



Axia80 F/T Sensor Manual



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Engineered Products for Robotic Productivity

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Note:

Please read the manual before calling customer service, and have the following information available:

1. Serial number (e.g., FT01234)
2. Sensor model (e.g., Axia80-M50)
3. Calibration (US-15-50, SI-65-6, etc.)
4. Accurate and complete description of the question or problem
5. Computer and software information (operating system, PC type, drivers, application software, and other relevant information about the application's configuration)

Be near the F/T system when calling (if possible).

Please contact an ATI representative for assistance, if needed:

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Table of Contents

Glossary	B-4
1. Safety	B-6
1.1 Explanation of Notifications	B-6
1.2 General Safety Guidelines	B-6
1.3 Safety Precautions	B-7
2. Product Overview	B-8
2.1 Model Type Identification	B-10
3. Installation	B-11
3.1 Interface Plates	B-11
3.2 Routing the Cable	B-13
3.3 Cable Kits	B-16
3.4 Install the Sensor	B-16
3.5 Remove the Sensor	B-18
3.6 Accuracy Check Procedure	B-19
3.7 Detecting Sensitivity Changes	B-20
4. Operation	B-21
4.1 Sensor Environment	B-21
4.2 Tool Transformation	B-22
4.2.1 Avoid Overloading the Sensor During Tool Transformation	B-24
4.2.2 Tool Transformation Functionality Through a Communication Interface	B-24
5. Maintenance	B-24
5.1 Periodic Inspection	B-24
5.2 Periodic Calibrating	B-24
6. Troubleshooting	B-25
6.1 Basic Guidance for Troubleshooting	B-26
7. Specifications	B-29
7.1 Environmental Conditions	B-29
7.2 Electrical Specifications	B-29
7.3 Calibration Ranges	B-29
7.4 Default Peak Values	B-30
8. Terms and Conditions of Sale	B-31

Glossary

Term	Definition
Bias	Biasing is useful for eliminating the effects of gravity (tool weight) or other acting forces. When the bias function is used, the software collects data for the forces and torques that are currently acting on the sensor and use these readings as a reference for future readings. Future readings will have this reference subtracted from them before they are transmitted. Bias may also be referred to as “zero out” or “tare” the sensor.
Calibration	Defines a specific measurement or sensing range for a given sensor. Calibration is also the process of measuring a transducer’s raw response to loads and creating data used in converting the response to forces and torques.
Complex Loading	Any load that is not purely in one axis.
Communication Interface Versions	The software standard that the customer device uses to apply features to the sensor and for the sensor to report data, for example: EtherCAT, RS422, and Ethernet.
Coordinate Frame	See Sensing Reference Frame Origin.
Data Rate	How fast data can be output over a network.
Force	A force is a push or pull action on an object caused by an interaction with another object. Force = mass x acceleration.
FS	Full-Scale, refers to the limits of a given calibration or sensing range.
F/T	Force/Torque.
F_{xy}	The resultant force vector comprised of components F_x and F_y .
Hysteresis	A source of measurement error caused by the residual effects of previously applied loads.
Interface Plate	A separate plate that attaches the sensor to another surface. Interface plates are often used if the bolt pattern on the sensor doesn’t match the bolt pattern on the robot arm or customer tooling. The interface plate has two bolt patterns, one on either side of the plate. One side is for the sensor. The other side is for the robot arm or customer tooling.
IP64	Ingress protection rating “64” designates protection against dust and splashing of water. An IP64 rating does not guarantee protection when a user submerges a device in water or any type of fluid.
Master Device	A customer supplied device such as a personal computer, robot, or programmable logic controller (PLC) that is compatible a specific communication interface.
Measurement Uncertainty	Commonly referred to as “accuracy”, “measurement uncertainty” is the worst-case error between the measured value and the true load. The measurement uncertainty is specified as a percentage of the full-scale measurement range for a given sensor model and calibration size. This value takes into account multiple sources of error. The sensor’s calibration certificate lists the measurement uncertainty percentage. For more information, refer to <i>Section 2.2: Measurement Uncertainty</i> in the Frequently Asked Questions (FAQ) document located at: https://www.ati-ia.com/library/documents/FT_FAQ.pdf .
Mechanical Coupling	When an external object such as customer tooling or utilities contacts a sensor’s surface between the sensor’s mounting side and tool side.
Mounting Interface Plate	An interface plate that attaches the sensor to a fixed surface like a robot arm.
N/A	Not Applicable
Overload	The condition where more load is applied to the transducer than it can measure. This will result in saturation.

Term	Definition
P/N	Part Number
Power Cycle	When a user removes and then restores power to a device.
Resolution	The smallest change in load that can be measured. Resolution is usually much smaller than accuracy.
Sample Rate	How fast the ADCs are sampling inside the unit.
Saturation	The condition where the transducer or data acquisition hardware has a load or signal outside of its sensing range.
Sensing Reference Frame Origin	The point on the sensor from which all forces and torques are measured.
Sensor	The component that converts a detected load into electrical signals.
Sensor System (or configuration)	The entire assembly consisting of a sensor body and a system interface to translate force and torque signals into a specific communication interface/protocol.
Tool Interface Plate	An interface plate that attaches the customer's tooling to the tooling side (sensing side) of the sensor.
Torque	The application of a force through a lever or moment arm that causes something to want to turn. For example, a user applies torque to a screw to make it turn. Torque = force x moment arm length.
T_{xy}	The resultant torque vector comprised of components T_x and T_y .

1. Safety

The safety section describes general safety guidelines to be followed with this product, explanations of the notifications found in this manual, and safety precautions that apply to the product. Product specific notifications are imbedded within the sections of this manual (where they apply).

1.1 Explanation of Notifications

These notifications are used in all of ATI manuals and are not specific to this product. The user should heed all notifications from the robot manufacturer and/or the manufacturers of other components used in the installation.



DANGER: Notification of information or instructions that if not followed will result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.



WARNING: Notification of information or instructions that if not followed could result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.



CAUTION: Notification of information or instructions that if not followed could result in moderate injury or will cause damage to equipment. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

NOTICE: Notification of specific information or instructions about maintaining, operating, installing, or setting up the product that if not followed could result in damage to equipment. The notification can emphasize, but is not limited to: specific grease types, best operating practices, and maintenance tips.

1.2 General Safety Guidelines

The customer should verify that the sensor is rated for the maximum load and torque expected during operation. Because static forces are less than the dynamic forces from the acceleration or deceleration of the robot, be aware of the dynamic loads caused by the robot.

1.3 Safety Precautions



CAUTION: Modifying or disassembly of the sensor could cause damage and void the warranty. Use the supplied mounting interface plate and the provided tool side mounting bolt pattern to mount the sensor to the robot and customer tooling to the sensor. For more information, refer to the customer drawings.



CAUTION: Probing openings in the sensor causes damage to the instrumentation. Avoid prying into the openings of the sensor.



CAUTION: Do not overload the sensor. Exceeding the single-axis overload values of the sensor causes irreparable damage.



CAUTION: The sensor should be protected from impact and shock loads that exceed rated ranges during transportation as the impacts can damage the sensor's performance. Refer to [Section 7—Specifications](#) for more information about rated ranges.

2. Product Overview

The Axia80 Force/Torque (F/T) sensor detects six components of force and torque ($F_x \setminus F_y \setminus F_z \setminus T_x \setminus T_y \setminus T_z$) that are applied to the tool side of the sensor. The sensor communicates this data to a device (such as a personal computer, robot, or PLC). The ATI Axia-series product line differs from the other (non-Axia) ATI F/T sensor models. Thus, the Axia sensors have different options and available features. The Axia-series force/torque sensors are available in several different payload and communication interface versions. For more information about the communication interface, refer to the applicable ATI Axia sensor manual in [Table 2.1](#).

