



**Model M1408-M119-02ADB**  
**FATIGUE RATED LOW PROFILE LOAD CELL, DUAL BRIDGE**  
**Installation and Operating Manual**

**For assistance with the operation of this product,  
contact PCB Piezotronics, Inc.**

**Toll-free: 800-828-8840**  
**24-hour SensorLine: 716-684-0001**  
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<b>Warranty, Service, Repair, and Return Policies and Instructions</b>
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**The information contained in this document supersedes all similar information that may be found elsewhere in this manual.**

**Total Customer Satisfaction** – PCB Piezotronics guarantees Total Customer Satisfaction. If, at any time, for any reason, you are not completely satisfied with any PCB product, PCB will repair, replace, or exchange it at no charge. You may also choose to have your purchase price refunded in lieu of the repair, replacement, or exchange of the product.

**Service** – Due to the sophisticated nature of the sensors and associated instrumentation provided by PCB Piezotronics, user servicing or repair is not recommended and, if attempted, may void the factory warranty. Routine maintenance, such as the cleaning of electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the physical material of construction, is acceptable. Caution should be observed to insure that liquids are not permitted to migrate into devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth and never submerged or have liquids poured upon them.

**Repair** – In the event that equipment becomes damaged or ceases to operate, arrangements should be made to return the equipment to PCB Piezotronics for repair. User servicing or repair is not recommended and, if attempted, may void the factory warranty.

**Calibration** – Routine calibration of sensors and associated instrumentation is recommended as this helps build confidence in measurement accuracy and acquired data. Equipment calibration cycles are typically established by the users own quality regimen. When in doubt about a calibration cycle, a good “rule of thumb” is to recalibrate on an annual basis. It is also good practice to recalibrate after exposure to any severe temperature extreme, shock, load, or other environmental influence, or prior to any critical test.

PCB Piezotronics maintains an ISO-9001 certified metrology laboratory and offers calibration services, which are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to the normally supplied calibration, special testing is also available, such as: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For information on standard recalibration services or special testing, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

**Returning Equipment** – *Following these procedures will insure that your returned materials are handled in the most expedient manner.* Before

returning any equipment to PCB Piezotronics, contact your local distributor, sales representative, or factory customer service representative to obtain a Return **Warranty, Service, Repair, and Return Policies and Instructions** Materials Authorization (RMA) Number. This RMA number should be clearly marked on the outside of all package(s) and on the packing list(s) accompanying the shipment. A detailed account of the nature of the problem(s) being experienced with the equipment should also be included inside the package(s) containing any returned materials.

A Purchase Order, included with the returned materials, will expedite the turn-around of serviced equipment. It is recommended to include authorization on the Purchase Order for PCB to proceed with any repairs, as long as they do not exceed 50% of the replacement cost of the returned item(s). PCB will provide a price quotation or replacement recommendation for any item whose repair costs would exceed 50% of replacement cost, or any item that is not economically feasible to repair. For routine calibration services, the Purchase Order should include authorization to proceed and return at current pricing, which can be obtained from a factory customer service representative.

**Warranty** – All equipment and repair services provided by PCB Piezotronics, Inc. are covered by a limited warranty against defective material and workmanship for a period of one year from date of original purchase. Contact

PCB for a complete statement of our warranty. Expendable items, such as batteries and mounting hardware, are not covered by warranty. Mechanical damage to equipment due to improper use is not covered by warranty. Electronic circuitry failure caused by the introduction of unregulated or improper excitation power or electrostatic discharge is not covered by warranty.

**Contact Information** – International customers should direct all inquiries to their local distributor or sales office. A complete list of distributors and offices can be found at [www.pcb.com](http://www.pcb.com). Customers within the United States may contact their local sales representative or a factory customer service representative. A complete list of sales representatives can be found at [www.pcb.com](http://www.pcb.com). Toll-free telephone numbers for a factory customer service representative, in the division responsible for this product, can be found on the title page at the front of this manual. Our ship to address and general contact numbers are:

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PCB工业监视和测量设备 - 中国RoHS2公布表  
 PCB Industrial Monitoring and Measuring Equipment - China RoHS 2 Disclosure Table

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	○	○	○	○	○	○
PCB板	X	○	○	○	○	○
电气连接器	○	○	○	○	○	○
压电晶体	X	○	○	○	○	○
环氧	○	○	○	○	○	○
铁氟龙	○	○	○	○	○	○
电子	○	○	○	○	○	○
厚膜基板	○	○	X	○	○	○
电线	○	○	○	○	○	○
电缆	X	○	○	○	○	○
塑料	○	○	○	○	○	○
焊接	X	○	○	○	○	○
铜合金/黄铜	X	○	○	○	○	○
本表格依据 SJ/T 11364 的规定编制。						
○：表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。						
X：表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。						
铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。						

CHINA RoHS COMPLIANCE

Component Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Chromium VI Compounds (Cr(VI))	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Housing	O	O	O	O	O	O
PCB Board	X	O	O	O	O	O
Electrical Connectors	O	O	O	O	O	O
Piezoelectric Crystals	X	O	O	O	O	O
Epoxy	O	O	O	O	O	O
Teflon	O	O	O	O	O	O
Electronics	O	O	O	O	O	O
Thick Film Substrate	O	O	X	O	O	O
Wires	O	O	O	O	O	O
Cables	X	O	O	O	O	O
Plastic	O	O	O	O	O	O
Solder	X	O	O	O	O	O
Copper Alloy/Brass	X	O	O	O	O	O

This table is prepared in accordance with the provisions of SJ/T 11364.

O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: Indicates that said hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirement of GB/T 26572.

Lead is present due to allowed exemption in Annex III or Annex IV of the European RoHS Directive 2011/65/EU.

