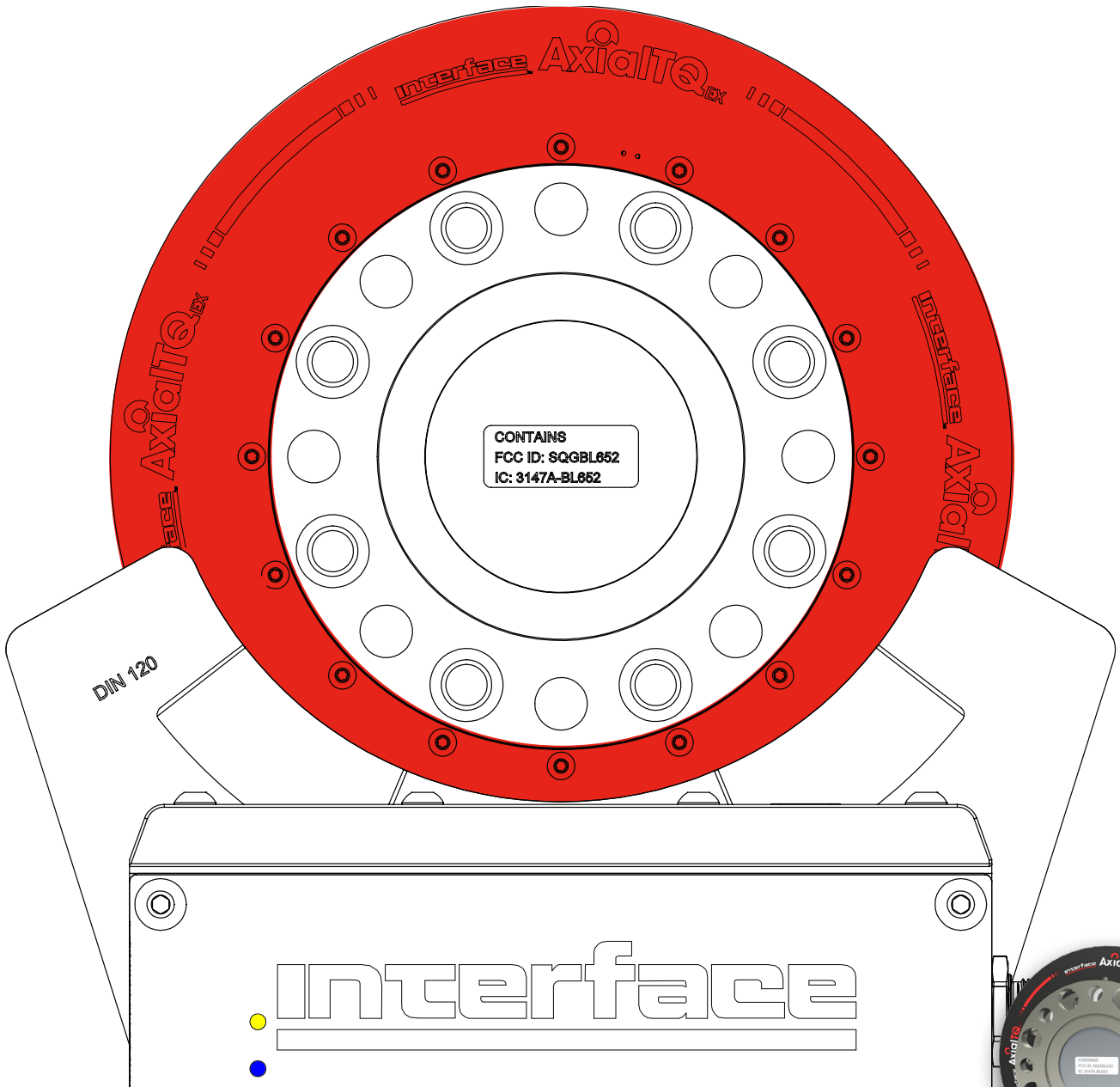


AxialTQ

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

User Manual



AXIALTQ User Manual 15-324 v3.2 06-07-2023



Table of Contents

Introduction.....	2	Figure 1.....	2
What is the AxialTQ?	2	Figure 2.....	6
System Architecture	2	Figure 3.....	7
Safety Instructions.....	3	Figure 4.....	7
System Startup	4	Figure 5.....	8
Abbreviations	4	Figure 6.....	8
Specifications.....	4	Figure 7.....	12
Rotor Installation.....	8	Figure 8.....	12
Shaft Misalignment	8	Figure 9.....	13
Stator Module	8	Figure 10.....	14
Output Module.....	9	Figure 11.....	15
AxialTQ Wiring.....	14	Figure 12.....	15
Cable Connection	16	Figure 13.....	16
AxialTQ Assistant.....	17	Figure 14.....	16
AxialTQ Data Management	30	Figure 15.....	16
Torque Transducer Calibration Certificate	35	Figure 16.....	18
Output Module Calibration Certificate.....	36	Figure 17.....	18
Appendix A Troubleshooting	37	Figure 18.....	19
Table 1	4	Figure 19.....	20
Table 2	4	Figure 20.....	20
Table 3	5	Figure 21.....	21
Table 4	5	Figure 22.....	21
Table 5	5	Figure 23.....	22
Table 6	5	Figure 24.....	22
Table 7	6	Figure 25.....	23
Table 8	10	Figure 26.....	23
Table 9	11	Figure 27.....	24
Table 10	14	Figure 28.....	24
Table 11	14	Figure 29.....	25
		Figure 30.....	25
		Figure 31.....	25
		Figure 32.....	26
		Figure 33.....	26
		Figure 34.....	26
		Figure 35.....	27
		Figure 36.....	27
		Figure 37.....	28
		Figure 38.....	29
		Figure 39.....	29
		Figure 40.....	31
		Figure 41.....	32
		Figure 42.....	35
		Figure 43.....	36

AXIALTQ User Manual 15-324 v3.2 06-07-2023

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 Purely digital data will, of course, provide the highest resolution but, 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*.

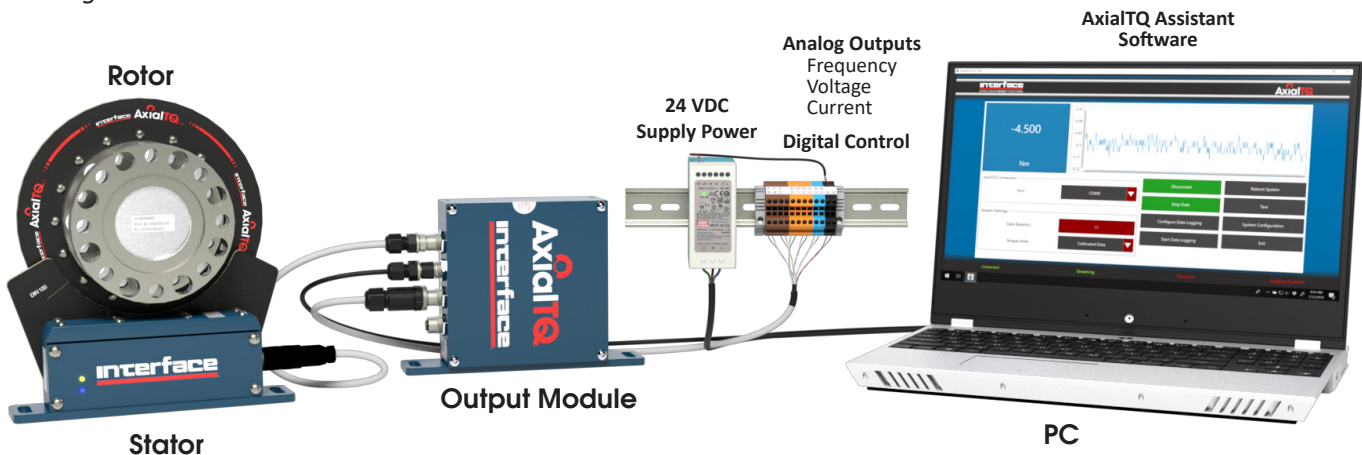


Figure 1

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 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 output 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


	<p>WARNING</p> <p>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.</p>
	<p>CAUTION</p> <p>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.</p>
	<p>NOTE</p> <p>This identifier accompanies text dealing with potential situations which might cause inaccurate data to be gathered.</p>


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

Table 1

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-m ²)	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	14,000	14,000	11,000	11,000	7,000	5,000
Maximum ¹ Speed Limit (RPM)	20,000	20,000	20,000	20,000	15,000	16,000	10,000	6,000
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

Table 2

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.*

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	38,400	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	2.402 to 2.480	GHz