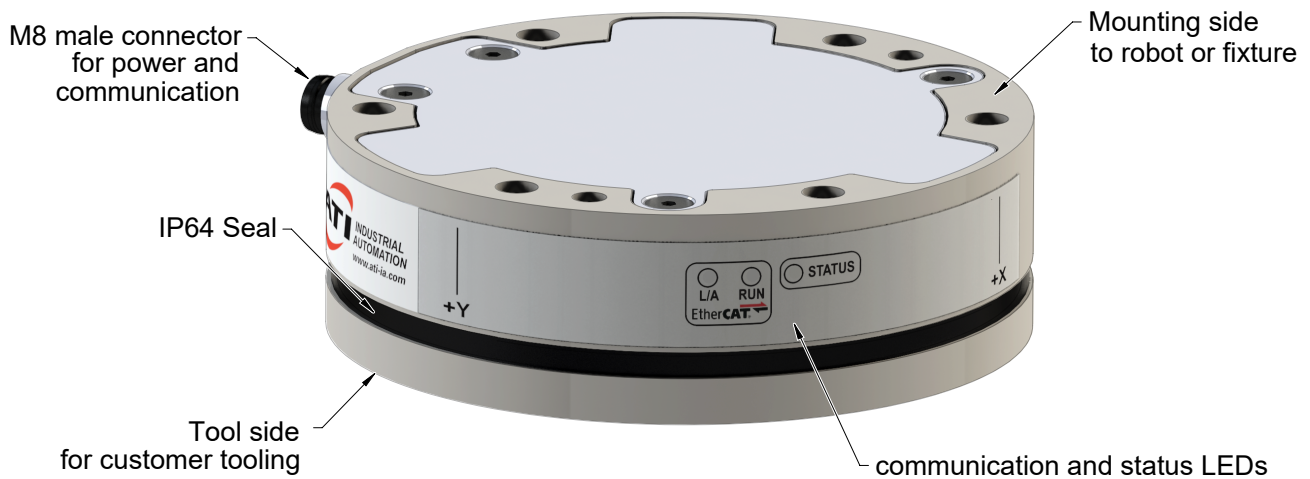
The Axia80 sensor is available in different model types (Axia80-MXX) that are identifiable by the grooves on the outer housing; refer to [Section 2.1—Model Type Identification](#). The MXX suffix signifies the full-scale torque measurement range. For the calibration ranges of each model, refer to [Section 7.3—Calibration Ranges](#).

The sensor's mounting side attaches to a rigid fixture or robot. The tool side attaches to the customer tooling. Both the mounting and tool sides have a 71.12 mm bolt circle pattern with (6) M5 tapped holes and (2) slip fit dowel holes. If the sensor does not have the same bolt pattern as the mounting or tool sides, use interface plates; refer to [Section 3.1—Interface Plates](#). The sensor is IP64 rated.

An M8 male connector is for power and communication. The number of pins on the connector depends on the communication type ([Table 2.1](#)). On the side of the sensor, LEDs indicate the sensor's operational state. For the connector pin assignments on the sensor and cables as well as more information about the LEDs, refer to the applicable ATI communication interface manual in [Table 2.1](#).

The customer drawing, ATI document #9230-05-1543, is available on the ATI website: https://www.ati-ia.com/app_content/Documents/9230-05-1543.auto.pdf.

Figure 2.1—Axia80 F/T Sensor



For more information on the electrical and software features of a specific communication interface version and the applicable cable, refer to the ATI manual in the following table:

Table 2.1—ATI Communication/Software Manual Reference			
Sensor Model ATI P/N	Communication Type	ATI Cable P/N	Refer to the ATI Manual
9105-NET- Axia80-MXX ^{1,2}	Ethernet	9105-C-ZC22-ZC28 ³ 9105-C-ZC28-U-RJ45S-x	ATI F/T Ethernet Axia manual (ATI document # 9620-05-C-Ethernet Axia)
9105-ECAT- Axia80-MXX	EtherCAT	9105-C-ZC22-ZC28 ³ 9105-C-ZC28-U-RJ45S-x	ATI F/T EtherCAT Axia manual (ATI document # 9620-05-C-EtherCAT Axia)
9105-RS422- Axia80-MXX ⁴	RS422	9105-C-ZC27-ZC28-4 ⁵ 9105-C-ZC28-MS-ZC35-X	ATI F/T RS422 Axia manual (ATI document # 9620-05-C-RS422 Axia)
Note: <ol style="list-style-type: none"> 1. MXX signifies the full-scale torque measurement range; refer to Section 2.1—Model Type Identification. 2. This P/N was formally 9105-NET-AXIA80-MXX-ZC22. 3. Included in 9105-CKIT-ZC22-ZC28-X; refer to Table 3.2. 4. This model has an 8-pin M8 connector on the sensor. All other Axia80 models have a 6-pin M8 connector. 5. Included in 9105-CKIT-ZC27-ZC28-X; refer to Table 3.3. 			

2.1 Model Type Identification

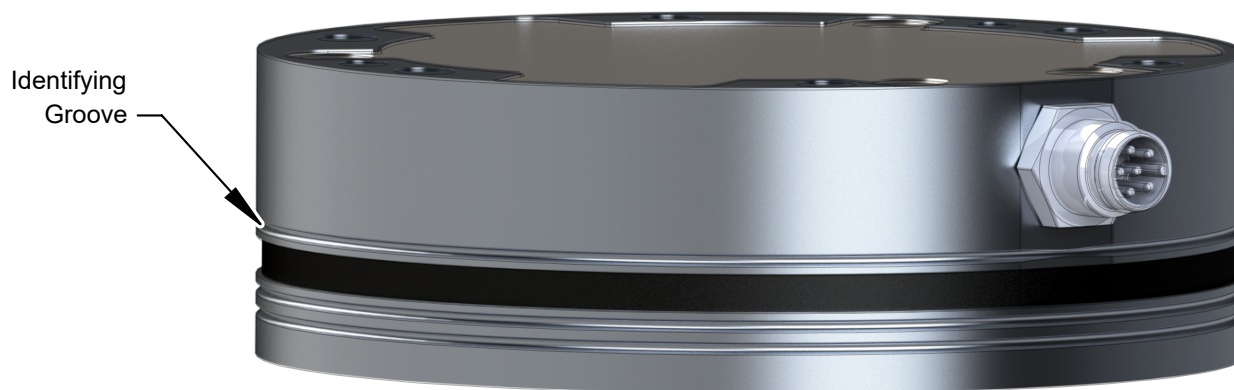
The Axia80 sensor is available in three different model types (Axia80-MXX) that are identifiable by the number of grooves on the outer housing. The MXX suffix signifies the full-scale torque measurement range. For the calibration ranges of each model type, refer to [Section 7.3—Calibration Ranges](#). An overview of each model is summarized in the following table:

Model	Part Number	Number of Identifying Grooves ¹	Material
Axia80-M8	9105-X ³ -Axia80-M8	3	Aluminum
Axia80-M20	9105-X ³ -Axia80-M20	0	
Axia80-M50	9105-X ³ -Axia80-M50	2	Stainless Steel

Notes:

1. Identifying grooves are physical indentations in the sensor body (refer to [Figure 2.2](#)). These grooves provide users a quick visual method to differentiate the sensor models.
2. For calibration ranges, refer to [Section 7.3—Calibration Ranges](#).
3. The X signifies the communication interface: NET, ECAT, or RS422.

Figure 2.2—Identifying Grooves (Axia80-M8 shown as a reference)



3. Installation



WARNING: Performing maintenance or repair on the sensor when circuits (for example: power, water, and air) are energized could result in death or serious injury. Discharge and verify all energized circuits are de-energized in accordance with the customer's safety practices and policies.



CAUTION: Using fasteners that exceed the customer interface depth penetrates the body of the sensor, damages the electronics, and voids the warranty. For more information, refer to the customer drawings.



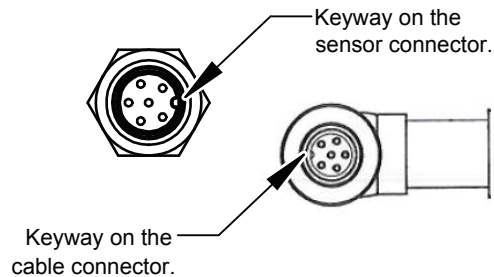
CAUTION: Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.



CAUTION: Avoid damage to the sensor from electrostatic discharge. Ensure proper grounding procedures are followed when handling the sensor or cables connected to the sensor. Failure to follow proper grounding procedures could damage the sensor.



CAUTION: Do not apply excessive force to the sensor and cable connector during installation, or damage will occur to the connectors. Align the keyway on the sensor and cable connector during installation to avoid applying excessive force to the connectors.