DOCUMENT NUMBER: 21354

DOCUMENT REVISION: C

ECN: 45605

Model Number <b>M1408-M119-02ADB</b>	<b>FATIGUE RATED LOW PROFILE LOAD CELL, DUAL BRIDGE</b>	Revision: A ECN #: 43840
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	<u>ENGLISH</u>	<u>SI</u>	
<b>Performance</b>			
Measurement Range(100 x 10 <sup>6</sup> cycles)	50 klb	222 kN	[5][6]
Sensitivity(± 10 %)	2.0 mV/V	2.0 mV/V	[7][1]
Non-Linearity	≤ 0.05 % FS	≤ 0.05 % FS	
Hysteresis	≤ 0.05 % FS	≤ 0.05 % FS	
Non-Repeatability	≤ 0.02 %RO	≤ 0.02 %RO	
Eccentric Load Sensitivity	0.1 %/in	0.1 %/25.4mm	
Resonant Frequency	18 kHz	18 kHz	
Side Load Sensitivity	0.1 %/in	0.1 %/25.4mm	
Creep(in 20 minutes)	0.025 %	0.025 %	
Static Error Band	≤ 0.05 % FS	≤ 0.05 % FS	[5]
<b>Environmental</b>			
Overload Limit	150 klb	667 kN	
Load Limit(Side Force, F <sub>X</sub> or F <sub>Y</sub> )	50 klb	222 kN	[3]
Load Limit(Bending Moment, M <sub>X</sub> or M <sub>Y</sub> )	50k in-lb	5649 Nm	[3]
Load Limit(Axial Torque, M <sub>Z</sub> )	50k in-lb	5649 Nm	[3]
Temperature Range(Operating)	-65 to +200 °F	-54 to +93 °C	
Temperature Range(Compensated)	+15 to +115 °F	-9 to +46 °C	
Temperature Effect on Output(Maximum)	± 0.0008 %Reading/°F	± 0.0018 %Reading/°C	[4]
Temperature Effect on Zero Balance(Maximum)	± 0.0008 %FS/°F	± 0.0018 %FS/°C	[4]
<b>Electrical</b>			
Bridge Resistance	350 Ohm	350 Ohm	[1]
Excitation Voltage(Recommended)	10 VDC	10 VDC	[2]
Insulation Resistance	>5k GOhm	>5k GOhm	
Zero Balance	≤ 1 %RO	≤ 1 %RO	
Output Polarity	+Tension	+Tension	
<b>Physical</b>			
Size (Diameter x Height)	8.00 in x 4.50 in	203.20 mm x 114.30 mm	[8]
Weight	54 lb	25.5 kg	
Mounting Thread	No English Equivalent	M42 x 2.0	
Sensing Element	Strain Gage	Strain Gage	
Mounting Torque	2600 in-lb	294 Nm	
Deflection at Full Scale Capacity	0.001 in	0.025 mm	
Electrical Connector	MS3102A-14S-2P (2)	MS3102A-14S-2P (2)	

All specifications are at room temperature unless otherwise specified.  
In the interest of constant product improvement, we reserve the right to change specifications without notice.

**OPTIONAL VERSIONS**

Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.

**NOTES:**

[1]Nominal.  
[2]Calibrated at 10 VDC, usable 5 to 20 VDC or VAC RMS.  
[3]Singularly applied, i.e. no other extraneous loads.  
[4]Over compensated operating temperature range.  
[5]FS - Full Scale.  
[6]Calibrated in tension and compression.  
[7]RO - Rated Output.  
[8]See Outline Drawing 60728 for Complete Dimensions.

Entered: AP	Engineer: PE	Sales: RWM	Approved: JSD	Spec Number:
Date: 2/17/2015	Date: 2/17/2015	Date: 2/17/2015	Date: 2/17/2015	<b>60729</b>

