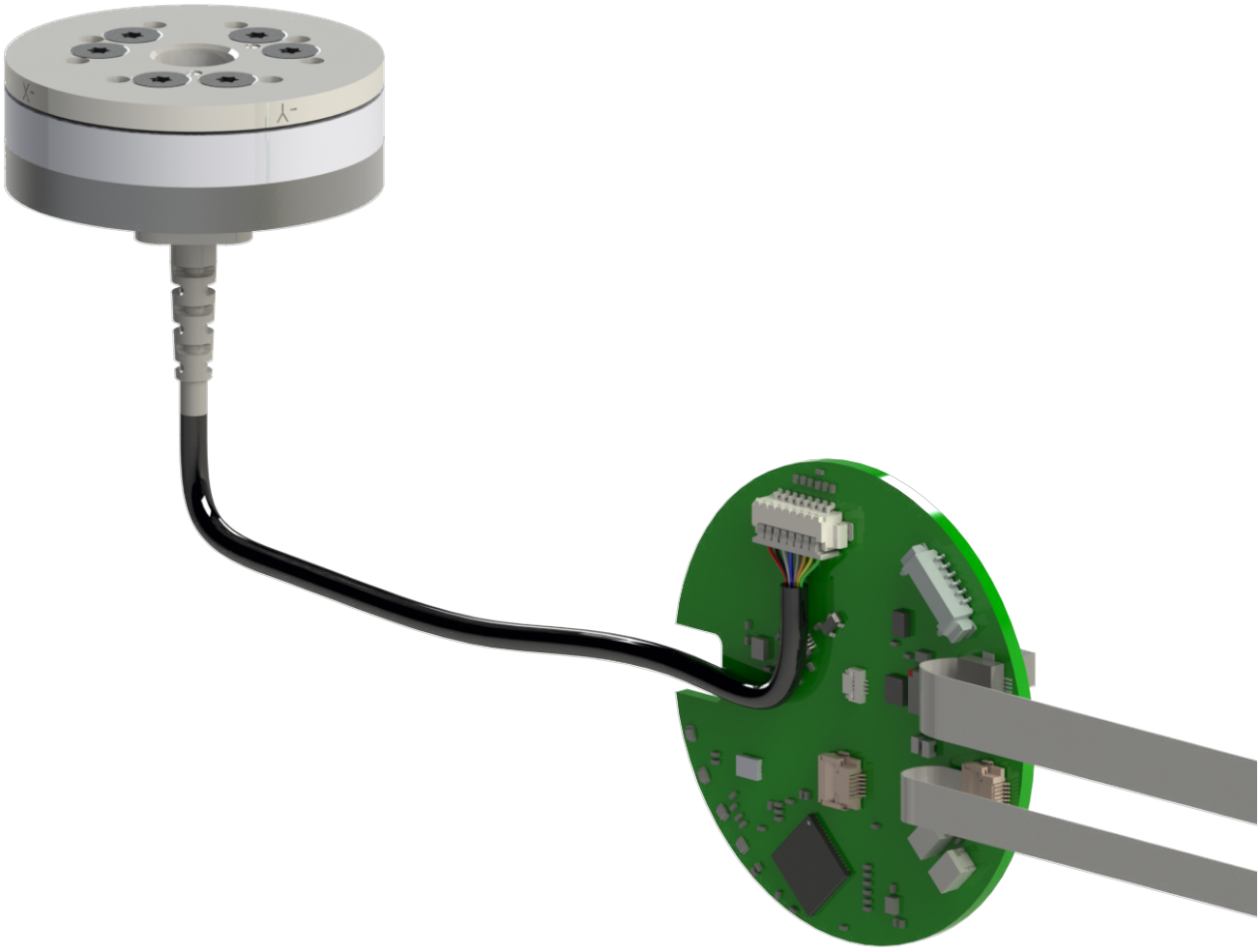
ATI INDUSTRIAL AUTOMATION

A Novanta Company

Manual

Network and Serial (NETrs) Communications Board Assembly (CBA) F/T System



Document #: 9620-05-NETRS CBA FT System

Engineered Products for Robotic Productivity

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> Note
>
> Please read the manual before calling customer service, and have the following information available:
>
> 1. Serial number; for example, FT01234.
> 2. Transducer model; for example, Nano17, Gamma, Theta.
> 3. Calibration; for example, US-15-50, SI-65-6.
> 4. Accurate and complete description of the question or problem
> 5. Computer and software information (operating system, PC type, drivers, application software, and other relevant information about the configuration)
>
> Be near the F/T system when calling (if possible).

Please contact an ATI representative for assistance, if needed:

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Table of Contents

Glossary

Term	Definition
CBA	Communications Board Assembly.
DINT	A data type representing a signed integer with 32 bits.
E-Exit	ATI's E-Exit transducers have a cable with an over-molded strain relief.
F/T	Force/Torque.
F/T Transducer	Converts force and torque into an electrical signal.
MAP	The Mounting Adapter Plate (MAP) is the transducer plate that attaches to the fixed surface or robot arm.
MOLEX® PicoBlade®	Product series from the connector manufacturer Molex.
NETrs	Network and Serial (RS422/RS485)
NETrs CBA	NETrs Communications Board Assembly. This is the stand-alone interface board used to communicate with an ATI sensor that can be integrated directly into the customer's application.
NETrs CBA FT System	NetRS Communications Board Assembly Force Torque System. The entire system consists of an ATI Nano or Mini transducer, along with the NETrs CBA. Together, the system allows the user to communicate via Ethernet or console commands over a Serial connection.
PDO	Process Data Object, a protocol for reading and writing real-time process information cyclically.
P/N	Part Number
SDO	Service Data Object, a protocol for reading and writing configuration information acyclically.
STG	Strain Gage
TAP	Tool Adapter Plate (TAP) is the transducer surface that attaches to the load to be measured.
Transducer	Transducer is the component that converts the sensed load into electrical signals.
UDINT	A data type representing an unsigned integer with 32 bits.
UINT	A data type representing an unsigned integer with 16 bits.
USINT	A data type representing an unsigned integer with 8 bits.

1. Safety

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

1.1 Explanation of Notifications

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

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

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

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

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

1.2 General Safety Guidelines

The customer should verify that the transducer selected is rated for maximum loads and moments expected during operation. Refer to the *Transducer manual* or contact ATI Industrial Automation for assistance. Particular attention should be paid to dynamic loads caused by robot acceleration and deceleration. These forces can be many times the value of static forces in high acceleration or deceleration situations.

1.3 Safety Precautions

CAUTION: Do not remove any fasteners or disassemble transducers without a removable mounting adapter plate. These include Nano, Mini, IP-rated, and some Omega transducers. This will cause irreparable damage to the transducer and void the warranty. Leave all fasteners in place and do not disassemble the transducer.

