

**milwaukee**  
*Cylinder*

Specials are Our Standard

ISO 9001  
REGISTERED

# Sensor Datasheet Collection



# milwaukee *Cylinder*

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# HR-DRO: High Resolution Digital Readout

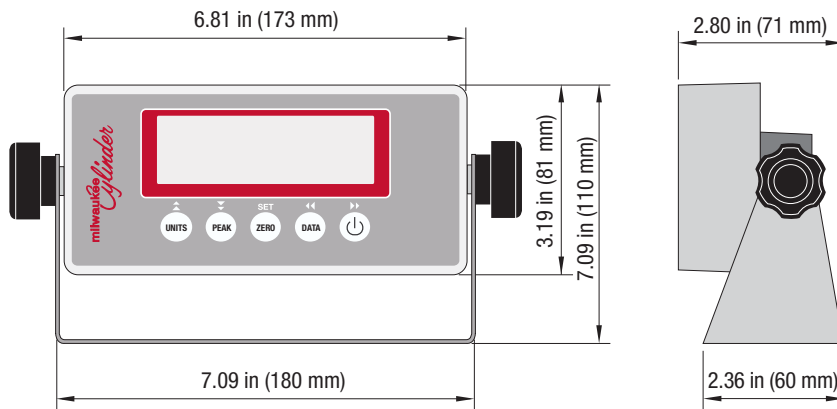
Ease of use, accuracy and a variety of standard and optional features make the HR-DRO a flexible, powerful solution for many load measurement applications. HR-DRO can be paired to unamplified sensors with mV/V output.

## Accuracy Enhancements

- Independent calibration equations (compression and tension) correct for sensor asymmetry
- Multi-point calibration equations correct sensor nonlinearity (≤7 points/loading mode)
- Available 6-wire sensor input mitigates error from cabling

## Key Features

- On-screen capture of peak force measurements
- Analog, digital or wireless output to PC / PCL for remote force monitoring
- ACV or battery powered



OPTIONS		
	Part Number	Description
Display Output	CABLE-RS232	RS-232 Output Cable*
	OUT-RS485	RS-485 Output
	OUT-ANALOG	0-5V/4-20mA Output (16 bit)
	OUT-RELAY	6V or 12V Internal Relay
	OUT-BT	Bluetooth 4.0 Output
	OUT-WIFI	WiFi Output
	Sensor Connection	CABLE-6W
CABLE-RF		Wireless Sensor Link

\*RS-232 digital output is standard

USER SELECTABLE OPTIONS		
Display Resolution	100 to 50,000	counts
Sampling Rate	1.75 to 1200	Hz
Averaging Filter	0 to 12	samples
Units of Measure	lbf, N, kgf	

INCLUDED SENSOR CABLE	
Wires	4
Length	15 ft

THERMAL	
Operating Temperature	15 to 105 °F

# s-RELS Series: Standard Rod-End Load Sensor

RELS Series sensors are mounted directly to the rod-end of a cylinder, situating the measurement device in an ideal position: directly within the load chain and immediately adjacent to the loading event.

### Benefits of Direct Force Measurement vs Pressure-Derived Load Estimates

- Excellent Accuracy and Sensitivity
- Improved Reproducibility and Repeatability
- Low Latency, Immune to Cylinder Friction
- Temperature Compensated
- Measurement is NIST Traceable

### Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Highly Repeatable Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging
- Calibration Reference for Pressure-Measurement-Based Systems



## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±lbf)	Combined Error (±lbf)	Non-Repeatability (±lbf)	Min Rod Ø (in)	Deflection (in / FS)
Standard Sensor Capacities	s-RELS-5K	5,000	15	3	1¼	0.001
	s-RELS-10K	10,000	30	5		
	s-RELS-25K	25,000	75	13		
	s-RELS-50K	50,000	150	25	2½	0.004
	s-RELS-100K	100,000	220	50	3½	
	s-RELS-200K	200,000	560	100	4½	0.012
	s-RELS-300K	300,000	600	90	5	
	s-RELS-500K	500,000	1,000	150	5½	
	s-RELS-700K	700,000	1,400	210	6½	
	s-RELS-1M	1,000,000	2,000	300	9	

Additional capacities available upon request. 5-Point ISO 17025 Accredited Calibration traceable to NIST is included with every RELS Sensor. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	150	± %FS

THERMAL		
Compensated Range	15 to 115	°F
Operating Range	-40 to 185	
Effect on Output	0.006	%FS / °F

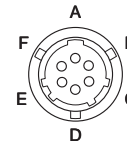
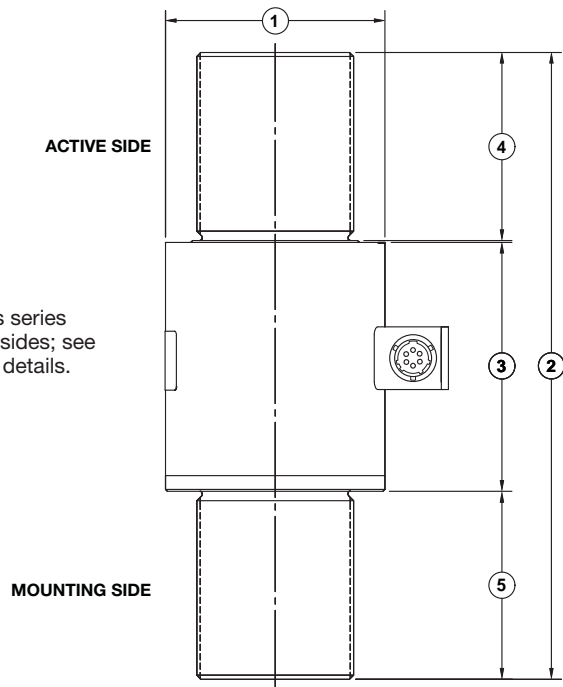
RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: s-RELS-100K-V**

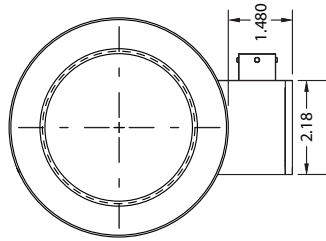
Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
	-V	-10 V	0 V	+10 V	11.5 – 26	26
-A	4 mA	12 mA	20 mA			

Other output types available upon request.

**Note:** Not all sensors in this series have male threads on both sides; see dimensions table below for details.



Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal



### DIMENSIONS (in)

Description	①	②	③	Loading Surface Ø		④ ⑤ Thread Type x Length	
	Body Ø	Total Length	Body Length	Active	Mounting	Active	Mounting
	s-RELS-5K	1.50	4.50	2.32	1.31	1.27	1.00-14 M x 1.00
s-RELS-10K	1.50	4.50	2.32	1.31	1.27	1.00-14 M x 1.00	1.00-14 F x 1.00
s-RELS-25K	1.73	4.50	2.32	1.50	1.50	1.00-14 M x 1.00	1.00-14 F x 1.00
s-RELS-50K	2.75	7.00	3.81	1.75	2.50	1.50-12 M x 1.50	1.50-12 F x 1.50
s-RELS-100K	3.50	10.00	3.97	3.50	3.50	2.50-12 M x 3.00	2.50-12 M x 3.00
s-RELS-200K	4.47	13.00	4.97	4.47	4.47	3.50-8 M x 4.00	3.50-8 M x 4.00
s-RELS-300K	5.50	16.50	9.00	5.00	5.00	3.50-12 F x 3.75	3.50-12 F x 3.75
s-RELS-500K	6.00	21.26	12.00	5.50	5.50	4.00-12 F x 4.50	4.00-12 F x 4.50
s-RELS-700K	7.50	25.50	14.00	7.00	7.00	5.00-8 F x 5.50	5.00-8 F x 5.50
s-RELS-1M	9.50	27.80	14.50	9.00	9.00	6.00-8 F x 6.50	6.00-8 F x 6.50

# f-RELS Series: Fatigue Rod-End Load Sensor

The f-RELS Series offers the exceptional measurement precision and temperature compensation of the p-RELS Series, while also meeting the extreme demands of high-cycle fatigue applications.

