



TorqueTrak TPM2 Torque and Power Monitoring System



User's Guide

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Product Information



866600-9_A

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1 System Overview

The TorqueTrak Torque and Power Monitoring System Generation 2 (TPM2) is a rugged precision instrument designed for applications where ongoing measurement of torque and/or power on a rotating shaft is required.

System Features include:

- Digital design inherently immune to electrical noise.
- Non-contact inductive power and data transfer eliminates wear surfaces for long life without signal degradation.
- Installation does not require shaft modification or machine disassembly.
- Built-in shunt system calibration.

New features:

- Single turn transmitter and stationary ring with a minimum number of connections and high reliability.
- Fully encapsulated electronics for high reliability.
- Eight user selectable input ranges from 0.25 to 32 mV/V (125 to 16000 microstrain with gage factor of 2.0).
- RS-422 serial communications from stationary interface for long distance error free data transmission to system monitoring and display equipment.
- 15 bit signed strain value, 16 bit signed speed value, and 24 bits of status information contained in every data sample.
- Four dual color LEDs on stationary interface for system status and error indication in addition to status information contained in the RS-422 serial communications data.

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the digitized signals to the stationary interface. The transmitter is powered inductively from the stationary ring.

1.1.2 Stationary Interface

The stationary interface generates power for, and receives data from the transmitter. The stationary interface then communicates the data to a connected host device through a dedicated bi-directional RS-422 interface.

2 Installation

WARNING!

PERSONAL INJURY

DO NOT USE this product as a safety or emergency stop device or in any application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.



*

The end user is responsible for the proper installation and operation of this device. Improper installation or operation could result in damage, injury or death.

Certain environments could cause damage or degradation to the components of the system resulting in mechanical failure.

The TPM2 system must be sealed by the installer for operation in wet/harsh environments.

Mechanical failure could cause parts to detach from the shaft and fly off at high speeds. These flying parts could cause equipment damage, bodily injury and possibly death. Keep equipment and personnel away from areas where parts flung from the shaft could enter.

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A shield or guard is recommended in applications where something or someone could come in contact with the rotating parts of the system.

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Except for the TPM2
and the shaft, all
metal should be kept
away from the unit;
out of the shaded
area indicated.

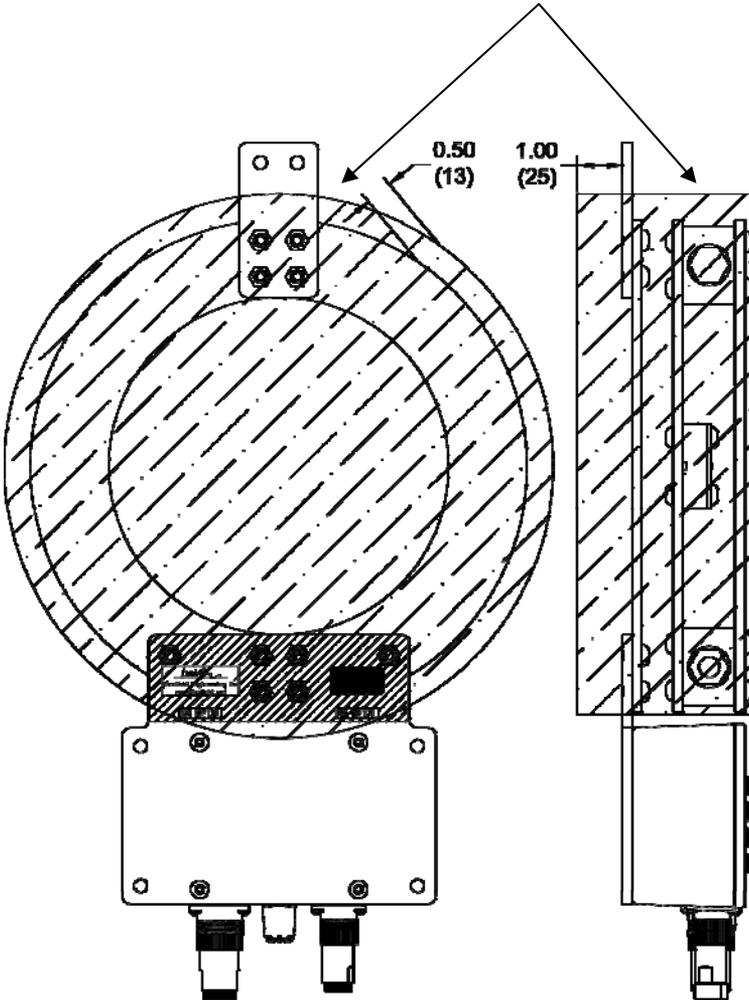


Figure 2 - Metal Interference area

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Make sure there is proper rotor-stator spacing before rotating the shaft.

Make sure the TPM2 is properly installed and clear of all obstructions before rotating the shaft.

Keep clear of the machinery while the shaft is rotating.

Each TPM2 is custom made to fit a certain shaft size range. Therefore the shaft diameter must be specified at time of order. Do not try to adapt the TPM2 to a shaft size outside its intended range of operation.

2.1 Rotating Collar Installation

If there is any damage to the rotating collar (gouges, chips, cuts, cracks, etc.) IMMEDIATELY DISCONTINUE USE, remove from the shaft and contact BEI for a replacement.

The Rotating Collar must be installed on a smooth, clean area of the shaft.

DO NOT operate the rotating collar at rotational speeds exceeding specifications listed in Appendix "F".

DO NOT mount the rotating collar directly over the strain gage.

DO NOT substitute mounting hardware. Use only the supplied mounting hardware for installation. Contact BEI for replacement mounting hardware.

DO NOT remove the Counter-Weight/Magnet or loosen its screws.

Use the supplied thread lubricant as indicated.

Use Threadlocker (Loctite 242) supplied as indicated.

Should removal of the transmitter be necessary, reinstall with #242 Loctite applied to the threads of M-6 screws.

Install the rotating collar assembly with the ring surface on which the transmitter is mounted, nearest to the stationary ring.

Apply anti-seize compound to the threads of all M-10 collar bolts prior to assembly.

