



Model 5302D-01A

TORKDISC® Rotary Torque Sensing System

Installation and Operating Manual

For assistance with the operation of this product, contact:

**PCB Load & Torque, Inc.
Toll-free: 866-684-7107
24-hour SensorLine™: 716-684-0001
Fax: 248-888-8266
E-mail: LTInfo@pcbloadtorque.com
Web: www.pcbLoadTorque.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 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCB板 | X | 0 | 0 | 0 | 0 | 0 |
| 电气连接器 | 0 | 0 | 0 | 0 | 0 | 0 |
| 压电晶体 | X | 0 | 0 | 0 | 0 | 0 |
| 环氧 | 0 | 0 | 0 | 0 | 0 | 0 |
| 铁氟龙 | 0 | 0 | 0 | 0 | 0 | 0 |
| 电子 | 0 | 0 | 0 | 0 | 0 | 0 |
| 厚膜基板 | 0 | 0 | X | 0 | 0 | 0 |
| 电线 | 0 | 0 | 0 | 0 | 0 | 0 |
| 电缆 | X | 0 | 0 | 0 | 0 | 0 |
| 塑料 | 0 | 0 | 0 | 0 | 0 | 0 |
| 焊接 | X | 0 | 0 | 0 | 0 | 0 |
| 铜合金/黄铜 | X | 0 | 0 | 0 | 0 | 0 |
| 本表格依据 SJ/T 11364 的规定编制。 | | | | | | |
| 0：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.

TABLE OF CONTENTS

| | |
|------------------------------------------------|-----------|
| GENERAL GUIDELINES | 2 |
| WARNING SYMBOLS AND TERMS | 2 |
| 1.0 INTRODUCTION | 3 |
| 2.0 SAFETY PRECAUTIONS | 3 |
| 3.0 OVERVIEW | 3 |
| 3.1 Supplied Components..... | 3 |
| 3.2 Dimensions..... | 3 |
| 3.3 Theory of Operation..... | 5 |
| 4.0 ELECTRICAL OPERATION | 6 |
| 4.1 Receiver Box – Front Panel..... | 6 |
| 4.2 Receiver Box – Back Panel..... | 6 |
| 4.3 Receiver Box – I/O Connector Pinouts..... | 7 |
| 4.4 Receiver Box – Adjustment Controls..... | 8 |
| 4.4.1 System Gain Range..... | 9 |
| 4.4.2 Zero/Additional Offset..... | 10 |
| 4.4.3 AC Gain..... | 10 |
| 4.4.4 Low & High Pass Filters..... | 11 |
| 4.4.4.1 Low Pass Filter..... | 11 |
| 4.4.4.2 Composite Low Pass Filter..... | 12 |
| 4.4.4.3 Composite High Pass Filter..... | 13 |
| 5.0 MECHANICAL INSTALLATION | 14 |
| 5.1 TORKDISC® Installation..... | 14 |
| 5.2 Mating Adaptors..... | 16 |
| 6.0 SYSTEM OPERATION | 17 |
| 6.1 System Tuning..... | 17 |
| 7.0 CALIBRATION | 17 |
| 7.1 Analog Output – Voltage..... | 18 |
| 7.2 Frequency Output..... | 18 |
| 8.0 TROUBLESHOOTING | 19 |
| 9.0 CALIBRATION / REPAIR SERVICES | 20 |
| 9.1 RMA / Purchase Order..... | 20 |
| 10.0 WARRANTY | 20 |

GENERAL GUIDELINES

Operators should read this manual and become thoroughly familiar with its contents before attempting to operate the 16-bit TORKDISC® rotary torque sensor system. Following the safety considerations and operation instructions outlined in this manual will minimize the possibility of accidents or injury. Although the procedures covered in this manual have proven safe in use, PCB Load & Torque assumes no responsibility for personal injury or damage to equipment resulting from their application. After reading this manual, personnel should review all instructions concerning safety procedures provided at the installation location. It is not possible to cover all safety considerations in this manual; therefore, always be alert and work safely. Only qualified system operators should perform the procedures covered in this manual.

WARNING SYMBOLS AND TERMS



This symbol on the unit indicates that the user should refer to the operating instructions located in the 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 system indicates safety, earth ground.



CAUTION

Indicates a potentially dangerous situation, which can lead to minor or moderate injury or property damage. It may also be used to alert against unsafe practices.



WARNING

Indicates a potentially dangerous situation, which can lead to severe personal injury or death. Always read the associated information very carefully before performing the indicated procedure.



DANGER

Indicates an imminently dangerous situation, which can lead to severe personal injury or death.

1.0 INTRODUCTION

The TORKDISC® is ideally designed to measure in-line rotating shaft torque and incorporates a unique digital telemetry system to transmit sensor excitation and output between the rotor and stator portion of the system,

This manual provides instructions for installation, calibration, operation, and troubleshooting.

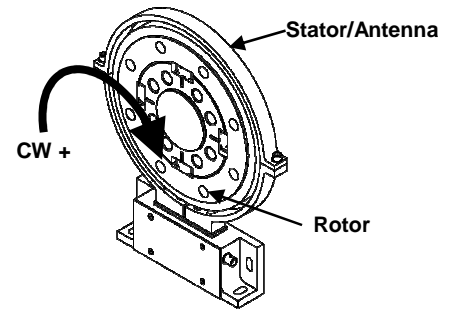


Figure 1 – TORKDISC® Loading & Components

2.0 SAFETY PRECAUTIONS



CAUTION

Personal injury to the operator, as well as, damage to the equipment may result if the TORKDISC® is operated at speeds higher than the maximum rated speed, or with loads greater than the overload capacity listed on the specification sheet. The operator should be protected from rotating parts by using safety shield guards. When in doubt about speed ratings or torque capacity, consult the Load & Torque Division of PCB Piezotronics.

3.0 OVERVIEW

The TORKDISC® product is a DC powered instrument and includes an external AC/DC power supply. The transmitter potted into the disc is inductively powered so it does not require any batteries or maintenance. This manual covers three series of TORKDISC® ranging in full-scale capacities from 500 to 100k in-lbf.

3.1 Supplied Components

The TORKDISC® rotary torque sensor system comes supplied with the following equipment:

- TORKDISC® rotor and stator/antenna assemblies.
- Receiver box with DB25 female connector w/mating connector
- Power supply with power cord
- 24 foot long BNC plug to TNC plug cable

3.2 Dimensions

This section gives some general dimensions for common TORKDISC® assembly models. Reference the individual model's outline drawing for extra details or special versions.

