



Ethernet Axia F/T Sensor Manual



Document #: 9610-05-Ethernet Axia

Engineered Products for Robotic Productivity

Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 • Tel: +1.919.772.0115 • Fax: +1.919.772.8259 • www.ati-ia.com

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“Electromagnetic Compatibility”

This device complies with EMC Directive 2014/30/EU and conforms to the following standards: CISPR 11, IEC/EN61000-4-2, IEC/EN61000-4-3 A1 A2, IEC/EN 61000-4-4 A1, IEC/EN61000-4-5, IEC/EN61000-4-6, IEC/EN61000-4-8

RoHS Compliance

This product conforms to EU Directive CE 2011/65/EU (RoHS).

Note

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

1. Serial number (e.g., FT01234)
2. Transducer model (e.g., Axia, etc.)
3. Calibration (e.g., US-15-50, SI-65-6, etc.)
4. Accurate and complete description of the question or problem
 - For the status code; refer to [Section 4.8—Status Code](#).
5. Computer and software information (operating system, PC type, drivers, application software, and other relevant information about the configuration)

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

Please contact an ATI representative for assistance, if needed:

Sale, Service and Information about ATI products:

ATI Industrial Automation

1031 Goodworth Drive
Apex, NC 27539 USA

www.ati-ia.com

Tel: +1.919.772.0115
Fax: +1.919.772.8259

Application Engineering

Tel: +1.919.772.0115, Extension 511
Fax: +1.919.772.8259
E-mail: ft_support@ati-ia.com

Statement of Compliance

Order Number:	12470285	Report Number:	R12470285-EMC	Page	2 of 64
Model Number:	9105-NET-Axia80 and 9105-RS485-Axia80				
Client Name:	ATI Industrial Automation			Issued:	2018-09-14

Test Report Details

Tests Performed By:	UL Verification Services 12 Laboratory Dr., RTP, NC 27709, USA
Tests Performed For:	ATI Industrial Automation 1031 Goodworth Dr. Apex, NC 27539, USA
Issue Date:	2018-09-14
Model Number:	9105-NET-Axia80 and 9105-RS485-Axia80
Sample Serial Number:	Non-serialized
Product Standards:	EN 61326-1
Testing Start Date:	2018-09-05
Date Testing Complete:	2018-09-07

Overall Results:

Compliant

UL LLC reports apply only to the specific samples tested under stated test conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. UL LLC shall have no liability for any deductions, inferences or generalizations drawn by the client or others from UL LLC issued reports. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government..

*This report may contain test results that are not covered by the NVLAP or A2LA accreditation. The scope of accreditation is limited to the specific tests that are listed on the NVLAP and/or A2LA websites referenced at the end of this report.

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Glossary

Term	Definitions
Active Configuration	The configuration that the system is currently using.
ADC	Analog-to-digital converter
Calibration	The factory-supplied data used by Ethernet Axia sensor so it can report accurate sensor readings. Calibrations apply to a specific loading range.
CGI	Common Gateway Interface (CGI) is the method of using web URLs to communicate data and parameters back to a web device.
Complex Loading	Any force or torque load that is not purely in one axis.
Configuration	User-defined settings that include which force and torque units are reported and which calibration is to be used.
Control Panel	A feature on a personal computer operating system where the user can adjust system settings.
Coordinate Frame	See Point of Origin.
Data Rate	How fast data can be output over the network.
DHCP	Dynamic Host Configuration Protocol (DHCP) is an automatic method for Ethernet equipment to obtain an IP address. The Ethernet Axia system can obtain its IP address using DHCP on networks that support this protocol.
DINT	Signed double integer (32 bit)
ENABL	Boolean that uses Enabled to represent 1 and Disabled to represent 0
Ethernet	A family of computer networking technologies commonly used in local area networks.
Fieldbus	A generic term referring to any one of a number of industrial computer networking standards. Examples include: Ethernet, CAN, Modbus, and PROFINET.
FT or F/T	Force and Torque.
F_{xy}	The resultant force vector comprised of components F_x and F_y .
HEX n	Hexadecimal number of n bits, prefixed with 0x
HTTP GET Method	A standard and common method that a user can request data from a specified resource such as a sensor. HTTP works as a request-response protocol between client (web browser) and server (the sensor).
Hysteresis	A source of measurement error caused by the residual effects of previously applied loads.
INT	Signed integer (16 bit)
Interface Plate	A separate plate that attaches the sensor to another surface. Interface plates are often used if the bolt pattern on the MAP or TAP doesn't match the bolt pattern on the robot arm or customer tooling. The interface plate has two bolt patterns on either side of the plate. One side is for the MAP or TAP. 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.
IP Address	An IP Address (Internet Protocol Address) is an electronic address assigned to an Ethernet device so that it may send and receive Ethernet data. IP addresses may be either manually selected by the user or automatically assigned by the DHCP protocol.
Java™	Java is a programming language often used for programs on web pages. The Ethernet Axia demo is a Java application. Java is a registered trademark of Sun Microsystems, Inc.
MAC	Media Access Controller is the hardware that implements the lowest sub-layer of the data link layer.
MAC Address	MAC Addresses (Media Access Control Addresses) are the unique addresses given to every Ethernet device when it is manufactured, to be used as an electronic Ethernet serial number.

Term	Definitions
MAC ID	Media Access Code Identifier (MAC ID) is a unique number that is user assigned to each device on an Ethernet network. Also called Node Address.
Mounting Adapter Plate MAP	The surface of the sensor that attaches to a fixed surface like an interface plate or robot arm.
N/A	Not Applicable
NVM	Non-Volatile Memory. Storage of information or device memory that can be retrieved even after the device goes through a power cycle.
Overload	The condition where more load is applied to the sensor than the rated measurement range that can be applied to the sensor. Overloads result in reduced accuracy and potentially reduced sensor life.
Plug-in Technology	A customized program that when downloaded and installed onto a host device adds a specific feature to an existing computer program.
P/N	Part Number
Point of Origin	The location on the sensor from which all forces and torques are measured. Also known as the Coordinate Frame.
Power Cycle	When a user removes and then restores power to a device.
REAL	Floating-point number (32 bit)
RDT	The rate per second at which the sensor sends streaming RDT data to a host. Raw Data Transfer (RDT) is a fast and simple Ethernet protocol for control and data transfer via UDP.
RDT Buffer Size	A mode where the sensor sends more than one data package per sample. Multiple data packages are buffered and sent in one block. Buffering reduces the amount of overhead data sent from the sensor and reduces the overall network traffic.
Resolution	The smallest change in load that can be measured.
Sample Rate	How fast the ADCs are sampling inside the unit.
Sense loads	The ATI F/T sensor detects sense loads that are a cumulation of forces and torques acted upon the customer tooling.
Sensor	The component that converts a detected load into electrical signals.
SINT	Signed short integer (8 bit)
STRING n	String of n characters
Status Bit	A unit of computer data sent from the ATI F/T sensor.
TCP	Transmission Control Protocol (TCP) is a low-level method of transmitting data over Ethernet. TCP provides a slower, more reliable delivery of data than UDP.
Thresholding	A software function of the sensor that performs a simple arithmetic comparison of a user-defined threshold to the loading on a transducer axis.
Transducer	Every transducer is also (or has) a sensor but every sensor isn't a transducer. A transducer is more than a sensor. It consists of a sensor/actuator along with signal conditioning circuits.
T_{xy}	The resultant torque vector comprised of components T_x and T_y .
UART	Universal asynchronous receiver transmitter.
UDINT	Unsigned double integer (32 bit)
UDP	UDP (User Datagram Protocol) is a low-level method of transmitting data over Ethernet. While UDP is faster than TCP, unlike TCP lost UDP data is not resent.
UINT	Unsigned integer (16 bit)
USINT	Unsigned short integer (8 bit)

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. More specific notifications are imbedded within the sections of the manual where they apply.

1.1 Explanation of Notifications

The following notifications are specific to the product(s) covered by this manual. It is expected that the user 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 declaration of the robot, be aware of the dynamic loads caused by the robot.

1.3 Safety Precautions



CAUTION: Modifying or disassembling the sensor could cause damage and void the warranty.



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: Do not contact the IP64 seal. Contacting the seal can cause the sensor to malfunction.



CAUTION: The sensor should be protected from impact and shock loads that exceed rated ranges during transport as the impacts can damage the sensor's performance. Refer to [Section 15—Specifications](#) for more information about rated ranges.

2. Product Overview

The Ethernet Axia Force/Torque (F/T) sensor measures six components of force and torque ($F_x \setminus F_y \setminus F_z \setminus T_x \setminus T_y \setminus T_z$) and communicates this data to customer devices via Ethernet. The user can communicate with the sensor from a console through Telnet or CGI. A user can also communicate with the sensor through the sensor's internal ATI webpages, the ATI demo program, or an ATI-provided LabVIEW® code.

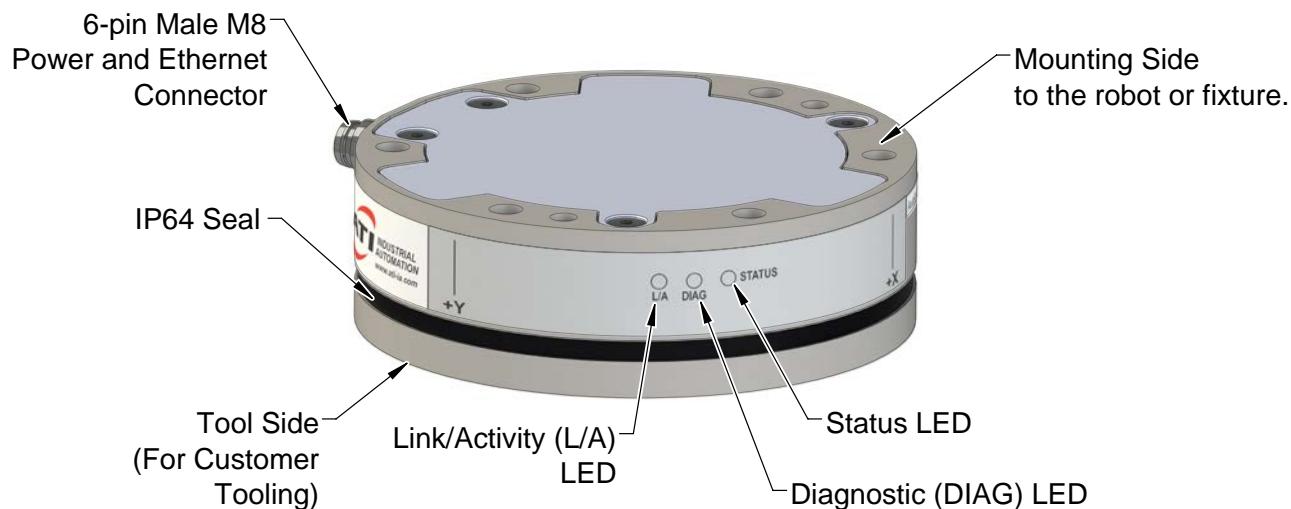
The sensor's mounting side attaches to a mounting interface plate, which mounts to the customer robot. The tool side attaches to the customer tooling. Both the mounting and tool sides have a 71.12 mm bolt circle pattern with (6) M5 tapped holes and (2) slip fit dowel holes. The customer drawing, ATI P/N 9230-05-1543, is available on the ATI website: https://www.ati-ia.com/app_content/Documents/9230-05-1543.auto.pdf.

The sensor is IP64 rated. An M8 6-pin male connector is for power and Ethernet. For the pin assignments, refer to [Section 3.5—Pin Assignment for the Ethernet and Power Connection](#) for Ethernet and power. Customer drawings for the cables and are available on the ATI website: https://www.ati-ia.com/app_content/Documents/9230-05-1554.auto.pdf (ATI P/N 9105-C-ZC22-ZC28-4) and https://www.ati-ia.com/app_content/Documents/9230-05-1555.auto.pdf (ATI P/N 9105-C-ZC28-U-RJ45S-4).

The Ethernet Axia sensor offers the following features:

- Calibrated force/torque data
- Bias functionality
- Programmable low-pass filtering with cut-off frequency
- Tool transformation
- Thresholding
- LED indicator for Link/Activity (L/A), Diagnostic (DIAG), and Status
- Compatible with the ATI Net F/T sensor UDP interface and Java demo application (refer to [Section 12—UDP Interface Using RDT](#), [Section 7—Java® Demo Application](#), and the 9620-05-NET F/T manual for more information)
- Compatible with parts of the ATI Net F/T web interface (refer to [Section 6—Configuring the Sensor with the Ethernet Axia Web Pages](#) and the [9620-05-NET F/T](#) manual for more information)

Figure 2.1—Ethernet Axia F/T Sensor



2.1 Overview of Axia Models

The Axia sensor is available in three different models. An overview of each model is summarized in the following table:

Table 2.1—Axia Models			
Model	Part Number	Number of Identifying Grooves ¹	Material
Axia80-M8	9105-NET-Axia80-M8 ²	3	Aluminum
Axia80-M20	9105-NET-Axia80-M20 ³	0	
Axia80-M50	9105-NET-Axia80-M50 ⁴	2	Stainless Steel

Notes:

- 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.
- This part number used to be 9105-NET-Axia80-M8-ZC22.
- This part number used to be 9105-NET-Axia80 or 9105-NET-Axia80-M20-ZC22.
- This part number used to be 9105-NET-Axia80-M50-ZC22.
- For calibration ranges, refer to [Section 15.3—Calibration Ranges](#).

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 (refer to the [drawing](#) on the ATI website).



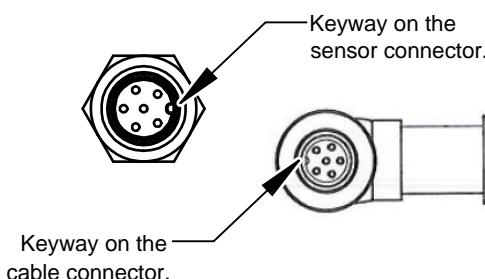
CAUTION: Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.



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 the robot arm, and the sensor's tool side attaches to the customer tool. If interface plates are required to adapt the sensor to the robot arm and customer tooling, ATI can supply custom robot mounting and tool interface plates. For technical information on the sensor's mounting features, refer to the [customer drawing](#) on the ATI website.



CAUTION: Incorrect installation of robot mounting and tool interface plates results in the failure of the F/T sensor to function properly. Because the mounting and tool sides of the sensor have identical bolt patterns, verify the robot mounting and tool interface plates are installed correctly.

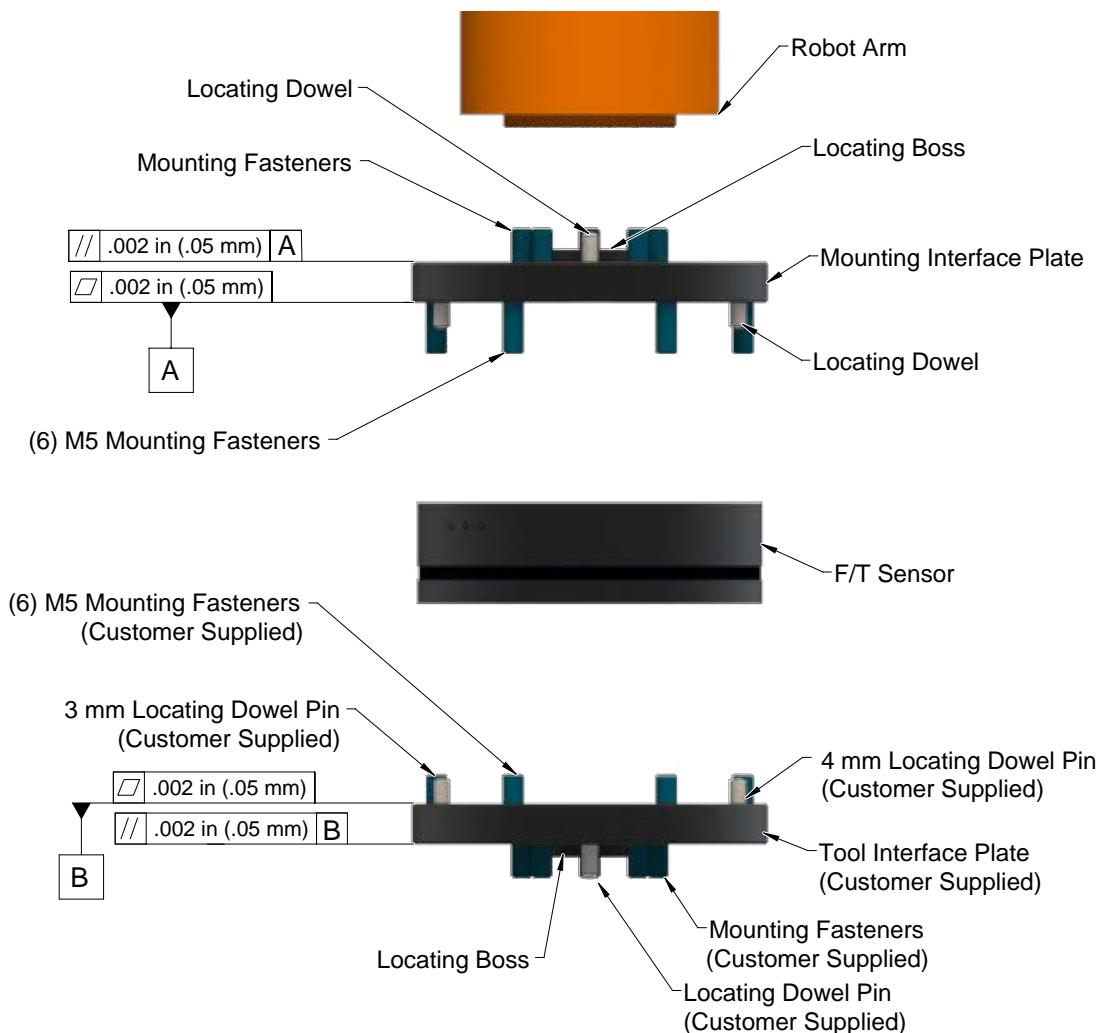


CAUTION: The customer tool should only touch the tool side. If the customer tool touches any other part of the sensor, it will not properly sense loads.

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

- The interface plate should include bolt holes for mounting fasteners as well as dowel pin and a boss for accurate positioning to the robot or customer's device.
- The thickness of the interface plate must provide sufficient thread engagement for the mounting fasteners.
- The mounting fasteners should not extend through the sensor's housing or interfere with the internal electronics. For thread depth, mounting patterns, and other details, , refer to the *customer drawing* on the ATI website.
- Do not use dowel pins that exceed length requirements and prevent the interface plate from mating flush with the robot and customer tooling. Fasteners that exceed length requirements create a gap between the interfacing surfaces and cause damage.
- The interface plate must not distort from the maximum force and torque values that can be applied to the sensor. For these values, refer to *Section 15—Specifications*.
- The interface plate must provide a flat and parallel mounting surface for the sensor.

Figure 3.1 —Interface Plate

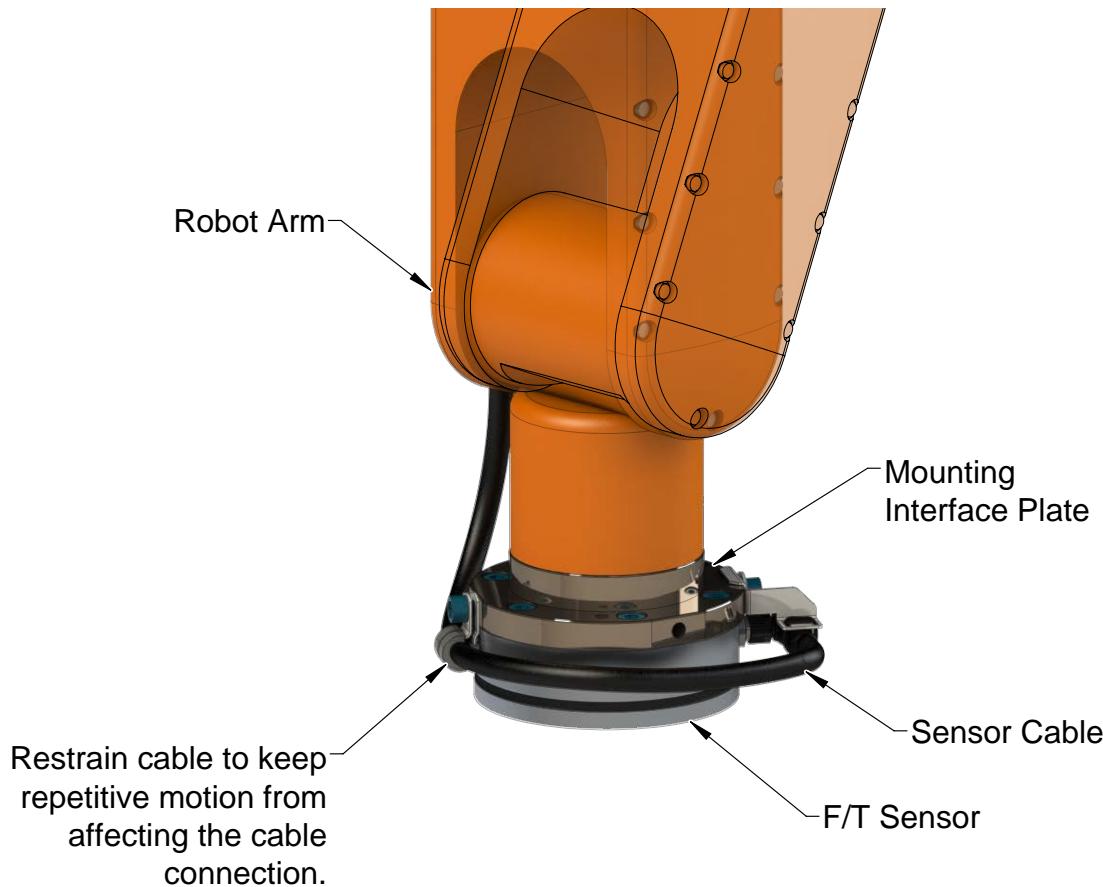


3.2 Routing the Cable

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.

