

Load Cells

PCB® load cells address many force measurement, monitoring and control requirements in laboratory testing, industrial, and process control applications. All models utilize strain gages, which are configured into a Wheatstone bridge circuit as their primary sensing element, along with temperature and pressure compensation. A variety of configurations and capacities address a wide range of installation scenarios. Fatigue-rated load cells are offered for applications where high cyclic loads are being monitored, such as with fatigue testing machines or repetitive processes.

Model Number Index

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		1408	7.16, 7.17

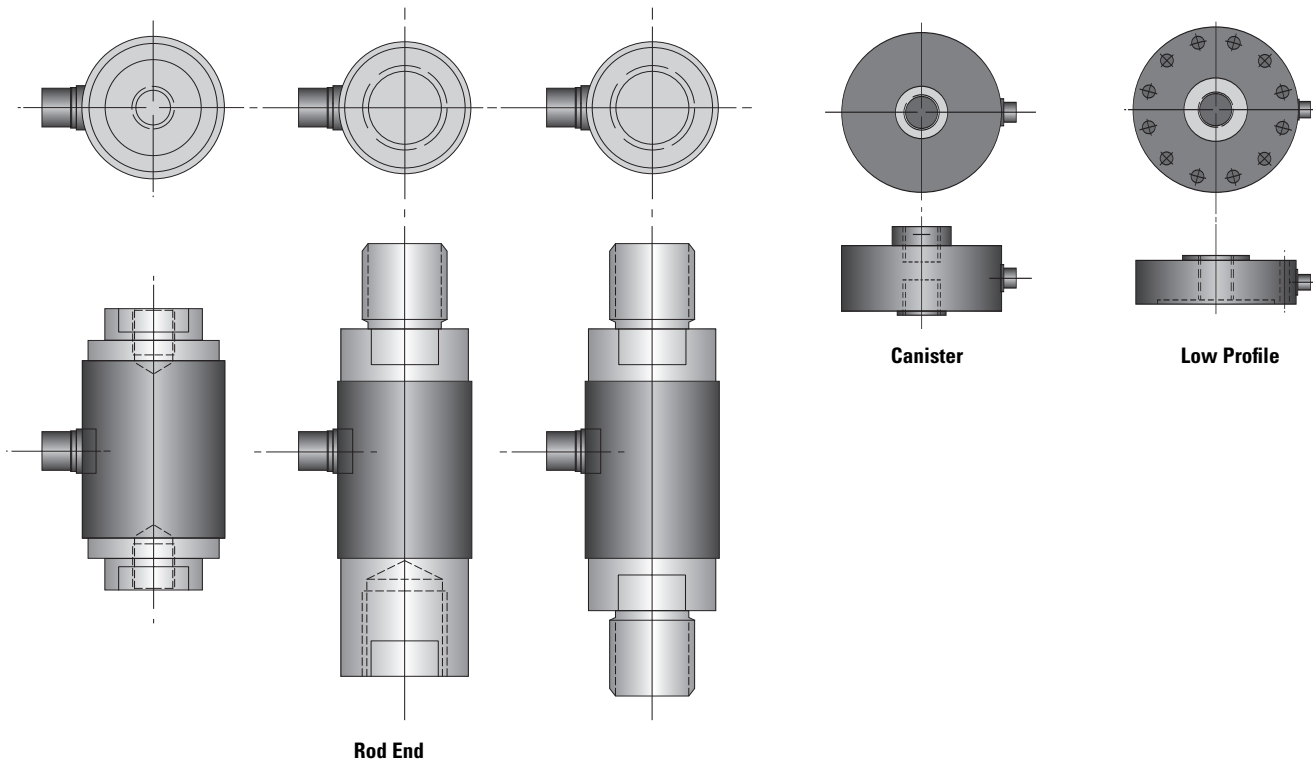
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General Purpose Load Cells

General purpose load cells are suitable for a wide range of general force measurement applications, including weighing, dynamometer testing, and material testing machines. Most of these designs operate in both tension and compression, and offer excellent accuracy and value.

A variety of configurations are available as shown below. Units range in capacity from as small as 25 lb, to as large as 100k lb (110 N to 450k N) full-scale.

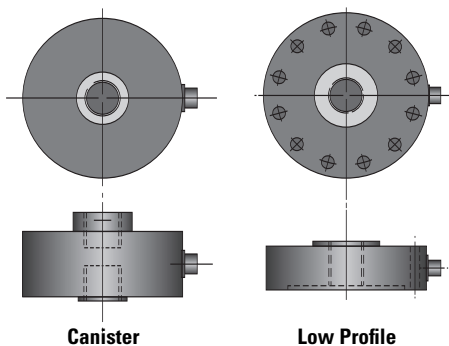


Fatigue-rated load cells

Fatigue-rated load cells are specifically designed for fatigue testing machine manufacturers and users, or in any application where high cyclic loads are present. All fatigue-rated load cells are guaranteed against fatigue failure for over 100 million fully reversed cycles.

These rugged load cells are manufactured using premium, fatigue-resistant, heat-treated steels. Internal flexures are carefully designed to eliminate stress concentration areas. Close attention is paid to the proper selection and installation of internal strain gages and wiring to ensure maximum life.

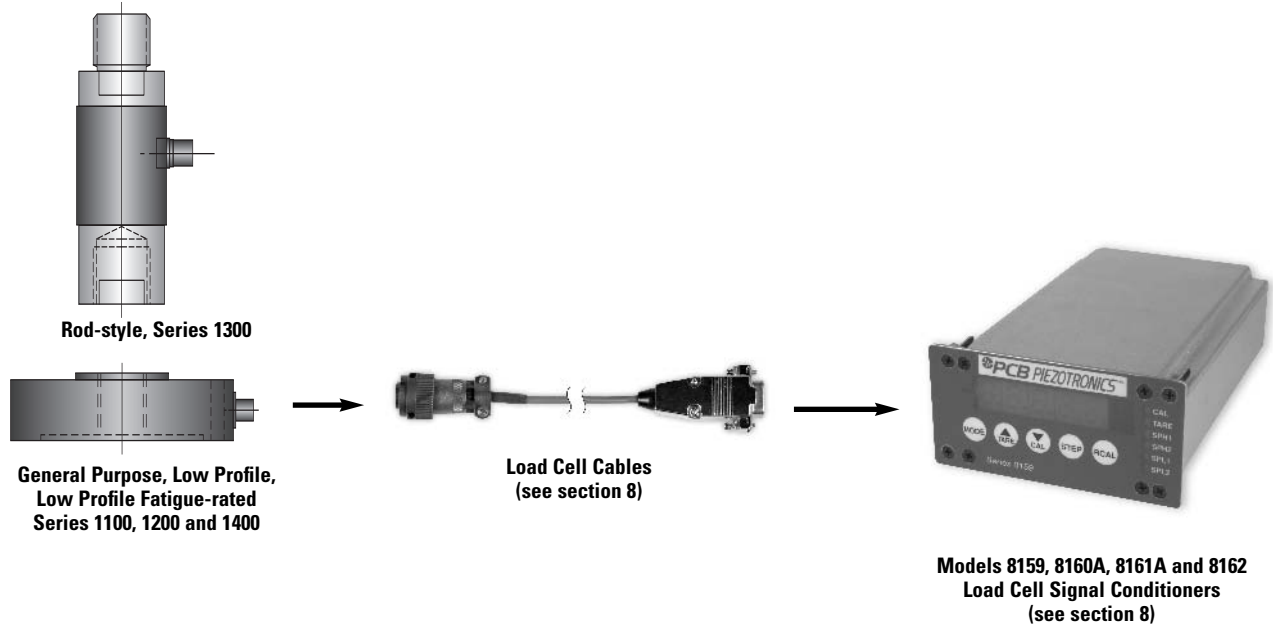
Fatigue-rated load cells are available in a variety of configurations, and in capacities from 250 lb to 50k lb (1100 N to 220k N) full-scale.



Typical measurement system for Series 1000 load cells

All PCB® strain gage load cells utilize strain gages that are configured in a Wheatstone bridge as their primary sensing element. The resistance value of the strain gages changes when load is applied to the sensing structure and consequently, any voltage through the Bridge circuit will be varied. The Wheatstone bridge requires a regulated DC voltage excitation that is commonly provided by a strain gage signal conditioner. The resultant output signal from the load cell is typically expressed in units of millivolt per volt of excitation. This millivolt signal then varies proportionately to the force applied to the load cell. The strain gage signal conditioner provides zero and span adjustments to scale its 0 to 5 VDC analog output to be proportional to any desired input range. Additional features of the signal conditioner may include a digital display and alarm set point limits.

Load cells are provided with either an electrical connector or integral cable. Cable assemblies are necessary to interface load cells having an electrical connector to the strain gage signal conditioner. Two types of cable are commonly available, and their use is dependent upon signal transmission distance. Cable assemblies may be selected with a terminating connector, which makes it easier to connect to a PCB® strain gage signal conditioner, or with a pigtail termination that allows connection to screw terminal connections on other styles of strain gage signal conditioners.



Typical Load Cell Applications

Typical Load Cell Applications

- Component Testing
- Weighing
- Quality Control
- Material Testing
- Seat Testing
- Torque Arm
- Life Cycle Testing
- Bumper Impact
- Structural Testing
- Press Applications
- Calibration Standard
- Wire or Cable Tension
- Hydraulic Actuators
- Production Monitoring
- Safety Testing
- Biomedical Applications
- Crash Barriers
- Push/Pull Testing
- Brake Pedal Testing
- Bumper Testing
- Steering Column Impact
- Fatigue Testing
- Bridge Testing
- Concrete Testing
- Seat Structure Testing
- Fabric Wear Testing
- Bushing and Bearing Testing
- Plugs and Seal Testing
- Dynamometer
- Engine Performance Testing

Selection Guide

General Purpose Canister Load Cells

Size (dia x height) - in	2.75 x 1.5		
Size (dia x height) - mm	69.9 x 38.1		
Thread	1/4-28		
Connector	6-pin PT		
Page	3.8		
Capacity		Model Number	
25 lb	(110 N)	1102-05A	
50 lb	(225 N)	1102-01A*	
100 lb	(445 N)	1102-02A*	
200 lb	(900 N)	1102-03A*	
300 lb	(1350 N)		

* Aluminum load cells (low weight). All other models are steel.