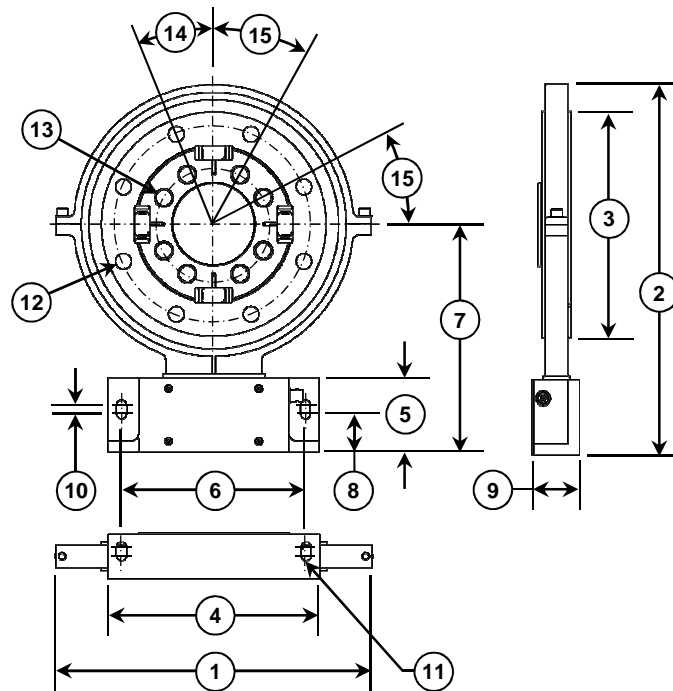


Figure 2 - Dimensions

Table 1 - Dimension Values

| Dimensions (see Figure 2) | Series Number | | | | | |
|------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|----------------------------------|-----------------------------------|
| | 5302 | | 5308 | | 5302 | |
| | 500 – 5k in-lbf | | 2.4k – 30k in-lbf | | 50k – 100k in-lbf | |
| | (in) | (mm) | (in) | (mm) | (in) | (mm) |
| 1 | 9.00 | 228.6 | 10.50 | 266.7 | 12.45 | 316.3 |
| 2 | 10.92 | 277.5 | 12.28 | 311.9 | 14.20 | 360.6 |
| 3 | Ø5.99 | Ø152.0 | Ø7.49 | Ø190.1 | Ø9.49 | Ø240.9 |
| 4 | 7.00 | 177.8 | 7.00 | 177.8 | 7.00 | 177.8 |
| 5 | 2.49 | 63.2 | 2.49 | 63.2 | 2.49 | 63.2 |
| 6 | 6.12 | 155.4 | 6.12 | 155.4 | 6.12 | 155.4 |
| 7 | 7.02 | 178.2 | 7.62 | 193.4 | 8.58 | 217.8 |
| 8 | 1.28 | 32.5 | 1.28 | 32.5 | 1.28 | 32.5 |
| 9 | 1.55 | 39.4 | 1.55 | 39.4 | 1.55 | 39.4 |
| 10 | 0.31 | 7.9 | 0.31 | 7.9 | 0.31 | 7.9 |
| 11 | R0.17 | R4.2 | R0.17 | R4.2 | R0.17 | R4.2 |
| 12 | 8X Ø0.406 THRU ON Ø5.000 | 8X Ø10.31 THRU ON Ø127.00 | 8X Ø0.531 THRU ON Ø6.500 | 8X Ø13.49THRU ON Ø165.10 | 16X Ø0.531 THRU ON Ø8.500 | 16X Ø13.49 THRU ON Ø215.90 |
| 13 | 8X 3/8"-24 THRU ON Ø3.000 | 8X 3/8"-24 THRU ON Ø76.25 | 8X 5/8"-11 THRU ON Ø3.750 | 8X 5/8"-11 THRU ON Ø95.25 | 12X 5/8"-11 THRU ON Ø6.000 | 12X 5/8"-11 THRU ON Ø152.40 |
| 14 | 22.5° | 22.5° | 22.5° | 22.5° | 22.5° | 22.5° |
| 15 | 22.5° | 22.5° | 28° | 28° | 25°* | 25°* |

*20° between holes

NOTE: See the outline drawing for the respective series for additional dimensions and bolt circle details.

3.3 Theory of Operation

The TORKDISC® system utilizes a unique digital data transmission technique. A radio frequency signal generated within the receiver box is inductively coupled from the pick-up antenna to the transmitting antenna and rectified to provide DC voltages to operate the rotating TORKDISC® transmitter. The transmitter has been configured for a full-scale input of $\pm 1.5\text{mV/V}$. The rotating circuitry provides excitation for the strain gage bridge, amplifies, and filters its output. The resulting signal is presented to an analog to digital converter that samples it and converts it to a noise immune digital code. To provide up to a 8.5kHz measurement bandwidth without creating aliasing errors, the A-to-D converter samples at a rate in excess of 26,000 samples per second. Data bits are transmitted off the rotor in this digitally encoded form. In this manner, they are not subject to noise degradation or "per rev" effects.

The digital data bits are recovered in the receiver box where they are re-converted to an analog signal. This signal is used to generate the standard voltage output, consult the factory for optional frequency system outputs.

The specified bandwidth represents the electronic capability of the TORKDISC® System only and does not reflect actual installed system performance and the influence of sensor and system mechanics. It is advisable that the customer model the entire drive line with the sensor installed and /or conduct an in-situ torsional vibration analysis to determine the measurement bandwidth.

The calibration of the TORKDISC® system is easy to accomplish and is extremely stable over time. The product is equipped with a remotely activated shunt calibration feature that can be controlled from the front panel of the receiver box. This allows the user to check calibration at any time during system operation. When the shunt calibration feature is invoked, a precision resistor is switched across one leg of the Wheatstone bridge, producing a positive shift in the receiver's output.

4.0 ELECTRICAL OPERATION



ATTENTION

The standard TORKDISC® system is supplied with a 24 foot long coaxial cable designed to transmit signals from the antenna assembly to the receiver box. This length is critical to proper operation of the TORKDISC® system. DO NOT SHORTEN IT. Any excess length should be coiled up. Consult the factory if additional cable length is required.

The receiver box is a signal conditioner and amplifier for the outputs coming from the TORKDISC®. It is the interface between the TORKDISC® and the output meter or transient recorder.

4.1 Receiver Box – Front Panel

The front panel of the receiver box contains push-button switches and LED indicators as shown in Figure 3.

The front panel switches and LED indicators are described in Table 2.



Figure 3 – Receiver Box Front Panel

Table 2 – Receiver Front Panel

| | |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| POWER: | Press the POWER button to turn the Receiver Box on and off. The amber LED will illuminate when the internal circuitry has correct power for operation. |
| TRANSMITTER LOW POWER: | This red LED is illuminated when the transmitter does not have adequate power to operate the electronics. |
| DATA: | This green LED is illuminated when the receiver has received valid data from the transmitter. |
| SHUNT CALIBRATION: | This green LED is illuminated when the shunt calibration feature is invoked. It indicates the status of the shunt calibration switch in the transmitter. The state of the shunt calibration (and LED) should change each time the push-button on the front panel is depressed. |

4.2 Receiver Box – Back Panel

The back panel of the receiver box contains connector ports and adjustment controls as shown in Figure 4.

The back panel connector ports and adjustment controls are described in Table 3.



Figure 4 – Receiver Box Back Panel

Table 3 – Receiver Back Panel

| | |
|-----------------------------|---------------------------------------------------------------------------------------------------|
| ADJUSTMENT CONTROLS: | Adjusts various settings of the receiver box including: gain, zero offset, and filtering. |
| I/O: | DB-25 connector for interface between the receiver box and a display meter or transient recorder. |
| DC IN: | The connector port for the supplied power supply. |
| ANTENNA: | The connector port for the TNC side of the supplied 24 foot coaxial transmission cable. |

4.3 Receiver Box – I/O Connector Pinouts

The outputs of the torque sensor are provided on the back of the receiver via the DB-25 connector labeled “I/O” (see Figure 4). Table 4 defines the signals and pinouts of the connector.

Table 4 – Receiver I/O Connector Pinouts & Signals

| | |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VOLTAGE OUTPUT: Pin 13 | Analog system output. This output has an adjustable gain (see figure 5) to select the desired full scale of the system. |
| Pin 25 | Voltage Output Ground |
| DIFFERENTIAL FREQUENCY OUTPUTS (optional): Pins 17(+), 4(-) | Digital system output. These outputs are a differential signal that are referenced to +5V and GROUND (TTL Compatible). It is recommended that this signal be terminated using a 100Ω resistor on longer cable runs. When using the frequency output, the receivers' SYSTEM GAIN RANGE must be set to position A, and adjusted to a full scale of ±10VDC (see Figure 5). |
| AC OUTPUT (Capacitively Coupled): Pin 12 | The AC output has an adjustable high pass filter which will remove the DC and lower frequency torque components. This filter is a two pole high pass Butterworth filter with user selectable cutoff frequencies of approximately 5, 10, 20, 200, 500, and 725 Hz. |
| Pin 24 | AC Output Ground |
| ANALOG GROUND: Pins 11, 23, 25 | The analog ground is the reference for the voltage output. This analog ground is isolated from the system ground and should not be connected to it. |
| DIGITAL GROUND: Pins 7, 19 | The digital ground is the reference for all digital inputs and outputs. This digital ground is isolated from the analog ground and should not be connected to it. |
| TRANSMITTER LOW POWER STATUS: Pin 6 | This is a digital (TTL level) output of the transmitter power low bit. This signal is activated when the power at the transmitter is insufficient to operate the electronics. HI = LOW POWER, LO = ADEQUATE POWER |
| SHUNT CALIBRATION STATUS: Pin 16 | This is a digital (TTL level) output for the status of the shunt calibration feature. HI = SHUNT ACTIVATED, LO = SHUNT CAL DEACTIVATED |
| DATA STATUS: Pin 5 | This is a digital (TTL level) output indicating that valid data is being received from the transmitter. HI = VALID DATA, LO = INVALID DATA |
| SHUNT CALIBRATION CONTROL: Pin 16 | For remote Shunt Calibration Control, a normally open, single pole, single throw momentary push-button switch can be connected across pins 16 and 19. |
| MAIN CLOCK: Pin 3 | Main clock for the receiver, provided for QSPI |
| SERIAL DATA: Pin 2 | Digital data stream received from the transmitter and used for the QSPI |
| EXTERNAL QSPI BIT CLOCK: Pin 14 | QSPI clock signal |
| SLAVE SELECT: Pin 1 | QSPI timing signal |
| RESERVED: Pins 8, 9, 10, 15, 20, 21, 22 | N/C |

4.4 Receiver Box – Adjustment Controls



ATTENTION

Manipulating the output adjustment controls will affect the measurement readings and should only be performed by trained personnel. Contact the factory with any questions or concerns about these controls and settings prior to adjusting.

The measured outputs can be adjusted via the controls on the rear of the receiver box as shown in Figure 5 and defined in Table 5.