NOTICE: The maximum supported cable length is 25 m.

Figure 3.2—Routing of the Sensor Cable

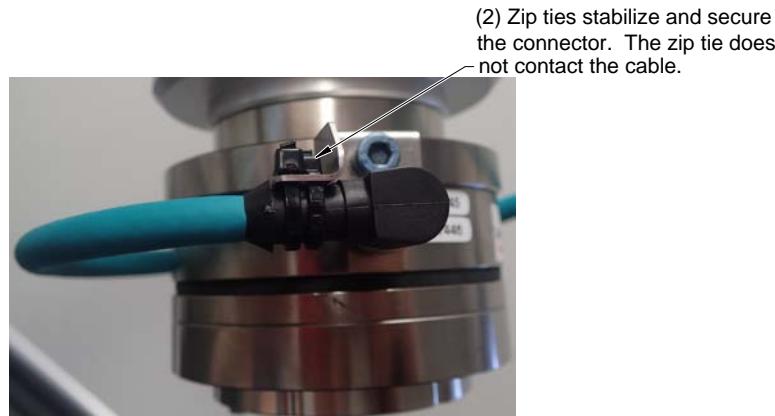




CAUTION: Subjecting the connector to the repetitive motion will cause damage to the connector. Restraine the cable close to the connector so that the repetitive motion of the robot does not interfere with the cable connector.

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.

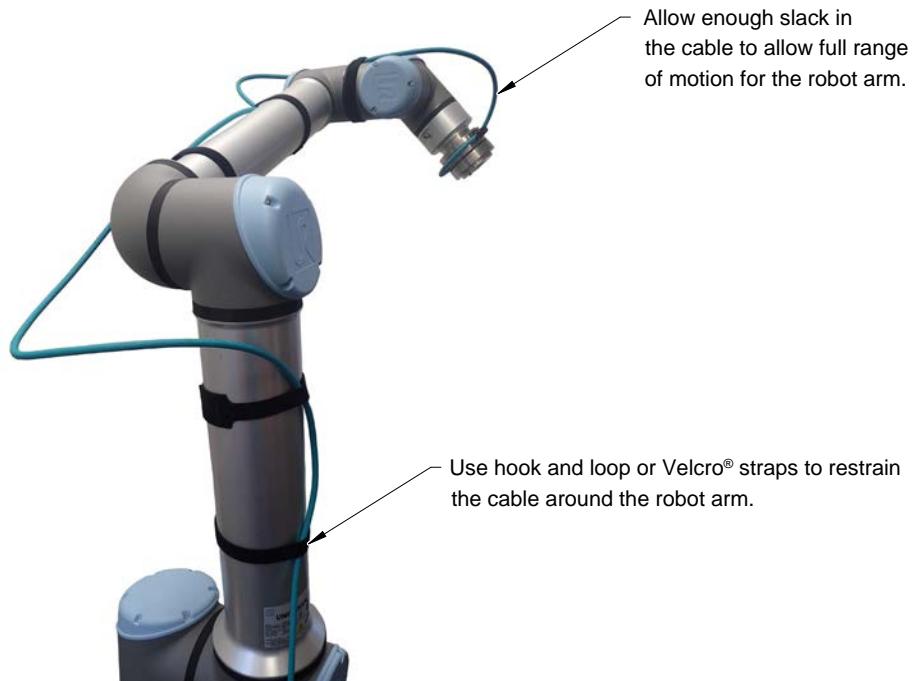
Figure 3.3—Use Zip Ties on the Connector



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.

Route the sensor cable so that it is not stressed, pulled, kinked, cut, or otherwise damaged throughout the full range of motion. Affix the cable by using hook and loop straps or Velcro® straps; do not use cable ties or zip ties.

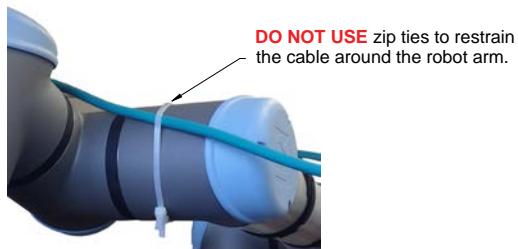
Figure 3.4—Use Hook and Loop or Velcro® Straps on the Cable



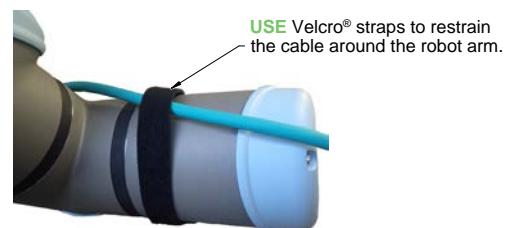


CAUTION: Do not cable ties or zip ties to bundle cables or restrain the cable to the robot arm. Directly affixing cable ties or zip ties to the cable jacket will prevent power and signal communication between the F/T sensor and robot controller. Use hook and loop or Velcro straps on the cable jacket surfaces. Examples of the incorrect and correct methods to restrain or bundle cables are in the following pictures:

INCORRECT



CORRECT



DO NOT USE zip ties to bundle cables.



USE Velcro® straps to bundle cables.



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	Spliced Cable Branch Description	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	N/A						
9105-C-ZC28-U-RJ45S-X	Branch 1, Power	6 (.24)	25	1	50	2	180°/m or 55°/ft
	Branch 2, Ethernet						

Notes:

1. Temperature affects cable flexibility. ATI recommends increasing the minimum dynamic bending radius for lower temperatures.

The 6-pin 9105-C-ZC22-ZC28-X cable attaches to the sensor's connector. The 9105-C-ZC28-U-RJ45S-X 8-pin connector attaches to the 9105-C-ZC22-ZC28-X power and Ethernet cable. The 9105-C-ZC28-U-RJ45S-X cable splits into the following (2) branches: an unterminated end for power and a RJ45 connection for Ethernet.

3.3 Installing the Sensor to the Robot

Parts required: Refer to [Figure 3.5](#) and refer to the [customer drawing](#) on the ATI website.

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 rag, Loctite® 242 (if applicable, refer to step [3](#))

1. Clean the mounting surfaces.
2. Attach the mounting interface plate to the robot arm with the mounting fasteners.

NOTICE: When mounting the sensor to the mounting interface plate, mounting the customer tooling or interface plate to the sensor, consider the following points:

- Screws must have a minimum thread engagement length of 4.5 mm and a maximum thread engagement less than the threaded depth that is listed in the [customer drawing](#) on the ATI website.
- 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 sensor to the mounting 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 3.2—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 or tool interface plate can be installed.

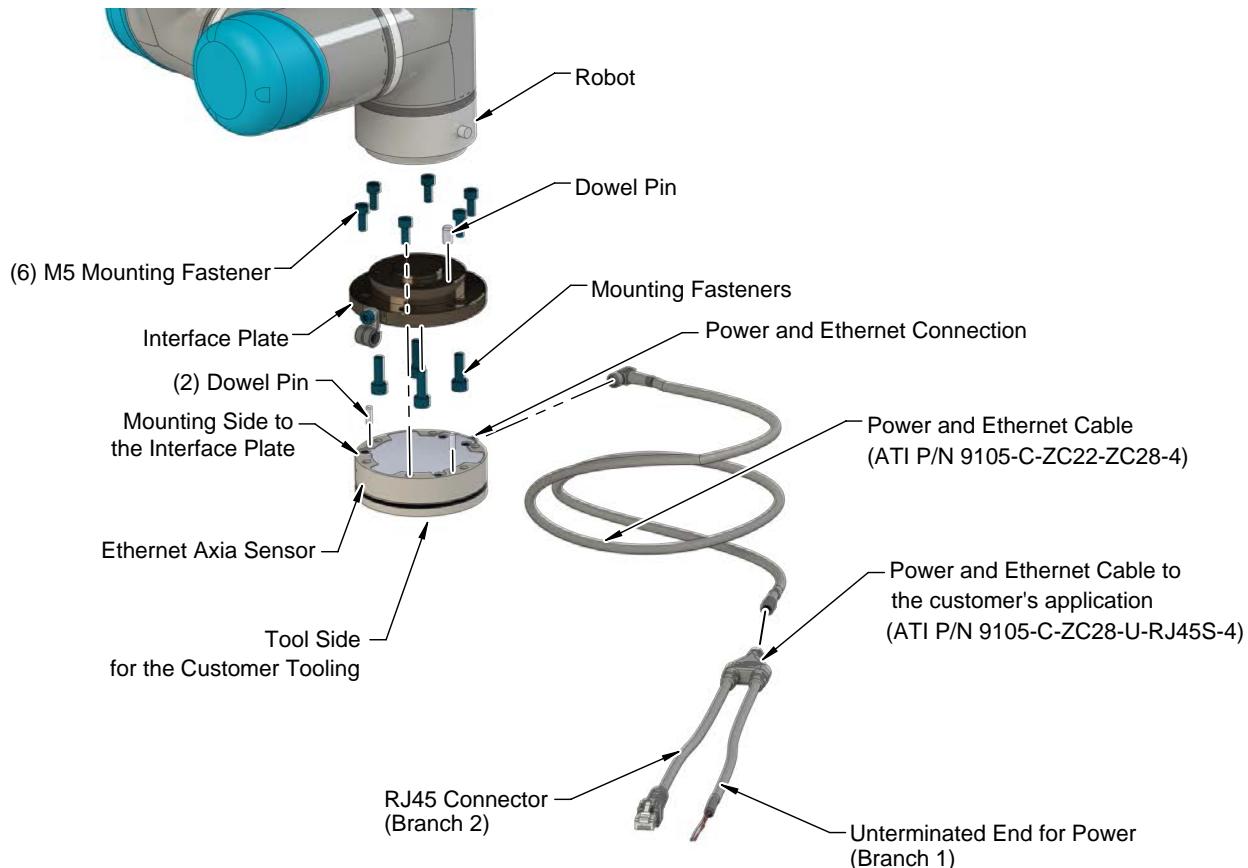
NOTICE: The tool must not touch any other part of the sensor except the tool side; otherwise, the sensor will not properly detect loads.

5. Connect the cables to the sensor and customer application:
 - a. Connect a power and Ethernet cable (ATI P/N 9105-C-ZC22-ZC28-X) to the sensor's M8 connector. Tighten to 4.43 in-lbs (0.5 Nm).
 - b. Connect the branched cable (ATI P/N 9105-C-ZC28-U-RJ45S-X) to the cable from step [a](#). Tighten to 7.08 in-lbs (0.8 Nm).
 - c. Connect the RJ45 and power connections to the customer application.

NOTICE: For the LED outputs that occur whenever power is applied to the sensor, refer to [Section 4.2.1—Self-Test LED Sequence](#).

6. Properly restrain and route the power and Ethernet cable; refer to [Section 3.2—Routing the Cable](#).
7. After installation is complete, the sensor is ready for an accuracy check. (refer to [Section 3.6—Accuracy Check Procedure](#))
8. Safely start normal operation.

Figure 3.5—Installation of the Sensor to the Robot



3.4 Removing the Sensor from the Robot

Tools required: 4 mm hex key

1. Turn off all energized circuits, for example: electrical.
2. Remove the power and Ethernet cable from the sensor's connection.
3. Supporting the customer tooling and/or interface plate, remove the customer supplied screws that attach to the customer tooling to the sensor.
4. Supporting the sensor, use a 4 mm hex key to remove the (6) M5 socket head cap screws that secure to the sensor to the mounting interface plate or robot.
5. Remove the sensor.

3.5 Pin Assignment for the Ethernet and Power Connection



CAUTION: Ensure the cable shield is properly grounded. Improper shielding on the cables can cause communication errors and inoperative sensor.

Pin assignment for the power and Ethernet connections on the sensor and cables are in the following sections. Customer drawings for the cables and are available on the ATI website: https://www.ati-ia.com/app_content/Documents/9230-05-1554.auto.pdf (ATI P/N 9105-C-ZC22-ZC28-4) and https://www.ati-ia.com/app_content/Documents/9230-05-1555.auto.pdf (ATI P/N 9105-C-ZC28-U-RJ45S-4). For supply voltage ratings, refer to the following table or [Section 15.2—Electrical Specifications](#).

Table 3.3—Power Supply¹

Power Source	Voltage			Power Consumption
	Minimum	Nominal	Maximum	
DC Power	12 V	24 V	30 V	1.5 W

Notes:

1. 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.

3.5.1 Pin Assignment : 6-pin Male M8 Sensor Connector

Signals and corresponding pin numbers for the 6-pin male M8 sensor connector are in the following table:

Table 3.4—Pin Assignment for the 6-pin, Male, M8 Connector (Power and Ethernet)

Connector Schematic	Pin Number	Signal
	1	TX+
	2	TX-
	3	RX+
	4	RX-
	5	V +
	6	V -

3.5.2 Pin Assignment : 8-Pin Male M12 ZC28 Connector

For the 8-pin male M12 ZC28 connector on cable P/N 9105-C-ZC22-ZC28-X that connects to cable P/N 9105-C-ZC28-U-RJ45S-X, the signals and corresponding pin numbers are in the following table.

Table 3.5—Pin Assignment for the 8-pin, Male, M12 Connector (Power and Ethernet)

Connector Schematic	Pin Number	Signal
	1	No Connection
	2	V +
	3	V -
	4	TX-
	5	RX+
	6	TX+
	7	No Connection
	8	RX-
	Shield	Shell

3.5.3 Pin Assignment for Cable P/N 9105-C-ZC28-U-RJ45S-X

This cable has (2) branches: an unterminated end for power and a RJ45 connection for Ethernet. For the signals and corresponding pin numbers/wire color, refer to the following sections.

3.5.3.1 Branch 1, Unterminated End for Power Connection

The signals and corresponding wire jacket color for the unterminated wires which connect to the customer's device are in the following table:

Table 3.6—Branch 1, Unterminated End: Wire Jacket Color, and Signal

Wire Jacket Color	Signal
-	Shield
Brown	V+
Brown/White	V-
Blue/White (TP1+) ¹	Sync
Blue (TP1-) ¹	Sync Ground

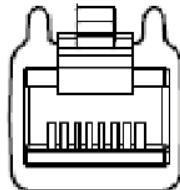
Note:

1. Reserved-not used.

3.5.3.2 Branch 2, RJ45 Connection for Ethernet

The signals and corresponding pin numbers for the 8-pin RJ45 connect which connect to the customer device are in the following table:

Table 3.7—Cable P/N 9105-C-ZC28-X Pin Assignment for the 8-pin, RJ45 Connector

Connector Schematic	Pin Number	Wire Color	Signal
 12345678	1	White/Orange	TX+
	2	Orange	TX-
	3	White/Green	RX+
	4	-	No Connection
	5	-	No Connection
	6	Green	RX-
	7	-	No Connection
	8	-	No Connection

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.
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 $F_{x, average}$ \ $F_{y, average}$ \ $F_{z, average}$:
 - 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.

4. Operation

Information required when using the software to operate the Axia Ethernet sensor is in the following sections. Communicating with the sensor requires knowledge of Ethernet standards and operation. Commands to operate and configure the sensor can be sent in the following ways:

- ATI website ([Section 5—Connecting Through Ethernet](#) and [Section 6—Configuring the Sensor with the Ethernet Axia Web Pages](#))
 - ATI demo program: [Section 7—Java® Demo Application](#)
- Console through Telnet ([Section 8—Console Interface Through Telnet](#))
- CGI ([Section 9—Common Gateway Interface \(CGI\)](#))

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.

4.2 LED Outputs

The Ethernet Axia sensor provides (3) LED units for Link/Activity (L/A), Diagnostic (DIAG), and Status. Each of these units can be off, red, green, or both red and green (orange).

4.2.1 Self-Test LED Sequence

When the user applies power to the sensor, the sensor completes a self-test, during which the LEDs individually turn on in the following sequence:

Table 4.1—Self-Test LED Sequence			
Sequence Order	LED	State	Duration
1	All	Off	Approximately one second for each LED.
2	Status	Red	
3	DIAG	Red	
4	L/A	Red	
5	Status	Green	
6	L/A	Green	
7	DIAG	Green	

4.2.2 L/A LED

One LED signals link/activity on the Ethernet port as follows:

Table 4.2—L/A LED			
LED State	Link	Activity	Condition
Off	No	No	Ethernet link/activity is not detected.
Green	Yes	Yes	Ethernet link/activity is detected. The light stays green for 5 seconds after any link activity.

4.2.3 DIAG LED

One LED signals the communication status of the Ethernet Axia sensor interface as follows:

Table 4.3—DIAG LED	
LED State	Description
Red	Indicates an error in the STATUS word except the following: 1. The gage temperature is out of range. 2. A gage is disconnected.
Off	Ethernet interface is in an operational state. No errors are found.

4.2.4 Sensor Status LED

One LED signals the health status of the sensor as follows:

Table 4.4—Sensor Status LED	
LED State	Description
Off	The sensor is powering up and checking STATUS.
Red	Indicates an error in the STATUS word, or a <i>bad system status</i> reported on the System Information webpage.
Green	Normal operation. Indicates no error in the STATUS word.
Red/Green (Orange)	Indicates that a F/T axis is out of range.

4.3 Sample Rate

The power-on default sample rate is the rate the user set before removing power. The sample rate is stored to nonvolatile memory. The **adcRate** field in [Section 8.4—Console “CAL” / “SET” Command Fields and Values](#) controls the current sample rate. The following table lists the rounded and exact sample rates.

Table 4.5—Sample Rate					
Rounded Sample Rate	0.5 kHz	1 kHz	2 kHz	4 kHz	8 kHz
Exact Sample Rate	488 Hz	976 Hz	1953 Hz	3906 Hz	7912 Hz

4.3.1 Sample Rate Versus Data Rate

The data rate is how fast data can be output over the Ethernet network.

If the data rate is faster than the sample rate, the customer sees duplicate samples output over the network until the next sample is read internally. A faster data rate could be useful so that the sensor sends data at the same rate that other devices in a customer’s system are outputting. For example: if a discrete I/O device on the same network as the Axia is outputting data at 7,000 Hz, the customer may want the Axia to be outputting data to the network at 7,000 Hz as well, even though the sensor is not sampling that quickly internally.

If the sample rate is faster than the data rate, the customer does not receive the data from every internal sample over the network. However, any filters that are enabled work based on the faster internal sample rate, and so the sensor filters out higher frequency noise sources than if the filter is operating at a slower data rate.

4.4 Converting Counts Per Force/Torque to F/T Values

To obtain the real force and torque values, each force value must be divided by the counts per force (cpf) factor, and each torque value must divided by the counts per torque (cpt) factor. The cpf and cpt factors can be obtained using the “set” command or from the **Configurations** webpage (refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#)).

For example: if a calibration reports 1,000,000 counts per N and the F_z reports 4,500,000 counts, then the force applied in the Z axis is 4.5 N.

4.5 Low-Pass Filter

The power-on default selection is no filtering. The “filtC” field in [Section 8.4—Console “CAL” / “SET” Command Fields and Values](#) controls the current filter selection. The cutoff frequency (i.e. -3 dB frequency) is dependent on the sample rate selection, which is defined in [Section 4.3—Sample Rate](#). The cutoff frequencies for the different sampling rates are listed in the following table.

