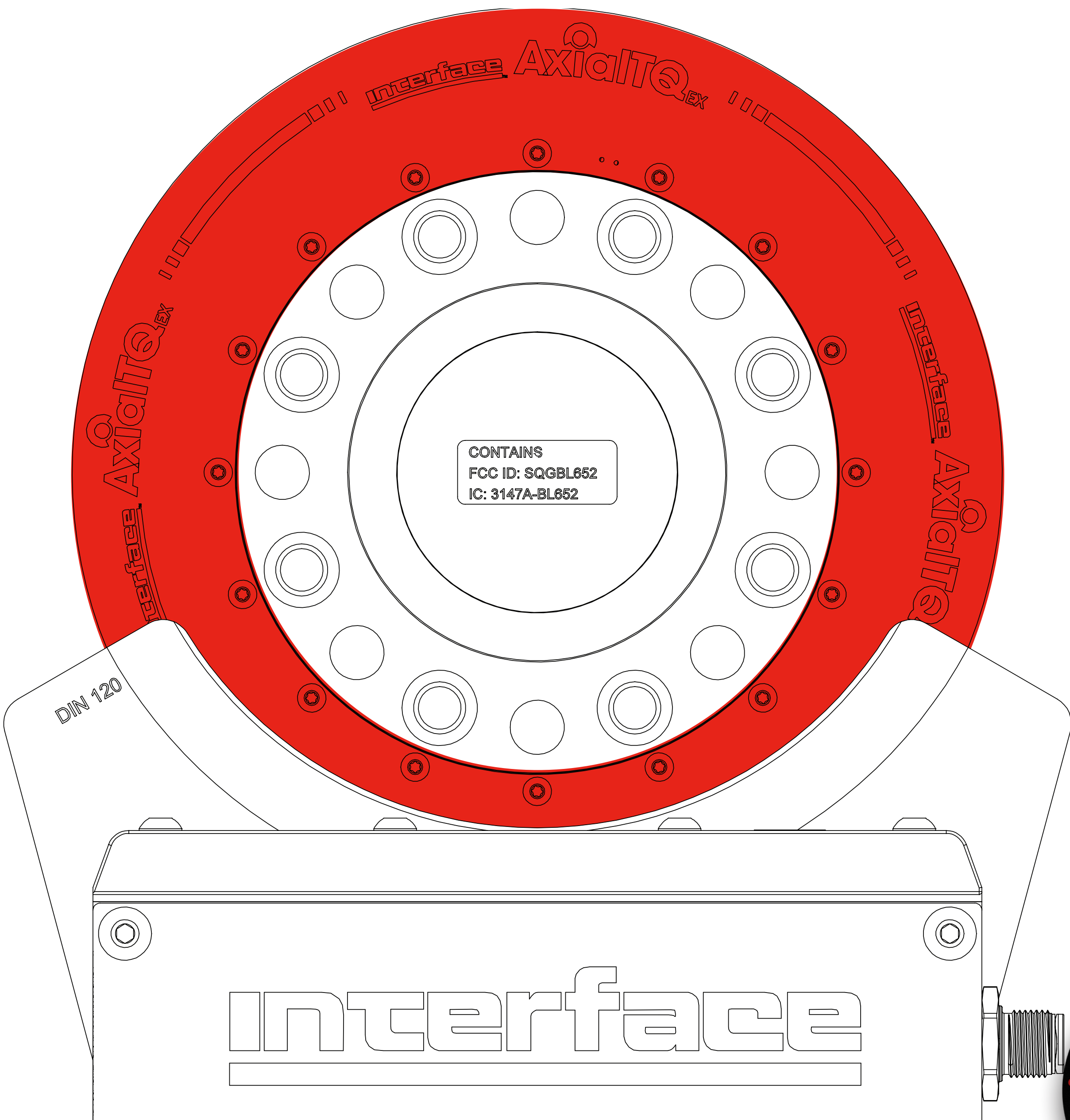
AxialTQ

User Manual

The Next Generation of **TORQUE MEASUREMENT DEVICES™**



AXIALTQ User Manual 15-324 v2.7 12-03-2019

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1. Introduction

1.1 The Interface AxialTQ torque sensing system is an innovative and user-friendly instrument for use in applications where the measurement data needs to be transferred from the rotating sensor using telemetry techniques.
The system is designed to be flexible so that the maximum range of applications can be covered by the same architecture. The system has a minimum set of rules that need to be followed by the installer, therefore making the product very easy to use.

2. What is the AxialTQ?

2.1 The system hardware consists of the Rotor, Stator and Output Module (OM). The Rotor senses the torque with a high precision sensing element and strain gages and the electrical output is converted from an analog to a digital signal in the rotor. The high accuracy of the system is based on this combination of the proven sensing element technology with next generation electronics to provide the highest quality torque measurement available in the industry.

2.2 The combination of the power transfer and communication technology allow contact free operation of the rotor to minimize uncertainty. Power is transferred from the stator coil to the rotor coil with a 3 mm axial separation gap that allows for +/- 2 mm of end play and 12 mm radial clearance to minimize the probability of contact and damage. The rotor and stator communicate through a 2.4 GHz link for rotor configuration, software updates and high speed transmission of the digital torque values. The rotor and stator are not a matched pair and any stator can be used with any rotor of same DIN size.

2.3 Converting the digital signal to analog and then back to digital for data collection will of course lose some of the inherent accuracy however, when the analog signal is needed for system control, the OM has the capability of simultaneously outputting digital and analog data with no loss of performance.

3. System Architecture

3.1 The AxialTQ torque flange measures static and dynamic torques on stationary and rotating shafts. Test beds can be extremely compact because of the compact design of the transducer. This offers a very wide range of applications. See *Figure 1*.

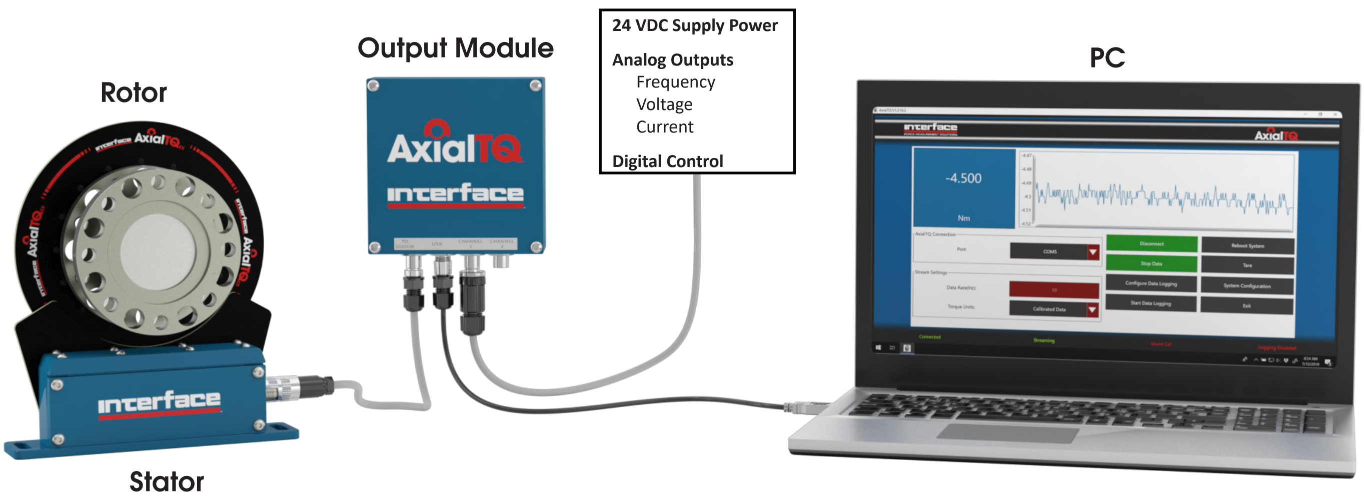

Figure 1

3.2 ROTOR MODULE – comprising a torque sensing element, complete with internally bonded strain gage bridge and shunt resistor. The rotor also houses the electronics that process the signal from the strain gage bridge, and the radio transceiver. A separate rotor feature harvests the power from the induction link, conditions it, and then supplies power to the rotor electronics. The standard configuration is a DIN flanged style sensor with threaded mounting holes on one flange and thru-holes on the other.

3.3 STATOR MODULE – this comprises the fixed part of the induction loop power supply, and also houses the second radio transceiver. Only one stator module is used per rotor and the stator does not need to be matched with a rotor from the factory. Any stator will work with any rotor as long as the coils match in DIN size.