General Purpose Low Profile Load Cells

Size (dia x height) - in	4.12 x 1.37	6.06 x 1.75	8 x 2.5
Size (dia x height) - mm	104.6 x 34.8	153.9 x 44.5	203.2 x 63.5
Thread	5/8-18	1 1/4-12	1 3/4-12
Connector	6-pin PT	6-pin PC	6-pin PC
Page	3.10	3.10	3.10
Capacity		Model Number	
500 lb	(2225 N)	1203-01A	
1000 lb	(4450 N)	1203-02A	
2000 lb	(8900 N)	1203-03A	
5000 lb	(22.2 k N)	1203-04A	
10k lb	(44.5k N)	1203-05A	1204-01B
20k lb	(89k N)		1204-02B
50k lb	(220k N)		1204-03B
100k lb	(450k N)		1208-01B
200k lb	(900k N)		1208-02B

Fatigue-rated Low Profile Load Cells

Size (dia x height) - in	4.12 x 1.37	6.06 x 1.75	8 x 2.5
Size (dia x height) - mm	104.6 x 34.8	153.9 x 44.5	203.2 x 63.5
Thread	5/8-18	1 1/4-12	1 3/4-12
Connector	6-pin PT	6-pin PC	6-pin PC
Page	3.12	3.12	3.12
Capacity		Model Number	
250 lb (1100N)	1403-01A		
500 lb (2225 N)	1403-02A		
1000 lb (4450 N)	1403-03A		
2500 lb (11.1k N)	1403-04A		
5000 lb (22.2k N)	1403-05A	1404-01B	
10k lb (44.5k N)		1404-02B	
25k lb (111k N)		1404-03B	1408-01B
50k lb (220k N)			1408-02B
100k lb (450k N)			

General Purpose Rod-style Load Cells

Size (dia x height) - in	2.25 x 4.5	1.71 x 4.5
Size (dia x height) - mm	57.2 x 114.3	43.4 x 114.3
Thread	5/8-18	1-14
Connector	6-pin PT	6-pin PT
Page	3.14	3.14
Capacity		Model Number
1000 lb (4450 N)	1302-01A*	
2000 lb (8900 N)	1302-02A*	1303-01A*
5000 lb (22.2k N)	1302-03A	1303-02A*
10k lb (44.5k N)	1302-04A	1303-03A
20k lb (89k N)		1303-04A
50k lb (220k N)		

* Aluminum load cells (low weight). All other models are steel.

Options For Load Cells

Shunt Resistor — A fixed resistor which is placed in parallel or shunted across a strain gage bridge to provide a known test signal to permit the user with a means of easily performing an accurate system calibration of a load cell and signal conditioner.

Dual-Bridge — Provides two signals for purposes of redundancy or to send a signal to two devices, such as a local area display and a data recorder.

Trimmed Output — The output of a strain gage based load cell is typically nominal ($\pm 15\%$) of specification. A trimmed output is within a 1/4% of the specified output.

Metric Threads and Capacities — Our standard product is manufactured with English attachment threads and English capacities and is calibrated with English standards. All load cell models are available with metric attachment threads, metric capacities, and metric calibration data (converted from English calibration data).

Strain Gage Load Cells

Highlights

- Low-profile
- Low-deflection
- Fatigue-rated
- NIST-traceable calibration
- Temperature & pressure compensated



PCB® manufactures a wide range of strain gage load cells for aerospace, automotive, industrial, and process control applications.

General purpose load cells are suitable for a wide range of routine static force measurement applications, including weighing, dynamometer testing, and material testing machines. Most general purpose designs operate in both tension and compression, and are available in configurations including: canister, low profile and rod end, styles. Capacities from 25 lb to 100k lb (110 N to 450k N) full-scale are available.

Fatigue-rated load cells are specifically designed for fatigue testing machine manufacturers and users, or in any application where high cyclic loads are present. Applications include material testing, component life cycle testing, and structural testing. All fatigue-rated load cells are guaranteed against fatigue failure for 100 million fully reversed cycles. Capacities are available from 250 lb to 50k lb (1100 N to 220k N) full-scale.

For special or unusual applications, please call to discuss your needs with one of our force application specialists.

General Purpose Load Cells / 25-300 lb

General Purpose Load Cells

Tension and compression measurements

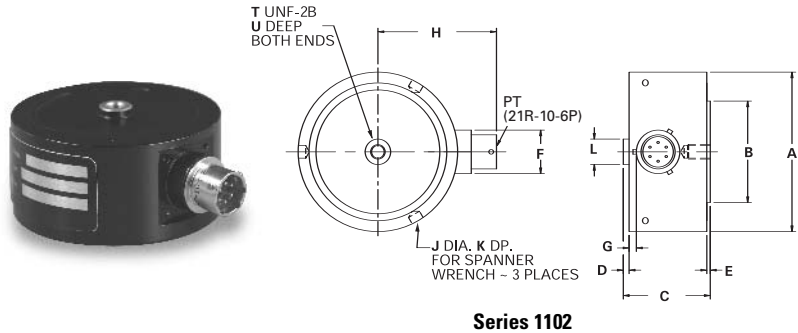
- component testing
- quality control
- material testing
- weighing
- seat testing
- torque arm

Series 1102 — general purpose canister-style with 6-pin connector

- Capacities from 25 to 300 lb (110 to 1350 N) FS
- 2 mV/V output sensitivity
- Low profile design

Recommended cables and accessories ⑩
— see section 8

Select a signal conditioner from those featured
in section 8



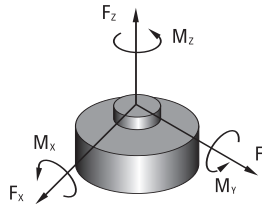
Series 1102

Dimensions — inches (mm)

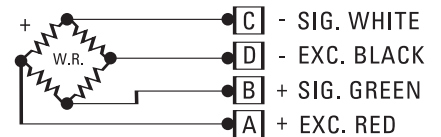
Series	A	B	C	D	E	F	G	H	J	K	L	T	U
1102	2.75 (69.9)	1.75 (44.5)	1.5 (38.1)	0.1 (2.5)	0.06 (1.5)	0.75	0.13 (3.3)	2.05 (52.07)	0.22 (5.5)	0.13 (3.3)	0.44 (11.2)	1/4-28	0.38 (9.7)

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ringing Frequency Hz	Weight lb (gm)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Canister Load Cells with 6-Pin Connector									
1102-05A	25 (110)	37.5 (165)	0.003 (0.08)	2100	0.67 (304)	aluminum	25 (110)	25 (2.8)	35 (4)
1102-01A	50 (225)	75 (330)	0.003 (0.08)	2800	0.67 (304)	aluminum	50 (225)	50 (5.6)	35 (4)
1102-02A	100 (445)	150 (675)	0.003 (0.08)	3800	0.67 (304)	aluminum	100 (445)	100 (11)	65 (7.3)
1102-03A	200 (900)	300 (1350)	0.003 (0.08)	5400	0.67 (304)	aluminum	200 (900)	200 (23)	65 (7.3)
1102-04A	300 (1350)	450 (2000)	0.003 (0.08)	7000	0.67 (304)	aluminum	300 (1350)	300 (34)	65 (7.3)
Common Specifications									
Output (nominal) ($\pm 25\%$)2 mV/V					Temp. Range (compensated)+70 °F to +170 °F (+21 °C to +77 °C)				
Non-linearity (max)0.05% FS [1]					Temp. Range (usable)- 65 °F to +200 °F (-54 °C to +93 °C)				
Hysteresis (max)0.05% FS [1]					Temp. Effect on Zero (max) ..0.002% FS/ °F (0.0036% FS / °C)				
Non-repeatability (max)0.02% FS [1]					Temp. Effect on Output (max)0.002% of reading / °F (0.0036% of reading / °C)				
Bridge Resistance (nom)700 ohm									
Excitation (recommended)10 Volts DC or AC rms									

Note: [1] Model 1102-05A — non-linearity 0.1%, hysteresis 0.1%, non-repeatability 0.05%



The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.



Wiring Diagram

Low Profile Load Cells / 500 - 10k lb

Low Profile Load Cells

For higher range tension and compression measurements

- component testing
- life cycle testing
- material testing
- bumper impact
- structural testing
- press applications

Series 1203

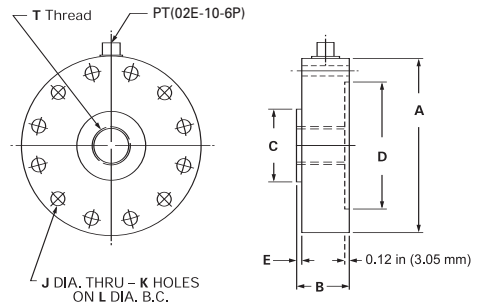
- Capacities from 500 to 10k (2225 N to 44.5k N) FS
- 2 mV/V or 3 mV/V output sensitivity
- 6-pin connector
- Optional mounting base available

Recommended cables and accessories ☎
— see section 8

Select a signal conditioner from those featured
in section 8

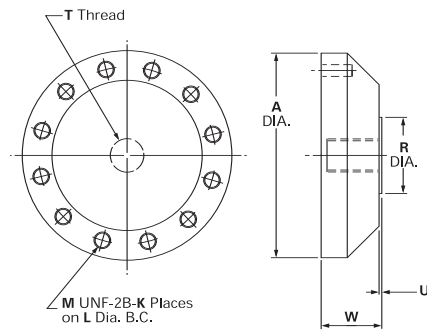


Series 1203



Series 1203

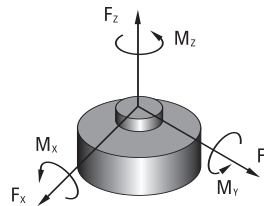
Load cell shown with optional mounting base.



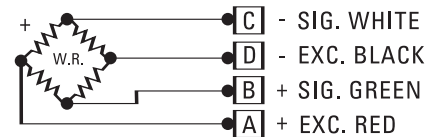
Dimensions — Inches (mm)

Series	A	B	C	D	E	J	K	L	M	R	T	U	W	Base PN
1203	4.12 (104.6)	1.37 (34.8)	1.27 (32.3)	2.85 (75.5)	0.12 (3.1)	0.28 (7.1)	8	3.5 (88.9)	1/4-28	1.25 (31.8)	5/8-18	0.03 (0.8)	1.13 (28.7)	C-30396-6A

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ringing Frequency Hz	Weight lb (kg)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Low Profile Aluminum Load Cells with 5/8-18 Thread									
1203-01A	500 (2225)	750 (3300)	0.002 (0.05)	2350	2.88 (1.31)	steel	250 (1100)	250 (28)	250 (28)
1203-02A	1000 (4450)	1500 (6675)	0.002 (0.05)	3500	2.88 (1.31)	steel	500 (2225)	500 (55)	500 (55)
1203-03A	2000 (8900)	3000 (13.3k)	0.001 (0.03)	5500	2.88 (1.31)	steel	1000 (4450)	1000 (115)	1000 (115)
1203-04A	5000 (22.2k)	7500 (33.3k)	0.0015 (0.038)	7000	2.88 (1.31)	steel	2500 (11.1k)	2500 (280)	2500 (280)
1203-05A	10k (44.5k)	15k (66.7k)	0.0015 (0.038)	10k	2.88 (1.31)	steel	5000 (22.2k)	5000 (565)	5000 (565)
Common Specifications									
Output (nominal)							Temp. Range (compensated)		
500 – 2000k lb Capacity							+70 °F to +170 °F		
5k – 100k lb Capacity.....							(+21 °C to +77 °C)		
Non-linearity (max)							Temp. Range (usable)		
0.05% FS							-65 °F to +200 °F		
Hysteresis (max)							(-54 °C to +93 °C)		
0.05% FS							Temp. Effect on Zero (max)		
Non-repeatability (max)							0.001% FS / °F [2]		
0.02% FS							(0.0018% FS / °C)		
Bridge Resistance (nom).....							Temp. Effect on Output (max)		
700 ohm							0.002% reading / °F		
Excitation (recommended)							(0.0036% reading / °C)		
10 Volts DC or AC rms									



The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.