Table 3

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

Table 4

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

Table 5

7.3 System Electronic Specifications

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

Table 6

7.4 Dimensions

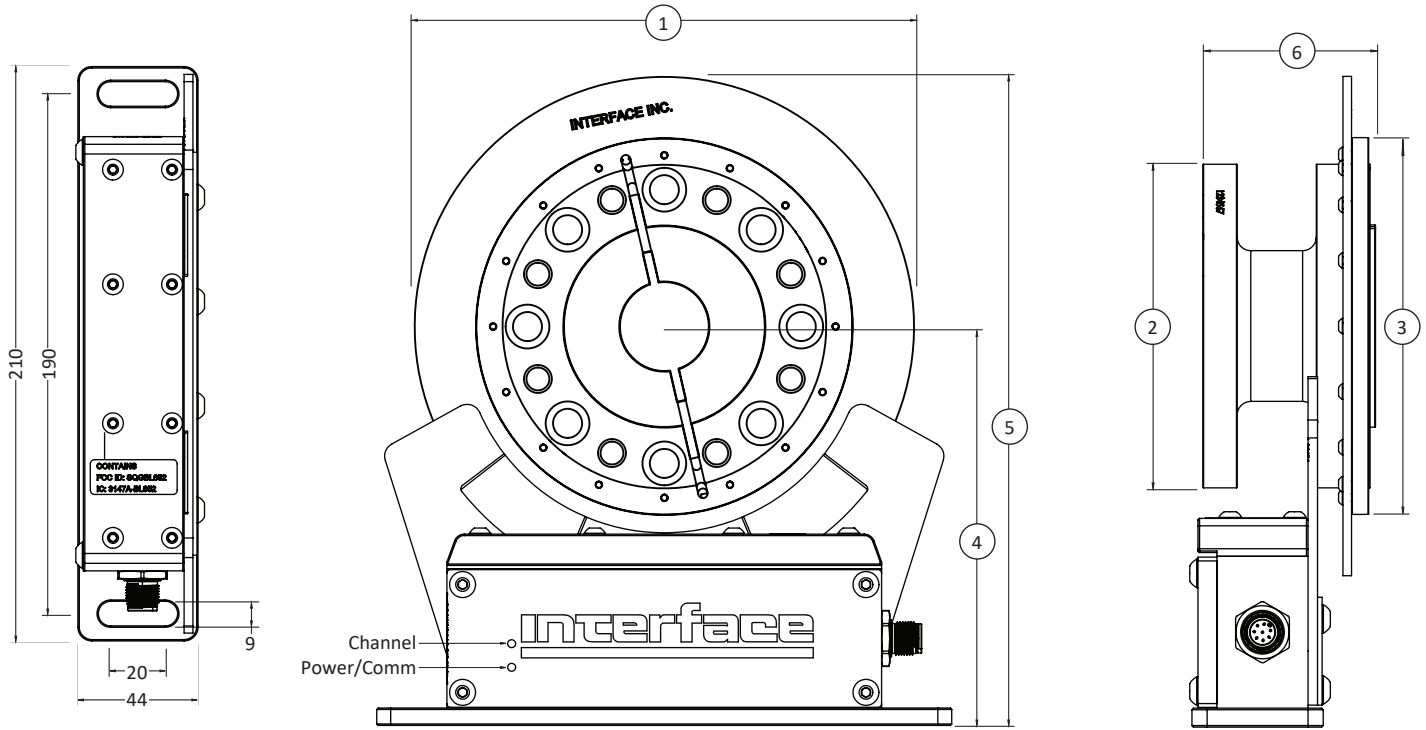


Figure 2

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

Table 7

7.6.8 Rotor and Stator Dimensions

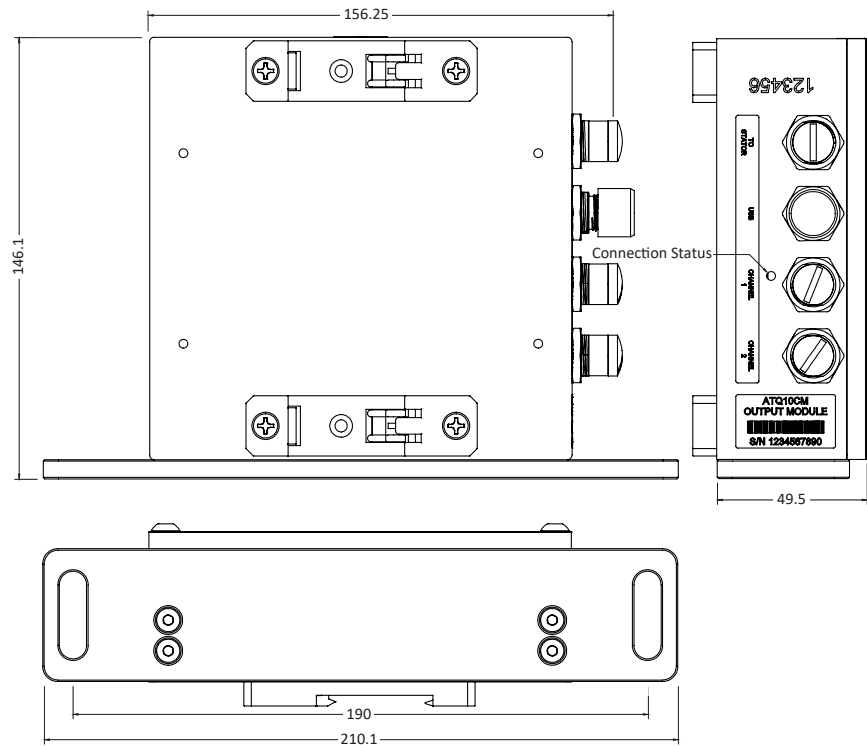


Figure 3

7.6.9 Mounting Plate Option Output Module Dimensions

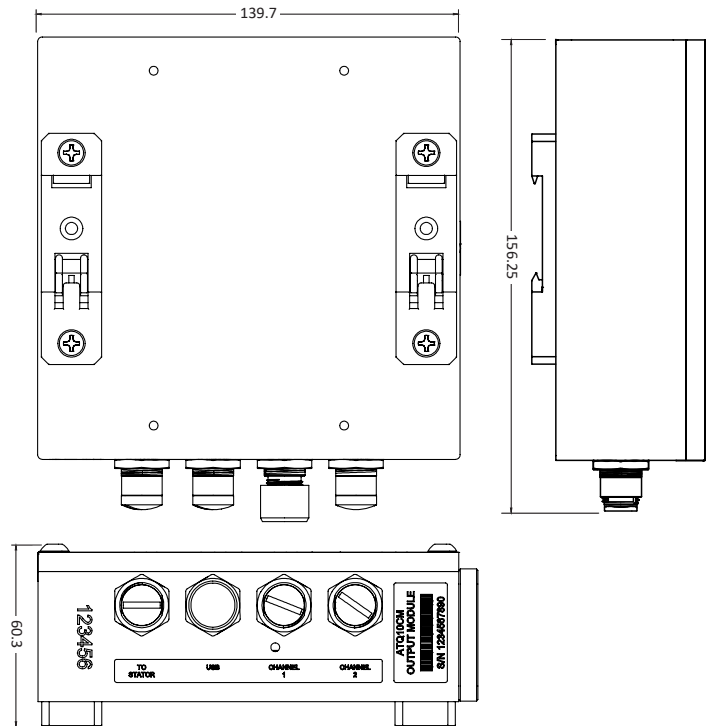


Figure 4

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.

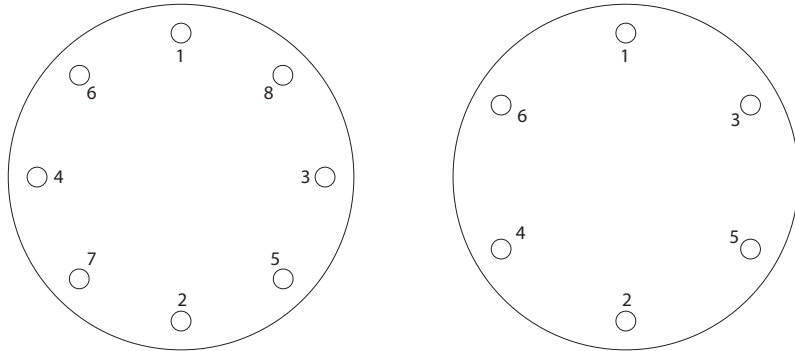


Figure 5

8.3 Tighten all screws in incremental steps in the order shown in *Figure 5*.

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.



Figure 6

10. Stator Module

10.1 Once the Rotor has been installed properly, position the stator using the alignment tool. See *Figure 6*.

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  Caution - Tying an analog output common to anything other than its proper return could cause signal errors.

11.2.3 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).


11.2.4 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  Note - 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 or 0-10 VDC unipolar
- ± 5 VDC or 0-5 VDC unipolar
- 12 ± 8 mA or 4-20 mA unipolar

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 Note - 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 \pm 5 kHz
- 60 kHz \pm 20 kHz
- 60 kHz \pm 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 8.

DAC Output:	<ul style="list-style-type: none"> • +/- 10 VDC – Default configuration • +/- 5 VDC • 12 mA +/- 8 mA
Frequency Outputs:	<ul style="list-style-type: none"> • 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:	<ul style="list-style-type: none"> • 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%

Table 8

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

11.7 OM Discrete Input/Output (DIO) Configuration

11.7.1 Shunt calibration when active places a high-quality shunt resistor across 2 legs of the rotor strain gage bridge which causes an output deflection equal to approximately 95% of rated output.

11.7.2 Invalid data is an output function that alerts the user to an issue that would mean that the torque data may not be reliable. This could be due to a poor radio connection between the rotor and stator or corrupt memory data.

11.7.3 Zero applies a digital offset to the calibrated torque data to normalize it to 0. This is generally used to eliminate misalignment and mounting torque errors. The zero function only works for the compensated data, if the serial data is selected as ADC counts no offset will be present. Care must be taken to only assert the zero function when the transducer is stopped, and no intentional static torque is applied.

11.7.4 Over Limit will alert the user if the torque data is greater than 105% of full scale.

11.7.5 The OM has (4) DIO that can...

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.

Table 9

**** If shunt or tare are assigned to a discrete input PC software control of these functions will be disabled.***

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 over voltage 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 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 7*.

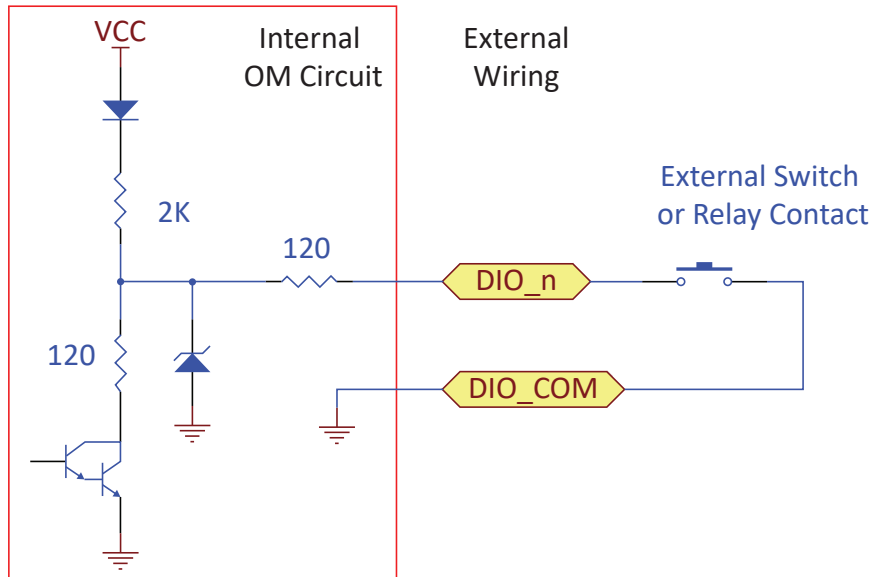


Figure 7

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 up to (50 mA) to directly drive small 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 8*.

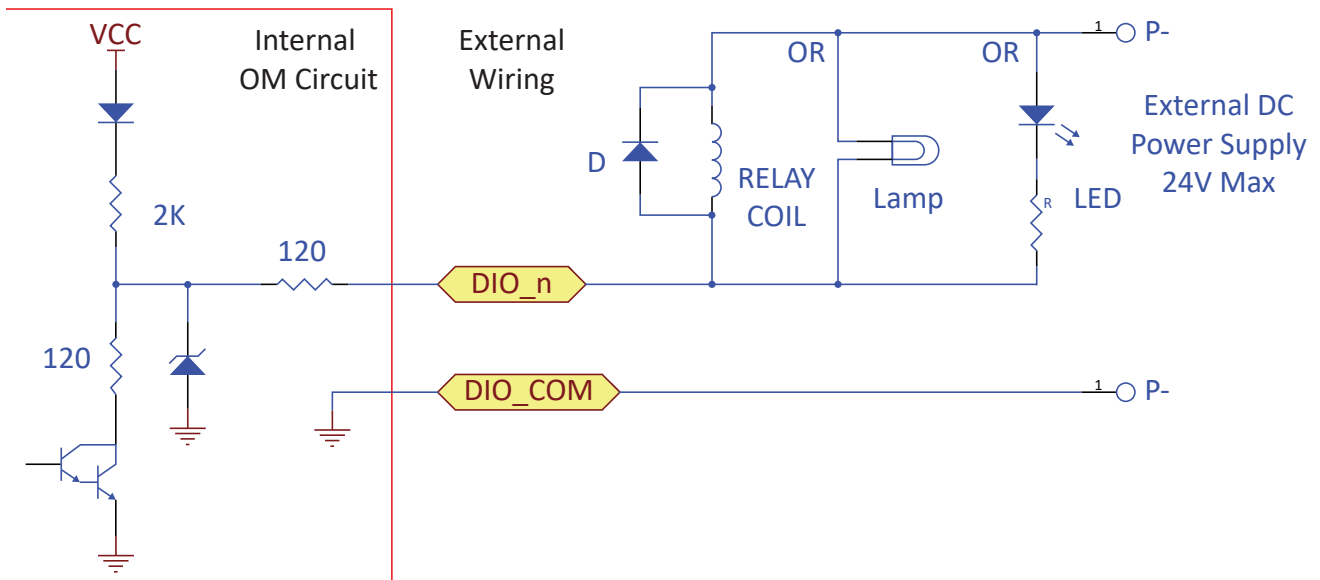


Figure 8

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.