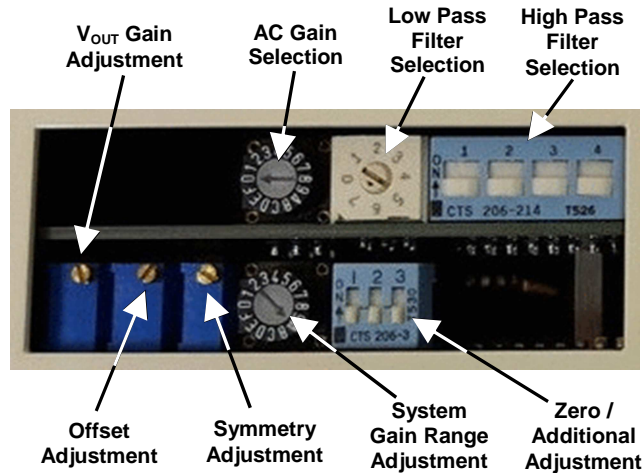


Figure 5 – Receiver Adjustments and Controls

Table 5 – Receiver Adjustments and Controls

| | |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V_{OUT} GAIN ADJUSTMENT: | Multi-turn potentiometer adjusts receiver output gains of the voltage. Preset at factory to ±10VDC full-scale equals sensor full-scale input (mV/V). Not recommended for user adjustment. |
| OFFSET ADJUSTMENT: | Multi-turn potentiometer adjusts output signal offset of the voltage and frequency. Preset at factory for zero receiver offset. Not recommended for user adjustment. The range of this adjustment is ±15% full-scale. If additional offset is needed, refer to ZERO/ADDITIONAL OFFSET. |
| SYMMETRY ADJUSTMENT: | Multi-turn potentiometer allows a 0.5% of full-scale gain adjustment to either the positive or negative portion of the receiver’s outputs. Preset at factory. Not recommended for user adjustment. |
| SYSTEM GAIN RANGE SELECTION: | Enables selection of 16 discrete gain ranges (see Table 6). Preset at factory. Not recommended for user adjustment. |
| ZERO/ADDITIONAL OFFSET: | Used for setting the receiver to a forced zero output and additional offset adjustment range (see Table 7). |
| AC GAIN SELECTION: | This adjustment allows the user to select gains for the AC output in integer steps from 1 to 16. This will allow users to further process low level AC components of the composite signal with greater resolution (see Table 8). |
| LOW PASS FILTER SELECTION: | The high frequency limit of the bandwidth is controlled by an 8 pole elliptical low pass filter in the receiver. This filter is adjustable via the rotary switch at the rear access port of the receiver (see Table 10). |
| HIGH PASS FILTER SELECTION: | The AC output has an adjustable high pass filter which will remove the DC and lower frequency torque components. This filter is a two pole high pass Butterworth filter with user selectable cut-off frequencies of approximately 5, 10, 20, 200, 500, and 725 Hz (see Table 11). |

4.4.1 System Gain Range



ATTENTION

The System Gain Range is set at the factory for optimum performance of the TORKDISC® system. Adjusting the switch settings may have adverse effects on the measurement values. **This setting is not recommended for user adjustment.**

Use the following equation to determine the System Gain switch setting.

$$\text{NOMINAL_GAIN} = \left[\frac{\pm \text{Transmitter_Sensitivity}(mV/V)}{\pm \text{Transducer_Sensitivity}(mV/V)} \right] \times \left[\frac{\pm \text{Desired_Output}(V)}{\pm 10V} \right]$$

Example:

$$\text{NOMINAL_GAIN} = \left[\frac{\pm 1.51(mV/V)}{\pm 1.10(mV/V)} \right] \times \left[\frac{\pm 10(V)}{\pm 10V} \right]$$

$$\text{NOMINAL_GAIN} = [1.373] \times [1]$$

NOMINAL_GAIN = 1.373 \implies Looking at the values in Table 6, the System Gain Range should be set to position E or F.

Table 6 describes the Zero/Added Offset switch settings

Table 6 – System Gain Range Switch Settings

| SWITCH SETTING | MINIMUM GAIN | NOMINAL GAIN | MAXIMUM GAIN |
|----------------|--------------|--------------|--------------|
| 0 | 0.222 | 0.257 | 0.292 |
| 1 | 0.284 | 0.328 | 0.372 |
| 2 | 0.351 | 0.406 | 0.461 |
| 3 | 0.413 | 0.477 | 0.542 |
| 4 | 0.465 | 0.537 | 0.610 |
| 5 | 0.526 | 0.608 | 0.691 |
| 6 | 0.594 | 0.686 | 0.779 |
| 7 | 0.655 | 0.758 | 0.860 |
| 8 | 0.756 | 0.874 | 0.992 |
| 9 | 0.817 | 0.945 | 1.072 |
| A* | 0.885 | 1.023 | 1.161 |
| B | 0.946 | 1.094 | 1.242 |
| C | 0.998 | 1.154 | 1.310 |
| D | 1.060 | 1.225 | 1.391 |
| E | 1.127 | 1.303 | 1.479 |
| F | 1.189 | 1.374 | 1.560 |

*For Frequency Output

4.4.2 Zero/Additional Offset

Table 7 describes the Zero/Additional Offset switch settings.



ATTENTION

Placing both switches 2 and 3 of the Zero/Additional Offset switch to the ON position will null each other and provide no added offset.

Table 7 – Zero/Additional Offset

| SWITCH POSITION | | | MODE |
|-----------------|-----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 2 | 3 | |
| OFF | OFF | OFF | Normal operation: Offset adjustment +/- 15% of full scale |
| ON | OFF | OFF | Zero Out Mode: Receiver will output digital zero regardless of transmitter operation. Useful for setting receiver offset adjustment to zero (no added offset correction). |
| OFF | ON | OFF | Adds +25% of full-scale to the offset adjustment for a total of + 40% of full-scale |
| OFF | OFF | ON | Adds -25% of full-scale to the offset adjustment for a total of -40% of full-scale |

4.4.3 AC Gain

Table 8 lists the available gain settings for the AC Gain selection switch. This gain is independent from the DC coupled voltage output and provides additional gain to the AC coupled output (see Figure 5).

Table 8 – AC Output Gain

| SWITCH SETTING | NOMINAL GAIN |
|----------------|--------------|
| 0 | 1.0 |
| 1 | 2.0 |
| 2 | 3.0 |
| 3 | 4.0 |
| 4 | 5.0 |
| 5 | 6.0 |
| 6 | 7.0 |
| 7 | 8.0 |
| 8 | 9.0 |
| 9 | 10.0 |
| A | 11.0 |
| B | 12.0 |
| C | 13.0 |
| D | 14.0 |
| E | 15.0 |
| F | 16.0 |

4.4.4 Low & High Pass Filters

Figure 6 shows the signal path on both the AC and DC voltage outputs and how they are influenced by the filter and gain settings.

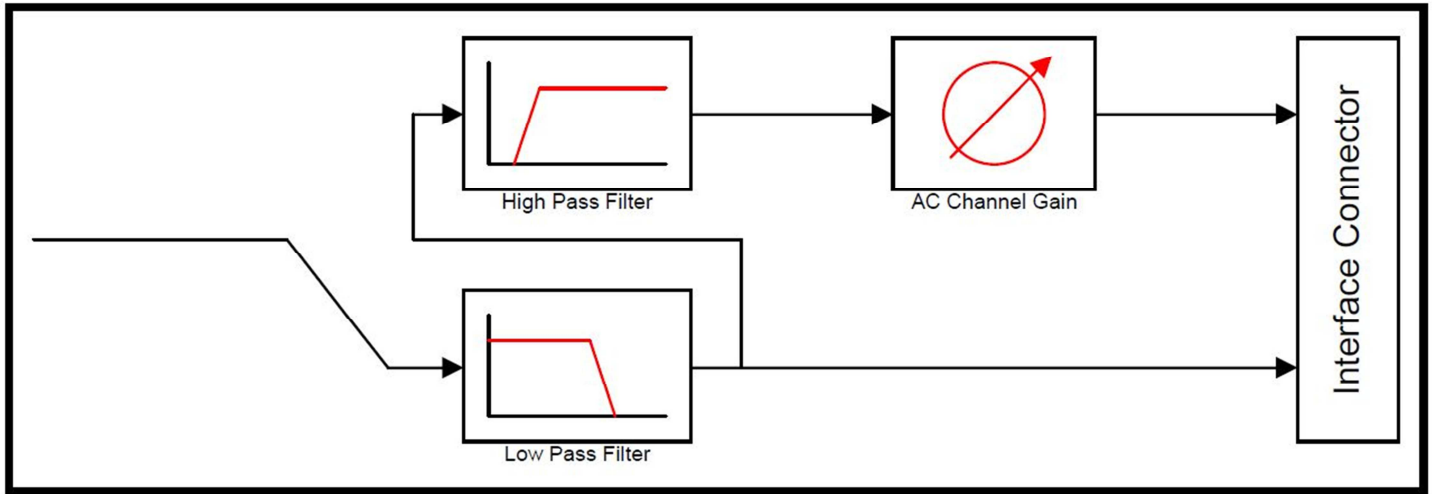


Figure 6 – Signal Path to I/O Connector

4.4.4.1 Low Pass Filter

Figure 7 shows low pass filter plots of the transmitter only, receiver only, and the composite of transmitter and receiver combined.