Selected Filter	-3dB Cutoff Frequency (in Hz)				
	at 488 Hz Sample Rate	at 976 Hz Sample Rate	at 1953 Hz Sample Rate	at 3906 kHz Sample Rate	at 7912 Hz Sample Rate
0	200	350	500	1000	2000
1	58	115	235	460	935.10
2	22	45	90	180	364.04
3	10	21	43	84	169.52
4	5	10	20	40	81.24
5	2.5	5	10	20	39.84
6	1.3	3	5	10	20.31
7	0.6	1.2	2.4	4.7	9.37
8	0.3	0.7	1.4	2.7	5.47

Figure 4.1—Filter Attenuation at 0.5 kHz Sample Rate

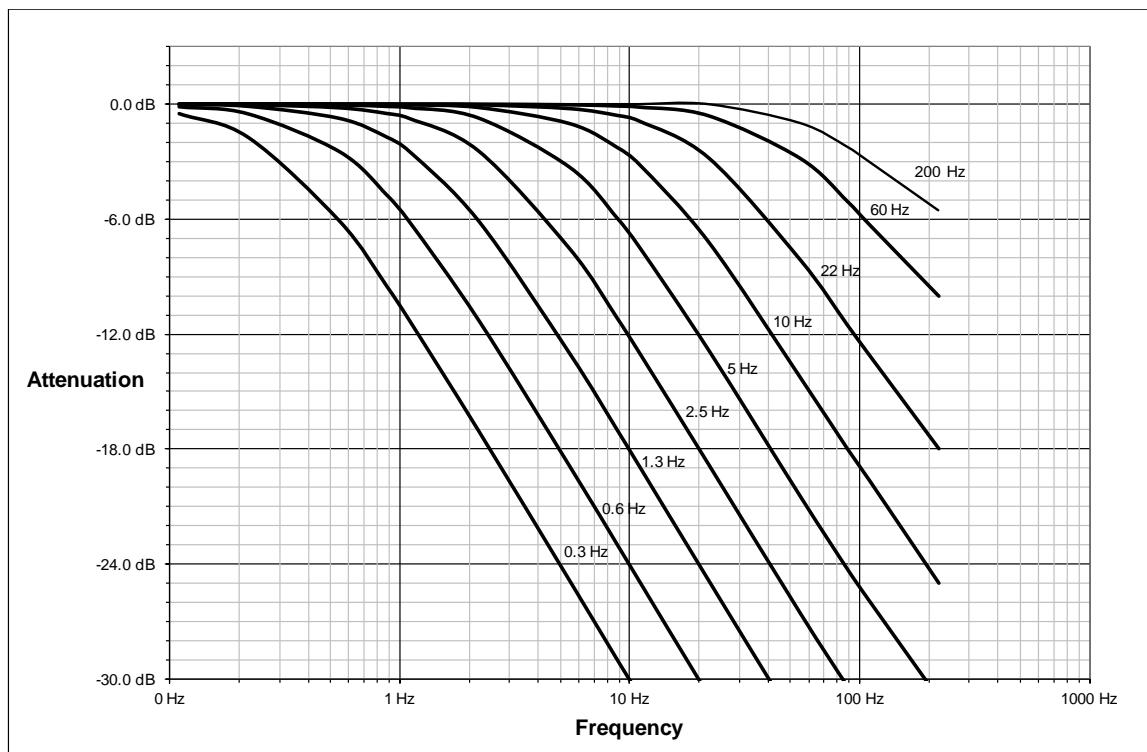


Figure 4.2—Filter Attenuation at 1 kHz Sample Rate

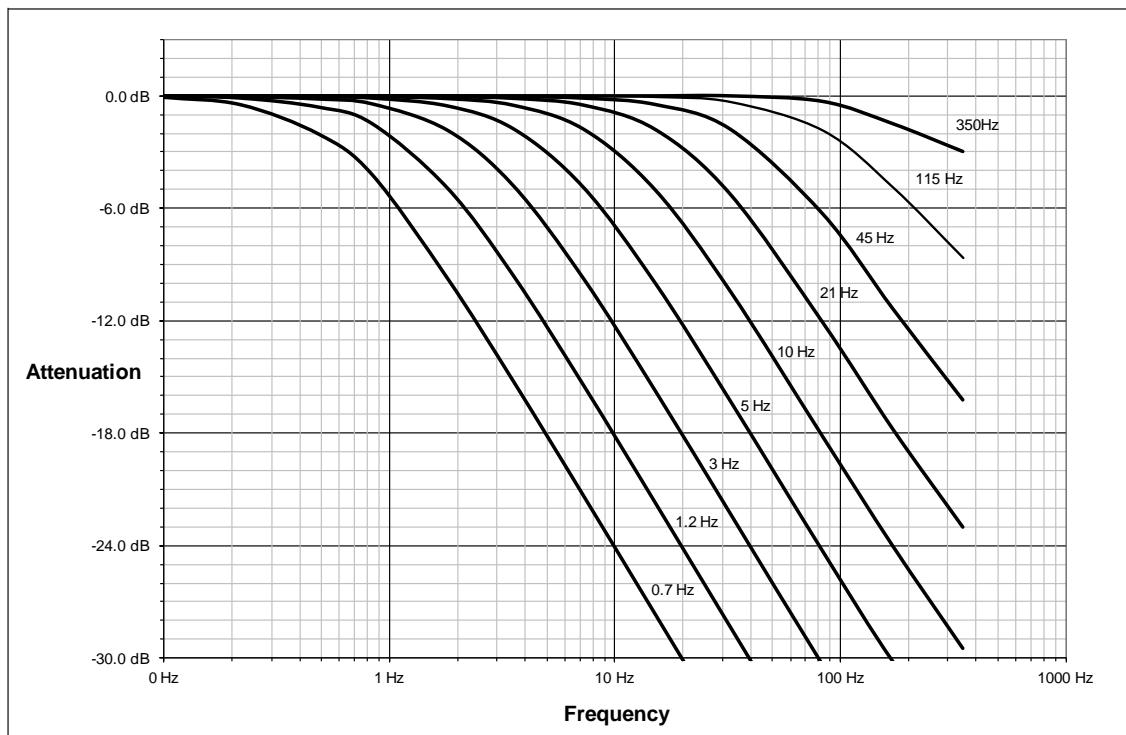


Figure 4.3—Filter Attenuation at 2 kHz Sample Rate

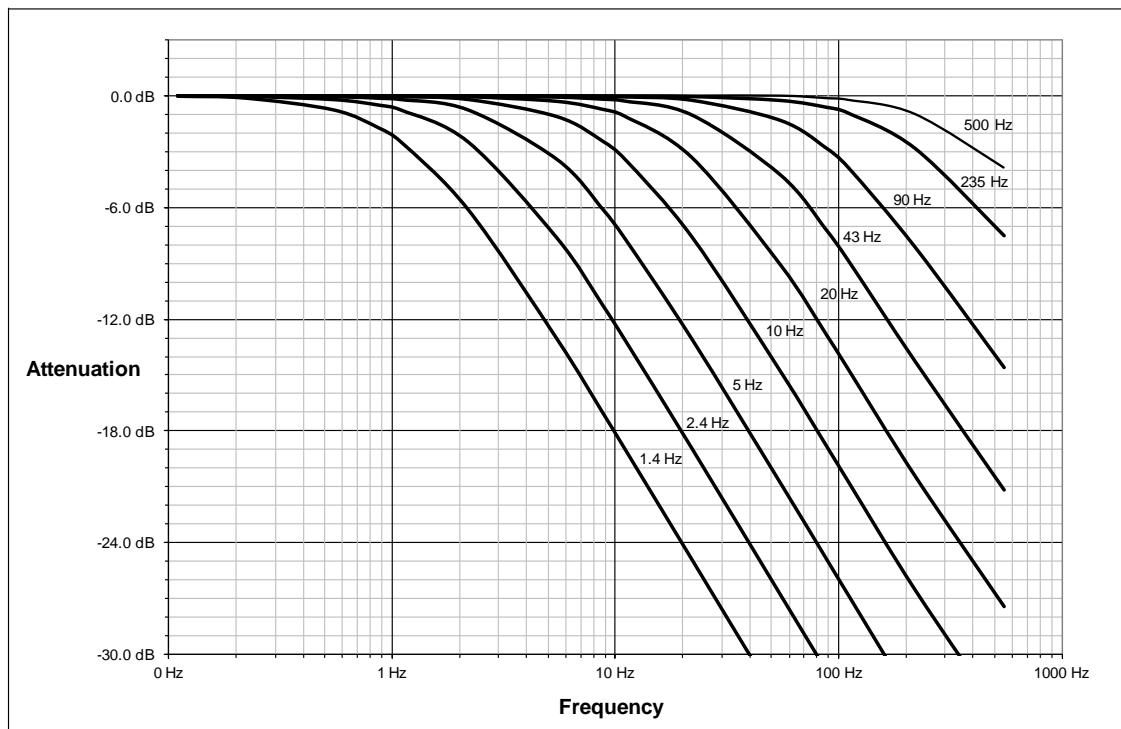


Figure 4.4—Filter Attenuation at 4 kHz Sample Rate

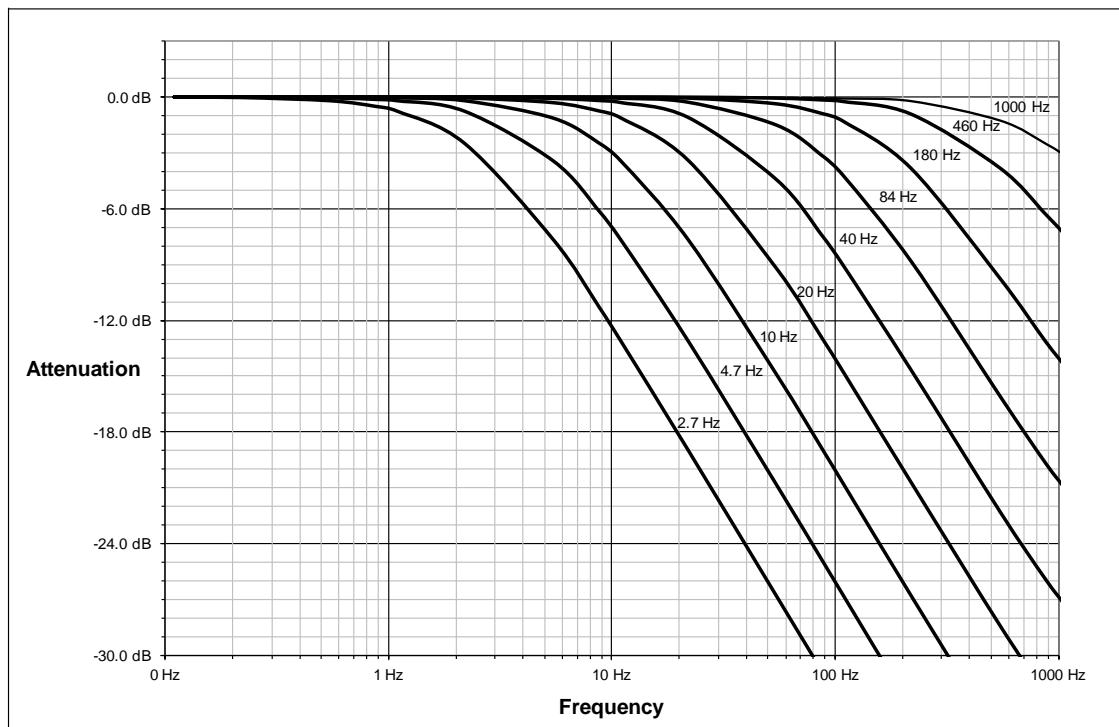
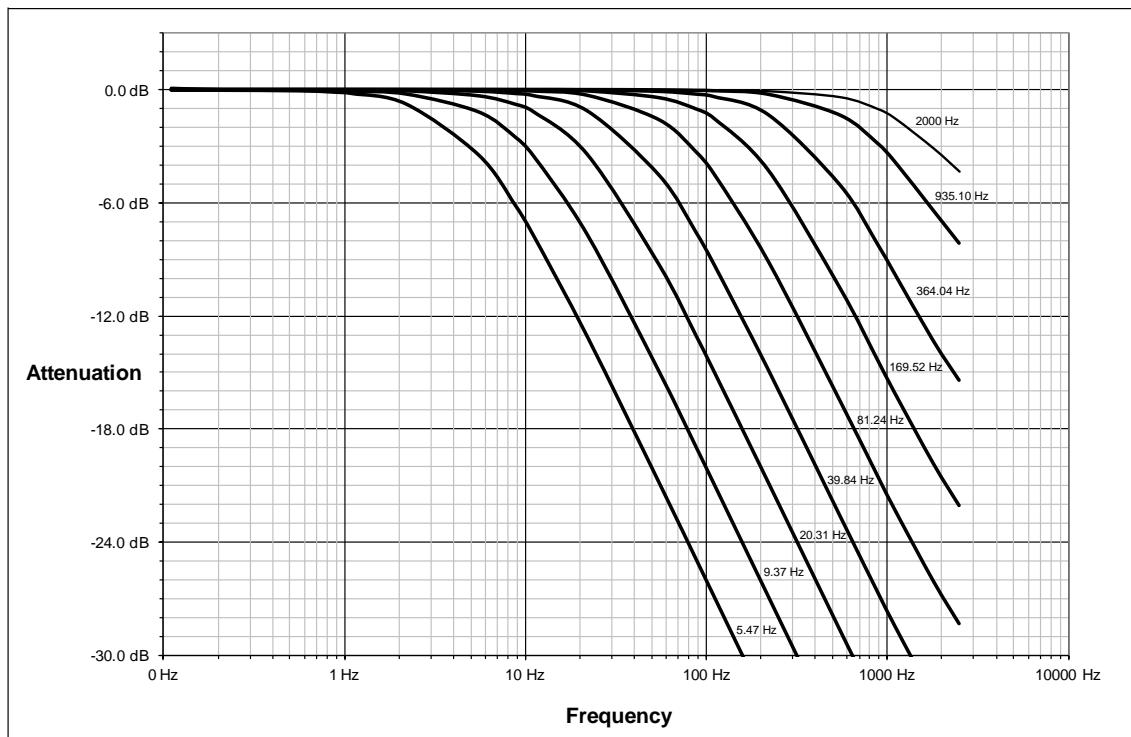


Figure 4.5—Filter Attenuation at 8 kHz Sample Rate



4.6 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.

4.7 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,. 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 4.7.1—Avoid Overloading the Sensor During Tool Transformation](#)). Therefore, when evaluating overloading conditions, use the sensor’s point of origin as the reference point.

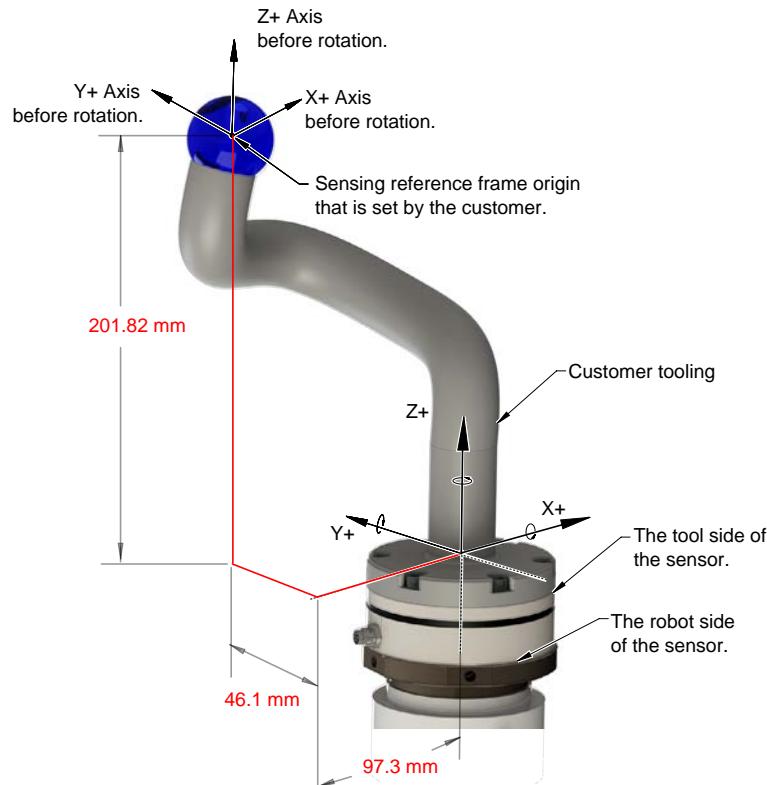
The user defines a reference point by inputting a parameter set that is a series of (3) displacements ($D_x \setminus D_y \setminus D_z$) and (3) rotations ($R_x \setminus R_y \setminus R_z$), for example:

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

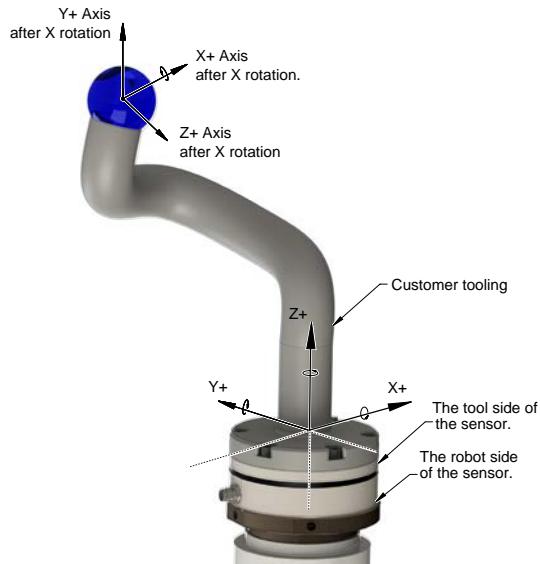
Figure 4.6—Tool Transformation : Distances



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

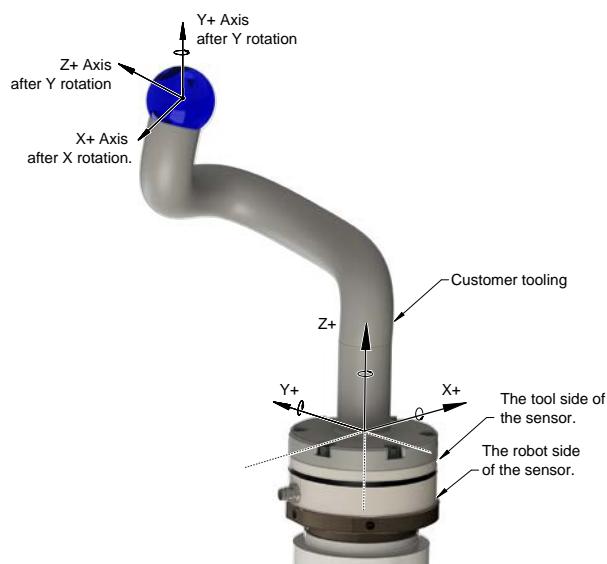
1. The first rotation is about the X-axis.
 - Recall in this example $R_x = +90^\circ$ rotation. The user point of origin rotates $+90^\circ$ about the X-axis, in the following figure.

Figure 4.7—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 4.8—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.

A user can issue tool transformation commands through these interfaces: a console interface through Telnet/CGI or the ATI website. To understand how to enter Tool Transformation commands through the Configurations page on the ATI website, refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#). For examples on how to enter tool transformation commands through Telnet or CGI, refer to the examples in the following sections.

4.7.1 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.

4.7.2 Example of Tool Transformation Functionality Through Telnet

To set a user reference point of origin by using the console commands through Telnet, [Section 8.4—Console “CAL” / “SET” Command Fields and Values](#), refer to the following example:

A user wants to set a reference point of origin from the example in [Figure 4.6](#) through [Figure 4.8](#):

$D_x = -97.3 \text{ mm}$ $D_y = 46.1 \text{ mm}$ $D_z = 201.82 \text{ mm}$

$R_x = +90^\circ$ rotation $R_y = +180^\circ$ rotation $R_z = 0^\circ$ rotation

- Set the units to mm for distances and degrees for rotation:

```
user:      set ttdu 2
response:   set ttdu 2
            ttdu was 1 now 2
user:      set ttaw 0
response:   set ttaw 0
            ttaw was 1 now 0
```

- Write the distances and rotations:

```
user:      set ttdx -97.3
response:   set ttdx -97.3
            ttdx was "0" now "-97.3"
user:      set ttidy 46.1
response:   set ttidy 46.1
            ttdx was "0" now "46.1"
user:      set ttdz 201.82
response:   set ttdz 201.82
            ttdz was "0" now "201.82"
user:      set ttrx 90
response:   set ttrx 90
            ttrx was "0" now "90"
```

```
user:      set ttry 180
response:   set ttry 180
            ttry was "0" now "180"
user:      set ttrz 0
response:   set ttrz 0
            ttrz not changed
```

- Send the tool transformation “tt” command:

```
user:      set tt
response:   set tt
            Field  Value
            ----  -----
            ttdu    2
            ttau    0
            tttx   -97.3
            ttty    46.1
            tttdz   201.82
            tttx    90
            ttry    180
            ttrz    0
```

If the user goes to the **Configuration** page on the ATI website ([Section 6.6—F/T Configurations Page \(config.htm\)](#)), the values in the **Tool Transformation** fields match these values that the user entered in the console.

4.7.3 Example of Tool Transformation Functionality Through CGI

To set a user defined point of reference by using CGI, [Section 9.1—URL Syntax Construction](#): and [Section 9.4—CGI Variable: Configurations \(config.cgi\)](#), refer to the following example:

A user wants to set the point of reference from the example in [Figure 4.6](#) through [Figure 4.8](#):

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

- Open a web browser and enter a URL request:

<http://192.168.1.1/config.cgi?cfgtdu=3&cfgtau=1&cfgtx0=-97.3&cfgtx1=46.1&cfgtx2=201.82&cfgtx3=90&cfgtx4=180&cfgtx5=0>

This request tells the sensor at IP address 192.168.1.1 to set CGI variables *cfgtdu* to 3, *cfgtau* to 1, *cfgtx0* to -97.3, *cfgtx1* to 46.1, *cfgtx2* to 201.82, *cfgtx3* to 90, *cfgtx4* to 180, and *cfgtx5* to 0.

If the user goes to the **Configuration** page on the ATI website ([Section 6.6—F/T Configurations Page \(config.htm\)](#)), the values in the **Tool Transformation** fields match these values that the user entered in the console.

4.7.4 Example of Tool Transformation Functionality Through TCP

With TCP, more advanced users can write their own software to set up a defined point of reference (refer to [Section 10.6—Write Tool Transform Command](#)). For most users, the ATI webpages or a Telnet console is the most efficient method to use the tool transformation functionality.

4.8 Status Code

The following table is a bitmap from bit number 0 to 31 for the current condition of the sensor. For help reading this table with hexadecimal codes, refer to [Section 4.8.2—How to Interpret Hexadecimal Output for the Status Code](#).

Table 4.7—Status Code		
Bit Number	Description	Indicates an Error?
0	Internal Temperature Out of Range: This bit is active (high) if the temperature is outside the range -5 to 70°C.	Yes
1	Supply Voltage Out of Range: This bit is active (high) if the input voltage is outside the range of 12 V to 32 V.	Yes
2	Broken Gage: This bit is active (high) whenever the gage reads positive full scale. It self resets 32 sample periods after the condition clears.	Yes
3	Busy Bit. The sensor is performing (1) or more of the following activities that may temporarily affect the F/T data: <ul style="list-style-type: none"> • Committing a change to NVM. • Changing the filter time constant. • Changing the calibration in use. • Changing the ADC sampling rate. • Any ADC ISR overrun. 	No
4	Reserved.	Yes
5	Common error bit.	Yes
6 to 15	Reserved.	Yes
16	Monitor Condition (0-15) Latched.	No
17 to 26	Reserved.	Yes
27	Gage Out of Range: The bit is set whenever a gage sample is outside of the range gageMinRange to gageMaxRange. This bit stays high for 32 samples after the last such sample so that time abates for the sample's effect on the data.	Yes
28	Simulated Error. This bit is used to test user error handling.	No
29	Calibration checksum error: This bit is set if the active calibration has an invalid checksum.	Yes
30	Force/Torque Out of Range: This bit is active whenever the force/torque sample is out of range or saturated. This bit stays high for 32 samples after the last such sample so that time abates for the sample's effect on the data.	Yes
31	Error: This bit is set whenever any status code bit that indicates an error is set.	Yes

4.8.1 Status Code: Sensing Range Exceeded

Bit 30 in [Table 4.7](#) is set when a F/T load is outside the sensor's detection capability. Bit 30 is set when either of the following conditions are TRUE:

- The total percentage of the calibrated range used by F_{xy} and T_z axes is greater than 105%. Refer to the following $F_{xy} T_z$ equation.

$$\frac{\sqrt{F_x^2 + F_y^2}}{F_{xy}\text{CalibratedRange}} + \frac{|T_z|}{T_z\text{CalibratedRange}} > 105\%$$

- The total percentage of the calibrated range used by F_z and T_{xy} axes is greater than 105%. Refer to the following $F_z T_{xy}$ equation.

$$\frac{|F_z|}{F_z \text{CalibratedRange}} + \frac{\sqrt{T_x^2 + T_y^2}}{T_{xy} \text{CalibratedRange}} > 105\%$$

Refer to [Section 15.3—Calibration Ranges](#) for the calibrated ranges that are used in the preceding equations.