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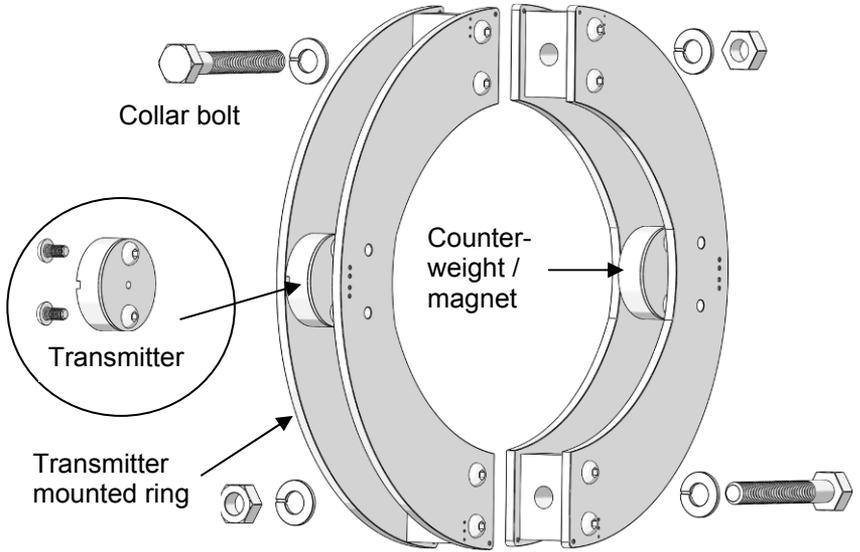


Figure 3 - Rotating collar installation

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Alternately tighten the collar bolts, keeping the gaps between the rotating collar sections equal, until specified bolt torque is reached.

Table 1: Torque specifications

Description	Type	N-m	ft-lbs	in-lbs
Collar bolts	M10 -1.5 class 10.9	20	15	180
Transmitter screws	M5-0.8 class 10.9	6.2	4.6	55
Stator Coil PCB	M6	3.6	2.7	32

Make sure the rotating collar is mounted squarely on the shaft and does not wobble.

The rotating collar bolts and transmitter mounting screws must be tightened for proper system operation since power for the Transmitter is conducted through these fasteners.

Make sure there is proper rotor-stator spacing before rotating the shaft.

2.2 Stationary Ring and Stationary Interface Installation

The TPM2 enclosure is only sealed when the mating connectors/cables are attached.

In other words: Do not expose to adverse conditions (liquids) if connectors/cables are disconnected.

The TPM2 stationary interface requires a custom fabricated mount to hold it securely in place. Refer to Appendix E: Dimensions, for mounting flange dimensions necessary to create a custom mounting bracket. Figure 2 provides information about rotor-to-stator spacing guidelines and a metal interference area that should be kept clear of all other metal.

Generally it is a good idea to mount the stationary interface with the cable connections pointing down to minimize the exposure of the connectors to contaminants, but axially rotated orientations are acceptable as dictated by available space and other application specific considerations. The mounting should secure the stationary interface and power ring as rigidly as possible.

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2.2.1 Stationary Interface Connections

2.2.1.1 Power Connection

The TPM2 comes with a standard 10ft (3m)¹ power cable terminated at one end with a rugged metal sealed circular 3 pin connector. The other end is un-terminated and must be connected by the end user to a 24VDC regulated power supply (a range from 10 to 30VDC is acceptable) with a maximum current of 2 amps and typical operating current of 0.5 amps. Actual operating current depends on the power supply voltage (lower voltages require more current), and the efficiency of the inductive power transfer to the rotating collar.

The power is fused at the TPM2 Stationary interface with a 5_x_20mm 2 amp fast blow fuse. The standard supplied power cable is 16awg shielded twisted pair with a resistance of 4.2mΩ/ft. Be sure to take into account the resistance and added voltage drop of any additional wire connected between the power supply and the TPM2 (for instance between an intermediate junction box and a control cabinet).

The three pin TPM2 power connector has the following pinout and color code:

Table 2: Stationary interface power cable

Pin#	Wire Color	Signal Description
1	RED	+24VDC (10 to 30VDC is acceptable), 15 watt max, 10 watt typical
2	BLK	Power Supply common
3	CLR	TPM2 chassis (connected to aluminum enclosure)

The internal power supply of the TPM2 is isolated from its aluminum enclosure so for safety and to reduce electrical noise, the CLR conductor in the power cable should be terminated to

¹ Contact Binsfeld Engineering for other cable lengths.

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chassis ground (cabinet, frame or earth ground) at the user terminated end.

2.2.1.2 Communications Connection

The TPM2 comes with a standard 10ft (3m) communications cable terminated at one end with a rugged metal sealed circular 7 pin connector. The other end must be field terminated by the end user.

Communication distances of over 1000ft (300m) are possible with proper cabling and installation. Slower baud rates generally allow for the longest possible cable lengths. When long cable lengths are required, use the lowest baud rate possible for the desired sampling rate.

The recommended RS-422 interface for connecting a PC USB port to the TPM2 communications connector is the model USOPTL4-LS isolated, locked S/N converter from B&B Electronics; <http://www.bb-elec.com>.

Any RS-422 interface should work but may not work with the standard BEI TPM2 Configuration and Monitoring software. Be aware that the baud rate must be set high enough to support the desired output sample rate. Please see the TPM2 Communications Specification document for detailed information.

DIP switch settings for the USOPTL4-LS (back side):

- 1 - RS-422
- 2 - Echo ON or OFF, does not matter
- 3 - 4 Wire
- 4 - 4 Wire

The 7 pin TPM2 communications connector has the following pinout and color code:

Table 3: Stationary interface communications cable

Pin#	Wire Color	Signal Description
1	BLU/WHT	RX+, connect to USOPTL4-LS TDB+
2	WHT/BLU	RX-, connect to USOPTL4-LS TDA-
3		common
4	CLR	common, connect to USOPTL4-LS GND
5		common
6	WHT/ORN	TX-, connect to USOPTL4-LS RDA-
7	ORN/WHT	TX+, connect to USOPTL4-LS RDB+

NOTE: Wire colors specified in the format XXX/ZZZ have a primary color of XXX and a stripe color of ZZZ.

2.2.2 Stationary Ring Installation

After securely mounting the stationary interface to its bracket, assemble and mount the stationary ring around the shaft. Mount the ring on top of the surface of the stationary interface mounting flange labeled "FRONT" with the surface of the ring that is labeled "FRONT" also facing to the front. Mount the ring splice tabs in the same plane as the mounting flange (on the back side of the ring). When the "FRONT" label on the mounting flange and the "FRONT" label on all the ring pieces and splice tabs can be read from the same side, it is mounted correctly. Tighten all ring assembly screws as specified in Table 1.

3 System Operation and LED Descriptions

3.1 Stationary Interface



Figure 4 - Stationary Interface Faceplate

3.1.1 Startup Operation

Immediately after power-up, internal operation is tested. If the test fails, only the red *Torque LED* is turned ON solid and remains so until power is removed.

If the test passes, the red *Torque LED* flashes at a rate of 5Hz for 1/2 second. The green *Rotor LED* flashes opposite the red *Torque LED*. The internal firmware of the Stationary Interface can be updated if special programming messages are received during this time period.

If no programming messages are detected, normal operation continues starting with a test of the indicator LEDs. First, all red LEDs are turned ON for 1 second then turned OFF. Next, all green LEDs are turned ON for 1 second and then turned OFF. After the LED test, normal LED operation commences.