3.1 Interface Plates

The sensor's mounting side attaches to a surface like the robot arm, and the sensor's tool side attaches to the customer tooling. ATI can supply robot mounting kits that include a mounting interface plate and fasteners; for more information, contact ATI (refer to [page B-2](#)). If the customer chooses to supply their own interface plates, refer to the following design guidelines and the [ATI Axia sensor customer drawing](#).

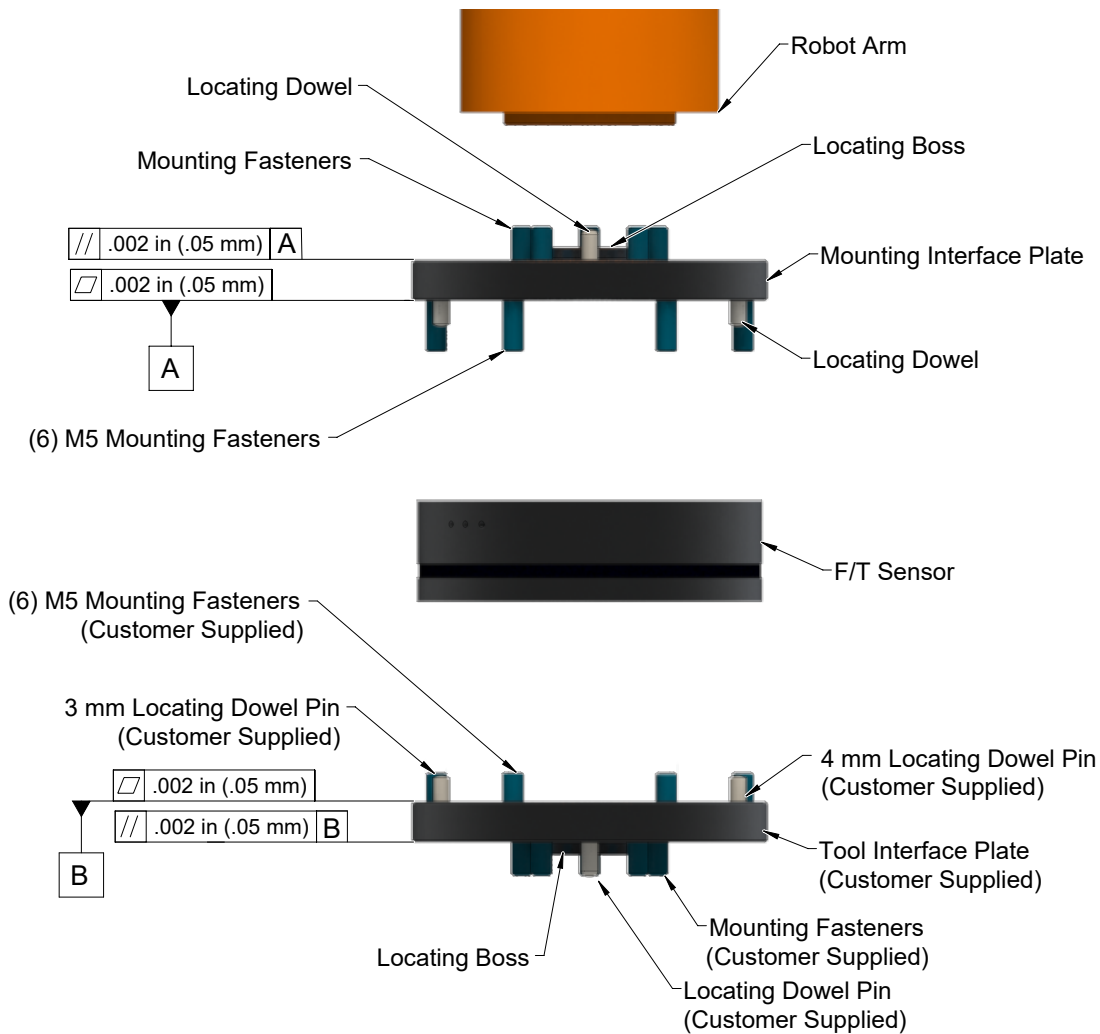


CAUTION: Incorrect installation of interface plates can prevent the F/T sensor from functioning properly.

If the customer chooses to design and build an interface plate, consider the following points:

- The interface plate should include bolt holes for mounting fasteners as well as a dowel pin and boss for accurate positioning to the robot.
- The thickness of the interface plate must provide sufficient thread engagement for the mounting fasteners.
- The mounting fasteners should not interfere with the internal electronics of the sensor. For thread depth, mounting patterns, and other details, refer to the *ATI Axia sensor customer drawing*.
- Do not use dowel pins that exceed length requirements and prevent interface plate from mating flush with the robot. Fasteners that exceed length requirements create a gap between the interfacing surfaces and cause damage.
- The interface plate must be as strong or stronger than the sensor so that maximum force and torque values applied to the sensor do not distort the interface plate. For these force and torque values, refer to *Section 7—Specifications*.
- The interface plate must provide a flat and parallel mounting surface for the sensor.

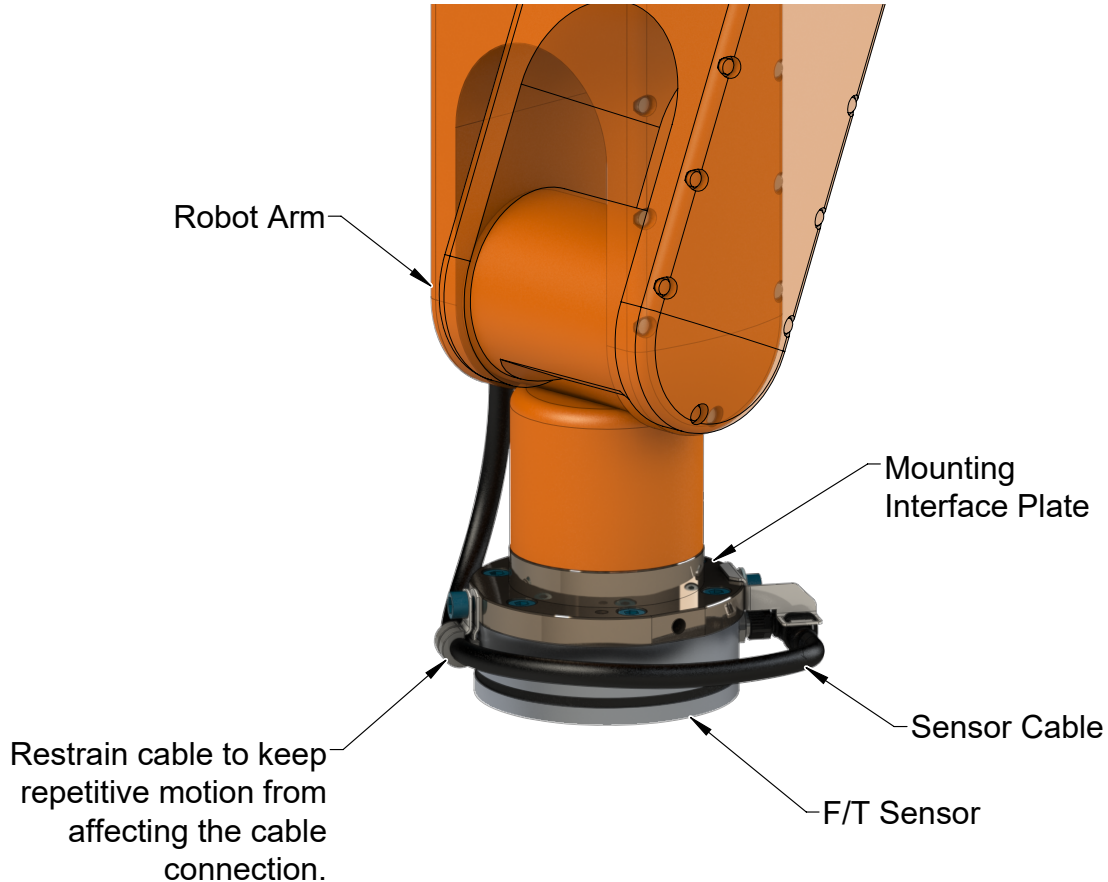
Figure 3.1 —Interface Plate(s)



3.2 Routing the Cable

The routing and bending radius of the cable depends upon the customer application. Unlike motionless applications, where the cable is in a static condition, dynamic applications subject the cable to a repetitive motion. For dynamic applications, restrain the cable at a distance that does not expose and damage the sensor's cable connection from the robot's repetitive motion.