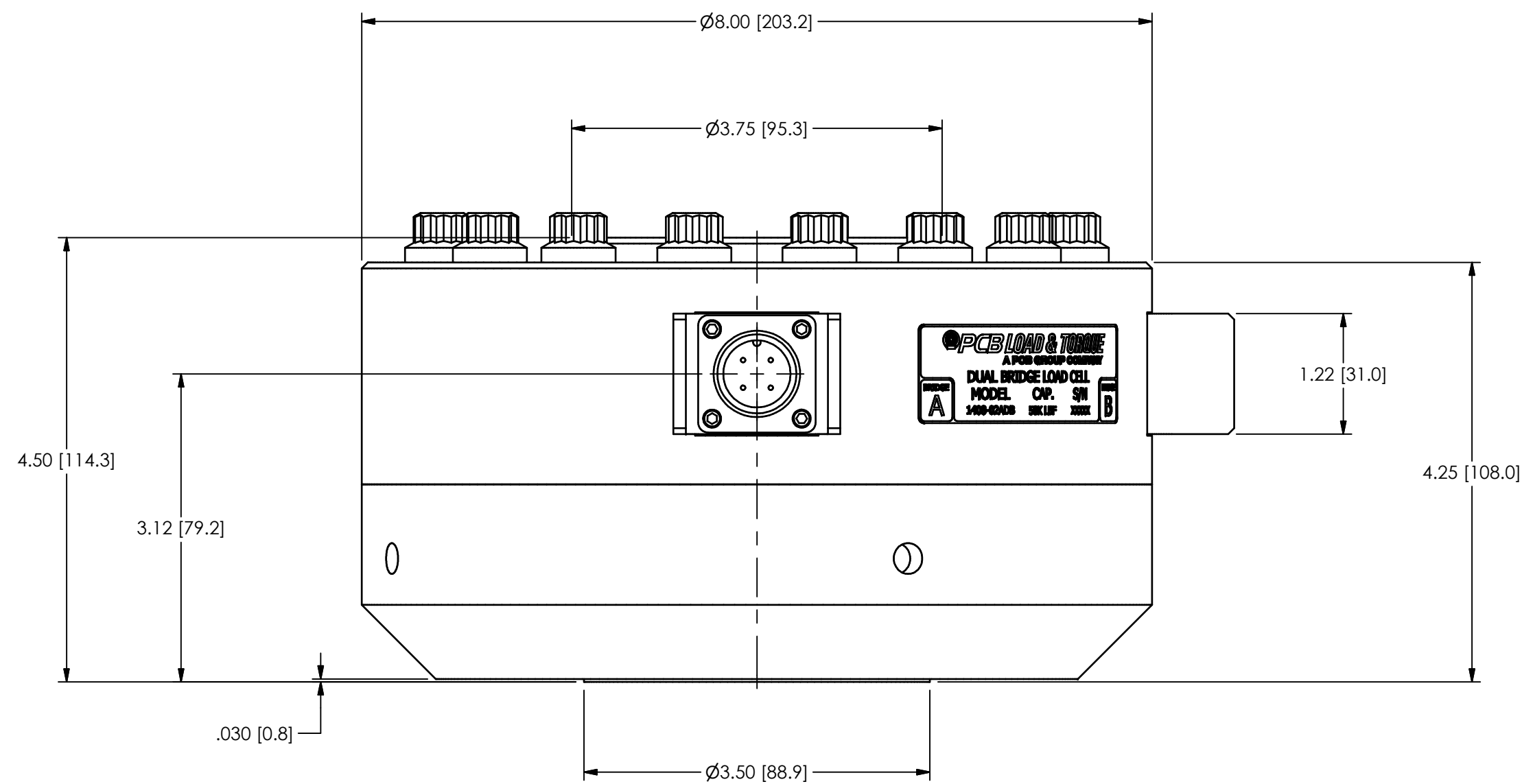
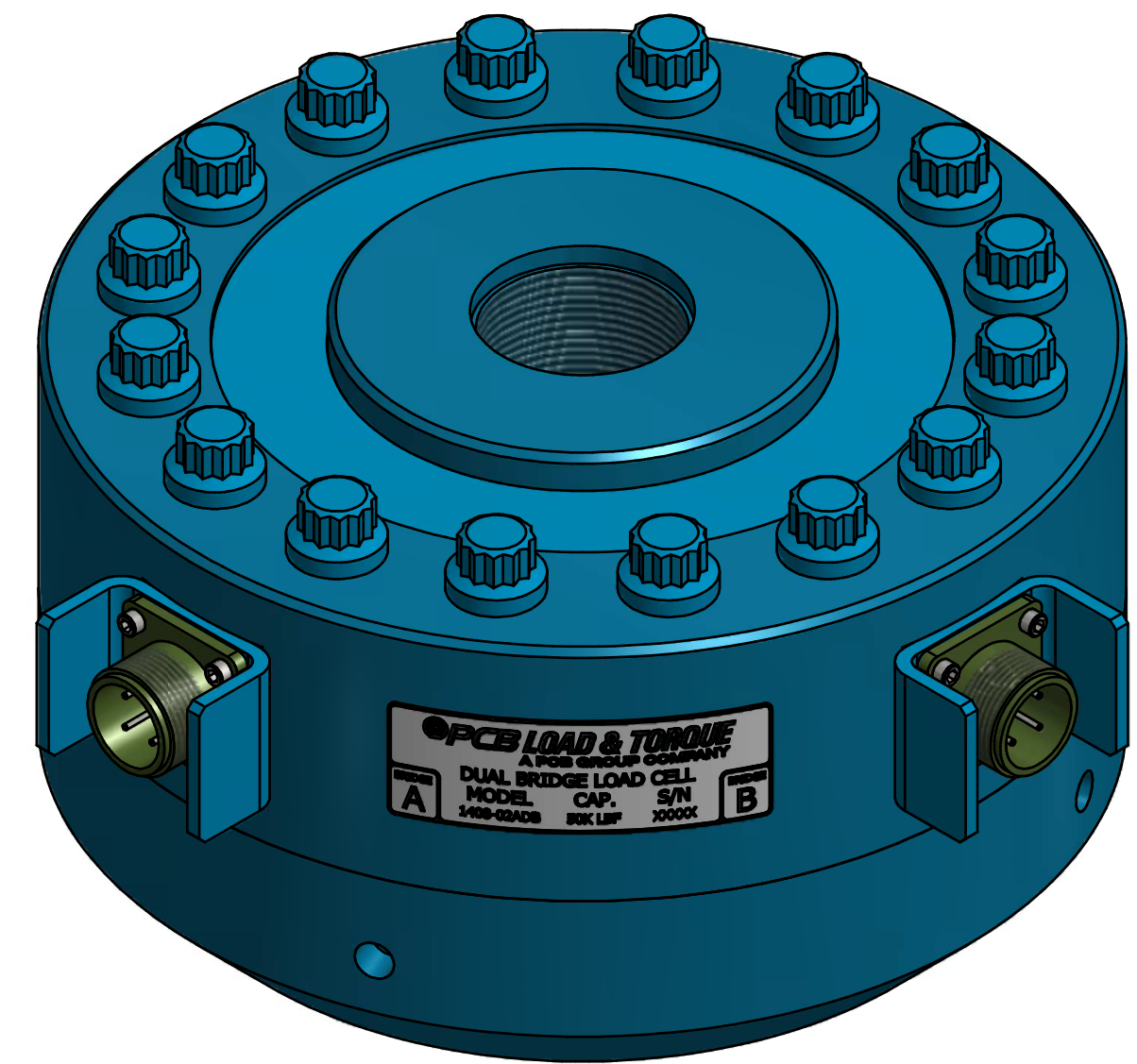
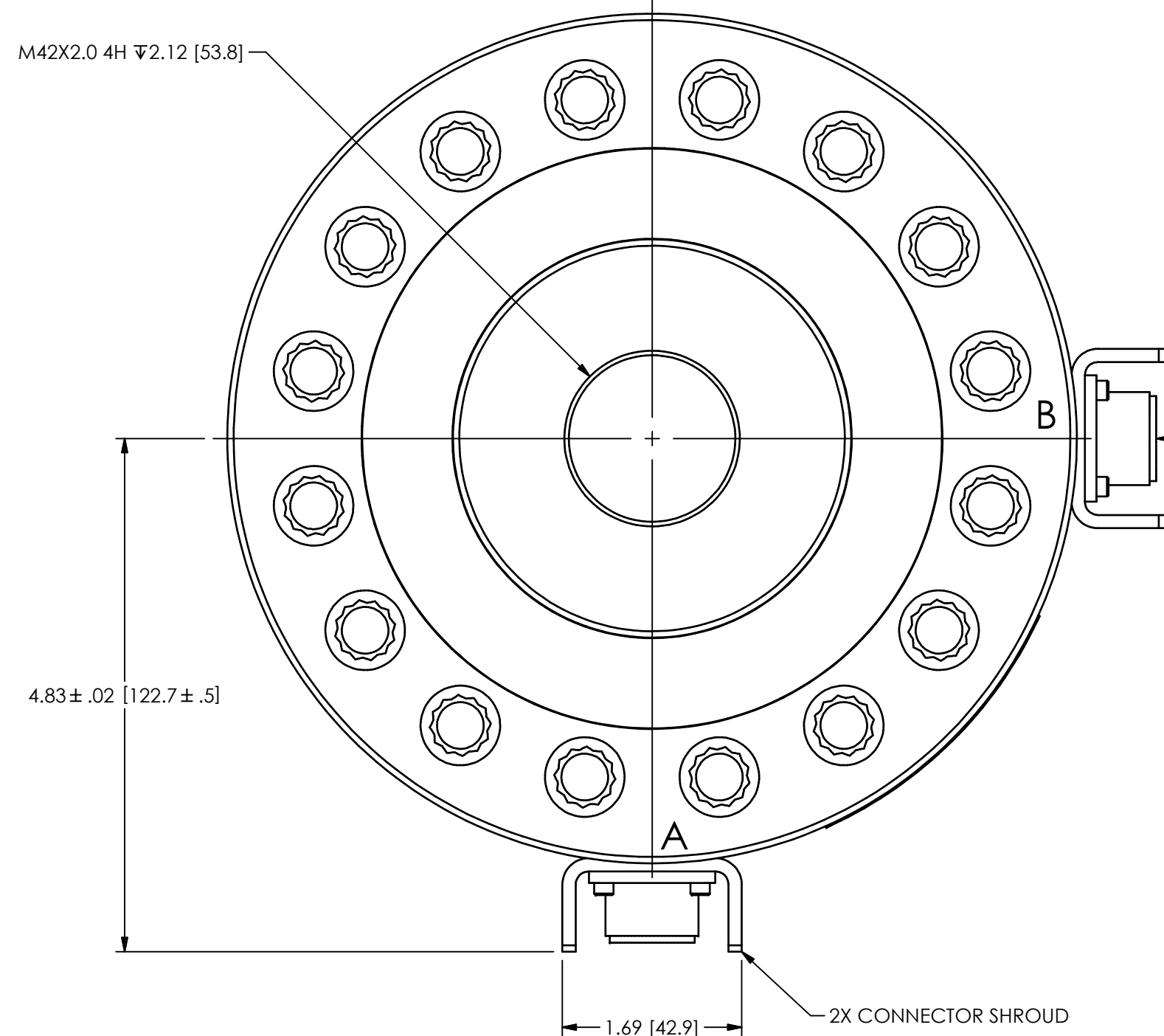