AXIALTQ User Manual 15-324 v3.2 06-07-2023

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

Notes:

- Relay coil must have a 240Ω and a reverse biased diode D connected across the coil windings as shown.
- Lamp must be rated for 12V 0.6W. 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 $1K\Omega$ to $2K\Omega$.
- The example 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 9*.

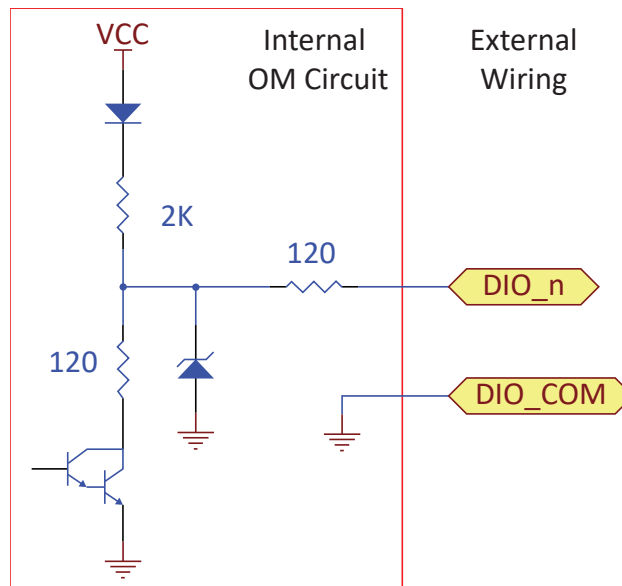


Figure 9

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 10 shows the pinout and wiring connections for each of the cables.

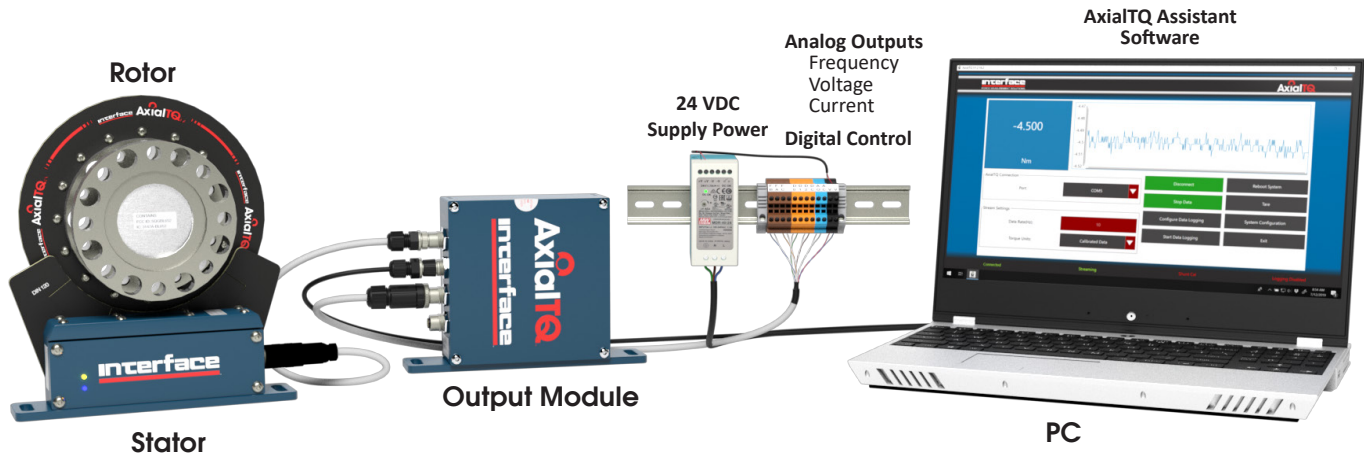


Figure 10

	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/N/C	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)	

Table 10



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.

	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	2/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)

Table 11

12.1 Maximum cable lengths.

- 12.1.1 Analog voltage output - 3 meters
- 12.1.2 Current output - Long distance (Shielded twisted pair)
- 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 11 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 12. An additional marker strip for D3, D4, D5, DC is included for Channel 2 Discrete I/O.

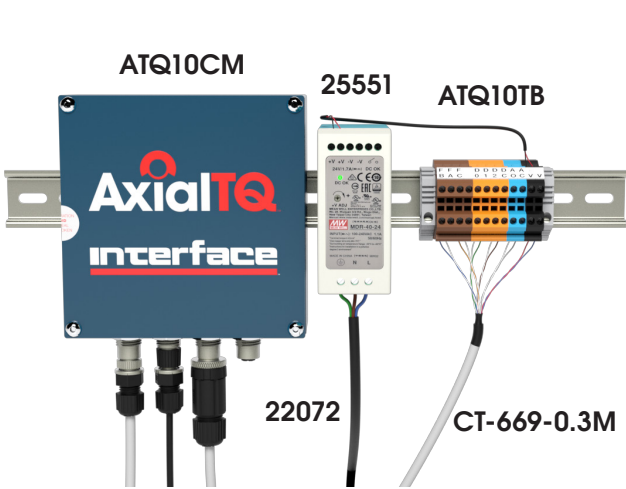


Figure 11

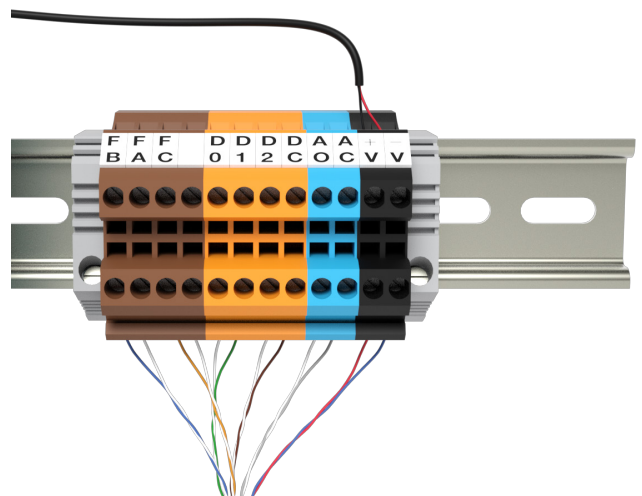


Figure 12

13. Cable Connections

13.1 Attach the cables to the output module. See *Figure 13*.



Figure 13



Figure 14

13.2 Attach the stator cable from the output module to the stator. See *Figure 15*.



Figure 15

13.3 Connect the Power/analog cable to a +24vdc power supply.

14. AxialTQ Assistant


AxialTQ Assistant Software is provided for system management and simple data collection. AxialTQ Assistant has been qualified for use on Windows 7 and Windows 10.

The Axial 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 digital torque data from the rotor
- Capture system information and troubleshooting data

14.1 Getting Started: The AxialTQ Assistant software is available on the website www.axialtq.com or from the AxialTQ product page of the main Interface website www.interfaceforce.com. 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 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 particular type of file is to be saved in the "AxialTQ Files" directory, or whatever file the user has given the directory, the user will need to browse to that location but after that the software should default to that location.

To install the software run the setup file located in the "AxialTQ Vww.xx.yy.zz" directory.

14.1.1  NOTE - If an older version of the AxialTQ Assistant had previously been installed, it will need to be uninstalled before installing the newer version.

14.2 Before starting the AxialTQ Assistant, the AxialTQ system must be powered and the USB connection made to the PC. Normally the drivers for the USB cable are automatically loaded when the cable is plugged in. If no driver exists on the target PC and it is not connected to the internet it may be necessary to download and install the driver manually. Use Windows Device Manager to confirm that a new com port is created when the USB cable is plugged into the computer. If no com port is created go to <https://www.ftdichip.com/Drivers/VCP.htm> to download the driver.

14.2.1  NOTE - The software only checks for available com ports on startup so the USB cable from the output module must be plugged in and a com port enumerated prior to starting the software.

14.3 Each software screen has a title bar at the top and a status bar at the bottom. The status bar is dynamic and will give real time updates as to connection, shunt cal, zero and logging.

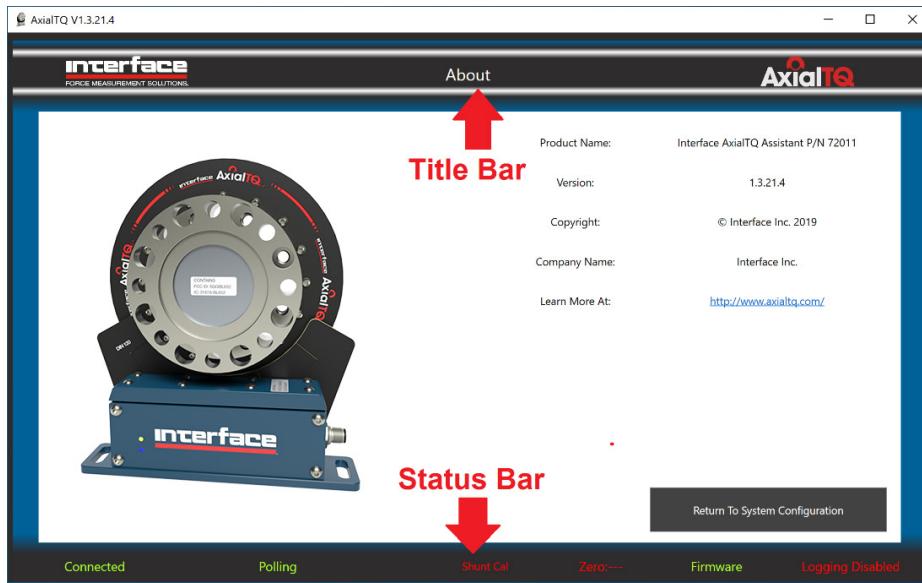


Figure 16

14.4 “Connect” This is the main screen that opens when the program is started, buttons or drop-down controls that are light gray are disabled. Buttons will be enabled once the required process is running.

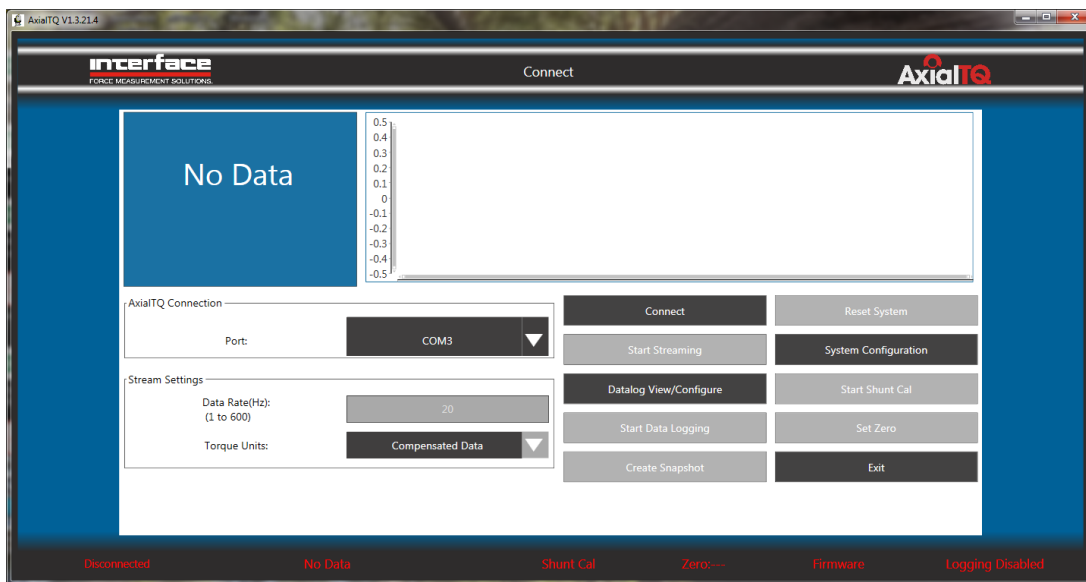


Figure 17

14.5 “Port” Use the down arrow on the right side of the control to open a pull-down menu of the available com ports. Generally, for the first use with a connected system, this will be the highest port number. If a new OM to USB cable is used, a new port number will be assigned and will have to be selected.