Figure 3.2—Routing of the Sensor Cable



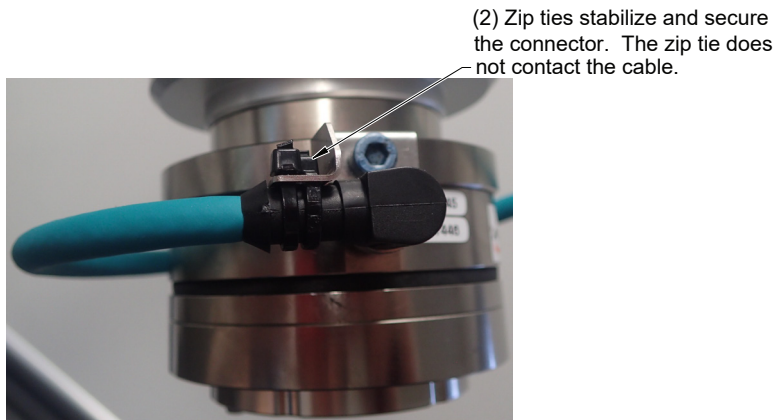
CAUTION: Subjecting the connector to the repetitive motion will cause damage to the connector. Restrain the cable close to the connector so that the repetitive motion of the robot does not interfere with the cable connector.



CAUTION: Improper cable routing may cause injury to personnel, poor functionality of critical electrical lines, or damage to the equipment. The electrical line, especially where attached to the sensor's connector, must be routed to avoid stress failure, sharp bends, or a disconnection from the equipment. Damage to the sensor or cable from improper routing will void the warranty.

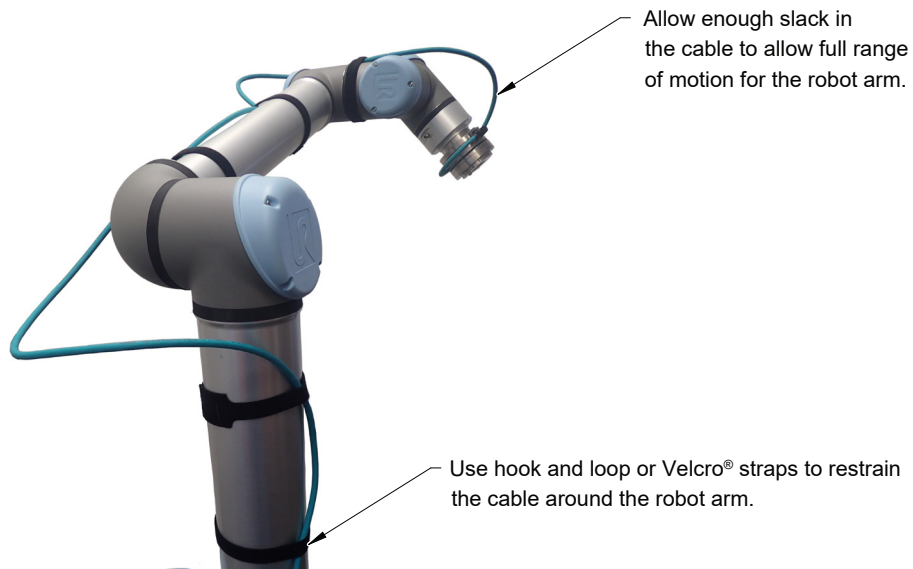
For added stability, zip ties can be used to secure the cable to a mounting bracket (refer to the following figure). The zip ties should never contact the cable jacket.

Figure 3.3—Use Zip Ties on the Connector (sensor shown for reference only)



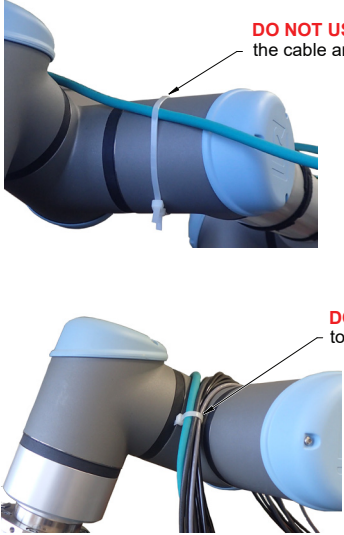
Route the sensor cable so that it is not stressed, pulled, kinked, cut, or otherwise damaged throughout the full range of motion. Use a robot dresspack solution, if possible. Examples of how to route the cable, if a dresspack is not available, are shown in the following figures and descriptions. Affix the cable by using hook and loop straps or Velcro® straps; do not use cable ties or zip ties.

Figure 3.4—Use Hook and Loop or Velcro® Straps on the Cable (sensor shown for reference only)

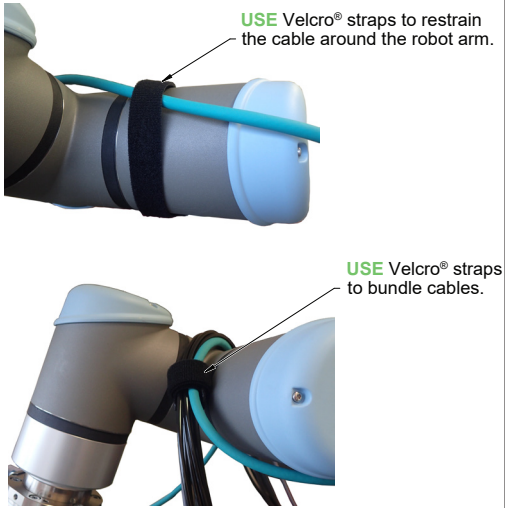


CAUTION: Do not use cable ties or zip ties to bundle cables or restrain the cable to the robot arm. Directly affixing cable ties or zip ties to the cable jacket will damage the cable. Use hook and loop or Velcro straps on the cable jacket surfaces. Examples of the incorrect and correct methods to restrain or bundle cables are in the following pictures:

INCORRECT



CORRECT



CAUTION: Do not damage or crush the cable by over tightening the straps on the cable.

CAUTION: When routing the cables, do not bend less than the minimum bending radius specified in [Table 3.1](#). A bend radius too small causes the cable to fail from fatigue of the robot’s repetitive motion.

Table 3.1—Sensor Cable Bending Radius and Dynamic Twist Angle

Cable Part Number	Cable Diameter mm (in)	Static Bending Radius (at room temperature)		Dynamic Bending Radius (at room temperature)		Dynamic Cable Twist Angle per Unit Length
		mm	in	mm	in	
9105-C-ZC22-ZC28-X ^{2,3}	6 (0.24)	25	1	50	2	180°/m or 55°/ft
9105-C-ZC27-ZC28-X ^{2,4}	6 (0.24)	25	1	50	2	
9105-C-ZC28-U-RJ45S-X ²	6 (0.24)	25	1	50	2	

Notes:

- Temperature affects cable flexibility. ATI recommends increasing the minimum dynamic bending radius for lower temperatures.
- The X in the part number represents the cable length. For more information, contact ATI.
- Available in an ATI kit; refer to [Table 3.2](#).
- Available in an ATI kit; refer to [Table 3.3](#).
- For information specific to the cable part number, refer to the applicable manual in [Table 2.1](#).

3.3 Cable Kits

For images of the sensor support bracket and P-clip, refer to [Figure 3.2](#) and [Figure 3.5](#).

