expansion:

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