CAUTION: Do not probe any openings in the transducer. This will damage the instrumentation.

CAUTION: Do not exert excessive force on the transducer. The transducer is a sensitive instrument and can be damaged by applying force exceeding the single-axis overload values of the transducer and cause irreparable damage. Small Nano and Mini transducers can easily be overloaded during installation. Refer to the F/T Transducer manual (9620-05-Transducer Section) for specific transducer overload values.

2. Product Overview

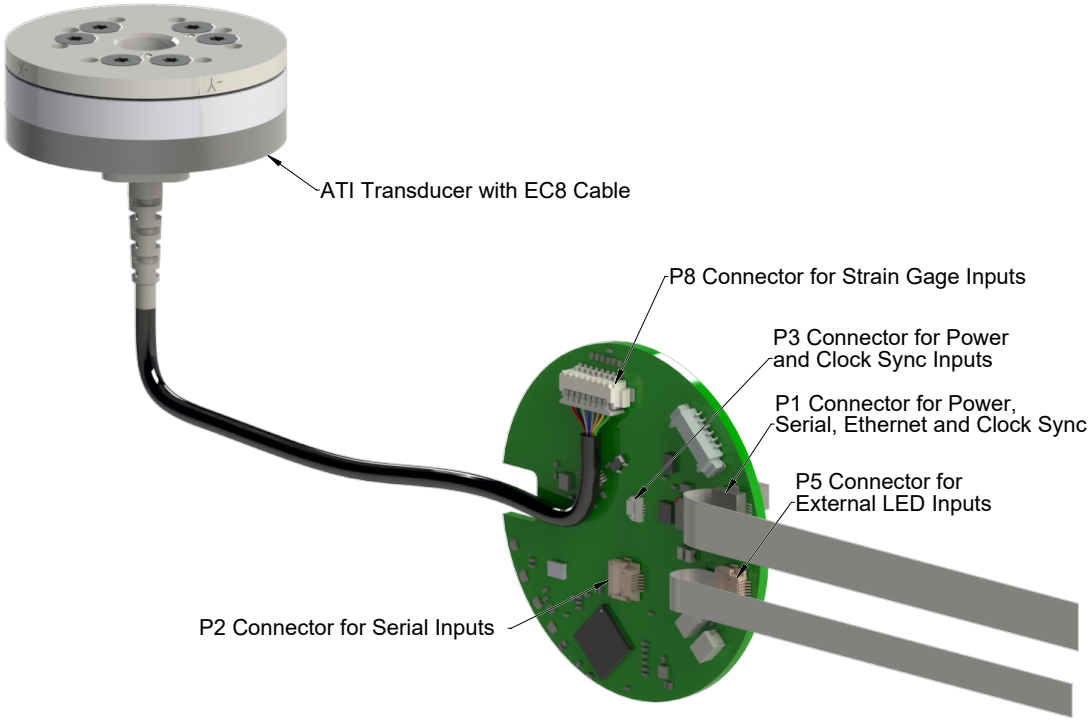
ATI's Network RS422/485 Communication Board Assembly Force/Torque System (NETrs CBA F/T System) consists of two main components:

- *Compatible Transducer* with an EC8 connector
- An F/T-to-Network and Serial interface board: *NETrs Communication Board Assembly (CBA)*

The NETrs CBA F/T System allows customers to integrate an NETrs CBA directly into their application without the requirement of an additional communication box. The system provides the following functionality:

- **Multiple Calibrations.** Up to four different transducer calibrations, each with a different sensing range, can be saved.
- **Multiple Interfaces**. The NETrs CBA F/T System can communicate via User Data Protocol (UDP), Transmission Control Protocol (TCP) and Raw Data Transfer. Additionally, it can communicate via console commands over a Serial connection.
- **System Status Code**. Each output data record contains a system status code which indicates the health of the transducer. Reference *Section 7.1—System Status Code.*
- **Tool Transformation** programmable. Refer to *Section 4.1—ATI Force/Torque Webpages*
- **Condition monitoring** functionality. Refer to *Section 4.1—ATI Force/Torque Webpages*
- **LED Indicators.** Available external LEDs can be instrumented for Power, Ethernet, Serial, and Status. Refer to *Section 5.8—LED Activity*

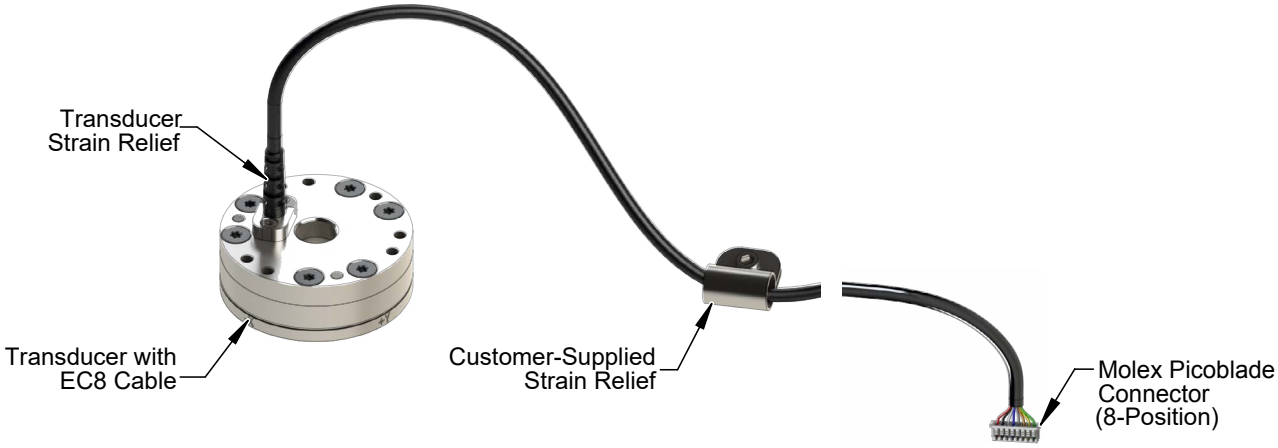
Figure 2.1—NETrs CBA F/T System Overview



2.1 Compatible Transducer

NOTICE: The transducer has no strain relief. Suitable strain relief must be provided in the final product to protect the crimp contacts