14.6 Once the com port has been selected, use “Connect” button to open the connection. The Connect button will turn green and the text will change to “Disconnect”. Note also that the red “Disconnected” text on the left of the status bar of the window turned to green “Connected” and the “No Data” text second from the left on the status bar changed to “Polling” in green.

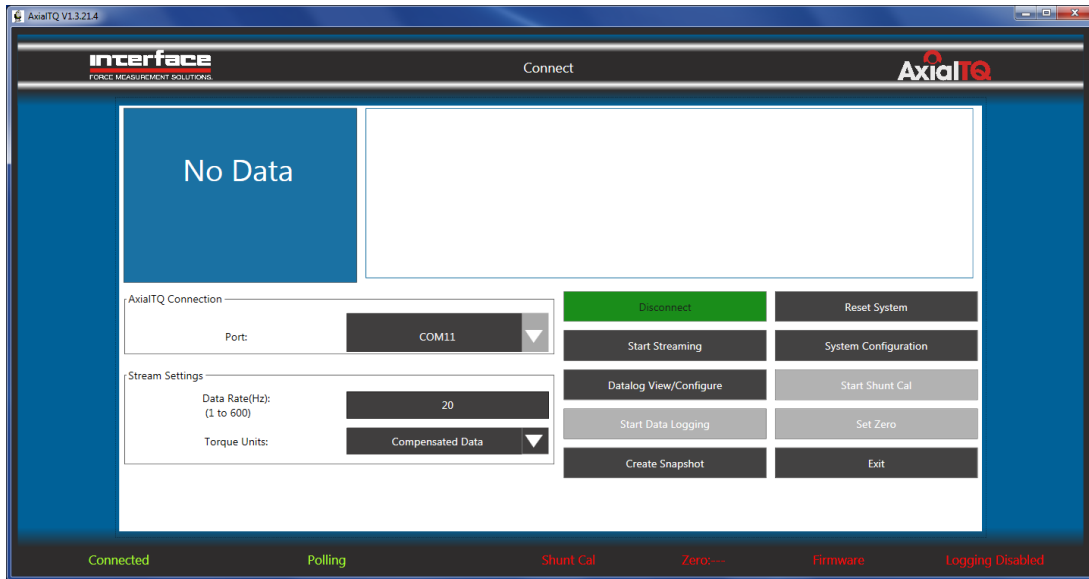


Figure 18

14.7 Select the desired stream settings:

14.8 Data Rate will set the rate at which readings are streamed from the output module. The default is 20 readings per second, when a higher rate is chosen a warning box will pop up “Faster data rates may affect your performance and may be at the mercy of your PC’s available resources”. If the streaming rate is faster than the PC can keep up the user will notice a lag in the data.

14.9 Torque Units:

14.9.1 Digital Counts will show raw ADC counts directly from the rotor.

14.9.2 Compensated Data will show Nm readings that have been scaled using an SEB calculation

14.10 Select “Start Streaming” to receive data.

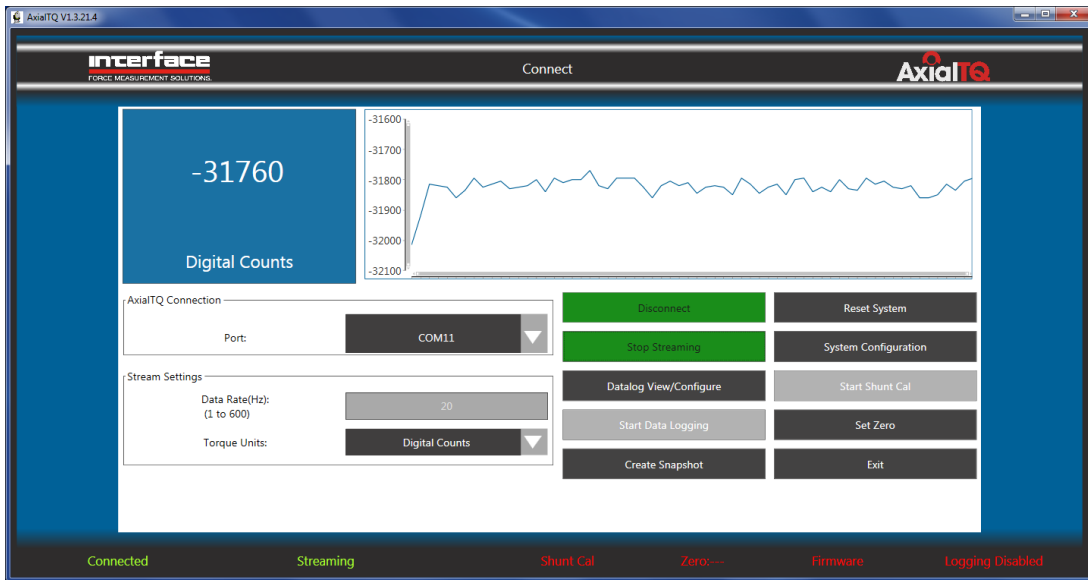


Figure 19

14.11 Above shows streaming digital counts (rotor ADC data) and below is the compensated data.

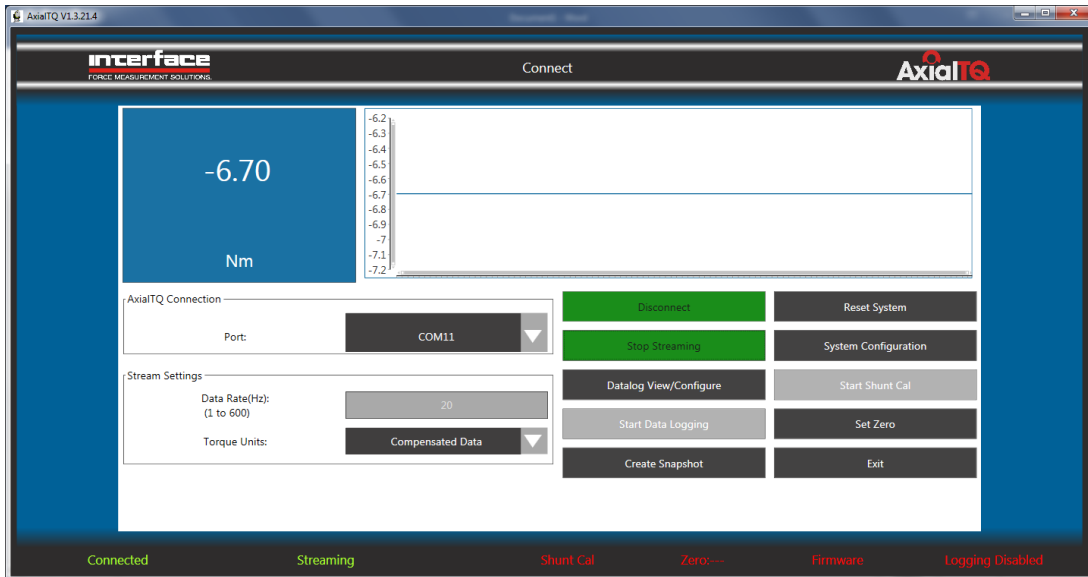


Figure 20

14.12 At this point numeric data corresponding to the stream settings will appear in the upper left area that has up to this point read “No Data” and a graph of the data will start to the right of that box.

14.13 Create Snapshot: this button will prompt the user to create a file name and location, read the system data, and then save the file. The snapshot file contains all the settings and system info including part numbers, serial numbers, firmware versions and build dates.

Once the file is created the software will read all information from the connected system.

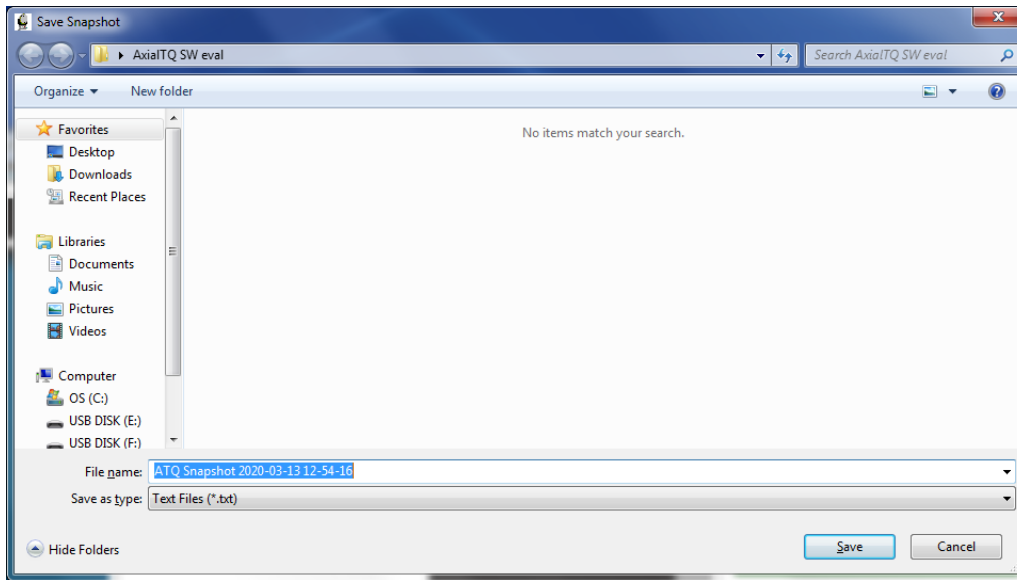


Figure 21

The “Reading system information” step should only take a few moments. The resulting text file that was saved in the selected location can be opened with Notepad, Word or any other text editor.