### Benefits of the f-RELS versus p-RELS

- Rated for 100,000,000 fully-reversed cycles
- Improved off-axis / eccentric load performance
- Higher stiffness / lower deflection
- Increased standard safe overload rating

### Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Extreme Repeatability of Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging



## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±lbf)	Combined Error (±lbf)	Non-Repeatability (±lbf)	Eccentric Load Sensitivity (%RDG / in)	Min Rod Ø (in)	Deflection (in / FS)
Standard Sensor Capacities	f-RELS-5K	5,000	4	1	0.1	1½	0.001
	f-RELS-12K	12,500	9	3		2½	
	f-RELS-25K	25,000	22	5		3	
	f-RELS-50K	50,000	45	10		4½	0.003
	f-RELS-100K	100,000	105	20		6	0.004
	f-RELS-135K	135,000	180	27		7¾	
	f-RELS-200K	200,000	315	40		10½	0.005
	f-RELS-300K	300,000	525	60		14	
	f-RELS-500K	500,000	1,300	100			
	f-RELS-1M	1,000,000	3,470	200			

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	300	± %FS

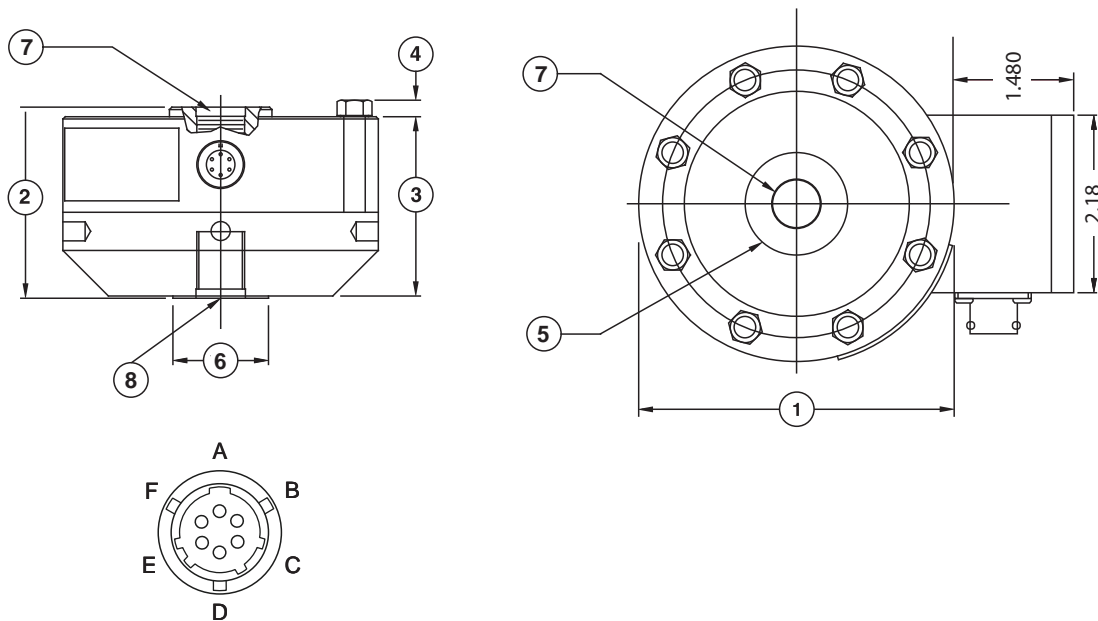
THERMAL		
Compensated Range	15 to 115	°F
Operating Range	-65 to 200	
Effect on Output	0.0008	%FS / °F

RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: f-RELS-100K-V**

Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
	-V	-10 V	0 V	+10 V	11.5 – 26	24
-A	4 mA	12 mA	20 mA			

Other output types available upon request.



Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal

DIMENSIONS (in)								
Description	① Body Ø	② Total Length	③ Body Length	④ Cap Head Height	⑤ Loading Surface Ø		⑦ Thread Type x Depth	
					Active	Mounting	Active	Mounting
f-RELS-5K	4.13	2.51	2.31	0.20	1.34	1.25	5/8-18 F x 1.12	5/8-18 F x 0.87
f-RELS-12K	6.06	3.50	3.20	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
f-RELS-25K	6.06	3.50	3.20	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
f-RELS-50K	8.00	4.50	4.10	0.40	3.76	3.00	1 3/4-12 F x 2.15	1 3/4-12 F x 1.75
f-RELS-100K	11.00	6.50	6.00	0.50	4.81	4.50	2 3/4-8 F x 3.25	2 3/4-8 F x 2.75
f-RELS-135K	11.00	8.00	7.50	0.50	4.81	4.50	2 3/4-8 F x 3.75	2 3/4-8 F x 3.75
f-RELS-200K	12.00	9.00	8.41	0.59	5.68	6.00	3 1/2-8 F x 3.75	3 1/2-8 F x 3.75
f-RELS-300K	15.50	10.50	9.81	0.69	7.73	7.75	4 1/4-8 F x 4.25	4 1/4-8 F x 4.25
f-RELS-500K	20.50	13.25	12.25	1.00	10.55	10.55	6-8 F x 5.63	6-8 F x 6.38
f-RELS-1M	26.00	16.75	15.50	1.25	13.79	14.00	8-8 F x 7.00	8-8 F x 7.25

# p-RELS Series: Premium Rod-End Load Sensor

RELS Series sensors are mounted directly to the rod-end of a cylinder, situating the measurement device in an ideal position: directly within the load chain and immediately adjacent to the loading event.

The Premium RELS enhances performance by offering significantly improved accuracy, repeatability, off-axis / eccentric load compensation, and temperature compensation.

### Benefits of Direct Force Measurement vs Pressure-Derived Load Estimates

- Excellent Accuracy and Sensitivity
- Improved Reproducibility and Repeatability
- Low Latency, Immune to Cylinder Friction
- Temperature Compensated
- Measurement is NIST Traceable



### Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Extreme Repeatability of Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging
- Calibration Reference for Pressure-Measurement-Based Systems

### PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±lbf)	Combined Error (±lbf)	Non-Repeatability (±lbf)	Eccentric Load Sensitivity (%RDG / in)	Min Rod Ø (in)	Deflection (in / FS)
Standard Sensor Capacities	p-RELS-5K	5,000	3.5	0.5	0.25	1 3/8	0.002
	p-RELS-10K	10,000	7	1		2 1/2	
	p-RELS-25K	25,000	20	2.5			3
	p-RELS-50K	50,000	40	5		4 1/2	0.012
	p-RELS-100K	100,000	100	10		6	0.007
	p-RELS-200K	200,000	240	20		7 3/4	0.008
	p-RELS-400K	400,000	680	80		10 1/2	0.008
	p-RELS-600K	600,000	1,200	120		14	0.012
	p-RELS-1M	1,000,000	2,500	200			
	p-RELS-2M	2,000,000	7,000	400			

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	150	± %FS
Enhanced SO (option)	300	

THERMAL		
Compensated Range	15 to 115	°F
Operating Range	-65 to 200	
Effect on Output	0.0008	%FS / °F