Wiring Diagram

Low Profile Load Cells / 10k - 100k lb

Low Profile Load Cells

For higher range tension and compression measurements

- component testing
- bumper impact
- Life cycle testing
- structural testing
- material testing
- press applications

Series 1204, 1208

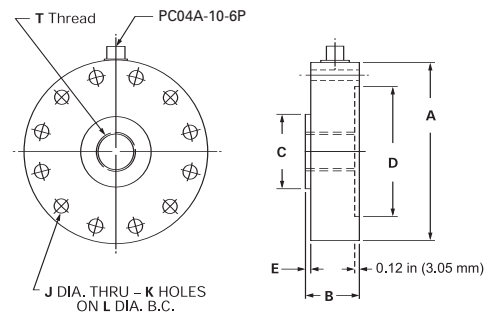
- Capacities from 10k to 100k lb (44.5k to 450k N) FS
- 3 mV/V output sensitivity
- 6-pin connector
- Optional mounting base available
- Built-in temperature compensation
- Barometric pressure compensation

Recommended cables and accessories ⑧
— see section 8

Select a signal conditioner from those featured
in section 8

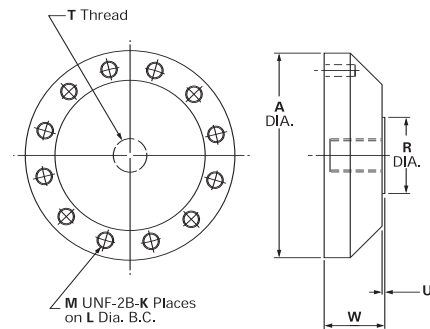


Series 1204, 1208



Series 1204, 1208

Load cell shown with optional mounting base.

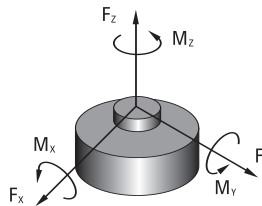


Dimensions — Inches (mm)

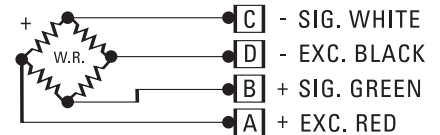
Series	A	B	C	D	E	J	K	L	M	R	T	U	W	Base PN
1204	6.06 (153.9)	1.75 (44.5)	2.42 (61.5)	4.33 (110)	0.12 (3.1)	0.41 (10.4)	12	5.13 (130.3)	3/8-24	2.25 (57.2)	1 1/4-12	0.03 (0.8)	1.75 (44.5)	D-30427-3A
1208	8 (203.2)	2.5 (63.5)	3.5 (88.9)	5.25 (133.4)	0.25 (6.4)	0.53 (13.5)	16	6.5 (165.1)	1/2-20	3.5 (88.9)	1 3/4-12	0.06 (1.5)	2 (50.8)	D-30110-1A

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ringing Frequency Hz	Weight lb (kg)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Low Profile Load Cells with 1 1/4-12 Thread									
1204-01B	10k (44.5k)	15k (66.7k)	0.0015 (0.038)	5500	8.96 (4.06)	steel	5000 (22.2k)	5000 (565)	5000 (565)
1204-02B	20k (89k)	30k (130k)	0.0015 (0.038)	8000	8.96 (4.06)	steel	10k (44.5k)	10k (1130)	10k (1130)
1204-03B	50k (220k)	75k (335k)	0.0015 (0.038)	12k	8.96 (4.06)	steel	25k (111k)	25k (2825)	25k (2825)
Low Profile Load Cells with 1 3/4-12 Thread									
1208-01B	50k (220k)	75k (335k)	0.002 (0.05)	8550	25.5 (11.57)	steel	25k (111k)	25k (2825)	25k (2825)
1208-02B	100k (450k)	150k (667k)	0.002 (0.05)	9550	25.5 (11.57)	steel	50k (220k)	50k (5650)	50k (5650)
Common Specifications									
Output (nominal) 10k – 100k lb Capacity.....3 mV/V					Temp. Range (compensated)+70 °F to +170 °F (+21 °C to +77 °C)				
Non-linearity (max)0.05% FS ^[1]					Temp. Range (usable)-65 °F to +200 °F (-54 °C to +93 °C)				
Hysteresis (max).....0.05% FS ^[1]					Temp. Effect on Zero (max)0.001% FS / °F [2] (0.0018% FS / °C)				
Non-repeatability (max).....0.02% FS ^[1]					Temp. Effect on Output (max)0.002% reading / °F (0.0036% reading / °C)				
Bridge Resistance (nom).....700 ohm									
Excitation (recommended)10 Volts DC or AC rms									

Note: [1] Series 1208 — non-linearity 0.1% FS, hysteresis 0.1%, non-repeatability 0.05%.



The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.



Wiring Diagram

Fatigue-Rated Load Cells / 250 - 5k lb

Low Profile, Fatigue-Rated Load Cells

Fatigue-rated load cells are rugged devices manufactured using premium heat-treated, fatigue-resistant steels.

- material testing
- torque arm
- structural testing
- component testing
- life cycle testing
- calibration standard

Series 1403 — low profile, fatigue-rated

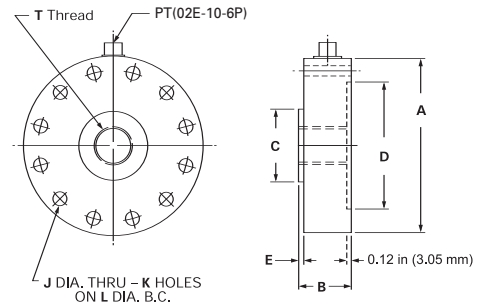
- Capacities from 250 to 5000k lb (1100 to 22.2k N) FS
- 1 mV/V or 1.5 mV/V output sensitivity
- 6-pin connector
- Fatigue-resistant steel
- Optional mounting base available
- Over 100 million fully reversed cycles without failure
- Built-in temperature compensation
- Barometric pressure compensated construction
- Low deflection

Recommended cables and accessories ☎
— see section 8

Select a signal conditioner from those featured
in section 8



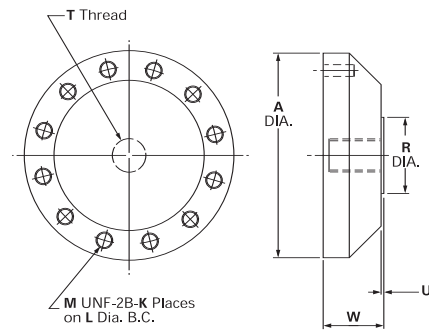
Series 1403



Load cell shown with
optional mounting base.



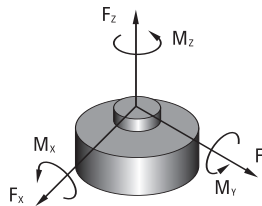
Series 1204



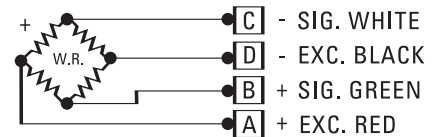
Dimensions — Inches (mm)

Series	A	B	C	D	E	J	K	L	M	R	T	U	W	Base PN
1403	4.12 (104.6)	1.37 (34.8)	1.27 (32.3)	2.85 (75.5)	0.12 (3.1)	0.28 (7.1)	8	3.5 (88.9)	5/8-18	1.25 (31.8)	5/8-18	0.03 (0.8)	1.13 (28.7)	C-30396-6A

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ringing Frequency Hz	Weight lb (kg)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Fatigue-rated Low Profile Aluminum Load Cells with 5/8-18 Thread									
1403-01A	250 (1100)	500 (2225)	0.001 (0.03)	2350	2.88 (1.31)	steel	250 (1100)	250 (28)	250 (28)
1403-02A	500 (2225)	1000 (4450)	0.001 (0.03)	3500	2.88 (1.31)	steel	500 (2225)	500 (56)	500 (56)
1403-03A	1000 (4450)	2000 (8900)	0.0005 (0.013)	5500	2.88 (1.31)	steel	1000 (4450)	1000 (115)	1000 (115)
1403-04A	2500 (11.1k)	5000 (22.2k)	0.001 (0.03)	7000	2.88 (1.31)	steel	2500 (11.1k)	2500 (280)	2500 (280)
1403-05A	5000 (22.2k)	10k (44.5k)	0.001 (0.03)	10k	2.88 (1.31)	steel	5000 (22.2k)	5000 (565)	5000 (565)
Common Specifications									
Output (nominal)					Bridge Resistance (nom).....700 ohm				
250 – 1000 lb Capacity1 mV/V					Excitation (recommended)10 Volts DC or AC rms				
5k lb Capacity1.5 mV/V					Temp. Range (compensated).....+70 °F to +170 °F (+21 °C to +77 °C)				
Non-linearity (max)0.05% FS					Temp. Range (usable)-65 °F to +200 °F (-54 °C to +93 °C)				
Hysteresis (max)0.05% FS					Temp. Effect on Zero (max)0.001% FS / °F (0.0018% FS / °C)				
Non-repeatability (max)0.02% FS					Temp. Effect on Output0.002% reading / °F (0.0036% reading / °C)				



The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.



Wiring Diagram

Fatigue-Rated Load Cells / 5k - 50k lb

Low Profile, Fatigue-Rated Load Cells

Fatigue-rated load cells are rugged devices manufactured using premium heat-treated, fatigue-resistant steels.

- material testing
- torque arm
- structural testing
- component testing
- life cycle testing
- calibration standard

Series 1404, 1408 — low profile, fatigue-rated

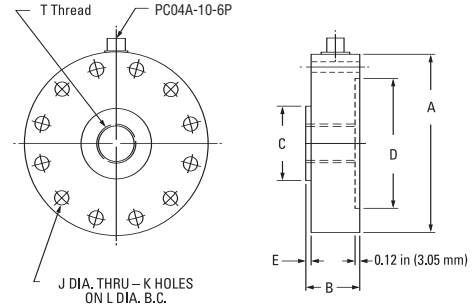
- Capacities from 5k to 50k lb (22.2k to 220k N) FS
- 1 mV/V and 1.5 mV/V output sensitivity
- 6-pin connector
- Fatigue-resistant steel
- Optional mounting base available
- Over 100 million fully reversed cycles without failure
- Built-in temperature compensation
- Barometric pressure compensated design
- Low deflection

Recommended cables and accessories ☎
— see section 8

Select a signal conditioner from those featured
in section 8

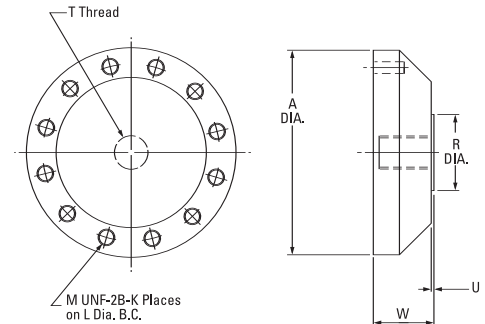


Series 1404, 1408



Series 1404, 1408

Load cell shown with optional mounting base.