For example:

An Axia80-M20 sensor that uses calibration range 0 (SI-500-20) is subjected to the following loads and has the following calibration ranges:

Axis	Applied Load	Calibration Range 0 <i>Table 15.3 Value</i>
F_x	87.5 N	500 N
F_y	-151.6 N	500 N
F_z	-500.0 N	900 N
T_x	1.0 Nm	20 Nm
T_y	2.0 Nm	20 Nm
T_z	-17.5 Nm	20 Nm

The $F_{xy} T_z$ equation simplifies as follows:

$$\frac{\sqrt{(87.5 \text{ N})^2 + (-151.6 \text{ N})^2}}{500 \text{ N}} + \frac{|-17.5 \text{ Nm}|}{20 \text{ Nm}} > 105\%$$

$$\frac{175 \text{ N}}{500 \text{ N}} + \frac{17.5 \text{ Nm}}{20 \text{ Nm}} > 105\%$$

$$35\% + 87.5\% > 105\%$$

$$122.5\% > 105\%$$

TRUE

The $F_z T_{xy}$ equation simplifies as follows:

$$\frac{|-500 \text{ N}|}{900 \text{ N}} + \frac{\sqrt{(1.0 \text{ Nm})^2 + (2.0 \text{ Nm})^2}}{20 \text{ Nm}} > 105\%$$

$$\frac{500 \text{ N}}{900 \text{ N}} + \frac{1.73 \text{ Nm}}{20 \text{ Nm}} > 105\%$$

$$55.6\% + 8.7\% > 105\%$$

$$64.3\% > 105\%$$

FALSE

Because the $F_{xy} T_z$ equation simplified to TRUE, bit 30 in [Table 4.7](#) is set.

4.8.2 How to Interpret Hexadecimal Output for the Status Code

The user converts hexadecimals to a 32-bit binary number that correlates to a status code from [Table 4.7](#). An example of bit patterns are in the following table.

Table 4.9—Bit Pattern Examples		
Bit Number	Simple Description (refer to Table 4.7)	Bit Pattern
0	Temperature	0x80000001
1	Supply voltage	0x80000002
2	Broken gage	0x80000004
3	Busy bit	0x80000008
4	Reserved	N/A
5	Other	0x80000020
6 to 15	Reserved	N/A
16	Monitor condition latched	0x00010000
17 to 26	Reserved	N/A
27	Gage out of range	0x88000000
28	Simulated error	0x10000000
29	Calibration checksum error	0xA0000000
30	F/T out of range	0xC0000000
31	Any error	0x80000000
--	Healthy	0x00000000

The bit pattern can be different if more than one error is present. For example, a user issues this console command (refer to [Section 8.3—Secondary Commands for the Query “c” or “s” Command](#)):

user: s !

response: 80000005

Using a free online calculator, convert the hexadecimal number to a binary number:

Hex	8	0	0	0	0	0	0	5
Binary	1000	0000	0000	0000	0000	0000	0000	0101

The binary number has 32-bits total. The least significant bit is on the right end of the following table. “1” means the bit is on. “0” means the bit is off.

Binary Number	1	0	0	0	0	000 0000 0000 0000 0000 0000 00	0	0	0	1	0	1
Bit Position	31	30	29	28	27	26 to 6	5	4	3	2	1	0

So in this example, bit number 0, 2 and 31 are on. According to the preceding table, the sensor has a “temperature”, “broken gage error”, and “any error” status codes (refer to [Table 4.7](#)).

4.9 Diagnostic Monitoring

During operation, the Ethernet Axia firmware monitors the hardware. When the user applies power to the sensor, the firmware waits (5) seconds before evaluating the supply voltage for errors. Status messages are in the following table.

Table 4.10—Status Messages During Monitoring

Message
Supply Voltage out of range
Gage Temperature out of range
Calibration checksum error
Gage(s) disconnected: <list>
Gage(s) out-of-range: <list>
Force/torque out of range
Common error
Simulated error
Monitor condition latched
Error (unspecified)
Good (no status code errors)

System health indicators that the Axia F/T firmware monitors are in the following table.

Table 4.11—Network Health System

Indicator	Description
Stack Usage	The maximum amount of the stack usage is continuously monitored. An error message is generated if the available stack is too low.
MCU Program Memory CRC	The CRC of the MCU program flash memory is continuously monitored. An error message is generated, if an error is found.
Parameter Memory CRC	The CRC of the MCU RAM Parameter Memory, which is used to store the calibration, is continuously monitored. An error message is generated, if an error is found.
MCU Data Memory Test	The MCU Data Memory (RAM) is continuously tested. An error message is generated, if an error is found.

5. Connecting Through Ethernet

Different methods for setting an IP address and how to configure a Windows® 7/8/10 and Windows® Vista operating system to connect the sensor to the ATI Ethernet Axia sensor webpages, are covered in the following sections.

For a sensor to connect through Ethernet, the user must configure the IP address setting of the sensor. The sensor can connect through Ethernet by one of the following options:

- Plug the end of the Ethernet cable into a port of an Ethernet switch that is connected to a computer.
- Connect the RJ45 cable adapter to a computer's Ethernet interface.

NOTICE:

- Connect to a computer's Ethernet interface for low latency, decreased chance of lost data packages, and best high-speed connection.
- If the computer does not have a second Ethernet port, an additional port must be installed. Users should contact their IT department for assistance.

The 9105-C-ZC28-U-RJ45S-X cable has a RJ45 adapter that is compatible with standard office-grade Ethernet cables (CAT5 or higher) that have RJ45 connectors.

5.1 IP Address Configuration for Ethernet

To apply new IP address settings, power cycle the sensor. New IP address settings are only loaded upon power up. Configure an IP address for the Ethernet Axia sensor with one of the following methods:

Method 1: Set the IP address to a static value stored on the **Communication Settings** web page. (refer to *Section 5.2—Connecting To the ATI Webpages Using a Windows Computer* steps 11 through 12)

Method 2: The DHCP server assigns an IP address. Enable this option in the Ethernet Axia's web pages (refer to *Section 5.2—Connecting To the ATI Webpages Using a Windows Computer* steps 11 through 12). To use this method, a DHCP server must be present in the network.

ATI ships the sensor with DHCP enabled and the static IP address set to 192.168.1.1. If the network does not support DHCP, the network automatically uses the static IP address. If a LAN connection is absent during power up, the network does not use DHCP. Users should contact their IT department for more information.

5.2 Connecting To the ATI Webpages Using a Windows Computer

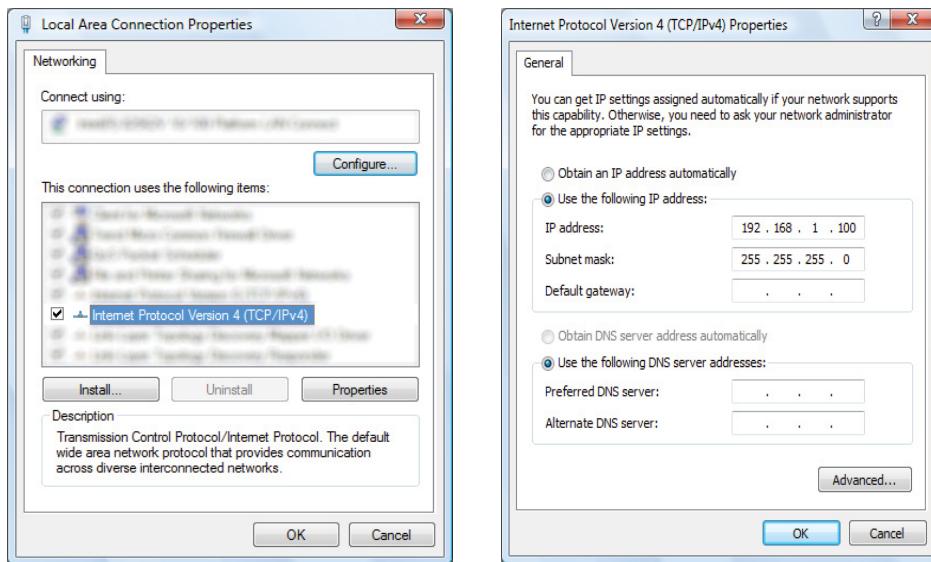
To initially access the ATI Ethernet Axia F/T web pages, configure the sensor to work on the network by assigning an IP address and provide basic information about the network.

For the initial connection, directly connect the computer to the sensor and disconnect from LAN. The sensor's default IP address is 192.168.1.1. Temporarily change the computer's Ethernet adapter to a static IP address with the same first three fields as the sensor, for example: 192.168.1.100.

NOTICE: If the computer has multiple connections to Ethernet, such as a LAN connection and a wireless connection, select the LAN that will be connected to the Ethernet Axia sensor.

1. Disconnect the Ethernet cable from the LAN port on the computer.
2. Open the computer's Internet Protocol (TCP IP) Properties window:
 - For Windows® 7/8/10 operating system, complete the following steps:
 - a. From the Start menu, select the Control Panel.
 - b. Click on the **Network and Internet** icon.
 - c. Click on the **Network and Sharing Center** icon.
 - d. Click on the **View network status and tasks** link.
 - e. Click on the **Local Area Connection** link.
 - f. A new window opens that displays the general settings for that local area connection link. Click on the **Properties** button.
 - g. On the **Networking** tab, scroll down and select **Internet Protocol Version 4 (TCP/IPv4)** connection item (refer to [Figure 5.1](#)).
 - h. Click on the **Properties** button (refer to [Figure 5.1](#)).
 - For a Windows® Vista operating system, complete the following steps:
 - a. From the Start menu, select the Control Panel.
 - b. Click on **Control Panel Home**.
 - c. Click on the **Network and Internet** icon.
 - d. Click on the **Network and Sharing Center** icon.
 - e. Click on the **Manage Network Connections** task link.
 - f. Right-click on **Local Area Connection** and select the **Properties** button.
 - g. Select **Internet Protocol Version 4 (TCP/IPv4)** connection item (refer to [Figure 5.1](#)).
 - h. Click on the **Properties** button (refer to [Figure 5.1](#)).

Figure 5.1—Windows Vista and Windows 7/8/10 Networking Information

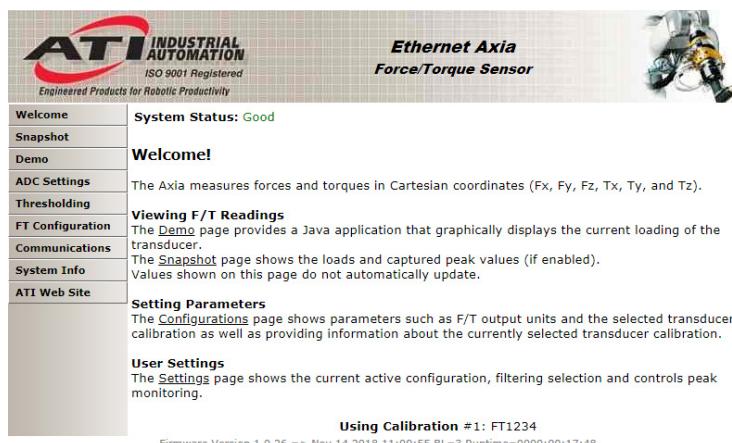


3. Record the values and settings shown in the properties window. Save these values so that the computer can be returned to its original configuration.
4. Select the **Use the following IP address** radio button.

NOTICE: IP addresses must be unique to each device. If 192.168.1.100 is already used by any other devices on the network, use another IP address with the same first three fields as the sensor.

5. In the **IP address:** field, type 192.168.1.100.
6. In the **Subnet mask** field, type 255.255.255.0.
7. Click on the **OK** button.
8. On the **Local Area Connection Properties** window, click the **Close** button.
9. Use an Ethernet cable to connect the sensor to the computer's LAN connection. Wait a moment to ensure the computer has time to recognize the connection.
10. Type the address 192.168.1.1 in the browser. The Ethernet Axia F/T's **Welcome** page appears.

Figure 5.2—The Ethernet Axia F/T Sensor Welcome Page



11. On the left side of the page is a menu bar with buttons that link to various Ethernet Axia webpages. Click on the **Communications** button.

Figure 5.3—The Ethernet Axia F/T Sensor Communications Page

System Status: Good

Communications

These settings control how the Axia communicates with external equipment.
Values are not stored unless the **Apply** button is clicked.

Ethernet Network Settings

A LAN connection must be present at power up for DHCP to function.
If DHCP is enabled and no DHCP server is found then the static IP address will be used.
These settings require the Axia to be powered off and then back on before they take effect.

	Active	Selection
IP Address Mode:	DHCP	<input checked="" type="radio"/> DHCP <input type="radio"/> Static IP
IP Address:	10.1.2.19	192.168.1.1
IP Subnet Mask:	255.255.252.0	255.255.255.0
IP Default Gateway:	10.1.1.20	10.1.1.20
Ethernet MAC Address:	d8:80:39:7a:c4:5e	

Raw Data Transfer (RDT) Settings

RDT data is routed through the local network and does not get routed through the default gateway.

RDT Output Rate (1 to 976):	976 Hz
RDT Buffer Size (1 to 40):	1

Apply **Cancel**

12. Select an IP address mode:

- For a static IP address, enter the appropriate values for the IP address, subnet mask, and default gateway. Click the **Apply** button. Power cycle the sensor.
- For DHCP, click the **Enabled** radio button next to DHCP, and then click the **Apply** button at the bottom of the page. Power cycle the sensor. If the sensor does not receive an IP address within 30 seconds after power up, the sensor defaults to use the static IP settings.
 - Find the IP address assigned to the sensor. (refer to [Section 5.3—Finding the Ethernet Axia Sensor on a Network](#))

NOTICE:

- When assigned by a DHCP server, IP addresses are not permanent and may change if the Ethernet Axia Sensor is disconnected from the network for a period of time. Users should contact their IT department in this situation. Static IP addresses are more favorable in permanent Ethernet F/T applications, because the IP address does not change.
- For a complete description of the fields on the **Communications** page, refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#).

13. Open up the TCP/IP properties of the local area connection of the computer.

- If the sensor was set to DHCP and the user's network has a DHCP server: restore the settings to what they were before reconfigured (use the values that were recorded in step 3).
- If the sensor was set to a static IP address or the network does not have a DHCP server: change the settings to an IP address on the same local subnet as the sensor. The first three fields of the IP address must be the same, but the last field must be unique. For example, if the sensor was set to 10.1.16.20, the computer can be set to 10.1.16.48 or 10.1.16.123.

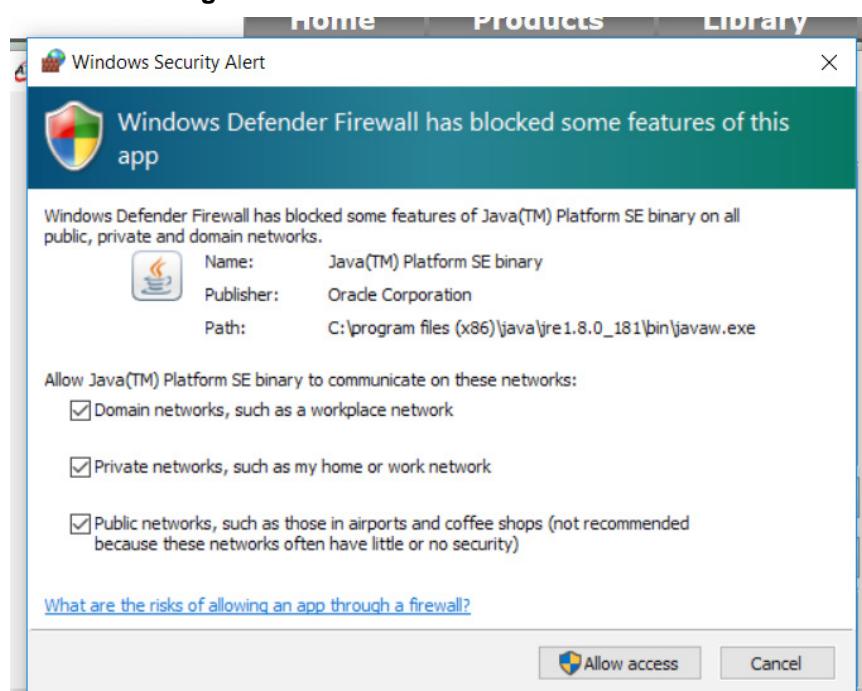
14. Open up a new web browser window. Type the sensor's IP address into the browser's address bar, and press Enter.
 - The Ethernet Axia Sensor's **Welcome** page should display again.
15. Communicate with the sensor over the network, without reconfiguring the communications settings.

5.3 Finding the Ethernet Axia Sensor on a Network

To find the IP address assigned by the DHCP server to an Ethernet Sensor, refer to the following procedure;

1. Download the ATI NET F/T Demo from the ATI website: https://www.ati-ia.com/Products/ft/software/net_ft_software.aspx.
2. The first time this discovery tool is downloaded, the program may trigger a firewall alert. Select the check boxes to give permission for the network to communicate with the sensor, and click the **Allow access** button.

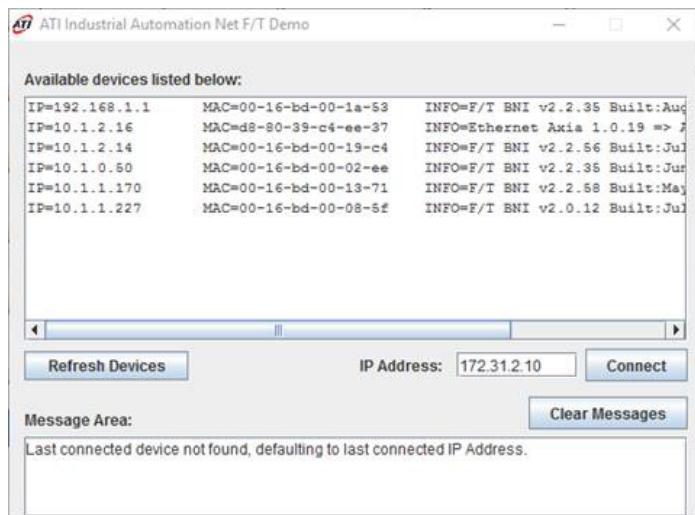
Figure 5.4— Windows 7/8/10 Firewall Alert



NOTICE: If the network is still not able to communicate, users should contact their IT Department for assistance.

3. The discovery tool opens in a window, and scans the network for available devices. The scan takes a few minutes. Verify the MAC address on the sensor's label matches the MAC address displayed in the window.
4. Use this IP address assigned by the DHCP server to the sensor's MAC address to communicate between the sensor and network.
5. Select this IP address and click **Connect**.

Figure 5.5—Discovery Tool



NOTICE: In addition to the ATI website, ATI provides this discovery tool in a directory that is sent to the user upon receipt of the sensor. To access the tool in the directory (9030-05-1026), open the folder “Utilities”, open the folder “ATI Discovery Tool”, and then install the file named “setup” .

6. Configuring the Sensor with the Ethernet Axia Web Pages

The ATI Ethernet Axia F/T sensor web pages provide full configuration options for the sensor. On the left side of the website, a menu bar has buttons that link the user to other pages for settings and sensor information.

The web pages use simple HTML browser scripting and do not require plug-in technology. If browser scripting is disabled, some non-critical user interface features are not available. The demo program is written in Java® and requires Java® to be installed on the computer.

The system status is displayed on all pages near the top of the page. This is the system status at the time the user loaded the page. To display the current system status the user must reload the page. Possible system status conditions are listed in [Section 4.8—Status Code](#).

Screenshots and a summary of the page's functionality or description of terms for each of the web pages is in the following sections.

Figure 6.1—Menu Bar



6.1 Welcome Page (index.htm)

When the user enters the sensor's IP address into the browser address field, the Ethernet F/T **Welcome** page appears. The **Welcome** page gives an overview of the Ethernet Axia's main functions. The bottom of the page lists the calibration used by this configuration.

Figure 6.2—Welcome Page

System Status: Good

Welcome!

The Axia measures forces and torques in Cartesian coordinates (Fx, Fy, Fz, Tx, Ty, and Tz).

Viewing F/T Readings
The [Demo](#) page provides a Java application that graphically displays the current loading of the transducer.
The [Snapshot](#) page shows the loads and captured peak values (if enabled).
Values shown on this page do not automatically update.

Setting Parameters
The [Configurations](#) page shows parameters such as F/T output units and the selected transducer calibration as well as providing information about the currently selected transducer calibration.

User Settings
The [Settings](#) page shows the current active configuration, filtering selection and controls peak monitoring.