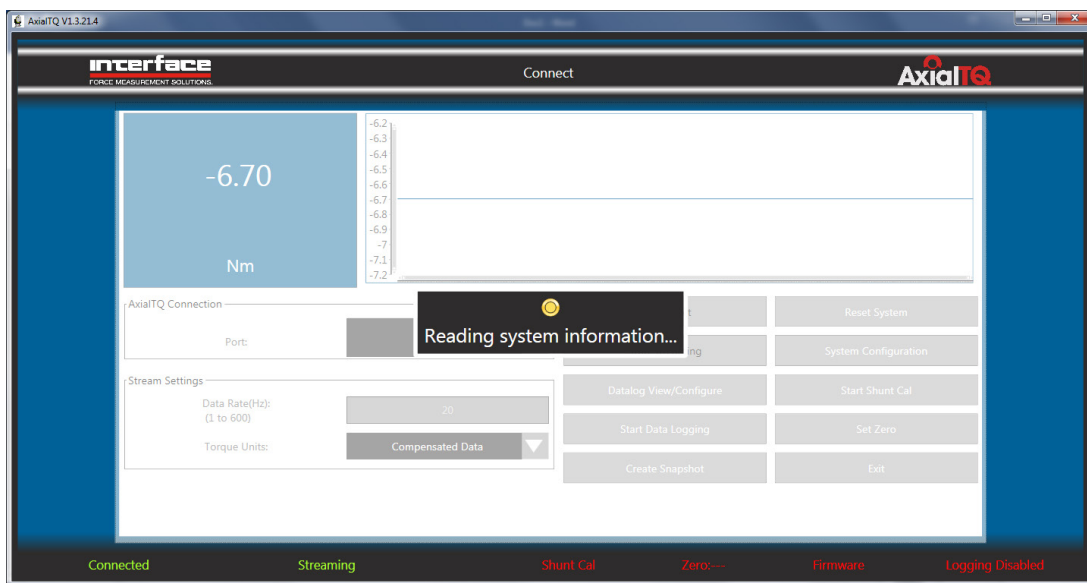


Figure 22

AXIALTQ User Manual 15-324 v3.2 06-07-2023

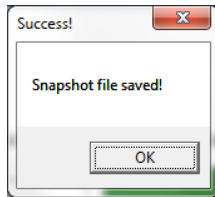


Figure 23

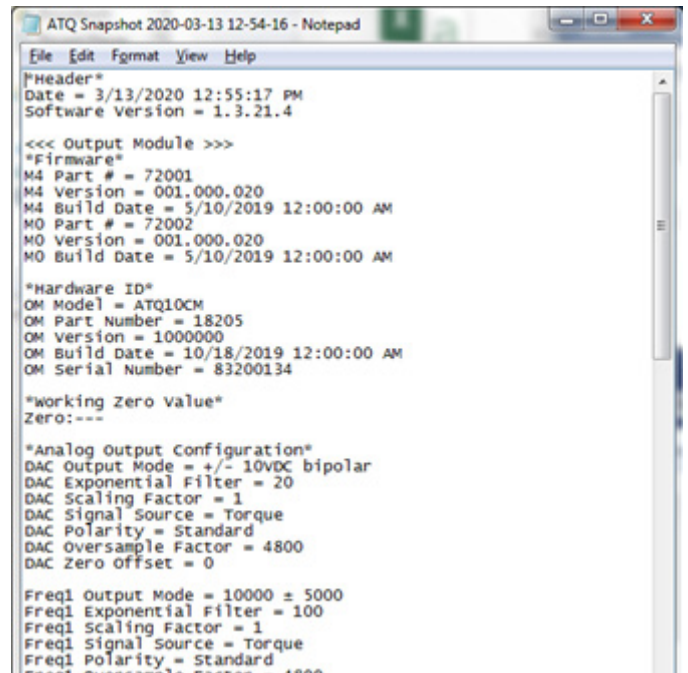


Figure 24

14.14 Set Zero: selecting this button will offset the readings to zero. This offset can be removed by using the Reset System button or by cycling the power to the ATQ system.



14.14.1 Note- care should be taken to only use this button when the system torque is in a zero state for the purposes of the defined test. Using the zero function while torque is applied will add an erroneous offset to the data. The red zero text on the status bar will turn green and will also show the calculated offset value.

14.15 Reset System: selecting this button will cause the ATQ system to reset and reboot. This is generally not needed during system operation, but it will remove the zero offset if the Set Zero button had previously been used.

14.16 Start Shunt Cal: this button will be grayed out if a digital IO line is assigned as shunt (DO is set to shunt by default, see 14.20). When active this button will cause a shunt resistor to be asserted across one leg of the rotor strain gage bridge causing a positive reading of approximately 95% of rated output. Once selected the button turns green and displays “Stop Shunt Cal”. The Shunt Cal text on the status bar also turns green.

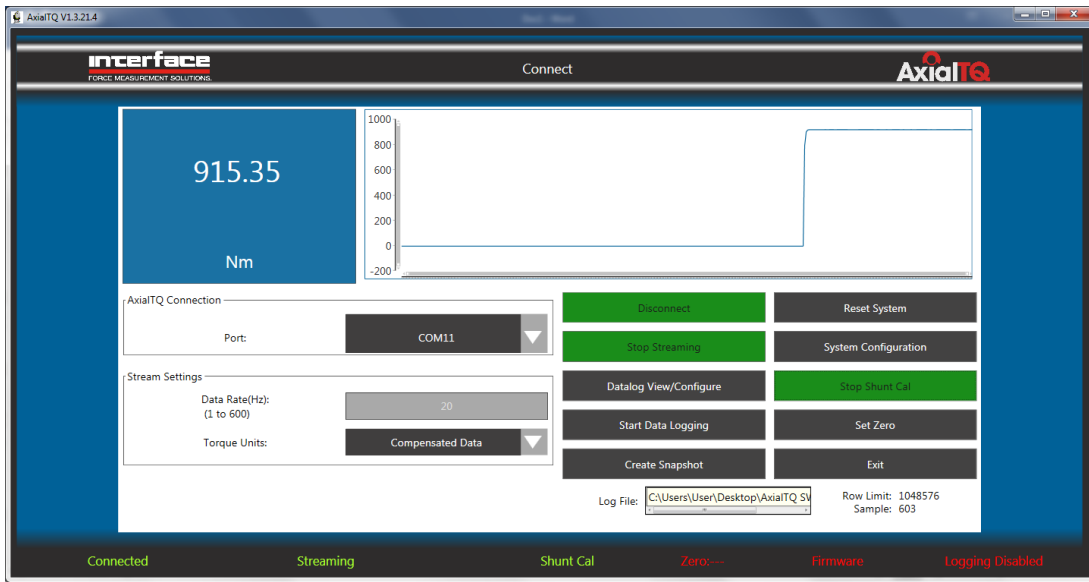


Figure 25

Clicking it again will remove the shunt, change the button color back to black and the text back to “Start Shunt Cal”.

14.17 Datalog View/Configure: selecting “Create Target File” will launch the Datalog View/Configure screen showing all the options for data logging. Notice in the example below a file named “TEST” was created in a folder on the Windows desktop.

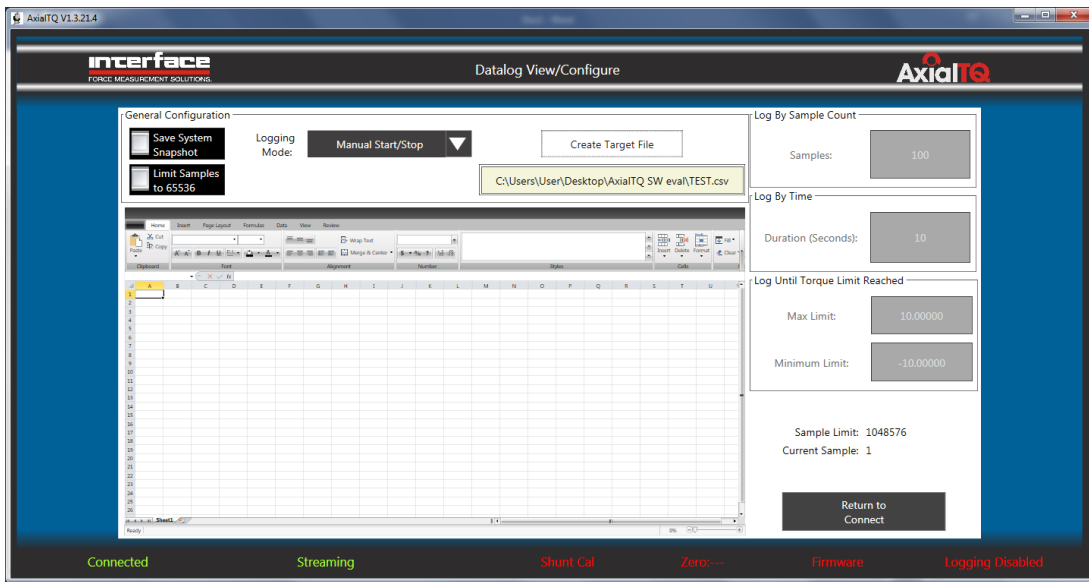


Figure 26

Then select the logging mode which will activate the controls on the right, in this case “Duration (Seconds)”, at this point to 10 could be changed to something else. When finished with settings select “Return to Connect” to launch the connect screen (lower right button).

AXIALTQ User Manual 15-324 v3.2 06-07-2023

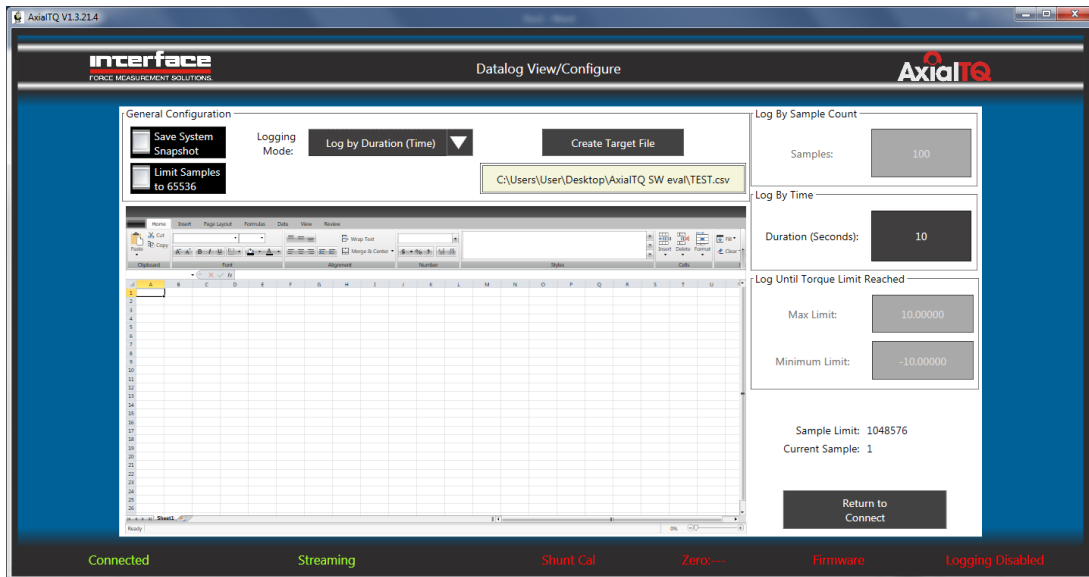


Figure 27

14.18 Start Data Logging (from the Connect screen): if the datalog setup has been configured then the log will start, the “Start Data Logging” button will turn green and display “Stop Data Logging” and the red “Logging Disabled” text on the status bar will turn green and read “Logging: Log by xxxx” where xxxx is the selected logging mode. If the “Stop Data Logging” button is selected logging will stop regardless of whether the stop condition has been satisfied.