3.4 OUTPUT MODULE (OM) – The digital data from the stator can be transferred directly to a PC or be translated into various formats using the OM. The highest accuracy data will be attained using the digital data directly or digital outputs of the OM (RS422 to USB). The OM also has these analog data formats available:

- 10 kHz +/- 5 kHz
- 60 kHz +/- 20 kHz
- 60 kHz +/- 30 kHz
- 12mA+/-8mA
- ± 5 VDC
- ± 10 VDC

4. Safety Instructions

4.1 Markings

	WARNING This icon accompanies text dealing with hazards to personnel. When present, it indicates that a potential hazard to your personal safety exists if information stated within the “WARNING” paragraph is not adhered to or procedures are executed incorrectly.
	CAUTION This icon accompanies text dealing with potential damage to equipment. When present, it indicates that there is a potential danger of equipment damage, software program failure or that a loss of data may occur if information stated within the “CAUTION” paragraph is not adhered to or procedures are executed incorrectly.
	NOTE This identifier accompanies text dealing with potential situations which might cause inaccurate data to be gathered.

4.2 Appropriate use

4.2.1 The AxialTQ torque flange is used exclusively for torque measurement.

4.3 Capacity Limits

4.3.1 Caution – The AxialTQ is designed to be used for high accuracy applications such as lab testing and End of Line (EOL) testing, however, it can be used as a machine element. When used in this manner, it must be noted that, to favor greater sensitivity, the transducer is not designed with the safety factors usual in mechanical engineering design and the difference must be accounted for in the design. Please refer to the specifications.

4.3.2 Warning – By the inherent design for high accuracy, the torque flanges must be used within limit of operation as defined in Table 6.1. When the limits are exceeded, failure may result in bodily harm or death. Therefore it is required that the torque flange components be shielded in case of flying debris and the flanges be contained in case of sensing element failure.

4.3.3 Caution – The AxialTQ output cannot be used as part of any safety control and system safety backup functions must be used in any application where the AxialTQ output is used for feedback control.

4.3.4 Caution – The AxialTQ may only be installed, operated or repaired by trained personnel within the limits of the specifications and documentation.

4.3.5 Caution – All installation and operating instructions must be read and understood before installation or use of the AxialTQ.

4.3.6 Caution – The AxialTQ may not be modified in any way from its original design and may only be used as originally intended per the specifications and documentation. Any such changes will void any and all warranties.

5. System Startup

5.1 The AxialTQ system is a standalone system that will start up running all of the internal firmware and provide the default or configured analog outputs. The digital I/O are pre-configured and are also operational on startup. If any system component is changed, the system will re-synchronize on power up with the new system components.

6. Abbreviations

AxialTQ	AxialTQ
DAQ	Data Acquisition
EXC	Excitation
SIG	Signal
PWR	Power
COM	Signal Common

7. Specifications

7.1 Rotor Mechanical

Model (NM)	100	250	500	1K	2K	3K	5K	10K
DIN Size	100	100	120	120	150	150	180	225
Material	Aluminum	Aluminum	Steel	Steel	Steel	Steel	Steel	Steel
Length (mm)	54.8	54.8	62	62	62	62	63.5	64
Maximum Weight (kg)	1.8	1.8	2.8	2.8	4.1	4.1	6.4	11.8
Torsion Angle at Mnom (Deg)	0.052	0.065	0.065	0.079	0.080	0.074	0.056	0.049
Torsional Stiffness (kNm/Rad)	109	222	440	727	1436	2331	5091	11620
Rotating Inertia (Kg-m2)	9.5E-04	1.0E-03	5.0E-03	5.0E-03	1.2E-02	1.2E-02	2.7E-02	7.8E-02
Overload[3] Limit (NM)	200	500	1000	2000	4000	6000	10000	20000
Nominal Speed Limit (RPM)	15,000	15,000	15,000	15,000	12,000	12,000	10,000	8,000
Maximum[1] Speed Limit (RPM)	24,000	24,000	24,000	24,000	16,000	16,000	14,000	12,000
Bending[2] Limit (NM)	50	125	200	250	500	600	800	1200
Axial[2] Limit (KN)	5	10	15	20	30	35	60	80
Bending Stiffness (KNM/Deg)	1.6	3.0	5.5	8.4	11.0	19.4	23.6	96.3
Fastening screws	M8	M8	M10	M10	M12	M12	M14	M16
Fastening screws Property Class	10.9	10.9	10.9	10.9	10.9	12.9	12.9	12.9
Fastening torque (Nm)	34	34	67	67	115	135	220	340

1. ***With system balance quality of better than grade G 2.5 and flange adaptors of equal thickness (min) to AxialTQ flange thickness.***
2. ***Each load limit is specified individually, if combined loading occurs only 50%of these limits may be applied.***
3. ***Static load.***

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7.1 Rotor Performance

Rotor Electronic Specifications		
Measurement	Full bridge strain gage	
Excitation	4.096 V	VDC
Bridge resistance	1400	Ohms
Sensitivity (nominal)for full scale	+/- 1.1	mV/V
A/D sampling rate	40,000	Samples/ sec
Output data rate	4800	Samples/ sec
Digital linearization	Configurable	
Calibration facilities	Factory calibrated in mV/V to an accuracy of 0.1%	
Shunt cal resistor	357K	Ohm
Radio frequency	2.4000 to 2.4835	GHz

Rotor Accuracy / Data Rate / Material / Speed	
Model	**EX**
Accuracy Class	**0.05**
Temp Effect on Zero - %RO/10°C	**± 0.05**
Temp Effect on Output - %RO/10°C	**±0.05**
Data Rate (max) samples/sec	**4800**
Accuracy Class Output	**Analog or Digital**

7.2 System Environmental Specifications

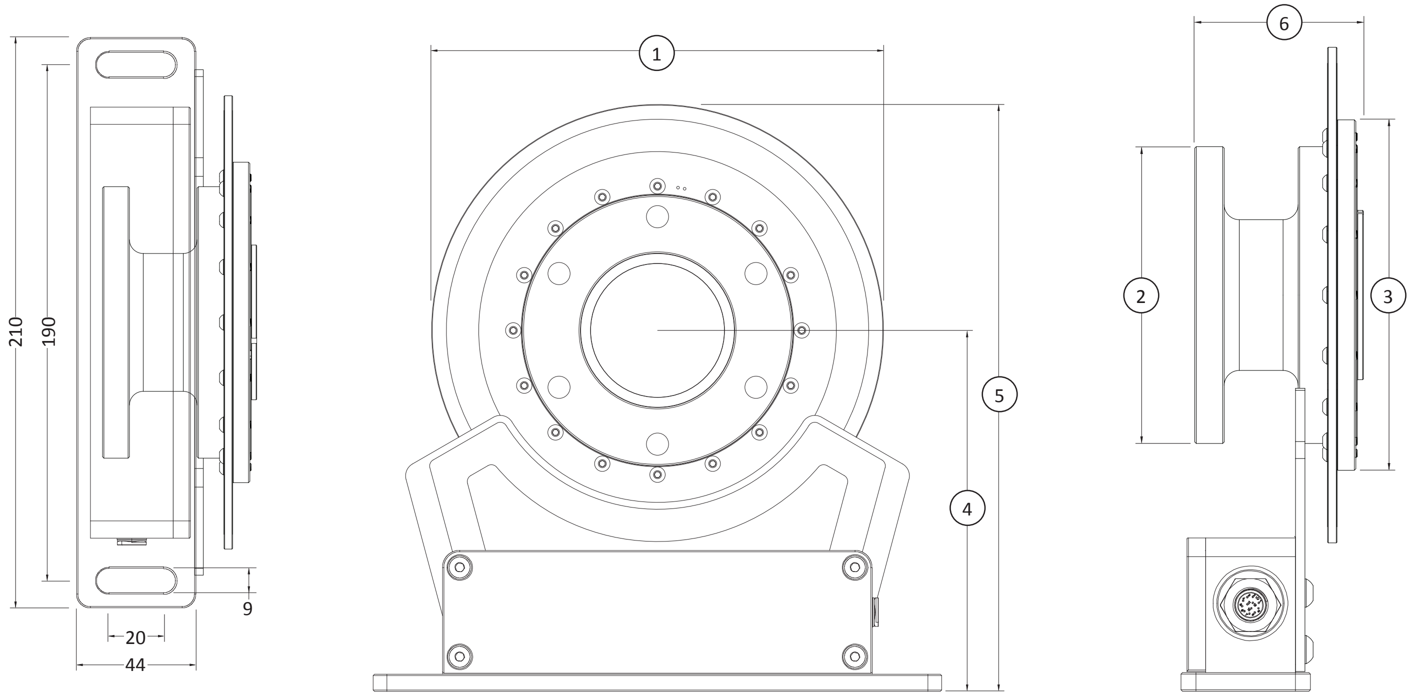
Compensated Operating Range	+10 to +70°C
Maximum Operating Range	-20 to +70°C
Storage Range	-40 to +85°C
IP Rating	IP65