Using Calibration #0: FT99931

6.2 Snapshot Page (rundata.htm)

This page displays the current sensor loading conditions. The information on the **Snapshot** page is static and becomes current after a user loads or reloads the page.

Figure 6.3—Snapshot Page

System Status: Good

Loading Snapshot

This display shows the transducer loading at the time of the loading of this web page.
After loading, this page does not refresh unless it is commanded to refresh.

Values displayed in *User Units* use the *Force Units* and *Torque Units* selected in [Configurations](#).
Values displayed in *Counts* use the *Counts per* values displayed in [Configurations](#).

Transducer Loading Snapshot (User Units):						
Force/Torque Data:	Fx	Fy	Fz	Tx	Ty	Tz
	0.104	-0.083	-0.133	0.001	-0.003	0.002

Transducer Loading Snapshot (Counts):						
Force/Torque Counts:	Fx	Fy	Fz	Tx	Ty	Tz
	-21390	-106640	-75545	-1571	-1966	2141

[Set User Bias](#) [Clear User Bias](#)

Strain Gage Data								
Unbiased Gage Data:	G0	G1	G2	G3	G4	G5	G6	G7
	-1496548	-589752	-938318	-1229398	-743812	1099142	-640546	6123468

Range: +/- 2^23

Firmware Version 1.0.11 => Jan 31 2018 15:55:09 BL=3 Runtime=0000:00:00:34

Transducer Loading Snapshot (User Units):

Force/Torque Data: These fields display the force and torque data scaled in the user units that the user selected on the **Configurations** page. If any strain gages are overloaded, these values are invalid and displayed in red with a line through them.

Transducer Loading Snapshot (Counts):

Force/Torque Counts: These fields display the force and torque data scaled with the counts per force and counts per torque displayed on the **Configurations** page. For more information about how F/T values are scaled, refer to [Section 4.4—Converting Counts Per Force/Torque to F/T Values](#). If any strain gages are overloaded, these values are invalid and displayed in red with a line through them.

Strain Gage Data:

Unbiased Gage Data: These fields display the sensor's raw strain gage information for troubleshooting overload errors. If the strain gages are overloaded, the values are invalid and displayed in red.

NOTICE:

- When an overload condition occurs, the reported force and torque values are invalid.
- Individual strain gage values do not correspond to individual force and torque axes.
- The sensor readings on this page are captured as the web page requests them. It is possible that the readings towards the bottom of the page have come from later F/T data records than the readings towards the top of the page.

6.3 Demo Page (demo.htm)

From the **Demo** page, the user may download the Java® Demo Application. Refer to [Section 7—Java® Demo Application](#) for more information.

Figure 6.4—Demo Page

System Status: Good

Demonstration Application

The demonstration application graphically displays transducer readings.

The application's features include:

- Display of transducer loading in real time as a bar graph and a 3D cube
- Ability to save transducer readings in CSV format
- Biasing of transducer readings to zero
- Reporting of communication errors

Click the *Download Demo Application* button to load and run the demo.
The IP address of this Axia is: 10.1.2.19

Download Demo Application
(61974 bytes)

The application requires Java version 6 (runtime 1.6.0) or later to run. Java can be downloaded from <http://www.java.com>. Java source code can be found in the Axia system documentation.

6.4 ADC Settings Page (setting.htm)

On the **ADC Settings** page, the user can select the following: the active calibration, ADC sampling frequency, low-pass filter cutoff frequency, and software bias values. When the user clicks the **Apply** button, the changes on this page are implemented on the sensor.

Figure 6.5—ADC Settings Page

System Status: Good

ADC Settings

These system settings are independent of configurations and affect all transducer readings.

Values are not stored unless the *Apply* button is clicked.

User Setup:

Active Calibration	#0 - FT001234																		
ADC Sampling Frequency:	976 Hz																		
Low-Pass Filter Cutoff Frequency:	None Hz																		
Software Bias Values:	<table border="1"><tr><td>Fx</td><td>Fy</td><td>Fz</td><td>Tx</td><td>Ty</td><td>Tz</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td colspan="6">Force/Torque Counts</td></tr></table>	Fx	Fy	Fz	Tx	Ty	Tz	0	0	0	0	0	0	Force/Torque Counts					
Fx	Fy	Fz	Tx	Ty	Tz														
0	0	0	0	0	0														
Force/Torque Counts																			

Apply **Cancel**

The descriptions for the fields on the **ADC Settings** page, [Figure 6.5](#), are the following:

Active Calibration: A user may select one of two calibrations to be applied to the force and torque readings. For more information about the two calibration options, refer to [Section 15.3—Calibration Ranges](#).

ADC Sampling Frequency: The user may select the sampling frequency for low-pass filtering. For more information about the sampling rate options, refer to [Section 4.3—Sample Rate](#))

Low-Pass Filter Cutoff Frequency: The user may select a value for the cutoff frequency for low-pass filtering. The **No Filter** value disables the low-pass filtering feature. For more information about the filtering values, refer to [Section 4.5—Low-Pass Filter](#).

Software Bias Values: The user may enter values for the bias offset applied to the sensor strain gage readings. To remove the bias offset, set the fields to all zeros.

Note that the strain gage readings do not have a 1:1 correspondence to force and torque readings.

6.5 Thresholding Page ([moncon.htm](#))

On the **Thresholding** page, the user can set up to 16 threshold conditions. Threshold conditions compare the sensor readings to simple user-defined threshold statements. After the user enables threshold monitoring and a sample is read, the user-defined output code for all threshold conditions satisfied by that sample are compared with a bitwise OR function or AND function (as defined by the user) to form the threshold output. In practice, it is very unlikely that more than one threshold sample is satisfied in a single sample. If the threshold conditions are exceeded, the threshold monitoring latch is set, and threshold monitoring is paused until the user issues a reset command or the user defined momentary time delay has passed.

Each threshold condition can be configured for:

- the axis to monitor
- the type of comparison to perform
- the threshold value to use for the comparison
- the output code to send when the comparison is true

Figure 6.6—Thresholding

System Status: Threshold Level Latched

Thresholding

When *Threshold Monitoring* is enabled the Axia compares transducer force and torque values to the *Threshold Conditions* that are turned on. The *Output Codes* for all true conditions are combined to form the *Thresholds Output*.

The *Units* column displays the force or torque counts value in user units, but it is not updated until the *Apply* button is clicked.

Values are not stored unless the *Apply* button is clicked.

Thresholding Settings

When *Relay Trigger* item *Any condition is true* is selected the *Thresholds Output* is the result of a bitwise-OR operation on valid *Output Codes*. When *All conditions are true* is selected a bitwise-AND operation is performed.

Threshold Monitoring: Enabled Disabled

Relay Trigger: Any condition is true All conditions are true

Relay Behavior: Momentary Latching Reset Latch

Relay Momentary Minimum-On Time: 100 ×0.1 seconds only applies when *Relay Behavior* is set to *Momentary*

WARNING: In systems without the solid-state relay option, setting this value to 0 could cause premature relay failure due to excessive activation.

N	On	Off	Axis	Comparison	Counts	Units	Output Code
0	<input checked="" type="radio"/>	<input type="radio"/>	If	< ▼	1000000	1 N Then	0
1	<input checked="" type="radio"/>	<input type="radio"/>	If	< ▼	1000000	1 N Then	0
2	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
3	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
4	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
5	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
6	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
7	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
8	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
9	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
10	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
11	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
12	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
13	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
14	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0
15	<input checked="" type="radio"/>	<input type="radio"/>	If	> ▲	0	0 N Then	0

Counts range: -2147483648 to +2147483647; Output code range: 0x00 to 0xFF

Status of Thresholds:	0	1	-2	-3	-4	-5	-6	-7	-8	-9	±0	±1	±2	±3	±4	±5
Use the Get Statuses button to update this static display of threshold statuses. Threshold numbers are crossed out if the threshold is unsatisfied. The <i>On/Off</i> setting for the threshold is ignored in this display.																

Apply Cancel

Threshold Monitoring: The user can enable or disable threshold monitoring by clicking the radial button.

Relay Behavior: The user can select if the output code is calculated by bitwise OR'ing (trigger if any condition is true) or bitwise AND'ing (trigger only if ALL conditions are true).

Reset Latch button: Clears any threshold latching.

Relay Momentary Minimum-On Time: The user may select in how many tenths of a second (0 to 25.5 seconds) that the firmware should wait in momentary mode before automatically resetting the monitor latch condition.

In case of any enabled threshold condition becoming true, the following occurs:

- The threshold's output code is updated.
- Bit 16 of the status code (*Table 4.7*) is set

Bit 16 holds these states until the user clicks the **Reset Latch** button on the **Thresholding** screen.

Threshold Condition Elements:

N: Statement number.

On / Off: Selects which statements are to be included in the processing of threshold conditions.

Axis: Selects the axis to be used in the comparison statement. Available axes are:

Table 6.1—Thresholding Statement Axis Selections	
Menu Value	Description
blank	Statement disabled
Fx	Fx axis
Fy	Fy axis
Fz	Fz axis
Tx	Tx axis
Ty	Ty axis
Tz	Tz axis

Comparison: Selects the type of comparison to perform. Available comparisons are:

Table 6.2—Thresholding Statement Comparison Selections	
Menu Value	Description
>	Greater Than
<	Less Than

Counts: The loading level to be compared to the sensor reading. This value displays in the units of the active configuration, after the user clicks the **Apply** button.

To determine the Counts value to use from a value in user units, multiply the value in user units by Counts per Force (or Counts per Torque if appropriate).

Example:

Desired Loading Level 6.25 N

Force Units: N (from Configurations page)

Counts per Force value 1000000 (from Configurations page)

Counts = Desired Loading Level × Counts per Force

= 6.25 N × 1000000 counts/N

= 6250000 counts

NOTICE: Comparison levels are stored as counts and only change when the user inputs new counts values. Changing the configuration or the force units or the torque units does not change or adjust the counts values.

Units: Displays the counts value in the units of the active configuration. This value is only updated after the Apply button is clicked.

Output Code: When this statement's comparison is found true, this 8-bit value will be bitwise OR'ed with the Output Code values of all other true statements to form the threshold output. Any set bits remain latched until the user issues a **Resent Latch**. If no statements are true the threshold output is zero.

The value displays in hexadecimal format 0x00. A user may type output codes in hexadecimal format or in decimal. Bit pattern representing each thresholding statement number are in the following table.

Table 6.3—Bit Patterns for Thresholds Breached							
#:	Bit Pattern	#:	Bit Pattern	#:	Bit Pattern	#:	Bit Pattern
0:	0x00000001	4:	0x00000010	8:	0x000000100	12:	0x00001000
1:	0x00000002	5:	0x00000020	9:	0x00000200	13:	0x00002000
2:	0x00000004	6:	0x00000040	10:	0x00000400	14:	0x00004000
3:	0x00000008	7:	0x00000080	11:	0x00000800	15:	0x00008000

Get Statuses: Click the **Get Statuses** button to update the static display of the threshold status. If a threshold is unsatisfied, the threshold numbers are crossed out.

6.6 F/T Configurations Page (config.htm)

On the **Configurations** page, a user may select the active calibration ([Section 15.3—Calibration Ranges](#)) and tool transformation settings for the sensor system. When the user clicks the **Apply** button, the changes on this page are implemented on the sensor. For more information about tool transformation feature, refer to [Section 4.7—Tool Transformation](#).

From the **Configurations** page, a user may obtain the following values: the sensor's **Serial Number**, **Part Number**, calibration **Family**, **Time** or date the sensor was calibrated, force units, torque units, counts per force, and counts per torque. Note that these are the same values that are in [Section 8.4—Console “CAL” / “SET” Command Fields and Values](#) and [Section 11.2—Calibration Information \(netftcalapi.xml\)](#).

For more information about how F/T values are scaled with the counts per force and counts per torque, refer to [Section 4.4—Converting Counts Per Force/Torque to F/T Values](#).

The **Calibrated Sensing Range** field displays the maximum rating for each axis of the selected calibration.

Figure 6.7—Configurations Page

FT Configuration

Values are not stored unless the **Apply** button is clicked.

Calibration #1 (Active calibration)					
Calibration Select:	#1 - FT1234 ▾				
Serial Number:	FT1234				
Part Number:	SI-500-200				
Family:	NET				
Time:	2018-01-01				
Force Units:	N				
Torque Units:	lbf-ft				
Counts per Force:	1				
Counts per Torque:	1				
Calibrated Sensing Range (Units):	Fx	Fy	Fz	Tx	Ty
	500	500	900	20	20
	Calibrated sensing range values apply to the factory origin (without tool transformation).				
Tool Transform					
Distance Units:	m ▾				
Angle Units:	radians ▾				
Tool Transform:	Dx	Dy	Dz	Rx	Ry
	0	0	0	0	0
	Using a tool transformation will change how transducer readings are reported and change the apparent sensing ranges and apparent resolutions. Values are floating-point.				
<input type="button" value="Apply"/> <input type="button" value="Cancel"/>					

Firmware Version 1.0.26 => Nov 14 2018 11:09:55 BL=3 Runtime=0000:00:04:00

6.7 Communication Page (comm.htm)

On the **Communication** page, the user may view and edit the system's Ethernet networking options. Usually these settings are set once when the user first setup the system and do not need to be changed later. A detailed overview of setting up Ethernet communications with the sensor is in [Section 5—Connecting Through Ethernet](#).

Figure 6.8—Communications Page

System Status: Good

Communications

These settings control how the Axia communicates with external equipment. Values are not stored unless the **Apply** button is clicked.

Ethernet Network Settings

A LAN connection must be present at power up for DHCP to function.
If DHCP is enabled and no DHCP server is found then the static IP address will be used.
These settings require the Axia to be powered off and then back on before they take effect.

	<u>Active</u>	<u>Selection</u>
IP Address Mode:	DHCP	<input checked="" type="radio"/> DHCP <input type="radio"/> Static IP 192.168.1.1
IP Address:	10.1.2.19	255.255.252.0
IP Subnet Mask:	255.255.252.0	255.255.255.0
IP Default Gateway:	10.1.1.20	10.1.1.20
Ethernet MAC Address:	d8:80:39:7a:c4:5e	

Raw Data Transfer (RDT) Settings

RDT data is routed through the local network and does not get routed through the default gateway.

RDT Output Rate (1 to 976):	976	Hz
RDT Buffer Size (1 to 40):	1	

Apply **Cancel**

The descriptions for the fields on the **Communications** page, [Figure 6.8](#), are the following:

Ethernet Network Settings:

IP Address Mode: The user can configure the IP address of the sensor (refer to [Section 5.1—IP Address Configuration for Ethernet](#)).

Static IP Address: The user can set the static IP address (refer to [Section 5.1—IP Address Configuration for Ethernet](#)).

Static IP Subnet Mask: This field is for the subnet mask portion of the IP address. Many networks use the default 255.255.255.0. Users should contact their IT department to know what static IP subnet mask to assign.

IP Default Gateway: This field is for the default gateway. Users should contact their IT department to know what default gateway to assign.

Ethernet MAC Address: A unique address given to the sensor at the time of manufacture. This address uniquely identifies this sensor from other sensors and other Ethernet devices.

NOTICE: Detailed information about RDT settings with a UDP interface is in [Section 12—UDP Interface Using RDT](#).

Raw Data Transfer (RDT) Settings:

RDT Output Rate: In this field, the user can set the RDT output rate from 1 to the value of the ADC sampling rate in [Section 4.3—Sample Rate](#).

RDT Buffer Size: In this field, the user can set the RDT buffer size to a value from 1 to 40.

6.8 System Information Page (manuf.htm)

The **System Information** page provides the user with a summary of the Ethernet Axia sensor's current state. ATI refers to this page, when troubleshooting the sensor. For status codes, refer to [Section 4.8—Status Code](#). On the top of the page, **System Status** is *good*, if all hardware diagnostics report “good”. The **System Status** is *bad*, if any hardware diagnostics report “bad”.

Figure 6.9—System Information Page

System Status: Good							
System Information							
This is a summary of the system's current state. This information may be helpful during troubleshooting.							
Transducer							
Strain Gage Values:							
G0 -1487900 -575588 -926234 -1229830 -738364 1108470 -693896 6257524							
Fx 0 Fy 0 Fz 0 Tx 0 Ty 0 Tz 0							
Software Bias Values:							
Force/Torque Counts:							
-11681364 31506724 11037848 211105 37313 92829							
Force/Torque Units:							
N N N N Nm Nm Nm							
Run-time Matrix:							
G0 78.8319 -72.1477 -7.21988 -7.11622 -72.1291 79.7986							
Fy -37.8669 50.5185 88.5176 -89.2425 -50.1949 38.2316							
Fx 59.4185 59.8229 60.9954 59.5984 64.2795 55.949							
Tx -2.12904 -1.27252 0.955521 -0.958976 1.33332 2.05951							
Ty 0.132833 1.80583 -2.01164 -1.9061 1.8916 0.0858098							
Tz 2.02883 -2.05575 2.03322 -2.00783 2.07986 -2.07972							
Calibrations							
Using Calibration #0							
Calibrations:							
Serial Number Part Number Family Time							
0 FT99931 SI-500-20 NET 2/5/2018							
1 FT99932 SI-200-8 NET 2/5/2018							
Board							
Status Word: 0x00000000							
Ethernet MAC: 00:16:bd:00:22:15							
Address:							
Serial Number: Serial number							
Firmware Revision: 1.0.11 => Jan 31 2018 15:55:09 BL=3							
Hardware Revision: 0							
Hardware Product Code: HW Product Code							
Run-time Matrix:							
NVM-Image-0 Good 525 K bytes							
NVM-Image-1 ----							
SPI-Param-0 Good 1164 bytes							
SPI-Param-1 Good 1164 bytes							
RAM-Param Good 1164 bytes							
UART ---- 115.4 KHz RX Faults: 0							
SPI-ADC ---- 14.0 MHz							
Run-time Matrix:							
Fy -37.8669 50.5185 88.5176 -89.2425 -50.1949 38.2316							
Fx 59.4185 59.8229 60.9954 59.5984 64.2795 55.949							
Tx -2.12904 -1.27252 0.955521 -0.958976 1.33332 2.05951							
Ty 0.132833 1.80583 -2.01164 -1.9061 1.8916 0.0858098							
Tz 2.02883 -2.05575 2.03322 -2.00783 2.07986 -2.07972							
Calibrations							
Using Calibration #0							
Calibrations:							
Serial Number Part Number Family Time							
0 FT99931 SI-500-20 NET 2/5/2018							
1 FT99932 SI-200-8 NET 2/5/2018							
Board							
Status Word: 0x00000000							
Ethernet MAC: 00:16:bd:00:22:15							
Address:							
Serial Number: Serial number							
Firmware Revision: 1.0.11 => Jan 31 2018 15:55:09 BL=3							
Hardware Revision: 0							
Hardware Product Code: HW Product Code							
Run-time Matrix:							
NVM-Image-0 Good 525 K bytes							
NVM-Image-1 ----							
SPI-Param-0 Good 1164 bytes							
SPI-Param-1 Good 1164 bytes							
RAM-Param Good 1164 bytes							
UART ---- 115.4 KHz RX Faults: 0							
SPI-ADC ---- 14.0 MHz							
Run-time Matrix:							
Fy -37.8669 50.5185 88.5176 -89.2425 -50.1949 38.2316							
Fx 59.4185 59.8229 60.9954 59.5984 64.2795 55.949							
Tx -2.12904 -1.27252 0.955521 -0.958976 1.33332 2.05951							
Ty 0.132833 1.80583 -2.01164 -1.9061 1.8916 0.0858098							
Tz 2.02883 -2.05575 2.03322 -2.00783 2.07986 -2.07972							
Hardware Diagnostics:							
MCU-Supply Good 24.1 V							
MCU-Regs Good							
MCU-PC Good							
MCU-RAM ---- 512 K bytes Errors: 0							
MCU-GPIO Good							
PCB-Temp Good 39.3 °C							
Gage-Temp Good 25.3 °C							
ADC-Gage Good Spikes: 0							
ADC-RegWr Good							
ADC-Intrpt Good ISR overruns: 0 CRC errors: 0							
PHY-State Good ISR overruns: 0							
EEPROM Good Retries: 0							
MonTime Good Max: 481 uS							
Stack Good 394060 bytes available of 395768 bytes allocated							

6.9 ATI Web Site Menu item

On the menu bar, if the user clicks the **ATI Web Site** button, the user goes to ATI Industrial Automation's official web site. To use this feature, be sure the user network is connected to the internet.

7. Java® Demo Application

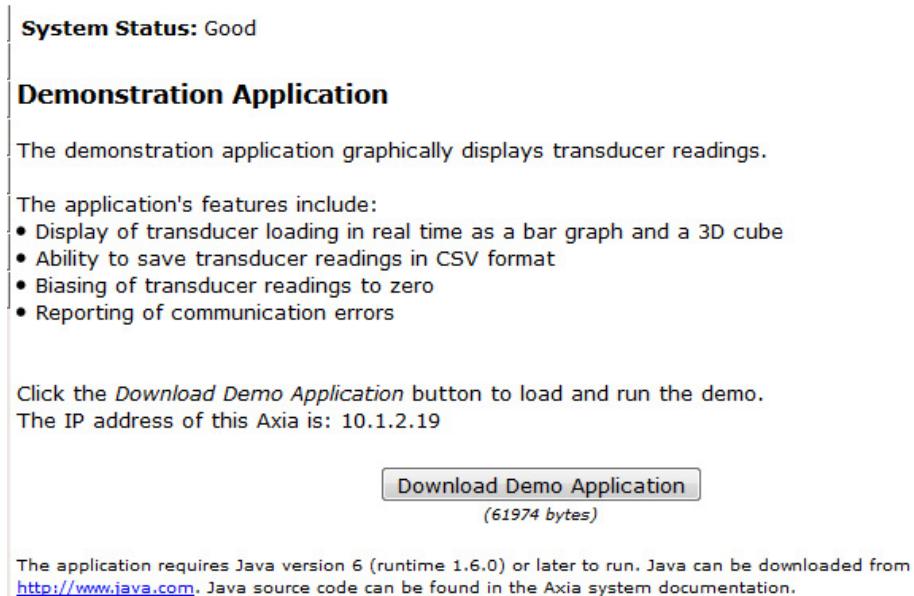
The user can collect and view F/T data through the Java® demo application on a personal computer. Install Java® version 6.0 (runtime 1.6.0) or later on the computer (download Java® from www.java.com/getjava).