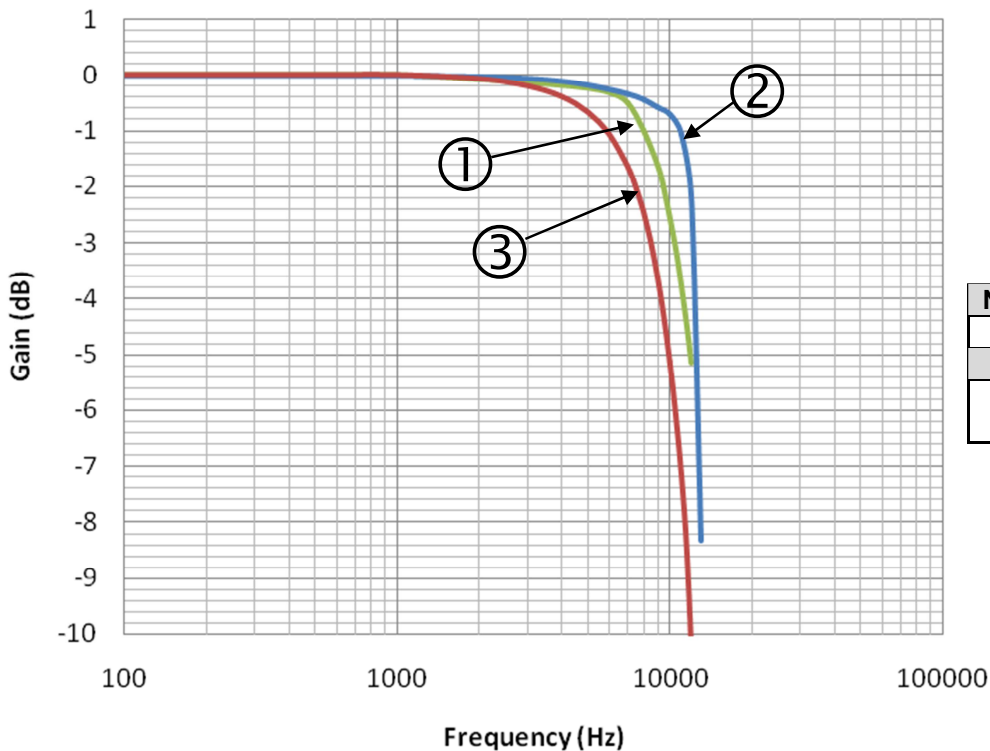


Table 9 – Low Pass Filter Plots

| Number | DESCRIPTION |
|--------|----------------------------------|
| 1 | Transmitter Only |
| 2 | Receiver Only |
| 3 | Transmitter & Receiver Composite |

Figure 7 –Low Pass Filter Plots

4.4.4.2 Composite Low Pass Filter

Figure 8 compares low pass filter plots for both the voltage output per pins 13 & 25 and the AC outputs per pins 12 & 24 on the DB-25 I/O connector.

NOTE: The low pass filter switch controls the low pass filtering for both the DC and AC coupled outputs.

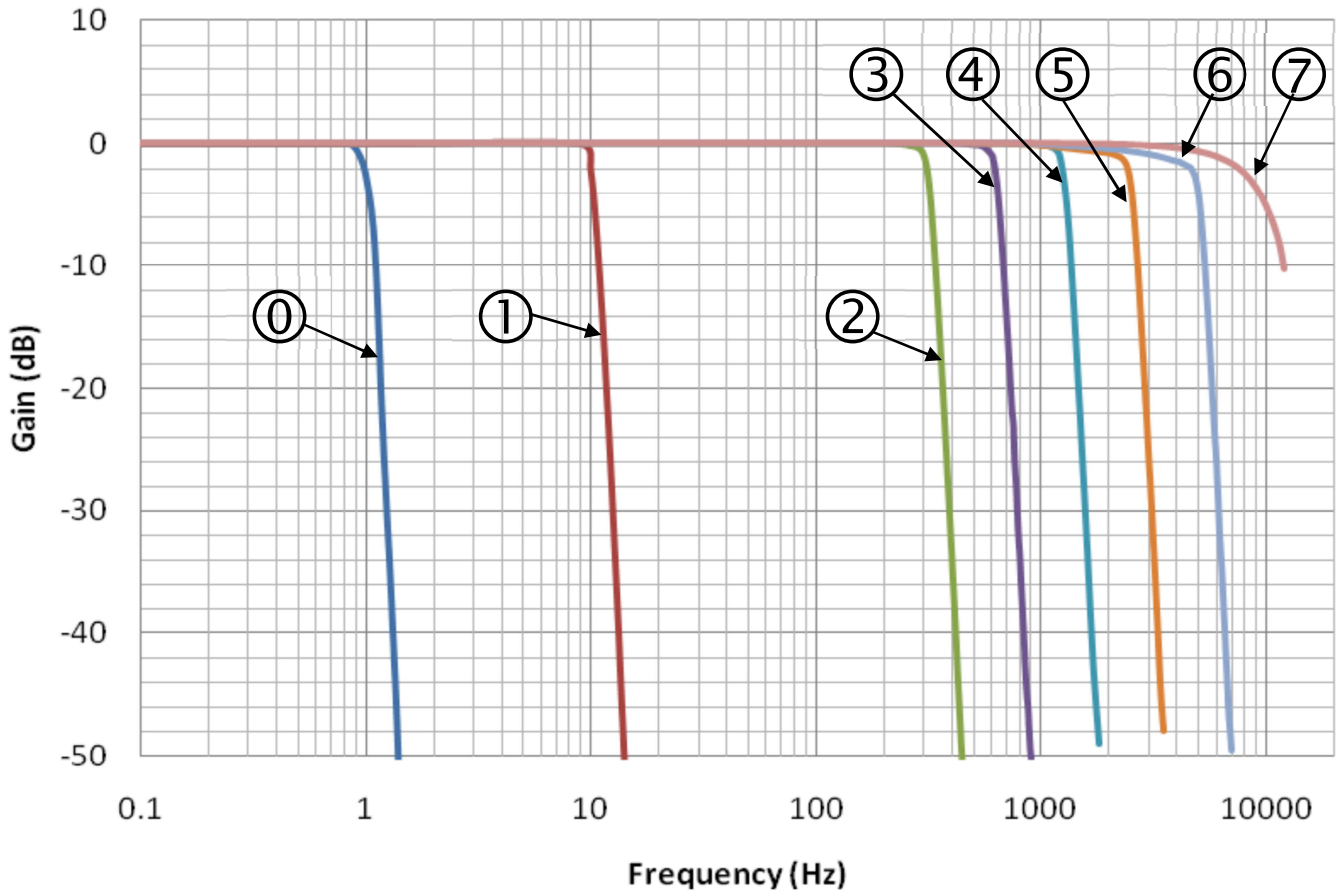


Figure 8 – Composite Low Pass Filter Plots for Both Outputs

Table 10 lists the available cut-off frequency settings for the low pass filter switch as shown in Figure 8.

Table 10 – Low Pass (AC & DC) Analog Output Filter Settings (composite output)

| SWITCH SETTING | FREQUENCY Hz (-3dB) |
|----------------|---------------------|
| 0 | 1 |
| 1 | 10 |
| 2 | 313 |
| 3 | 625 |
| 4 | 1250 |
| 5 | 2500 |
| 6 | 5000 |
| 7 | 8500 |

4.4.4.3 Composite High Pass Filter

Figure 9 compares high pass filter plots for the AC output for pins 12 & 24 on the DB-25 I/O connector.