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3.1.2 Normal Operation

Following Startup, the Inductive Interface varies inductive power from high to low seeking to establish communications with the rotor. The green *Stator LED* flashes with a frequency of 2.34Hz and a duty cycle (ON time relative to OFF time) that is proportional to the power level. The greater the ratio of the ON to OFF duration of the green *Stator LED*, the higher the inductive power.

The *Rotor LED* becomes solid green to indicate that the rotor power supply voltage is within its target range. At that point the *Stator LED* stops indicating the inductive power level and begins indicating stator power and connected device communications status.

3.1.3 Stator LED

The *Stator LED* has two modes during normal operation. Typically it operates as an indicator for the status of Stator main regulated voltage, main regulator over current, power amplifier over temperature, and connected device communications. It also indicates the output power level while it varies to produce the required transmitter voltage level. When the *Rotor LED* is flashing, the stator is adjusting and indicating the output power level.

The *Stator LED is solid green* when stator power supply voltage is in range, the power supply current is under the over current threshold, the power amplifier is below the over temperature threshold, and no communications errors exist with the connected device. The acceptable stator power supply range is 10 to 30 volts DC.

Auto baud rate detection of the RS-422 connection is a feature of the TPM2. Requirements are defined in the TPM2 Communications Specification that allow the TPM2 to properly and accurately determine the baud rate being used. While operating in Auto Baud Rate Detection mode, the *Stator LED flashes green with a 50% duty cycle at 5Hz*.

The *Stator LED will change to red* while power supply voltage, power supply over current, power amplifier over temperature, or communications errors exist. Communications errors are UART errors like framing, parity, checksum, and buffer overrun. As soon as the error condition clears, the LED returns to solid green.

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Power supply over current errors begin to appear when an over current condition is sensed for more than 2 seconds. When over current errors are detected the *Stator LED is red*. If the error condition lasts for more than 3 seconds, an over current fault is triggered and inductive power for the transmitter is shut OFF for 7 seconds, during which the *Stator LED remains red*. After the 7 second OFF period expires, inductive power is re-enabled and adjusted. If over current is detected again, the cycle repeats.

Power amplifier over temperature errors begin to appear whenever the sensed amplifier section temperature exceeds the over temperature threshold. While over temperature errors exist, the *Stator LED is red*. If the condition remains for more than 1 second, an over temperature fault is triggered and the inductive power is shut OFF. The inductive power is held OFF and the *Stator LED remains red* until the temperature is sensed to cool below a lower threshold temperature. Cooling could take several seconds or minutes depending on the ambient temperature around the instrument. When the power amplifier section has cooled, it is re-enabled.

3.1.4 Rotor LED

The function of the Rotor LED is to indicate the health of the inductive link between the rotor and the stator regarding power transfer and communications. It does not indicate the status of rotor measurement problems. Rotor measurement problems like signal overrange are indicated in the status bits of the RS-422 data from the stator to a connected device or host.

The *Rotor LED is solid green* when rotor power supply voltage and communications are OK.

The *Rotor LED flashes (red or green)* when rotor power supply voltage is not within the normal operating window.

The *Rotor LED is red* when rotor communication errors are detected.

The *Rotor LED is off* when rotor communications are lost for 16 consecutive 4800Hz sample times.

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3.1.5 Torque LED

The *Torque LED is solid green* when the rotor is communicating and the differential and common mode inputs are within range.

The *Torque LED is red* when the differential or common mode inputs are not within range.

The *Torque LED is off* when rotor communications are lost.

3.1.6 Speed LED

The *Speed LED flashes green for 200msec* for every magnet pulse detected when the pulse frequency is low. The *Speed LED flashes green for 20msec* for every magnet pulse detected when the pulse frequency is high. The low pulse frequency threshold is approximately 1.75Hz when frequency is increasing from below 0.88Hz. The low frequency threshold is approximately 0.88Hz when frequency is decreasing from above 1.75Hz.

If the duration of speed pulses becomes too short or pulse frequency is erratic, the *Speed LED flashes red* (not green).

3.2 Transmitter LED Operation

When the single green Transmitter LED is ON solid, all is OK with the transmitter.

One quick Transmitter LED pulse (about 0.1 second every 1.7 seconds) indicates transmitter voltage is detected to be outside of the normal operating range.

Two quick Transmitter LED pulses (each pulse 0.1 second duration, separated by 0.3 seconds of OFF time, repeated every 1.7 seconds) indicates the transmitter is having problems saving configuration values in memory.

A 50% duty cycle 1.2Hz flashing rate indicates that the transmitter input signal is out of range, either common mode or differential mode.

A 50% duty cycle 4.7Hz flashing rate indicates that the transmitter input reference signal is out of range.

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If the Transmitter LED is OFF, the transmitter voltage is very low.

4 Communications Protocol

Bi-directional RS-422 communications are supported with the connected device but are not required. The TPM2 does not expect any data to be received from the connected device so no communications errors are declared if there is nothing connected to the RS-422 connector. In simple systems the connected device could just monitor the data sent from the TPM2 but bi-directional communications are required to configure parameters such as gain, baud rate and sample rate. Please refer to the TPM2 Stationary Interface RS-422 Communication Specification (866600-C_A) for detailed information.

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Appendix A: TPM2 Specifications

Transmitter (mounted inside rotating collar)

Sensor Input: Full Bridge strain gage
(4 active arms, 350 Ω standard; up to 1000 Ω acceptable.)

Bridge Excitation: 3.0 VDC, Regulated
25mA max.

Linearity: 0.05% Full Scale

DC Specifications:

Table 4: Transmitter input range specifications

Nominal Input Range (mV/V)	32	16	8	4	2	1	0.5	0.25
Strain ¹ max PFS ($\mu\epsilon$)	16000	8000	4000	2000	1000	500	250	125
Offset Error max (%FS)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Gain Error max (%)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Offset TC max (%FS/ $^{\circ}$ C)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.010
Gain TC max (%/ $^{\circ}$ C)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.010

FS - Full Scale, PFS – Positive Full Scale,
TC – Temperature Coefficient

¹ Strain using gage factor = 2.0

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AC Specifications:

Table 5: Typical signal bandwidth and delay

Sample Rate (samples/second)	Bandwidth¹ (Hz)	Delay² (ms)
9.375	3	1700
18.75	6	850
37.5	12	420
75	25	210
150	50	104
300	100	50
600	200	25
1200	380	11
2400	740	4.3
4800	1000	1

¹ Bandwidth is the frequency at which the signal is -3dB (70.8%) relative to the DC (0Hz) level.

² Signal delay is measured from analog (gage) input of the transmitter to the end of the sample transmission out of the communication link.

These values are valid for all input range (gain) settings.