7.1 Starting the Demo

Download the demo from the **Demo** page on the ATI Ethernet Axia F/T web page:

1. Click the **Download Demo Application** button and follow the browser's instructions.
 - The file ATINetFT.jar downloads. If the browser does not automatically run the downloaded file, manually open the file on the computer.

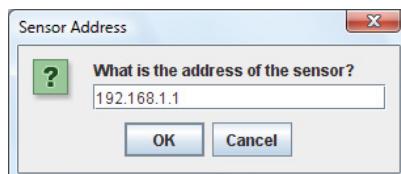
Figure 7.1—Demo Page



NOTICE: The Java® Demo requires the Ethernet F/T to have its RDT Interface enabled. RDT is enabled in the Ethernet F/T by default. For information on RDT settings, refer to [Section 6.7—Communication Page \(comm.htm\)](#).

- The demo program opens with the following window:

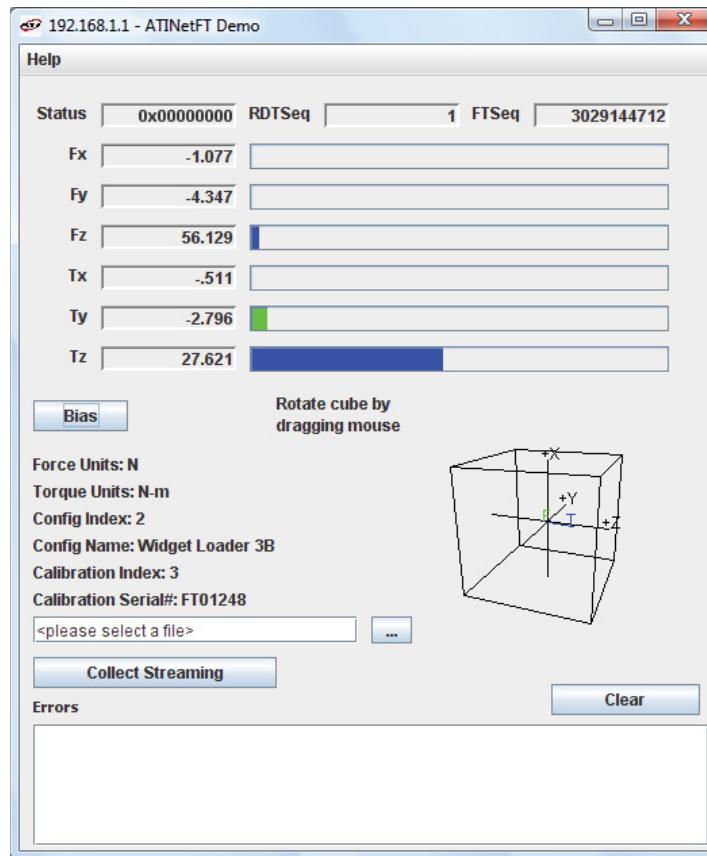
Figure 7.2—Ethernet IP Address Request



- If the window does not appear, it may be hidden under the browser window. In this case, minimize the browser window.
- 2. Type the IP address of the sensor.
 - On the **Demo** page, the IP address of the sensor is in the paragraph above the **Download Demo Application** button.
- 3. Click **OK**.
 - The Java® Demo application main window opens.

- If the demo is unable to make contact with the Ethernet Axia sensor, the force and torque values will display zero and the Force units and other configuration-related items will each display a question mark.

Figure 7.3—Java® Demo Application



The first time the demo is used, the program may trigger a firewall alert. If this occurs with a Windows® 7/8/10 operating system, select the check boxes to give permission for the network to communicate with the sensor, and click the **Allow access** button (refer to *Figure 7.4*). If this occurs with a Windows® Vista operating system, click the **Unblock** button (refer to *Figure 7.5*). If the network is still not connecting with the demo program, users should contact their IT department for assistance.

Figure 7.4—Windows 7/8/10 Firewall Alert

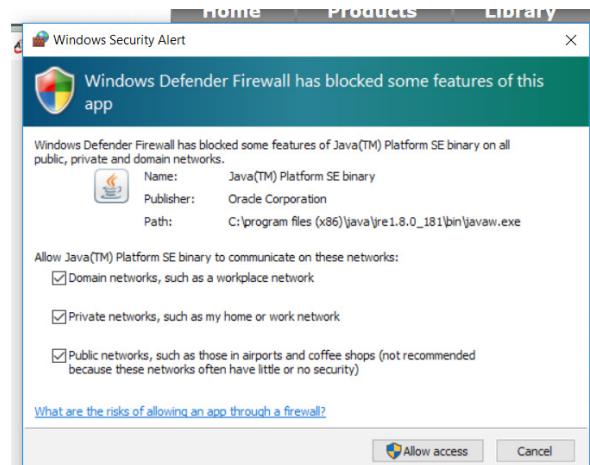


Figure 7.5—Windows Vista Firewall Alert



7.2 Data Display with the Demo

The main screen in [Figure 7.3](#) features a live display of the current F/T data, sequence numbers, and status code. To understand how to interpret the status code, refer to [Section 4.8—Status Code](#). During normal operation, the application requests single records, so the RDT sequence remains constant. For more information about RDT protocol, refer to [Section 12—UDP Interface Using RDT](#).

A cube in the lower screen provides a real-time visual representation of the F/T data. The user can bias the data and select the calibration configuration.

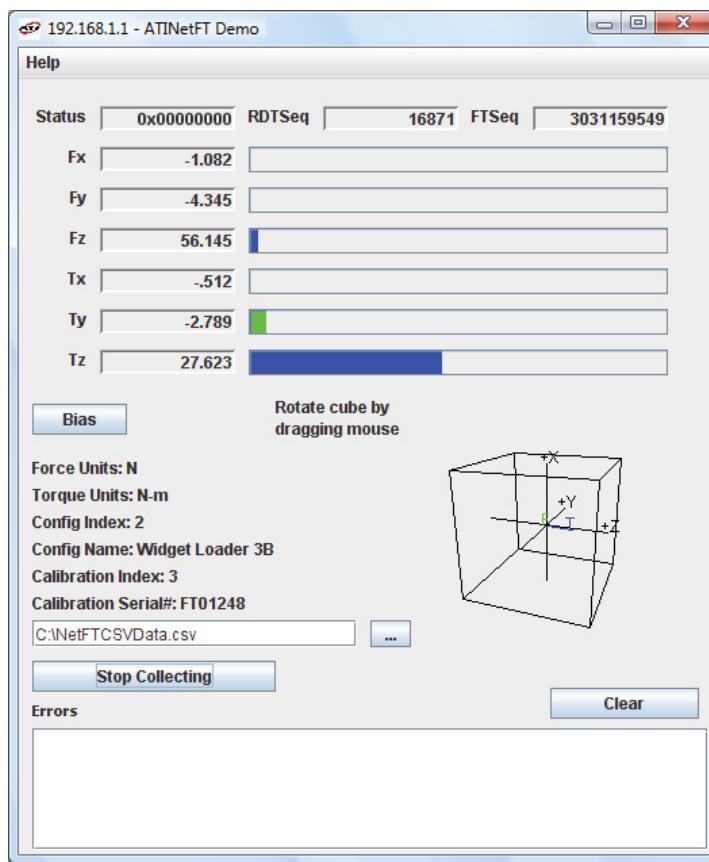
7.3 Collecting Data with the Demo

To collect F/T data, follow these steps:

1. On the Java® demo application main window, select a file to save the data by one of the following methods (refer to [Figure 7.6](#)):
 - click the ... button to the right of the file selection field and navigate to the file destination.
 - directly type the file path into the file selection field.
2. Click the **Start Collecting** button(refer to [Figure 7.3](#)):
 - The application sends out a request for high-speed data to the Ethernet Axia sensor.
 - The user can see the RDT sequence incrementing in real-time because the application requests more than a single record when in high-speed mode.
 - The measurement data are stored in comma-separated value format (CSV) so it can be read by spreadsheets and data-analysis programs.
3. Name the file with a .CSV extension.
4. Double-click on the file to open it.

NOTICE: If collecting large amounts of data, understand any limitations a spreadsheet or data analysis program may have to accommodate a certain number of rows.

Figure 7.6—Java® Demo Application while Collecting Data



5. To stop collecting data, click the **Stop Collecting** button (the **Collect Streaming** button changes to **Stop Collecting**, during collections).

7.4 Demo CSV File Format

Information stored in the CSV file is organized as follows :

Figure 7.7—Sample Data Opened in Spreadsheet

A	B	C	D	E	F	G	H	I	J	
1	Start Time: 10/28/08 4:45 PM									
2	RDT Sample Rate: 7000									
3	Force Units: N									
4	Counts per Unit Force: 1000000.0									
5	Torque Units: N·m									
6	Counts per Unit Torque: 1000000.0									
7	Status (hex)	RDTSequence	F/T Sequence	Fx	Fy	Fz	Tx	Ty	Tz	Time
8	0x80010000	1	3031142679	-1082088	-4344421	56145954	-512907	-2789325	27622278	Tue Oct 28 16:45:31 EDT 2008
9	0x80010000	2	3031142680	-1082080	-4344397	56146508	-512897	-2790736	27622288	Tue Oct 28 16:45:31 EDT 2008
10	0x80010000	3	3031142681	-1082060	-4343688	56146485	-513175	-2791845	27621563	Tue Oct 28 16:45:31 EDT 2008
11	0x80010000	4	3031142682	-1082341	-4342832	56147539	-513359	-2791420	27621240	Tue Oct 28 16:45:31 EDT 2008
12	0x80010000	5	3031142683	-1082371	-4342861	56148597	-512138	-2790008	27621264	Tue Oct 28 16:45:31 EDT 2008
13	0x80010000	6	3031142684	-1082385	-4342524	56148628	-511978	-2790022	27621981	Tue Oct 28 16:45:31 EDT 2008
14	0x80010000	7	3031142685	-1082389	-4342191	56148118	-512436	-2789687	27622688	Tue Oct 28 16:45:31 EDT 2008
15	0x80010000	8	3031142686	-1082363	-4341816	56149196	-512870	-2791481	27622352	Tue Oct 28 16:45:31 EDT 2008
16	0x80010000	9	3031142687	-1082350	-4342498	56149183	-513193	-2791443	27622000	Tue Oct 28 16:45:31 EDT 2008
17	0x80010000	10	3031142688	-1082658	-4343039	56148680	-513432	-2789853	27623085	Tue Oct 28 16:45:31 EDT 2008
18	0x80010000	11	3031142689	-1082649	-4343057	56148669	-514051	-2788802	27623093	Tue Oct 28 16:45:31 EDT 2008
19	0x80010000	12	3031142690	-1082364	-4342864	56147033	-513374	-2790000	27622309	Tue Oct 28 16:45:31 EDT 2008
20	0x80010000	13	3031142691	-1081778	-4342833	56145442	-513406	-2792379	27622237	Tue Oct 28 16:45:31 EDT 2008
21	0x80010000	14	3031142692	-1081805	-4343552	56144381	-513136	-2790561	27622936	Tue Oct 28 16:45:31 EDT 2008
22	0x80010000	15	3031142693	-1081820	-4344608	56142267	-513644	-2789069	27623972	Tue Oct 28 16:45:31 EDT 2008
23	0x80010000	16	3031142694	-1082089	-4345096	56141691	-513861	-2789611	27622892	Tue Oct 28 16:45:31 EDT 2008
24	0x80010000	17	3031142695	-1082344	-4345231	56143795	-513900	-2790895	27621519	Tue Oct 28 16:45:31 EDT 2008
25	0x80010000	18	3031142696	-1082342	-4345217	56143265	-513897	-2791596	27621503	Tue Oct 28 16:45:31 EDT 2008
26	0x80010000	19	3031142697	-1081777	-4345564	56142209	-513490	-2792190	27621809	Tue Oct 28 16:45:31 EDT 2008
27	0x80010000	20	3031142698	-1081488	-4346106	56141657	-513765	-2790886	27621793	Tue Oct 28 16:45:31 EDT 2008

Row 1:

Start Time: the date and time when the data collection started.

Row 2:

RDT Sample Rate: the speed (in samples per second) at which data is sent to the host computer. The speed is the RDT Output Rate the user inputs on the **Communications** page (refer to [Section 6.7—Communication Page \(comm.htm\)](#)).

Note: If the user changes the sample rate after start of the demo program, this value will not be updated.

Row 3:

Force Units: the force unit the user select on the **Configuration** page (refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#)).

Row 4:

Counts per Unit Force: Divide all force values Fx, Fy, Fz in the CSV file by this number to calculate the force values in the user selected unit.

Row 5:

Torque Units: the torque unit the user select on the **Configuration** page (refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#)).

Row 6:

Counts per Unit Torque: Divide all torque values Tx, Ty, Tz in the CSV file by this number to calculate the torque values in the user selected unit.

Row 7:

Header Row: This row names each of the columns of CSV data (refer to [Table 7.1](#)).

Table 7.1—CSV File Column Headings										
Column:	A	B	C	D	E	F	G	H	I	J
Name:	Status (hex)	RDT Sequence	F/T Sequence	Fx	Fy	Fz	Tx	Ty	Tz	Time

Column A: **Status (hex):** a 32-bit system status code for this row. To understand how to interpret the hexadecimal code and find the status code, refer to [Section 4.8—Status Code](#).

Column B: **RDT Sequence:** a number that starts at (1) and is incremented with each set of data that is sent from the sensor to the host computer.

Find elapsed measurement time with the following formula:

$$\text{Elapsed Measurement Time} = \frac{\text{RDT Sequence Number}}{\text{RDT Sample Rate}}$$

Missing sequences indicate that data packages were lost. To avoid lost samples, refer to [Section 14.8—Improving Ethernet Throughput](#).

Column C: **F/T Sequence:** a number that is incremented with each new F/T measurement. The user sets the rate on the **ADC settings** page. Refer to [Section 6.4—ADC Settings Page \(setting.htm\)](#).

Column D: **Fx:** the Fx axis reading in counts.

Column E: **Fy:** the Fy axis reading in counts.

Column F: **Fz:** the Fz axis reading in counts.

Column G: **Tx:** the Tx axis reading in counts.

Column H: **Ty:** the Ty axis reading in counts.

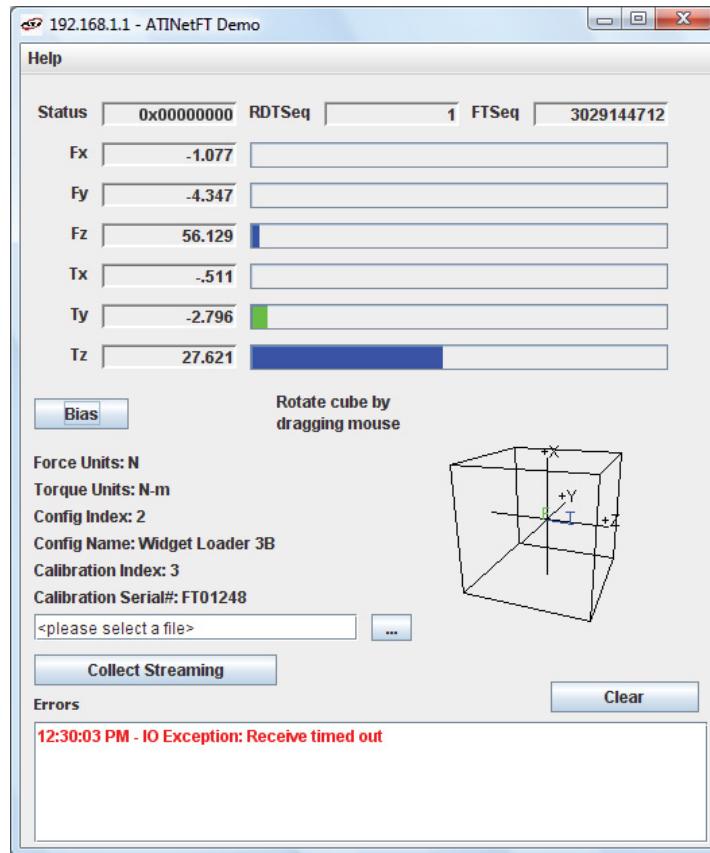
Column I: **Tz:** the Tz axis reading in counts.

Column J: **Time:** a time stamp that indicates when the demo program received the data row. This time stamp is created by the user's computer and is limited to the clock resolution of the user's computer.

7.5 The Errors Field Display of the Demo

On the bottom of the Java® demo application main window, an **Errors** field tracks errors that have occurred and the times they occurred (see *Figure 7.8* for an example). For assistance with troubleshooting these error messages, refer to *Table 14.3*. If there are excessive “IO Exception: Receive timed out errors”, refer to *Section 14.8—Improving Ethernet Throughput*.

Figure 7.8—Java® Demo Application with an Error Message



7.6 Developing a Customized Java® Application

Experienced Java® programmers can develop Ethernet F/T applications by using Java® source code that is in the 9030-05-1026 directory, which is sent to the user upon receipt of the Ethernet Axia sensor. The source code for the Java® demo is also on the ATI website at: <http://www.ati-ia.com/library/download.aspx>.

8. Console Interface Through Telnet

The Ethernet Axia sensor has a console interface that is available to the user through Telnet.

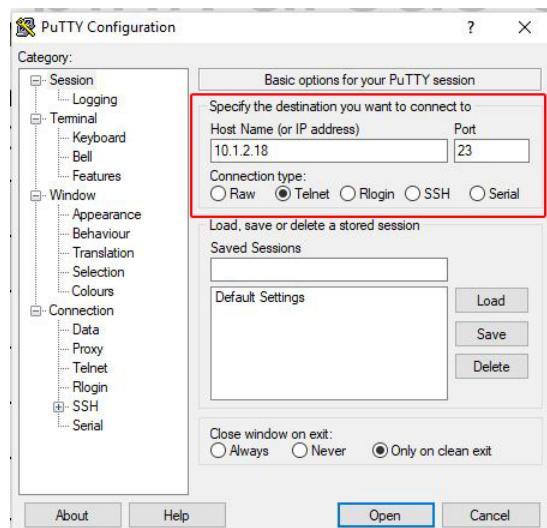
8.1 Setting-Up Communications

By using a console interface on the computer, the user can communicate with the sensor. Free Telnet console software, such as PuTTY, is available online.

For instructions on setting up a console through Telnet like PuTTY, refer to the following procedure:

1. Open the serial console, for example: PuTTY. A window opens that allows the user to set the configuration for the session.
2. Set the configuration:
 - a. Under **Connection type**: select the radio button for **Telnet**.
 - b. In the **Host Name (or IP Address)** field, enter “10.1.2.18”.
 - c. In the **Port** field, verify the default port is “23”.
 - d. Select **Open**.

Figure 8.1—Set the Configuration



3. After a terminal window opens, the session prompts the user to enter a **Login** (or username) and **Password**. The Login is “ati”, the password is “ati7720115”.
4. Enter a console command from, press the (enter) key to send the command.

NOTICE: Commands which are entered are not case sensitive.

Figure 8.2—PuTTY Terminal Window

The screenshot shows a PuTTY terminal window titled "10.1.2.18 - PuTTY". The window displays the following text:
Microchip Telnet Server 1.1
Login: ati
Password: ati7720115
Logged in successfully
--- Telnet Console ---
Type help for commands
>|

8.2 Console Commands

These console commands can be used to view the status, parameters, and adjust settings of the sensor.

Table 8.1—Commands

Command	Operand(s)	Description
HELP		The help command reports a list of the console commands and software version.
H		
MAN		
?		
BIAS		The bias command allows the user to turn the bias feature on and off.
	on	“BIAS ON” turns the feature on and sets the F/T output to 0.
	off	“BIAS OFF” turns the feature off and clears the bias bit.
	[values]	The user can bias the sensor with user determined values.

Table 8.1—Commands		
Command	Operand(s)	Description
PEAK	Not Applicable	The peak command reports the highest and lowest F/T values that occurred for a run-time and for all-time, since the last peak reset command was issued. No operand reports the peaks in units.
	C	“PEAK C” reports the peaks in counts.
	R	“PEAK R” resets the run-time peaks.
S	DH!#@01234567SFTXYZMCU>< in any order	A query command reports a single line of F/T data that is scaled by the counts per force or counts per torque..
C	(refer to Section 8.3—Secondary Commands for the Query “c” or “s” Command)	A query command reports continuous lines of F/T data that stops when a user holds another key. If using PuTTY Telnet, press the (enter) key to stop.
CAL or SET		The “CAL” or “SET” command reports all parameters.
	[field-name]	Print all matching field(s) (refer to Section 8.4—Console “CAL” “SET” Command Fields and Values).
	[field-name] [value]	Write field with value (refer to Section 8.4—Console “CAL” “SET” Command Fields and Values).
SIMERR		The simulated error command refers to bit 28 from Table 4.7 . A user can issue this command to view the status of bit 28. The simulated error command is useful for customers who need to test their error-handling routines. When a simulated error occurs, the “red” status LED turns on (refer to Section 4.2.4—Sensor Status LED).
	ON	Turns bit 28 on.
	OFF	Turns bit 28 off.
RESET	ON	This command resets the MCU.
	OFF	Turns the “reset” command off.
SAVEALL		This command records all values that remain through a power cycle to NVM.
STATUS		If there could be an underlying problem within the sensor hardware, the “status” command can be used to retrieve detailed information or for the user to send the information to ATI for troubleshooting. The “status” command reports various components of the sensor. The content of this command varies among sensors.

