Model 1903-02A

Load Cell, Side Force, 100 Lb FS, Integral Cable with pigtails, Stainless Steel Construction

Installation and Operating Manual

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

Toll-free: 716-684-0001
24-hour SensorLine: 716-684-0001
Fax: 716-684-0987
E-mail: info@pcb.com
Web: www.pcb.com

Repair and Maintenance

PCB guarantees Total Customer Satisfaction through its "Lifetime Warranty Plus" on all Platinum Stock Products sold by PCB and through its limited warranties on all other PCB Stock, Standard and Special products. Due to the sophisticated nature of our sensors and associated instrumentation, **field servicing and repair is not recommended and, if attempted, will void the factory warranty**.

Beyond routine calibration and battery replacements where applicable, our products require no user maintenance. Clean electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the material of construction. Observe caution when using liquids near devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth—never saturated or submerged.

In the event that equipment becomes damaged or ceases to operate, our Application Engineers are here to support your troubleshooting efforts 24 hours a day, 7 days a week. Call or email with model and serial number as well as a brief description of the problem.

Calibration

Routine calibration of sensors and associated instrumentation is necessary to maintain measurement accuracy. We recommend calibrating on an annual basis, after exposure to any extreme environmental influence, or prior to any critical test.

PCB Piezotronics is an ISO-9001 certified company whose calibration services are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to our standard calibration services, we also offer specialized tests, including: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For more information, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment

If factory repair is required, our representatives will provide you with a Return Material Authorization (RMA) number, which we use to reference any information you have already provided and expedite the repair process. This number should be clearly marked on the outside of all returned package(s) and on any packing list(s) accompanying the shipment.

Contact Information

PCB Piezotronics, Inc.
3425 Walden Ave.
Depew, NY14043 USA
Toll-free: (800) 828-8840
24-hour SensorLine: (716) 684-0001
General inquiries: info@pcb.com
Repair inquiries: rma@pcb.com

For a complete list of distributors, global offices and sales representatives, visit our website, www.pcb.com.

Safety Considerations

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions required to avoid injury. While our equipment is designed with user safety in mind, the protection provided by the equipment may be impaired if equipment is used in a manner not specified by this manual.

Discontinue use and contact our 24-Hour Sensorline if:

- Assistance is needed to safely operate equipment
- Damage is visible or suspected
- Equipment fails or malfunctions

For complete equipment ratings, refer to the enclosed specification sheet for your product.

Definition of Terms and Symbols

The following symbols may be used in this manual:

DANGER
Indicates an immediate hazardous situation, which, if not avoided, may result in death or serious injury.

CAUTION
Refers to hazards that could damage the instrument.

NOTE
Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

The following symbols may be found on the equipment described in this manual:

This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.

This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.

This symbol indicates safety, earth ground.

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	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

O： 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.

1.0 INTRODUCTION

Load Cells manufactured by the Force/Torque Division of PCB Piezotronics are designed to accurately measure static and quasi-static compressive and tensile forces ranging from 5 lbs. to 100k lbs. (22 to 4.45kN). 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 1**.

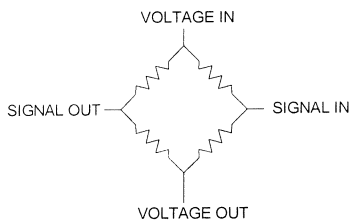

Figure 1 - Wheatstone Bridge Circuit

Most PCB load cells follow a wiring code established by the Western Regional Strain Gage Committee as revised in May 1960. The wiring code is as follows:

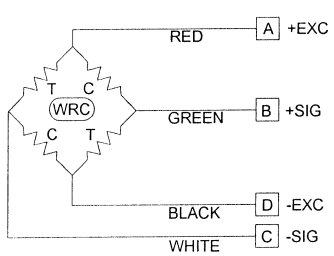

Figure 2 - Western Regional Strain Gage Committee Wiring Code

Refer to the wiring drawing included with this manual for specific wiring of the supplied load cell.