Table 6: Typical signal to noise ratio (dB)

Sampling Rate (SPS)	Input Range							
	1	2	3	4	5	6	7	8
9.375	>100	>100	>100	>100	>100	94	81	73
18.75	>100	>100	>100	>100	>100	88	79	70
37.5	>100	>100	>100	>100	94	84	76	68
75	>100	>100	>100	>100	88	82	73	66
150	>100	>100	>100	98	85	79	71	64
300	96	96	96	92	82	76	69	62
600	89	89	89	84	79	74	66	60
1200	82	82	81	80	76	71	64	58
2400	76	76	76	76	73	68	62	56
4800	73	73	73	72	70	66	60	54

Signal to Noise Ratio (in dB) is calculated as follows:

$$S/N = 20 * \log_{10} (\text{NominalSignalRange} / \text{ResidualNoiseLevel})$$

Transmitter Connections:

Power Connection: Through Collar mounting bolts and Transmitter mounting screws

Sensor Input: Full (Wheatstone) bridge (120Ωmin)

Sensor Excitation: 3.0Vdc (25mA max)

Sensor Connection: Solder pads or included cable

- +Exc: positive excitation voltage to the sensor (red)
- +Sen: positive sense voltage from the sensor (green)
- Sen: negative sense voltage from the sensor (white)
- Exc: negative excitation voltage to the sensor (black)

Table 7: Stationary interface general specifications

Input Power	10-30Vdc; 15W max, 10W nom
Communication	RS-422 full duplex, point-to-point serial interface
External Connections (included)	Harsh environment sealed circular connectors with 10ft (3m) cables and discrete wire termination at the user end (standard). Contact BEI for other lengths or custom end terminations.
PC software (included)	For device configuration and simple monitoring of output data. Not intended to replace data acquisition system.

Table 8: TPM2 general system specifications

Torque signal resolution	15 bits, 1 unit in 32,768
Torque signal sampling rate	4800Hz (max)
Shaft speed signal resolution	33.91nsec
Shaft speed signal sampling rate	1 per revolution
Operating temperature	-40° to +70°C, 0 to 90% non-condensing humidity

Specifications are subject to change without notice.

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Appendix B: Strain, Torque and Power Calculations

Please refer to the TPM2 Communications Specification document for detailed information.

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Appendix C: Troubleshooting

There are multiple features built into the TPM2 system to aid in troubleshooting. There are four bi-color status LED's on the Stationary Interface. There are also 24 status bits in the serial data transmitted from the Stationary Interface.

Generally the first step in troubleshooting is to observe (if possible) all LED's on the Stationary Interface.

There should always be at least one LED ON or flashing in some way. If all Stationary Interface LED's are OFF, it may not be receiving power:

1. Check the power source and wiring to the TPM2.
2. Check the TPM2 power fuse (5 x 20mm 2 amp fast blow).

If at least one Stationary Interface LED is ON or flashing, observe (if possible) the transmitter LED on the rotating collar. The transmitter LED operation is detailed in paragraph 3.2 of this document.

If the transmitter LED is always OFF, then the transmitter power is too low for operation:

3. Check that the stationary ring is mounted correctly with the proper surface facing the rotating collar as specified in the installation instructions.
4. Check that the rotating collar is mounted with the proper surface facing the stationary ring as specified in the installation instructions.
5. Check that the spacing between the stationary ring and the rotating collar is as specified in the installation instructions.
6. Check that all bolts in the rotating collar are tight, including the bolts that secure the transmitter.
7. Check that all bolts holding the stationary ring together are tight.

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If the Transmitter and/or Stationary Interface LED's are flashing in some manner, refer to section 3 of this manual to determine the operational status.

In addition to the status LED's, the TPM2 RS-422 data contains status information. Please refer to the TPM2 Communications Specification document for detailed information.

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Appendix D: Strain Gage Installation

View BEI's online Strain Gage Installation Training videos at www.binsfeld.com/torquetrak/torquetrak-revolution/training-videos.html

(Also refer to instruction bulletin B-127-12 provided with GAK-2-200 Strain Gage Application Kit from Vishay Measurements Group, Inc., Raleigh, NC, 919-365-3800, www.measurementsgroup.com.)

PREPARING THE SURFACE

1. A 3-inch square area will be used for gaging. Scrape off any paint or other coatings and inspect shaft for oil residue. If necessary, use a degreasing solution or isopropyl alcohol to remove.
2. Rough sand the gaging area with **220 grit paper**. Finish the sanding procedure by wetting the gaging area with **M-Prep Conditioner A** and the wetted surface with **400 grit paper** provided. Rinse by squirting with **M-Prep Conditioner A**. Wipe the area dry with **tissue** taking care to wipe in only one direction. Each time you wipe use a clean area of the tissue to eliminate contamination.
3. Rinse shaft this time by squirting with **M-Prep Neutralizer 5A**. Wipe the gaging area dry with a clean tissue, wiping in only one direction and using clean area of tissue with each wipe. Do not allow any solution to dry on the surface as this may leave a contaminating film which can reduce bonding. Surface is now prepared for bonding.

MARKING THE SHAFT FOR GAGE ALIGNMENT

4. The gage needs to be perpendicular to the shaft axis. In general, this can be accomplished by eye since misalignment of less than 4 degrees will not generate significant errors. For higher precision, we recommend two methods for marking the shaft:
 - a. Use a machinist square and permanent marker or scribe for perpendicular and parallel lines; or

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- b. Cut a strip of graph paper greater than the circumference of the shaft. Tape it to the shaft while lining up the edges. Mark desired gage position with a scribe or permanent marker.

PREPARING THE GAGE FOR MOUNTING

5. Using tweezers, remove one gage from its package. Using the plastic gage box as a clean surface, place the gage on it, bonding side down. Take a 6" piece of **PCT-2M Mylar Tape** and place it on the gage and terminal, centered. Slowly lift the tape at a shallow angle. You should now have the gage attached to the tape.

POSITIONING THE GAGE

6. Using the small triangles located on the four sides of the gage, place the taped gage on the shaft, perpendicular with the shaft axis, aligned with your guide marks. If it appears to be misaligned, lift one end of tape at a shallow angle until the assembly is free to realign. Keep one end of the tape firmly anchored. Repositioning can be done as the PCT-2M tape will retain its mastic when removed and therefore not contaminate the gaging area.

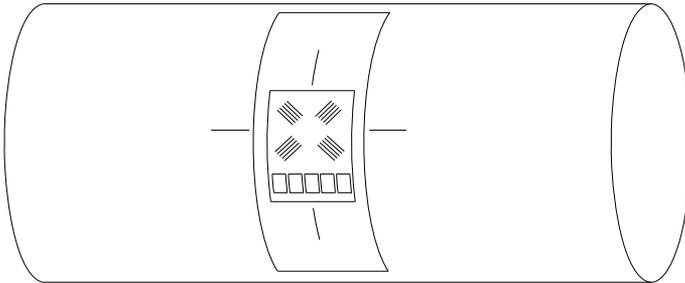


Figure 5 - Strain gage mounting

POSITIONING THE GAGE ON THE SHAFT

7. Gage should now be positioned. Once again, lift the gage end of the tape at a shallow angle to the surface until the

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gage is free of the surface. Continue pulling the tape until you are approximately 1/8" – 1/4" beyond gage. Turn the leading edge of the tape under and press it down, leaving the bonding surface of the gage exposed.