7.3 System Electronic Specifications

Power Supply	24 ±6 VDC
Stator Power Consumption	<= 10 W
Output Module plus Stator Power Consumption	<= 15 W

7.4 Dimensions

7.6.8 Rotor and Stator Dimensions



Din Size	100	100	120	120	150	150	180	225
Torque Capacity	100 Nm	250 Nm	500 Nm	1K Nm	2K Nm	3K Nm	5K Nm	10K Nm
(1)	167 mm	167 mm	185 mm	185 mm	220 mm	220 mm	244 mm	287 mm
(2)	Ø100 mm	Ø100 mm	Ø120 mm	Ø120 mm	Ø150 mm	Ø150 mm	Ø180 mm	Ø225 mm
(3)	Ø117 mm	Ø117 mm	Ø140 mm	Ø140 mm	Ø170 mm	Ø170 mm	Ø200 mm	Ø245 mm
(4)	133 mm	133 mm	144 mm	144 mm	161 mm	161 mm	175.5 mm	199 mm
(5)	217 mm	217 mm	236 mm	236 mm	271 mm	271 mm	298 mm	343 mm
(6)	54.8 mm	54.8 mm	62 mm	62 mm	62 mm	62 mm	62 mm	75.7 mm

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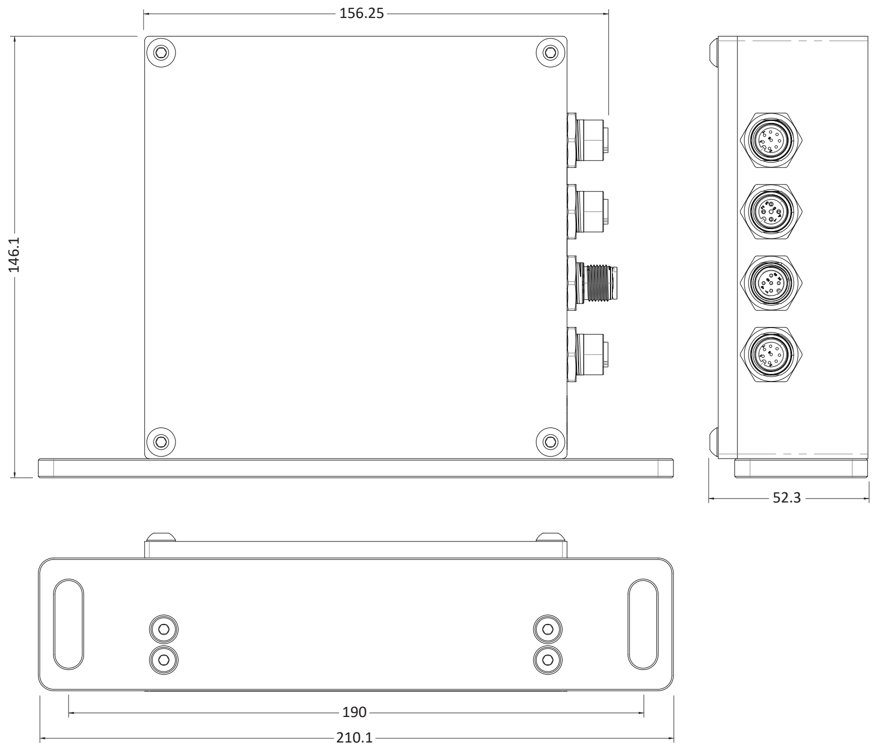
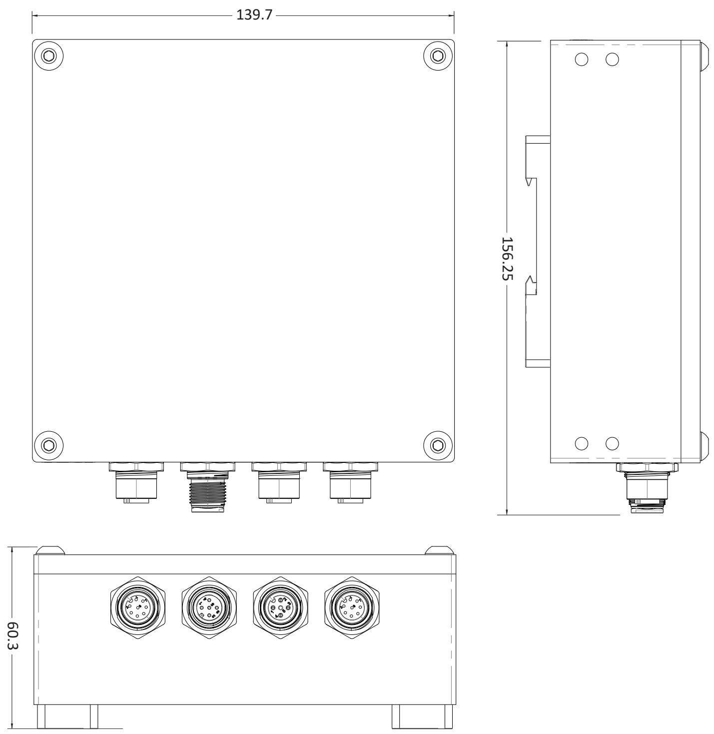
7.6.9 Mounting Plate Option Output Module Dimensions



7.6.10 DIM Rail Mounting Output Module Dimensions



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8. Rotor Installation

8.1 Fastening Screws.

⚠ Caution – Use a screw locking glue to hold the connecting screws into place. Guard against contamination from varnish fragments.

8.2 Refer to the Fastener Specifications for the correct screw and torque specifications.

8.3 Tighten all screws in incremental steps in the order shown in *Figure 2*.

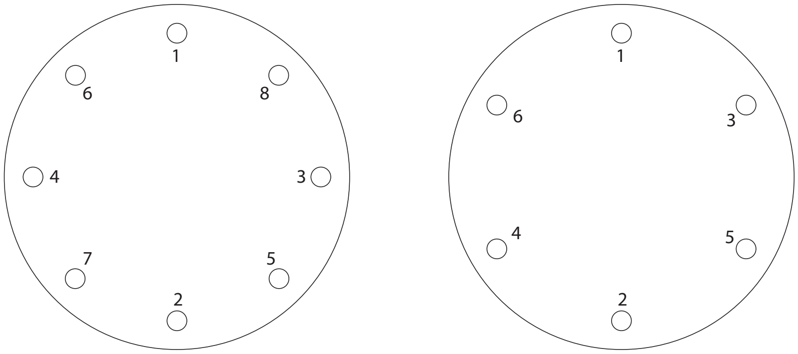

Figure 2

Step 1 – Hand tighten all of the screws.
Step 2 – Tighten the screws in order shown to 50% of the specified torque value.
Step 3 – Tighten the screws in the order shown to the specified torque value.
Step 4 – Turn the rotor several times and retighten the screws in the order shown to the specified torque value.

8.4 The torque sensor can be mounted in any position, provided the face of the stator coil is in the relative position shown with the rotor coil.

9. Shaft Misalignment

9.1 The preferred installation is with single-flex style couplings on either side of the rotor. Alternatively one side of the rotor can be hard-mounted with a double-flex style coupling on the other side. Care should be taken to minimize misalignment thereby reducing bending loads into the sensor.