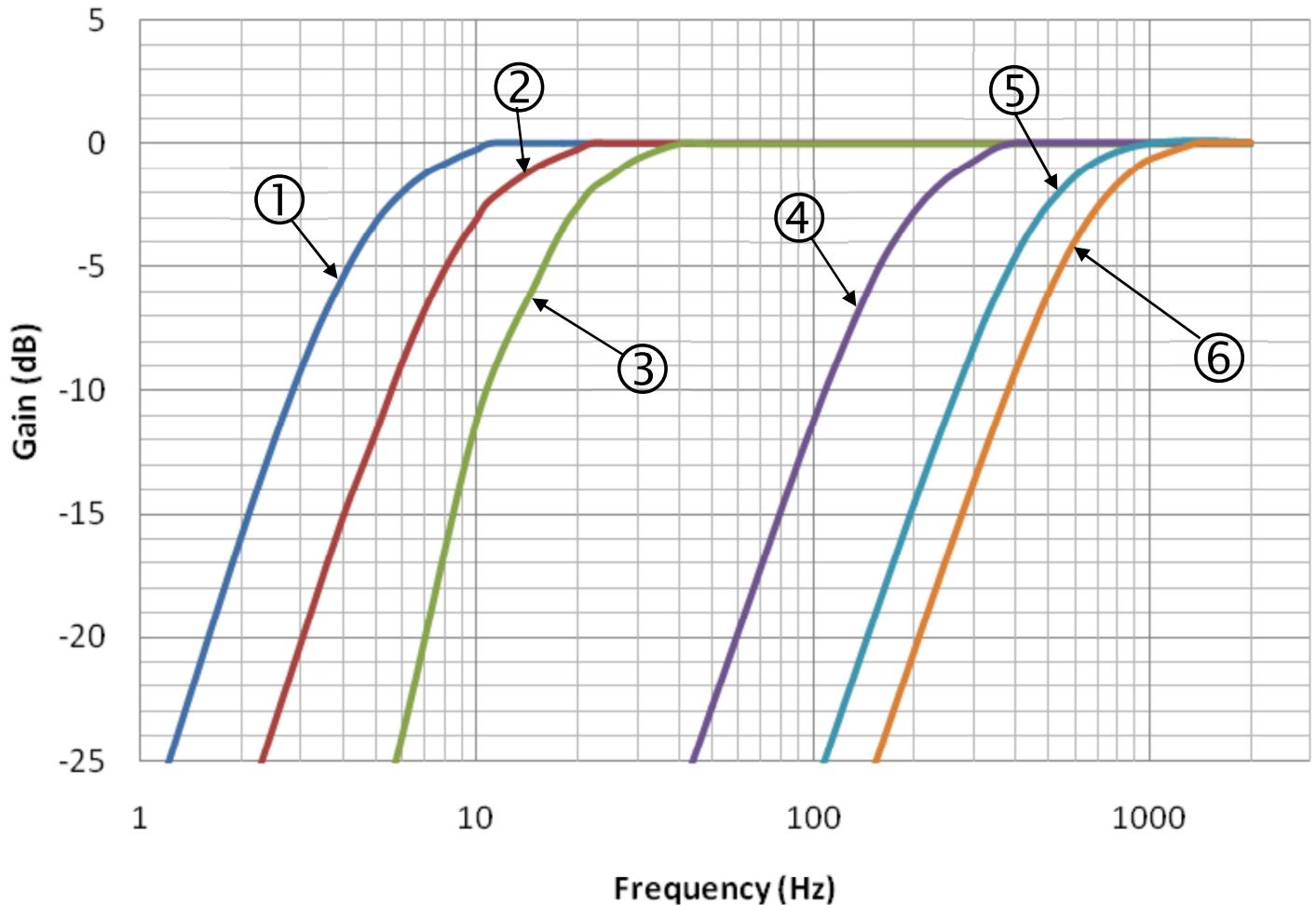


Figure 9 – Composite High Pass Filter Plots for the AC Output

Table 11 lists the available cut-off frequency settings for the high pass filter switches as shown in Figure 9.

Table 11 – High Pass (AC Coupled) Analog Output Filter Settings

| NUMBER | SWITCH SETTING | | | | FREQUENCY Hz (-3dB) |
|--------|----------------|-----------|-----------|-----------|---------------------|
| | 1 | 2 | 3 | 4 | |
| 1 | OFF | OFF | OFF | OFF | 5 |
| 2 | ON | OFF | OFF | OFF | 10 |
| 3 | OFF | ON | OFF | OFF | 20 |
| 4 | OFF | OFF | ON | OFF | 200 |
| 5 | OFF | OFF | OFF | ON | 500 |
| 6 | ON | ON | ON | ON | 725 |

5.0 MECHANICAL INSTALLATION

CAUTION

Proper mechanical installation of the TORKDISC® rotary torque sensor system is critical to ensure proper operation and long-term life. Read this entire section before installing the system. When in doubt about application, consult the Load & Torque Division of PCB Piezotronics prior to proceeding.

CAUTION

This wireless data acquisition system contains delicate electronic components that must be protected from excessive shock and prolonged exposure to water, oil, or other chemical contaminants. All electrical connections must be well protected from electrostatic discharge by using protective wrist straps during installation.

CAUTION



**DO NOT USE AN IMPACT WRENCH
WHEN INSTALLING THIS PRODUCT!**

5.1 TORKDISC® Installation

1. The TORKDISC® is designed to be installed between a prime mover and a load, such as a combustion engine and a dynamometer. A total of two degrees of freedom is required between the TORKDISC® and mating components to accommodate minor misalignment that may occur after installation. The required two degrees of freedom can be provided on one end of the torque sensor or can be divided up to one degree per end.
2. In most applications, we recommend that the female pilot end of the TORKDISC® be hard-coupled to the dynamometer, and the male pilot end be connected to the test article by means of a flexible coupling. Automotive-style drive shafts with a universal or constant velocity joint at each end are acceptable (see Figure 10). When using a drive shaft with universal joints at each end, a slip yoke at one end is desirable to prevent axial forces from being transmitted to the TORKDISC®. It is also important that the universal joints are in phase end-to-end, and drive shafts run 2 to 3 degrees out of level end-to-end. If preferred, commercially available flexible couplings are acceptable alternatives.

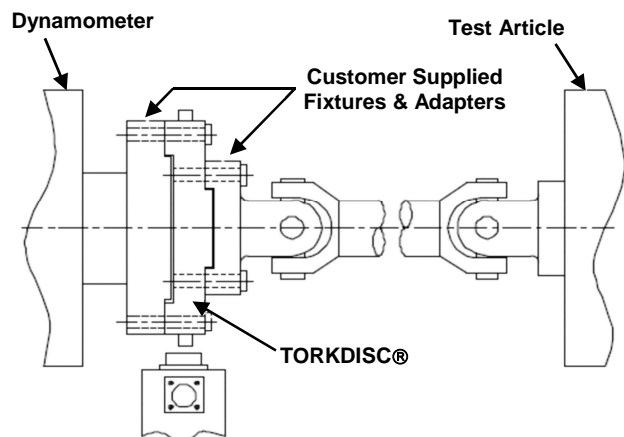


Figure 10 – Typical Installation

3. Connecting drive shafts usually can be bolted directly to the TORKDISC® through use of an adapter, without need for additional support, assuming that the resultant bending moment on the TORKDISC® does not exceed the specified limit. Request specification sheets from PCB to determine the maximum permissible bending moment of a given TORKDISC® model.
4. Mechanically align the connecting drive shaft(s) as accurately as possible to minimize the effects of parallel offset of shafts, angular misalignment, and shaft end float.
5. Drive shaft run-out ideally should not exceed 0.001 inches, as excessive run-out (>0.002 inches) will multiply the static bending moment, and may exceed the sensor's bending moment capability.
6. The TORKDISC® will produce a positive output when a clockwise torque is applied to the input end (male pilot end). Counterclockwise torque will produce a negative output
7. The stationary antenna assembly (stator) of the TORKDISC® is designed to be installed directly over the rotating sensor assembly (rotor) to transmit excitation and digitized torque data. Center the loop such that the rotor and stator do not touch. The top portion of the stator can be removed to aid installation, if desired. The base of the stator is designed to be bolted to a rigid support structure in any orientation around the rotor, but is typically installed at the six o'clock position.
8. Careful attention is required when installing the stator, as the loop portion that surrounds the non-contacting rotor requires a minimum of a 0.5-inch axial air gap between it and any nearby metallic surfaces (see Figure 11).
9. The supplied signal conditioning electronics (receiver) is designed to be installed in a clean, temperature-controlled (70°F, ±10°) environment, usually outside the test cell in a cabinet or console. Mounting feet are provided to secure the receiver to a panel or shelf.
10. Typically a 24 ft (7.3 m) TNC plug to BNC plug cable is supplied to connect the receiver to the stator assembly. This cable is an integral component to the TORKDISC® system, and the cable must not be shortened, nor should additional cable be added. Be sure to coil any excess cable, and consult PCB Piezotronics if a longer cable length is required.

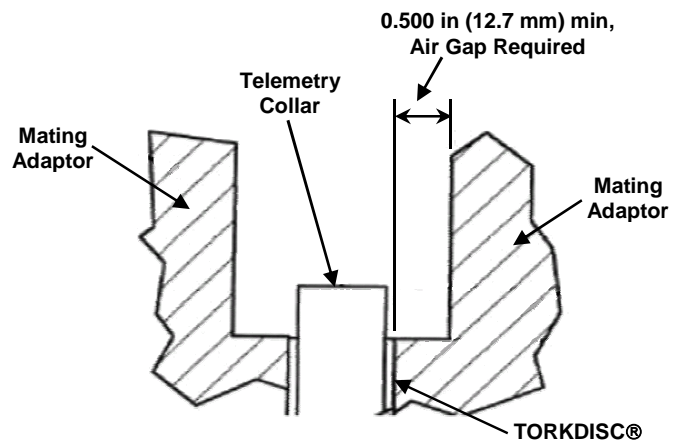


Figure 11 – Stator Loop Air Gap

5.2 Mating Adaptors

1. Mating adaptors **MUST** be hard and flat. The mating adaptors should be fabricated from SAE 4140 or 4340 and heat-treated to at least R_C 38 to 42. The diameter of the mating adaptors should not exceed the diameter of the rotating sensor element.
2. Mating adaptors must have respective pilots that are concentric within 0.001 inches to maintain concentricity between the TORKDISC® and mating adaptors during assembly. Design mating pilots such that they contact the TORKDISC® pilot diameters only, to avoid creating a mechanical parallel path.
3. Mating surfaces of the adaptor must be ground flat to 0.0005" total indicator run-out or better, with a surface finish of 16 microns, and must be square within 0.001 inches with respect to the pilot.
4. Use Grade 8 or better socket head cap screws. Tighten to 30% of yield for aluminum sensors and 60% of yield for steel sensors. See Table 12 for recommended torque values. Hand-tighten, then torque to recommended value in two or three increments in cross pattern. Sensor and mating fixtures must be dry and free of oil. Use mild degreaser with a clean cloth if necessary. Use of a serviceable thread locker is recommended.
5. Dynamically balance TORKDISC® and mating adaptors as an assembly to ISO Quality Grade G2.5. All TORKDISC® models with a speed rating greater than 8,000 RPM are shipped dynamically balanced from PCB as standard procedure. If desired, PCB will bolt your supplied mating adaptors and hardware to the TORKDISC® and dynamically balance it as an assembly (additional cost may be applicable- contact the Load & Torque Division of PCB Piezotronics for more information).