8. Apply a very thin, uniform coat of ***M-Bond 200-Catalyst*** to the bonding surface of the gage. This will accelerate the bonding when glue is applied. Very little catalyst is needed. Lift the brush cap out and wipe excess on lip of bottle. Use just enough catalyst to wet gage surface. Before proceeding, allow catalyst to dry at least one minute under normal ambient conditions of + 75°F and 30-65% relative humidity.

NOTE: The next three steps must be completed in sequence within 3 – 5 seconds. Read through instructions before proceeding so there will be no delays.

Have Ready:

M-Bond (Cyanoacrylate) Adhesive

2" – 5" piece of teflon tape

Tissues

MOUNTING THE GAGE

9. Lift the leading edge of the tape and apply a thin bead of adhesive at the gage end where the tape meets the shaft. Adhesive should be of thin consistency to allow even spreading. Extend the line of glue outside the gage installation area.
10. Holding the tape taut, slowly and firmly press with a single wiping stroke over the tape using a teflon strip (to protect your thumb from the adhesive) and a tissue (to absorb excess adhesive that squeezes out from under the tape). This will bring the gage back down over the alignment marks on the gaging area. This forces the glue line to move up and across the gage area. A very thin, uniform layer of adhesive is desired for optimum bond performance.
11. Immediately, using your thumb, apply firm pressure to the taped gage by rolling your thumb over the gage area. Hold the pressure for at least one minute. In low humidity

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conditions (below 30%) or if ambient temperature is below + 70° F, pressure application time may have to be extended to several minutes.

12. Leave the mylar tape on an additional five minutes to allow total drying then slowly peel the tape back directly over itself, holding it close to the shaft while peeling. This will prevent damage to the gages. It is not necessary to remove the tape immediately after installation. It offers some protection for the gaged surface and may be left until wiring the gage.

WIRING THE GAGE

13. Tin each solder pad with a solder dot. (It is helpful to polish the solder tabs, e.g. with a fiberglass scratch brush or mild abrasive, before soldering.) Trim and tin the ends of the 4-conductor ribbon wire. Solder the lead wires to the gage by placing the tinned lead onto the solder dot and pressing it down with the hot soldering iron. Note: For single-stamp torque gages, a short jumper is required between solder pads 2 and 4 as shown in the diagram on the next page
14. Use the **rosin solvent** to clean excess solder rosin from the gage after wiring. Brush the gage pads with the solvent and dab with a clean tissue.
15. Paint the gage area (including the solder pads) with **M-Coat A polyurethane** and allow to air dry 15 minutes. This protects the gage from moisture and dirt. To further protect the gage, apply M-Coat J protective coating for protection against moisture, fluids and mechanical damage.