Table 3.2—Cable Kit 9105-CKIT-ZC22-ZC28-X		
Part Number	Description	Quantity
9105-C-ZC22-ZC28-4	6-pin M8 connector to 8-pin M12 connector with a 4 m cable	1
9005-05-1078	(1) bracket, (1) M5 x 10 socket head cap screw, (1) M5 flat washer, and (1) tie	1
9005-05-1079	(1) P-clamp and (1) M5 x 10 socket head cap screw	1

Table 3.3—Cable Kit 9105-CKIT-ZC27-ZC28-X		
Part Number	Description	Quantity
9105-C-ZC27-ZC28-4	8-pin M12 connector to 8-pin M12 connector with a 4 m cable	1
9005-05-1078	(1) bracket, (1) M5 x 10 socket head cap screw, (1) M5 flat washer, and (1) tie	1
9005-05-1079	(1) P-clamp and (1) M5 x 10 socket head cap screw	1

3.4 Install the Sensor

Parts required: Refer to [Figure 3.5](#) and [ATI Axia sensor customer drawing](#)

Tools required: 4 mm hex key or 4 mm low profile hex key (part of ATI Kit P/N 9105-IP-2126)

Supplies required: Clean cloth, Loctite® 242

1. Clean the mounting surfaces.
2. Use the mounting fasteners to attach the interface plate to the mounting surface.

NOTICE: When installing an interface plate:

- Screws must have a minimum thread engagement length of 4.5 mm. Maximum screw thread engagement shall not exceed the threaded depth listed on the [ATI Axia sensor customer drawing](#).
- Unless otherwise specified, apply Loctite 242 to the (6) M5 socket head cap screws (class 12.9) so that the fasteners secure the sensor to the mounting plate.

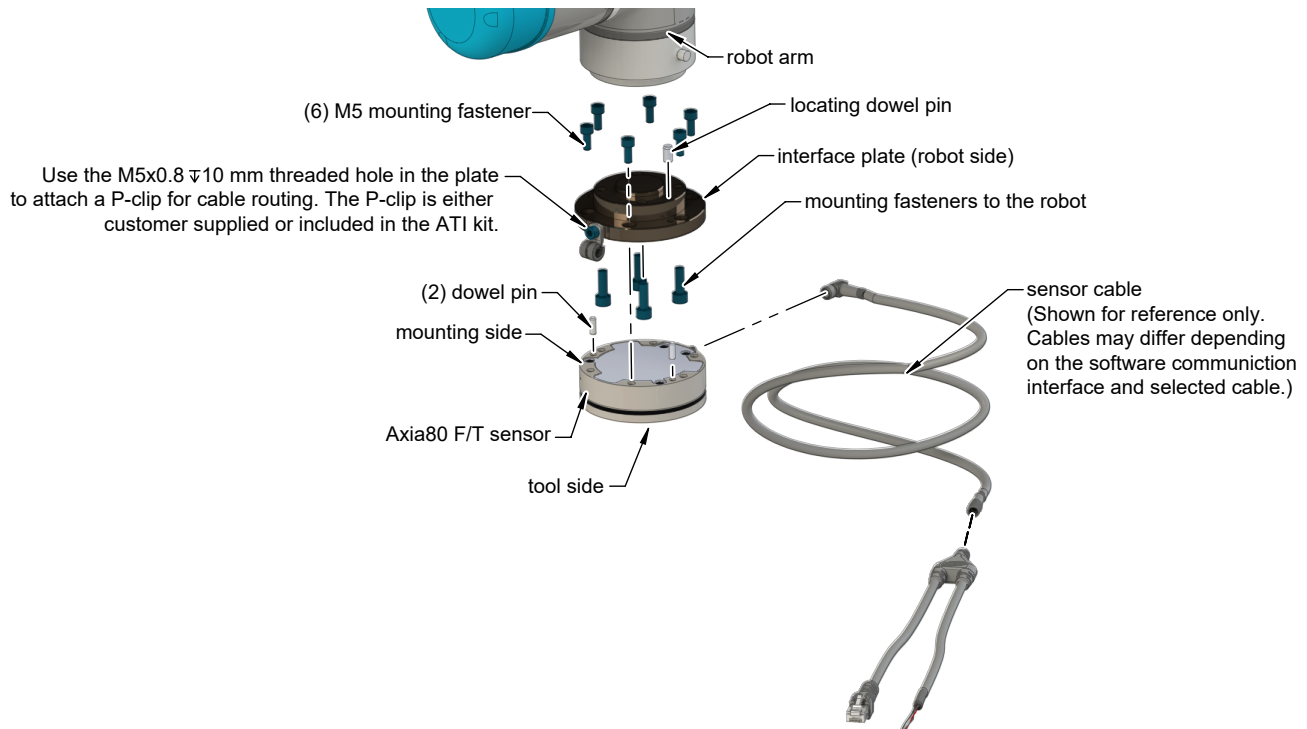
3. Attach the mounting side of the sensor to the interface plate.
 - a. Using a 4 mm hex key, secure the sensor to the mounting interface plate with (6) M5 socket head cap screws (class 12.9). Tighten the fasteners per the specifications in the following table.

Table 3.4—Torque Values for Axia Models	
Model	Torque
Axia80-M8	52 in-lbs (5.88 Nm)
Axia80-M20	
Axia80-M50	75 in-lbs (8.47 Nm)

4. Once the sensor is installed on the robot, the customer tooling can be installed.

NOTICE: The tool must not touch any other part of the sensor except the tool side; otherwise, the sensor will not properly detect loads.

Figure 3.5—Installation of the Sensor to the Robot



NOTICE: For the LED outputs that indicate the sensor's operational condition, refer to the applicable manual listed in [Table 2.1](#).

5. Connect the cable(s) to the sensor and customer application. For the sensor and cable connector pinout information, refer to the applicable manual in [Table 2.1](#).
6. After connecting the cable to the customer interface, set up the sensor communication interface software; for additional information about the software communication interface, refer to the applicable manual in [Table 2.1](#).
7. Properly restrain and route the cable (refer to [Section 3.2—Routing the Cable](#)). If using an ATI cable kit:
 - a. Above the sensor connector, secure the bracket to the interface plate. Insert the M5 screw through the flat washer. Use a 4 mm hex key to tighten the M5 socket head cap screw.
 - b. Use the tie in the kit to secure the connector to the bracket (refer to [Figure 3.3](#)).
 - c. Secure the P-clip to the interface plate (refer to [Figure 3.2](#)). Use a 4 mm hex key to tighten the M5 socket head cap screw.
 - d. Route the cable (refer to [Section 3.2—Routing the Cable](#)).
8. After installation is complete, the sensor is ready for an accuracy check (refer to [Section 3.6—Accuracy Check Procedure](#)).
9. Safely start normal operation.

3.5 Remove the Sensor

Tools required: 3 mm hex key

1. Turn off all energized circuits, for example: electrical.
2. Remove the cable from the sensor.
3. Supporting the customer tooling, remove the customer supplied screws that attach the customer tooling to the sensor.
4. Supporting the sensor, use a 3 mm hex key to remove the (6) M4 socket head cap screws that secure to the sensor to the mounting interface plate or surface.
5. Remove the sensor

3.6 Accuracy Check Procedure

Complete the following procedures after the initial installation of the sensor to the robot and once annually for maintenance.

NOTICE: The mass on the tool side can be the weight of the tooling used in the application.

1. Attach a fixed mass to the tool side of the F/T sensor:
 - a. Remove cables that form bridges between the sensor's mounting and tool sides.
2. Power on the sensor. Allow a 30 minute warm-up time. Minimize external sources of temperature change.

NOTICE: For optimal results, write a robot program to move the sensor and mass to each of the following positions sequentially. At each position, the robot should pause to record the sensor's output. Avoid jogging the robot and waiting several minutes between each position.