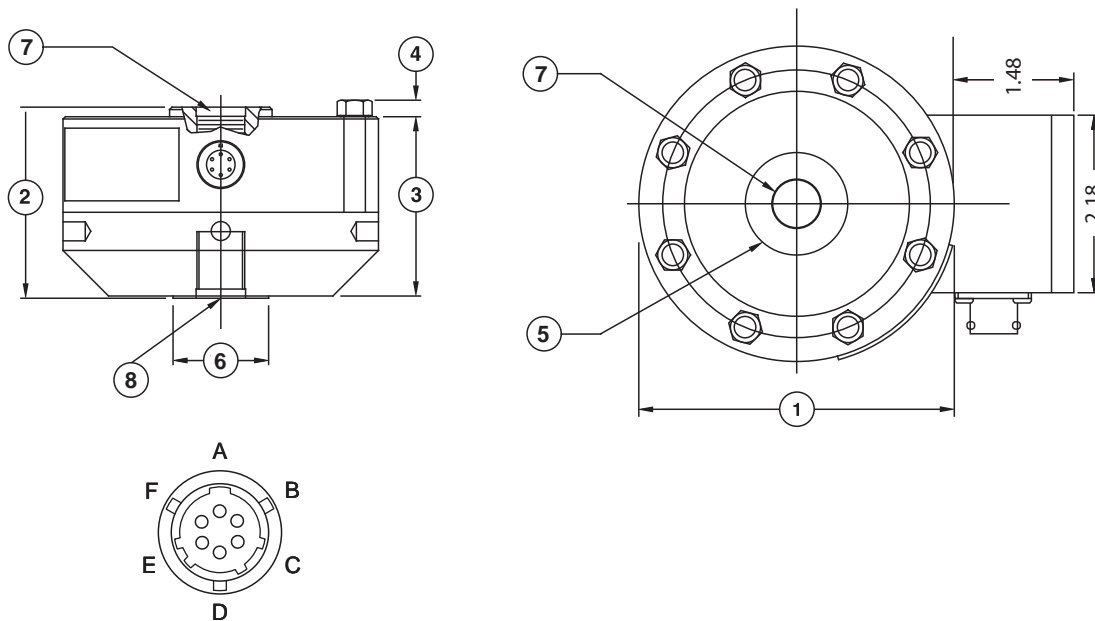
RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-RELS-100K-V**

Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
	-V	-10 V	0 V	+10 V	11.5 – 26	24
-A	4 mA	12 mA	20 mA			

Other output types available upon request.





Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal

DIMENSIONS (in)								
Description	①	②	③	④	⑤		⑦	
	Body Ø	Total Length	Body Length	Cap Head Height	Active	Mounting	Active	Mounting
p-RELS-5K	4.13	2.51	2.38	0.20	1.34	1.25	5/8-18 F x 1.12	5/8-18 F x 0.87
p-RELS-10K	4.13	2.51	2.38	0.20	1.34	1.25	5/8-18 F x 1.12	5/8-18 F x 0.87
p-RELS-25K	6.06	3.50	3.38	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
p-RELS-50K	6.06	3.50	3.38	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
p-RELS-100K	8.00	4.50	4.25	0.40	3.76	3.00	1 3/4-12 F x 2.15	1 3/4-12 F x 1.75
p-RELS-200K	11.00	6.50	6.00	0.50	4.81	4.50	2 3/4-8 F x 2.75	2 3/4-8 F x 2.75
p-RELS-400K	12.00	9.00	8.75	0.59	6.18	6.00	3 1/2-8 F x 4.13	3 1/2-8 F x 3.75
p-RELS-600K	15.50	10.50	10.00	0.69	7.73	7.75	4 1/4-8 F x 4.25	4 1/4-8 F x 4.25
p-RELS-1M	20.50	13.25	13.00	1.00	10.55	10.55	6-8 F x 5.63	6-8 F x 6.38
p-RELS-2M	26.00	16.75	16.50	1.25	13.79	14.00	8-8 F x 7.00	8-8 F x 7.25

# p-RELS Series: Premium Rod-End Load Sensor

RELS Series sensors are mounted directly to the rod-end of a cylinder, situating the measurement device in an ideal position: directly within the load chain and immediately adjacent to the loading event.

The Premium RELS enhances performance by offering significantly improved accuracy, repeatability, off-axis / eccentric load compensation, and temperature compensation.

## Benefits of Direct Force Measurement vs Pressure-Derived Load Estimates

- Excellent Accuracy and Sensitivity
- Improved Reproducibility and Repeatability
- Low Latency, Immune to Cylinder Friction
- Temperature Compensated
- Measurement is NIST Traceable



## Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Extreme Repeatability of Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging
- Calibration Reference for Pressure-Measurement-Based Systems

## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±N)	Combined Error (±N)	Non-Repeatability (±N)	Eccentric Load Sensitivity Full Scale (%RDG / mm)	Min Rod Ø (mm)	Deflection (mm / FS)
Standard Sensor Capacities	p-RELS-25KN	25,000	20	2.5	0.10	28	0.05
	p-RELS-50KN	50,000	35	5		56	
	p-RELS-100KN	100,000	80	10		70	0.10
	p-RELS-250KN	250,000	160	25		110	0.30
	p-RELS-450KN	450,000	450	45		140	0.20
	p-RELS-900KN	900,000	1,500	90		180	0.20
	p-RELS-1.8MN	1,800,000	3,000	180		240	0.20
	p-RELS-2.7MN	2,700,000	5,400	270		320	0.30
	p-RELS-4.5MN	4,500,000	11,250	450			
	p-RELS-9MN	9,000,000	31,500	900			

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	150	± %FS
Enhanced SO (option)	300	

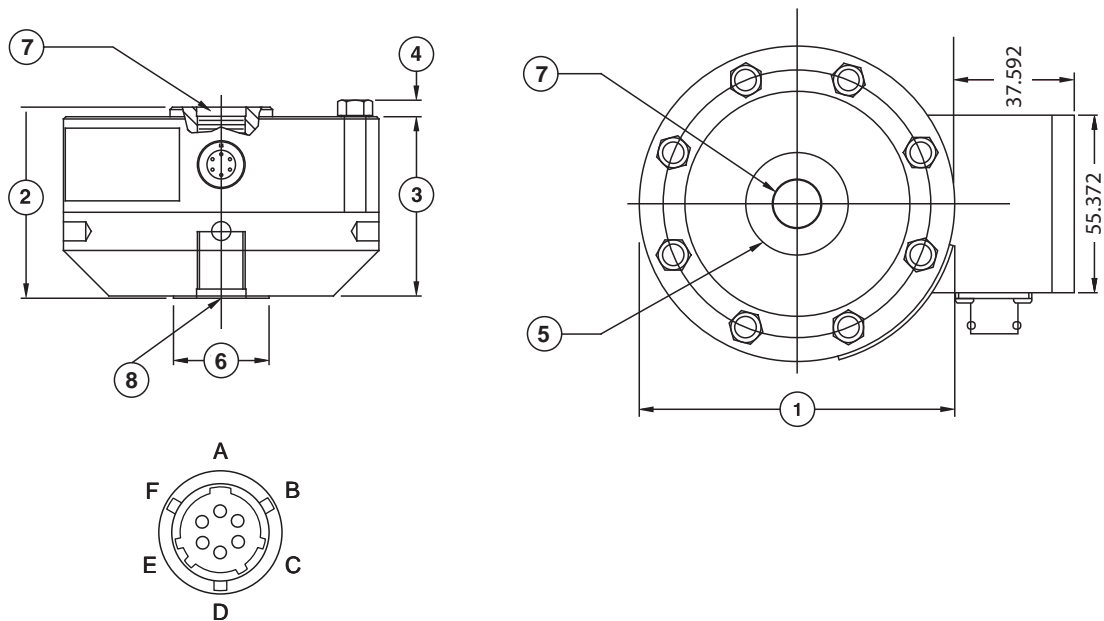
THERMAL		
Compensated Range	-10 to 45	°C
Operating Range	-20 to 90	
Effect on Output	0.0015	%FS / °C

RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-RELS-100K-V**

Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
	-V	-10 V	0 V	+10 V	11.5 – 26	24
-A	4 mA	12 mA	20 mA			

Other output types available upon request.



Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal

DIMENSIONS (mm)								
Description	① Body Ø	② Total Length	③ Body Length	④ Cap Head Height	⑤ Loading Surface Ø		⑦ Thread Type x Depth	
					Active	Mounting	Active	Mounting
p-RELS-25KN	104.8	63.5	60.3	5.1	34.0	31.8	M16x2 x 28.4	M16x2 x 22.1
p-RELS-50KN	104.8	63.5	60.3	5.1	34.0	31.8	M16x2 x 28.4	M16x2 x 22.1
p-RELS-100KN	153.9	89.0	85.9	7.6	67.3	57.2	M33x2 x 35.6	M33x2 x 35.6
p-RELS-250KN	153.9	89.0	85.9	7.6	67.3	57.2	M33x2 x 35.6	M33x2 x 35.6
p-RELS-450KN	203.2	114.3	108.0	10.2	95.2	76.2	M42x2 x 54.6	M42x2 x 44.5
p-RELS-900KN	279.0	165.1	152.4	12.7	122.2	114.3	M72x2 x 70.0	M72x2 x 69.8
p-RELS-1.8MN	304.8	228.6	222.3	20.0	156.8	152.4	M90x3 x 104.9	M90x3 x 95.3
p-RELS-2.7MN	393.7	266.7	254.0	12.5	196.3	196.9	M120x4 x 108.0	M120x4 x 108.0
p-RELS-4.5MN	520.7	336.6	330.2	25.4	267.9	267.9	M150x4 x 143.0	M150x4 x 162.0
p-RELS-9MN	660.4	425.5	419.1	31.3	350.3	355.6	M200x4 x 178.0	M200x4 x 184.0

# p-RELS-DRO Series: Premium Rod-End Load Sensor with Digital Readout

RELS Series load sensors mount directly to the rod-end of a cylinder, situating the measurement device in an ideal position: directly within the load chain and immediately adjacent to the loading event.

Premium RELS load sensors enhance performance by offering significantly improved accuracy, repeatability, off-axis / eccentric load compensation, and temperature compensation.

The p-RELS-DRO package is a Premium RELS load cell mated with a HR-DRO digital readout, which are calibrated together as a dedicated pair. Its variety of configuration options and user-selectable features create a flexible, accurate, traceable and easy-to-use measurement system.



### Key Applications

- On-screen capture of peak force measurements
- Analog, digital or wireless connection to PC / PCL for remote force monitoring
- Transfer standard for calibration/verification of force measurement devices
- Determination of effective area in pressure-based force measurement systems

## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±lbf)	Resolution (lbf)	Combined Error (±lbf)	Non-Repeatability (±lbf)	Eccentric Load Sensitivity (%RDG / in)	Min Rod Ø (in)	Deflection (in / FS)
	Standard Sensor Capacities	p-RELS-5K-DRO	5,000	0.1	3.5	0.5	0.25	1¾
p-RELS-10K-DRO		10,000	0.2	7	1	2½		
p-RELS-25K-DRO		25,000	1	20	2.5			3
p-RELS-50K-DRO		50,000	1	40	5	4½		
p-RELS-100K-DRO		100,000	2	100	10			6
p-RELS-200K-DRO		200,000	0.01k	240	20	7¾		
p-RELS-400K-DRO		400,000	0.01k	680	80			10½
p-RELS-600K-DRO		600,000	0.02k	1,200	120	14		
p-RELS-1M-DRO		1,000,000	0.02k	2,500	200			
p-RELS-2M-DRO		2,000,000	0.1k	7,000	400			

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

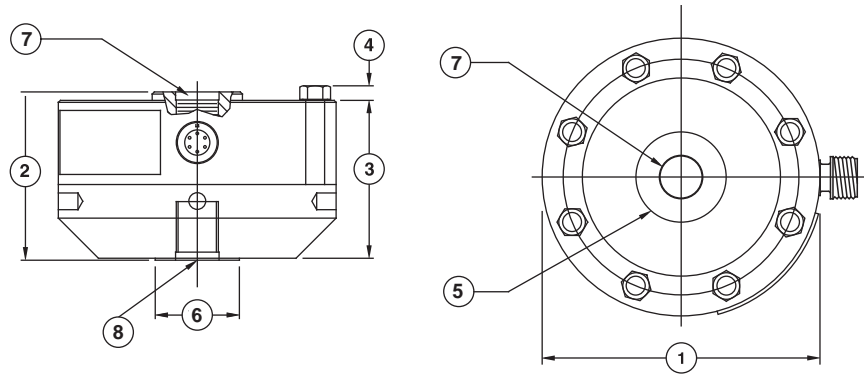
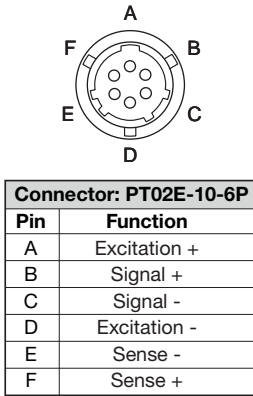
MECHANICAL (sensor)	
Safe Overload	±150%FS
Enhanced Safe Overload	+300%FS (compression only)

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-RELS-100K-DRO**

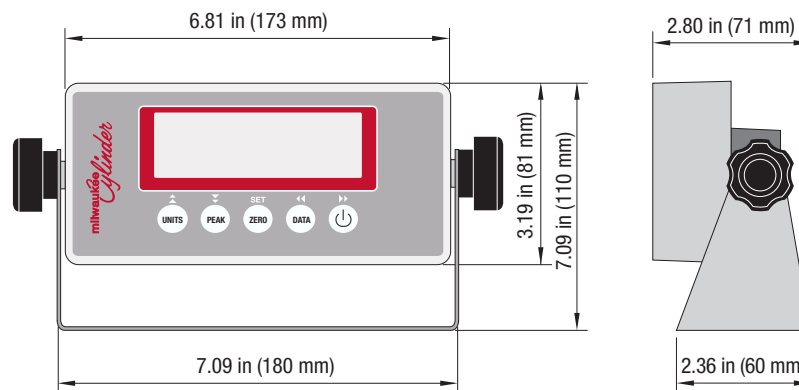
THERMAL	
Compensated Range (sensor)	15 to 115°F
Operating Range (sensor)	-65 to 200°F
Effect on Output (sensor)	0.0008%FS/°F
Operating Range (display)	15 to 105°F

USER-SELECTABLE DISPLAY OPTIONS	
Display Resolution	100 to 50,000 counts
Sampling Rate	1.75 to 1200.00 Hz
Averaging Filter	0 to 12 samples
Units of Measure	lbf, N, kgf

STANDARD SENSOR CABLE	
Wires	4
Length	15 ft.



DIMENSIONS (in)								
Description	①	②	③	④	⑤		⑦	
	Body Ø	Total Length	Body Length	Cap Head Height	Active	Mounting	Active	Mounting
p-RELS-5K-DRO	4.13	2.51	2.38	0.20	1.34	1.25	5/8-18 F x 1.12	5/8-18 F x 0.87
p-RELS-10K-DRO	4.13	2.51	2.38	0.20	1.34	1.25	5/8-18 F x 1.12	5/8-18 F x 0.87
p-RELS-25K-DRO	6.06	3.50	3.38	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
p-RELS-50K-DRO	6.06	3.50	3.38	0.30	2.65	2.25	1 1/4-12 F x 1.40	1 1/4-12 F x 1.40
p-RELS-100K-DRO	8.00	4.50	4.25	0.40	3.76	3.00	1 3/4-12 F x 2.15	1 3/4-12 F x 1.75
p-RELS-200K-DRO	11.00	6.50	6.00	0.50	4.81	4.50	2 3/4-8 F x 2.75	2 3/4-8 F x 2.75
p-RELS-400K-DRO	12.00	9.00	8.75	0.59	6.18	6.00	3 1/2-8 F x 4.13	3 1/2-8 F x 3.75
p-RELS-600K-DRO	15.50	10.50	10.00	0.69	7.73	7.75	4 1/4-8 F x 4.25	4 1/4-8 F x 4.25
p-RELS-1M-DRO	20.50	13.25	13.00	1.00	10.55	10.55	6-8 F x 5.63	6-8 F x 6.38
p-RELS-2M-DRO	26.00	16.75	16.50	1.25	13.79	14.00	8-8 F x 7.00	8-8 F x 7.25



OPTIONS		
	Part Number	Description
Display Output	CABLE-RS232	RS-232 Output Cable*
	OUT-ANALOG	0-10V / 4-20mA Output
	OUT-BT	Bluetooth 4.0 Output
Sensor Connection	CABLE-6W	6-Wire Cable (15ft)
	CABLE-RF	Wireless Sensor Link
Sensor Modification	p-RELS-Capacity-DRO-ESO	Enhanced Safe Overload

\* RS-232 digital output is standard

# p-RELS-DRO Series: Premium Rod-End Load Sensor with Digital Readout

RELS Series load sensors mount directly to the rod-end of a cylinder, situating the measurement device in an ideal position: directly within the load chain and immediately adjacent to the loading event.