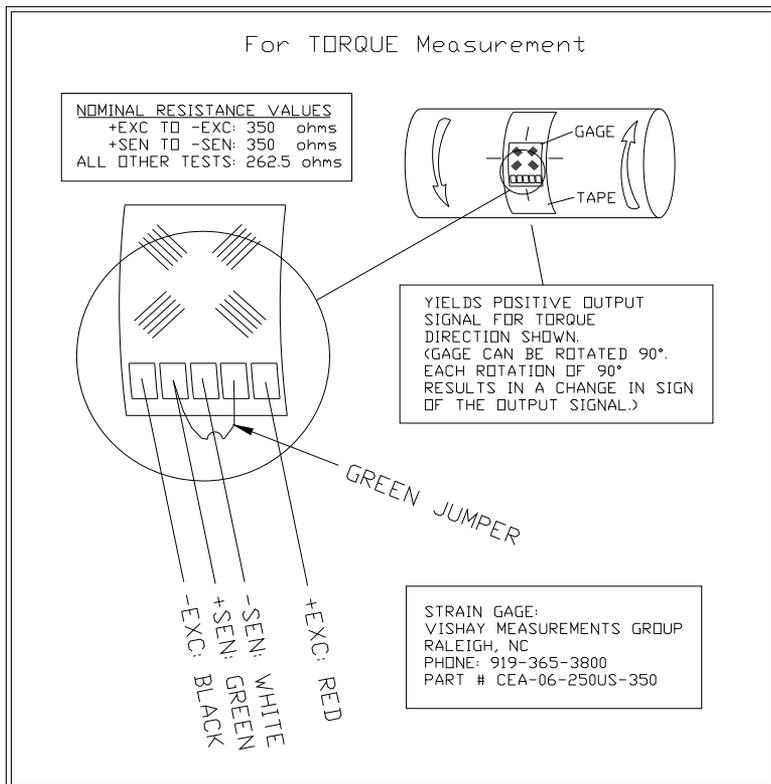


Figure 6 - Strain gage wiring

Appendix E: Dimensions

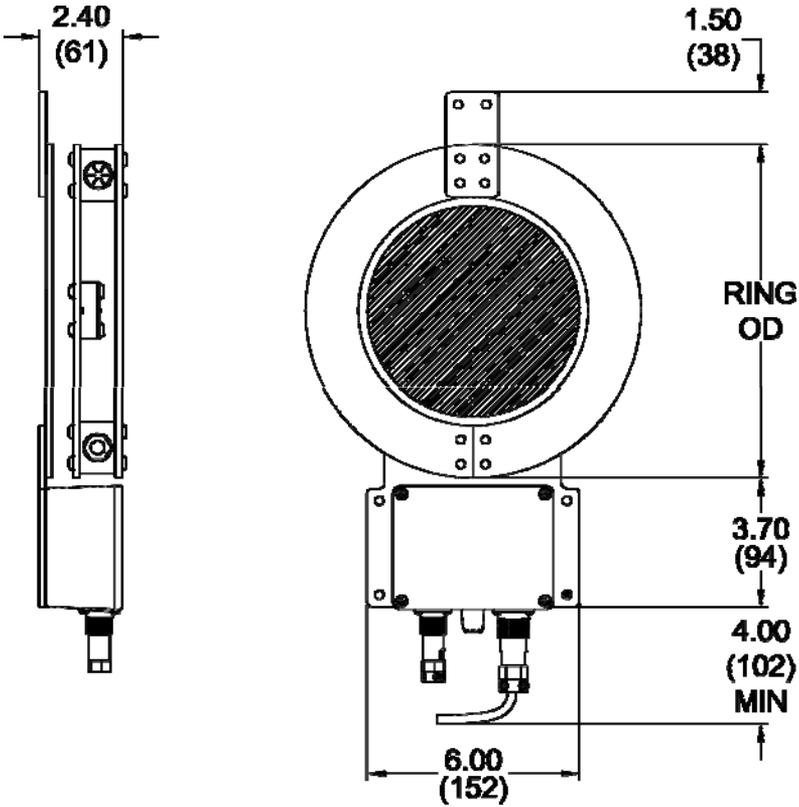


Figure 7 - General dimensions

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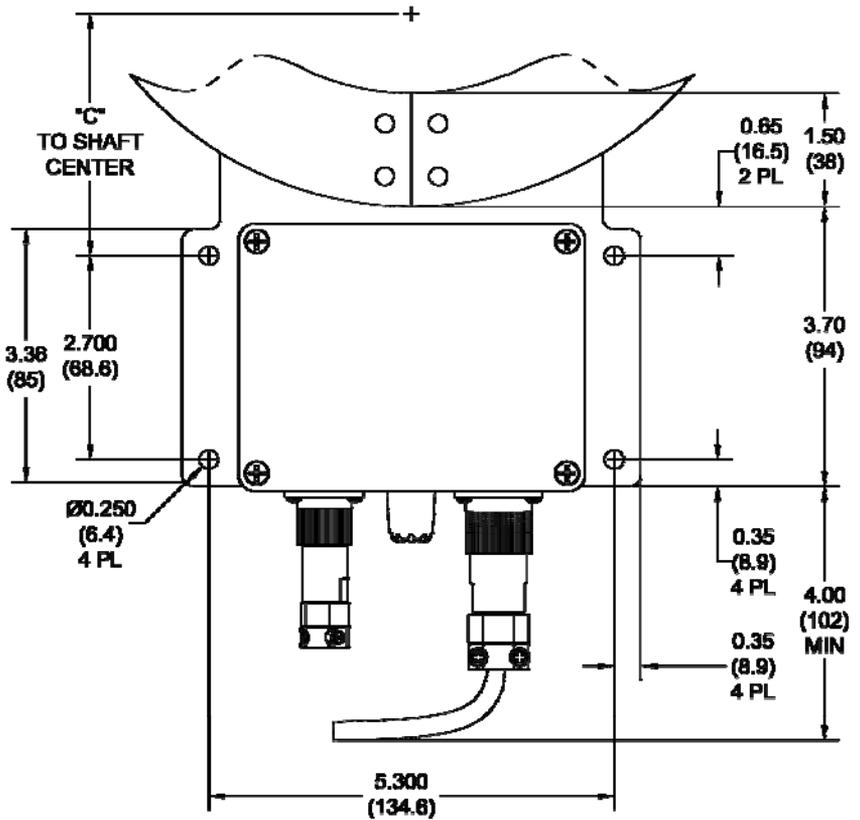


Figure 8 - Stationary Interface Mounting Dimensions

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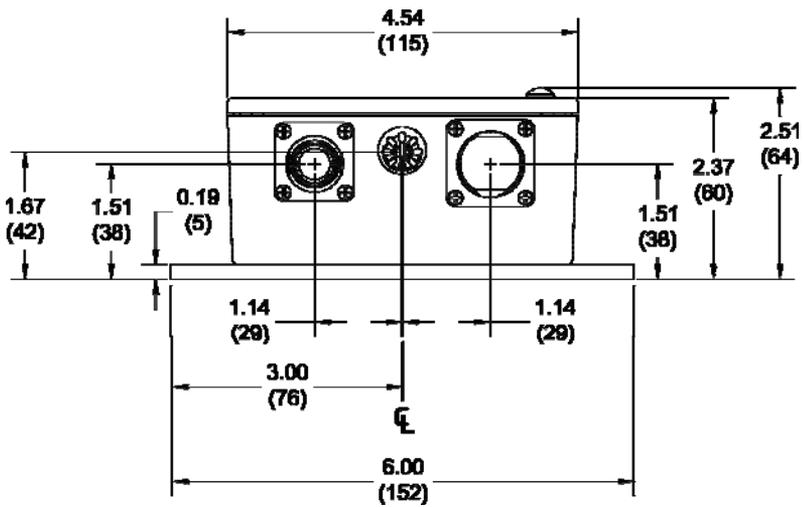
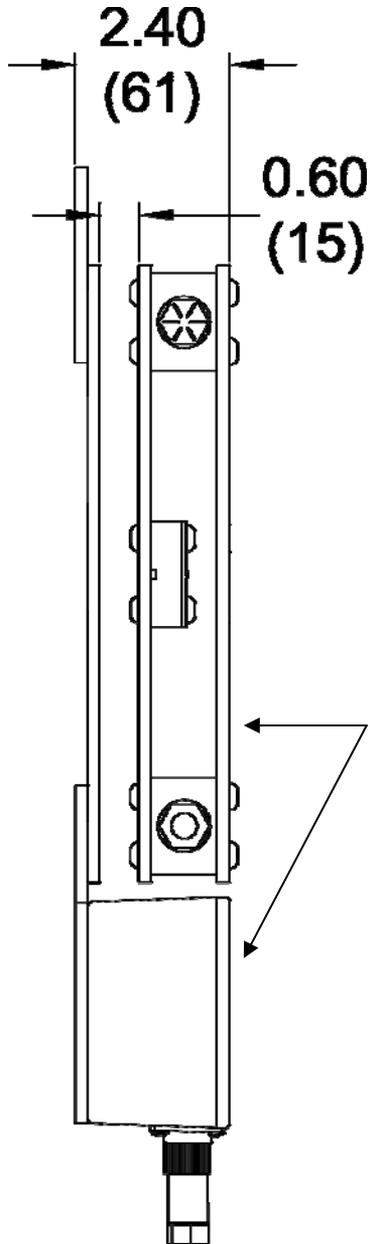


Figure 9 - Stationary Interface Bottom Dimensions

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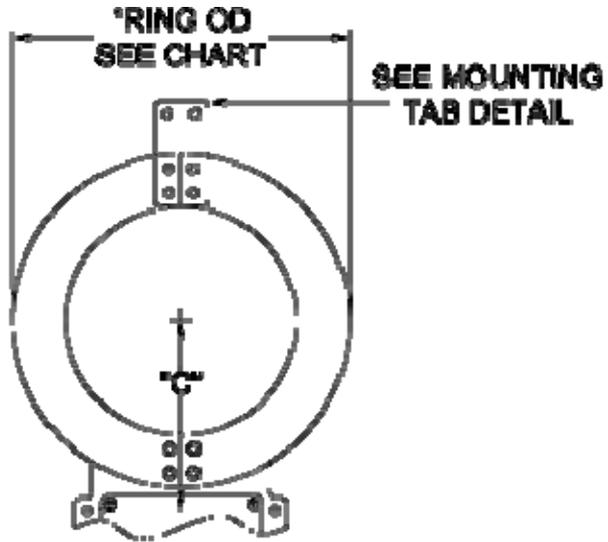


Rotor to stator spacing is accomplished by aligning the non-transmitter side of the rotor collar with the front of the stationary interface.