All TORKDISC® models are designed to provide years of accurate and repeatable torque measurements when installed in accordance to the below recommendations. Please contact the Load & Torque Division of PCB Piezotronics, Inc. regarding any questions you may have regarding the PCB TORKDISC® rotary torque sensor system.

Table 12 – Recommended Tightening Torque for Grade 8 or Better Screws and Bots on PCB TORKDISC® Sensors

| Screw Thread | | Aluminum (30% Yield) | | Steel (60% Yield) | |
|--------------|-------|----------------------|---------|-------------------|---------|
| Size | Pitch | (ft-lb) | (in-lb) | (ft-lb) | (in-lb) |
| 1/4" | 20 | 6 | 75 | 12 | 150 |
| | 28 | 7 | 87 | 14 | 175 |
| 5/16" | 18 | 12 | 150 | 25 | 300 |
| | 24 | 15 | 175 | 30 | 350 |
| 3/8" | 16 | 22 | 275 | 45 | 550 |
| | 24 | 25 | 300 | 50 | 600 |
| 7/16" | 14 | 37 | 450 | 75 | 900 |
| | 20 | 40 | 500 | 80 | 1,000 |
| 1/2" | 13 | 55 | 700 | 110 | 1,400 |
| | 20 | 65 | 775 | 130 | 1,550 |
| 5/8" | 11 | 115 | 1,375 | 230 | 2,750 |
| | 18 | 130 | 1,550 | 260 | 3,100 |
| 3/4" | 10 | 200 | 2,400 | 400 | 4,800 |
| | 16 | 225 | 2,700 | 450 | 5,400 |
| 7/8" | 9 | 275 | 3,300 | 550 | 6,000 |
| | 14 | 305 | 3,675 | 610 | 7,350 |
| 1" | 8 | 415 | 5,000 | 830 | 10,000 |
| | 12 | 450 | 5,500 | 900 | 11,000 |
| | 14 | 475 | 5,750 | 950 | 11,500 |
| | 16 | 500 | 6,000 | 1,000 | 12,000 |
| 1 1/4" | 7 | 825 | 10,000 | 1,650 | 20,000 |
| | 12 | 925 | 11,000 | 1,850 | 22,000 |
| 1 1/2" | 6 | 1,450 | 17,500 | 2,900 | 35,000 |
| | 12 | 1,625 | 19,500 | 3,250 | 39,000 |



ATTENTION

New screws should be used every time the TORKDISC® is installed. Fasteners should be of sufficient length to provide full thread engagement, including at least two threads past full engagement. Reference the instructions in step 4 above.

6.0 SYSTEM OPERATION

After all of the telemetry components have been installed and connected, the system is ready for operation. To activate the telemetry system, simply press the switch located on the front panel of the receiver to the ON position (see Figure 3).

On initial power up of the system, the **POWER** and **DATA** indicators should be illuminated while the **SHUNT CALIBRATION** and the **TRANSMITTER LOW POWER** are not (see Figure 3). Depressing the **SHUNT CALIBRATION** switch on the front panel will toggle the state of the **SHUNT CALIBRATION** indicator if an external shunt resistor is installed on the transmitter. The telemetry system is now ready for use.

6.1 System Tuning

System tuning may be required if one of the following scenarios occurs upon initial power up:

- If the system has not powered up with all of the indicators as described above
- If the **DATA LED** on the front panel of the receiver is not illuminated (indicating invalid data) or the **LOW POWER LED** is illuminated (indicating insufficient power at the transmitter collar assembly) and the coaxial cable continuity is satisfactory.

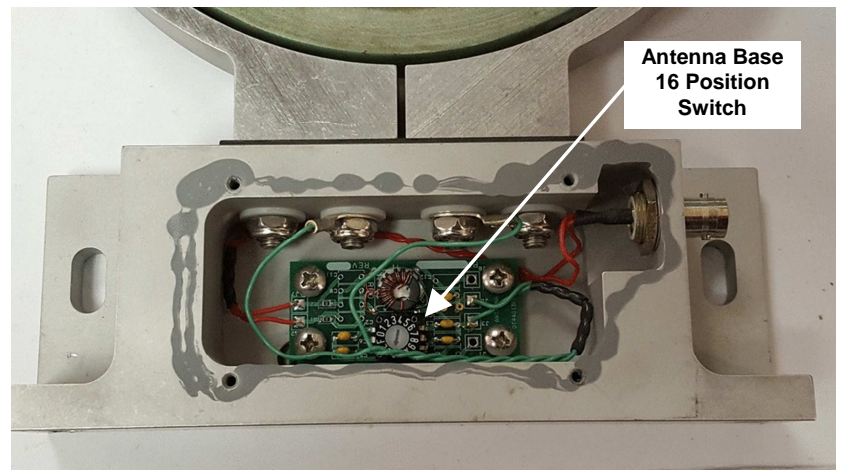


Figure 12 – Antenna Base 16 Position Switch Location

System tuning consists of incrementing the Antenna Base 16 position switch (see Figure 12) to the adjacent position and again check whether the **DATA LED** illuminates or the **LOW POWER LED** extinguishes (on receiver box see Figure 3). Repeat this procedure until a switch position is found where the **DATA LED** is illuminated and the **LOWER POWER LED** is extinguished. If the system does not operate after trying all of the 16 positions, refer to section 8.0 Troubleshooting.

7.0 CALIBRATION



ATTENTION

To maximize measurement accuracy, allow the system to warm-up for at least 30 minutes prior to performing a calibration procedure. When calibrating the system, the transmitter's input must be connected to the transducer.

7.1 Analog Output – Voltage

Sometimes users may wish to alter the factory calibration of the system. Offset and gain potentiometer adjustments are accessible on the rear of the receiver (see Figure 5).

1. Connect a precision voltmeter across pins 13 (Voltage Output) & 25 (Voltage Output Ground) of the I/O connector.
2. Adjust the OFFSET potentiometer so that the output is at zero volts. This simulates a balanced bridge configuration. The adjustment range is $\pm 15\%$ of full scale (optional $\pm 40\%$; see Table 7).
3. Apply the shunt calibration by pressing the switch located on the front panel of the receiver. The green SHUNT CALIBRATION indicator is illuminated. Alternately, gain adjustment can be made using a dead weight calibration or other mechanical stimulus as the reference.
4. Adjust the V_{OUT} GAIN potentiometer to provide the desired span corresponding to the shift caused by the shunt resistance.
5. Remove the shunt resistor from the bridge by pressing the SHUNT CALIBRATION switch (green indicator should extinguish), or the mechanical stimulus, and check the system zero adjustments. It may be necessary to cycle through the zero and gain adjustment several times before a precision calibration is achieved.

7.2 Frequency Output

Sometimes users may wish to alter the factory calibration of the system. Offset and gain potentiometer adjustments are accessible on the rear of the receiver (see Figure 5).



ATTENTION

The receiver box SYSTEM GAIN RANGE must be set to position A when using the frequency output (see Figure 5).

1. Connect a precision frequency meter across pins 17 (Frequency Output+) & 4 (Frequency Output-) of the I/O connector.



ATTENTION

The frequency outputs are differential and it is recommended they be terminated with a 100 Ω resistor for longer cable runs.

2. Adjust the OFFSET potentiometer so that the output is at 10,000 Hz. This simulates a balanced bridge configuration. The adjustment range is $\pm 15\%$ of full scale (optional $\pm 40\%$) (See Table 7).
3. Apply the shunt calibration by pressing the switch located on the front panel of the receiver. The green SHUNT CALIBRATION indicator is illuminated. Alternately, gain adjustment can be made using a dead weight calibration or other mechanical stimulus as the reference.

4. Adjust the V_{OUT} GAIN potentiometer to provide the desired frequency span corresponding to the shift caused by the shunt resistance.
5. Remove the shunt resistor from the bridge by pressing the SHUNT CALIBRATION switch (green indicator should extinguish), or the mechanical stimulus, and check the system zero adjustments. It may be necessary to cycle through the zero and gain adjustment several times before a precision calibration is achieved.

8.0 TROUBLESHOOTING

In the unlikely event that the system is not operating properly, refer to Table 13.