3. Move the robot so that the sensor is in the following positions:
 - a. Record the sensor's output, $F_{x, point n}$, $F_{y, point n}$, $F_{z, point n}$, at each point without biasing.
 - Point 1: +Z up
 - Point 2: +X up
 - Point 3: +Y up
 - Point 4: -X up
 - Point 5: -Y up
 - Point 6: -Z up
4. Calculate $F_{x, average}$, $F_{y, average}$, and $F_{z, average}$:
 - a. Use the following equations, to complete the calculations:

$$F_{x, average} = \frac{F_{x, point 1} + F_{x, point 2} + \dots + F_{x, point 6}}{6}$$

$$F_{y, average} = \frac{F_{y, point 1} + F_{y, point 2} + \dots + F_{y, point 6}}{6}$$

$$F_{z, average} = \frac{F_{z, point 1} + F_{z, point 2} + \dots + F_{z, point 6}}{6}$$

5. For each of the 6 points, complete the following calculation:

$$F_x = F_{x, point n} - F_{x, average}$$

$$F_y = F_{y, point n} - F_{y, average}$$

$$F_z = F_{z, point n} - F_{z, average}$$

$$\text{Tooling Mass} = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

6. The calculated tooling masses for all (6) points should deviate from each other by less than twice the worst accuracy rating of the sensor.
 - For example: the Axia80-M20 sensor's rated accuracy is 2% the range on all axes. For a 500 N F_{xy} range and a 900 N F_z range, the allowable errors of any single data point would be ± 10 N F_{xy} and ± 18 N F_z respectively. Since F_z has the larger tolerance, then one data point could be + 18 N and another data point could be - 18 N, for a total range (max-min) of 36 N error.
 - In addition, the tooling mass should be within 36 N of the results of this test when it was performed with a new sensor.
7. If this test fails, then the sensor should be returned to ATI for diagnosis or recalibration.

3.7 Detecting Sensitivity Changes

Sensitivity checking of the sensor can also be used to measure the Axia sensor's health. Apply known loads to the sensor and verifying the system output matches the known loads. For example, a sensor mounted to a robot arm may have an end-effector attached to it. Use the following process to set a sensitivity value:

1. If the end-effector has moving parts, they must be moved in a known position.
 - a. Place the robot arm in an orientation that allows the gravity load from the end-effector to exert load on many sensor output axes.
2. Record the output readings.
3. Position the robot arm to apply another load, this time causing the outputs to move far from the earlier readings.
4. Record the second set of output readings.
5. Find the differences from the first and second set of readings.
6. Use the differences as a sensitivity value.

Even if the sensitivity values vary from sample set to sample set, these values can be used to detect gross errors. Either the resolved outputs or the raw sensor voltages may be used (the same must be used for all steps of this process).

4. Operation

Information that applies generally to all Axia80 sensors is in the following section. For more information specific to the communication protocol of the sensor, such as sampling rate, LEDs, operation commands, refer to the applicable manual in [Table 2.1](#).

4.1 Sensor Environment



CAUTION: Damage to the outer jacketing of the sensor cable could enable moisture or water to enter an otherwise sealed sensor. Ensure the cable jacketing has not deteriorated to prevent sensor damage.

NOTICE: Sensors may react to exceptionally strong and changing electromagnetic fields, such as those fields created by magnetic resonance imaging (MRI) machines.

The user must ensure that the dust and water in the environment does not exceed the IP64 rating of the sensor. Ingress protection rating “64” designates protection against dust and splashing of water. An IP64 rating does not guarantee protection when a user submerges a device in water or any type of fluid. While the Axia80 sensor is IP64 rated, keep debris and dust from accumulating on or in the sensor.

4.2 Tool Transformation

By default, the forces and torques are reported with respect to a point of origin on the sensor that is set by ATI. For the sensor's point of origin, refer to the [ATI Axia sensor customer drawing](#). The tool transformation function allows measurement of the forces and torques at a reference point other than the sensor's point of origin.



CAUTION: If the customer sets a reference point that is at the same location to which a force is applied, there will be no report of a torque applied to the sensor. As a result, the sensor could be overloaded (refer to [Section 4.2.1—Avoid Overloading the Sensor During Tool Transformation](#)). Therefore, when evaluating overloading conditions, use the sensor's point of origin as the reference point.

The user defines a reference point by inputting a parameter set that is a series of (3) displacements ($D_x \setminus D_y \setminus D_z$) and (3) rotations ($R_x \setminus R_y \setminus R_z$), for example:

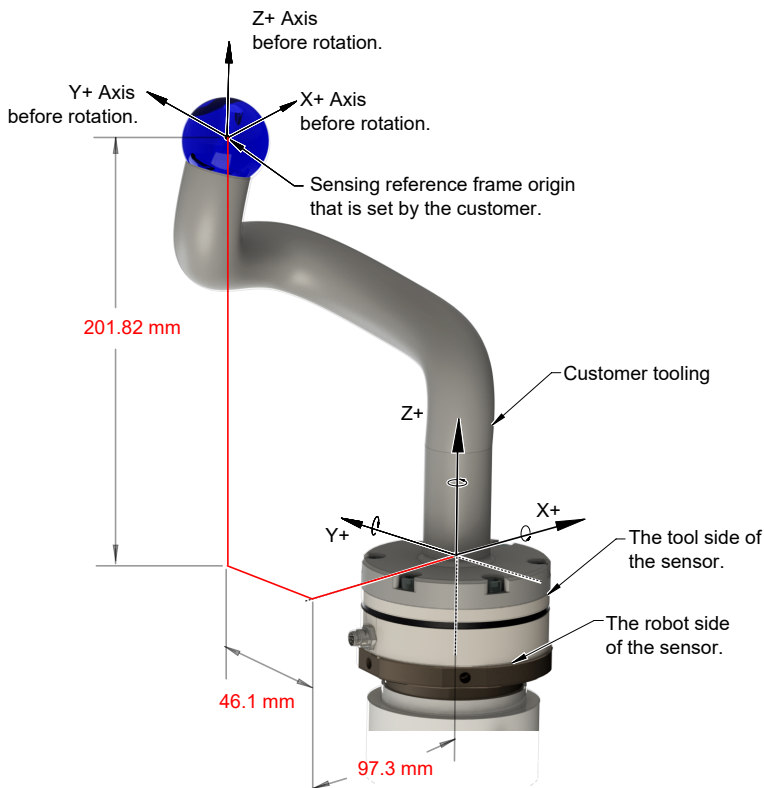
$D_x = -97.3 \text{ mm}$ $D_y = 46.1 \text{ mm}$ $D_z = 201.82 \text{ mm}$ $R_x = +90^\circ \text{ rotation}$ $R_y = +180^\circ \text{ rotation}$ $R_z = 0^\circ \text{ rotation}$

If zeros are entered for any of the parameter set values, the tool transformation is not performed for that particular parameter. Entering zero for all of the parameters, turns the tool transformation feature off. Once a new parameter set is entered and saved, previously entered parameter sets are no longer in effect.

Once a user enters a parameter set, the displacements are performed first. The displacements of the user reference frame of origin from the sensor point of origin is shown in the following figure. In this figure, the user reference frame of origin has not yet rotated relative to the sensor point of origin.

NOTICE: In the following figures, the sensor model is shown for reference only. The connector and sensor axes may align differently between sensor models. To determine the location of the default sensor axes, refer to the ATI sensor drawing or the axes labels on the sensor.

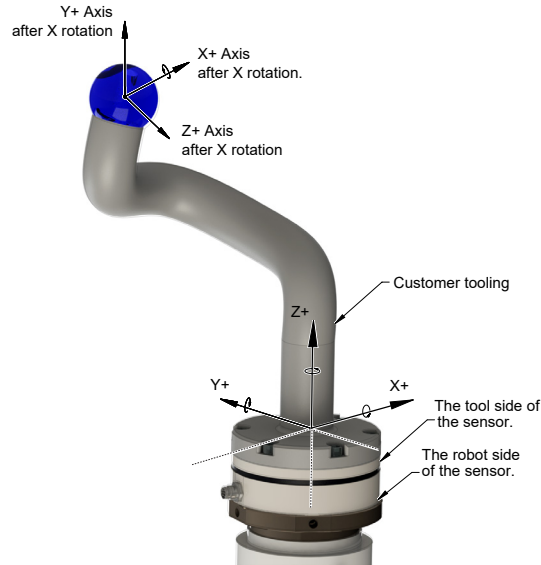
Figure 4.1—Tool Transformation : Distances



After the displacements, the user point of origin rotates in the following order:

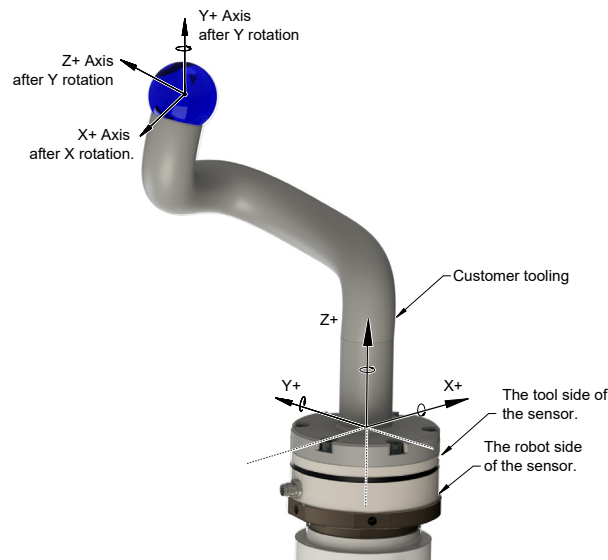
1. The first rotation is about the X-axis.
 - Recall in this example $R_x = +90^\circ$ rotation. The user point of origin rotates $+90^\circ$ about the X-axis, in the following figure.