Table 8.1—Commands		
Command	Operand(s)	Description
VIEW		The “view” command reports properties such as the F/T part number, units, calibration date, and calibration family (refer to Section 15.3—Calibration Ranges). If a user sends this command with no operand, all calibrations are reported.
	0	Calibration 0
	1	Calibration 1
	A	Active calibration
DIAG		The diagnostic status command provides a report for each of the gages within the sensor. Compare this information to the values in Section 15.3—Calibration Ranges . Use the “status” command, for troubleshooting. The report includes the following: gage number, gage readings in counts, gage status indicator, F/T axis, F/T reading in units, all-time peak data, and the active tool transformation.

8.3 Secondary Commands for the Query “c” or “s” Command

A user can adjust the type of data reported from the query “c” or “s” by using secondary commands or specifiers. This feature is useful for users who want to develop their own program for storing the data to an external file or view the data in figures such as charts. A list of secondary commands is in the following table.

If a “s” or “c” command is issued without a specifier(s), the specifier(s) from the previous “c” or “s” command is used in the data print out. The power-on default specifier is the following: “XYZTXYZ”.

Table 8.2—Secondary “c” or “s” Commands		
Category	Secondary Command or Specifier	Notes
Gage number(s).	0	Gage values are printed in counts only. As many as all gage numbers can be reported or as few as a single gage number.
	1	
	2	
	3	
	4	
	5	
	6	
	7	

Table 8.2—Secondary “c” or “s” Commands		
Category	Secondary Command or Specifier	Notes
Axis.	x	The user can choose to view force and torque data in the x, y, z axis. The output value can be displayed in F/T counts or engineering units. Counts are converted to units by scaling or dividing the count value by the cpf or cpt. Refer to Section 4.4—Converting Counts Per Force/Torque to F/T Values .
	y	
	z	
	m	
Force and/or Torque.	f	The XYZM force data is displayed.
	t	The XYZM torque data is displayed.
Magnitude	m	Force or torque data is displayed as the magnitude of the vector components in the x, y, and z axis. The output value can be displayed in F/T counts or engineering units. Counts are converted to units by scaling or dividing the count value by the cpf or cpt. Refer to Section 4.4—Converting Counts Per Force/Torque to F/T Values .
Counts or Units.	c	The XYZM data is displayed in counts.
	u	The XYZM data is displayed with the selected user units, for example: N or Nm. Units are the default setting.
Numeric System.	h	The data is displayed as a hexadecimal number. Except any data printed in units is always displayed as a decimal number by default.
	d	The data is displayed as a decimal number.
Format.	>	The data is displayed in a formatted human-readable output, for example: lined-up columns. “>” is the default setting.
	<	The data is displayed in a compressed output that has no leading zeros, trailing zeros, or unnecessary blanks. This output is intended for high-speed applications that are used in an automated setting.
Additional inputs to aid in the development of a software program.	s	This command specifies a CRC.
	#	This command specifies a sample counter that is incremented each time that a “c” or “s” line is printed.
	@	This command specifies an ADC read counter that is incremented each time that the ADC is read.
Troubleshooting	!	This command specifies the 32-bit status code (refer to Section 4.8.2—How to Interpret Hexadecimal Output for the Status Code).

8.3.1 Examples of Secondary Commands (Specifiers)

The following are examples of a “c” or “s” command with specifiers:

1. C XTY is interpreted as:

user:	s xty
response:	0.001 N 0.0009 Nm

- a. The C is a command for reporting continuous lines of data.
- b. The X specifies printing F_x , because force is the default.
- c. The T specifies printing torques whenever an x, y, z, or m is seen from now on (on this line).
- d. The Y specifies printing T_y .

2. C TXY is interpreted as:

user:	s txy
response:	0.0009 Nm 0.0009 Nm

- a. The C is a command for reporting continuous lines of data.
- b. The T specifies printing torques whenever an x, y, z, or m is seen from now on (on this line).
- c. The X specifies printing T_x .
- d. The Y specifies printing T_y .

3. S D0123 is interpreted as:

user:	s d01234567
response:	246123 245592 246707 246029

- a. The S is a command for reporting a single line of data.
- b. The D specifies printing raw ADC values in counts decimal.
- c. A number 0 through 7 specifies to print the data for the corresponding gage number. For example, the 0 specifies to print data for gage 0, and the 3 specifies to print data for gage 3.

4. S CDFXYZTXYZ is interpreted as:

user:	s cdfxyztxyz
response:	961 959 963 960 966 965

- a. The S is a command for reporting a single line of data.
- b. The C and D specifies printing x, y, z, or m F/T data in counts decimal.
- c. The F specifies printing torques whenever an X, Y, Z, or M is seen from now on (on this line).
- d. The T specifies printing the torques whenever an X, Y, Z, or M is seen from now on (on this line).

8.4 Console “CAL” | “SET” Command Fields and Values

A user can send the “CAL” or “SET” command with additional fields and sometimes values to read or edit parameters such as tool transformation and calibration range. These fields and values are listed in [Table 8.3](#). All write commands are temporary until a “saveall” command is issued. When a “saveall” command is given, the parameter is stored in NVM.

Table 8.3—“CAL” “SET” Fields and Values					User Read/ Write
Field	Long Name	Description	Example Contents	Type	
serialNum	F/T Serial	The F/T serial number	FT001234	STRING(8)	Read
partNum	Calibration Part Number	The calibration part number	Num-4	STRING(30)	
calFamily	Calibration Family	The field always reads “NET”.	NET	STRING(8)	
calTime	Calibration Time	The date and time the sensor was calibrated.	1970-01-01 00:00	STRING(30)	

Table 8.3—“CAL” “SET” Fields and Values					
Field	Long Name	Description	Example Contents	Type	User Read/Write
max0	Max F _x Counts	The maximum rated value for this axis, in F/T counts.	214748647	32-bit unsigned integer	Read
max1	Max F _y Counts				
max2	Max F _z Counts				
max3	Max T _x Counts				
max4	Max T _y Counts				
max5	Max T _z Counts				
forceUnits	Force Units	Force units: 0 = Lbf 1 = N 2 = Klf 3 = kN 4 = Kg	1	8-bit unsigned integer	Read
torqueUnits	Torque Units	Torque units: 0 = Lbf-in 1 = Lbf-ft 2 = Nm 3 = Nmm 4 = Kg-cm 5 = kN-m	2		
cpf	Counts per Force	Calibration counts per force unit.	1000000	32-bit unsigned integer	Read
cpt	Counts per Torque	Calibration counts per torque unit.			
peakPos0	PeakLoadsPosF _x	All-time peak positive force/torque loads that are in F/T counts.	2395927	32-bit unsigned integer	Read
peakPos1	PeakLoadsPosF _y		624574		
peakPos2	PeakLoadsPosF _z		0		
peakPos3	PeakLoadsPosT _z		0		
peakPos4	PeakLoadsPosT _y		159210		
peakPos5	PeakLoadsPosT _x		74910		
peakNeg0	PeakLoadsNegF _x	All-time peak negative force/torque loads that are in F/T counts.	-988570	32-bit unsigned integer	Read
peakNeg1	PeakLoadsNegF _y		-2099525		
peakNeg2	PeakLoadsNegF _z		-91487584		
peakNeg3	PeakLoadsNegT _x		-48751		
peakNeg4	PeakLoadsNegT _y		-12854		
peakNeg5	PeakLoadsNegT _z		0		
sensorHwVer	N/A	The version of the sensor hardware	0	16-bit integer	Read and Write

Table 8.3—“CAL” “SET” Fields and Values					
Field	Long Name	Description	Example Contents	Type	User Read/Write
adcRate	N/A	The ADC update rate in Hz. The ADC rate must be one of the following in units of Hz: 488 976 1953 3906 7812 (refer to Table 4.5)	976	16-bit integer	Read and Write
rdtRate	N/A	The RDT transmission rate in units of Hz. The RDT transmission rate must be 1 to the adcRate.	40	16-bit integer	Read and Write
rdtSize		The number of RDT records to include in each UDP packet that is transmitted.			
filTc	N/A	The IIR filter shift value (refer to Table 4.6)	0	8-bit integer	Read and Write
calib	N/A	The calibration to use: 0 or 1 This bit controls which of the two sets of calibrations are displayed in the preceding fields. (refer to Table 15.3)	0	8-bit integer	Read and Write
location	N/A	Display the physical location of the sensor.	Alex's Bench	String(40)	Read and Write
serNum	N/A	The serial number	Serial number	String(100)	Read
hwProdCode		The hardware product code	HW Product Code	String(20)	
hwRev		The hardware revision number	0	16-bit integer	

Table 8.3—“CAL” “SET” Fields and Values					
Field	Long Name	Description	Example Contents	Type	User Read/Write
ttdu	N/A	Tool transformation distance units: 0 = in 1 = ft 2 = mm 3 = cm 4 = m	0	8-bit integer	Read and Write
ttau		Tool transformation angle units: 0 = degrees 1 = radians			
ttdx	D _x	Tool transform distances (refer to Section 4.7—Tool Transformation)	0	float	
ttdy	D _y				
ttdz	D _z				
ttrx	R _x				
ttry	R _y	Tool transform rotation angles (refer to Section 4.7—Tool Transformation)			
ttrz	R _z				
tt	N/A	Perform tool transformation.	N/A		
baud	N/A	UART baud rate. Must be in range from 300 baud to 3M baud. Any baud rate change is temporary until a SAVEALL command is issued.	115200	32-bit integer	Read and Write
msg	N/A	Unprompted error messages: 1 = print unprompted messages 0 = do not print unprompted messages	0	8-bit integer	Read and Write

Table 8.3—“CAL” “SET” Fields and Values					
Field	Long Name	Description	Example Contents	Type	User Read/Write
mcEnabled	N/A	Global monitor conditions are enabled or disabled: 0 = disabled 1 = enabled	0	8-bit integer	Read and Write
mcOutMomen		Global monitor conditions are momentary or latching. When latching is set, processing of monitor conditions is suspended, and monitor condition data is inactive. 0 = latching 1 = momentary reset	1		
mcOutDelay	N/A	A delay the firmware should wait in momentary mode before automatically resetting the monitor condition latch. The user can type a value between 0 and 225. This value represents tenths (0.1) of a second (0 - 25.5 seconds).	20	8-bit integer	Read and Write
mcAndCodes		Bitwise global monitor condition output codes: 0 = bitwise OR 1 = bitwise AND	1		

9. Common Gateway Interface (CGI)

A user can configure the sensor over Ethernet by using standard CGI protocol and standard HTTP GET method which sends configuration variables and their values in the requested URL. External factors to the sensor determine the maximum length of these URLs. If a user exceeds the maximum length, an error or variables might be incorrectly set.

Each variable is only settable from the CGI page which is responsible for that variable. Each CGI page and the settable variables associated with the page are explained in the following sections and tables.

9.1 URL Syntax Construction:

A user can send commands to a URL by using the following syntax:

http://<netFTAddress>/<CGIPage.cgi>?<firstVariableAssignment><&nextVariable Assignment>

where:

http://	indicates an HTTP request
<netFTAddress>	is the Ethernet address of the Ethernet Axia sensor
/	a separator
<CGIPage.cgi>	the name of the CGI page that holds the variables you will be accessing
?	a separator marking the start of variable assignments
<firstVariableAssignment>	a variable assignment using the format described below
<&nextVariableAssignment>	a variable assignment using the following format, but the variable name is proceeded by an ampersand (&). This variable assignment is optional and may be repeated for multiple variables.

9.1.1 Assigning a New Values to a Variable

A user can assign new values to a variable by using the following syntax:

variableName=newValue

where:

variableName	is the name of the variable to be assigned
=	indicates assignment
newValue	is the value to be assigned to the variable. Text for text variables should not be enclosed in quotes. To include the ampersand character in text for a text variable use %26. Floating point numbers are limited to twenty characters.

- For example:

http://192.168.1.1/setting.cgi?setcfgsel=2&setuserfilter=0&setpke=1

tells the sensor at IP address 192.168.1.1 to set CGI variables *setcfgsel* to 2, *setuserfilter* to 0, and *setpke* to 1.

9.2 CGI Variable: Settings (setting.cgi)

A user can specify certain global settings such as ADC rate, low-pass filter selection, and bias (refer to [Section 6.4—ADC Settings Page \(setting.htm\)](#) for related information).

Table 9.1—setting.cgi Variables

Variable Name	Allowed Values	Description				Example
setadcrate	integers: 488, 976, 1953, 3906, 7812 (Hz)	Sets the ADC sampling rate.				setadcrate=488
setuserfilter	integers: 0 to 8	Sets the cutoff frequency (percent of the ADC sample rate) of the low-pass filtering as follows:				setuserfilter=0
		Value	Cutoff	Value	Cutoff	
		0	no filter	5	0.51%	
		1	11.97%	6	0.26%	
		2	4.66%	7	0.12%	
		3	2.17%	8	0.07%	
setbiasn	integers: -32768 to 32767	Sets the offset value for strain gage <i>n</i> . For example, <i>setbias3=0</i> would zero the bias of the fourth strain gage (Strain gages are enumerated starting at zero.)				setbias3=0

9.3 Thresholding CGI (moncon.cgi)

A user can define Thresholding settings and conditions.

Table 9.2—moncon.cgi Threshold Settings

Variable Name	Allowed Values	Description	Example
setmce	Integers: 0 or 1	Threshold statement processing: enable = 1 or disable = 0	setmc=1
mcandcodes	Integers: 0 or 1	Relay trigger: any condition is true = 0 or all conditions are true = 1	mcandcodes=1
mcfloating	Integers: 0 or 1	Relay Behavior: momentary = 1 or latching = 0	mcfloating=1
mcReset	Integer: 1	Reset latch	mcReset=1
mcresettme	Integer: 0 to 255	Relay momentary minimum-on time or a delay in a tenth (0.1) of a second: 0 seconds = 0 to 25.2 seconds = 255	mcresettme=20

Table 9.3—moncon.cgi Threshold Conditions								
Variable Name ¹	Allowed Values	Description			Example			
mcen	Integers: 0 or 1	Threshold statement n : enable = 1 or disable = 0			mce0=1			
mcxn	Integers: -1 to 5	Selects the axis evaluated by threshold statement n.	Value	Description	Menu Value			
		-1	Statement disabled	blank				
		0	Fx axis	Fx				
		1	Fy axis	Fy	mcx0=5			
		2	Fz axis	Fz				
		3	Tx axis	Tx				
		4	Ty axis	Ty				
		5	Tz axis	Tz				
mcvn	Integers: -2147483648 to +2147483647	Sets the counts value to compare the current axis value by threshold statement n.			mcv0=20			
mcon	Hexadecimal: 0x00 to 0xFF	Sets the output code for threshold statement n.			mco0=0x00			
Note:								
1. where n is an integer ranging from 0 to 15 representing the threshold statement index								

9.4 CGI Variable: Configurations (config.cgi)

The user can set the calibration and tool transformation for the sensor (refer to [Section 6.6—F/T Configurations Page \(config.htm\)](#) for related information). An example of setting tool transformation parameters is in [Section 4.7.3—Example of Tool Transformation Functionality Through CGI](#).

Table 9.4—config.cgi Variables				
Variable Name	Allowed Values	Description		
cfgcalsel	integers: 0 to 1	Sets the calibration used by the sensor.		
cfgtdu	integers: 1 to 5	The distance measurement units that are used by the configuration's tool transformation.		
		Value	Description	Menu Value
		1	inch	in
		2	foot	ft
		3	millimeter	mm
		4	centimeter	cm
		5	meter	m
		The rotation units used by the configuration's tool transformation.		
cfgtau	integers: 1 to 2	Value	Description	Menu Value
		1	degrees (°)	degrees
		2	radians	radians

Table 9.4—config.cgi Variables

Variable Name	Allowed Values	Description
cfgtx0	Floating point	Sets the tool transformation distance D_x with the units that are specified in the variable: cfgtdu.
cfgtx1		Sets the tool transformation distance D_y with the units that are specified in the variable: cfgtdu.
cfgtx2		Sets the tool transformation distance D_z with the units that are specified in the variable: cfgtdu.
cfgtx3		Sets the tool transformation distance R_x with the units that are specified in the variable: cfgtau.
cfgtx4		Sets the tool transformation rotation R_y with the units that are specified in the variable: cfgtau.
cfgtx5		Sets the tool transformation rotation R_z with the units that are specified in the variable: cfgtau.

9.5 CGI Variable: Communications (comm.cgi)

A user can set the networking options of the sensor (refer to [Section 6.7—Communication Page \(comm.htm\)](#) for more information).

Table 9.5—comm.cgi Variables

Variable Name	Allowed Values	Description					
comnetdhcp	Integers: 0 or 1	Sets DHCP behavior.					
		<table border="1"> <thead> <tr> <th>Value</th><th>Description</th></tr> </thead> <tbody> <tr> <td>0</td><td>Use DHCP if available on network</td></tr> <tr> <td>1</td><td>Use software-defined static IP values</td></tr> </tbody> </table>		Value	Description	0	Use DHCP if available on network
Value	Description						
0	Use DHCP if available on network						
1	Use software-defined static IP values						
Sets the static IP address to be used when DHCP is disabled.							
Sets the subnet mask to be used when DHCP is disabled.							
comnetgw	Any IPV4 address in dot-decimal notation.	Sets the gateway to be used when DHCP is disabled.					
comrdtbsiz	Integers: 1 to 40	RDT Buffer Mode buffer size.					

10. TCP Interface

TCP interface allows a more advanced user to write their own software to interact with the sensor. This software could be written with a programming language such as [python™](#) or [C#](#). For a command-line demo of C#, refer to the ATI NET F/T software download webpage: https://www.ati-ia.com/Products/ft/software/net_ft_software.aspx.

The TCP interface listens on TCP port 49151. All commands are 20 bytes in length. All responses begin with the two byte header 0x12, 0x34.

10.1 Command Codes

<i>READFT</i>	=	0,	/* Read F/T values. */
<i>READCALINFO</i>	=	1,	/* Read calibration info. */
<i>WRITETRANSFORM</i>	=	2,	/* Write tool transformation. */
<i>WRITETHRESHOLD</i>	=	3,	/* Write monitor condition. */

10.2 Read F/T Command

```
{  
    uint8          command;      /* Must be READFT (0) . */  
    uint8          reserved[15]; /* Should be all 0s. */  
    uint16         MCEnable;    /* Bitmap of MCs to enable. */  
    uint16         sysCommands; /* Bitmap of system commands. */  
}
```

Each bit position 0-15 in MCEnable corresponds to the monitor condition at that index. If the bit is a ‘1’, that monitor condition is enabled. If the bit is a ‘0’, that monitor condition is disabled.

Bit 0 of sysCommands controls the Bias. If bit 0 is a ‘1’, the system is biased. If bit 0 is a ‘0’, no action is taken.

Bit 1 of sysCommands controls the monitor condition latch. If bit 1 is a ‘1’, the monitor condition latch is cleared, and monitor condition evaluation begins again. If bit 1 is a ‘0’, no action is taken.

10.3 Read F/T Response

```
{  
    uint16 header;        /* always 0x1234. */  
    uint16 status;        /* Upper 16 bits of status code. */  
    int16 ForceX;        /* 16-bit Force X counts. */  
    int16 ForceY;        /* 16-bit Force Y counts. */  
    int16 ForceZ;        /* 16-bit Force Z counts. */  
    int16 TorqueX;       /* 16-bit Torque X counts. */  
    int16 TorqueY;       /* 16-bit Torque Y counts. */  
    int16 TorqueZ;       /* 16-bit Torque Z counts. */  
}
```

The status code is the upper 16 bits of the 32-bit status code described in the Net F/T user manual.

The force and torque values in the response are equal to (actual ft value * calibration counts per unit / 16-bit scaling factor). The counts per unit and scaling factor are read using the read calibration information command.

10.4 Read Calibration Info Command

```
{  
    uint8 command;           /* Must be READCALINFO (1). */  
    uint8 reserved[19];     /* Should be all 0s. */  
}
```

10.5 Read Calibration Info Response

```
{  
    uint16 header;          /* always 0x1234. */  
    uint8 forceUnits;       /* Force Units. */  
    uint8 torqueUnits;      /* Torque Units. */  
    uint32 countsPerForce;  /* Calibration Counts per force unit. */  
    uint32 countsPerTorque; /* Calibration Counts per torque unit. */  
    uint16 scaleFactors[6]; /* Further scaling for 16-bit counts. */  
}
```

The status code is the upper 16 bits of the 32-bit status code described in the Net F/T user manual.

The force and torque values in the response are equal to (actual ft value * calibration counts per unit / 16-bit scaling factor). The counts per unit and scaling factor are read using the read calibration information command.

The force unit codes are:

- 1: Pound
- 2: Newton
- 3: Kilopound
- 4: Kilonewton
- 5: Kilogram
- 6: Gram

The torque unit codes are:

- 1: Pound-inch
- 2: Pound-foot
- 3: Newton-meter
- 4: Newton-millimeter
- 5: Kilogram-centimeter
- 6: Kilonewton-meter

10.6 Write Tool Transform Command

```
{  
    uint8 command;           /* Must be WRITETRANSFORM (2). */  
    uint8 transformDistUnits; /* Units of dx,dy,dz */  
    uint8 transformAngleUnits; /* Units of rx,ry,rz */  
    int16 transform[6];      /* dx, dy, dz, rx, ry, rz */  
    uint8 reserved[5];       /* Should be all zeroes. */  
}
```

The ‘transform’ elements are multiplied by 100 to provide good granularity with integer numbers.

The distance unit codes are:

- 1: Inch
- 2: Foot
- 3: Millimeter
- 4: Centimeter
- 5: Meter

The angle unit codes are:

- 1: Degrees
- 2: Radians.