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Figure 10 - Collar Spacing

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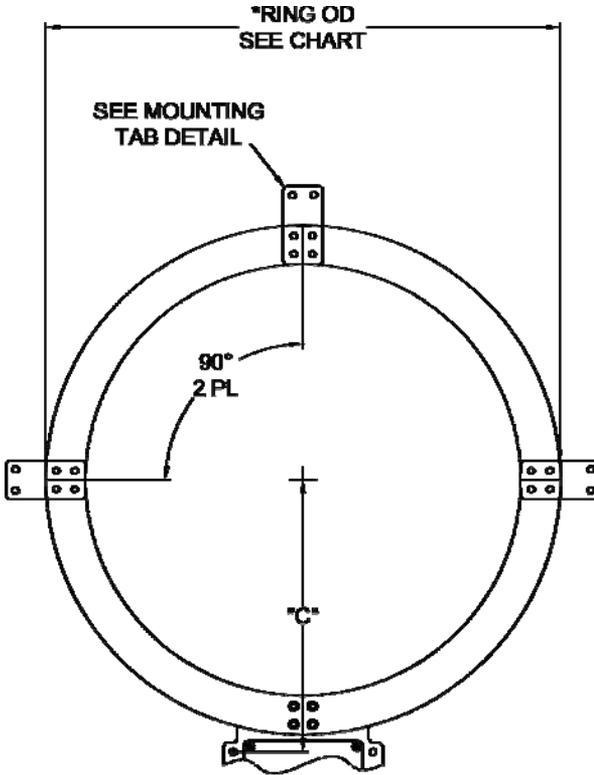


SHAFT SIZES 0.75-6.00 (20-152)			
SHAFT OD MIN	SHAFT OD MAX	*RING OD	"G"
0.75 (19)	1.50 (38)	5.00 (127)	3.15 (80)
1.00 (25)	2.00 (51)	5.50 (140)	3.40 (86)
2.00 (51)	4.00 (102)	7.50 (191)	4.40 (112)
4.00 (102)	6.00 (152)	9.50 (241)	5.40 (137)

***RING AND ROTOR OD ARE NOMINALLY SAME SIZE**

Figure 11 - 0.75" to 6" Shaft Diameter Dimensions

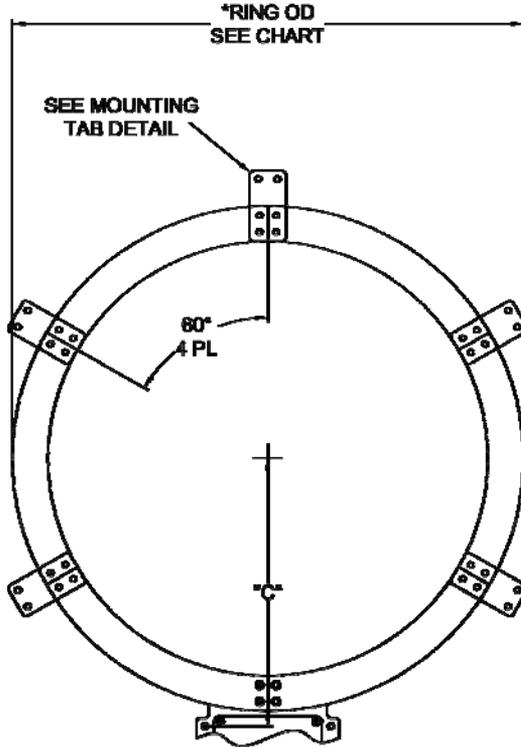
This document is subject to change without prior notification.



SHAFT SIZES 6.00-16.00 (152-408)			
SHAFT OD MIN	SHAFT OD MAX	*RING OD	*C*
6.00 (152)	8.00 (203)	11.50 (292)	6.40 (163)
8.00 (203)	10.00 (254)	13.50 (343)	7.40 (188)
10.00 (254)	12.00 (305)	15.50 (394)	8.40 (213)
12.00 (305)	14.00 (356)	17.50 (445)	9.40 (239)
14.00 (358)	16.00 (408)	19.50 (495)	10.40 (264)
*RING AND ROTOR OD ARE NOMINALLY SAME SIZE			

Figure 12 - 6" to 16" Shaft Diameter Dimensions

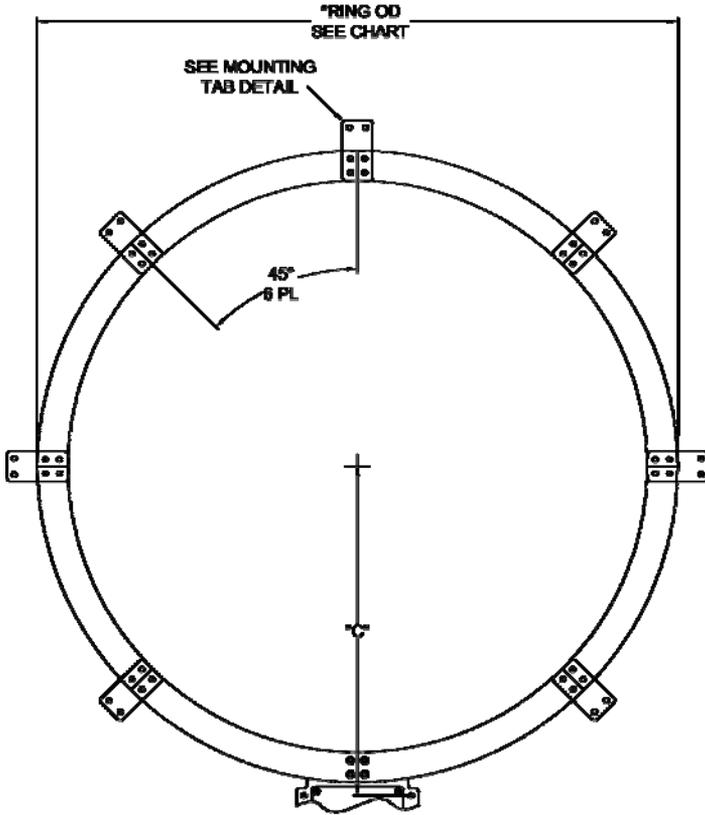
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SHAFT SIZES 18.00-24.00 (406-810)			
SHAFT OD MIN	SHAFT OD MAX	*RING OD	"C"
18.00 (406)	18.00 (457)	21.50 (546)	11.40 (290)
18.00 (457)	20.00 (508)	23.50 (597)	12.40 (315)
20.00 (508)	22.00 (559)	25.50 (648)	13.40 (340)
22.00 (559)	24.00 (610)	27.50 (699)	14.40 (366)
*RING AND ROTOR OD ARE NOMINALLY SAME SIZE			