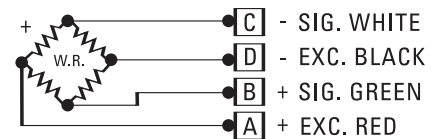
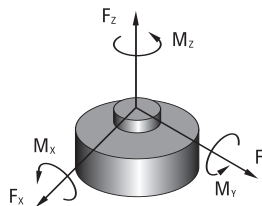


Dimensions — Inches (mm)

Series	A	B	C	D	E	J	K	L	M	R	T	U	W	Base PN
1404	6.06 (153.9)	1.75 (44.5)	2.42 (61.5)	4.33 (110)	0.12 (3.1)	0.41 (10.4)	12	5.13 (130.3)	3/8-24	2.25 (57.2)	1 1/4-12	0.03 (0.8)	1.75 (44.5)	D-30427-3A
1408	8 (203.2)	2.5 (63.5)	3.5 (88.9)	5.25 (133.4)	0.25 (6.4)	0.53 (13.5)	16	6.5 (165.1)	1/2-20	3.5 (88.9)	1 3/4-12	0.06 (1.5)	2 (50.8)	D-30110-1A

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ring Frequency Hz	Weight lb (kg)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Fatigue-rated Low Profile Load Cells with 1 1/4-12 Thread									
1404-01B	5000 (22.2k)	10k (44.5k)	0.001 (0.03)	5500	8.96 (4.06)	steel	5000 (22.2k)	5000 (565)	5000 (565)
1404-02B	10k (44.5k)	20k (89k)	0.001 (0.03)	8000	8.96 (4.06)	steel	10k (44.5k)	10k (1130)	10k (1130)
1404-03B	25k (111k)	50k (222k)	0.001 (0.03)	12k	8.96 (4.06)	steel	25k (111k)	25k (2825)	25k (2825)
Fatigue-rated Low Profile Load Cells with 1 3/4-12 Thread									
1408-01B	25k (110k)	50k (220k)	0.001 (0.03)	6750	25.5 (11.57)	steel	25k (111k)	25k (2825)	25k (2825)
1408-02B	50k (220k)	100k (450k)	0.001 (0.03)	9550	25.5 (11.57)	steel	50k (220k)	50k (5650)	50k (5650)
Common Specifications									
Output (nominal) 5000 – 50k lb Capacity1.5 mV/V					Excitation (recommended)10 Volts DC or AC rms				
Non-linearity (max)0.05% FS ^[1]					Temp. Range (compensated)+70 °F to +170 °F (+21 °C to +77 °C)				
Hysteresis (max)0.05% FS ^[1]					Temp. Range (usable)-65 °F to +200 °F (-54 °C to +93 °C)				
Non-repeatability (max)0.02% FS ^[1]					Temp. Effect on Zero (max)0.001% FS / °F (0.0018% FS / °C)				
Bridge Resistance (nom)700 ohm					Temp. Effect on Output (max)0.002% reading / °F (0.0036% reading / °C)				

Note: [1] Series 1408 — non-linearity 0.1% FS, hysteresis 0.1%, non-repeatability 0.05%.



Wiring Diagram

The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.

Rod-Style Load Cells / 1000 - 20k lb

Small Diameter Rod-Style Load Cells

Lower weight aluminum for lower ranged units, high-strength steel for higher ranged units

- ideal for tension applications
- process automation
- quality assurance
- hydraulic actuators
- cable, chain, or wire tension
- production monitoring

Series 1302 — small diameter with female threads

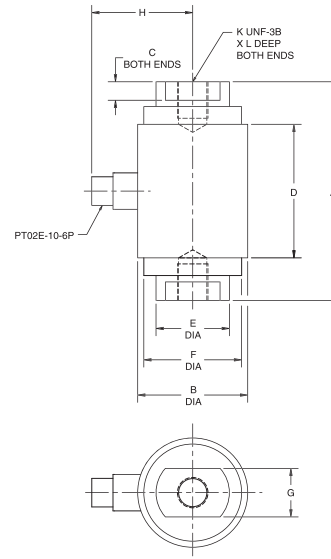
- Capacities from 1000 to 10k lb (4450 to 44.5k N) FS
- 2 mV/V output sensitivity
- 6-pin connector

Recommended cables and accessories ②
— see section 8

Select a signal conditioner from those featured in section 8



Series 1302



Series 1303 — small diameter with male/female threads

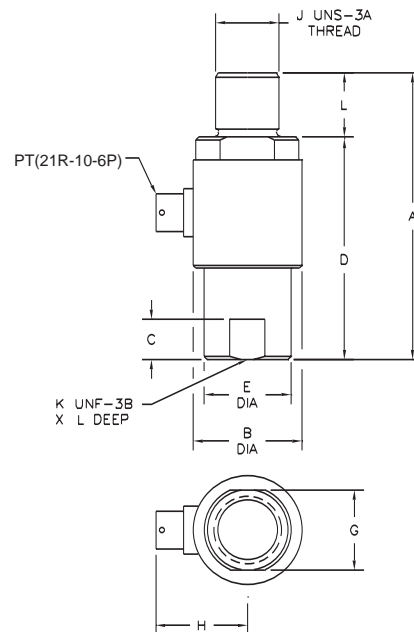
- Capacities from 2000 to 20k lb (8900 to 89k N) FS
- 2 mV/V output sensitivity
- 6-pin connector
- Splash-proof construction

Recommended cables and accessories ②
— see section 8

Select a signal conditioner from those featured in section 8



Series 1303



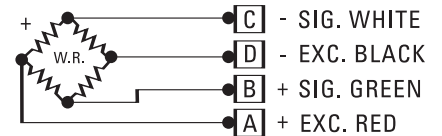
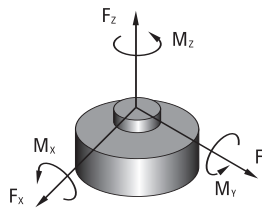
Dimensions — Inches (mm)

Series	A	B	C	D	E	F	G	H	J	K	L
1302	4.5 (114.3)	2.25 (57.2)	0.38 (9.7)	2.75 (69.9)	1.5 (38.1)	2 (50.8)	1 (25.4)	2 (50.8)	N/A	5/8-18	0.75 (19.1)
1303	4.5 (114.3)	1.71 (43.4)	0.63 (16)	3.5 (88.9)	1.37 (34.8)	N/A	1.25 (31.8)	1.44 (36.6)	1-14	1-14	1 (25.4)

Specifications							Extraneous Load Limits		
Model Number	Capacity lb (N)	Overload lb (N)	Deflection at Capacity in (mm)	Ringing Frequency Hz	Weight lb (kg)	Material	Side Force Fx or Fy lb (N)	Bending Moment Mx or My in-lb (N-m)	Torque Mz in-lb (N-m)
Rod-style Load Cells with 5/8-18 Female/Female Thread									
1302-01A	1000 (4450)	1500 (6675)	0.002 (0.05)	2600	1.7 (0.77)	aluminum	500 (2225)	1000 (115)	2000 (225)
1302-02A	2000 (8900)	3000 (13.3k)	0.002 (0.05)	3500	1.7 (0.77)	aluminum	700 (3100)	1500 (170)	3000 (340)
1302-03A	5000 (22.2k)	7500 (33.3k)	0.002 (0.05)	3500	4.2 (1.9)	steel	2000 (8900)	4000 (450)	4000 (450)
1302-04A	10k (44.5k)	15k (66.7k)	0.002 (0.05)	5000	4.2 (1.9)	steel	2500 (11.1k)	6000 (675)	6000 (675)
Rod-style Load Cells with 1-1/4-12 Male/Female Thread									
1303-01A	2000 (8900)	3000 (13.3k)	0.003 (0.08)	6000	0.5 (0.23)	aluminum	50 (225)	125 (14)	150 (17)
1303-02A	5000 (22.2k)	7500 (33.3k)	0.003 (0.08)	9000	0.5 (0.23)	aluminum	150 (667)	500 (56)	600 (68)
1303-03A	10k (44.5k)	15k (66.7k)	0.003 (0.08)	8000	1.25 (0.57)	steel	300 (1335)	800 (90)	1100 (124)
1303-04A	20k (89k)	30k (133k)	0.003 (0.08)	10k	1.25 (0.57)	steel	700 (3114)	2000 (226)	3000 (339)

Common Specifications

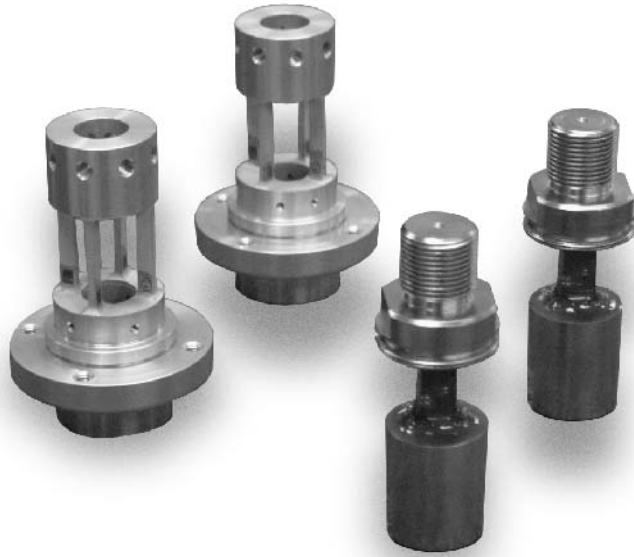
Model Number	1302	1303	Temp. Range (compensated)	+70 °F to +170 °F (+21 °C to +77 °C)
Output: mV/Volt (nominal)	2	2	Temp. Range (usable)	- 65 °F to +200 °F (-54 °C to +93 °C)
Non-linearity: % FS (max)	0.05	0.2	Temp. Effect on Zero (max)	0.002% FS / °F (0.0036% FS / °C)
Hysteresis: % FS (max)	0.05	0.2	Temp. Effect on Output (max)	0.002% reading / °F (0.0036% reading / °C)
Non-repeatability: % FS max	0.02	0.05		
Bridge Resistance (nom).....	350 ohm			
Excitation (recommended)	10 Volts DC or AC rms			



Wiring Diagram

The above chart tabulates maximum extraneous side force, bending moment and torque that may be applied singularly without electrical or mechanical damage to the load cell. Where combined extraneous loads are applied, decrease above loads proportionally.

Load Cells



Load cell structures may be machined into a variety of configurations to adapt to a multitude of measurement, monitoring, and control applications.