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REVISIONS		
REV	DESCRIPTION	ECO
A	CORRECTED WIRING CODE - 11.03.15, PTE	44775

60728



UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN	CHECKED	ENGINEER	PCB LOAD & TORQUE A PCB GROUP COMPANY		
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	PTE	01.15.15	JSD		01.16.15	PTE
DECIMALS .XX ±.01 XXX ±.005	DECIMALS X ±0.3 XX ±0.13	TITLE			24350 Indoplex Circle, Farmington Hills, MI 48335 (248) 888-8260 E-MAIL: linfo@pcb.com		
ANGLES ± .5 DEGREES	ANGLES ± .5 DEGREES	OUTLINE DRAWING 8" METRIC DB LP LC MS CONNECTOR			DWG. NO. <b>60728</b>		
FILLETS AND RADII .015 MAX	FILLETS AND RADII 0.38 MAX				SCALE: 3/4 SHEET 1 OF 1		

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### 1.0 INTRODUCTION

Dual bridge fatigue-rated load cells manufactured by PCB Load and Torque, Inc. are guaranteed to last 100 million fully reversed cycles (full tension through full compression). These load cells feature high accuracy with resistance to off-center loading, extraneous bending and side-loading forces. The load cells are manufactured using premium fatigue resistant steel or aluminum, and are carefully processed to ensure mechanical and electrical integrity, as well as accuracy. The nominal full scale output of the fatigue rated load cells is 2.0 mV/V.

The following document explains how to properly install the dual bridge load cell, including detailed procedures on specified torques installation, adapter thread class 3 and tension pre-load specifications.

### 2.0 SAFETY PRECAUTIONS

Fatigue rated load cells are designed with very high safety factors for overload, and of course, cyclic fatigue loads when used in testing programs. However, failure of the load cell structure or fasteners used in the load cell installation may cause personal injury and equipment damage.

It is important to provide adequate clearances and safety guards or shields properly surrounding test fixtures where fatigue rated load cells are used.

It is important to review the manufactured data when selecting rod ends and fasteners for load cell installation. Failure might occur due to combine measurement axis and extraneous loads if installation specifications are not followed. All test fixtures designed for use with fatigue rated load cells should be carefully evaluated for potential failure modes of the fixtures.

It is important to use threaded fasteners properly when assembling test fixtures used with the load cells. Fixtures with inadequately designed bolted joints, or improperly tightened threaded fasteners can fail before the parts under test have completed the planned fatigue test cycles.

### 3.0 OVERVIEW

Dual bridge fatigue-rated load cells are specifically designed for repetitive testing. Applications include material testing, component life cycle testing, and structural testing. The load cells contain an extra bridge to be used either as a back-up incase the primary bridge fails during a test, or just for confirmation of the primary bridge readings. As an added benefit, these load cells are extremely resistant to extraneous bending and side loading forces

### 3.1 Dimensions

The following figure and table give the general outline dimensions of the dual bridge fatigue-rated load cells.

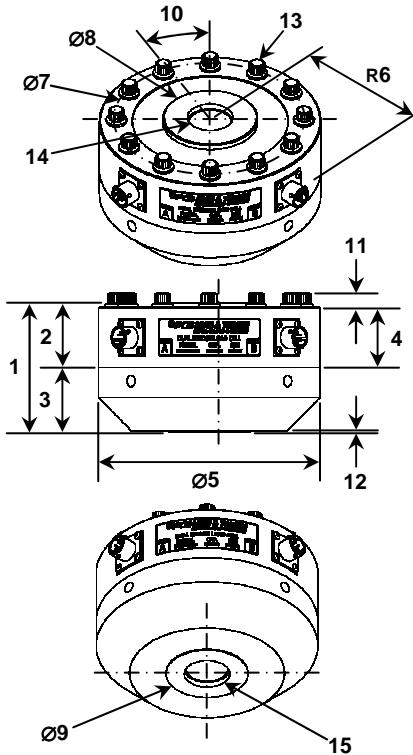


Figure 1 - Dimensions

Table 1 – Dimension Descriptions

Dim.	Description
1	Total Height
2	Load Cell Height
3	Tension Base Height
4	Load Cell Body Height
Ø5	Load Cell Diameter
R6	Max. Clearance Radius
Ø7	Bolt Circle Diameter
Ø8	Top Loading Surface Diameter
Ø9	Bottom Loading Surface Diameter
10	Angle Between Screws
11	Screw Head Height
12	Bottom Loading Surface Height
13	Screw for Tension Base
14	Load Cell Mounting Thread
15	Tension Base Mounting Thread

Table 2 – Dimension Values

Dimensions (see Figure 1)	Model Series							
	1403		1404		1408		1411	
	Capacity (Lbf)							
	5k		12.5k, 25k		50k		100k	
	(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)
1	2.50	63.5	3.50	88.9	4.50	114.3	6.50	165.1
2	1.37	34.8	1.75	44.5	2.50	63.5	3.50	88.9
3	1.13	28.7	1.75	44.5	2.00	50.8	3.00	76.2
4	1.25	31.8	1.63	41.4	2.25	57.2	3.25	82.6
Ø5	4.12	104.6	6.06	153.9	8.00	203.2	11.00	279.4
R6	2.54	64.6	3.53	89.7	4.85*	123.2*	6.10*	154.9*
Ø7	3.50	88.9	5.13	130.2	6.50	165.1	9.00	228.6
Ø8	1.25	31.8	2.42	61.4	3.50	88.9	5.38	136.5
Ø9	1.25	31.8	2.25	57.2	3.50	88.9	4.50	114.3
10	45°		30°		22.5°		22.5°	
11	0.25	6.4	0.37	9.4	0.48	12.2	0.75	19.1
12	0.03	0.76	0.03	0.76	0.03	0.76	0.03	0.76
13	1/4-28x1 3/4 screw 12 pt. Qty. 8		3/8-24x2 1/4 screw 12 pt. Qty. 12		1/2-20x3 1/2 screw 12 pt. Qty. 16		3/4-16x4 1/2 screw 12 pt. Qty. 16	
14	5/8-18		1 1/4-12		1 3/4-12		2 3/4-8	
Thread Depth	0.88	22.4	1.37	34.8	2.12	53.8	2.56	65.0
15	5/8-18		1 1/4-12		1 3/4-12		2 3/4-8	
Thread Depth	0.88	22.4	1.37	34.8	1.71	43.4	3.15	80.0

\*Indicates dimension with connector protector.