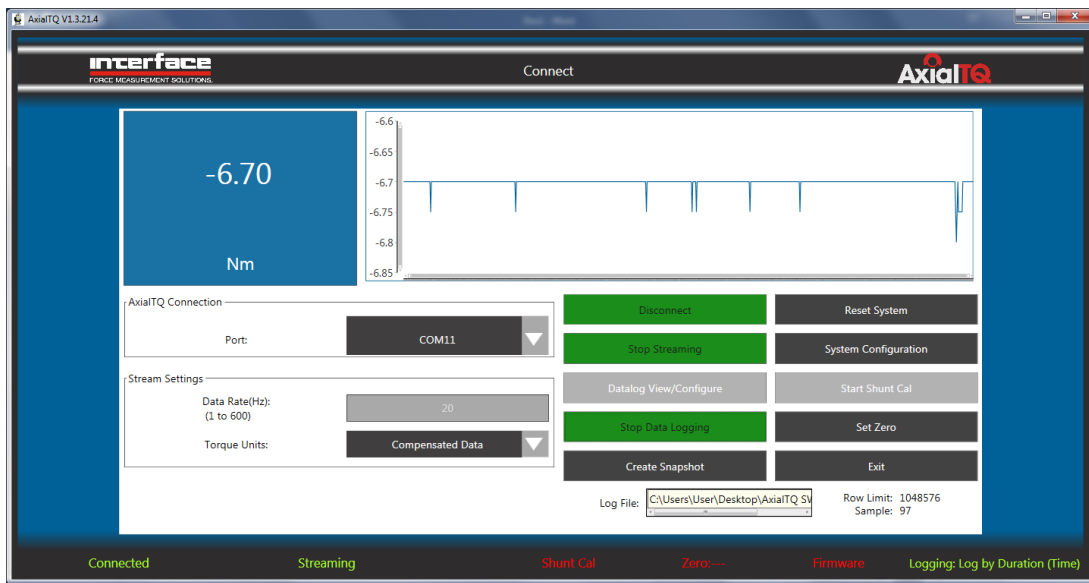


Figure 28

14.19 Exit: selecting this will exit the program.

14.20 System Configuration: this button will send the user to a new screen that will allow the changes to the analog outputs and digital IO.

14.21 Selecting “Yes” will stop streaming and open the system configuration screen. If the user is not logged in as a supervisor the settings can only be read, not changed or written back. Use the “Login” button to login as supervisor.

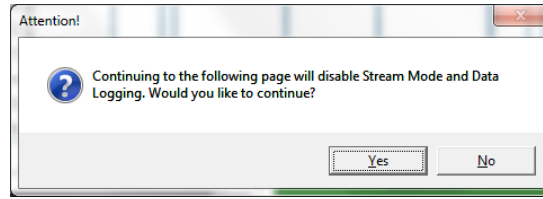


Figure 29

14.22 When the Login screen appears, type “Supervisor” in the “User Name” box and “Password” in the “Password box”. If the login credentials are wrong an error box will pop up “Invalid user name or password”. If the user name or password had previously been changed and forgotten, contact the factory for reset instructions.

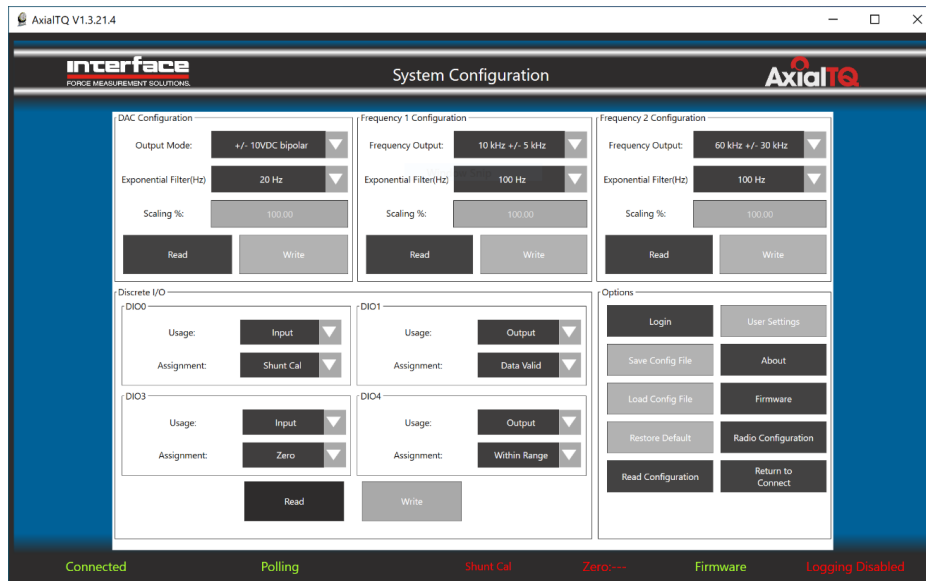


Figure 30

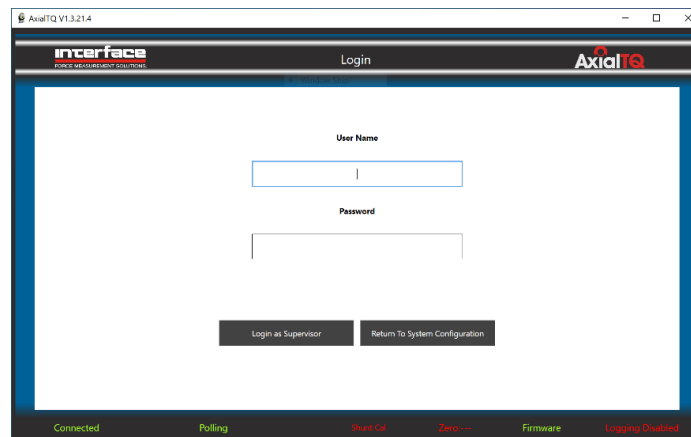


Figure 31

14.23 Once the user is logged in as supervisor, they will be returned to the configuration screen and all the selections and write boxes will be active.

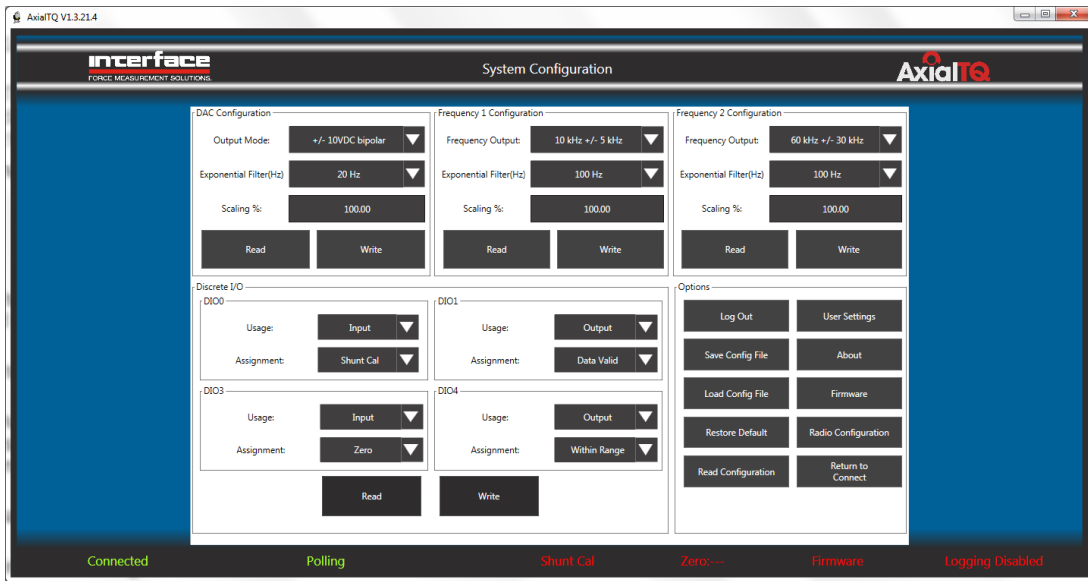


Figure 32

14.24 Change a DIO assignment: For example, change DIO0 usage to None and the assignment to None and select the Write button at the bottom of the Discrete I/O section. The new settings will be written, and the system will reset. If the write is confirmed by being read back after the reset, a success box will pop up.

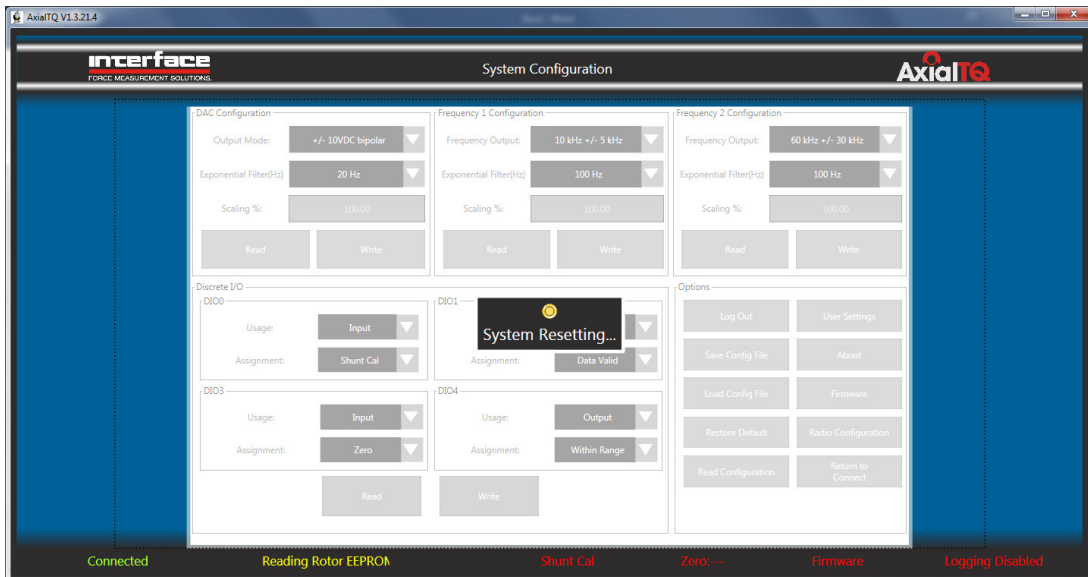


Figure 33

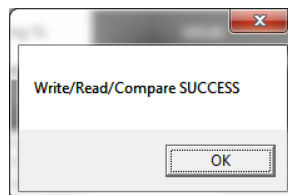


Figure 34

Note the changed settings below.

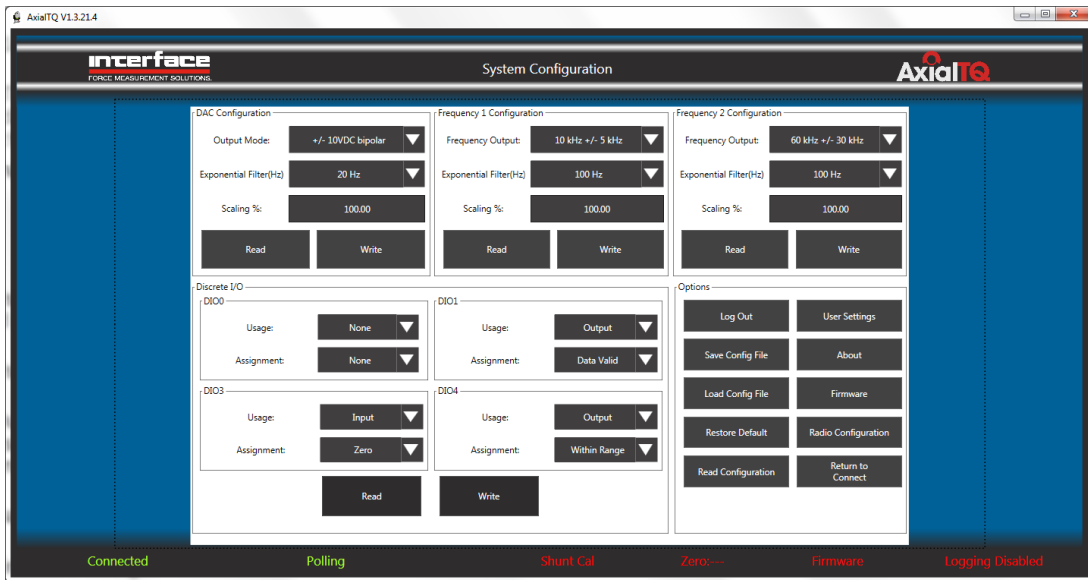


Figure 35

14.25 “Restore Default” will load the default settings into the respective fields of the PC software but will not change anything in the output module. When this button is selected this popup box will appear: As the box instructions note each set of configuration settings must be individually written to the output module.