Table 13 – Troubleshooting

| Symptom | Diagnosis |
|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Receiver Power LED is not illuminated: | <ul style="list-style-type: none"> • Check that DC power supply cord is plugged into wall and receiver with the power switch in the ON position. • Verify the fuse is not blown. |
| Data LED is flickering or off: | <ul style="list-style-type: none"> • Verify that the pick-up antenna is connected to the RF connector on the back of the receiver. • Verify that the transmitting and pick-up antennas are properly installed and aligned. |
| Shunt Calibration LED is continuously illuminated and receiver is not responding: | <ul style="list-style-type: none"> • Verify that the Zero/Added Offset switch position 1 is in the OFF position. • Verify that the pick-up antenna is connected to the RF connector on the back of the receiver. • Verify that the transmitting and pick-up antennas are properly installed and aligned. |
| Analog Output does not respond to Shunt Calibration: | <ul style="list-style-type: none"> • Verify that the Zero/Added Offset switch position 1 is in the OFF position. • Verify antenna connections and alignment. • Verify Shunt resistor connections at the transmitter. • Verify transmitter connections to the transducer. |
| Analog Output does not respond to torque: | <ul style="list-style-type: none"> • Verify that the Zero/Added Offset switch position 1 is in the OFF position. • Verify antenna connections and alignment. • Verify transmitter connections to the transducer. |
| Transmitter Low Power LED is illuminated: | <ul style="list-style-type: none"> • Verify pick-up antenna is connected to the receiver. • Verify the antennas are in proper alignment. • RF power level from the receiver is too low. • Verify transmitter input connections. • Verify that the Zero/Added Offset switch position 1 is in the OFF position. |

9.0 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 four points descending. Additional data points are available at extra cost upon request.

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

9.1 RMA / Purchase Order


Please request a return material authorization (RMA) before sending a TORKDISC® system or any components 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.

10.0 WARRANTY

The standard warranty on TORKDISC® systems covers parts and workmanship. For full details, refer to the Warranty Statement supplied with each load cell.

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

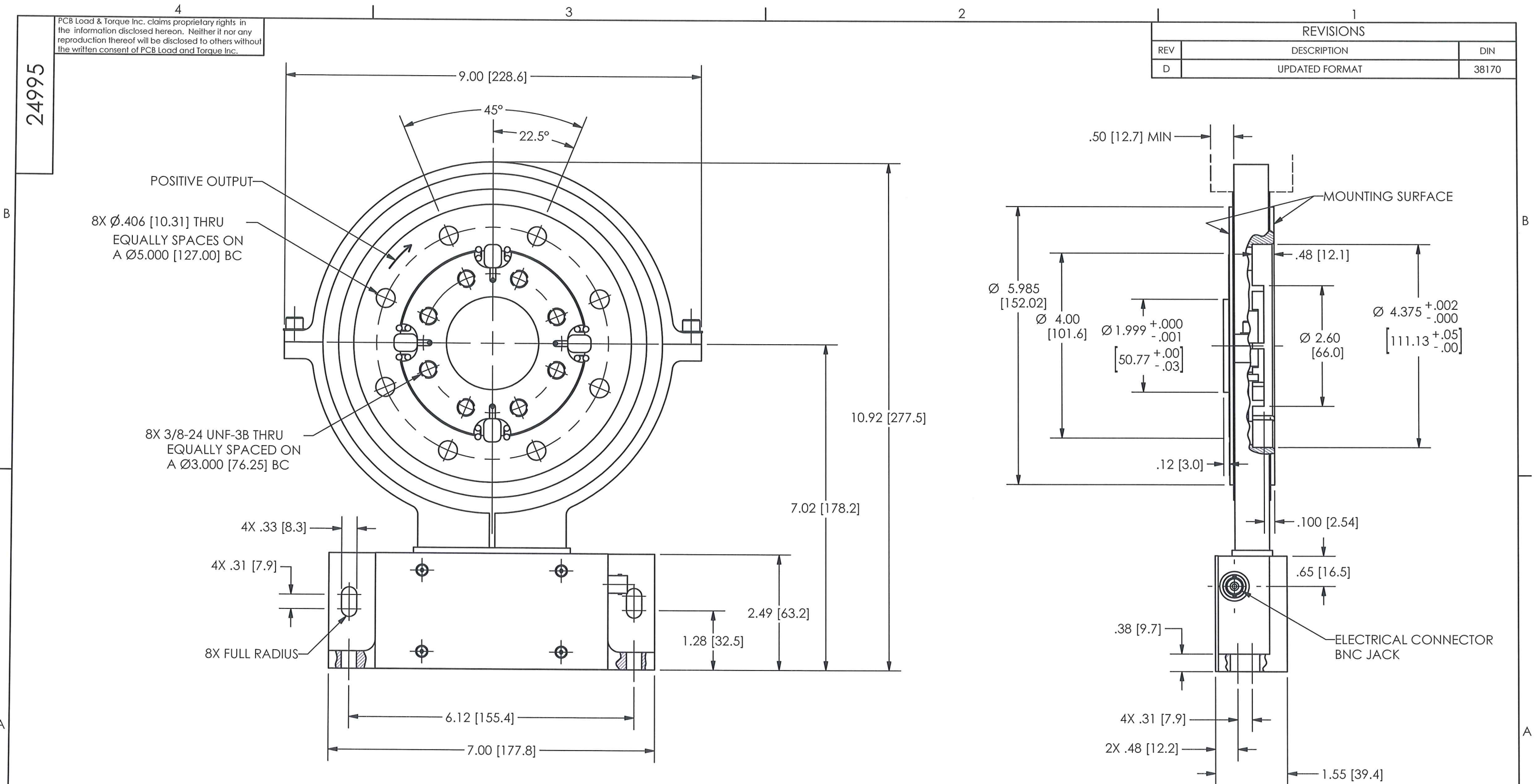
*Manual Number: 65799
Manual Revision: NR
Revision Date: 1/17/17
ECO Number: 46405*

| Model Number 5302D-01A | TORKDISC® ROTARY TORQUE SENSING SYSTEM | | | Revision: B ECN #: 44198 | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------|---------------|--------------|-----------------|-----------------|-----------------|-----------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Performance Measurement Range(Full Scale Capacity) Accuracy Frequency Range(-3 dB) Filter Type(High Pass) Filter Type(Low Pass - Anti Alias) Voltage Output(channel A - AC coupled) Voltage Output(channel B - DC coupled) Gain(Channel A) Gain(Channel B) Digital Output Maximum Load(Axial) Maximum Load(Lateral) Maximum Moment | ENGLISH 2000 in-lb ± 0.10 % FS 0 to 8500 Hz 2-pole Butterworth 8-pole Elliptical ± 10 V ± 10 V 1-16 dB 0.3-1.3 dB QSPI 500 lb 500 lb 1500 in-lb | SI 226 Nm ± 0.10 % FS 0 to 8500 Hz 2-pole Butterworth 8-pole Elliptical ± 10 V ± 10 V 1-16 dB 0.3-1.3 dB QSPI 2.2 kN 2.2 kN 169 Nm | 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]Supplied with universal AC power adaptor. [2]Bolt joint slip torque is calculated assuming a coefficient of friction (μ) of 0.1 and that grade 8 socket head cap screws are used and tightened to 30% of yield. [3]Root sum square of non-linearity, hysteresis, and non repeatability. [4>Selectable High Pass cutoff frequencies of 5, 10, 20, 200 and 500 Hz. [5>Selectable Low Pass cutoff frequencies of 10,000, 5000, 2500, 1200, 625 and 313 Hz. [6]Request Technical Note FTQ-STN5 regarding digital output signal. [7]Extraneous load limits reflect the maximum axial load, lateral load, and bending moment that may be applied singularly without electrical or mechanical damage to the sensor. [8]Where combined extraneous loads are applied, decrease loads proportionally. [9]See PCB Declaration of Conformance PS069 for details. | | | | | | | | | | |
| Environmental Overload Limit(Bolt Joint Slip) Overload Limit(Failure) Overload Limit(Safe) Temperature Range(Rotor/Stator - Operating) Temperature Range(Rotor - Compensated) Temperature Range(Receiver - Operating) Temperature Effect on Output(System - within compensated range) Temperature Effect on Zero Balance(System - within compensated range) Position Sensitivity(180° rotation of sensor) | 3300 in-lb 8000 in-lb 6000 in-lb +32 to +185 °F +70 to +170 °F 0 to +122 °F 0.002 %FS/°F 0.002 %FS/°F ≤ 0.1 % FS | 373 Nm 904 Nm 678 Nm 0 to +85 °C +21 to +77 °C -17.7 to 50 °C 0.0036 %FS/°C 0.0036 %FS/°C ≤ 0.1 % FS | | | | | | | | | | | |
| Electrical Power Required(50 to 60 Hz) Digital Resolution Digital Sample Rate Analog Resolution(based on ±10 V FSO and 16-bit resolution) | 9 to 18 VDC 16 Bit 26,484 samples/sec 0.31 mV | 9 to 18 VDC 16 Bit 26,484 samples/sec 0.31 mV | SUPPLIED ACCESSORIES: Model 012AC024AT Cable (1) Model 182-028A Connector (1) Model M0003978 Power supply (1) | | | | | | | | | | |
| Physical Maximum Speed Permissible Axial Float(rotor to stator) Permissible Radial Float(rotor to stator) Rotating Inertia(without adaptors) Dynamic Balance Torsional Stiffness Torsional Angle(at Full Scale Capacity) Housing Material(Sensor) Weight(rotor/sensor) | 15,000 RPM 0.25 in 0.25 in 0.056 in-lb/sec ² per ISO G 2.5 5,800,000 in-lb/radian 0.020 ° Anodized Aluminum 3.5 lb | 15,000 RPM 6.4 mm 6.4 mm 0.006 N-m/sec ² per ISO G 2.5 655,312 N-m/radian 0.020 ° Anodized Aluminum 1.6 kg | | | | | | | | | | | |
|  <p data-bbox="157 1282 1134 1334">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.</p> | <table border="1"> <tr> <td>Entered: AP</td> <td>Engineer: JM</td> <td>Sales: KWW</td> <td>Approved: JSD</td> <td>Spec Number:</td> </tr> <tr> <td>Date: 5/13/2015</td> <td>Date: 5/13/2015</td> <td>Date: 5/13/2015</td> <td>Date: 5/13/2015</td> <td>40425</td> </tr> </table> | | Entered: AP | Engineer: JM | Sales: KWW | Approved: JSD | Spec Number: | Date: 5/13/2015 | Date: 5/13/2015 | Date: 5/13/2015 | Date: 5/13/2015 | 40425 | <p data-bbox="1512 1063 1848 1177">PCB Load & Torque 24350 Indoplex Circle Farmington Hills, MI 48335 UNITED STATES</p> <p data-bbox="1512 1185 1774 1209">Phone: 866-684-7107</p> <p data-bbox="1512 1218 1743 1242">Fax: 716-684-0987</p> <p data-bbox="1512 1250 1921 1274">E-Mail: ltinfo@pcbloadtorque.com</p> <p data-bbox="1512 1282 1638 1307">Web site:</p> <p data-bbox="1512 1315 1890 1339">http://www.pcbloadtorque.com</p> |
| | Entered: AP | Engineer: JM | Sales: KWW | Approved: JSD | Spec Number: | | | | | | | | |
| Date: 5/13/2015 | Date: 5/13/2015 | Date: 5/13/2015 | Date: 5/13/2015 | 40425 | | | | | | | | | |