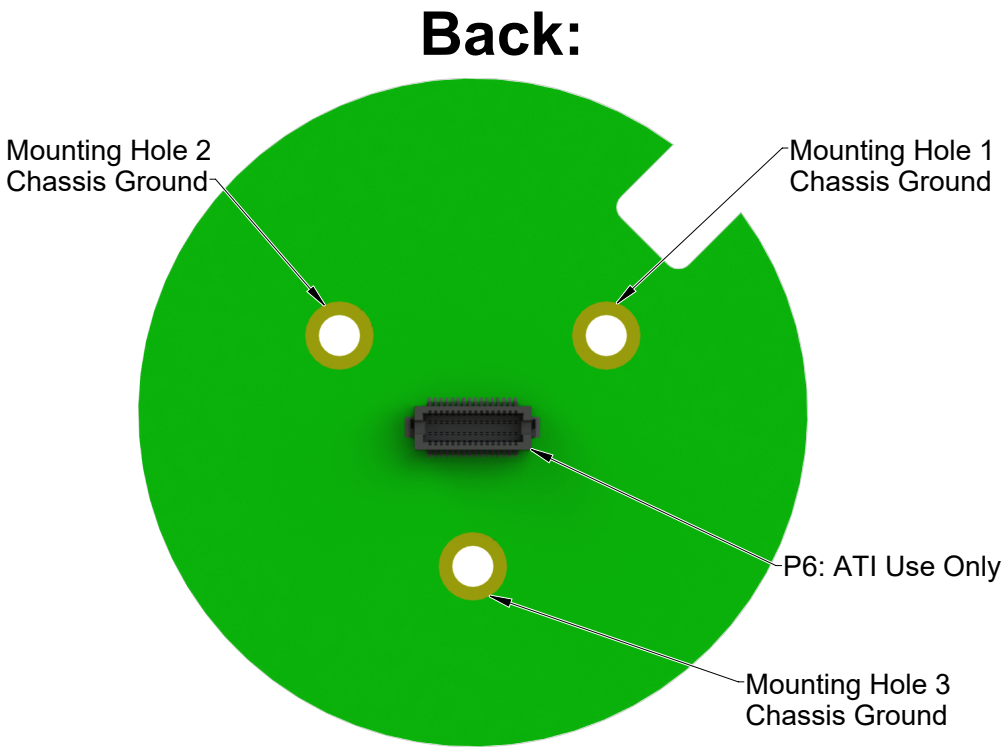
Figure 2.2—Transducer with Strain Relieved EC8 Cable



Note: Cable typically includes longer length of unjacketed wire and drain wire leading up to Molex connector.

ATI transducers with part numbers that end in EC8 are custom designed for use with ATI's NETrs CBA F/T System. These sensors include an attached transducer cable with a MOLEX PicoBlade connector, which plugs directly into the NETrs CBA on connector P8, reference *Section 2.3—NETrs CBA Components*

The connection between the ATI transducer and the NETrs CBA allows the user to communicate sensor data from the transducer to the board.



2.2 NETrs Communication Board Assembly (CBA)

The NETrs CBA provides both an Ethernet interface and console interface for ATI's EC8 transducers. The NETrs CBA should be mounted within a customer's enclosure and supplied a DC power of 12-30 V.

The NETrs CBA includes a series of connectors to allow the customer to:

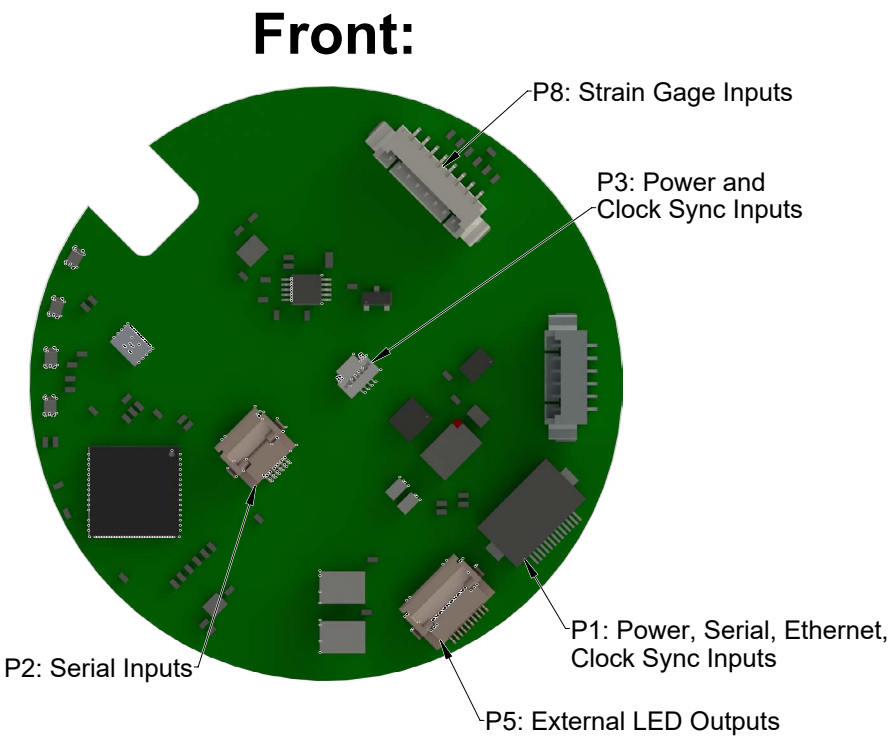
- communicate with the sensor via Ethernet or console commands over RS422 or RS485.
- stream strain gage data.
- read internal sensor temperature data.
- configure LEDs to monitor sensor health and activity
- store and toggle between three transducer calibrations.

2.3 NETrs CBA Components

CAUTION: Do not connect power or communication to multiple flex cables at the same time. Supplying power to multiple connectors may cause damage to power supply. Supplying the same communication channel over multiple connectors will result in a loss of communication.

Individual connectors on the NETrs CBA are outlined below.

Figure 2.3—NETrs CBA Components Overview



2.3.1 P1 Connector for Power, Serial, Ethernet, Clock Sync

Connector: Hirose FH12-13S-0.5SH(55)

Mating Contact: Molex 151660831 or similar

Pin No.	Signal Name[1]	Description
1	SL_VP	12 to 30 VDC Power Supply Positive
2	SL_GND	Power Supply Ground
3	CLK_SYNC	Clock Sync
4	CLK_SYNC_GND	Clock Sync Ground
5	Ethernet_TX_P	Ethernet TX Positive
6	Ethernet_TX_N	Ethernet TX Negative
7	Ethernet_RX_P	Ethernet RX Positive
8	Ethernet_RX_N	Ethernet RX Negative
9	RS4XX_P	RS485 Positive OR RS422 TX Positive
10	RS4XX_N	RS485 Negative OR RS422 TX Negative
11	RS422_RX_P	RS422 RX Positive
12	RS422_RX_N	RS422 RX Negative
13	SHIELD_DRAIN	Shield to Drain

Note:
1. RS422 communication uses pins 9, 10, 11, and 12. RS485 communication only uses pins 9 and 10.
2. Not all pins are required for proper functionality. If the user only desires ethernet communication, pins 9 through 12 are not required, for example. Power and Clock Sync functionality may also be supplied via alternative connectors.