Figure 13 - 16" to 24" Shaft Diameter Dimensions

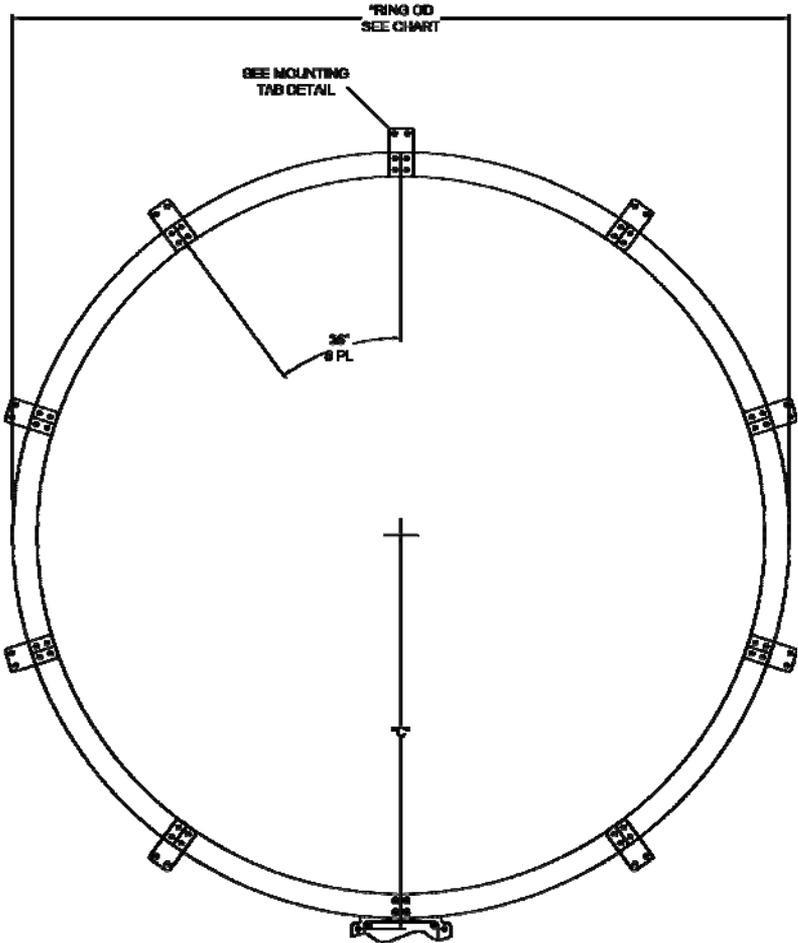
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SHAFT SIZES 24.00-40.00 (610-1016)			
SHAFT OD MIN	SHAFT OD MAX	*RING OD	"C"
24.00 (610)	28.00 (711)	31.50 (800)	18.40 (417)
28.00 (711)	32.00 (813)	35.50 (902)	18.40 (467)
32.00 (813)	36.00 (914)	39.50 (1003)	20.40 (518)
36.0 (914)	40.00 (1016)	43.50 (1105)	22.40 (568)
*RING AND ROTOR OD ARE NOMINALLY SAME SIZE			

Figure 14 - 24" to 40" Shaft Diameter Dimensions

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SHAFT SIZES 40.00-48.00 (1016-1219)			
SHAFT OD MIN	SHAFT OD MAX	*RING OD	*C"
40.00 (1016)	44.00 (1118)	47.50 (1207)	24.40 (620)
44.00 (1118)	48.00 (1219)	51.50 (1308)	26.40 (671)
*RING AND ROTOR OD ARE NOMINALLY SAME SIZE			

Figure 15 - 40" to 48" Shaft Diameter Dimensions

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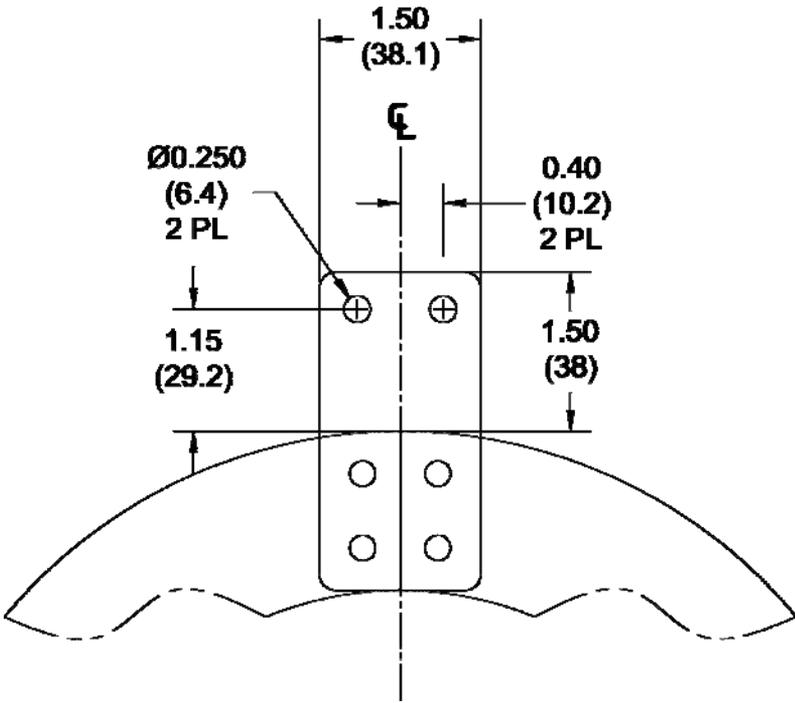


Figure 16 - Stationary Ring Mounting Tab Dimensions

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Appendix F: Maximum Shaft Speeds

Table 9: Rotating Collar OD and max recommended RPM

Collar Outside Diameter		¹ Maximum safe RPM
(inches)	(mm)	
5	127	9100
5.5	139	8500
7.5	190	6900
9.5	241	5900
11.5	292	4300
13.5	342	3800
15.5	393	3400
17.5	444	3100
19.5	495	2800
21.5	546	2300
23.5	596	2200
25.5	647	2100
27.5	698	1900
31.5	800	1500
35.5	901	1400
39.5	1003	1300
43.5	1104	1200
47.5	1206	1000
51.5	1308	1000

¹Valid only if rotating collar is properly installed with mounting bolts tightened to specified torque values.

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Binsfeld Engineering Inc. warrants that its products will be free from defective material and workmanship for a period of one year from the date of delivery to the original purchaser and that its products will conform to specifications and standards published by Binsfeld Engineering Inc. Upon evaluation by Binsfeld Engineering Inc., any product found to be defective will be replaced or repaired at the sole discretion of Binsfeld Engineering Inc. Our warranty is limited to the foregoing, and does not apply to fuses, paint, or any equipment, which in Binsfeld Engineering's sole opinion has been subject to misuse, alteration, or abnormal conditions of operation or handling.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose or use. Binsfeld Engineering Inc. will not be liable for any special, indirect, incidental or consequential damages or loss, whether in contract, tort, or otherwise.

NOTE (USA only): Some states do not allow limitation of implied warranties, or the exclusion of incidental or consequential damages so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may have other rights which vary from state to state.

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