10. Stator Module

10.1 Once the Rotor has been installed properly, position the stator using the alignment tool. See *Figure 3*.

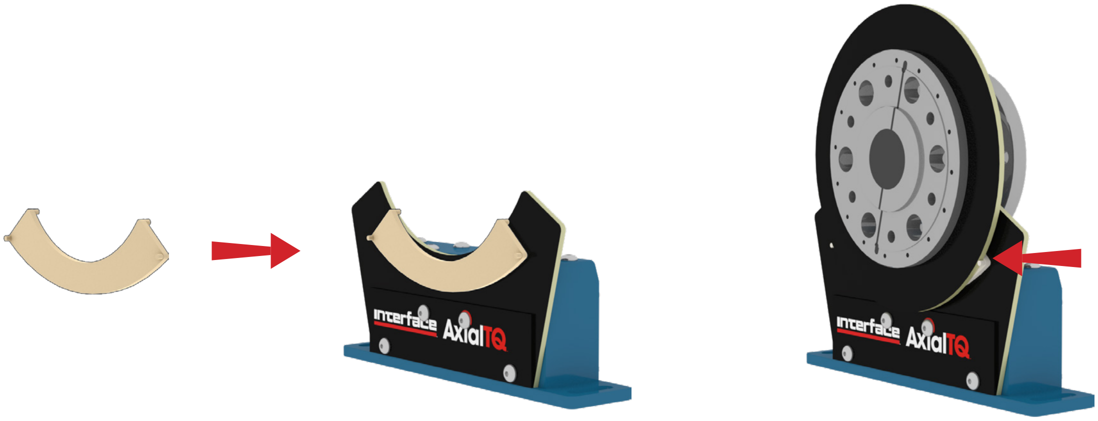

Figure 3

10.2 ⚠ Caution – Remove the Alignment Tool after installation to avoid AxialTQ equipment damage.

10.3 For best power coupling with the rotor unit, the stator coil should be parallel with the rotor coil and positioned using the Alignment Tool. In no case may the stator coil come in contact with the rotor coil during operation.

10.4 Using the Alignment Tool, the centerline of the stator coil must be aligned with the center of the rotor and the distance from the bottom of the stator baseplate must match the spec sheet.

11. Output Module (OM)

11.1 Output Module mounting

11.1.1 The OM may be mounted using the mounting foot provided or with the DIN clips also provided. The mounting foot will go on either side of the OM and the DIN clips can be in any orientation.

11.2 OM Analog Outputs

11.2.1 The output module has a total of three analog outputs: one Digital to Analog Converter (DAC) Output and two Frequency Outputs. Each analog output is Galvanically isolated from each other and from the rest of the OM circuitry.

11.2.2 Each analog output is individually configured for low pass filtered bandwidth:

- Bandwidth selection is from 1 Hz to 2000 Hz (1 Hz resolution).
- The analog output is updated at least 2.5 times faster than the selected bandwidth in order to prevent aliasing of the signal (to satisfy Nyquist criteria).
- The analog output bandwidth should be set to about 40% of the user's input sampling rate (users input sample rate should be 2.5 times as fast as the outputs bandwidth).

11.2.3 Filter selection examples:

- If a customer is sampling an input at a 4800 Hz rate then the bandwidth should be set to 2000 Hz. maximum. This will result in a 2000 Hz bandwidth limited signal that is updated at a 4800 Hz rate. This is the fastest updated output rate the OM is capable of.
- For steady state analysis, a signal bandwidth of 20 Hz is recommended. This will give excellent power line noise rejection.
- For calibration systems, a signal bandwidth of 1 Hz will give the most stable output possible.

11.3 DAC Output Details:

11.3.1 The DAC output is a digital to analog converter with the following characteristics:

- 16 bit resolution
- Able to drive a 1200 Ω resistive load or a 50 mH inductive load
- 10% over range capability

11.3.2 A fault condition is indicated as follows:

- Voltage output mode: max positive voltage (5.5V or 11V).
- Current Loop mode: 0 mA

11.3.3 The DAC output can be configured for any of the following output modes:

- ± 10 VDC
- ± 5 VDC
- 12 ± 8 mA

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11.4 DAC Output Wiring:

11.4.1 DAC_OUT: active output signal

11.4.2 DAC_COM: Isolated DAC ground

11.5 Frequency Outputs Details:

11.5.1 Frequency outputs have the following characteristics:

- Digital square wave (Differential)
- 0.05 Hz resolution
- Isolated RS-422 buffer IC
- 10% over range capability

11.5.2 A fault condition is indicated by the frequency output = 0 Hz (not toggling).

11.5.3 Frequency outputs can be configured for any of the following output modes:

- 10 kHz ± 5 kHz
- 60 kHz ± 20 kHz
- 60 kHz ± 30 kHz

11.5.4 Frequency Output Wiring: Each frequency output has two output signals and an isolated common (COM):

- Freq_1_B: This is the positive output (sometimes referred to as COM+ or COM_B)
- Freq_1_A: This is the inverted output (sometimes referred to as COM- or COM A)

11.5.5 The user's RS-422 input receiver should have a 120 ohm termination resistor connecting Freq_n_B and Freq_n_A together at their end of the cable. The frequency output can daisy chain to several receivers. The 120 ohm termination resistor should be located at the extreme end of the cable from the Output Module.

11.6 Default Analog Configuration

11.6.1 The DAC and frequency outputs are pre-configured per Table 3.

DAC Output:	• +/- 10 VDC – Default configuration • +/- 5 VDC • 12 mA +/- 8 mA
Frequency Outputs:	• 10 kHz +/_ 5 kHz – Default = Frequency Channel 1 • 60 kHz +/_ 20 kHz • 60 kHz +/_ 30 kHz – Default = Frequency Channel 2
DAC or Frequency Output Filters:	• 2 kHz • 1 kHz – Frequency Default Configuration • 500 Hz • 200 Hz • 100 Hz – Analog Default Configuration • 50 Hz • 20 Hz • 10 Hz
DAC or Frequency Output Scaling:	Any percentage from 20% to 100% of full scale output. Default = 100%

11.6.2 The Analog outputs may be reconfigured using the AxialTQ Assistant.

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11.7 OM Discrete Input/Output (DIO) Configuration

11.7.1 The OM has (4) DIO that can be used as inputs to control operation of the AxialTQ (Shunt Cal, tare, etc.) and as outputs to indicate measurement status or fault conditions to the customer. The Digital I/O are pre-configured per Table 4.

Digital I/O	Input vs. Output	Function
D0	Input	Shunt Calibration – Low = shunt cal off, Hi = shunt cal on.
D1	Output	Invalid Data – Lo = either no rotor data or invalid EEPROM data.
D3	Input	Tare – momentary input contact Hi to set the output to zero based on the current torque value.
D4	Output	Over Limit – Hi = current torque exceeds 105% of nominal capacity.

11.8 DIO signal characteristics:

11.8.1 The DIO signals are to be used with 24VDC signal levels.

11.8.2 The DIO are hardened to resist damage from overvoltage and customer miss-wiring.

11.8.3 The DIO are on a Galvanically isolated power and ground domain. DIO are not isolated from each other, but are isolated from every other part of the OM circuitry.

11.9 DIO Low True Input Mode:

11.9.1 The DIO input mode is a low true input. The customer connects the DIO signal to DIO_COM in order to turn on the input. This can be done with a mechanical switch, a relay contact closure, or a PLC 24VDC output. An external power supply is not required to use DIO inputs. Here is an example of a DIO being used as a low true input. See *Figure 4*.

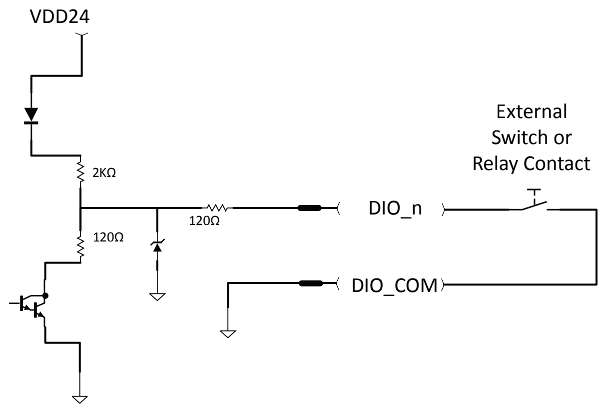

Figure 4

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11.10 DIO External Power Output Mode:

11.10.1 A DIO output is designed for low true operation. It is able to sink current (50 mA) to directly drive small 12V relay coils or lamps. Here is an example of a DIO being used to drive low true outputs. This mode requires an external power supply as shown in the drawing below. See *Figure 5*.