2.3.2 P2 Connector for Serial Interfaces

Connector: Hirose FH12-6S-0.5SH(55)
Mating Contact: GTC 05-06-A-0076-A-4-06-4-T or similar

Pin No.	Signal Name[1]	Description
1	ERS4XX_P	RS422_TX Positive OR RS485 Positive
2	ERS4XX_N	RS422_TX Negative OR RS485 Negative
3	ERS422_RX_P	RS422_RX Positive
4	ERS422_RX_N	RS422_RX Negative
5	SHEILD_DRAIN	Shield to Drain
6	DGND	Digital Ground

Note:
1. RS422 communication uses pins 1, 2, 3, and 4. RS485 communication only uses pins 1 and 2

2.3.3 P3 Connector for Power and Clock Sync

Connector: Hirose FH19C-4S-0.5SH(10)
Mating Contact: GTC 05-04-A-0076-A-4-06-4-T or similar

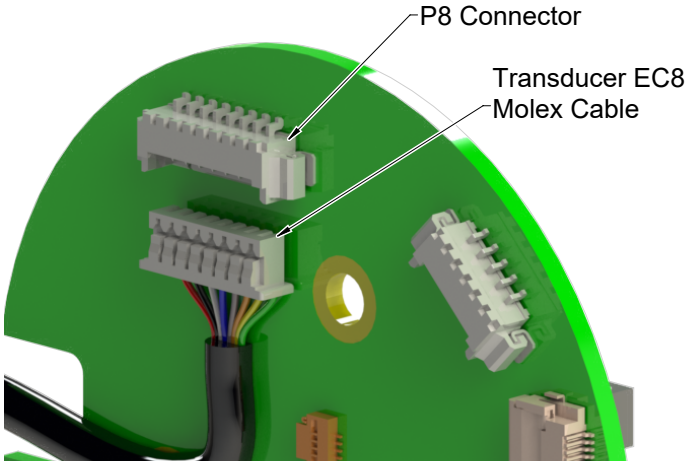
Pin No.	Signal Name	Description
1	SL_VP	12 to 30 VDC Power Supply
2	CLK_SYNC	Clock Sync
3	CLK_SYNC_GND	Clock Sync Ground
4	SL_GND	Power Supply Ground

2.3.4 P5 Connector for LED Board

Connector: Hirose FH12-10S-0.5SH(55)
Mating Contact: Molex 152660115 or similar

Reference *Section 5.8—LED Activity* for detailed LED activity information.

Pin No.	Signal Name	Description
1	+3.3VD	Voltage Source for External LEDs
2	STAT_LED_GN	Status LED Green
3	STAT_LED_RD	Status LED Red



4	NET_LED_GN	Ethernet LED Green
5	NET_LED_RD	Ethernet LED Red
6	PWR_LED_GN	Power LED Green
7	PWR_LED_RD	Power LED Red
8	SER_LED_GN	Serial LED Green
9	SER_LED_RD	Serial LED Red
10	DGND	Digital Ground

2.3.5 P8 Connector for Strain Gage Input

Connector: Molex 0532610871
Mating Contact: Molex 0510210800 or similar

Pin No.	Signal Name	Description
1	+VBR	Voltage Source for Strain Gages
2	AGND	Analog Ground
3	SG0	Strain Gage 0 Input
4	SG1	Strain Gage 1 Input
5	SG2	Strain Gage 2 Input
6	SG3	Strain Gage 3 Input
7	SG4	Strain Gage 4 Input
8	SG5	Strain Gage 5 Input

3. Installation

The following section provides information for installing the NETrs CBA into a user application Refer to the *Transducer manual* for instructions on installing the ATI transducer.

There are multiple connectors on the NETrs CBA, which provides the user flexibility when wiring the board into the customer application. Not all connectors are required for the NETrs CBA F/T System to operate properly. At a minimum, a connection to the ATI transducer, power supply, and customer-desired communication are required.

WARNING: Ensure all three mounting holes on the NETrs CBA are connected to chassis ground. Failure to ground the interface board propertly could result in injury, damage to the equipment, or cause unpredictable behavior.

CAUTION: Do not plug in and power the interface board until after it has been mounted and all conductive tools are away from the interface board.

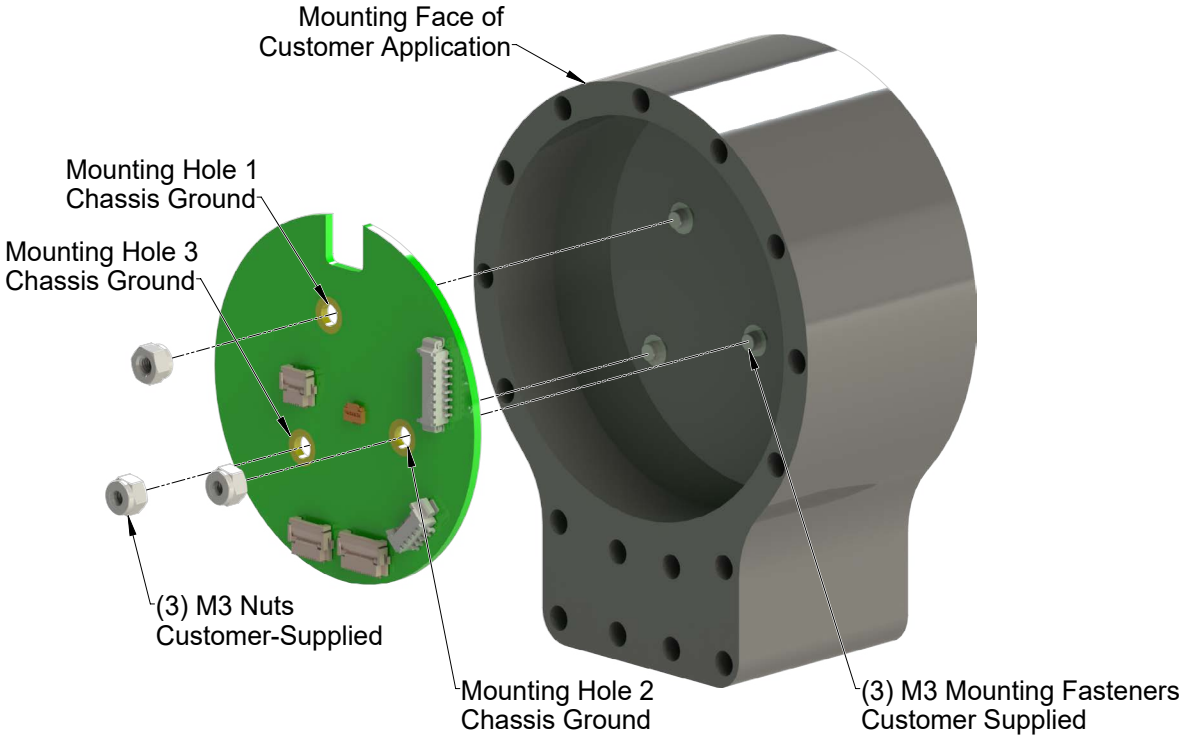
CAUTION: Do not connect power or communication to multiple flex cables at the same time. Supplying power to multiple connectors may cause damage to power supply. Supplying the same communication channel over multiple connectors will result in a loss of communication.