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. The magnitude of the output voltage corresponds to the deformation of the load cell and therefore 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 millivolt per volt of excitation.

Optional signal conditioners are available from PCB. A signal conditioner may have analog voltage output, current output, or digital output. Digital display signal conditioners are also available.

Axis Definition

PCB force products 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 show below.

A (+) sign indicates force in a direction that produces a (+) signal voltage and generally defines a tensile force. The primary axis of rotation or axis of radial symmetry of a load cell is the z-axis as defined in **Figure 3**.

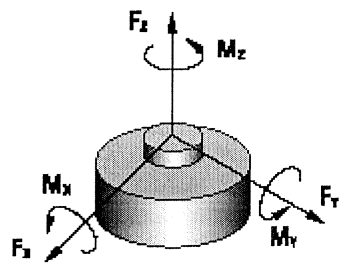

Figure 3 - Axis and Sense Nomenclature for PCB Load Cells

2.0 SAFETY INFORMATION

Failure of the load cell structure or fasteners used in the load cell installation may cause personal injury and equipment damage. To prevent structure failure, review the extraneous load limits listed on the load cell specification sheet supplied with this manual.

Loads must be limited to 100% of the measurement axis load combined with 200% of any one of the extraneous loads. To determine an acceptable level of extraneous loads that prevents output signal degradation, review the extraneous load limits and note on the specification sheet.

When selecting rod ends and fasteners for load cell installation, review the manufacturers data to determine if failure might occur due to combined measurement axis and extraneous loads.

3.0 MECHANICAL INSTALLATION

Refer to the outline drawing supplied with this manual for specific outline dimensions and installation details for your particular model. The specification is also included to provide details of the sensor's characteristic properties.

General Purpose Load Cells
It is important that the surface to which each load cell is mounted be clean and perfectly flat to avoid flexing of the base, which could affect sensor sensitivity and result in erroneous data. Ideally, surface flatness should be held to within 0.001" (TIR) over the entire mating surface. Ensure that the sensor is correctly aligned and oriented, and that it is mounted with proper torque and hardware.

If the load cell is used in an application where both tension and compression forces are applied, use spherical rod end bearings to eliminate bending loads. A load button should be used in compression-only applications.

Extraneous loads, such as bending moments and side loads, may reduce measurement accuracy and cause structure damage. Install the load cell in a manner that minimizes these loads.

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 and special processing to insure mechanical and electrical integrity as well as accuracy. Fatigue rated load cells manufactured by the Force/Torque Division 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 that they are extremely resistant to extraneous bending and side loading forces.

Mounting Bases
All low-profile load cells are calibrated with a mounting base. An optional mounting base, if purchased with a load cell, is pre-installed at the factory. Unless otherwise specified, 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.

Steel hex head cap screws used in mounting load cells must be rated Grade 8 or better. Screws should be fastened in a criss-cross pattern, and tightened to the appropriate torque value listed below.

Screw Thread	Torque (foot-pounds)
1/4"-28	15
3/8"-24	50
1/2"-20	130
5/8"-18	260

Figure 4 – Screw Torque Values

Rod-Style Load Cell
Loads applied to rod-style load cells must be even and centered. Compensation linkages (e.g. rod end bearings, alignment couplers) are recommended to help minimize load misalignment. When installing fixtures, thread the fixture to the load cell, not the load cell to the fixture. If alignment fixtures are not used, insure loading surfaces are flat and parallel, with loads applied in line with the sensor.

S-Beam Load Cell
S-beam load cells can be mounted in a variety a ways, depending on the end use of the sensor. In tension applications, loads must be applied in line, centered on the sensor. To insure optimum loading, compensation linkages such as rod end bearings and alignment couplers are recommended.

In compression applications, loads must be applied even and centered. Load surfaces must be clean, flat and parallel. A load button mounted to the top of the sensor, with the sensor bottom secured to a base plate, provides a reliable mounting arrangement.

