

# **CALIBRATION AND CAPABILITY PROCEDURE OF INGERSOLL RAND PRECISION FASTENING TOOLS**

## **MODEL SERIES: QE/QX**



## 1. TOOLS:

*Table 1*

<u>TOOLS USED</u>	<u>TOOL DESCRIPTION</u>	<u>TOOL SPECIFICATIONS</u>	<u>TEST METHOD</u>
QE/QX Series	Electric Hand Held Angle Wrench	5% of reading	Belleville Joint Simulator
QE/QX Series	Electric Hand Held Pistol Wrench	5% of reading	Belleville Joint Simulator

## 2. EQUIPMENT REQUIREMENTS:

*Table 2*

<u>TEST EQUIPMENT USED</u>	<u>TEST EQUIPMENT DESCRIPTION</u>	<u>TEST EQUIPMENT SPECIFICATION</u>
Torque Analyzer	Ingersoll-Rand EXTA and EXTT Torque Analyzer	Range: 0.1-1000Nm
Rotary Transducers	Ingersoll-Rand Rotary Transducers	Range: As Needed Accuracy: +/-1% Full Scale Cal. Date: Current, Up to Date
Belleville Joint Stand	GSE Joint Simulator, 140180-00	Max Torque: 180 lb-ft
QE Tool Controller	IC1D or IC1M Controller	110V/220V
QE Tool Cable	GEA40-CORD-3M CPS3-CORD-3M	3 meters 3 meters
Tool Battery QX{}2P and QX{}2A	BL2005 BL2012 BL2010 BL2022	20V, 1.5Ahr 20V, 2.5Ahr 20V, 3.0Ahr 20V, 5.0Ahr
Tool Battery QX{}5A	BL4011	40V, 2.5Ahr
Tool USB Cable (QX Series)	84737-CABLE-USB	1 meter

### **3. PRELIMINARY OPERATIONS:**

- 3.1 Review and become familiar with the entire Calibration and Capability Test Procedure before beginning the Calibration and Capability Test Procedure.
- 3.2 This Calibration and Capability Test Procedure is applicable only to the tools listed above in Section 1, Table 1.
- 3.3 The operator of the Calibration and Capability Test Procedure needs to be familiar with torquing techniques and standard safety procedures in order to minimize risk of personnel injury and/or equipment damage.

#### **WARNING**

Ensure all hardware used to connect the tool to the external transducer, adapter(s) and joint stand simulator are properly sized and securely fastened. Failure to comply may result in personnel injury and/or equipment damage.

#### **WARNING**

Ensure all Belleville washers used in joint simulator are free of defects including stress fractures and/or substantial deformation. Failure to comply may result in unreliable results, personnel injury and/or equipment damage.

#### **WARNING**

All mating surfaces of the tool, transducers, adapters and joint simulator need to be free of dirt and other residue prior to calibration, in order to minimize damage to hardware and/or unreliable results.

#### **WARNING**

Excitation voltage for the transducers is provided via the Torque Analyzer, and is present whenever the Torque Analyzer is powered. To prevent any damage to the transducers, connecting and disconnecting the transducers should be performed only when the Torque Analyzer is powered off.

#### **NOTE**

Exercise TI to full scale at least three times prior to calibration

- 3.4 Use of IR Rotary Transducers and Expert Torque Analyzer (EXTA & EXTT) is preferred method to perform Calibration and Capability Test Procedure.
- 3.5 Maintain alignment of the tool with the axis of rotation on the transducer, adapters and joint stand simulator.
- 3.6 When using IR Rotary Transducers, it is recommended that only one transducer is used to cover the entire torque range of the tool being used.
- 3.7 Annotate final TI T/R value on certification.

#### 4. EXTT/EXTA TORQUE ANALYZER/TRANSDUCER SETUP:

For information about the use of the EXTA/EXTT Series Torque Analyzer and IR Rotary Transducers refer to the User Manual, 45652906.

**Note:** Depending on the tool maximum rated torque, an EXTT with a rundown adapter or an EXTA with a joint simulator can be used. The EXTT Torque Analyzer is offered in the following ranges: 1Nm, 4Nm, 12Nm and 30Nm. If using the EXTT be sure that the tool max torque does not exceed the max torque of the analyzer. If using the EXTA, be sure that the tool max torque does not exceed the rated torque of the connected rotary transducer.