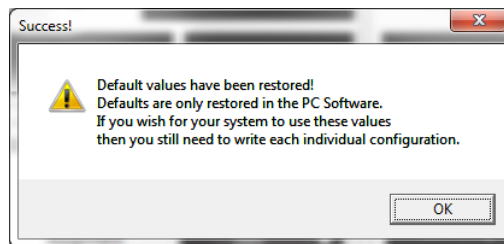


Figure 36

14.26 “Read Configuration” loads the current settings from the output module and populates the individual fields.

14.27 “Save Config File” is similar to the snapshot file but in this case only the items on the configuration screen are saved.

14.28 “Load Config File” selecting this button is similar to the “Restore Default” button with the exception that it reads the configuration settings from a stored file and then populates the various fields with those values. Like the restore default the individual groups of settings must be written for them to take effect.

14.29 “Firmware” this will launch the Firmware screen and read the installed firmware versions from the output module, stator and rotor and indicate whether the they are the most current versions. If the boxes are green they are the most current version, the “Firmware” text in the status bar at the bottom of the screen will also be green.

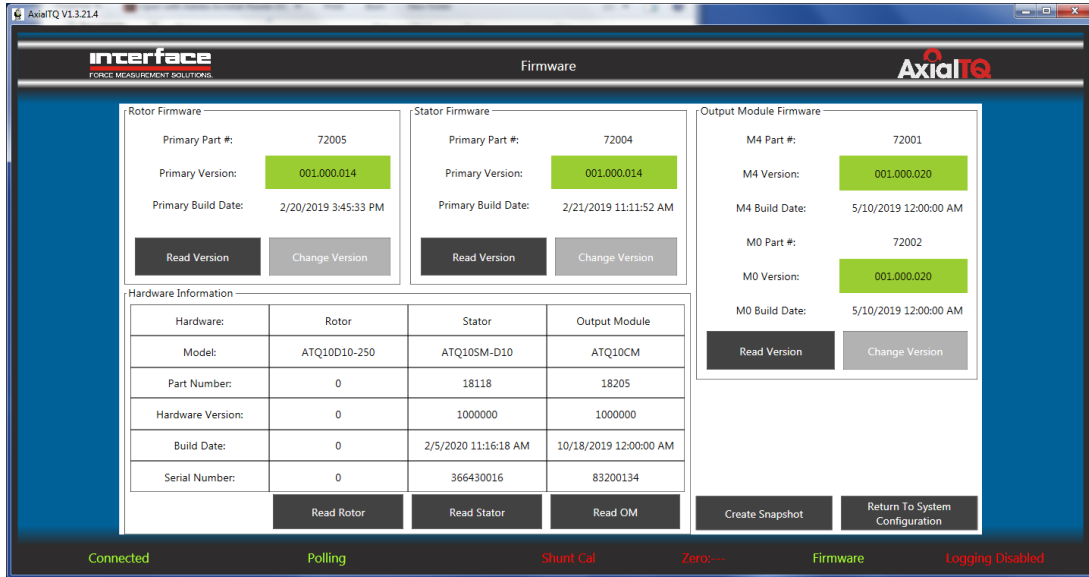


Figure 37

14.30 The “Read Rotor”, “Read Stator” and “Read OM” buttons at the bottom of the Firmware screen will read the hardware information including the serial numbers from the respective components.

14.31 “Change Version” this will open a dialog to select firmware files to upload. Use the directory that was created in the “Getting Started” step to find the firmware files.

14.32 The “Create Snapshot” on the firmware screen functions the same as the corresponding button on the connect screen.

14.33 “Return To System Configuration” since everything on this screen is considered part of the system configuration the user is returned to that screen rather than the connect screen.

14.34 “Radio Configuration” will open the radio configuration dialog. This will allow the user to change the radio channel and transmit power for the rotor. The AxialTQ uses the same 2.4 GHz bandwidth used by WiFi, Bluetooth and other wireless protocols. There are 80 channels available is can use for communication between the rotor and stator. The system always starts on channel 77 on power up then switches to the last saved channel for normal operation. The factory default channel is 50. If multiple AxialTQ systems are used in close proximity they should be set to different channels. Do not use channels 50 or 77. Recommended channels to try are 2, 25, 73 and 80.

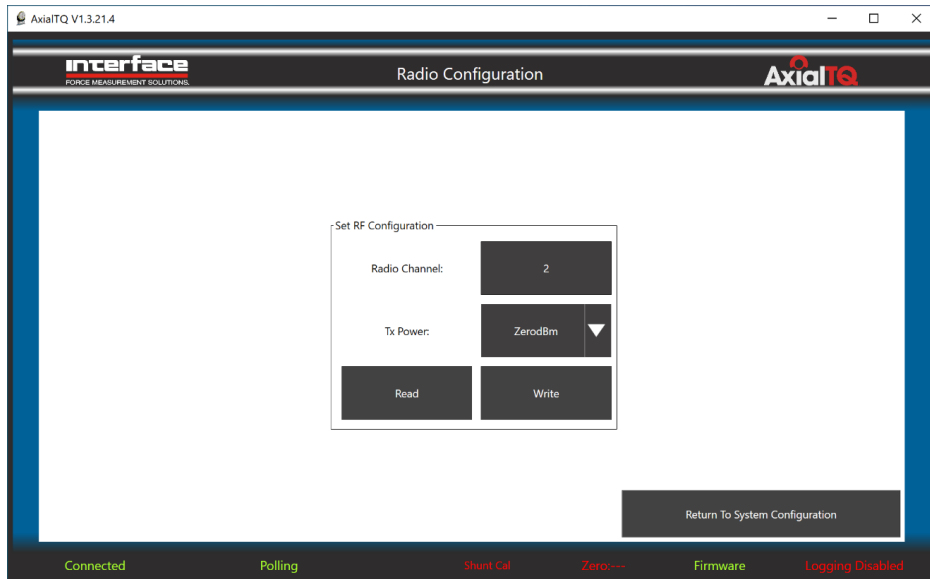


Figure 38

14.35 “User Settings” this allows the user to change login and password info. The user enters the current user name and password then a new user name and/or password and clicks “Update User Settings” to save the new information.

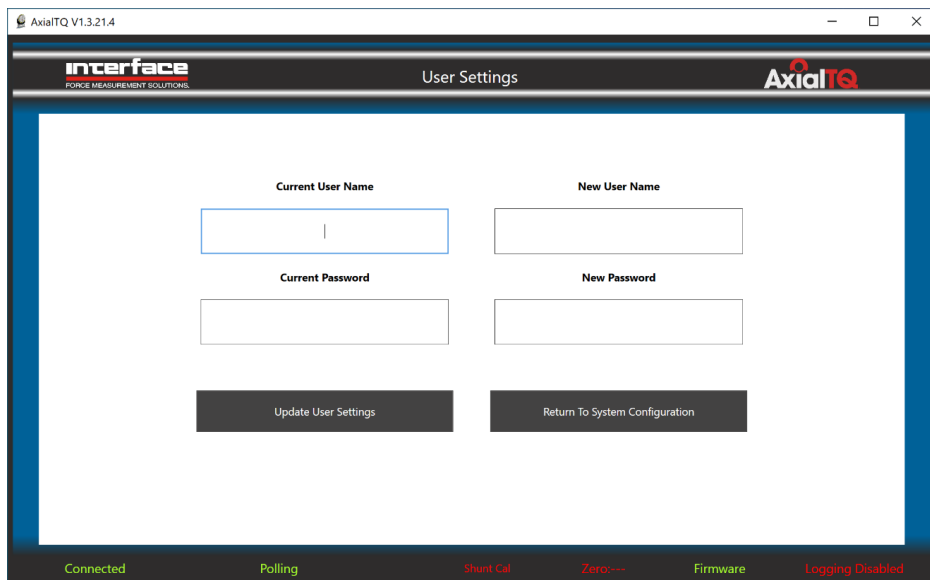


Figure 39

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 42). 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 43) which gives the measured zero and span signal values for various analog signal types which the device is capable of supplying.

15.2 Data Measurement and Conversion

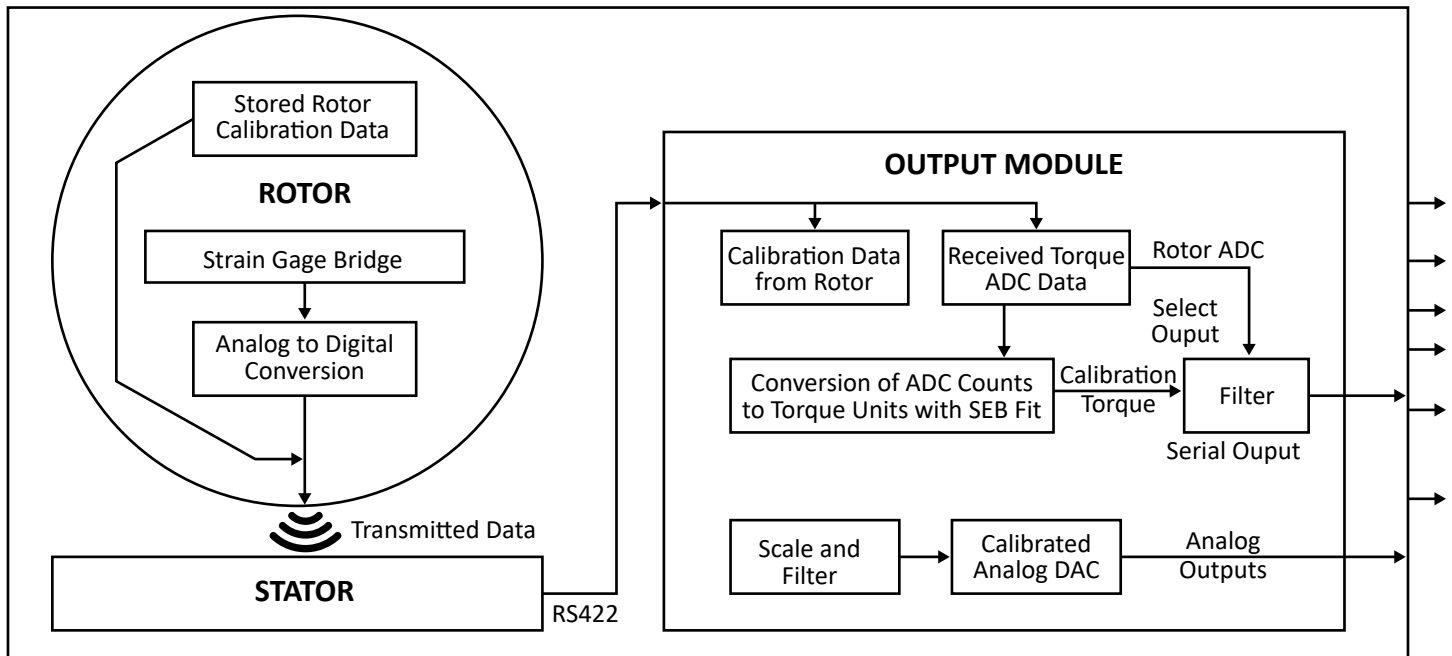


Figure 40

- 15.2.1 Rotor: Calibration data is stored in non-volatile memory in the rotor, think of this as a virtual calibration certificate. The data that can be found are the load points, typically in Nm, the load point readings in ADC counts and the transducer rated capacity.
- 15.2.2 Stator: The stator performs no calculations or conversions. It just sends the rotor data on to the output module via an RS422 connection.
- 15.2.3 Output Module: On power-up the OM authenticates the rotor and then reads the calibration data from the non-volatile memory. With this information the OM calculates conversion factors for ADC counts to Nm based on a straight line fit of the SEB (Static Error Band) output. (see appendix x for information on how the SEB output is calculated) When the OM receives streaming data, it converts the ADC counts to Nm based on the SEB calculations and applies the zero offset that is calculated when the zero function is used. If compensated serial data is selected, this is what is contained in the serial output. If ADC data is selected, then the output is raw data from the rotor. Filtering can be applied to the serial output. The SEB adjusted data is also sent to the analog output section of the OM. From the rotor data the OM knows what the rated output of the rotor is and uses this to scale the calculated SEB readings into 0-100 percent of rated output.