CAUTION: Take care when wiring in the power connections, as not all communication ports are protected against overvoltage..

Parts required:

- NETrs CBA
- ATI Mini or Nano Transducer with EC8 Molex Cable
- (3) customer-supplied M3 fasteners or other mounting hardware
- Flat Flex Cables (for connection to connectors: P1, P2, P3, and P5)

Figure 3.1—NETrs CBA F/T System Installation



1. Install ATI Transducer with EC8 connector into customer application. Refer to *Transducer manual* for detailed instructions.
2. Attach the NETrs CBA to the customer application
    a. Use (3) customer-supplied M3 fasteners to mount board to customer-supplied mounting.
    b. Connect all three M3 fasteners to chassis grounding.
3. Connect NETrs CBA to ATI transducer:
    a. Connect attached EC8 cable connector from transducer to P8 connector on NETrs CBA. Refer to *Figure 3.2.*

Figure 3.2—Connect ATI Transducer to NETrs CBA

4. Connect Ethernet communication input to NETrs CBA:
    a. The following Ethernet connectors are available for customer use:
        - P1 for Power, Serial, Ethernet, and Clock Sync. Refer to *Section 2.3.1—P1 Connector for Power, Serial, Ethernet, Clock Sync*
5. Connect serial communication inputs to NETrs CBA:
    a. The following serial connectors are available for customer use:
        - P1 for Power, Serial, Ethernet, and Clock Sync. Refer to *Section 2.3.1—P1 Connector for Power, Serial, Ethernet, Clock Sync*
        - P2 for Serial. Refer to *Section 2.3.2—P2 Connector for Serial Interfaces*
6. Connect additional functionalities to NETrs CBA:
    a. The following connectors are available for additional customer use:
        - P1 for Clock Sync. Refer to *Section 2.3.1—P1 Connector for Power, Serial, Ethernet, Clock Sync*
        - P3 for Clock Sync. Refer to *Section 2.3.3—P3 Connector for Power and Clock Sync*
        - P5 for external LED functionality. Refer to *Section 2.3.5—P5 Connector for LED Board*
7. Supply between 12 and 30 V power to NETrs CBA:
    a. The following power connectors are available for customer use:
        - P1 for Power, Serial, Ethernet, and Clock Sync. Refer to *Section 2.3.1—P1 Connector for Power, Serial, Ethernet, Clock Sync*
        - P3 for Power and Clock Sync. Refer to *Section 2.3.3—P3 Connector for Power and Clock Sync*
8. Bias system.
    a. Refer to *Table 5.1.*

3.1 Transducer Handling

In addition to the standard transducer handling instructions, which are outlined in the *Transducer manual,* the following considerations should be observed:

- The transducer calibration label FTxxxx must not be removed or painted over. If a transducer gets returned to ATI for calibration or repair, it is important that this number is present.
- The transducer connector has no strain relief. To protect the fragile crimp contacts it is important to provide a suitable strain relief in the final product.

3.2 Ground and cable shield considerations

There are two options for connecting the transducer cable shield:

1. If the transducer is connected to chassis ground, the cable shield can still be connected to SHIELD_

DRAIN to keep the cable shield from energizing by draining to 0 volts (ground).

2. If the transducer is isolated, SHIELD_DRAIN can be connected to a cable shield or to a nearby chassis ground point.

3.3 Cable Routing Considerations

The NETrs CBA F/T System can be used in a variety of applications that will affect how best to route the cable and determine the proper bending radius to use. Some applications will allow the transducer and the cable to remain in a static condition, other applications require the transducer to be in a dynamic condition that requires the cable to be subjected to repetitive motion. It is important not to expose the transducer cable connectors to this repetitive motion, and properly restrain the cable close to the transducer connection. Refer to the *Transducer manual* for proper cable bending radius and cable restraint methods.

3.4 Optional Breakout Board

If desired, you may choose to purchase a 9105-GEN3-BOB-001 to evaluate the NETrs CBA FT System. The 9105-GEN3-BOB-001 is an evaluation kit that breaks out the flex connector into visible LEDs, a wireable connector block for power and communication, and RJ45 ports for communication.

3.4.3 P3 BOB Customer Wireable Connector

Connector: Phoenix Contact 1990122

Pin No.	Signal Name	Description
1	RS422_RX-	RS422 RX Negative
2	RS422_RX+	RS422 RX Positive
3	RS4XX-	RS485 Negative OR RS422 TX Negative
4	RS4XX+	RS485 Positive OR RS422 TX Positive
5	CLK_SYNC_GND	Clock Sync Ground
6	CLK_SYNC	Clock Sync
7	GROUND (SL_GND)	Power Supply Ground
8	12V-30V (SL_VP)	12 to 30 VDC Power Supply Positive
9	No Connect	Unused
10	SHIELD_DRAIN	Shield to Drain
11	NET_RX-	Ethernet RX Negative
12	NET_RX+	Ethernet RX Positive
13	NET_TX-	Ethernet TX Negative
14	NET_TX+	Ethernet TX Positive

3.4.3 P4 BOB Customer RJ45 Connector

Connector: Amphenol RJHSE5E80

Pin No.	Signal Name	Description
1	NET_TX+	Ethernet TX Positive
2	NET_TX-	Ethernet TX Negative
3	NET_RX+	Ethernet RX Positive
4	No Connect	Unused
5	No Connect	Unused
6	NET_RX-	Ethernet RX Negative
7	No Connect	Unused
8	No Connect	Unused

3.4.3 P5 BOB Customer RJ45 Connector

Connector: Amphenol RJHSE5E80

Pin No.	Signal Name	Description
1	RS4XX+	RS485 Positive OR RS422 TX Positive
2	RS4XX-	RS485 Negative OR RS422 TX Negative
3	RS422_RX+	RS422 RX Positive
4	No Connect	Unused
5	No Connect	Unused
6	RS422_RX-	RS422 RX Negative
7	No Connect	Unused
8	No Connect	Unused

3.5 Set-up of the RS422/RS485 Communication Interface

The NETrs sensor is a serial device that is used programmatically with the user's application.