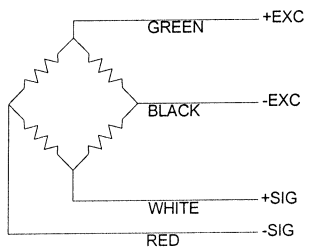

Figure 5 - S-Beam Load Cell Wiring Diagram

If fixtures are mounted to the load cell, be sure to thread the fixture to the load cell. Threading the load cell to the fixture may inadvertently apply a torque load that could damage the sensor.

Hollow Compression Load Cells
Hollow compression load cells feature a smooth thru-hole design that allows a load structure to pass directly through the load cell itself. The load structure must contact the top inner ring only, and the support fixture must contact the lower outer ring only. Hardened washers are supplied and should be used between the load cell and mounting surfaces to obtain the best performance.

Load Washer
Load washer load cells were originally designed to determine the clamp force vs. torque on fasteners. As torque is applied to a fastener, a tensile loading occurs on the fastener, which results in compression load on the load cell. Hardened washers are supplied and should be used between the load cell and mounting surfaces to obtain the best performance.

Load Button
Load buttons are compact, compression-only load cells with an integral spherical loading surface. It is extremely important that the mounting surface is clean, flat and even. Loads must be applied in line on the center of the button to insure optimum sensor performance. Loads must not contact the sensor diaphragm. Fixtures used with load buttons must be oriented in line with the sensor.

4.0 ELECTRICAL INSTALLATION

For proper electrical connections, refer to the installation drawing for the load cell, and the wiring drawing for the signal conditioner used. Construct the interconnect cable from high-quality shielded instrumentation cable. Various cable assemblies are available through PCB.

Connect one end of the cable to the sensor connector and the other end to the signal conditioner. Make sure to tighten the cable connector to the sensor. For installation in dirty, humid, or rugged environments, it is suggested that the connection be shielded against dust or moisture with shrink tubing or other protective material. Strain relieving the cable/sensor connection can also prolong cable life. Mounting cables to a test structure with tape, clamps, or adhesives minimizes cable whip. (See **Figure 6** for an example of a sensor installation with a securely fastened cable.)

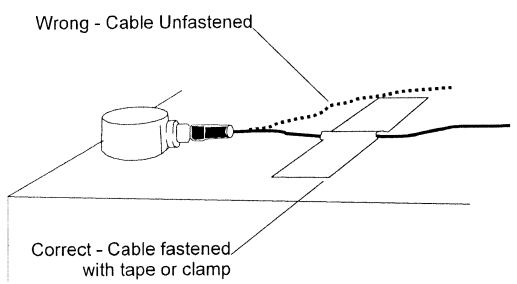

Figure 6 - Cable Strain Relief

5.0 POLARITY

Compressive forces upon standard PCB tension/compression load cells produce a negative-going voltage output. Tensile forces produce a positive-going voltage output.

Compressive forces upon a compression-only load cell produce a positive-going signal.

6.0 SHUNT CALIBRATION

Shunt calibration is the known, electrical, unbalancing of a strain gage bridge by means of a fixed resistor that is placed, or "shunted", across one leg of the bridge. The "Wheatstone Bridge" utilized by PCB load cells are typically calibrated using the shunt calibration technique.

Shunt calibration is a method of periodically checking the gain or span of a signal conditioner, which is used in conjunction with a strain gage based transducer, without exposing the transducer to known, traceable, physical input values. If required, adjustments can then be made to the signal conditioner to insure accurate measurement results.

The strain gage bridge is "in balance" when the host mechanical structure is unloaded and unstressed. As the host structure (diaphragm, bending beam, shear beam, column, etc.) is loaded or stressed, the Wheatstone Bridge becomes unbalanced, resulting in an output signal that is proportional to the applied load.

Shunt calibration simulates the mechanical input to a transducer by unbalancing the bridge with a fixed resistor placed across, or in parallel with, one leg of the bridge. For tension shunt calibration, or +CAL, the shunt resistor (R_{st}) is shunted across the +Excitation (A) and +Signal (B) leg of the bridge. For compression shunt calibration, or –CAL, the shunt resistor (R_{sc}) is shunted across the -Excitation (D) and +Signal (B) leg of the bridge. Refer to **Figure 7** for shunt resistor locations in the Wheatstone Bridge circuit.