Premium RELS load sensors enhance performance by offering significantly improved accuracy, repeatability, off-axis / eccentric load compensation, and temperature compensation.

The p-RELS-DRO package is a Premium RELS load cell mated with a HR-DRO digital readout, which are calibrated together as a dedicated pair. Its variety of configuration options and user-selectable features create a flexible, accurate, traceable and easy-to-use measurement system.

### Key Applications

- On-screen capture of peak force measurements
- Analog, digital or wireless connection to PC / PCL for remote force monitoring
- Transfer standard for calibration/verification of force measurement devices
- Determination of effective area in pressure-based force measurement systems



## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±N)	Resolution (±N)	Combined Error (±N)	Non-Repeatability (±N)	Eccentric Load Sensitivity (±%RDG / mm)	Min Rod Ø (mm)	Deflection (mm / FS)	
Standard Sensor Capacities	p-RELS-25KN-DRO	25,000	1 N	20	2.5	0.10	28	0.05	
	p-RELS-50KN-DRO	50,000	1 N	35	5		56		
	p-RELS-100KN-DRO	100,000	2 N	80	10				
	p-RELS-250KN-DRO	250,000	0.01 kN	160	25			70	0.10
	p-RELS-450KN-DRO	450,000	0.01 kN	450	45			110	0.30
	p-RELS-900KN-DRO	900,000	0.02 kN	1,500	90			140	0.20
	p-RELS-1.8MN-DRO	1,800,000	0.1 kN	3,000	180			180	0.20
	p-RELS-2.7MN-DRO	2,700,000	0.1 kN	5,400	270			240	0.20
	p-RELS-4.5MN-DRO	4,500,000	0.1 kN	11,250	450			320	0.30
	p-RELS-9MN-DRO	9,000,000	0.2 kN	31,500	900				

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

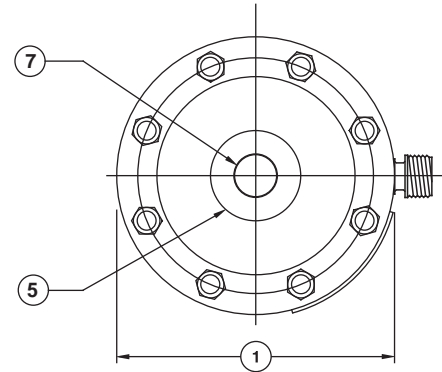
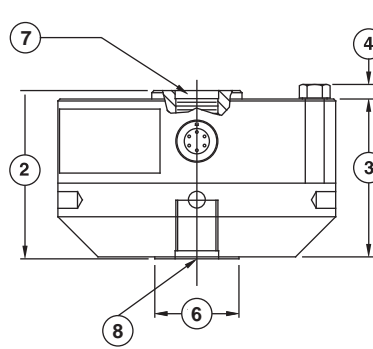
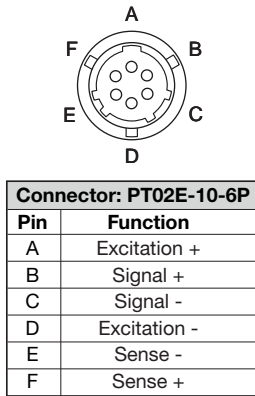
MECHANICAL (sensor)	
Safe Overload	±150%FS
Enhanced Safe Overload	+300%FS (compression only)

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-RELS-100K-DRO**

THERMAL	
Compensated Range (sensor)	-10 to 45°C
Operating Range (sensor)	-20 to 90°C
Effect on Output (sensor)	0.0015%FS/°C
Operating Range (display)	-10 to 40°C

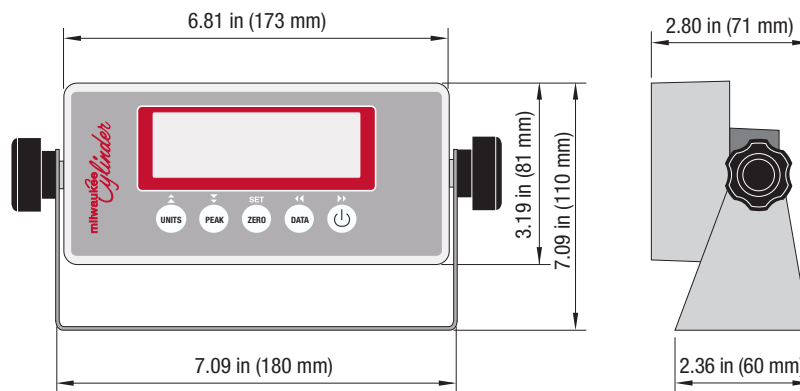
USER-SELECTABLE DISPLAY OPTIONS	
Display Resolution	100 to 50,000 counts
Sampling Rate	1.75 to 1200.00 Hz
Averaging Filter	0 to 12 samples
Units of Measure	lbf, N, kgf

STANDARD SENSOR CABLE	
Wires	4
Length	4.5 m



### DIMENSIONS (mm)

Description	①	②	③	④	⑤		⑦		⑧
	Body Ø	Total Length	Body Length	Cap Head Height	Active	Mounting	Active	Mounting	
p-RELS-25KN-DRO	104.8	63.5	60.3	5.1	34.0	31.8	M16x2 x 28.4	M16x2 x 22.1	
p-RELS-50KN-DRO	104.8	63.5	60.3	5.1	34.0	31.8	M16x2 x 28.4	M16x2 x 22.1	
p-RELS-100KN-DRO	153.9	89.0	85.9	7.6	67.3	57.2	M33x2 x 35.6	M33x2 x 35.6	
p-RELS-250KN-DRO	153.9	89.0	85.9	7.6	67.3	57.2	M33x2 x 35.6	M33x2 x 35.6	
p-RELS-450KN-DRO	203.2	114.3	108.0	10.2	95.2	76.2	M42x2 x 54.6	M42x2 x 44.5	
p-RELS-900KN-DRO	279.0	165.1	152.4	12.7	122.2	114.3	M72x2 x 70.0	M72x2 x 69.8	
p-RELS-1.8MN-DRO	304.8	228.6	222.3	20.0	156.8	152.4	M90x3 x 104.9	M90x3 x 95.3	
p-RELS-2.7MN-DRO	393.7	266.7	254.0	12.5	196.3	196.9	M120x4 x 108.0	M120x4 x 108.0	
p-RELS-4.5MN-DRO	520.7	336.6	330.2	25.4	267.9	267.9	M150x4 x 143.0	M150x4 x 162.0	
p-RELS-9MN-DRO	660.4	425.5	419.1	31.3	350.3	355.6	M200x4 x 178.0	M200x4 x 184.0	



### OPTIONS

	Part Number	Description
Display Output	CABLE-RS232	RS-232 Output Cable*
	OUT-ANALOG	0-10V / 4-20mA Output
	OUT-BT	Bluetooth 4.0 Output
Sensor Connection	CABLE-6W	6-Wire Cable (4.57m)
	CABLE-RF	Wireless Sensor Link
Sensor Modification	p-RELS-Capacity-DRO-ESO	Enhanced Safe Overload

\* RS-232 digital output is standard

# p-SMLS Series: Premium Surface-Mount Load Sensor

SMLS Series sensors can be mounted to any flat, rigid surface to capture a direct measurement of force normal to that surface.