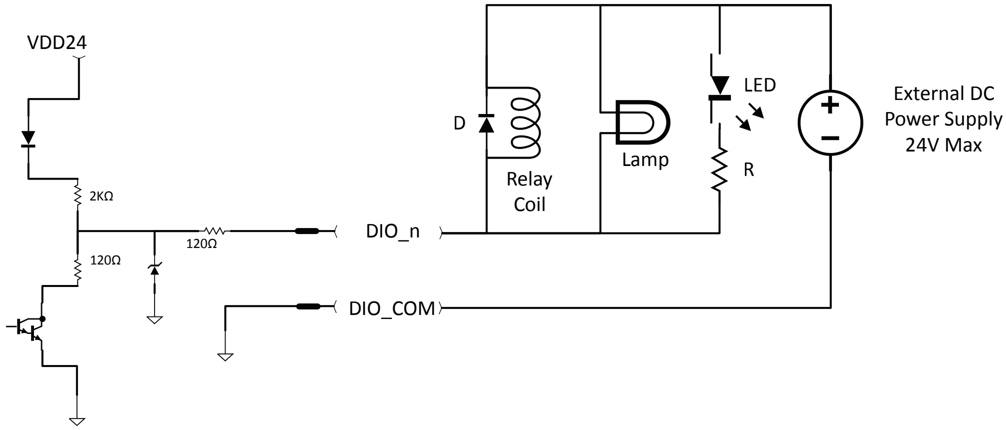

Figure 5

11.10.2 A low true DIO output is intended to drive 12V load with a 240Ω or higher impedance. Max Sink current is ~ 50mA. The output is internally current limited to survive direct connection to a 24V power supply in the output mode, but this would be a miss wiring condition.

11.10.3 Example loads include a 12V Relay coil, a 12V lamp indicator, or an LED.

Notes:

- Relay coil must have a reverse biased diode D connected across the coil windings as shown.
- Lamp must be rated for 12V. A lower voltage lamp can be used if an external current limit resistor is added.
- An LED will require an external limiting resistor R as shown. A typical value for this resistor is in the range of 1KΩ to 2KΩ.
- The exampled diagram shows all 3 possible outputs connected. This is for example only, use only a single load device at a time.

11.11 DIO Internal Power Output Mode

11.11.1 DIO outputs are compatible with IEC 61131-2 PLC high true PLC discrete inputs. Each DIO is pulled up to an internal 24V power supply by means of a 2.12K resistor which means the DIO is capable for delivering a high level output of 15V @ 3.3 mA (IEC 61131-2 compliant). No external power supply is required in this mode. Here is an example of a DIO being used as a PLC High True output. See *Figure 6*.

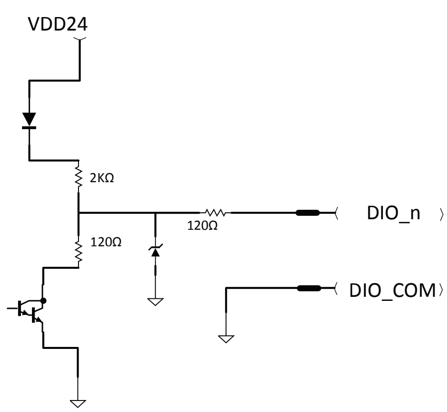

Figure 6

12. AxialTQ Wiring

The typical wiring for AxialTQ is shown in Figure 1. Once the system has been configured, the connection to the PC using cable CT-667 may be removed and the system will use the same configuration every time it is powered up. Power is supplied to the system through cable CT-669 as well as the analog outputs and discrete I/O. The data from the rotor/stator is sent to the OM through Cable CT-666 which is also used to communicate with the rotor and stator. Figure 2 shows the pinout and wiring connections for each of the cables.

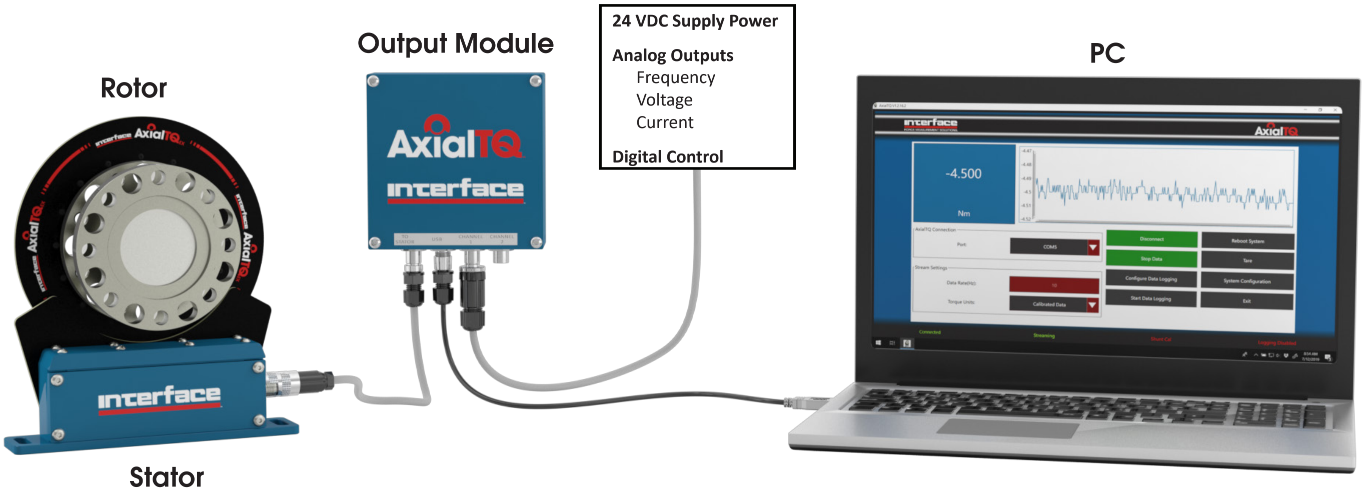

Figure 1

	OM Channel 1	OM Channel 2	
Cable P/N	CT-669-XX	CT-669-XX	
Pin	**Cable Pair/Function**	**Cable Pair/Function**	**CT-669-XX Cable Wire Color (Channel 1&2) Base/Stripe**
1	1/Freq1_B	1/Freq2_B	BLU/WHT
2	1/Freq1_A	1/Freq2_A	WHT/BLU
3	2/Freq1_COM	2/Freq2_COM	ORG/WHT
4	2/N/C	2/N/C	WHT/ORG
5	3/DIO_0	3/DIO_3	GRN/WHT
6	3/DIO_1	3/DIO_4	WHT/GRN
7	4/DIO_2	4/DIO_5	BRN/WHT
8	4/DIO_COM	4/DIO_COM	WHT/BRN
9	4/DAC_OUT	5/N/C	GRY/WHT
10	5/DAC_COM	5/N/C	WHT/GRY
11	6/24VDC_PWR	6/N/C	BLU/RED
12	6/24VDC_GND	6/N/C	RED/BLU
	(Note 1)	(Note 3)	

	Stator/OM	OM/USB
Cable P/N	CT-666-XX	CT-667-XX
Pin	**Cable Pair/Function**	**Cable Pair/Function**
1	1/TX-B	1/TX-B
2	1/TX-A	1/TX-A
3	2ww/RX-B	2/RX-B
4	2/RX-A	2/RX-A
5	3/N/C	3/N/C
6	3/N/C	3/N/C
7	4/24VDC_PWR	4/N/C
8	4/24VDC_GND	4/GND
		(Note 2)

Figure 2

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Notes:
1). Twisted pairing designated by prefix number for all external cables.
2). Shown for the OM side. Cable side only uses pins 1-4, plus ground, to USB converter.
3). All N/C connections mean that there is no connection of the connector in the Stator or OM however, the wires in the external cables are connected on each end as designated.

12.1 Maximum cable lengths.

12.1.1 Analog voltage output - 3 meters

12.1.2 Current output - 30 meters

12.1.3 Frequency output - 100 meters (With proper shield grounding)

12.1.4 Stator to OM - 30 meters

12.1.5 OM to PC - 30 meters

12.2 Interface also has available accessory components to make the OM wiring easier. The components are mounted on a DIN rail along with the OM. Figure 3 shows the OM mounted on a DIN rail with the 24 VDC power supply (25551) and terminal block (AxialTQ10TB). CT-669-0.3M makes the connection from the OM to the terminal block and the 110 VAC power cable (22072) provides power to the 24 VDC power supply.

The terminal block (AxialTQ10TB) is marked as shown in Figure 4 for Channel 1 however it also works with Channel 2. Pin 4 is shown as 5V which may not be connected on some OM models. These terminals correspond to the pinouts as shown in Figure 2. An additional marker strip for D3, D4, D5, DC is included for Channel 2 Discrete I/O.