### 3.2 Standard Components

The following figure describes the standard components of the dual bridge fatigue-rated load cells.

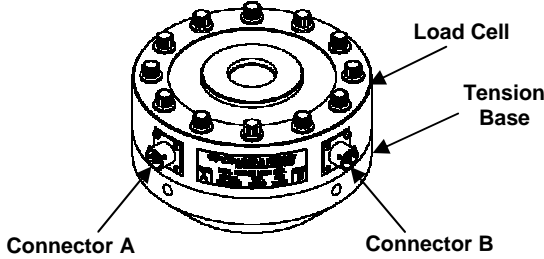


Figure 2 – Standard Components

### 3.3 Optional Components

The following figure describes the optional components of the dual bridge fatigue-rated load cells.

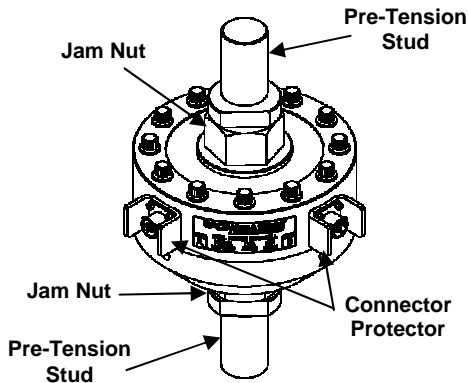


Figure 3 – Optional Components

**NOTE:** Connector protectors are standard on 8” and 11” models.

Table 3 describes the available optional components

Table 3 – Optional Components

Item Number	Item Description
084A40	Lifting Rings (side), 1411 Series
084A41	Lifting Plug (top), 1411 Series
084A55	Pre-Tension Stud (5/8”-18 Thread), 1403 Series
084A56	Pre-Tension Stud (1 1/4”-12 Thread), 1404 Series
084A57	Pre-Tension Stud (1 3/4”-12 Thread), 1408 Series
084A58	Pre-Tension Stud (2 3/4”-8 Thread), 1411 Series
084A59	Pre-Tension Stud (2 3/4”-8 to 1 3/4”-12 Thread) 1411 Series
084A90	Connector Protector, 1403 and 1404 Series

**NOTE:** Pre-tension studs include the threaded stud and the jam nut.

## 4.0 MECHANICAL INSTALLATION

Standard components of the dual bridge fatigue-rated load cells have all been installed to factory specified values for optimum performance. The following mechanical installation instructions should be observed if optional components are to be used.

### 4.1 Mounting Bases

All low-profile load cells are calibrated and supplied with a factory installed standard mounting base. An optional custom (customer supplied) mounting base can, with special arrangements, be installed and used for calibration. However, there will be an extra charge for removal of the standard base, and installation of the load cell on the customer’s base / fixture.

**NOTE:** To insure catalog performance specifications are met the customer’s supplied fixture or base must be flat to within 0.0002 inch and provide similar stiffness and hardness to a factory base.

Unless otherwise specified/requested, the base and load cell are calibrated as a unit. It is important to note that the performance of the load cell may be affected if the factory-installed mounting base is removed or modified.

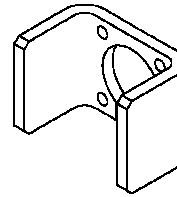
### 4.2 Mounting Load Cell to a Standard Base or Custom Fixture

If the load cell is to be mounted to a custom base or fixture, it is necessary to consider the following:

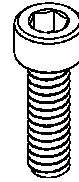
1. The thickness of the new base or fixture must not be any thinner than the original base supplied with the load cell. Materials used must have the same temperature coefficient of expansion (for example, 4140 Steel or 2024-T4 Aluminum for 250,500 and 1,000 capacity aluminum cells).
2. The mounting surface must be flat (within 0.0002 inches), and steel fixtures must have a hardness of Rockwell C 33 to 37.
3. The threaded holes and under-head of the fasteners must be lightly lubricated with 30 weight oil or equivalent prior to tightening the mounting bolts.
4. Refer to Table 4 for the final tightening torque required for each bolt size.
5. Tighten the bolts in an incremental cross pattern with the following sequence: start with all bolts finger tight followed by 25%, 50% and finally 100% of the required torque being applied.

**Table 4 – Tension Base Installation Torque Values**

Bolt Size	Part Number	Installation Torque
1/4-28x1 3/4	100-8011-10	15-17 LbFt (180-204 Lbln)
3/8-24x2 1/4	100-8082-20	75-80 LbFt (900-960 Lbln)
1/2-20x3 1/2	100-8011-30	120-130 LbFt (1440-1560 Lbln)
3/4-16x4 1/2	100-10026-40	370-400 LbFt (4440-4800 Lbln)



**Figure 5 - Connector Protector (54823-02)**



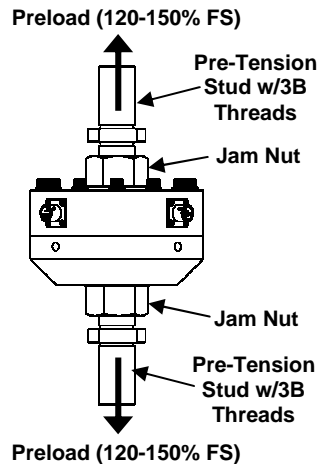
**Figure 6 - #4-40 x 3/8" Socket Head Cap Screw**

### 4.3 Threaded Tension Rods

**NOTE:** Threaded tension rods are an optional feature on the dual bridge fatigue-rated load cell.

Installation of the load cell starts with tension pre-loading the load cell to 120-150% of full scale capacity and lightly tightening a jam nut to lock in the preload on both the load cell and base tension rods. Once the preload tension is released, the threads will be securely engaged.