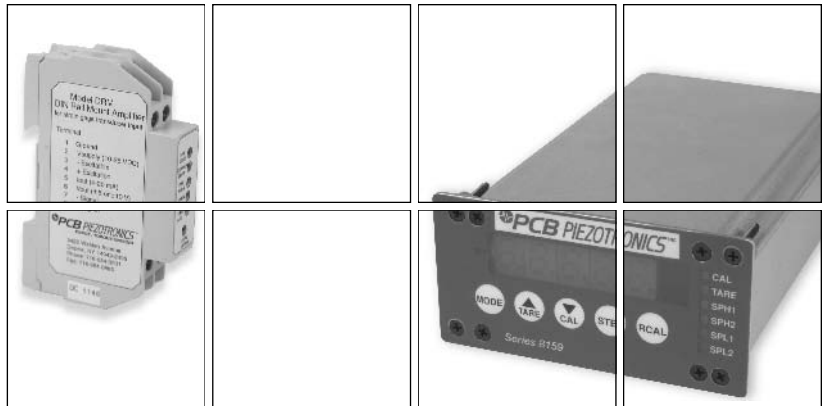


Strain gage sensing elements are examined and tested to insure integrity, accuracy, and longevity.

Load Cell Accessories and Services

Highlights

- Strain gage signal conditioners
- Cable assemblies
- Mounting accessories
- Calibration services



Signal Conditioners

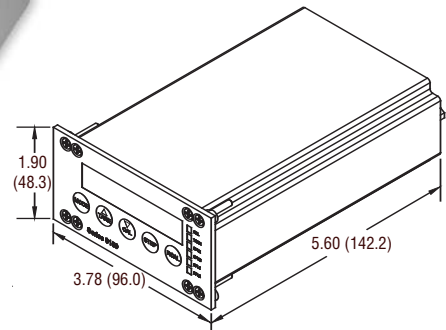
A variety of signal conditioners are offered for use with strain gage load cells and reaction torque sensors. These units provide the necessary, regulated excitation voltage and deliver conditioned output signals for recording, control, or analysis purposes.

Series 8159 — Digital Force Indicator / Controller

- Operates from 115 or 230 VAC power
- Provides 5 or 10 VDC strain gage bridge excitation
- Delivers ± 10 Volts and 4 to 20 mA output signals
- 5-digit, red LED display with 1/8 DIN panel mounting
- 4 programmable set points with LED status indicators
- Easy, menu-driven setup
- Optional RS-232 output



Series 8159



Series 8159
Dimensions shown are in inches (millimeters)

How to Order

Base Model

8159 – 115 VAC Powered Indicator with Transducer Excitation
F Prefix for 230 VAC Powered Version (internal jumper selectable)

Communications

0 None
1 RS-232 (transmit only)

Sense Leads (internal jumper selectable)

0 Disabled
1 Enabled (recommended for cables >20 ft (6.1 m))

Bridge Excitation (internal jumper selectable)

1 10 VDC
5 5 VDC

Full-scale Input (internal switch selectable)

1 1.5 mV/V
2 2.5 mV/V
3 3.5 mV/V

Version Code

A Initial Release

Example

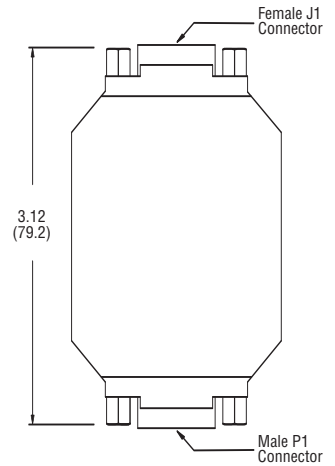
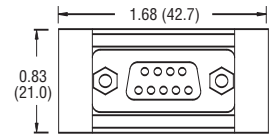
8159- 0 0 1 2 A 115 VAC Powered Indicator with 10 VDC Transducer Excitation and 2.5 mV/V Full Scale Input

Series 8160 — In-line Strain Gage Signal Conditioner

- Operates from 12 to 24 VDC power
- Provides 5 or 10 VDC strain gage bridge excitation
- Delivers ± 5 Volts and 4 to 20 mA output signals
- Adjustable zero and span
- Small size
- Multi-pin input and output connectors
- Built-in, switch-activated, shunt calibration



Series 8160



Series 8160
Dimensions shown are in inches (millimeters)

How to Order

Base Model

8160- In-line Strain Gage Signal Conditioner

Calibrated Output Signal

- 0** Voltage
- 1** Current

Bridge Excitation (internal jumper selectable)

- 1** 10 VDC
- 5** 5 VDC

Version Code

- A** Initial Release

Example

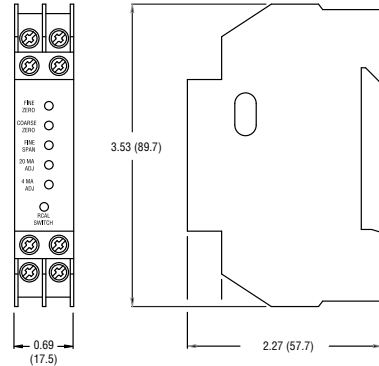
8160- 0 1 A Strain gage signal conditioner with ± 5 Volts and 4 to 20 mA output signals, 10 VDC bridge excitation, and calibrated in voltage.

Series 8161 — DIN Rail Mount Signal Conditioner

- Operates from 12 to 28 VDC power
- Provides 5 or 10 VDC strain gage bridge excitation
- Delivers ± 5 or ± 10 Volts and 4 to 20 mA output signals
- Built-in, switch-actuated, shunt calibration



Series 8161



Series 8161

Dimensions shown are in inches (millimeters)

Switch Positions for Input Signal Range Adjustment

Sensitivity (mV/V) Vexc = 5 VDC	Sensitivity (mV/V) Vexc = 10 VDC	SW2 Settings				SW2 1 = SW "ON"												
		1	2	3	4													
7.0 to 11.0	3.5 to 5.5	0	0	0	1	<div style="border: 1px solid black; padding: 5px;"> <p>"ON"</p> <table style="width: 100%; text-align: center;"> <tr> <td style="width: 25%;">1</td> <td style="width: 25%;">2</td> <td style="width: 25%;">3</td> <td style="width: 25%;">4</td> </tr> <tr> <td style="width: 25%;"><input type="checkbox"/></td> <td style="width: 25%;"><input type="checkbox"/></td> <td style="width: 25%;"><input type="checkbox"/></td> <td style="width: 25%;"><input type="checkbox"/></td> </tr> <tr> <td style="width: 25%;">0</td> <td style="width: 25%;">1</td> <td style="width: 25%;">2</td> <td style="width: 25%;">3</td> </tr> </table> </div>	1	2	3	4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0	1	2	3
1	2	3	4															
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>															
0	1	2	3															
4.6 to 7.0	2.3 to 3.5	0	0	1	0													
3.0 to 4.6	1.5 to 2.3	0	1	0	0													
2.0 to 3.0	1.0 to 1.5	1	0	0	0													
1.5 to 2.0	0.75 to 1.0	1	0	1	0													
1.0 to 1.5	0.50 to 0.75	1	1	0	1													
0.9 to 1.0	0.45 to 0.50	1	1	1	1													

How to Order

Base Model

8161— DIN Rail Mount Strain Gage Signal Conditioner

Calibrated Output Signal

0 Voltage

1 Current

Output Signals (internal jumper selectable)

1 ± 10 Volts and 4 to 20 mA

5 ± 5 Volts and 4 to 20 mA

Bridge Excitation (internal jumper selectable)

1 10 VDC

5 5 VDC

Version Code

A Initial Release

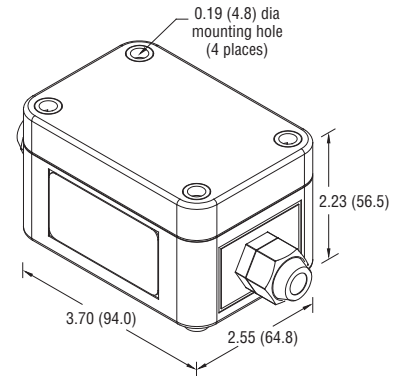
8161— 0 1 1 A Strain gage signal conditioner with ± 10 Volts and 4 to 20 mA output signals, 10 VDC bridge excitation, and calibrated in voltage.

Series 8162 — In-line Strain Gage Signal Conditioner

- Operates from 12 to 28 VDC power
- Provides 5 or 10 VDC strain gage bridge excitation
- Delivers ± 5 or ± 10 Volts and 4 to 20 mA output signals
- Built-in, switch-actuated, shunt calibration
- IP66 (NEMA 4X) enclosure
- Screw terminal connections



Series 8162



Series 8162

Dimensions shown are in inches (millimeters)

Switch Positions for Input Signal Range Adjustment			
Sensitivity (mV/V) Vexc = 5 VDC	Sensitivity (mV/V) Vexc = 10 VDC	SW2 Settings	SW2 1 = SW "ON"
7.0 to 11.0	3.5 to 5.5	1 2 3 4	
4.6 to 7.0	2.3 to 3.5	0 0 0 1	
3.0 to 4.6	1.5 to 2.3	0 1 0 0	
2.0 to 3.0	1.0 to 1.5	1 0 0 0	
1.5 to 2.0	0.75 to 1.0	1 0 1 0	
1.0 to 1.5	0.50 to 0.75	1 1 0 1	
0.9 to 1.0	0.45 to 0.50	1 1 1 1	

How to Order

Base Model

8162- Strain Gage Signal Conditioner

Calibrated Output Signal

0 Voltage
1 Current

Output Signals (internal jumper selectable)

1 ± 10 Volts and 4 to 20 mA
5 ± 5 Volts and 4 to 20 mA

Bridge Excitation (internal jumper selectable)

1 10 VDC
5 5 VDC

Version Code

A Initial Release

Example

8162- 0 1 1 A Strain gage signal conditioner with ± 10 Volts and 4 to 20 mA output signals, 10 VDC bridge excitation, and calibrated in voltage.

Recommended Cables and Accessories

Code	Model #	Description
⑫	8311-01-10A	Cable assembly for sensors with PT conn., 10-ft, PT conn. to pigtails, 4-cond. cable
⑬	8315-01-10A	Cable assembly for sensors with PC conn., 10-ft, PC conn. to pigtails, 4-cond. cable

Recommended Load Cell Signal Conditioners and Cables

Recommended Signal Conditioners				
	Series 8120	Series 8159	Series 8160A	Series 8161A, 8162, & Pigtails
Load Cell Type	Recommended Cables			
Load cell with PT connector ≤ 20 -ft	8311-04-xxA	8311-17-xxA	8311-15-xxA	8311-01-xxA
Load cell with PT connector ≥ 20 -ft	8311-05-xxA	8311-18-xxA	8311-15-xxA	8311-02-xxA
Load cell with PC connector < 20 -ft	8315-04-xxA	8315-17-xxA	8315-15-xxA	8315-01-xxA
Load cell with PC connector ≥ 20 -ft	8315-05-xxA	8315-18-xxA	8315-15-xxA	8315-02-xxA

"xx" indicates length in feet.
[Standard lengths include 5 ft (1.5 m), 10 ft (3 m) 20 ft (6.1 m), & 50 ft (15.2 m).]