Figure 3

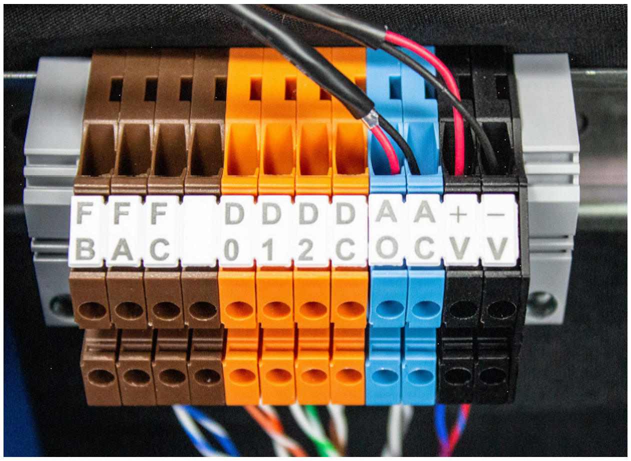

Figure 4

13. Cable Connections

13.1 Attach the cables to the output module. See *Figure 7*.

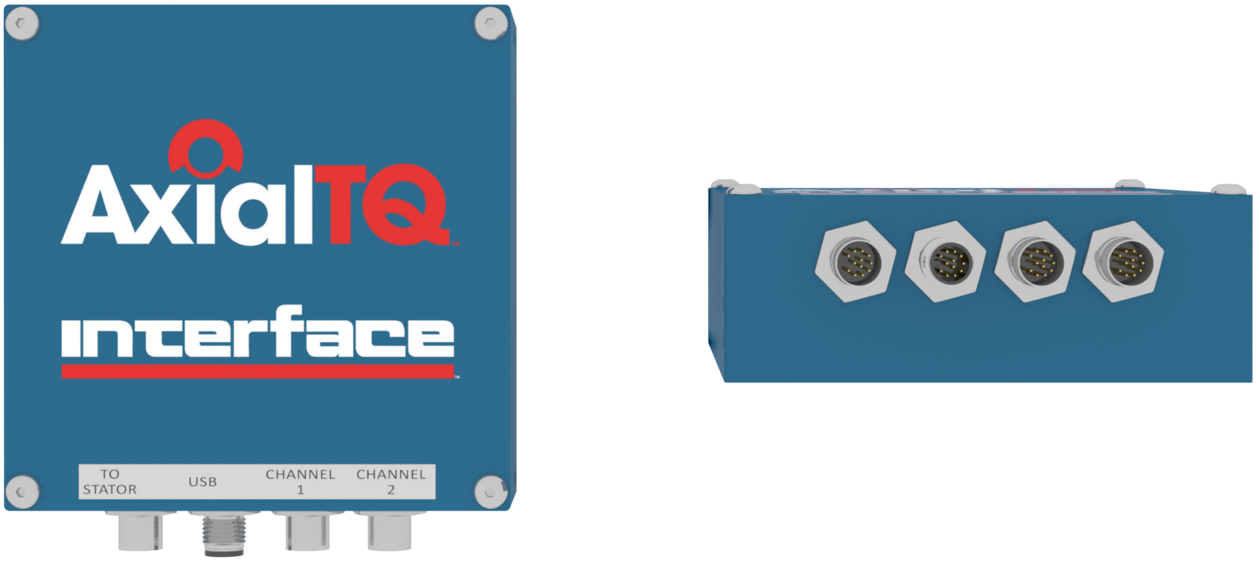

Figure 7

13.2 Attach the stator cable from the output module to the stator. See *Figure 8*.

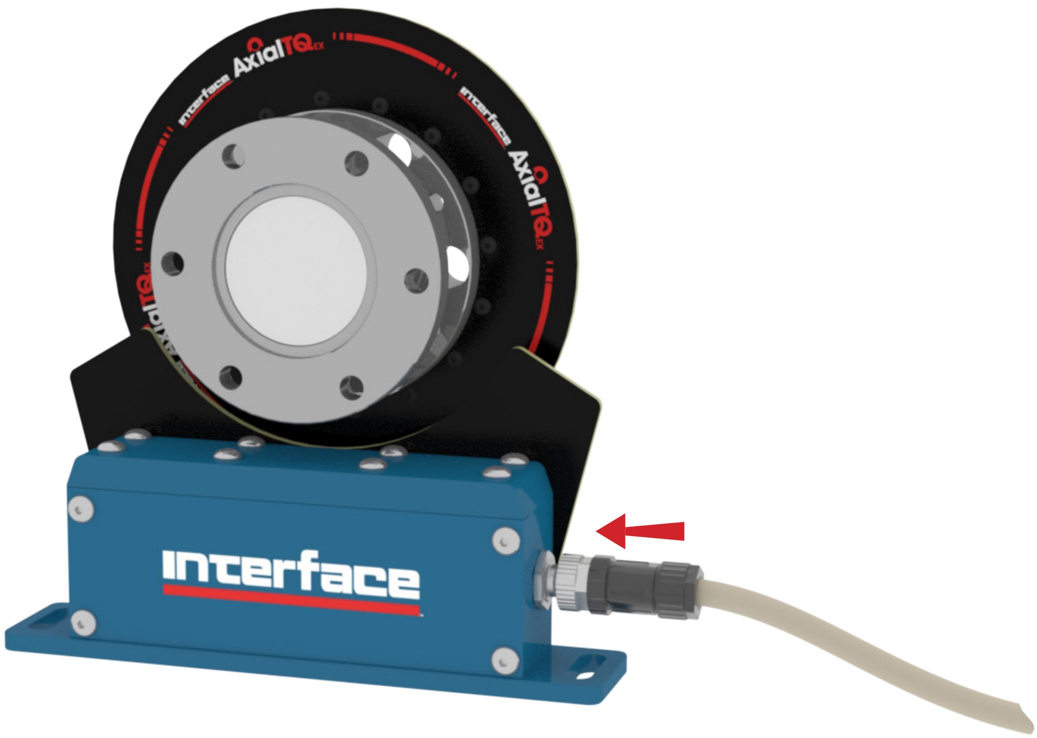

Figure 8

14. AxialTQ Assistant

The AxialTQ Assistant is provided to manage the system and collect data. The AxialTQ Assistant has included with it all of the firmware that has been qualified as a package to ensure compatibility. AxialTQ Assistant has been qualified for use on Windows 7 and Windows 10.

The AxialTQ Assistant is used to:

- Connect the PC to the AxialTQ system
- Monitor the rotor data
- Check the shunt calibration and set the Zero
- Change the configuration of the Output Module analog or digital outputs
- Change the firmware in the rotor, stator or OM
- Collect the digital data from the rotor
- Capture system information and troubleshooting data

14.1 AxialTQ Assistant – Getting Started

14.1.1 AxialTQ Assistant Software Installation

AxialTQ Assistant software is shipped with the AxialTQ rotor on a thumb drive. It is also available on the web site www.axialtq.com. The AxialTQ software is released as a single package for the PC software as well as all of the firmware for the OM, stator and rotor. The software release package will have the designation "AxialTQ Vww.xx.yy.zz" as the directory name. It is recommended that this entire directory be saved from the thumb drive or the FTP download to a location, such as the "Documents" directory, where it will be easy to find for future use.

It may also be useful to create another directory in the "Documents" directory at this time called "AxialTQ Files". This will be used for storing digital data files, configuration files or snapshot files of the current system information and configuration. The snapshot files are used for troubleshooting if needed. The first time a file is to be saved in the "AxialTQ Files" directory, the user will need to find it but the software should default to it after that.

Everything needed to manage the software revision is included in the "AxialTQ Vww.xx.yy.zz" directory. Selecting the directory will bring up the setup file as well as the Firmware and Documentation directories. Double clicking on the setup file will automatically start loading AxialTQ Assistant. There will be an error if a version of AxialTQ Assistant is already loaded. More than one version of AxialTQ Assistant may be stored however, only one version may be loaded at a time. The existing software version must be uninstalled before another version can be loaded.

14.1.2 System Connection

Before starting AxialTQ Assistant, the AxialTQ system must be powered and the USB connection made to the PC. AxialTQ Assistant will then start on the home page and should identify which COM ports it is ready to communicate through. "Connect" to the system and "Connected" will show up on the lower left of the screen. If the first COM port doesn't work, try another one. When AxialTQ Assistant is connected to the system, the lights on the USB adapter will flash green.

The Interface AxialTQ product family has been designed for component interchangeability. This means that any AxialTQ Output Module is interchangeable with any AxialTQ Rotor or AxialTQ Stator Module. The AxialTQ Rotor and Stator Modules are interchangeable with any other Rotor or Stator Module of the same DIN size.