24995

PCB Load & Torque Inc. claims proprietary rights in the information disclosed hereon. Neither it nor any reproduction thereof will be disclosed to others without the written consent of PCB Load and Torque Inc.

| REVISIONS | | |
|-----------|----------------|-------|
| REV | DESCRIPTION | DIN |
| D | UPDATED FORMAT | 38170 |

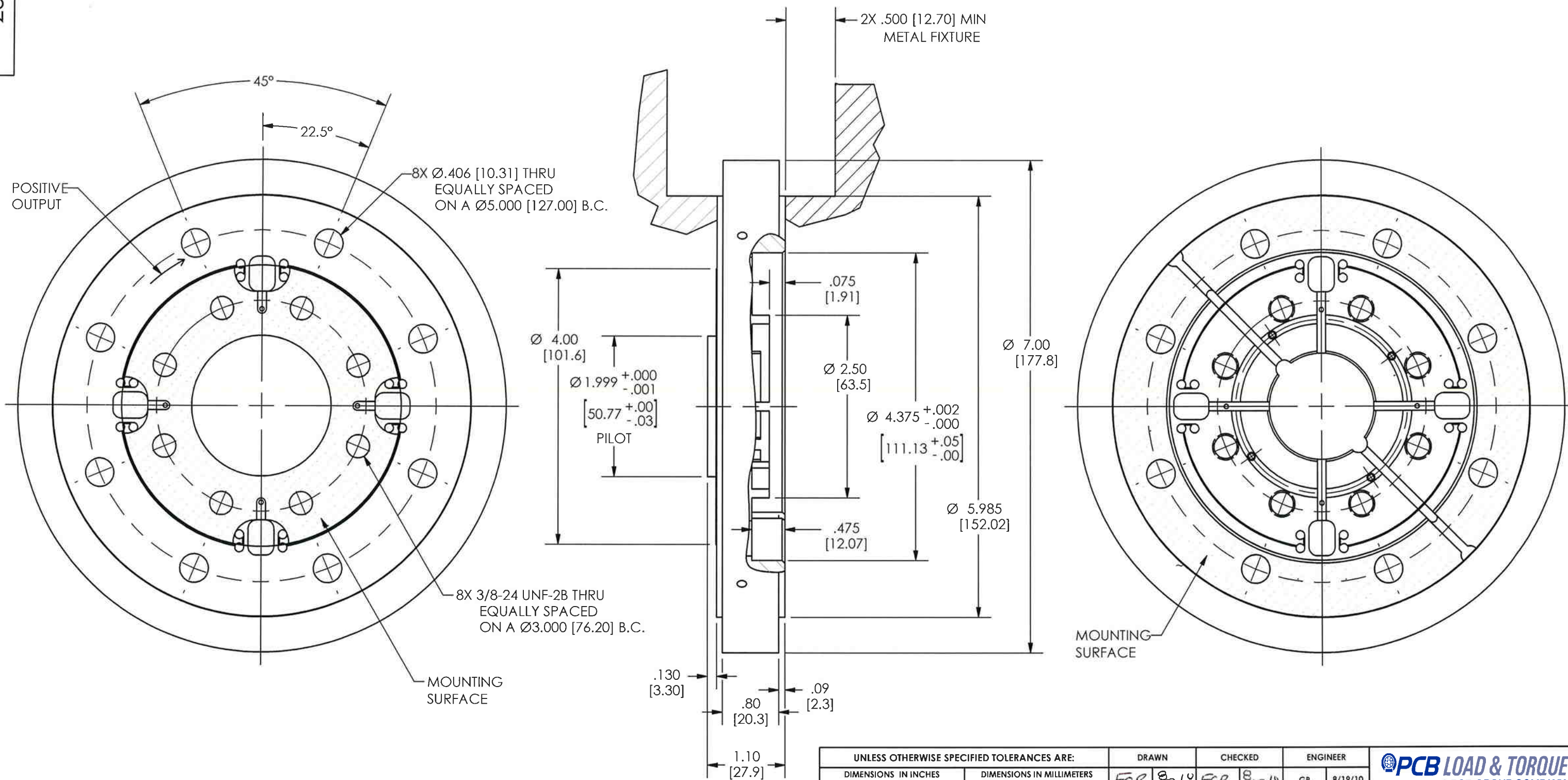


| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: | | DRAWN | CHECKED | ENGINEER | PCB LOAD & TORQUE A PCB GROUP COMPANY |
|--------------------------------------------|-------------------------------------------|------------------------------------------------------------|--------------------|-------------|-----------------------------------------------------------------------------------------------------|
| DIMENSIONS IN INCHES | DIMENSIONS IN MILLIMETERS [IN BRACKETS] | <i>[Signature]</i> | <i>[Signature]</i> | JAM 1/13/12 | |
| DECIMALS XX ±.01 XXX ±.005 | DECIMALS X ±.03 XX ±.013 | TITLE OUTLINE DRAWING MODEL 5302 SERIES TORKDISC® | | | 24350 Indoplex Circle, Farmington Hills, MI 48335 (716) 684-0001 E-MAIL: linfo@pcbloadtorque.com |
| ANGLES ± .5 DEGREES | ANGLES ± .5 DEGREES | | | | DWG. NO. |
| FILLETS AND RADII .015 MAX | FILLETS AND RADII 0.38 MAX | SCALE: .5 X | | | SHEET 1 OF 1 |

PCB Load & Torque Inc. claims proprietary rights in the information disclosed hereon. Neither it nor any reproduction thereof will be disclosed to others without the written consent of PCB Load and Torque Inc.

| REVISIONS | | |
|-----------|-------------------------|-------|
| REV | DESCRIPTION | ECO |
| D | ADD 8X TO 3/8-24 THREAD | 33361 |

25139



| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: | | DRAWN | CHECKED | ENGINEER | |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------|--------------|----------|---------|
| DIMENSIONS IN INCHES | DIMENSIONS IN MILLIMETERS [IN BRACKETS] | ECB | ECB | GB | 8/19/10 |
| DECIMALS XX $\pm .01$ XXX $\pm .005$ | DECIMALS X ± 0.3 XX ± 0.13 | TITLE | | | |
| ANGLES $\pm .5$ DEGREES | ANGLES $\pm .5$ DEGREES | OUTLINE DRAWING MODEL 5302 SERIES TORKDISC [®] | | | |
| FILLETS AND RADII .015 MAX | FILLETS AND RADII 0.38 MAX | PCB LOAD & TORQUE A PCB GROUP COMPANY | | | |
| 24350 Indoplex Circle, Farmington Hills, MI 48335 (716) 684-0001 E-MAIL: linfo@pcbloadtorque.com | | | | | |
| DWG. NO. 25139 | | | | | |
| SCALE: .75X | | | SHEET 1 OF 1 | | |