The Premium SMLS features advanced eccentric / off-axis load compensations to significantly improve accuracy and repeatability; this is particularly beneficial when load alignment can be subject to variance.

## Benefits of Direct Force Measurement vs Pressure-Derived Load Estimates

- Excellent Accuracy and Sensitivity
- Improved Reproducibility and Repeatability
- Low Latency, Immune to Cylinder Friction
- Temperature Compensated
- Measurement is NIST Traceable



## Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Extreme Repeatability of Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging
- Calibration Reference for Pressure-Measurement-Based Systems

## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale (±lbf)	Combined Error (±lbf)	Non-Repeatability (±lbf)	Eccentric Load Sensitivity (%RDG / in)	Deflection (in / FS)
<b>Standard Sensor Capacities</b>	p-SMLS-5K	5,000	3.5	0.5	0.25	0.002
	p-SMLS-10K	10,000	7	1		
	p-SMLS-25K	25,000	20	2.5		
	p-SMLS-50K	50,000	40	5		
	p-SMLS-100K	100,000	100	10		0.003
	p-SMLS-200K	200,000	240	20		0.012
	p-SMLS-400K	400,000	680	80		0.007
	p-SMLS-600K	600,000	1,200	120		0.008
	p-SMLS-1M	1,000,000	2,500	200		0.008
	p-SMLS-2M	2,000,000	7,000	400		0.012

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	150	± %FS

THERMAL		
Compensated Range	15 to 115	°F
Operating Range	-65 to 200	
Effect on Output	0.0008	%FS / °F

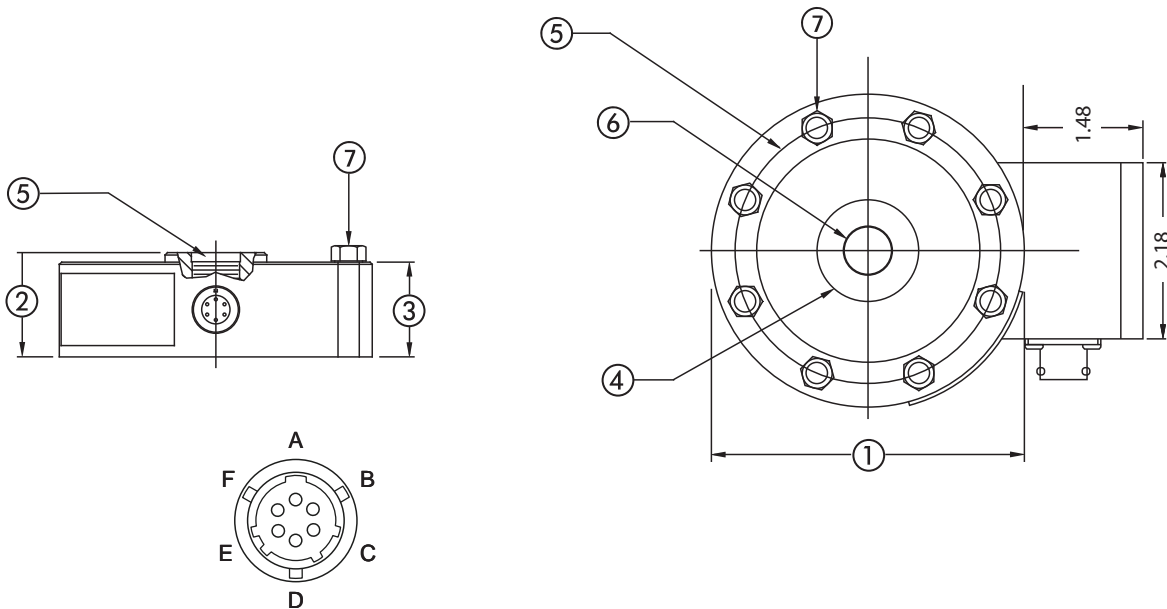
RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-SMLS-100K-V**

Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
		-V	-10 V	0 V	+10 V	11.5 – 26
-A	4 mA	12 mA	20 mA			

Other output types available upon request.





Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal

DIMENSIONS (in)							
Description	① Body Ø	② Total Height	③ Body Height	④ Loading Surface Ø	⑤ Bolt Circle	⑥ Thread Type (UNF) x Length	
						Loading Thread	Mounting Screws*
p-SMLS-5K	4.13	1.38	1.25	1.34	3.50	5/8-18 F x 1.12	1/4-28 x 1.50
p-SMLS-10K	4.13	1.38	1.25	1.34	3.50	5/8-18 F x 1.12	1/4-28 x 1.50
p-SMLS-25K	6.06	1.75	1.63	2.65	5.13	1 1/4-12 F x 1.40	1/4-28 x 1.50
p-SMLS-50K	6.06	1.75	1.63	2.65	5.13	1 1/4-12 F x 1.40	3/8-24 x 2.25
p-SMLS-100K	8.00	2.50	2.25	3.76	6.50	1 3/4-12 F x 2.15	1/2-20 x 3.00
p-SMLS-200K	11.00	3.50	3.00	4.81	9.00	2 3/4-8 F x 2.75	5/8-18 x 4.00
p-SMLS-400K	12.00	4.50	3.25	6.18	9.88	3 1/2-8 F x 4.13	3/4-16 x 5.50
p-SMLS-600K	15.50	5.50	5.00	7.73	12.68	4 1/4-8 F x 4.25	7/8-14 x 6.40
p-SMLS-1M	20.50	6.25	6.00	10.55	16.50	6-8 F x 5.63	1-14 x 7.50
p-SMLS-2M	26.00	7.75	7.50	13.79	20.50	8-8 F x 7.00	1 1/4-12 x 9.50

\*Mounting screws should be Grade 8 (10.9) or better

# p-SMLS Series: Premium Surface-Mount Load Sensor

SMLS Series sensors can be mounted to any flat, rigid surface to capture a direct measurement of force normal to that surface.

The Premium SMLS features advanced eccentric / off-axis load compensations to significantly improve accuracy and repeatability; this is particularly beneficial when load alignment can be subject to variance.

## Benefits of Direct Force Measurement vs Pressure-Derived Load Estimates

- Excellent Accuracy and Sensitivity
- Improved Reproducibility and Repeatability
- Low Latency, Immune to Cylinder Friction
- Temperature Compensated
- Measurement is NIST Traceable

## Key Applications

- Direct Input to Delta Computer Systems and other PLC platforms
- Accurate, Reproducible and Sensitive Force Measurements
- Extreme Repeatability of Displacement Measurements for Servo Control
- High Speed Measurements / Data Logging
- Calibration Reference for Pressure-Measurement-Based Systems



## PERFORMANCE SPECIFICATIONS

	Part Number	Full Scale	Combined Error	Non-Repeatability	Eccentric Load Sensitivity Full Scale (%RDG / mm)	Deflection
		(±N)	(±N)	(±N)		(mm / FS)
Standard Sensor Capacities	p-SMLS-25KN	25,000	20	2.5	0.10	0.05
	p-SMLS-50KN	50,000	35	5		
	p-SMLS-100KN	100,000	80	10		
	p-SMLS-250KN	250,000	160	25		
	p-SMLS-450KN	450,000	450	45		0.10
	p-SMLS-900KN	900,000	1,500	90		0.30
	p-SMLS-1.8MN	1,800,000	3,000	180		0.20
	p-SMLS-2.7MN	2,700,000	5,400	270		0.20
	p-SMLS-4.5MN	4,500,000	11,250	450		0.20
	p-SMLS-9MN	9,000,000	31,500	900		0.30

Additional capacities available upon request. %RDG: percent of applied load. 5-Points bidirectional NIST / ISO 17025 Accredited Calibration included. FS: full scale, the capacity of the sensor. Min Rod Diameter: Recommended to fully support load cell in compressive loading.