When the sensor is attached via cable to the customer's device such as a personal computer or robot, the computer assigns the sensor a COM port. Then by using a console on the computer, the user can communicate with the sensor. Free console software, such as PuTTY, is available online. Commands are covered in *Section 5—Operation*

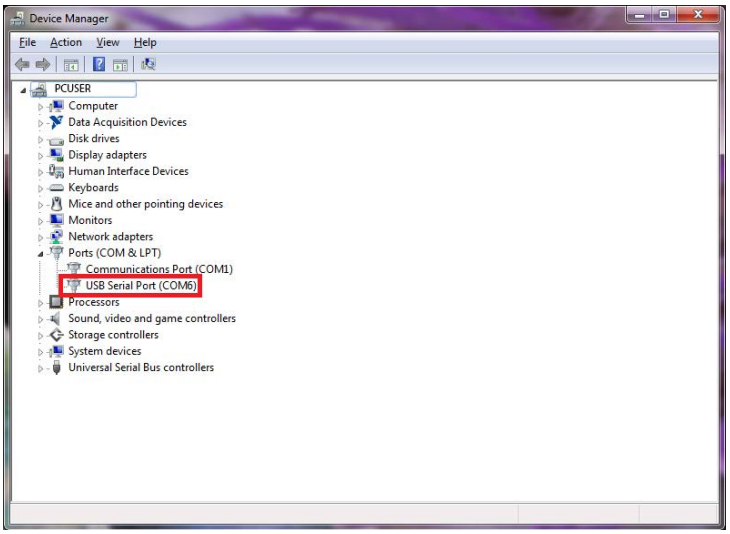
For additional instructions on setting up a console like PuTTY, refer to the following procedure:

1. If an RS422/RS485 serial port is not on the customer device, use a third party serial device to add the port.
2. Connect the RS422/RS485 cable from the NETrs sensor configuration to the RS422/RS485 serial port
3. Find the COM port that is assigned to the NETrs device.

- In Windows®, from the Control Panel go to the Device Manager > **ports** > **USB Serial Port**. The sensor is assigned **COM6** in the following figure.

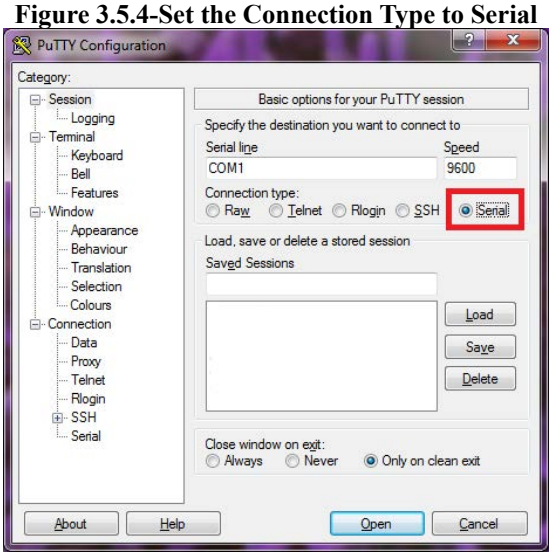
> **NOTICE:** The name of the device may differ based on the name of the PC's RS422/RS485 port or name of the third-party RS422/RS485 device.

Figure 3.5.3-Device Manager, Port Assignment



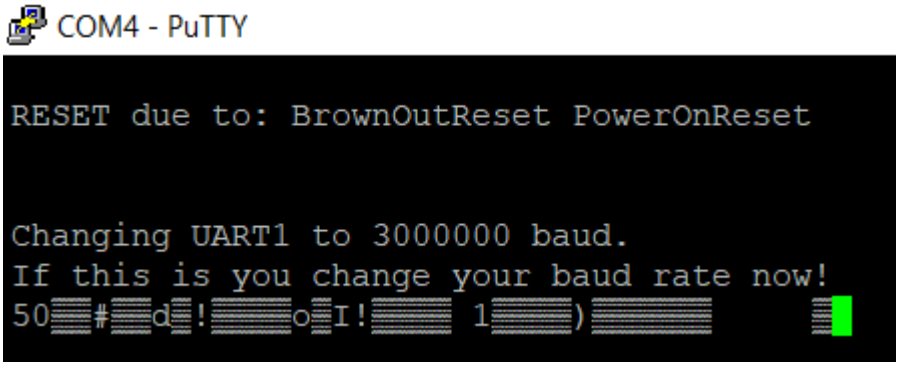
4. Open the console, for example: PuTTY. A window opens that allows the user to set the configuration for the session.
5. Set the configuration:
   a. Under **Connection type:** select the radio button for **Serial**.

Figure 3.5.4-Set the Connection Type to Serial



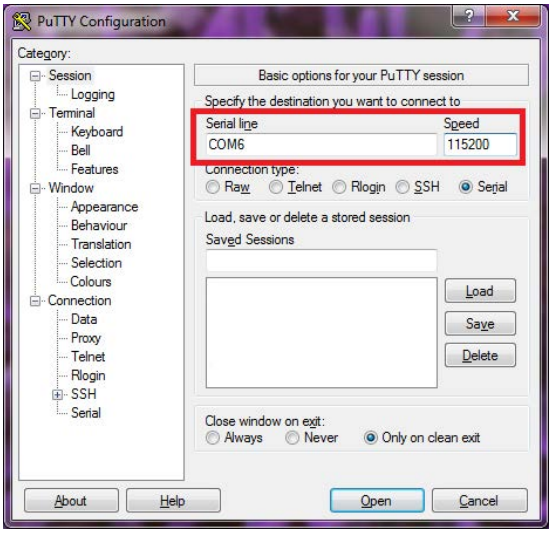
   b. In the **Serial Line** field, enter the assigned COM port from step *3*.

   c. In the **Speed** field, enter the default baud rate of 115200 or the baud rate to which the user has set the NETrs Refer to *Section 5.1.2—Set Command* for more information on how to set the baud rate.



NOTICE: If the baud rate that is set on the console configuration does not match the baud rate set on the NETrs, then the console terminal window will open but commands cannot be sent. The factory default baud rate is 115200. In case the user cannot remember what baud rate the sensor is set to, at startup the sensor will print a message at 115,200 baud to list the actual baud rate setting.

Figure 3.5.5**—Set the COM port and the Baud Rate**



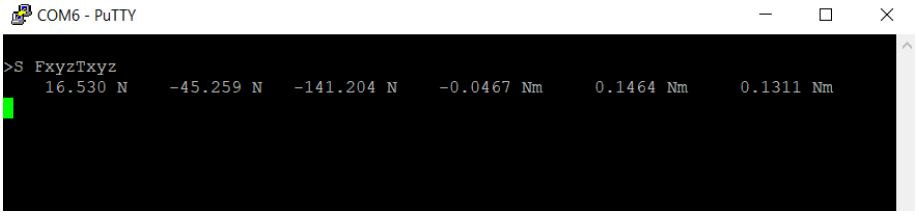
d. Select **Open**.

e. After a terminal window opens, the user can then start entering commands.

f. After a command is entered from *Section 5—Operation.*

NOTICE: Commands which are entered are not case sensitive.