Failure to pre-load the attachment rods/ fixtures can result in damage to the threads on the load cell and base during cyclic load tests.



**Figure 4 – Installation of Pre-Tension Studs**

Threaded rods engaging the load cell should have Class 3 threads to ensure thread-to-thread close contact forces.

**NOTE:** It is important that the tension rods installed in the load cell and base use full thread engagement, but are not jammed, or torqued. They should be 1/2-1 turn from the bottom of the threads in both the base and load cell.

### 4.4 Mounting Optional Connector Protectors

Models 1403 and 1404 dual bridge fatigue-rated load cells do not come standard with connector protectors. If optional connector protectors are to be mounted, it is necessary to consider the following:

#### 4.4.1 Included Components in Kit (084A90)

**Table 5 - Kit Components**

Component	Quantity
Connector Protector (54823-02)	2
#4-40 x 3/8" Socket Head Cap Screw	8

### 4.4.2 Required Tools

**Table 6—Required Tools (Not Included)**

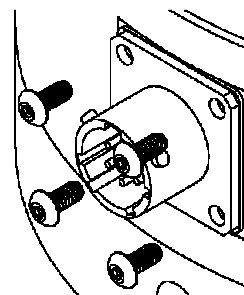
1/16" Hex Wrench
3/32" Hex Wrench
Loctite® Threadlocker Blue 242®

### 4.4.3 Installation of Connector Protector

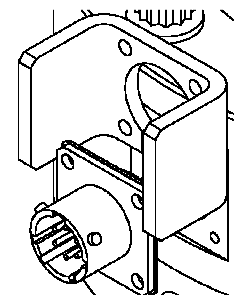
1. Remove the #4-40 x 1/4" button head cap screws from the connector using a 1/16" hex wrench as shown in Figure 7.
2. Carefully pull the connector from the load cell. Take care to not break or loosen any wire connections.
3. Slide the connector protector (54823-02) behind the connector as shown in Figure 8.
4. Apply a drop Loctite® Threadlocker Blue 242® to the threads of the #4-40 x 3/8" socket head cap screws.

**NOTE:** Please refer to the Loctite® Threadlocker Blue 242® technical data sheet for directions of use.

5. Attach the connector protector (54823-02) to the load cell with the #4-40 x 3/8" socket head cap screws using a 3/32" hex wrench as shown in Figures 9 and 10.



**Figure 7 - Remove the #4-40 x 1/4" Button Head Cap Screws**



**Figure 8 - Slide the Connector Protector (54823-02) Behind the Connector**

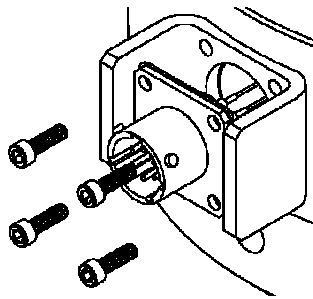


Figure 9 - Attach the Connector Protector (54823-02) using #4-40 x 3/8" Socket Head Cap Screws

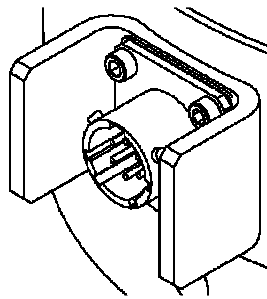


Figure 10 - Fully Assembled

### 5.2 Cable & Grounding Considerations

Proper grounding and shielding is required to prevent electrical noise in strain gage load cell measuring systems. The cable must be shielded twisted pairs with a drain wire.

Cable shields must be grounded only at one end, for example, on the instrument or control system ground. The load cell case is grounded by mechanical attachment to the structure to which it is mounted.

The instrument or control system is grounded through its power cord. Ground loops and measuring system wiring may result in unstable or noisy signals.

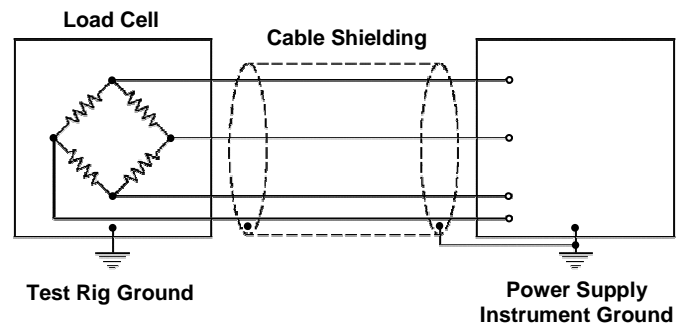


Figure 12 - Grounding

A simple test with a voltmeter connected between the power cord ground and the structure on which the load cell is mounted can confirm that the structure has been properly grounded. If the power cord ground and structure ground are not at the same potential, it may be necessary to provide a secure structure ground, perhaps by driving a copper rod and attaching a ground strap.

## 6.0 CALIBRATION

Every dual bridge fatigue-rated load cell purchased from PCB Load & Torque, Inc. has been fully calibrated per ISO/IEC 17025 procedures, and meets all published specifications. Each load cell will come with a calibration certificate designated with matching model and serial numbers. PCB Load & Torque also offers calibration services on an on-going basis.

### 6.1 Calibration Certificate Description

Calibration reports supplied with PCB Load & Torque dual bridge load cells contain valuable information to assist the customer in use of the equipment. A separate calibration report is provided for tension and compression calibrations on each bridge. Calibration procedures, equipment, and reports comply with ISO/IEC 17025.

## 5.0 ELECTRICAL INSTALLATION

Table 6 – Electrical Connections

<b>Load Cell Receptacle "A-Type":</b>	PT02E-10-6P		
<b>Mating Connector:</b>	PT06A-10-6S	<b>PCB Item No:</b>	181-012A
<b>Load Cell Receptacle "B-Type":</b>	PC04E-10-6P		
<b>Mating Connector:</b>	PC06A-10-6S	<b>PCB Item No:</b>	182-025A

### 5.1 Electrical Drawing / Western Regional Std.

All load cells are wired following the Western Region Standard. All models utilize strain gages configured into a Wheatstone Bridge Circuit to produce the primary sensing element. The four-arm Wheatstone bridge configuration is shown below in Figure 11.

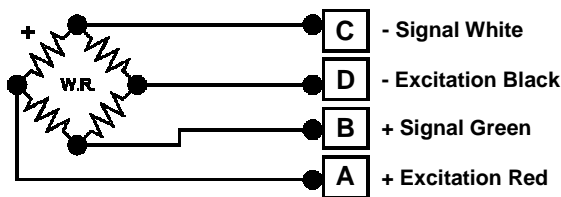


Figure 11 - Western Regional Strain Gage Committee Wiring Code

The gages are bonded to the load cell's structure. Typically, a regulated DC or AC excitation is applied between A and D of the bridge. When a force is applied to the load cell, the Wheatstone bridge becomes unbalanced, causing an output voltage between B and C, which is proportional to the applied load. This configuration allows for temperature and pressure compensation, as well as cancellation of signals caused by forces not directly applied to the axis of the applied load. Output is typically expressed in units of mV/V of excitation.