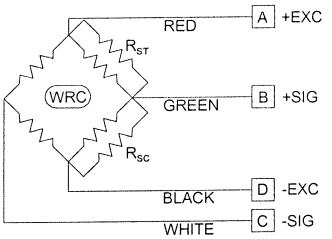

Figure 7 - Shunt Resistor Locations

Shunt calibration is accepted throughout the industry as a means of periodic calibration of a signal conditioner and transducer between calibrations of known, applied, traceable, mechanical, input values. Consequently, most all strain gage transducer manufacturers collect and supply shunt calibration data, along with a shunt calibration resistor, as a standard feature.

Shunt Calibration Procedure

1. Connect the transducer to an appropriate strain gage signal conditioner and allow adequate time for the system to stabilize.
2. Apply a full-scale, N.I.S.T. traceable, mechanical input (or load) to the transducer.
3. Adjust the signal conditioner's gain or span controls, as required, to obtain a full-scale electrical output signal, and/or numeric display that represents the applied, mechanical input quantity.
4. Remove the mechanical input (or load).

Shunt Calibration Procedure – continued

5. Place the shunt calibration resistor across an appropriate leg of the Wheatstone Bridge as discussed above.
6. Record the value of the signal conditioner's output signal and/or numeric display. This value is the shunt calibration value, or equivalent load.
7. It is important to note that the shunt calibration value is specific for the particular shunt resistor used. This value, and the particular resistor, are now matched to the transducer and form a basis of the transferable shunt calibration.

7.0 OPERATION

Typical Load Cell System Configurations
Operation requires the connection of the load cell to a signal conditioner, then to a readout device (if signal conditioner does not have a display). Strain gage signal conditioners and cable assemblies are available from PCB.

Operation with a Signal Conditioner
The signal conditioner span and zero must be set before the load cell system can be used. The span can be set using dead weights or the shunt calibration value. Refer to the shunt calibration information in this manual, and the signal conditioner instruction manual, for proper set-up information.

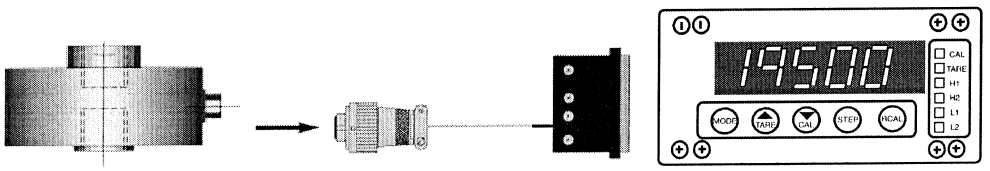

Figure 8 - Typical Load Cell System Configuration

8.0 TROUBLESHOOTING

No output
✓No power
✓Loose or dirty connections
✓Circuit opens or shorts
✓Faulty or improper wiring
✓No load applied

Erratic or Improper Readings
✓Excitation voltage drift
✓Electrical noise
✓Loose fixturing
✓Circuit opens or shorts
✓Improper load applied
✓Cable too long

Blinking Display
✓Overload condition
✓Open circuit

Zero Balance
✓Load applied to sensor
✓Overloaded or side-loaded sensor
✓Open circuit
✓Improper electrical connections

Zero Shift
✓Fixture preload
✓Faulty or improper wiring
✓Improper tare

Zero Drift
✓Unconditioned power supply
✓Circuit opens or shorts
✓Loose wiring
✓RFI/EMI interface
✓Temperature change

Damaged or Deformed Equipment
✓Improper use

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, the Force/Torque Division, 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.

Error Analysis

The Force/Torque Division typically supplies accuracy information on its products in the form of individual errors (see specification sheet). They are: Non-Linearity, Hysteresis, Non-Repeatability, Effect of Temperature on Zero, and Effect of Temperature on Output.

The customer can combine these 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, temperature related errors may 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.