The user should then select the Data Rate (Hz), for streaming the data, and the Torque Units. See the section on Data Management for more information on data filtering and Torque Units. “Start Data” will then collect data from the AxialTQ system.

14.1.3 Channel Selection

AxialTQ uses the same 2.4 gHz bandwidth used for WIFI however, there are 80 channels it can use for communication between the rotor and stator. The system starts communication using channel 77 and then will change automatically to channel 50. The channel can be changed to any other channel between 2 and 80 and the system will always revert to that channel on power up. AxialTQ systems that are in close proximity should always be set to different channels. To change the channel, use the Radio Configuration page to select and save a different channel between 2 and 80. Recommended channels to try are 2, 25, 73 and 80. If changing channels, do not use channels 77 or 50. The user will need to be logged in to change the channel.

14.1.4 Shunt Cal Function

While the system data collection is turned on, a good test of the system is to read the Shunt Cal from the rotor. This can be done by simply shorting discrete DIO 0 to DIO COM and compare the reading with the information on the calibration certificate.

14.1.5 Zero Function

The compensated data output may be set to Zero by shorting discrete DIO_3 to DIO_COM. This will offset all data values by the amount of the offset. The Zero value will remain effective until the OM is set to Zero again, the OM is Reset or the power is recycled.

Notes

1. Always Stop Data before resetting the system.
2. Always wait 5 seconds from the last action before setting the Zero.
3. The Zero function does not apply to the counts read from the rotor, only the compensated data.

14.2 User Login Page allows the user to login as a Supervisor to be able to change the system configuration and upload new software. The default login is “Supervisor” and “Password”.

14.3 User Setting Page allows the user to manage login name and password.

14.4 Output Module - From the Configuration page the user can view or change the Analog outputs. Please review the description of Analog output in the Data Management section. The user must be logged in to be able to change the configuration. The Discrete I/O have a fixed configuration as defined in the Output Module section.

14.5 Data Logging Configuration Page allows the user to configure various methods of data logging to a csv or xl file.

14.6 Firmware Changes

When connected to the system and logged in as a Supervisor, selecting the Firmware target on the Configuration page will show the user if the firmware on each device is compatible with the PC software by selecting “Read Version” for each device. If the firmware version indicator is red, the firmware on the device has not been qualified with the PC software.

The firmware can be changed by selecting “Change Version” for each device. Go to the “AxialTQ Vww.xx.yy.zz” > ”Firmware” directory to find the firmware for the device. The rotor and stator each have a single firmware file however, the OM directory may have multiple firmware files. Select all of the OM files for the firmware change. Once the firmware is changed, the firmware version indicator will turn to green and there is no need to change it again for use with that version of AxialTQ Assistant.

15. AxialTQ Data Management

The Interface AxialTQ system has been designed for maximum flexibility and ease of use without losing any accuracy or dependability. There are several aspects of the design that have been optimized to provide the user with the data and accuracy they are looking for. This section goes into the details of each of these aspects so the user can understand how the data is generated.

The Interface AxialTQ product family has been designed for component interchangeability. This means that any AxialTQ Output Module is interchangeable with any AxialTQ Rotor or AxialTQ Stator Module. The AxialTQ Rotor and Stator Modules are interchangeable with any other Rotor or Stator Module of the same DIN size.

15.1 Calibration

AxialTQ Rotors are supplied with a Torque Transducer Calibration Certificate (Figure 9). This certificate shows the test loads applied and the recorded Rotor output readings in both clockwise (CW) and counterclockwise (CCW) load directions during calibration. These output readings are in digital counts from the analog to digital converter inside the Rotor. Note that a zero load on the calibration certificate gives 0 counts of output signal, this is because the calibration data presented has been normalized to 0 digital counts.

For the true Rotor zero balance, or zero load reading, refer to the top left of the certificate where the zero balance reading is given in terms of percent of the CW rated output. The data is presented in this manner because each unique mounting situation will affect the zero load reading, but will not affect the rated output of the device. Most users will zero the Rotor output reading after it is mounted and ready for operation.

The center portion of the certificate gives the CW and CCW rated output readings which correspond to the rated capacity of the Rotor. It also gives the calculated CW and CCW SEB output readings for the rated capacity. The maximum non-linearity, hysteresis, and SEB errors are also given in this portion of the certificate.

The AxialTQ Stator Modules do not have calibration certificates. These modules simply pass thru the digital counts from the Rotor to the Output Module, so a calibration certificate is not required.

The AxialTQ Output Modules are supplied with a calibration certificate (Figure 10) which gives the measured zero and span signal values for various analog signal types which the device is capable of supplying.

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TORQUE TRANSDUCER CALIBRATION CERTIFICATE

CONDITION: FINAL
MODEL: ATQ10D12-01KNM   SERIAL: 791295   BRIDGE: A   CAPACITY: 1000 Nm
PROCEDURE: C-1928

ZERO BALANCE: 0.000 %RO

TEST CONDITIONS

TEMPERATURE: 75 °F   HUMIDITY: 30%

TRACEABILITY

TORQUE STANDARD: STD-45   NIST #: 12131-17-09   DUE: 15-SEP-2019
STANDARD INDICATOR: BRD309   NIST #: EVL472884

SHUNT CALIBRATION

	Shunt (+/- .01%)	Output
CW	357.0 KOhm	4356100 Counts

PERFORMANCE

	Rated Output	SEB Output	Nonlinearity	Hysteresis	SEB
CW	4734018 Counts	4733569 Counts	-0.015 %FS	0.017 %FS	± 0.009 %FS
CCW	-4735269 Counts	-4735848 Counts	-0.006 %FS	0.025 %FS	± 0.016 %FS

STATIC ERROR BAND (SEB): The band of maximum deviations of the ascending and descending calibration points from a best fit straight line through zero OUTPUT. It includes the effects of NONLINEARITY, HYSTERESIS, and nonreturn to MINIMUM LOAD.

TEST LOAD APPLIED (Nm)	Recorded Readings (Counts) CW	CCW
0	0	0
200	946284	-946986
400	1892979	-1893919
600	2839720	-2840858
800	3786641	-3787937
1000	4734018	-4735269
400	1893793	-1895081
0	-951	-313

Interface Inc. certifies that torque measurements are traceable to SI units through a recognized National Metrology Institute (NMI). Estimated measurement uncertainty is 0.11% RDG. expressed as the expanded uncertainty at 95% confidence level using a coverage factor of k=2. Results relate to load cell serial 791295 only.
DO NOT REPRODUCE THIS REPORT except in full or with Interface Inc. written approval.

TECHNICIAN : BRAD A. HANSON   CALIBRATION DATE : 28-NOV-2018

APPROVED : ______________________________

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Figure 9

OUTPUT MODULE CALIBRATION CERTIFICATE

CONDITION: FINAL

Model	: ATQ10CM	Serial	: 83200075	Procedure	: C-1927
Equipment ID	: STD-7028	Traceability #	: PC6K102K5D7	Due:	: 07-MAR-2019

Operating Mode		Signal	Error	Uncertainty
0 ±5 VDC	Zero Balance	- 0.00002 VDC	-0.00002 VDC	83 µV
	CCW Span	- 5.00002 VDC	+0.00002 VDC	192 µV
	CW Span	+ 4.99999 VDC	-0.00001 VDC	192 µV
0 ±10 VDC	Zero Balance	- 0.00014 VDC	-0.00014 VDC	82 µV
	CCW Span	- 9.99984 VDC	-0.00016 VDC	356 µV
	CW Span	+10.00018 VDC	+0.00018 VDC	356 µV
12 ± 8mA	Zero Balance	+11.99998 mA	-0.00002 mA	7166 nA
	CCW Span	- 7.99970 mA	-0.00030 mA	2956 nA
	CW Span	+ 8.00000 mA	-0.00000 mA	11687 nA
10 ± 5 kHz	Zero Balance	+ 9,999.98 Hz	- 0.02 Hz	1186 mHz
	CCW Span	- 4,999.96 Hz	- 0.04 Hz	638 mHz
	CW Span	+ 5,000.02 Hz	+ 0.02 Hz	1752 mHz
60 ± 20 kHz	Zero Balance	+59,999.93 Hz	- 0.07 Hz	6929 mHz
	CCW Span	-19,999.95 Hz	- 0.05 Hz	4624 mHz
	CW Span	+19,999.96 Hz	- 0.04 Hz	9239 mHz
60 ± 30 kHz	Zero Balance	+59,999.93 Hz	- 0.07 Hz	6929 mHz
	CCW Span	-29,999.94 Hz	- 0.06 Hz	3473 mHz
	CW Span	+30,000.00 Hz	+ 0.00 Hz	10390 mHz

Interface Inc. certifies that measurements are traceable to SI units through a recognized National Metrology Institute (NMI). Calibration performed per Interface QA program. Estimated Measurement Uncertainty shown expressed as the expanded uncertainty at 95% confidence level using a coverage factor of k=2. Results relate to ATQ Output Module serial number 83200075 only. Do not reproduce this report except in full or with Interface Inc.