Figure 4.2—Tool Transformation : Rotation About the X-Axis



2. The second rotation is about the Y-axis of the new user output reference frame.
 - In this example $R_y = +180^\circ$ rotation. The user point of origin rotates $+180^\circ$ about the Y-axis of the new user output reference frame, in the following figure.

Figure 4.3—Tool Transformation: Rotation About the Y-Axis



3. The third and final rotation is about the Z-axis of the new user output reference frame.
 - In this example $R_z = 0^\circ$ rotation. Therefore, the user point of origin does not rotate any more.
- After, the rotations are complete, the final user reference frame of origin is set.

4.2.1 Avoid Overloading the Sensor During Tool Transformation

It is possible for the user to set a reference point of origin that does not detect that a torque is applied to the customer tooling, and by extension, the sensor. Torque is the force multiplied by the distance of that force from a reference point of origin. If the customer reference point of origin is at the same point at which a force is applied, the distance from that force to the customer reference point of origin is zero. Any force that is multiplied by a distance of zero yields zero torque. The software tool transformation reports that no torque is applied to the sensor. However, the sensor's point of origin has not changed, and the force is still applied at a distance from the sensor's point of origin. Therefore, if the customer is evaluating overloading conditions, the customer should use the sensor's point of origin as the reference point.

4.2.2 Tool Transformation Functionality Through a Communication Interface

The user defines a reference point by inputting a parameter set that is a series of (3) displacements ($D_x \setminus D_y \setminus D_z$) and (3) rotations ($R_x \setminus R_y \setminus R_z$). For commands that write a parameter set and units, refer to the appropriate manual in [Table 2.1](#).

5. Maintenance

5.1 Periodic Inspection

With industrial-type applications that frequently move the system's cabling, inspect the cable jacket for signs of wear. While the Axia sensor is IP64 rated, keep debris and dust from accumulating on or in the sensor. Clean the surface of the sensor with isopropyl alcohol.

5.2 Periodic Calibrating

Periodic calibration of the sensor and its electronics is required to maintain traceability to national standards. The sensor cannot be calibrated in the field; return the sensor to ATI for recalibration. Contact an ATI account manager or rma-admin@ati-ia.com to request a Returned Materials Authorization (RMA) for recalibration. ATI recommends annual accuracy checks (refer to [Section 3.6—Accuracy Check Procedure](#)). If the sensor does not meet the performance requirements of the user application and fails the accuracy check, return the sensor to ATI for recalibration.

6. Troubleshooting

This section includes solutions to some issues that might arise when setting-up and using the sensor. For questions and troubleshooting assistance with software, refer to the appropriate manual in [Table 2.1](#). Answers to frequently asked questions are available from the ATI website: https://www.ati-ia.com/library/documents/FT_FAQ.pdf.

The information in this section should answer many questions that might arise in the field. Customer service is available to users who have questions or concerns addressed in the manuals.

Note

Please read the manual before calling customer service. Before calling, have the following information available:

1. Serial number (e.g., FT01234)
2. Sensor model (e.g., Axia80-M50)
3. Calibration (US-15-50, SI-65-6, etc.)
4. Accurate and complete description of the question or problem
5. Computer and software information (operating system, PC type, drivers, application software, and other relevant information about the application's configuration)

If possible, be near the F/T system when calling.

For additional troubleshooting information or to speak with a customer service representative, please contact ATI at:

ATI Industrial Automation

1031 Goodworth Drive
Apex, NC 27539 USA
www.ati-ia.com

Application Engineering

Tel: +1.919.772.0115, Extension 511
Fax: +1.919.772.8259
E-mail: ft_support@ati-ia.com
24/7 Support: +1 855 ATI-IA 00 (+1 855-284-4200)

6.1 Basic Guidance for Troubleshooting

Basic symptoms of inaccurate data and errors are listed in the following section. For each symptom, causes and appropriate solutions are suggested.

Symptom: Noise — jumps in force torque readings greater than 0.05% of full-scale counts.

Cause: Noise can be caused by mechanical vibrations and electrical disturbances that are possibly from a poor ground. Electrical interference can also come from a high noise output device such as a motor.

Solution: Make sure that the DC supply voltage for the Axia sensor has little to no noise superimposed. Ground the sensor by connecting the cable's shield to ground. In most setups, 0 V is also connected to ground. Connect the robot or other fixture to the same ground.

Verify that sensor cables do not cross over other cables or are within close proximity to other equipment that could generate electrical noise.

Avoid sources of mechanical noise. If not possible, apply a filter to the data as described in the applicable communication interface ATI manual in [Table 2.1](#).

Cause: Noise can also indicate component failure within the system.

Solution: Check the status code of the sensor; refer to the applicable communication interface ATI manual in [Table 2.1](#).

Perform an accuracy check; refer to [Section 3.6—Accuracy Check Procedure](#) or refer to [Section 4.5: How do I evaluate the accuracy of health of the sensor?](#) in the Frequently Asked Questions (FAQ) ATI document located at: https://www.ati-ia.com/library/documents/FT_FAQ.pdf.

To return the sensor to ATI for inspection, contact ATI for a Returned Materials Authorization (RMA); refer to [Section 5.2—Periodic Calibrating](#).

Symptom: Drift — when the force torque data continues to increase or decrease after a load is removed.

Cause: Some drift from a change in temperature is normal. Drift is observed more easily in the Z axis, compared to the X and Y axes.

Solution: For approximately thirty minutes, allow the sensor to warm up until it is at a steady state with the air and other objects touching the sensor.

Use the bias command to shift the readings back to zero. Bias regularly.

Use an insulator between the sensor and any tooling or fixtures which are at a different temperature. Avoid creating a temperature gradient across the sensor. Shield the sensor from excessive air flow.

For more information about how to avoid drift from temperature change, refer to the following ATI document: <https://www.ati-ia.com/Library/Documents/DriftExplanation.pdf>.

Symptom: Hysteresis — when the sensor is loaded from a zeroed or biased state and then the load is removed, sensor output does not immediately return to zero.

Cause: Mechanical coupling or internal failure can cause Hysteresis which is outside of the sensor's specified and acceptable measurement uncertainty (error) range.

Solution: Verify the sensor is properly installed, fasteners are tightened, and the customer tooling is securely installed per [Section 3—Installation](#).

Use the bias command to shift the readings back to zero.

Symptom: The initial F/T values are non-zero and no load is applied.

Normal. Bias the sensor to bring all the F/T values back to zero.

Symptom: The sensor does not report accurate F/T data.

Cause: The sensor may be in an error state.

Solution: Check the sensor status code. For how to read and interpret the status code, refer to the appropriate manual in [Table 2.1](#)). If there are no error bits ON, continue troubleshooting.

Cause: The sensor is not properly installed or not mounted to a flat, stiff surface.

Solution: Verify the sensor is correctly installed per [Section 3—Installation](#).

Cause: The mounting fasteners are not properly secured.

Solution: Verify the fasteners are secured per the installation procedures in [Section 3.4—Install the Sensor](#).

If fasteners are customer supplied, do not use fasteners that are too long. For maximum fastener penetration depth into the sensor, refer to the [ATI sensor drawing](#). When selecting fasteners: use a high quality, high strength screw or bolt and ensure the fastener's material type, fastener head, and fastener grade are proper for the application.

Cause: Mechanical coupling — an external object such as customer tooling or utilities contacts a sensor's surface between the mounting side and tool side.

Solution: Remove any debris between the tool side and interface plate. Use proper cable management for cables and hoses; do not connect them tightly between the mounting and tool side of the sensor.