Load Cell Cable Specifications and Standard Models

The following tables provide specifications and configuration diagrams for the variety of cable types available. Where applicable, standard cable assembly model numbers are provided. Standard models can be less costly than custom cables and available for immediate shipment. For alternate cable lengths or custom models, contact the factory.

Four-Conductor Cables

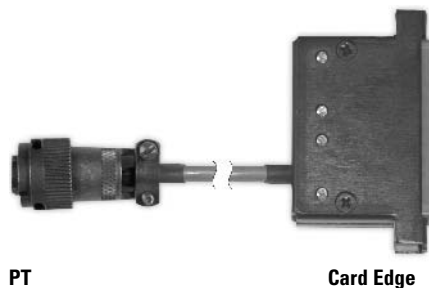
Usage	Construction		
General purpose, use with load cells. 24AWG common stranded tinned copper drain wire, polypropylene insulated, twisted pair in a chrome PVC jacket. Use when desired cable is < 20 feet (6.1 m).			
Outer Jacket			PVC, grey
Diameter			0.168 in 4.27 mm
Capacitance			35 pF/ft 44.3 pF/m
Temperature Range			-4 to +140 °F -20 to +60 °C
Impedance			45 ohm

Standard Cable Assemblies

Model #	Length (feet)	Length (meters)
8311-01-05A	5 ft	1.5 m
8311-01-10A	10 ft	3.0 m



8311-04-05A	5 ft	1.5 m
8311-04-10A	10 ft	3.0 m



8311-15-05A	5 ft	1.5 m
8311-15-10A	10 ft	3.0 m
8311-15-20A	20 ft	6.1 m
8311-15-50A	50 ft	15.2 m



Continued on next page.

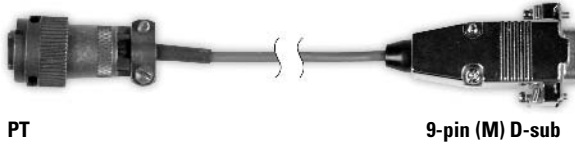
Stock Cable Assemblies

Four-Conductor Cables, continued

Standard Cable Assemblies

Model # Length (feet) Length (meters)

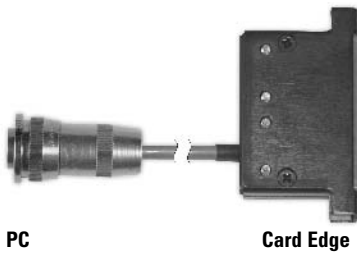
8311-17-05A 5 ft 1.5 m
8311-17-10A 10 ft 3.0 m



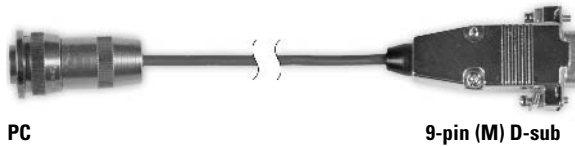
8315-01-05A 5 ft 1.5 m
8315-01-10A 10 ft 3.0 m



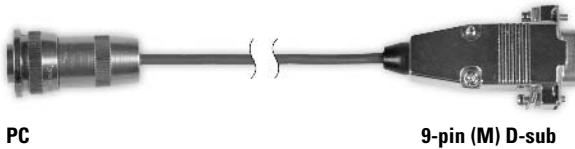
8315-04-05A 5 ft 1.5 m
8315-04-10A 10 ft 3.0 m



8315-15-05A 5 ft 1.5 m
8315-15-10A 10 ft 3.0 m
8315-15-20A 20 ft 6.1 m
8315-15-50A 50 ft 15.2 m



8315-17-05A 5 ft 1.5 m
8315-17-10A 10 ft 3.0 m



8314-20-05A 5 ft 1.5 m
8314-20-10A 10 ft 3.0 m



8314-21-05A 5 ft 1.5 m
8314-21-10A 10 ft 3.0 m



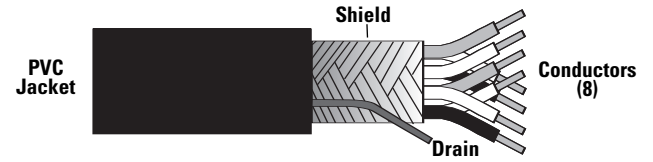
Eight-Conductor Cables

Usage

General purpose, use with load cells. 24AWG common stranded tinned copper drain wire, polypropylene insulated, twisted pair in a chrome PVC jacket. Use when desired cable is ≥ 20 feet (6.1 m).

Outer Jacket	PVC, grey	
Diameter	0.363 in	9.22 mm
Capacitance	13.5 pF/ft	44.3 pF/m
Temperature Range	-4 to +140 °F	-20 to +60 °C
Impedance	100 ohm	

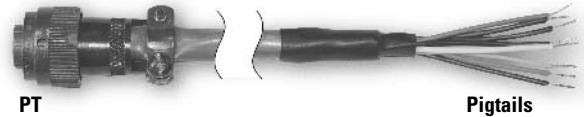
Construction



Standard Cable Assemblies

Model # Length (feet) Length (meters)

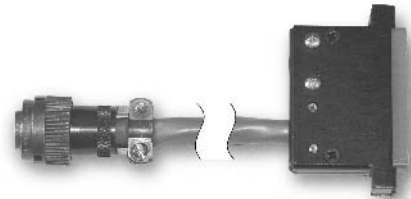
8311-02-20A 20 ft 6.1 m
8311-02-50A 50 ft 15.2 m



PT

Pigtails

8311-05-20A 20 ft 6.1 m
8311-05-50A 50 ft 15.2 m



PT

Card Edge

8311-18-20A 20 ft 6.1 m
8311-18-50A 50 ft 15.2 m



PT

9-pin (M) D-sub

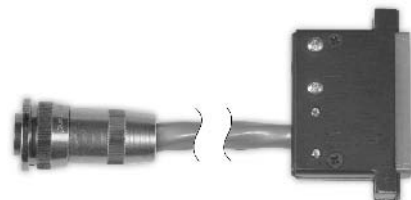
8315-02-20A 20 ft 6.1 m
8315-02-50A 50 ft 15.2 m



PC

Pigtails

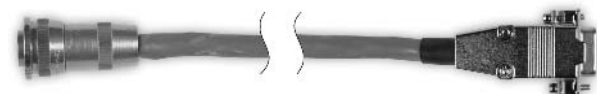
8315-05-20A 20 ft 6.1 m
8315-05-50A 50 ft 15.2 m



PC

Card Edge

8315-18-20A 20 ft 6.1 m
8315-18-50A 50 ft 15.2 m



PC

9-pin (M) D-sub

Mating Connectors

Mating Connectors

Optional mating connectors are used for load cells and signal conditioners.

Model

181-012A

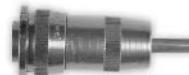
Features cable strain relief. For use with load cells which have an "A" at end of model number, and Series 1500 S-beam load cells.



6-socket PT Connector & Back Shell

182-025A

Features cable strain relief. For use with load cells which have a "B" at end of model number, except for Series 1500 S-beam load cells.



6-socket PC Connector & Back Shell

182-026A

For transducer connection to Series 8159 Signal Conditioner (see page 3.20).



9-pin (M) D-sub Connector & Back Shell

182-027A

For input/output connection to Series 8159 Signal Conditioner (see page 3.20).



15-socket (F) D-sub Connector & Back Shell

182-022A

For input/output connection to Series 8160 Signal Conditioner (see page 3.21).



9-socket (F) D-sub Connector & Back Shell

182-023A

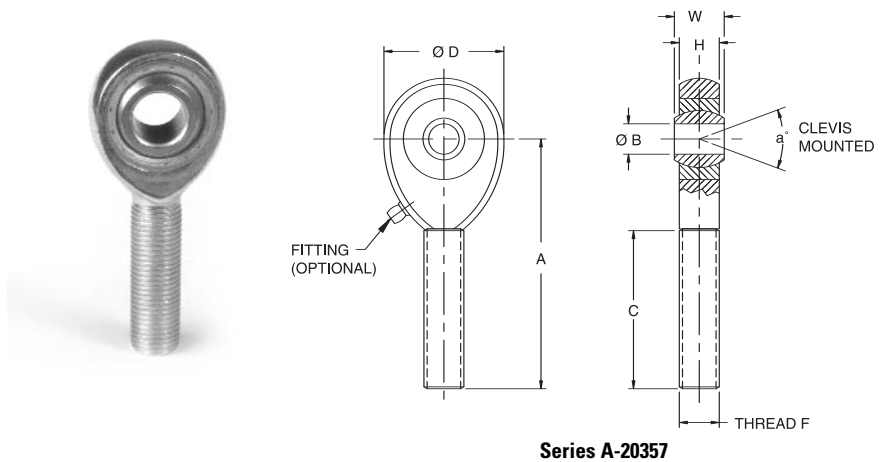
For transducer connection to Series 8160 Signal Conditioner (see page 3.21).



9-pin (M) D-sub Connector & Back Shell

Rod Ends

Rod ends are designed to maintain tension loading alignment between a load cell and mounting surface.



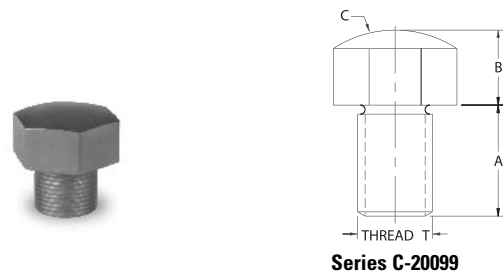
Series A-20357

Rod Ends

Model Number	Thread UNF-3A	Dimensions — Inches (mm)								Static Load lb (N)	Weight lb (g)
		B	W	H	A	D	C	a (deg.)			
A-20357-1A	1/4-28	0.19 (4.8)	0.31 (7.9)	0.281 (7.14)	1.56 (39.6)	0.75 (19.1)	1 (25.4)	16	2150 (9600)	0.04 (18)	
A-20357-2A	3/8-24	0.31 (7.9)	0.44 (11.2)	0.406 (10.3)	1.94 (49.3)	1 (25.4)	1.25 (31.8)	12	5300 (23k)	0.25 (113)	
A-20357-3A	1/2-20	0.44 (11.2)	0.56 (14.2)	0.5 (12.7)	2.44 (62)	1.312 (33.3)	1.5 (38.1)	12	23k (100k)	0.25 (113)	
A-20357-4A	5/8-18	0.5 (12.7)	0.63 (16)	0.562 (14.3)	2.63 (66.8)	1.5 (38.1)	1.625 (41.4)	16	31k (135k)	0.38 (172)	
A-20357-5A	3/4-16	0.63 (16)	0.75 (19.1)	0.687 (17.5)	2.88 (73.2)	1.75 (44.5)	1.75 (44.5)	14	40k (180k)	0.6 (272)	
A-20357-6A	1-14	1 (25.4)	1.38 (35.1)	1.0 (25.4)	4.13 (104.9)	2.75 (69.9)	2.125 (54.1)	17	43k (190k)	2.1 (953)	
A-20357-7A	1 1/4-12	1.25 (31.8)	1.09 (27.7)	1.0 (25.4)	4.13 (104.9)	2.75 (69.9)	2.125 (54.1)	17	44k (195k)	2.4 (1089)	

Load Buttons

Load buttons are designed to direct applied forces to the measuring axis of a load cell used in compression.