Figure 3.5.6—PuTTY Terminal Window



3.6 Connecting to Ethernet

For information on configuring NETrs F/T Ethernet settings, refer to *Section 3.6.1—IP Address Configuration for Ethernet*, and for information on configuring a Windows XP or Windows Vista or later computer, refer to *Section 3.6.2—Connecting to Ethernet using a Windows Computer*.

NOTICE: Avoid connecting the NETrs F/T to the organization's network. Being connected to a network requires the periodic access to the Ethernet interface by processes other than the measurement application. This type of network connection can lead to loss of NETrs F/T UDP data.

NOTICE: Use a dedicated Ethernet network for the NETrs F/T. Placing the NETrs F/T 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.

3.6.1 IP Address Configuration for Ethernet

The NETrs F/T system's IP address settings are only loaded upon power up, consequently the NETrs F/T must be power cycled for new IP address setting changes to be used. There are two methods the NETrs F/T system's IP address can be configured.

Method 1: Set IP address to a static value stored on the NETrs F/T's *Communications* web page. This method is described in *3.6.2.*

Method 2: Let a DHCP server take care of the IP address assignment. This option can be enabled in the NETrs F/T's webpages (see *3.6.2* for details). To use this method, a DHCP server must be present in the network. This is usually the case in company networks.

The NETrs F/T is shipped with DHCP enabled and the static IP address set to 192.168.1.1. If the network does not support DHCP, the static IP address is automatically used. If a LAN connection is absent during power up, DHCP is not be used.

3.6.2 Connecting to Ethernet using a Windows Computer

Most of the Ethernet configuration is completed through the ATI NETrs F/T's webpages. To initially access the webpages, set-up the NETrs F/T to work on the network by assigning it an IP address and telling it basic information about the network.

For purposes of this initial connection, a computer is connected directly to the NETrs F/T and disconnected from the LAN. Temporarily provide a computer with a fixed IP address of 192.168.1.100. It is important that the Ethernet cable to the Net F/T is disconnected from the computer during this step.

NOTICE: If a computer has multiple connections to Ethernet, such as a LAN connection and a wireless connection, be sure to select the LAN that will be connected to the NETrs F/T.

1. Unplug the Ethernet cable from the LAN port on the computer.
2. Open the computer's Internet Protocol (TCP/IP) Properties window. Refer to the appropriate set of instructions depending on the computer operating system:

- Windows 10:

    g. From the **Start** menu, select **Control Panel**.

    h. Click on the **Network and Internet** icon.

    i. Click on the **Network and Sharing Center** icon.

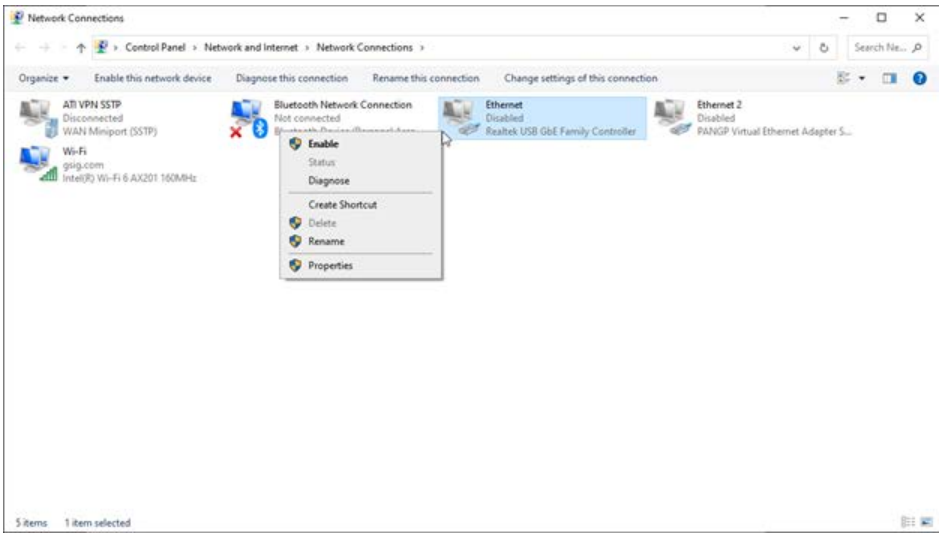
    j. Click on the **Change adapter settings** link on the left side of the window.

- A new window opens that displays the available network adapters.

    k. Right click the network adapter to which the sensor is connected.

    l. From the dropdown menu, select **Properties**.

Figure 3.3—Windows 10 Networking Information



m. In the Ethernet Properties' Networking tab, select **Internet Protocol Version 4 (TCP/IPv4)** from the list of items (refer to *Figure 3.3*).

n. Click the **Properties** button.

- Windows Vista and Windows 7:

    a. From the **Start** menu, select **Control Panel**.

    b. For Vista, click on **Control Panel Home**.

    c. Click on the **Network and Internet** icon.

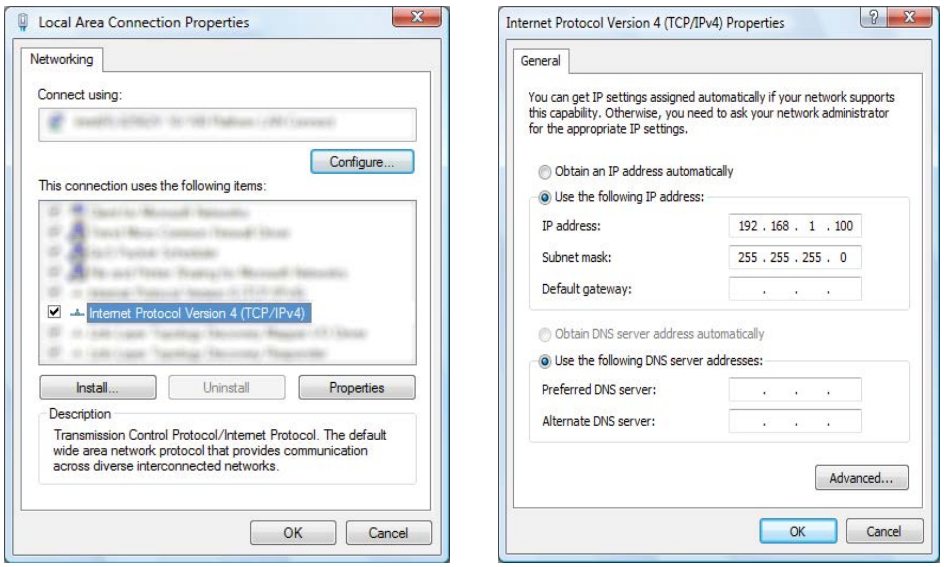
d. Click on the **Network and Sharing Center** icon.

e. For Vista, click on the **Manage Network Connections** task link. For Windows 7, click on the **Local Area Connection** link.

f. For Vista, right-click on **Local Area Connection** and click the **Properties** button. For Windows 7, click on the **Properties** button.

g. Select **Internet Protocol Version 4** *(TCP/IPv4)* connection item and click on the **Properties** button.