The response is a standard Write Response.

10.7 Write Monitor Condition Command

```
{  
    uint8 command;           /* Must be WRITETHRESHOLD. */  
    uint8 index;             /* Index of monitor condition. 0-31. */  
    uint8 axis;              /* 0 = fx, 1 = fy, 2 = fz, 3 = tx, 4 = ty, 5 = tz. */  
    uint8 outputCode;        /* Output code of monitor condition. */  
    int8 comparison;         /* Comparison code. 1 for "greater than" (>), -1  
    for "less than" (<). */  
    int16 compareValue;      /* Comparison value, divided by 16 bit  
    Scaling factor. */  
    uint8 reserved[13];       /* Should be all zeroes. */  
}
```

10.8 Write Response

```
{  
    uint16 header;           /* Always 0x1234. */  
    uint8 commandEcho;       /* Echoes command. */  
    uint8 status;             /* 0 if successful, nonzero if not. */  
}
```

11. System Settings XML Pages

A user application can retrieve the sensor settings in XML format by using standard Ethernet HTTP requests. This enables programs to read system settings such as the Counts per Force value. The Java® demo application uses data from these XML pages to correctly scale displayed data.

In the following tables, the data types of XML elements are as follows:

Table 11.1—Types Used by XML Elements	
Data Type	Description
DINT	Signed double integer (32 bit)
ENABL	Boolean using <i>Enabled</i> to represent 1 and <i>Disabled</i> to represent 0
HEXn	Hexadecimal number of <i>n</i> bits, prefixed with 0x
INT	Signed integer (16 bit)
REAL	Floating-point number (32 bit)
SINT	Signed short integer (8 bit)
STRINGn	String of <i>n</i> characters
UDINT	Unsigned double integer (32 bit)
UINT	Unsigned integer (16 bit)
USINT	Unsigned short integer (8 bit)

The values of all data types are presented as an ASCII strings.

Arrays are represented if the suffix *[i]* is attached to the data type, where *i* indicates the number of values in the array. Array values in an XML element may be separated by a semicolon, comma, or space.

11.1 System and Configuration Information (netftapi2.xml)

The XML page netftapi2.xml retrieves the system setup and active configuration.

The reference column in *Table 11.2* indicates which .htm page and .cgi function access this element. Refer to the corresponding entry in [Section 6—Configuring the Sensor with the Ethernet Axia Web Pages](#) or [Section 9—Common Gateway Interface \(CGI\)](#) for related information.

Table 11.2—XML Elements in netftapi2.xml			
XML Element	Data Type	Description	Reference
runstat	HEX32	System status code	—
runtf	DINT[6]	Force and torque values in counts	rundata
runsg	INT[6]	Strain gage values	
runmtx	REAL	Matrix value	
runmcb	HEX32	Threshold breached	
runmco	HEX8	Threshold output	
runmcl	USINT	Threshold latched	
unbiasedsg	INT	Unbiased strain gage values	
setbias	DINT[6]	Software bias vector	setting
setrate	USINT	Set the ADC rate	
setiirshift	USINT	Set a filter	

Table 11.2—XML Elements in netftapi2.xml			
XML Element	Data Type	Description	Reference
setmce	USINT	Threshold processing status	moncon
mce	USINT[16]	Threshold statements' individual enabling	
mcx	USINT[16]	Threshold statements' selected axes	
mcc	USINT[16]	Threshold statements' comparisons	
mcv	DINT[16]	Threshold statements' counts values for comparison	
mco	HEX8[16]	Threshold statements' output codes	
cfgcalsel	USINT	Calibration used by active configuration	config
cfgcalsn	STRING8	Serial number of active configuration's calibration	
cfgfu	USINT	Force units used by active configuration	
scfgfu	STRING8	Name of force units used by active configuration	
cftgtu	USINT	Torque units used by active configuration	
scfgtu	STRING8	Name of torque units used by active configuration	
cfgtdu	USINT	Tool transformation distance units that are used by an active configuration.	
scfgtdu	STRING16	Name of tool transformation distance units that are used by an active configuration.	
cfgtau	USINT	Tool transformation rotation units that are used by an active configuration.	
scfgtau	STRING8	Name of tool transformation rotation units that are used by an active configuration.	
cfgtx	REAL[6]	Tool transformation distances and rotations that are applied by active configuration.	comm
comnetdhcp	ENABL	DHCP behavior setting	
comnetip	STRING15	Static IP address	
comnetmsk	STRING15	Static IP subnet mask	
comnetgw	STRING15	Static IP gateway	
nethwaddr	STRING17	Ethernet MAC address	
commrdtrate	UDINT	RDT output rate	manuf
comrdtbsiz	USINT	RDT Buffer Mode buffer size	
mfgdighwa	STRING17	Ethernet MAC Address	
mfgdigsn	STRING8	Digital board serial number	
mfdigver	STRING8	Digital board firmware revision	manuf
mfdigrev	STRING8	Digital board hardware revision	
mfgtxdmdl	STRING16	Analog board location	
netip	STRING15	IP address in use	–
runrate	UDINT	Internal sample rate for strain gage collection	

11.2 Calibration Information (*netftcalapi.xml*)

The XML page *netftcalapi.xml* retrieves information about a specific calibration. Retrieved calibration information has not been modified by any of the Ethernet Axia configuration settings.

A calibration index can be specified when requesting this calibration information. This is done by appending *?index=n* to the request, where n is the index of the desired calibration. If a calibration index is not specified the currently-used calibration will be assumed.

For example, to retrieve calibration information for the second calibration the requested page would be *netftcalapi.xml?index=1*.

Table 11.3—XML Elements in *netftcalapi.xml*

XML Element	Data Type	Calibration Information
calsn	STRING8	Serial number
calpn	STRING32	Calibration type
caldt	STRING20	Calibration date
calmtx	REAL	Matrix value
calfu	USINT	Force units (refer to config.cgi variable cfgfu for values)
scalfu	STRING8	Name of force units
caltu	USINT	Torque units used (refer to config.cgi variable cfgtu for values)
scaltu	STRING8	Name of torque units
calmr	REAL[6]	Calibrated sensing ranges in calfu and caltu units
calcpf	DINT	Counts per force unit
calcpt	DINT	Counts per torque unit
calrng	REAL	Calibrated sensing range

12. UDP Interface Using RDT

The Ethernet Axia can output data at up to 7912 Hz over Ethernet using UDP. This method of fast data collection is called Raw Data Transfer (RDT). RDT provides the following data in a packet: forces, torques, and status codes of the Ethernet Axia.

NOTICE: Multi-byte values must be transferred to the network high byte first and with the correct number of bytes. Some compilers align structures to large field sizes, such as 32- or 64-bit fields, and send an incorrect number of bytes. C compilers usually provide the functions *htonl()*, *htons()*, *ntohs()*, and *ntohl()* that can automatically handle byte ordering issues and provide alignment directives that force structures to place fields directly next to each other in memory. Consult the compiler's documentation for information on structure alignment.

12.1 RDT Protocol

The Ethernet Axia listens on the selected UDP port for commands. The sensor responds to the IP address and port that sent the command. The default UDP port is 49152.

In the RDT protocol, there are (4) commands that are listed in following table. A command received by the Ethernet Axia sensor takes precedence over previously-received commands.

Table 12.1—RDT Commands

Command	Code	Purpose	Command Response
Stop	0x0000	Stop sending RDT packets over UDP.	None.
Start single-block	0x0001	Start sending RDT packets over UDP to the requestor, single blocks only, regardless of the RDT buffer size setting. Use the Count field to send a specific number of packets, 0 = unlimited.	RDT record(s).
	0x0002		
Start multi-block	0x0003	Start sending RDT packets over UDP to the requestor, how many RDT packets are blocked depends on the RDT buffer size setting. Use the Count field to send a specific number of packets, 0 = unlimited.	RDT record(s).
Bias	0x0042	Set Software Bias.	None.

The sensor generates a record in a format that is specified by the RDT Output Rate “rdtRate”. The sensor groups one or more of these records into a single UDP packet. The size of the packet depends on the value of the RDT buffer size or “rdtSize”. If using buffered mode, then the number of RDT records received in a UDP packet will be equal to the RDT buffer size displayed on the Communications page. See [Section 6.7—Communication Page \(comm.htm\)](#) for a description of RDT Buffer Size. The following sections explain the command format and reply format.

12.1.1 RDT Request For Records Structure

All RDT requests have the following structure:

```
{  
    Uint16 command_header = 0x1234;      // Required  
    Uint16 command;                  // Command to execute  
    Uint32 sample_count;            // Samples to output (0 =  
                                infinite)  
}
```

- Set the command field of the RDT request to a command from [Table 12.1](#).
- Set sample_count to the number of samples to output. If sample_count is set to zero, the Ethernet Axia outputs continuously until the user sends a RDT request with command set to zero.

12.1.2 RDT Records Sent Structure

In response to the request, the sensor sends RDT records with the following structure:

```
{  
    Uint32 rdt_sequence;        // RDT sequence number of this packet.  
    Uint32 ft_sequence;        // The record's internal  
                                number  
    Uint32 status;             // System status code  
  
    // Force and torque readings use counts values  
    Int32 Fx;                 // X-axis force  
    Int32 Fy;                 // Y-axis force  
    Int32 Fz;                 // Z-axis force  
    Int32 Tx;                 // X-axis torque  
    Int32 Ty;                 // Y-axis torque  
    Int32 Tz;                 // Z-axis torque  
}
```

- rdt_sequence: The position of the RDT record within a single output stream. The RDT sequence number is useful for determining if any records were lost in transit. For example, in a request for 1000 records, rdt_sequence will start at 1 and run to 1000. The RDT sequence counter will roll over to zero for the increment following 4294967295 ($2^{32}-1$).
- ft_sequence: The internal sample number of the F/T record contained in this RDT record. The F/T sequence number starts at 0 when the Ethernet Axia is powered up and increments at the internal sample rate (7000 per sec). Unlike the RDT sequence number, ft_sequence does not reset to zero when an RDT request is received. The F/T sequence counter will roll over to zero for the increment following 4294967295 ($2^{32}-1$)
- status: Contains the system status code at the time of the record.
- Fx, Fy, Fz, Tx, Ty, Tz: The F/T data as counts values.

12.2 Calculating F/T Values for RDT

To obtain the real force and torque values, divide each force output value by the Counts per Force, and divide each torque output value by the Counts per Torque factor. The Counts per Force and Counts per Torque factors can be found in the netftapi2.xml page. See cfgcpf and cfgcpt in [Section 11.1—System and Configuration Information \(netftapi2.xml\)](#).

12.3 Multiple Clients

The RDT protocol is designed to respond to one client only. If a second client sends a command, the Ethernet Axia responds to the new client. Multiple clients could repeatedly request single packets, minimizing problems. (The Java® demo operates in this manner.)

12.4 Notes on UDP and RDT Mode

RDT communications use UDP, with its minimal overhead, to maximize throughput. UDP does not check if a package was received.

In some Ethernet network configurations, this can lead to the loss of RDT data sets. By checking the RDT sequence number of each set, it can be determined if a data set was lost. The RDT sequence number of each data set sent will be one greater than the last data set sent for that RDT request. If a received data set's RDT sequence number is not one greater than the last received data set, then a loss of data has occurred (the program must also account for rollover of the RDT sequence number).

The likelihood of data loss highly depends on the Ethernet network configuration and there are ways to reduce the probability of data loss to almost zero. Refer to [Section 14.8—Improving Ethernet Throughput](#) for details.

The maximum data latency, measured from the beginning of data acquisition to when the last data bit is sent to the Ethernet network, is less than 28 ms.

The Ethernet Axia only supports one UDP connection at a time.

12.5 Example Code

Example C code can be found on the ATI website at http://www.ati-ia.com/Products/ft/software/net_ft_software.aspx and on the file that was sent via e-mail to the customer, when the product was shipped.

13. Maintenance

13.1 Periodic Inspection

With industrial-type applications that frequently move the system's cabling, check the cable jacket for signs of wear. The Axia sensor is IP64 rated. Debris and dust should be kept from accumulating on or in the sensor. The surface of the sensor can be cleaned with isopropyl alcohol, if contaminated by its environment. The sensor itself should experience no wear, if used within the operating ranges and fastened to the proper torque specification. Refer to [Section 15—Specifications](#) and [Section 3.3—Installing the Sensor to the Robot](#).

13.2 Periodic Calibrating

Periodic calibration of the sensor and its electronics is required to maintain traceability to national standards. Follow the applicable ISO-9000-type standards for calibration. ATI Industrial Automation recommends annual accuracy checks. Refer to [Section 3.6—Accuracy Check Procedure](#).

14. Troubleshooting

This section includes answers to some issues that might arise when setting up and using the Ethernet Axia. The question or problem is listed followed by its probable answer or solution. They are categorized for easy reference.

The information in this section should answer many questions that might arise in the field. Customer service is available to users who have problems or questions 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., Axia, etc.)
3. Calibration (e.g., US-15-50, SI-65-6, etc.)
4. Accurate and complete description of the question or problem
 - For the status code; refer to [Section 4.8—Status Code](#).
5. Computer and software information. Operating system, PC type, drivers, application software, and other relevant information about your configuration.

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

How to Reach Us

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

14.1 Errors Powering Up

Table 14.1—Powering Up

Symptom	Cause and Resolution
Status LED stays red after the 20 second power up phase.	Check the sensor cable connections. Verify the sensor cable is not damaged. There may be an internal error in the sensor.
Status LED is red for the first 20 seconds, after power up, and then turns green.	Normal operation
The L/A LED is not green or flashing green.	Check the Ethernet cable connection.

14.2 Errors with Communications

Table 14.2—Communications

Symptom	Cause and Resolution
What IP address is assigned to the sensor?	Refer to Section 5.1—IP Address Configuration for Ethernet .
How can the Ethernet Axia be set to the default IP address of 192.168.1.1?	Configure the computer to communicate with the sensor at its current address by following the instructions in Section 5.1—IP Address Configuration for Ethernet . The Axia's current IP address can be found using the discovery utility which is available on the file 9030-05-1026 that was e-mailed to the customer when the product was shipped. Once communication is established, reset the address to a value compatible with the user's network.
DHCP is not assigning an IP address.	Ethernet LAN must be connected during power up. DHCP is not selected as the IP Address Mode on the Communications page. The DHCP server waits more than 30 seconds to respond, and the sensor requires the DCHIP server to react more quickly. The sensor must be power cycled when any IP Address settings are changed.
Browser cannot find the Axia sensor on Ethernet network.	Clear the Windows® computer's ARP table to remove memory of a previous device that used the same IP address as the sensor by restarting the computer or, if you have administrative privileges, by going to the computer's Start menu, selecting Run..., and entering "arp -d *".

14.3 Errors with the Java® Demo

Table 14.3—Java® Demo	
Symptom	Cause and Resolution
Demo displays zeros for force and torque values and displays question marks for configuration data.	Check IP address and restart demo.
Excessive IO exception: Receive timed out errors	The Ethernet connection was interrupted. Check Ethernet cabling and Axia sensor power.
Error message: IO exception: <path and file name> (The process cannot access the file because it is being used by another process)	Selected file for data is in use by another program. Close file or change file name and select Collect Streaming again.
The following message appears in a window titled Java® Virtual Machine Launcher: “Could not find the main class. Program will exit.”	Computer requires a newer version of Java®. Download Java® from www.java.com/getjava .

14.4 Errors with Ethernet Axia Webpages

Table 14.4—Web Pages	
Symptom	Cause and Resolution
The Invalid Request page appears.	One or more entries on the previous web page were invalid or out of range. Go back to the previous page and review the last entry. Make only one change at a time to make debugging easier.
The HTTP 1.0 401 Error - Unauthorized page appears	The user tried to access one of the protected pages of the web server. These pages are reserved for ATI Industrial Automation maintenance.

14.5 Errors with Force and Torque Readings

Incorrect data from the sensor's strain gages can cause errors in force/torque readings. Listed in the following table are the basic conditions of incorrect data. Use this table to troubleshoot a problem. In most cases, problems can be better identified while looking at the raw strain gage data, displayed on the Snapshot page. See [Section 6.2—Snapshot Page \(rundata.htm\)](#) for more details.

Table 14.5—Errors with Force and Torque Readings	
Symptom	Cause and Resolution
The sensor is not streaming measurement data to the customer devices.	Verify the sensor is correctly installed. Ensure the robot mounting and tool adapter plates are installed on the proper side of the sensor. Refer to Section 3—Installation for more information.
Either the “Force/Torque Out of Range” or the “Gage Out Range” bit is set (refer to Section 4.8—Status Code),	The sensor is reporting that it is no longer within the calibrated range and may experience inaccuracy and reduced life.
The “Broken Gage Bit” is set (refer to Section 4.8—Status Code).	An electrical failure has potentially occurred inside the sensor. The sensor must be returned to ATI for diagnosis.
Noise	Jumps in force torque data readings (with the sensor unloaded) greater than 0.05% of full scale counts is abnormal. Noise can be caused by mechanical vibrations and electrical disturbances, possibly from a poor ground. Noise can also indicate component failure within the system. Make sure that the DC supply voltage for the Axia sensor has little to no noise superimposed. The sensor should be grounded through installation construction. See Section 14.6—Reducing Noise .
Drift	After a load is removed or applied, the raw gage reading does not stabilize but continues to increase or decrease. A shift in the raw gage reading is observed more easily in the resolved data mode using the bias command. Some drift from a change in temperature or mechanical coupling is normal. Mechanical coupling occurs when a tool plate contacts the sensor body, for example, debris between the tool adapter plate and the sensor body or in applications such as hoses and wires attached to a tool.
Hysteresis	When the sensor is loaded and then unloaded, gage readings do not return quickly and completely to their original readings. Hysteresis is caused by mechanical coupling (explained in Drift section) or internal failure.

14.6 Reducing Noise

14.6.1 Mechanical Vibration

In many cases, perceived noise is actually a real fluctuation of force and/or torque, caused by vibrations in the tooling or the robot arm. The Ethernet Axia sensor offers digital low-pass filters that can dampen frequencies above a certain threshold. If digital low-pass filters are insufficient, a digital filter may be added to the application software.

14.6.2 Electrical Interference

To reduce the effects of electrical noise on the sensor, do the following:

- If interference by motors or other noise-generating equipment is observed, check the sensor's ground connections.
- If sufficient grounding is not possible or does not reduce noise, consider using the sensor's digital low-pass filters.
- Verify the power supply is Class 1, which has an earth ground connection.

14.7 Detecting Sensitivity Changes

Sensitivity checking of the sensor can also be used to measure the Ethernet Axia sensor's condition. Apply known loads to the sensor and verify 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 to 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).

14.8 Improving Ethernet Throughput

In an optimum network setup, the sensor's RDT data arrives at the host computer with no loss of data. If data samples are lost, consider the following:

14.8.1 Direct Connection between Axia Ethernet and Host

To achieve the best Ethernet performance (and avoid the loss of data packages), connect the sensor directly to the host computer. If using a switch, then try to use only one switch between sensor system and host. Avoid going through several switches or going through a hub.

14.8.2 Choice of Operating System

The Windows® operating system periodically performs housekeeping processes that can require a significant amount of processing power over a short amount of time. During these intervals, a loss of data can occur because Windows does not treat UDP data with a high enough priority. If a loss of data is not acceptable for the application, then use a real-time operating system.

14.8.3 Increasing Operating System Performance

The following items may also help increase the performance of a computer system so that it can best respond to the Ethernet Axia's fast data rates:

- **Disable software firewall.** One way to improve the Ethernet performance is not to have any software firewall activated. In some cases, this may require help from IT personnel.
- **Disable file and printer sharing.** File and printer sharing can slow down an operating system's response to Ethernet data and may lead to lost data.
- **Disable unnecessary network services.** Unnecessary network services and protocols can slow down an operating system's response to Ethernet data and may lead to lost data.
- **Use an Ethernet traffic snooper.** An Ethernet traffic snooper can detect that there are processes using up Ethernet bandwidth and potentially slowing down the response of a computer's operating system. This is an advanced technique that your IT department may need to perform. The free software program Wireshark (www.wireshark.org) is commonly used for this type of investigation.
- **Use a dedicated computer.** A dedicated measurement computer isolated from the company network is not burdened by the company network processes.

14.8.4 Avoid Logging the Host to a Company Network

Being logged onto a network requires the periodic access to the Ethernet interface by processes other than the measurement application and can lead to loss of UDP packages.

14.8.5 Use a Dedicated Network

Placing the sensor on a dedicated Ethernet network with no other devices on the network, other than the host computer, removes data collisions and gives the best network performance.

15. Specifications

The requirements for the Ethernet Axia sensor interface are covered in the following sections.

15.1 Environmental Conditions

Table 15.1—Environmental Conditions	
Parameter	Value
Storage Temperature, °C	-20 to +85
Operating Temperature, °C	0 to +65
Relative Humidity	<95%, non-condensing

15.2 Electrical Specifications

Power Source	Voltage			Maximum Power Consumption
	Minimum	Nominal	Maximum	
DC Power	12 V	24 V	30 V	1.5 W
Notes:				
1. 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.				

15.3 Calibration Ranges

Table 15.3—Calibration Range 0 and Calibration Range 1									
Model	Axia80-M8			Axia80-M20			Axia80-M50		
Parameter	Fxy	Fz	Txyz	Fxy	Fz	Txyz	Fxy	Fz	Txyz
Calibration Range 0	150 N	470 N	8 Nm	500 N	900 N	20 Nm	1200 N	2000 N	50 Nm
Calibration Range 1	75 N	235 N	4 Nm	200 N	360 N	8 Nm	480 N	800 N	20 Nm

Notes:

1. Each Ethernet Axia80 sensor is calibrated with both of these calibration ranges.

16. 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.

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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.

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