15.3 Static Error Band (SEB) Output Calculation

STATIC ERROR BAND or SEB – The band of maximum deviations of the ascending and descending calibration points from a best fit line through zero OUTPUT. It includes the effects of NONLINEARITY, HYSTERESIS, and non-return to MINIMUM LOAD. Normally expressed in units of %FS.

SEB OUTPUT – A computed value for OUTPUT at CAPACITY derived from a line best fit to the actual ascending and descending calibration points and through zero OUTPUT.

Given the above definitions, it is desired to establish a method of calculating the two parameters. Because SEB is a band that encompasses all values of a calibration or test run, its upper bound is actually determined by the most positive deviating point relative to the SEB Output line; and the lower bound is determined by the most negative deviating point relative to the SEB Output line. Thus, only the correct 2 points are needed for a solution.

To simplify, imagine a test run with only two values in addition to zero. We call one of them V_j and the other V_i . We plot them on a graph with the vertical axis representing output and the horizontal axis representing load expressed as a fraction R of full scale. This can be visualized in Figure 1 where $S = \text{SEB Output}$ and $a = \text{SEB}$.

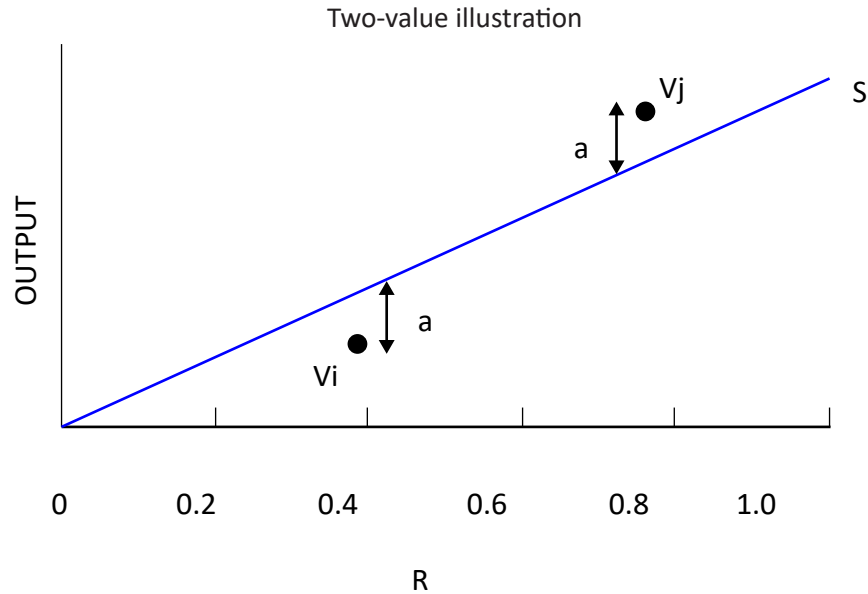


Figure 41

Because the SEB Output line is linear, we can call the R coordinates of V_j and V_i as R_j and R_i respectively and write an equation for each point relating its deviation from the line in terms of S and a :

$$a = S \cdot R_i - V_i \qquad a = V_j - S \cdot R_j$$

Combining these two equations we get:

$$S \cdot R_i - V_i = V_j - S \cdot R_j$$

Rearranging,

$$S = (V_j + V_i) / (R_j + R_i)$$

We now have expressed SEB Output = S and SEB = a . To generalize, SEB is always positive by definition so we take the absolute value. We divide by S and multiply by 100 to have SEB expressed in units of %Full Scale. We may use either of the above equations for “ a ”. We choose the second and write

$$\text{SEB} = \text{ABS} ((V_j - S \cdot R_j) / S) \cdot 100$$

To visualize our solution in a simple example, say

$$V_j = 2.05 \quad R_j = 0.8 \qquad V_i = 0.95 \quad R_i = 0.4$$

$$\text{Then } S = (2.05 + 0.95) / (0.8 + 0.4)$$

$$= 3.0 / 1.2 = 2.50$$

$$\text{And SEB} = (2.05 - 2.5 \cdot 0.8) / 2.5 \cdot 100$$

$$= 0.05 / 2.5 \cdot 100 = 2.0 \% \text{FS}$$

The remaining task for a general solution is to expand our two-value solution to any number of values. This is done by testing all combinations of two values and selecting the test with the highest value of a. This is best done by solving the pairs of values in a loop that tests all possible pairs. One such algorithm follows:

```
a = 0
b = 0
For i = 0 to NumberSetPoints - 1
  For j = 0 to NumberSetPoints - 1
    IF I <> j Then
      IF Rj + Ri <> 0 Then
        S = (Vj + Vi) / (Rj + Ri)
        a = ABS((Vj - S*Rj)/S)
      Else
        S = 0
        a = 0
      End If
      If a >= b Then
        b = a
        T = S
      End If
    End If
  Next J
Next I
SEB = b * 100
SEB Output = T
```

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.



TORQUE TRANSDUCER CALIBRATION CERTIFICATE

CONDITION: FINAL
 MODEL: ATQ10D12-01KNM SERIAL: 000000 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 :

CALIBRATION DATE : 28-NOV-2018

APPROVED : _____

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FIG 252D 7-0-18 Rev. A

Page 1 OF 1

Figure 42



OUTPUT MODULE CALIBRATION CERTIFICATE

CONDITION:FINAL

Model : ATQ10CM

Serial : 0000000

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 :

CALIBRATION DATE : 21-JAN-2019

APPROVED : _____

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F16-259D-0519 Rev. A

Page 1 OF 1

Figure 43

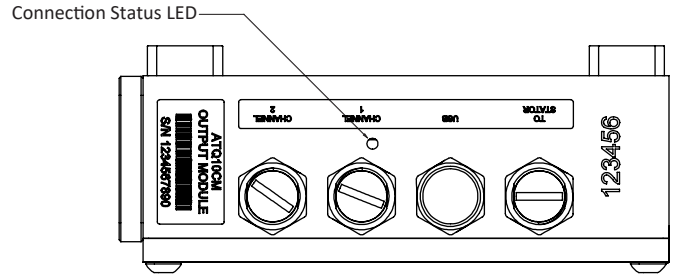
Appendix A Troubleshooting

- General Problems
 - Check diagnostic LEDs. *See figure 44*
- No Analog Output
 - Check that power supply is present
 - If using current or frequency output check for fault
- Incorrect Analog Output
 - If voltage or is 10% higher than selected range (11V for ± 10 , 5.5V for ± 5) and is not changing then the output module is signaling that a fault condition exists:
 - No rotor data is being received.
 - Torque value is greater than 105% of the calibrated rated output.
 - Stator earth ground issue.
 - EEPROM error.
 - If current is 0mA there is a fault condition in the OM (see above) or broken wire.
 - If frequency is 0Hz there is a fault condition in the OM (see above).
 - If an analog output is drifting or is otherwise incorrect based on the digital torque reading.
 - The analog outputs have their own isolated common returns, make sure the common for the output is not connected to the DC power ground or any other ground.
- Software Won't Connect to the ATQ
 - Has the proper COM port been selected?
 - Is the power supply to the ATQ active?
- The discrete input zero function isn't working.
 - With the software make sure shunt cal is selected for that specific DIO channel.
- The software shunt function doesn't work.
 - Make sure none of the DIO channels have shunt cal selected, this will lock out the software control.
- Zero reading is incorrect.
 - Was the zero-function initiated while the system was rotating?
 - Is there residual torque on the system?
 - System was power cycled, removing previous zero.
 - The system reset control on the software was initiated.
- Streaming data seems to be lagging real time events.
 - Streaming data settings much lower than analog outputs
 - If possible, change COM port settings to preferred.
 - Contact IT for assistance.
- The ATQ USB cable COM port doesn't show up when plugged into the PC.
 - The FTDI drivers have not been installed on the computer, this can happen when the PC has never been connected to the internet.
 - More than 255 FTDI serial converters with the same PID and VID have been plugged into that PC and it is not allowing any additional COM port to be enumerated.

Figure 44

Output Module

- 2 Hz Blink: Output module powered on, no communication with rotor (connected or disconnected to stator).
- 0.5 Hz Blink: Output module powered on, communicating with rotor (takes about 5 seconds after the stator connects to the rotor for blink rate to change on the OM).
- Solid LED: Output module powered on, communication lost with rotor.



Stator

On startup:

- On power up both LEDs flash blue for 100ms
-
- Then red for 200ms
-

Startup complete, ready to communicate:

- CHAN LED goes yellow
- PWR/COMM LED goes blue

Initiating communication on default channel 77:

- On initial connection with the rotor on default channel 77 CHAN turns yellow
- PWR/COMM LED goes red showing attempt to communicate

If communication attempt succeeds and new channel is selected:

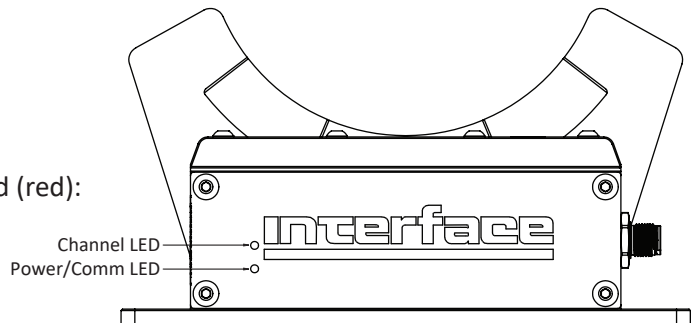
- Once channel is negotiated the CHAN LED turn green
- PWR/COMM LED goes green if data is received from rotor

If communication attempt fails:

- Still yellow for default channel 77
- PWR/COMM LED goes red for communicate failure

If communication succeeds but new channel not negotiated (red):

- Yellow for default channel
- Green, communicating with rotor



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Interface engineers around the world are empowered to create high-level tools and solutions that deliver consistent, high quality performance. These products include load cells, torque transducers, multi-axis sensors, wireless telemetry, instrumentation and calibration equipment.

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