TECHNICIAN : HUFFORD, MILES

CALIBRATION DATE : 21-JAN-2019

APPROVED : ____

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Figure 10

15.2 Data Measurement and Conversion

The strain gages located in the active area of the load cell are connected in a wheatstone bridge arrangement and when an excitation voltage is applied with the torque, it will create a differential voltage across the bridge output terminals. The typical output will be 1.0 to 1.1 mV/V at Rated Output (RO) for AxialTQ (Refer to Figure 11).

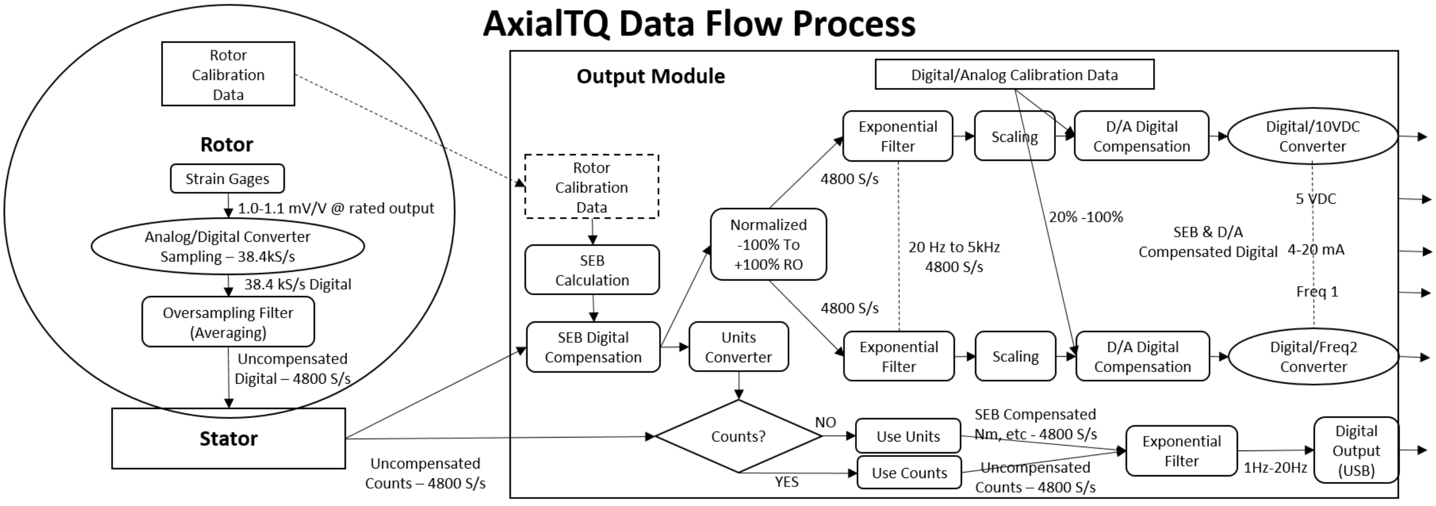

Figure 11

The strain gage output is processed through a high accuracy analog to digital converter with 24 bit resolution at the rate of 38,400 Samples per second. The digital data is then run through an oversampling filter, which is a type of averaging filter, and outputs the data at 4800 Samples per second. This uncompensated data is transferred through the 2.4 GHz radio link to the stator and then to the Output Module (OM) through an RS422 protocol. From here the data is processed in the OM for the various output formats.

15.3 Static Error Band (SEB) Output Calculation

This is a good time to step aside and take a look at the process of calculating the Static Error Band (SEB) Output used for data compensation and how it's used. The torque transducer is calibrated in the factory using standards traceable to a National Metrology Institute (NMI) as described in the calibration section. In this example we will use the CW calibration data from Figure 9. The calibration error from straight line in Figure 12 shows the five points increasing to the Full Scale (FS) and the one point on the return to zero depicting the hysteresis.

The calibration output at 100% of FS defines the ideal calibrated output at 100% of RO. This will typically be within +/-10% of the nominal digital counts of 4.5 million counts at RO. The SEB is defined as the maximum error above and below the ideal calibration line with the same slope as the ideal calibration line. The SEB output line (Figure 12) is therefore defined as the line from zero that is so positioned as to have equal maximum error above and below the line. By definition the line extends from zero to the SEB Output. The line considers both ascending and descending calibration points.

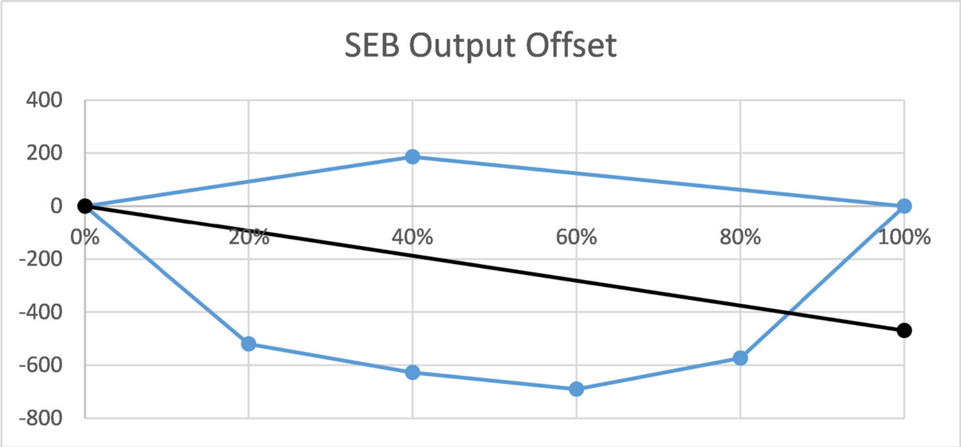

Figure 12

Using the data from Figure 9, the SEB Output is 4,733,569 counts. If the uncompensated digital counts reading is 1,453,773 this corresponds to an SEB compensated output of 30.712% of RO. On a 1000 Nm ATQAXIALTQ rotor, the compensated output would therefore be 307.12 Nm.

15.4 Analog Outputs

Each of the analog outputs is treated independently and has its own compensation, filter and scaling. As shown in the calibration section, each output is calibrated independently and are therefore compensated accordingly. The filtering and scaling can also be set independently so the user can read the outputs with settings for different applications. An example might be to use the 0 +/-10 VDC analog output for control and a frequency output for data collection.

After the digital data has been compensated for the SEB output, it is then normalized to be a percentage of the SEB Output as described in the previous section. The data is then run through an exponential low pass filter with a configurable cutoff frequency of 20 Hz to 2 kHz. This is the frequency where the output digital counts are attenuated by 3dB and drops at the rate of 20 dB/decade above that frequency.

The digital counts for the analog signal may then be scaled to "amplify" the output for low input readings. The scaling is configurable from 20% to 100% and has a default setting of 100%. If the transducer is to read 100Nm CW on a 1000Nm transducer, and the OM analog output is configured for 0+/- 10 VDC, and scaled for 100%, then the output voltage will be 1 VDC. If the scaling is set for 50% then the output will read 2 VDC for the same torque input. Likewise, it will read 5 VDC if the scaling is set for 20%. The downside is that the noise increases proportionally with the scaling factor and there is no increase in accuracy or resolution.

After scaling, the analog signal is compensated for any offset in zero or slope found during OM calibration. The calibration data shown in Figure 10 is the residual error after the digital counts have been compensated for the zero and slope offset.

15.5 Digital Outputs

The data from the rotor and stator is sent to the OM at the rate of 4800 S/s. If the user selects digital counts from the OM, the uncompensated data is filtered at a selectable frequency of 1Hz to 20 Hz. This data can then be used for calibration verification with the calibration data available from the rotor using the Snapshot feature.

If the user selects a Compensated Data for the digital data, the SEB compensated data will be converted to Nm and then filtered at a selectable frequency of 1Hz to 20 Hz. The user can select the data collection frequency to be stored in the data file.

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