Series C-20099

Load Button

Model Number	Thread T	Dimensions — Inches (mm)		
		A	B	C
C-20099-1A	1/4-28	0.37 (9.4)	0.25 (6.35)	0.75 (19.1)
C-20099-2A	3/8-24	0.5 (12.7)	0.375 (9.53)	2 (50.8)
C-20099-3A	1/2-20	0.62 (15.7)	0.5 (12.7)	2 (50.8)
C-20099-4A	5/8-18	0.62 (15.7)	0.625 (15.9)	2 (50.8)
C-20099-5A	1-14	0.87 (22.1)	0.75 (19.1)	4 (101.6)
C-20099-6A	1 1/4-12	1 (25.4)	1.0 (25.4)	4 (101.6)
C-20099-7A	2 3/4-8	2.5 (63.5)	1.0 (25.4)	6 (152.4)
C-20099-8A	3/4-16	0.6 (15.2)	0.3 (7.6)	6 (152.4)

Load Cell Calibration Services

PCB® maintains a completely equipped calibration laboratory for calibration and re-certification of strain gage based torque sensors, single axis load cells, and multi-axis transducers. These services are available for sensors manufactured by PCB® as well as other companies.

Calibrations and re-certifications performed by PCB® are traceable to the National Institute of Standards and Technology (NIST) and conform to ISO/IEC 17025-1999 and ANSI/NCSL Z540-1-1994. PCB®'s calibration laboratory is accredited by The American Association for Laboratory Accreditation (A2LA) to ISO 17025.

The scope of our accreditation for load cells is:

Range	Best Uncertainty [1] (±)
10 to 500 lb (0 to 2225 N)	0.04% FS
100 to 10k lb (445 to 45k N)	0.06% FS
10k to 100k lb (45k to 445k N)	0.08% FS

[1] Best Uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor $k = 2$.

Basic Calibration

Standard calibration services include five (5) points ascending and descending in tension and compression. Charted calibration data is provided in a theoretical vs. actual format with mV/V, non-linearity, and hysteresis provided at each increment. Shunt calibration data is also provided along with a precision shunt calibration resistor. The standard calibration service includes a basic certificate of NIST traceability.

Load Cell Calibration Services

PCB Sensor	Competitor Sensor	
Calibration Code	Calibration Code	
LCS-1A	LCS-0	Calibration of load cell, 5-point, single bridge, up to 5000 lb (22.2k N)
LCS-1B	LCS-0	Calibration of load cell, 5-point, single bridge, above 5000 lb (22.2k N) and up to 50k lb (220k N)
LCS-1C	LCS-0	Calibration of load cell, 5-point, single bridge, above 50k lb (220k N)
LCS-2A	LCS-0	System calibration (load cell, signal conditioner, cable), 5-point, single bridge, up to 5000 lb (22.2k N)
LCS-2B	LCS-0	System calibration (load cell, signal conditioner, cable), 5-point, single bridge, above 5000 lb (22.2k N) and up to 50k lb (220k N)
LCS-2C	LCS-0	System calibration (load cell, signal conditioner, cable), 5-point, single bridge, above 50k lb (220k N)
Other calibration services available; contact factory for more information.		

Certificate of Calibration

Model Number: 1102-01A
Serial Number: 513
Capacity: 50 LBS.

Date: 04/16/2003
Temperature: 71°F
Humidity: 30%

TENSION				
Load (lbs.)	Up (mV/V)	Down (mV/V)	N/L (%FS)	HYST (%FS)
0	0.0000	0.0001	0.00	0.01
10	0.3989	0.3991	-0.02	0.01
20	0.7982	0.7984	-0.02	0.01
30	1.1975	1.1976	-0.02	0.01
40	1.5968	1.5970	-0.02	0.01
50	1.9965	1.9965	0.00	0.00

COMPRESSION				
Load (lbs.)	Up (mV/V)	Down (mV/V)	N/L (%FS)	HYST (%FS)
0	0.0000	-0.0001	0.00	0.01
10	-0.3986	-0.3988	0.03	0.01
20	-0.7968	-0.7973	0.04	0.03
30	-1.1949	-1.1952	0.04	0.02
40	-1.5928	-1.5929	0.04	0.01
50	-1.9901	-1.9901	0.00	0.00

RESULTS

	TENS	COMP	Shunt Calibration			Resistance		
			(lbs.)	% FS	Shunt Resistor	0.0005 mV/V (0.0250 %FS)	
OUTPUT @ 50 LBS. (mV/V):	1.9965	-1.9901			120 K Ohms	Exc. Resist.	350.66	ohms
MAX NON-LINEARITY (%FS):	-0.02	0.04	36.28	72.56	120 K Ohms	Sig. Resist.	350.75	ohms
MAX HYSTERESIS (%FS):	0.01	0.03	36.55	73.10				

This certificate may not be reproduced, except in full, without written approval of PCB Piezotronics.



Cert. No. 1832 D1



3425 Walden Avenue Depew, New York, USA 14043-2496

For any questions concerning this certificate, please call PCB at (888) 684-0004, and ask for an Application Engineer

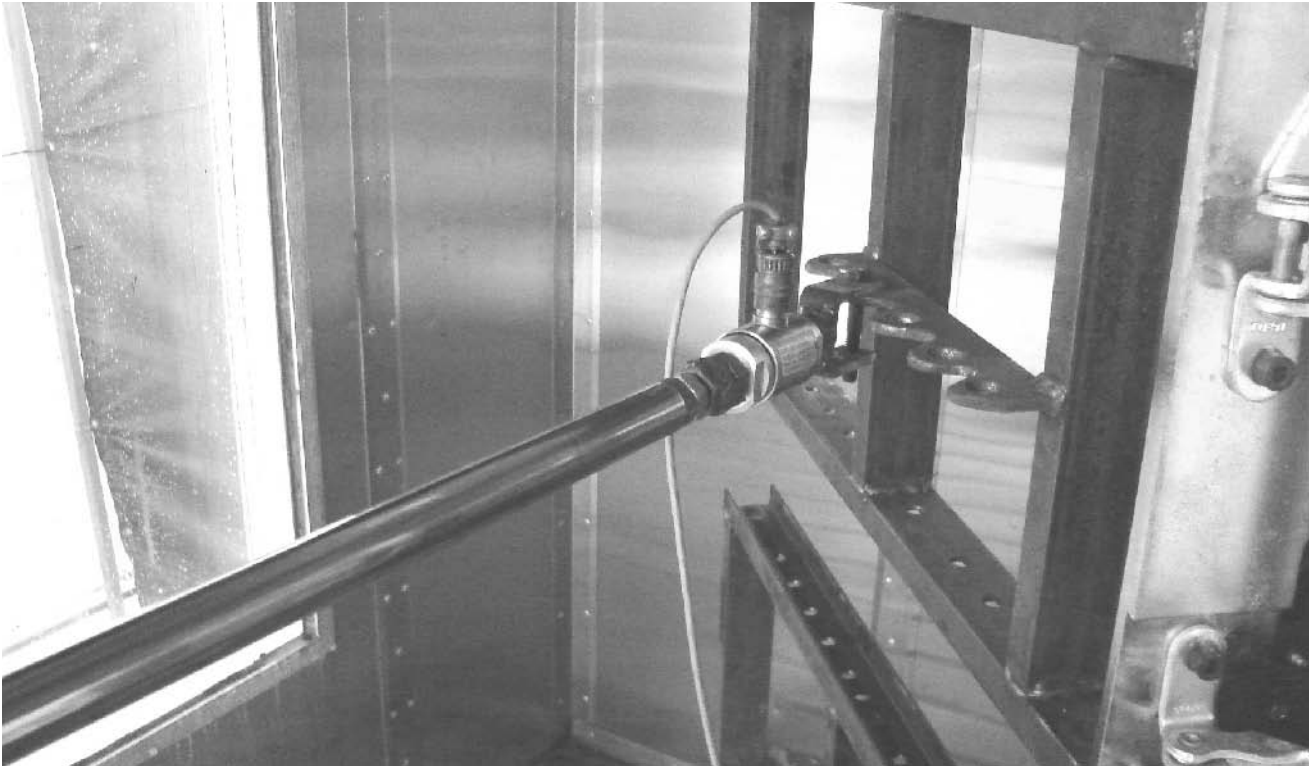


Photo courtesy of MGA Research Corp.

Series 1302 rod end load cell shown on a durability test rig.

Load Cell

Technical Information

Highlights

- Introduction to load cells
- Glossary of terms

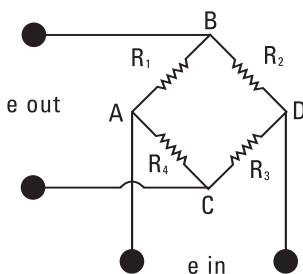


Figure 1.
Wheatstone Bridge

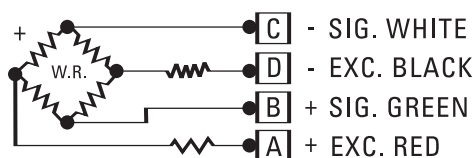


Figure 2.
Load Cell Wiring Code

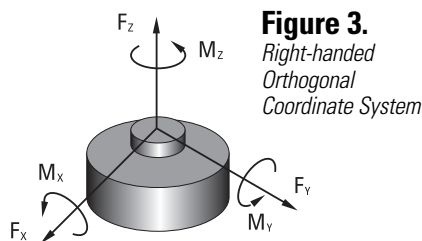


Figure 3.
Right-handed
Orthogonal
Coordinate System

Principal of Operation

PCB® manufactures a wide variety of load cells whose output voltage is proportional to the applied force produced by a change in resistance in strain gages which are bonded to the load cell's structure. The magnitude of the change in resistance corresponds to the deformation of the load cell and therefore the applied load.

The four-arm Wheatstone bridge configuration shown in **Figure 1** depicts the strain gages used in our load cells. This configuration allows for temperature compensation and cancellation of signals caused by forces not directly applied to the axis of the applied load.

A regulated 5 to 20 volt DC or AC rms excitation is required and is applied between A and D of the bridge. When a force is applied to the transducer structure, the Wheatstone bridge is unbalanced, causing an output voltage between B and C which is proportional to the applied load.

Most all PCB® load cells follow a wiring code established by the Western Regional Strain Gage committee as revised in May 1960. The code is illustrated in **Figure 2**.