MECHANICAL		
Safe Overload	150	± %FS

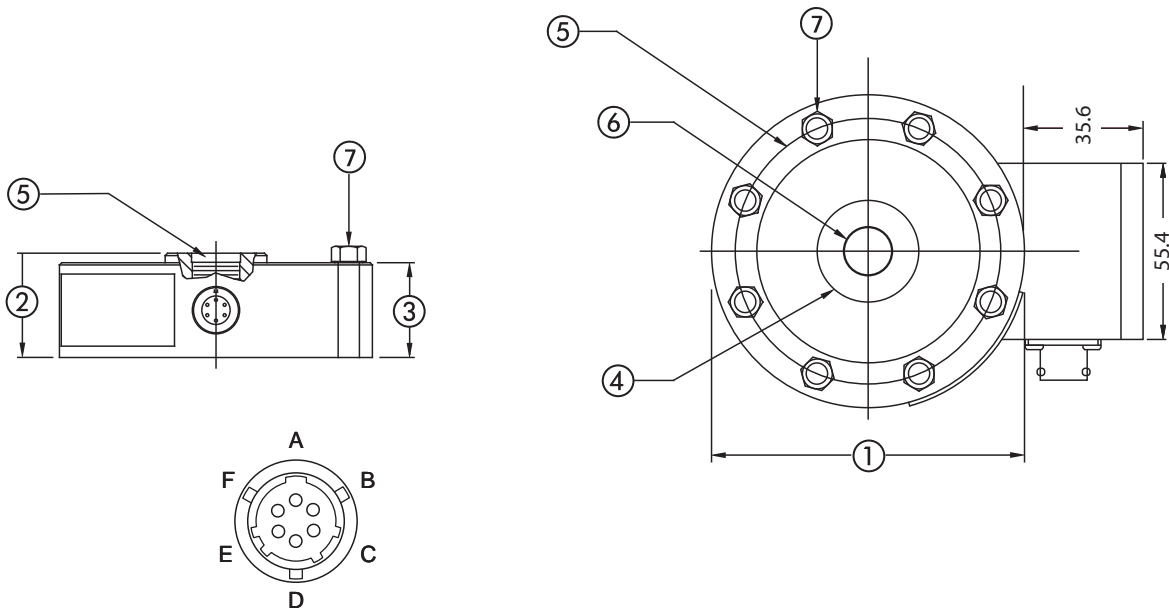
THERMAL		
Compensated Range	-10 to 45	°C
Operating Range	-20 to 90	
Effect on Output	0.0015	%FS / °C

RESPONSE		
Dynamic	1000	Hz
Bandwidth	1	ms

**NAMING SCHEME: Modifier-Series-Capacity-Output**  
**EXAMPLE: p-SMLS-100K-V**

Signal Output Selection	PN Suffix	Output At			Power Supply	
		Tension FS	Zero	Compression FS	VDC	mA
		-V	-10 V	0 V	+10 V	11.5 – 26
-A	4 mA	12 mA	20 mA			

Other output types available upon request.



Connector: PT02E-10-6P	
Pin	Function
A	+ Supply
B	Supply Ground
C	Output Ground
D	+ Output
E	Shunt Cal
F	Shunt Cal

DIMENSIONS (mm)							
Description	①	②	③	④	⑤	⑥	
	Body Ø	Total Height	Body Height	Loading Surface Ø	Bolt Circle	Thread Type x Length	
						Loading Thread	Mounting Screws*
p-SMLS-25KN	104.8	34.9	31.7	34	88.9	M16 x 2 x 28.4	M6 x 40
p-SMLS-50KN	104.8	34.9	31.7	34	88.9	M16 x 2 x 28.4	M6 x 40
p-SMLS-100KN	153.9	44.5	41.4	67.3	130.3	M33 x 2 x 35.6	M10 x 60
p-SMLS-250KN	153.9	44.5	41.4	67.3	130.3	M33 x 2 x 35.6	M10 x 60
p-SMLS-450KN	203.2	63.5	57.2	95.2	165.1	M42 x 2 x 54.6	M12 x 75
p-SMLS-900KN	279.0	88.9	76.2	122.2	228.6	M72 x 2 x 70.0	M16 x 100
p-SMLS-1.8MN	304.8	114.3	108.0	156.8	250.8	M90 x 3 x 104.9	M20 x 140
p-SMLS-2.7MN	393.7	139.7	127.0	196.3	322.1	M120 x 4 x 108.0	M24 x 165
p-SMLS-4.5MN	520.7	158.8	152.4	267.9	419.1	M150 x 4 x 143.0	M24 x 190
p-SMLS-9MN	660.4	196.9	190.5	350.3	520.7	M200 x 4 x 178.0	M30 x 250

\*Mounting screws should be Grade 8 (10.9) or better

# HTVK: High Tonnage Verification Kit

HTVK Series Verification Kits are an accurate means of directly calibrating the compressive output of ENERPAC High Tonnage Cylinders and other high-force devices. Using the HTVK, the force output of a cylinder at various pressures can be measured and then used to determine its effective piston area.

Combined error of less than  $\pm 0.15\%$  of sensor capacity allows a single kit to service a broad range of cylinders or DUT (devices under test). Its high resolution makes hydraulic leak detection immediate and definitive.

### Key Features

- High-Resolution Digital Readout
- Selectable Units of Measure
- Real Time and Peak Force Modes
- Temperature Compensated for Field Measurements
- Standard RS-232 Output for Data Collection
- Optional Wireless Sensor Connection



### PERFORMANCE SPECIFICATIONS (klbf)

	Part Number	Full Scale	Resolution	Combined Error	Non-Repeatability
				( $\pm$ )	( $\pm$ )
Standard Sensor Capacities	HTVK-150T	300	0.01	0.45	0.09
	HTVK-200T	400	0.01	0.60	0.12
	HTVK-250T	500	0.01	0.75	0.15
	HTVK-300T	600	0.02	0.90	0.18
	HTVK-350T	700	0.02	1.05	0.21
	HTVK-500T	1,000	0.02	1.50	0.30
	HTVK-600T	1,200	0.05	1.80	0.36
	HTVK-800T	1,600	0.05	2.40	0.48
	HTVK-1000T	2,000	0.05	3.00	0.60

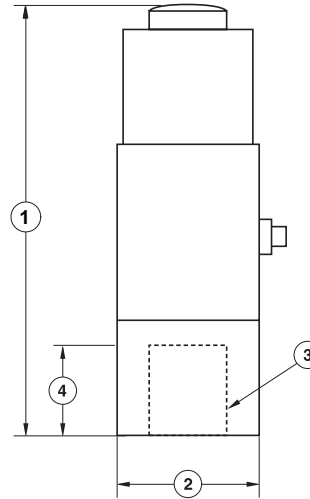
MECHANICAL (sensor)	
Safe Overload	$\pm 150\%$ FS

THERMAL	
Compensated Range (sensor)	32 to 132°F
Operating Range (sensor)	-30 to 200°F
Effect on Output (sensor)	0.003%FS/°F
Operating Range (display)	15 to 105°F

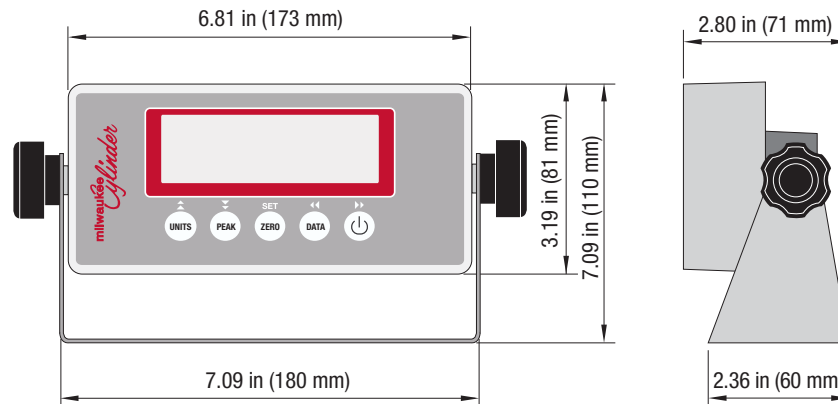
USER-SELECTABLE DISPLAY OPTIONS	
Display Resolution	100 to 50,000 counts
Sampling Rate	1.75 to 1200.00 Hz
Averaging Filter	0 to 12 samples
Units of Measure	lbf, N, kgf

STANDARD SENSOR CABLE	
Wires	4
Length	15 ft.