#### 5. QE TOOL / IC1D CONTROLLER SETUP:

5.1 Connect the 3 meter tool cable between the tool and an IC1D/M controller, and power up controller. Once the controller has fully booted up and the tool has been detected by the controller, changes to the controller parameters will need to be made.

5.2 To acquire the most accurate results, Table 3 below shows the values the controller/tool parameters need to be set to for 100%, 75%, 50% and 25% of tool max torque. This can be done by using ICS Software for all tools or via the front panel of the IC1D controller for QE series tools only. Store these values into a configuration file on the controller

*Table 3*

<u>PARAMETER</u>	<u>VALUE</u>
Target Torque	100% Max Torque
Hi Torque Limit	105% Target Torque
Low Torque Limit	95% Target Torque
Angle Hi Limit	3600 degrees
Angle Low Limit	0 degrees
Torque Threshold	35% Target Torque (For Targets Torques under 6Nm, use 50%)
Free Speed	40%
Shiftdown Point	33% of Target Torque
Shiftdown Speed	10%
Reverse Speed	100% (For Target Torques under 6Nm, use 50%)

5.3 Save three more configuration files on the IC1D/M controller using the values in Table 3, except use 25%, 50% and 75% of Max Torque for the Target Torque values.

## 6. QX TOOL / CONFIGURATION SETUP:

6.1 Connect the QX tool to PC with ICS software installed via 1 meter USB cable supplied with the tool. Once the tool and PC are connected and ICS running, changes to the configurations will need to be made.

6.2 To acquire the most accurate results, Table 4 below shows the values the tool parameters need to be set to. This can be done by using ICS Software. Store these values into a configuration file on the PC in local database.

*Table 4: QX Tool Configuration Settings*

	<u>Pistol</u>		<u>20V Angle</u>		<u>40V Angle</u>	
	<u>4-8Nm</u>	<u>12-18Nm</u>	<u>5Nm</u>	<u>10-27Nm</u>	<u>20-80Nm</u>	
<b>PARAMETER</b>	<b>+Target Torque</b>		100%			
	<b>^Hi Torque Limit</b>		105%			
	<b>^Low Torque Limit</b>		95%			
	<b>Angle Hi Limit</b>		3600°			
	<b>Angle Low Limit</b>		0°			
	<b>^Torque Threshold</b>		20%			
	<b>Free Speed</b>		70%	100%	45%	100%
	<b>Shiftdown Point</b>		15%		10%	20%
	<b>Shiftdown Speed</b>		10%			
	<b>*Reverse Speed</b>		100%			

Notes: +Values listed are percentage of max tool torque  
 ^Values listed are percentage of target torque  
 \*For Target Torques under 6Nm, use 50%

6.3 Save three more configuration files in ICS using the values in Table 3, except use 25%, 50% and 75% of Max Torque for the Target Torque values.

## **7. JOINT SIMULATOR SETUP:**

- 7.1 At this point, the tool should be properly mounted onto the joint simulator with the appropriately sized transducer and adapter's inline and in place. The transducer, Torque Analyzer and controller have been properly configured, but before calibration of the tool can begin, the joint angle of the joint simulator needs to be adjusted such that it falls between 100-200 degrees. Ensure the joint angle remains between 100-200 degrees when changing TI torque values.
- 7.2 First insert 6 Belleville washers of equal thickness onto each guide rod of the joint simulator. The direction of convex for each successive Belleville washer on each guide rod should be alternated (i.e. convex up, convex down, convex up, convex down...) and the Belleville washer stacks should be identical for the two guide rods. If using an EXTT, adjust single washer stack in rundown adapter.
- 7.3 Next, several tightening cycles should be run and the resultant joint angle provided on the ICS Software should be noted. If the reported angle is out of the 100-200 degree range, adjustment can be made by changing the number of washers symmetrically on each guide rod, as well as changing the thickness of individual Belleville washers or repositioning the Belleville washers such that the convex orientations are in parallel or serial. These changes will allow for flexibility in the resultant joint angle.
- 7.4 Once the 100-200 degree joint angle is achieved, verify that the two guide rods have identical Belleville washer stacks and that the stacks do not go solid while performing a tightening cycle.