9.0 MAINTENANCE

Routine maintenance, such as 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 damp cloth and never submerged or have liquids poured on them.

Model Number	STRAIN GAGE SIDE FORCE LOAD CELL	Revision: F
1903-02A		ECN #: 49055

Performance	**ENGLISH**	**SI**	
Measurement Range	100 lbf	445 N	[4]
Sensitivity(10 %)	1.3 mV/V	1.3 mV/V	[5]
Non-Linearity	≤ 0.10 % FS	≤ 0.10 % FS	
Hysteresis	≤ 0.10 % FS	≤ 0.10 % FS	
Non-Repeatability	≤ 0.02 %RO	≤ 0.02 %RO	
Environmental			
Overload Limit	150 lbf	667 N	
Temperature Range(Operating)	-65 to +200 °F	-54 to +93 °C	
Temperature Range(Compensated)	+70 to +170 °F	+21 to +77 °C	
Temperature Effect on Output(Maximum)	± 0.002 %Reading/°F	± 0.0036 %Reading/°C	[3]
Temperature Effect on Zero Balance(Maximum)	± 0.001 %FS/°F	± 0.0018 %FS/°C	[3]
Electrical			
Bridge Resistance	2000 Ohm	2000 Ohm	[1]
Excitation Voltage(Recommended)	10 VDC	10 VDC	[2]
Insulation Resistance	$>5x10^9$ Ohm	$>5x10^9$ Ohm	
Zero Balance	≤ 1 % FS	≤ 1 % FS	
Output Polarity(Tension)	Negative	Negative	
Physical			
Size (Height x Diameter)	1.25 in x 1.50 in	31.75 mm x 38.1 mm	[6]
Weight	0.30 lb	0.13 kg	
Mounting Thread	#4-40 Female	No Metric Equivalent	
Housing Material	Aluminum	Aluminum	
Sensing Element	Strain Gage	Strain Gage	
Deflection at Full Scale Capacity	0.004 in	0.12 mm	
Electrical Connector	pigtail ends	pigtail ends	
Electrical Connection Position	Bottom	Bottom	

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 3 to 20 VDC or VAC RMS.
[3] Over compensated operating temperature range.
[4] FS - Full Scale.
[5] RO - Rated Output.
[6] See Outline Drawing 58830 for Complete Dimensions.

Entered: LK	Engineer: PE	Sales: RB	Approved: JSD	Spec Number:
Date: 1/23/2019	Date: 1/23/2019	Date: 1/23/2019	Date: 1/23/2019	**59501**