**6.1.1 Measured Output**

The applied load starting at zero is measured in five increments to full scale. Output (mV/V) is measured at each increment. The straight-line from zero to the full scale measurement is compared to the measured readings at each increment to calculate the error at each load increment. The deviations (% Full Scale) corresponding to non-linearity at each measurement increment are then calculated.

**6.1.2 Hysteresis**

The difference between the ascending and descending measured readings at 40% of full scale is used to calculate the hysteresis value.

**6.1.3 Best Fit Output**

The best fit calibration second-order equation has been calculated from the calibration data by the method of least squares. Deviation between measured output and best-fit output is calculated and displayed in the column next to the best-fit output for each measurement increment. The deviations (% Full Scale) of measured outputs from the calculated best fit are tabulated for each measured reading.

**6.1.4 Strain Gage Measurements**

Table 7 – Strain Gage Measurements

<b>Bridge Resistance:</b>	350 Ohm Nominal
<b>Excitation:</b>	+P(A) to –P(D) Ohms
<b>Signals:</b>	+S(B) to –S(C) Ohms
<b>Leakage to Ground:</b>	> 5k GOhm
<b>Bridge Unbalance:</b>	±1.0% Full Scale
<b>Output:</b>	2.0 mV/V Nominal
<b>Maximum Voltage:</b>	20 VDC

**6.1.5 Shunt Calibration Standard Resistor**

All dual bridge load cell calibrations use a 60K Ohm (0.01%) precision resistor shunt calibration value that is supplied into the calibration report.

**6.1.6 Static Error Band (SEB)**

The static error band (SEB) is determined by the maximum deviations of the ascending and descending calibration points from the best fit straight line through zero output. The SEB includes the effects of nonlinearity, hysteresis, and non-return to minimum load.

**7.0 MOMENT COMPENSATION**

When an eccentric axial load is applied to a load cell that is not coincident exactly with the centerline of the load cell, it introduces bending moments into the load cell structure. The strain gage bridges on dual bridge fatigue rated load cells are adjusted such that the error due to eccentric loading is less than ±0.1% per inch of offset.

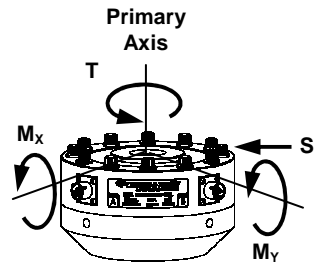


Figure 13 - Extraneous Loads

Side loads, moments and torque must be limited to avoid electrical or mechanical damage to the load cell. The allowable extraneous loads are directly related to the rated capacity of the load cell.

- Maximum side force allowed is 100% of the rated capacity for the load cell.
- Maximum moment allowed is 100% of the rated capacity times 1 inch.
- Maximum torque allowed about the measurement axis is rated capacity times 1 inch.

Maximum error due to side loading or moment loading is 0.1% per inch of the rated capacity. Each dual bridge load cell is carefully tested and adjusted according to our specifications ensuring that crosstalk due to off-center loading, moments and side load is less than 0.1% of applied load.

**8.0 FATIGUE & OVERLOAD**

Dual bridge load cells are designed and manufactured to perform accurately and reliably for 100 million fully reversed full scale load cycles. They have been specifically designed for applications involving high cycle fatigue loading on products and structures. The designs are based on more than four decades (since 1970) of experience in the design and manufacture of precision low-height load cells.

The load cell structure is machined from aircraft quality alloy steel, heat treated, and finished with attention to details critical for maximum fatigue life. For maximum stiffness and low stresses throughout the load cell structure, the maximum stresses are concentrated precisely under the strain gages.

The load cell structural safety factor against fatigue failure is in excess of 2.5 for alloy steel and 2 for aluminum. See Figure 14. The maximum shear stress measured by the bonded strain gages is less than 40% of the endurance limit shear stress for alloy steel and 48% for aluminum.

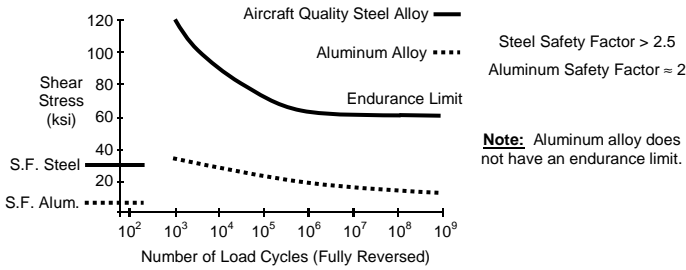


Figure 14 - S-N Curve (Load Cell)

The strain gages used are made with Modulus Compensated Modified Karma Alloy. The alloy steel gages have a safety factor against fatigue of approximately 2, and the aluminum gages' is approximately 4 as shown in Figure 15.

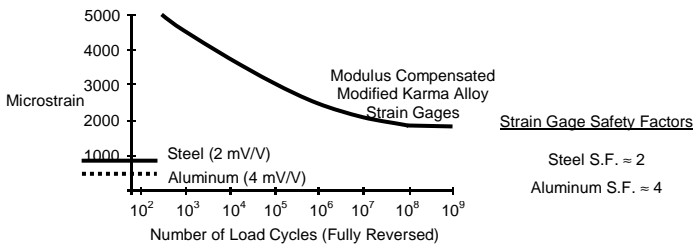


Figure 15 - Strain-N Curve (Strain Gages)

Dual bridge fatigue-rated load cells are capable of surviving exceptionally high overloads. Occasional loads up to 300% of the rated capacity (due to accidental overload) have a safety factor against yield of the strain gage sections of approximately 1.5 for both alloy steel and aluminum as shown in Figure 16.

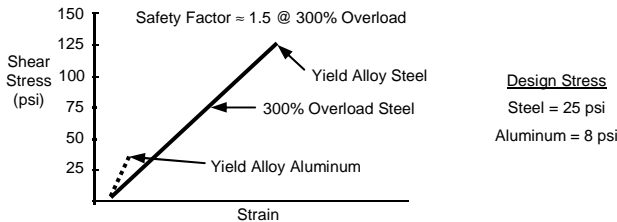


Figure 16 - Shear Stress/Strain Curves (Load Cell)

## 9.0 SHUNT CALIBRATION DESCRIPTION

Shunt calibration is used to simulate a known tension or compression load on a load cell. The calibration certificate will indicate which leg of the bridge to apply the shunt resistor to for both tension and compression load simulation. Typically tension is simulated by inserting the shunt resistor between the +P and +S connector leads. Compression loading is simulated by inserting the shunt resistor between the +S and -P connector leads.