**8. PERFORMANCE CHECK:**

8.1 Using the previously stored configurations in the IC1D/M controller, test the TI at 100%, 75%, 50%, and 25% of TI max torque. Run the TI for three tightening cycles at each torque value. Using Table 5 as a worksheet, record the displayed TI torque value and the displayed EXTT/EXTA torque value. At each torque value, the displayed TI torque value must be within 5% of the displayed torque value on the Torque Analyzer.

**NOTE**

Ensure the angle on the joint simulator remains in the 100-200 degree window when changing torque TI torque values. Adjustments to the Belleville washer stacks may be necessary to maintain the 100-200 degree joint angle.

8.2 If the TI does not meet specifications, perform the adjustment procedure in paragraph 8.

Table 5

<b>TI ID:</b> _____			
100% of Max TI Torque		Setting:	
Cycle	TI displayed Torque	EXTT/EXTA displayed Torque	Deviation %
1			
2			
3			
75% of Max TI Torque		Setting:	
Cycle	TI displayed Torque	EXTT/EXTA displayed Torque	Deviation %
1			
2			
3			
50% of Max TI Torque		Setting:	
Cycle	TI displayed Torque	EXTT/EXTA displayed Torque	Deviation %
1			
2			
3			
25% of Max TI Torque		Setting:	
Cycle	TI displayed Torque	EXTT/EXTA displayed Torque	Deviation %
1			
2			
3			

9. TOOL ADJUSTMENT:

**NOTE**

Perform this section only if the TI does not meet specification

**NOTE**

Adjustment should be performed at 100% of the tools max torque. If 100% max torque of the tool exceeds the Full Scale value of the external transducer, switch to the next higher transducer or adjust the tool at 90% max torque. If adjustment is performed at 90%, consider the tool fully adjusted. The torque transducer should never be used above its Full Scale value.

**NOTE**

Adjustment can be performed through the Auto Calibration option available on the ICS Software. Refer to ICS manuals 48619696 and 04581849 for instructions on auto and manual calibration. Auto Calibration requires connectivity between the Torque Analyzer and the ICS Software via the provided ETA-PC99 cable.

9.1 The adjustment procedure will be performed by running 10 tightening cycles on the joint simulator with a joint angle of 100-200 degrees, and with the controller parameters set in accordance with Table 3. Once the 10 cycles have been run, and the torque results have been recorded by the external transducer and EXTT/EXTA Torque Analyzer, adjustment to the TR value will be made automatically via the Auto Calibration option available on the ICS software. This option records the 10 tightening cycles provided by the EXTT/EXTA Torque Analyzer and then automatically adjusts the TR value based on the current TR value and the difference between the average external torque measured and the average torque measured by the controller.

9.2 If connectivity between the EXTT/EXTA Torque Analyzer and ICS Software is unavailable, manual adjustment of the TR value can also be performed. After running the 10 tightening cycles, and manually recording the average external torque measured and manually recording the average torque measured by the controller, the new TR value can be determined by the following Equation 1.

*Equation 1*

TR2 = New TR Value

TR1 = Default or Previous TR Value

IT = Internal Measured Torque, Averaged over 10 cycles. Torque results output on IC1D/M controller screen.

ET = External Measured Torque, Averaged over 10 cycles. Torque results output on EXTT/EXTA Torque Analyzer by external transducer.

$$\mathbf{TR2 = (ET/IT)*TR1}$$

9.3 Repeat Step 8.1 or 8.2 until a tight correlation between the Internal and External Torque values has been reached. The tool is now calibrated at Full Scale.