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74950

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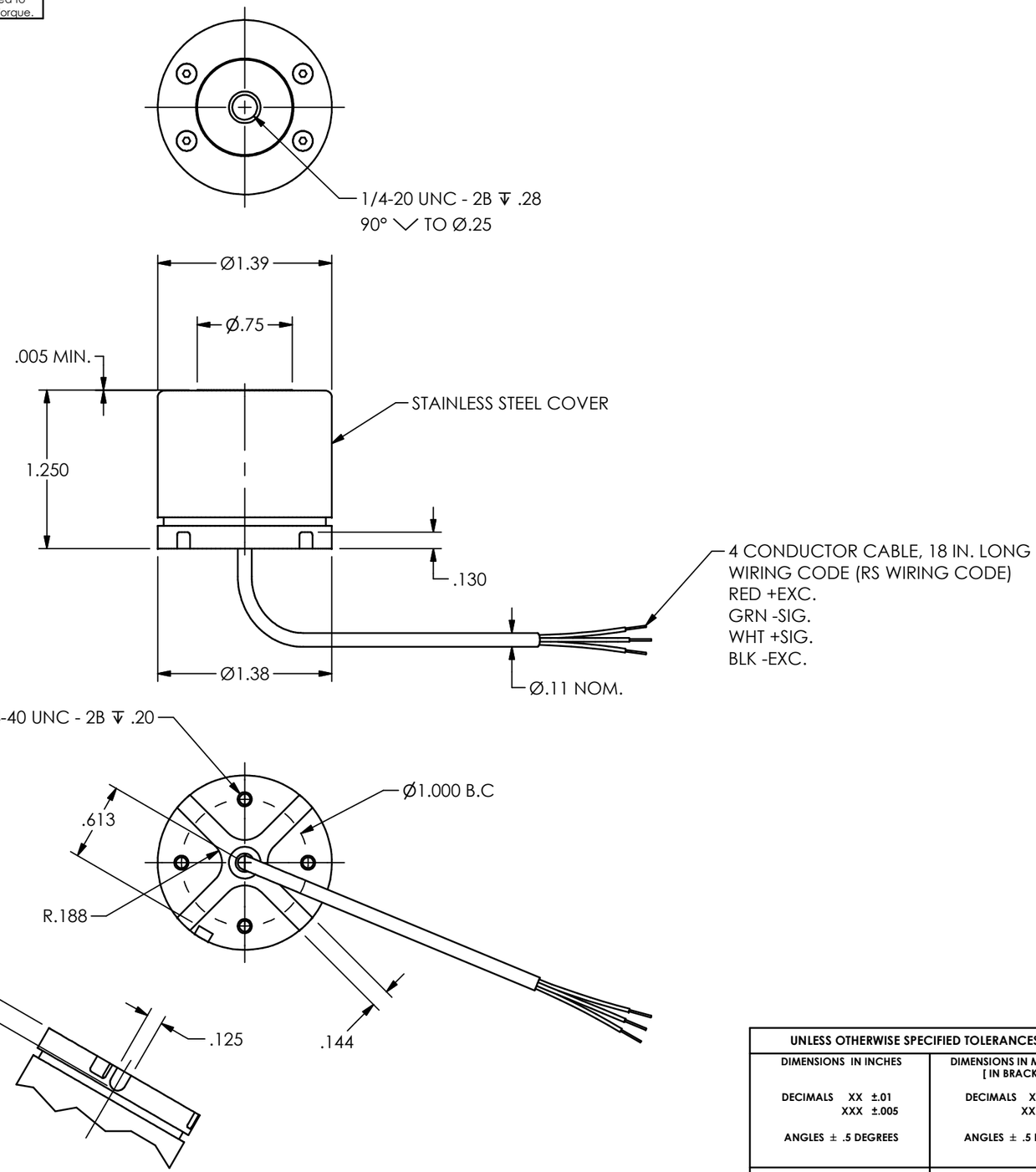
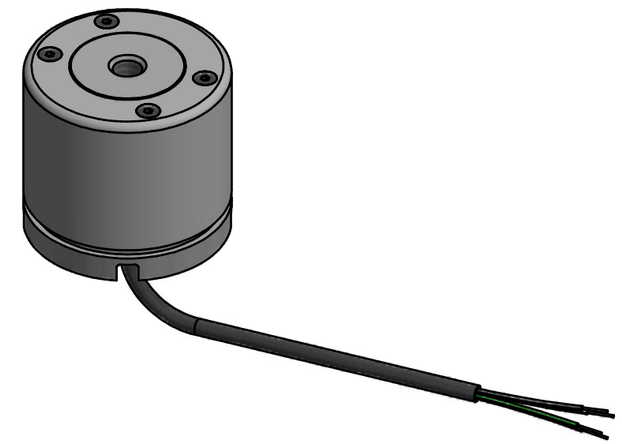
REVISIONS		
REV	DESCRIPTION	ECO
B	ADDED -01C SERIES - 02.06.23, PTE	53590





UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN		CHECKED		ENGINEER	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	PTE	04.29.14	JAM	05.04.21	JAM	05.04.21
DECIMALS XX ±.01 XXX ±.005	DECIMALS X ± 0.3 XX ± 0.13	TITLE					
ANGLES ± .5 DEGREES	ANGLES ± .5 DEGREES	OUTLINE DRAWING SIDE FORCE TRANSDUCER 1903-01B, -01C SERIES					
FILLETS AND RADII .015 MAX	FILLETS AND RADII 0.38 MAX						

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DWG. NO. 74950

SCALE: FULL SHEET 1 OF 1