## 9.1 Resistor Value

Dual bridge load cells have a nominal 2.0 mV/V full scale output. For a 350 ohm strain gage bridge the precision shunt resistor is, 60,000 ohms ± 0.01%, simulates an output of approximately 73% of the full scale output for the load cell. The calibration values for each bridge are found on the calibration certificates supplied with each load cell.

## 9.2 Shunt Calibration Process

To perform the shunt calibration, use the following procedure:

1. Stabilize all forces on the load cell. If possible, remove all loads.
2. Set the load indicator display to read exactly 00.000.
3. Connect the shunt resistor to the terminals specified in the calibration certificate, and adjust the span or gain until the display reads the force value stated on the certificate.
4. Repeat steps 1-3 to verify that a valid calibration setting has been obtained.
5. If possible, apply a known load to the measurement system to further verify that the calibration has been accurately set up.

## 9.3 Estimating Shunt Resistor for a Given Load

The following formula can be used to estimate the approximate value of shunt resistor required to simulate a mechanical load.

$$R_{cal} = (25 * R_b) / (Output_{FS} * L_{cal})$$

Where:

$R_{cal}$  = Shunt Resistor (K ohms)

$R_b$  = Bridge Resistance (ohms)

$Output_{FS}$  = Full Scale output of the load cell (mV/V)

$L_{cal}$  = Load to be simulated, % of Load Cell Capacity

## 10.0 MAINTENANCE

Routine maintenance of the dual bridge load cell should include cleaning the electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the physical material of construction. Make sure liquids are not allowed to migrate into devices that are not hermetically sealed. Such devices should only be wiped with a damp cloth, and never be submerged or have liquids poured on them. Never use a pressure washer on the load cells.

Dual bridge fatigue rated load cells, when mounted on the factory supplied base, are barometric compensated through a small port located in one of the spanner wrench holes on the base.

The bolts used to install bases at the factory have been tightened to specifications to prevent loosening under normal usage. However, if the base has been removed for any reason, or the load cell has been mounted on a custom fixture without the base, it is a good idea to periodically test the mounting bolt tightness using a calibrated torque or click wrench.

## 11.0 TROUBLE SHOOTING

Proper performance of a load cell requires careful attention to both electrical and mechanical aspects of the measurement system. A basic understanding of the electrical and mechanical installation requirements is recommended.

### 11.1 Mechanical Trouble Shooting

A mechanical checklist includes:

1. Check for proper installation of load cell.
2. Check for properly tightened bolts.

### 11.2 Electrical Trouble Shooting

An electrical checklist should start with:

1. Check cables for proper wiring.
2. Inspect for loose or dirty electrical connections.
3. Check for improper shield grounds.
4. Check for proper grounding of the structure that the load cell is mounted on.
5. Check the signal conditioning electronics for proper setup.
6. Check the insulation resistance of shielded conductors for short circuits.
7. Check isolation resistance, load cell flexure to conductors.
8. Check load cell bridge resistances, (A-D) excitation and (B-C) the signal leads.
9. Check bridge balance.
10. Keep a record of your observations, correct problems, or contact PCB factory for assistance.

### 11.2.1 Estimating Bridge Balance using an Ohm Meter

A load cell that has been severely overloaded will exhibit a significant zero offset in the Wheatstone bridge. It can be useful to estimate the bridge unbalance using a digital ohm meter with resolution of at least 0.1 ohm.

Following the Western Region wiring diagram measure the resistances for each leg of the bridge, i.e.:  $R_{AB}$ ,  $R_{AC}$ ,  $R_{DB}$ , and  $R_{DC}$ .

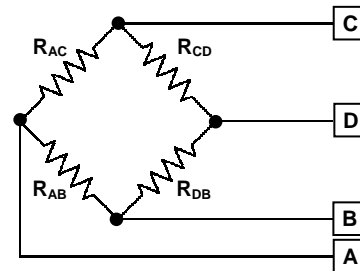


Figure 17 – Wheatstone Bridge

1. Estimate the Zero Offset (mV/V):

$$\text{Zero Offset} = 1.4 \times (R_{AC} - R_{AB} + R_{DB} - R_{CD})$$

2. Estimate the Bridge Unbalance (% Full Scale):

$$\text{Bridge Unbalance} = 100 \times (\text{Zero Offset} / \text{Output}_{FS})$$

Where:

$$\text{Output}_{FS} = \text{Full Scale output of the load cell (mV/V)}$$

A Zero Offset of greater than 10% indicates probable overload or possible fatigue damage. A load cell that has been significantly overloaded enough to create a large zero offset is not repairable. In some instances it may be possible to temporarily continue to use the load cell by attempting to balance the bridge through use of external resistors. However, the user should expect that such a load cell no longer will meet the performance parameters related to its original specifications. (User beware!!)

## 12.0 CALIBRATION / REPAIR SERVICES

PCB Load & Torque offers calibration and repair services. The PCB Calibration Laboratory in Farmington Hills, Michigan is A2LA Accredited per ISO/IEC 17025.

Standard calibration certificates list five force points ascending and one point descending. Additional data points are available at extra cost upon request. A 60 K ohm ( $\pm 0.01\%$ ) shunt calibration resistor is supplied with each load cell calibration.

Certificate information includes tabulated measurement variable data zero balance, bridge input/output resistance, computer nonlinearity and hysteresis, static error band (SEB) calculations and entries abilities and traceability statements.

If an initial evaluation shows that a transducer requires repair, PCB will provide the customer with an estimate prior to taking any corrective action.

### **12.1 RMA / Purchase Order**

Please request a return material authorization (RMA) before sending a load cell back to the factory for any reason. For calibration services, if possible, a copy of the purchase order covering the requested services should be included with the returned load cell.

## **13.0 WARRANTY**

Standard warranty on dual bridge load cells covers parts and workmanship. For full details, refer to the Warranty Statement supplied with each load cell.

If the load cell is defective for reasons other than overloads, return it to the factory for detailed evaluation. Factory evaluation may show that the load cell is repairable or non-repairable and if repair or replacement will be under warranty. If not under warranty, the customer will be contacted with the cost of repairs and recalibration. Once authorization to proceed is received, a delivery date will be provided.

*Manual Number: 54811  
Manual Revision: A  
Revision Date: 6/6/13  
ECO Number: 41606*