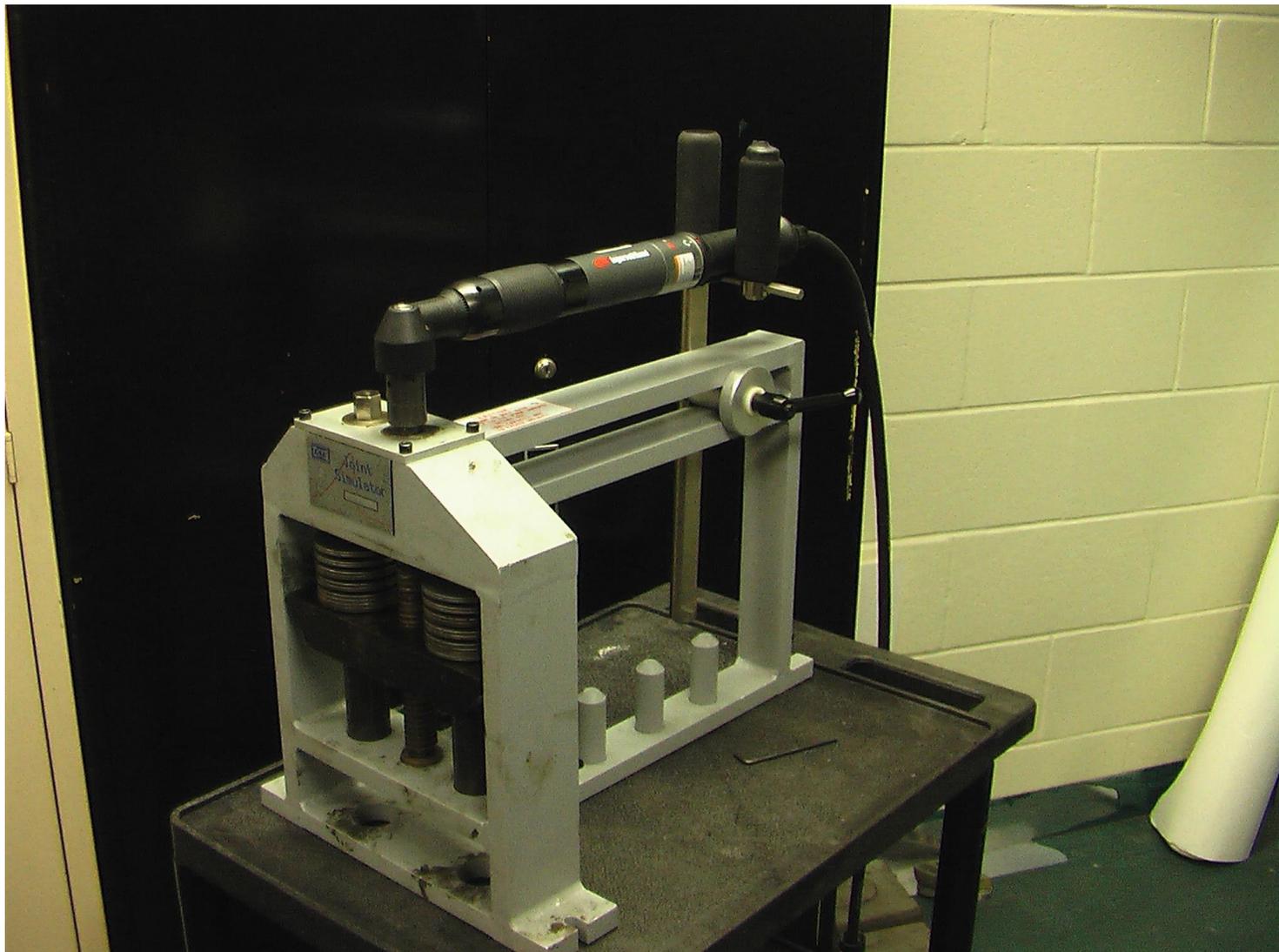
9.4 Perform steps 7.1 thru 7.3 to ensure the TI meets specifications.

## 10. TOOL RESULTS

*When tested at a torque value between 25 and 100% of the QE Series tool's rated maximum torque, Ingersoll Rand will guarantee **±5% of reading** on tools shipped new from the Ingersoll Rand Distribution Center when tested in accordance with the comprehensive test procedure described in this document.*

*This statement of accuracy is valid for all QE/QX Series tool, both angle and inline configurations.*

**Figure 1: Example of Test Setup**



**Figure 2: Example of Test Results**

Tool Model: QE6AT080PA5508		Controller Model: IC1D	
<b>Controller/Test Settings:</b>			
Target Torques: 16Nm, 40Nm, 79.9Nm	Angle Hi Limit: 3600, 3600, 3600	Free Speed: 50%, 50%, 50%	
Hi Torque Limits: 20Nm, 50Nm, 100Nm	Angle Low Limit: 0, 0, 0	Shiftdown Point: 5.33Nm, 13.33Nm, 26.66Nm	
Low Torque Limits: 12Nm, 30Nm, 60Nm	Torque Thresholds: 5.6Nm, 14Nm, 28Nm	Shiftdown Speed: 10%, 10%, 10%	
Acceleration Value: 20%, 20%, 20%	Joint Angle: 100-200 degrees	Shiftdown Type: Hard, Hard, Hard	
MCE Software Version: R3.5.11		Reverse Speed: 100%, 100%, 100%	