Connector: MS3102A-14S-5P	
Pin	Function
A	Excitation +
B	Excitation -
C	Output -
D	Output +
E	None



DIMENSIONS (in)				
Description	① Height	② Body Ø	③ Thread Type (UNF)	④ Thread Depth
HTVK-150T	17.50	5.50	3 1/2-12	3.75
HTVK-200T	20.00	5.50	3 1/2-12	4.00
HTVK-250T	22.25	6.00	4-12	4.50
HTVK-300T	24.25	7.00	4 1/2-8	5.00
HTVK-350T	26.50	7.50	5-8	5.50
HTVK-500T	28.80	9.50	6-8	6.50
HTVK-600T	14.50	7.25	Base is Unthreaded	
HTVK-800T	16.25	8.25	Base is Unthreaded	
HTVK-1000T	18.00	14.00	Base is Unthreaded	



OPTIONS		
	Part Number	Description
Display Output	CABLE-RS232	RS-232 Output Cable*
	OUT-ANALOG	0-10V / 4-20mA Output
	OUT-BT	Bluetooth 4.0 Output
Sensor Connection	CABLE-RF	Wireless Sensor Link
Sensor Modification	Handles	Installed Handle Kit

\* RS-232 digital output is standard

# SGPS Series: Servo-Grade Pressure Sensors

When a direct force measurement is either impossible or unnecessary, a pair of pressure transducers can be mounted on the opposing sides of the piston to develop a differential pressure measurement used to estimate the force generated.

**The SGPS Series Offer:**

- Quick dynamic response required for servo control applications
- Integrated signal conditioning
- Reliable over a wide temperature range
- Robust stainless steel design
- Thrive in harsh / high-shock / high-vibration environments



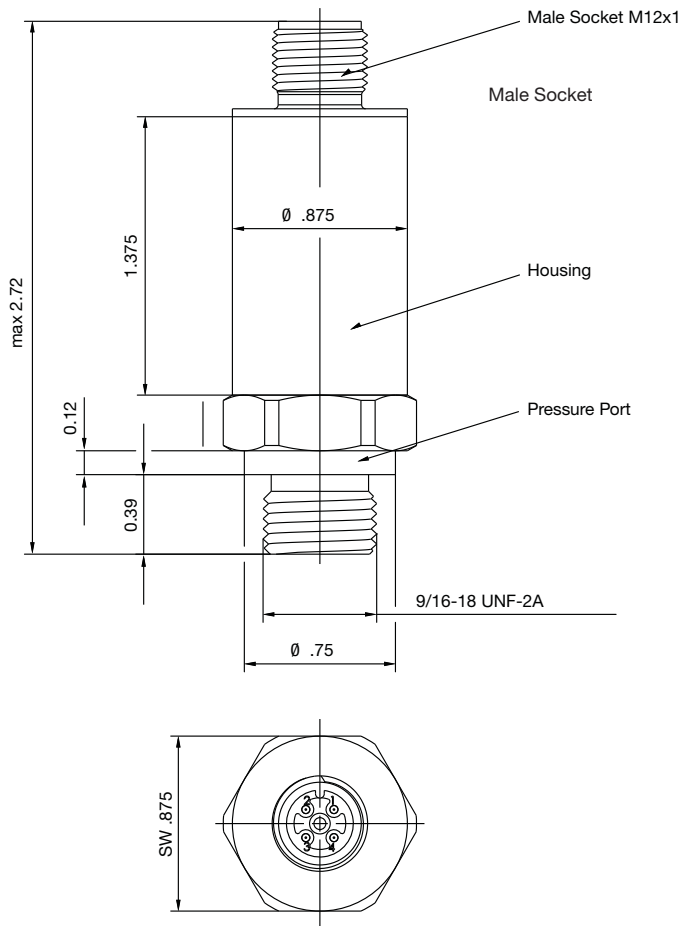
Force Estimation Uncertainty			
	Temperature Range		
	70° to 74°F	-4° to 185°F	-40° to 221°F
Calibrated Accuracy of Pressure Sensor ( $\pm\%$ FS)	0.25	1.50	2.00
Combined Uncertainty of Force Estimate* ( $\pm\%$ FS)	0.59	3.50	4.75

\*Uncertainty Estimate assumes: two SGPS transducers used to develop differential pressure measurement; maximum force (FS) at 3000PSI cylinder input pressure; no internal cylinder friction; diameter of steel piston measured to  $\leq \pm 0.02\%$  at 72°F; insignificant error contribution from ADC electronics.

SPECIFICATIONS	
<b>MATERIALS</b>	
Housing	Stainless Steel
Pressure Connection	304 SS
Sensor Diaphragm	17-4PH SS
<b>PROTECTIONS</b>	
IP Ingress Rating	67
Reverse Polarity Protect	Yes
Miswired Protect	Yes
<b>DURABILITY</b>	
Overpressure (psi)	10,000
Burst Pressure (psi)	25,000
Vibration	IEC 68-2-6 / IEC 68-2-36
Shock	IEC 68-2-32
Drop Height (ft)	3.3
Duty Life (cycles)	10,000,000
<b>IMPLEMENTATION</b>	
Pressure Connection	9/16-18 UNF-2A Male
Electrical Connection	4-Pin with M12 Male
Power Supply (VDC)	12 to 32
Power Supply (max mADC)	24
<b>SENSOR RESPONSE</b>	
Dynamic Response (Hz)	> 1000
Bandwidth (ms)	< 1

Product Series	Output Suffix	Output At		Number of Wires
		0 psi	5000 psi	
SGPS	-V	0 V	10 V	3
	-A	4 mA	20 mA	2

SGPS Series are sold in pairs; quantity 1 is an order for 2 transducers.



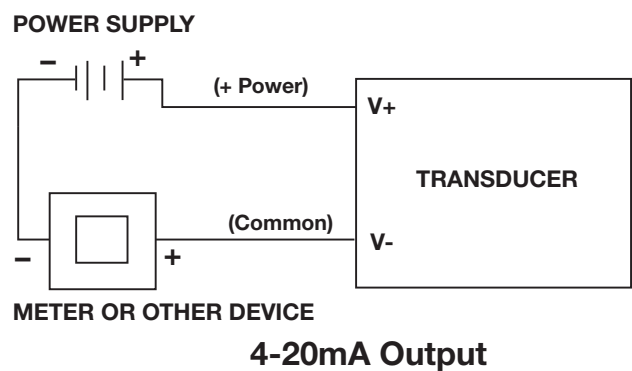
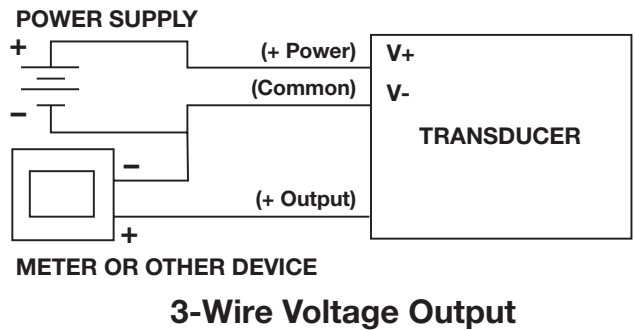
Connections* Plug M12x1
<b>0-10 Voltage</b>
1: V in 2: none 3: GND 4: V out
<b>4-20mA Current</b>
1: V in 2: none 3: GND/Signal 4: none

nc = not connected \*

The electrical connection must be made in accordance with the respective connection diagram unless otherwise agreed upon.

\* Custom-made adjustments are possible.

### Wiring Diagrams:



### Power Supply Requirements:

Output Signal	Min Supply	Max Supply
0-10V	12Vdc	32Vdc
4-20mA**	12Vdc	32Vdc



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