Axis Definition

Our load cells comply with the Axis and Sense Definitions of NAS-938 (National Aerospace Standard-Machine Axis and Motion) nomenclature and recommendations of the Western Regional Strain Gage committee.

These axes are defined in terms of a "right handed" orthogonal coordinate system as shown in **Figure 3**.

A tensile load exhibits a positive (+) polarity going output, while a compressive load exhibits a negative (-) polarity going output.

The primary axis of rotation or axis of radial symmetry of a load cell is the z-axis.

Principal of Operation

PCB® manufactures load cells under two classifications. They are general purpose and fatigue-rated.

General Purpose

General purpose load cells are designed for a multitude of applications across the automotive, aerospace, and industrial markets. The general purpose load cell, as the name implies, is designed to be utilitarian in nature. Within the general purpose load cell market there are several distinct categories. They are: precision, universal, weigh scale, and special application. PCB® primarily supplies general purpose load cells into the universal and special application categories. Universal load cells are the most common in industry. Special application load cells are load cells that have been designed for a specific unique force measurement task.

Continued on next page.

Special application load cells can be single axis or multiple axis. They include but not limited to:

- pedal effort
- steering column
- crash barrier
- hand brake
- femur
- skid trailer
- tire test
- gear shift

Fatigue-rated Load Cells

Fatigue-rated load cells are specially designed and manufactured to withstand millions of cycles. They are manufactured using premium fatigue-resistant steel or aluminum and special processing to ensure mechanical and electrical integrity, as well as accuracy. Fatigue-rated load cells manufactured by PCB® are guaranteed to last 100 million fully reversed cycles (full tension through zero to full compression). An added benefit of fatigue-rated load cells is their extreme resistance to extraneous bending and side loading forces.

Error Analysis

PCB® typically supplies accuracy information on its products in the form of individual errors. They are: non-linearity, hysteresis, non-repeatability, effect of temperature on zero, and effect of temperature on output.

The customer can combine individual errors to establish the maximum possible error for the measurement, or just examine the applicable individual error. If the temperature remains stable during the test, the temperature related errors can be ignored. If the sensor is used for increasing load measurement only, ignore the hysteresis error. If the load measurement is near the full capacity, the linearity error can be ignored. If the capability exists to correct the data through linearization-fit or a look-up table, the error in the measurement can be minimized. A sophisticated user can get rid of all the errors except for the non-repeatability error in the measurement.

Often overlooked by the customer is the error due to the presence of non-measured forces and bending moments. Even though the single axis of measurement sensors are designed and built to withstand these non-measured forces and bending moments (extraneous loads), the errors due to them are present. PCB® engineers can design the set-up to eliminate or minimize these extraneous loads. However, if these extraneous loads are present, the errors due to them should be considered.

Due to cost restraints, PCB®, as with its competition, does not typically measure or compensate for errors due to extraneous loads. If the presences of these extraneous loads are known, the user should request the transducer manufacturer to run a special test, at extra cost, to define and quantify the extraneous load errors. These errors are defined as cross-talk errors.

Typical Application Examples:

- | | | |
|---------------------------------|---------------------------|------------------------|
| Hydraulic Actuators | Life Cycle Testing | Quality Control |
| Material Fatigue Testing | Torque Arm | Tank Weighing |

Application Questionnaire

Determine the capacity required

- A. What is the maximum expected load?
- B. What is the minimum expected load?
- C. What is the typical expected load?
- D. What are the dynamics of the system, i.e. frequency response?
- E. What are the maximum extraneous loads to which the load cell will be subjected?

How will the load cell be integrated into the system?

- A. What are the physical constraints, e.g. height, diameter, thread?
- B. Will the load cell be in the primary load path or will the load cell see forces indirectly?

What type of environment will the load cell be operating in?

- A. Maximum temperature?

- B. Minimum temperature?

- C. Humidity?

- D. Contaminants, (e.g. water, oil, dirt, dust)?

What accuracy is required?

- A. Non-linearity?

- B. Hysteresis?

- C. Repeatability?

- D. Cross-talk?

Accuracy —

Stated as a limit tolerance, which defines the average deviation between the actual output versus theoretical output.

In practical transducer applications, the potential errors of non-linearity, hysteresis, non-repeatability and temperature effects do not normally occur simultaneously, nor are they necessarily additive.

Therefore, accuracy is calculated based upon RMS value of potential errors, assuming a temperature variation of ± 10 °F (± 5.5 °C), full rated load applied, and proper set-up and calibration. Potential errors of the readout, cross-talk, or creep effects are not included.

Ambient Conditions —

The conditions (humidity, pressure, temperature, etc.) of the medium surrounding the transducer.

Ambient Temperature —

The temperature of the medium surrounding of transducers.

Calibration —

The comparison of transducer output against standard test loads.

Calibration Curve —

a record (graph) of the comparison of transducer output against standard test loads.

Combined Error —

(Non-linearity and Hysteresis) — the maximum deviation from a straight line drawn between the original no-load and rated load outputs expressed as a percentage of the rated output and measured on both increasing and decreasing loads.

Compensation —

The utilization of supplementary devices, materials, or processes to minimize known sources of error.

Creep —

The change of transducer output occurring with time, while under load, and with all environmental conditions and other variables remaining constant.

Note: Usually measured with rated load applied and expressed as a percent of rated output over a specific period of time.

Creep Recovery —

The change in no-load output occurring with time, after removal of a load, which has been applied for a specific period of time.

Cross-Talk —

With one component loaded to capacity, and the other unloaded, the output of the unloaded component will not exceed the percentage specified of its full-scale capacity.

Deflection —

The change in length along the primary axis of the load cell between no-load and rated load conditions.

Drift —

A random change in output under constant load conditions.

Error —

The algebraic difference between the indicated and true value of the load being measured.

Excitation, Electrical —

The voltage or current applied to the input terminals of the transducer.

Fatigue Capacity —

Capacity as percentage of the nominal load limit capacity, and based on 100×10^6 cycles (minimum) from zero to full fatigue capacity and 50×10^6 cycles (minimum) from full fatigue capacity tension to full fatigue capacity compression load.

Hysteresis —

The maximum difference between the transducer output readings for the same applied load, one reading obtained by increasing the load from zero and the other by decreasing the load from rated load.

Note: Usually measured at half rated output and expressed in percent of rated output. Measurements should be taken as rapidly as possible to minimize creep.

Insulation Resistance —

The DC resistance measured between the transducer circuit and the transducer structure.

Note: Normally measured at 50 Volts DC and under standard test conditions.

Natural Frequency —

The frequency of free oscillations under no-load conditions.

Nominal Load Limit Capacity —

It is the designed normal maximum capacity of a transducer. Output sensitivity of the transducer is based on this capacity unless specified.

Non-linearity —

The maximum deviation of the calibration curve from a straight line drawn between the no load and rated load output, expressed as a percentage of the rated output and measured on increasing load only.

Output —

This signal (voltage, current, etc.) produced by the transducer.

Note: Where the output is directly proportional to excitation, the signal must be expressed in terms of volts per volt, volts per ampere, etc., of excitation.

Output, Rated —

The algebraic difference between the outputs at no-load and at rated load.

Overload Rating —

The maximum load in percent of rated capacity, which can be applied without producing a permanent shift in performance characteristics beyond those specified.

Primary Axis —

The axis along which the transducer is designed to be loaded; normally its geometric centerline.

Rated Capacity (Rated Load) —

The maximum axial load that the transducer is designed to measure within its specifications.

Repeatability —

The maximum difference between transducer output readings for repeated loading under identical loading and environmental conditions.

Resolution —

The smallest change in mechanical input, which produces a detectable change in the output signal.

Sensitivity —

The ratio of the change in output to the change in mechanical input.

Shunt Calibration —

Electrical simulation of transducer output by insertion of known shunt resistors between appropriate points within the circuitry.

Shunt-to-load Correlation —

The difference in output readings obtained through electrically simulated and actual applied loads.

Standard Test Conditions —

The environmental conditions under which measurements should be made, when measurements under any other conditions may result in disagreement between various observers at different times and places. These conditions are as follows:

Temperature 72 °F ± 3.6 °F (23 °C ± 2 °C)

Relative Humidity: 90% or less

Barometric Pressure: 28 to 32 inch Hg

Static Extraneous Load Limits —

Static Extraneous Load Limits are calculated such that only one extraneous load (Fx or Fy or Mx or My or Mz) can be applied simultaneously with 50% of the nominal load limit applied.

Temperature Effect on Output —

The change in output due to a change in transducer temperature.

Note: Usually expressed as a percentage of load reading per degree Fahrenheit change in temperature.

Temperature Effect on Zero Balance —

The change in zero balance due to a change in transducer temperature.

Note: Usually expressed as the change in zero balance in percent of rated output per degrees Fahrenheit (change in temperature).

Temperature Range, Compensated —

The range of temperature over which the transducer is compensated to maintain rated output and zero balance within specified limits.

Temperature Range, Usable —

The extremes of temperature within which the transducer will operate without permanent adverse change to any of its performance characteristics.

Terminal Resistance —

The resistance of the transducer circuit measured at specific adjacent bridge terminals at standard temperature, with no-load applied, and with the excitation and output terminals open-circuited.

Terminal Resistance, Excitation —

The resistance of the transducer circuit measured at the excitation terminals, at standard temperature, with no-load applied, and with the output terminals open-circuited.

Terminal Resistance, Signal —

The resistance of the transducer circuit measured at the output signal terminals, at standard temperature, with no-load applied, and with the excitation terminals open-circuited.

Traceability —

The step-by-step transducer process by which the transducer calibration can be related to primary standards.

Zero Balance —

The output signal of the transducer with rated excitation and with no-load applied, usually expressed in percent of rated output.

Zero Return —

The difference in zero balance measured immediately before rated load application of specified duration and measured after removal of the load, and when the output has stabilized.

Zero Shift, Permanent —

A permanent change in the no-load output.

Zero Stability —

The degree to which the transducer maintains its zero balance with all environmental conditions and other variables remaining constant.

Application Notes and Technical Articles

To order copies of the following application notes, call PCB® toll-free at 888-684-0004.

Application Notes

- AP-1001** Extraneous Loads
- AP-1002** Equivalent Force of a Falling Object
- AP-1003** Mechanical Installation of PCB® Torque Transducers
- AP-1004** Installation of PCB® Driveline Torque Transducers
- AP-1007** Dynamometer Installation of PCB® Model 1401 Load Cell
- AP-1008** Spline Lubrication PCB® Model 4115A & K, Preliminary Release
- AP-1009** Explosive Environment
- AP-1011** Effects of Thrust and Bending Moment on The Torque Output of Torque Disk. Model 5304-101-01
- AP-1012** Grease Lubrication
- AP-1015** Effects of Extraneous Loads on TORKDISC® Series 5308 and 5309
- AP-1016** Shunt Calibration of a Strain Gage Sensor

Technical Articles

- TA-1001** What is a Transducer?
- TA-1002** Cross-talk in a Multi-Component Sensor
- TA-1003** Accuracy