CALIBRATION AND JOINT ANGLE TEST					
Run	Controller Torque	Ext. Trans. Torque	Old TR	New TR	Angle
1	Auto Calibrated	Auto Calibrated	103.7	104.28	-150
2	Auto Calibrated	Auto Calibrated			
3	Auto Calibrated	Auto Calibrated			
4	Auto Calibrated	Auto Calibrated			
5	Auto Calibrated	Auto Calibrated			
6	Auto Calibrated	Auto Calibrated			
7	Auto Calibrated	Auto Calibrated			
8	Auto Calibrated	Auto Calibrated			
9	Auto Calibrated	Auto Calibrated			
10	Auto Calibrated	Auto Calibrated			
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

CAPABILITY TEST									
Run	16.0 Nm Torque	16.0 Nm Torque	16.0 Nm Torque	40.0 Nm Torque	40.0 Nm Torque	40.0 Nm Torque	79.9 Nm Torque	79.9 Nm Torque	79.9 Nm Torque
1	16.26	16.21	16.31	40.87	39.75	40.73	80.50	80.10	80.40
2	16.12	15.70	16.03	40.73	39.89	39.28	80.60	80.20	78.40
3	16.07	16.45	16.17	41.01	39.60	39.65	80.10	80.10	78.70
4	15.98	16.40	16.17	39.28	39.89	39.56	79.20	79.80	79.20
5	16.03	16.45	16.12	39.51	39.79	39.65	80.30	79.80	78.70
6	15.98	16.31	16.12	39.37	39.98	39.79	80.70	81.10	78.50
7	16.26	16.40	16.17	39.46	39.70	39.56	80.30	80.50	78.40
8	16.40	16.31	16.03	39.28	39.93	39.51	80.20	79.90	78.70
9	16.21	16.26	16.12	39.70	39.79	39.56	80.30	79.60	78.50
10	16.21	16.21	16.12	39.89	39.56	39.56	81.00	78.00	78.40
11	16.17	16.26	16.26	39.93	39.65	39.37	80.50	80.50	81.00
12	15.93	16.12	16.26	40.03	40.03	39.70	80.50	79.70	78.60
13	15.89	16.17	16.26	39.51	39.89	39.56	79.90	80.40	79.00
14	15.93	16.35	16.17	39.42	39.75	39.75	80.50	80.10	79.70
15	15.98	16.31	16.21	39.42	39.75	39.42	80.30	81.10	78.90
16	15.89	16.45	16.07	39.42	40.07	39.51	80.70	80.60	78.40
17	16.40	16.31	15.98	39.84	40.07	39.75	80.20	78.30	78.00
18	15.93	16.21	16.07	39.75	39.84	39.56	80.10	78.90	78.90
19	15.75	16.17	15.93	39.79	39.79	39.42	80.60	78.40	78.40
20	16.35	16.31	16.17	39.84	39.93	39.70	80.20	78.00	78.10
21	16.26	16.31	16.07	39.84	39.79	39.46	78.60	80.20	79.20
22	16.26	16.26	16.03	39.98	39.98	39.75	78.90	80.10	78.00
23	15.89	16.21	16.12	39.98	39.93	39.60	80.10	79.80	78.80
24	16.45	16.35	16.12	39.98	39.65	39.46	80.20	78.50	78.80
25	16.31	16.12	16.07	40.03	39.60	39.56	78.70	78.10	79.90
26	15.89	16.31	15.98	39.70	39.84	39.56	80.10	78.90	78.90
27	16.35	16.40	16.21	39.51	39.70	39.70	78.50	78.30	81.00
28	16.26	16.40	16.03	39.70	39.84	39.56	80.30	79.60	80.50
29	16.50	16.07	16.12	39.84	39.60	39.51	80.70	78.50	82.90
30	16.50	16.26	16.12	39.70	39.98	39.75	81.10	78.30	79.20