Anything that contacts surfaces such as the through hole in the sensor or cover plates on either side of the sensor induces loading or movement that could result in inaccurate F/T data.

Symptom: The F/T values do not match expected values, for example: the F/T values are fluctuating but are higher than a known applied load.

Cause: The sensor may be in a mode that reports gage data instead of F/T data.

Solution: Gage data is not a 1:1 correlation to F/T axis data. View F/T data instead of gage data; refer to the applicable communication interface ATI manual in [Table 2.1](#).

Cause: The sensor outputs data in counts. The user must convert the counts to calibration units.

Solution: Counts must be divided by the Counts per Force (CpF) or Counts per Torque (CpT) in order to convert them to calibration units such as N and Nm.

In addition to CpF and CpT, depending on the communication protocol, the values may be further scaled by a 16-bit scale factor. 16-bit counts must be divided by (CpF or CpT ÷ 16-bit scale factor) in order to convert to calibration units.

Cause: If once the F/T readings are converted to calibration units and exceed the sensor's calibration range per [Section 7.3—Calibration Ranges](#), the reported values are inaccurate and the sensor may be overloaded.

Solution: Check the status code. For information on how to read and interpret the sensor's status code, refer to the applicable communication interface ATI manual in [Table 2.1](#).

Unmount the sensor. Improper mounting methods can induce high loads in the sensor.

Switch to a larger calibration size, if the application requires loads outside the range of the smaller calibration size.

After using the larger calibration size and without applying a load, if errors such as "Sensing Range Exceeded", "Gage Out of Range", or "Gage Broken" persist, the sensor is likely permanently damaged due to overload

7. Specifications

Some requirements and specifications for the Axia80 sensor are covered in the following sections. For more information, refer to the customer drawing.

7.1 Environmental Conditions

Table 6.1—Environmental Conditions	
Parameter	Value
Storage Temperature, °C	-20 to +85
Operating Temperature, °C	0 to +65
Relative Humidity	<95%, non-condensing

7.2 Electrical Specifications

Table 6.2—Power Supply ¹				
Power Source	Voltage			Power Consumption
	Minimum	Nominal	Maximum	Maximum
DC Power	12 V	24 V	30 V	1.5 W

Notes:

- The power supply input is reverse polarity protected. If the power and ground to the power supply inputs are plugged in reverse, then the reverse polarity protection stops the incorrectly wired supply input from damaging or powering on the sensor.

7.3 Calibration Ranges

Table 6.3—Calibration Range 0 and Calibration Range 1			
Model	Axia80-M8		
Parameter	Fxy	Fz	Txyz
Calibration Range 0 (SI-150-8)	150 N	470 N	8 Nm
Calibration Range 1 (SI-75-4)	75 N	235 N	4 Nm

Notes:

- Each sensor is calibrated with both of these calibration ranges.

Table 6.4—Calibration Range 0 and Calibration Range 1			
Model	Axia80-M20		
Parameter	Fxy	Fz	Txyz
Calibration Range 0 (SI-500-20)	500 N	900 N	20 Nm
Calibration Range 1 (SI-200-8)	200 N	360 N	8 Nm

Notes:

- Each sensor is calibrated with both of these calibration ranges.

Table 6.5—Calibration Range 0 and Calibration Range 1			
Model	Axia80-M50		
Parameter	Fxy	Fz	Txyz
Calibration Range 0 (SI-1500-50)	1200 N	2000 N	50 Nm
Calibration Range 1 (SI-480-20)	480 N	800 N	20 Nm

Notes:

- Each sensor is calibrated with both of these calibration ranges.

7.4 Default Peak Values

When powered on, the sensor records the peak values seen on any single axis. The following values are the default values programmed at the factory during calibration. If the sensor shows peak values higher than these defaults, the sensor has been loaded past the intended calibrated sensing range.

Table 6.6—Default Peak Values in Counts						
Sensor Model	Axia80-M8					
Parameter	Fx	Fy	Fz	Tx	Ty	Tz
Positive Default Value	2.25 x 10 ⁸		7.05 x 10 ⁸	1.2 x 10 ⁷		
Negative Default Value	-2.25 x 10 ⁸		-7.05 x 10 ⁸	-1.2 x 10 ⁷		

Table 6.7—Default Peak Values in Counts						
Sensor Model	Axia80-M20					
Parameter	Fx	Fy	Fz	Tx	Ty	Tz
Positive Default Value	7.50 x 10 ⁸		1.35 x 10 ⁹	3.0 x 10 ⁷		
Negative Default Value	-7.50 x 10 ⁸		-1.35 x 10 ⁹	-3.0 x 10 ⁷		

Table 6.8—Default Peak Values in Counts						
Sensor Model	Axia80-M50					
Parameter	Fx	Fy	Fz	Tx	Ty	Tz
Positive Default Value	7.499988 x 10 ⁸		1.249998 x 10 ⁹	3.124995 x 10 ⁷		
Negative Default Value	-7.499988 x 10 ⁸		-1.249998 x 10 ⁹	-3.124995 x 10 ⁷		

8. Terms and Conditions of Sale

The following Terms and Conditions are a supplement to and include a portion of ATI's Standard Terms and Conditions, which are on file at ATI and available upon request.

ATI warrants to Purchaser that force torque sensor products purchased hereunder will be free from defects in material and workmanship under normal use for a period of one (1) year from the date of shipment. The warranty period for repairs made under a RMA shall be for the duration of the original warranty, or ninety (90) days from the date of repaired product shipment, whichever is longer. ATI will have no liability under this warranty unless: (a) ATI is given written notice of the claimed defect and a description thereof with thirty (30) days after Purchaser discovers the defect and in any event, not later than the last day of the warranty period and (b) the defective item is received by ATI not later than (10) days after the last day of the warranty period. ATI's entire liability and Purchaser's sole remedy under this warranty is limited to repair or replacement, at ATI's election, of the defective part or item or, at ATI's election, refund of the price paid for the item. The foregoing warranty does not apply to any defect or failure resulting from improper installation, operation, maintenance, or repair by anyone other than ATI.

ATI will in no event be liable for incidental, consequential, or special damages of any kind, even if ATI has been advised of the possibility of such damages. ATI's aggregate liability will in no event exceed the amount paid by the purchaser for the item which is the subject of claim or dispute. ATI will have no liability of any kind for failure of any equipment or other items not supplied by ATI.

No action against ATI, regardless of form, arising out of or in any way connected with products or services supplied hereunder, may be brought more than one year after the cause of action accrued.

No representation or agreement varying or extending the warranty and limitation of remedy provisions contained herein is authorized by ATI, and may not be relied upon as having been authorized by ATI, unless in writing and signed by an executive officer of ATI.

Unless otherwise agreed in writing by ATI, all designs, drawings, data, inventions, software, and other technology made or developed by ATI in the course of providing products and services hereunder, and all rights therein under any patent, copyright, or other law protecting intellectual property, shall be and remain ATI's property. The sale of products or services hereunder does not convey any expressed or implied license under any patent, copyright, or other intellectual property right owned or controlled by ATI, whether relating to the products sold or any other matter, except for the license expressly granted below.

In the course of supplying products and services hereunder, ATI may provide or disclose to Purchaser confidential and proprietary information of ATI relating to the design, operation, or other aspects of ATI's products. As between ATI and Purchaser, ownership of such information, including without limitation any computer software provided to Purchaser by ATI, shall remain in ATI and such information is licensed to Purchaser only for Purchaser's use in operating the products supplied by ATI hereunder in Purchaser's internal business operations.

Without ATI's prior written permission, Purchaser will not use such information for any other purpose or provide or otherwise make such information available to any third party. Purchaser agrees to take all reasonable precautions to prevent any unauthorized use or disclosure of such information.

Purchaser will not be liable hereunder with respect to disclosure or use of information which: (a) is in the public domain when received from ATI, (b) is thereafter published or otherwise enters the public domain through no fault of Purchaser, (c) is in Purchaser's possession prior to receipt from ATI, (d) is lawfully obtained by Purchaser from a third party entitled to disclose it, or (f) is required to be disclosed by judicial order or other governmental authority, provided that, with respect to such to maintain the confidentiality of such information.