Figure 3.4—Connection Properties



- Windows XP:

a. From the **Start** menu, select **Control Panel**.

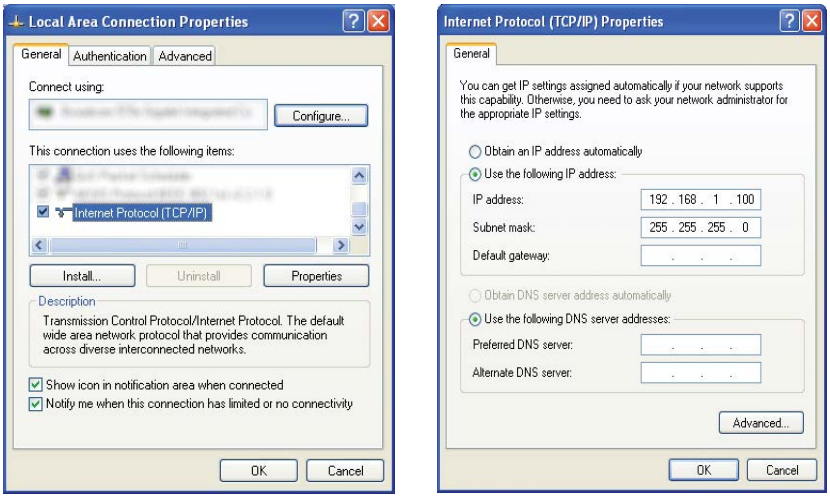
b. Select the **Network Connections** icon from within the Control Panel. If the Control Panel says **Pick a category** at the top, first click on the **Network and Internet Connections** icon.

c. Click on the **Network Connections** icon.

d. Right-click on **Local Area Connection** and select **Properties**.

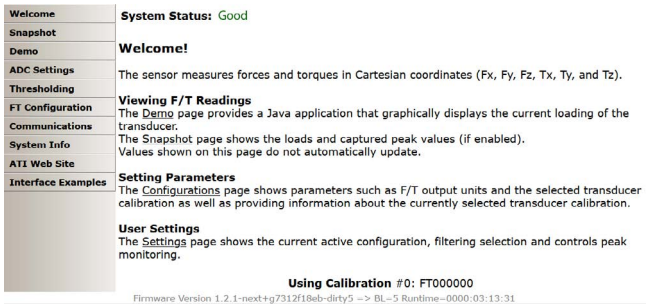
e. Select **Internet Protocol (TCP/IP)** connection item and click on the **Properties** button.

Figure 3.5—Windows XP Networking Information



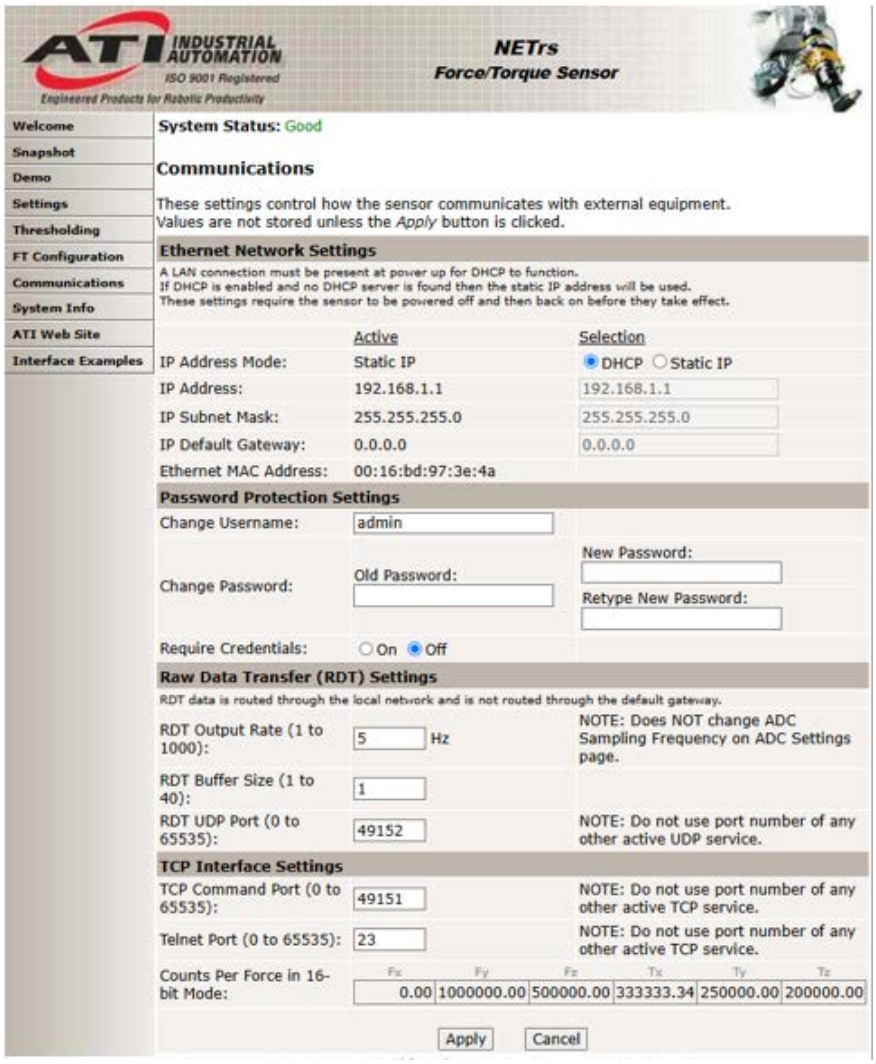
3. Record the values and settings shown in the properties window. Use these recorded values later to return the computer to its original configuration.
4. Select the **Use the following IP address** button.
5. In the **IP address***:* field, type 192.168.1.100.
6. In the **Subnet mask***:* field, type 255.255.255.0.
7. Click on the **OK** button.
8. Click on the **Local Area Connection Properties** window's **Close** button.
9. Use an Ethernet cable to connect the Net F/T system to the computer's LAN connection. Wait for the computer to recognize the connection.
10. Type the address *192.168.1.1* in the web browser to view the *ATI NETrs F/T's Welcome* page.

Figure 3.6—NETrs F/T's Welcome Page



11. On the left side of the page are menu buttons that link to various NETrs F/T web pages. Click on the **Communications** button.

Figure 3.7—The NETrs F/T's Communications Page



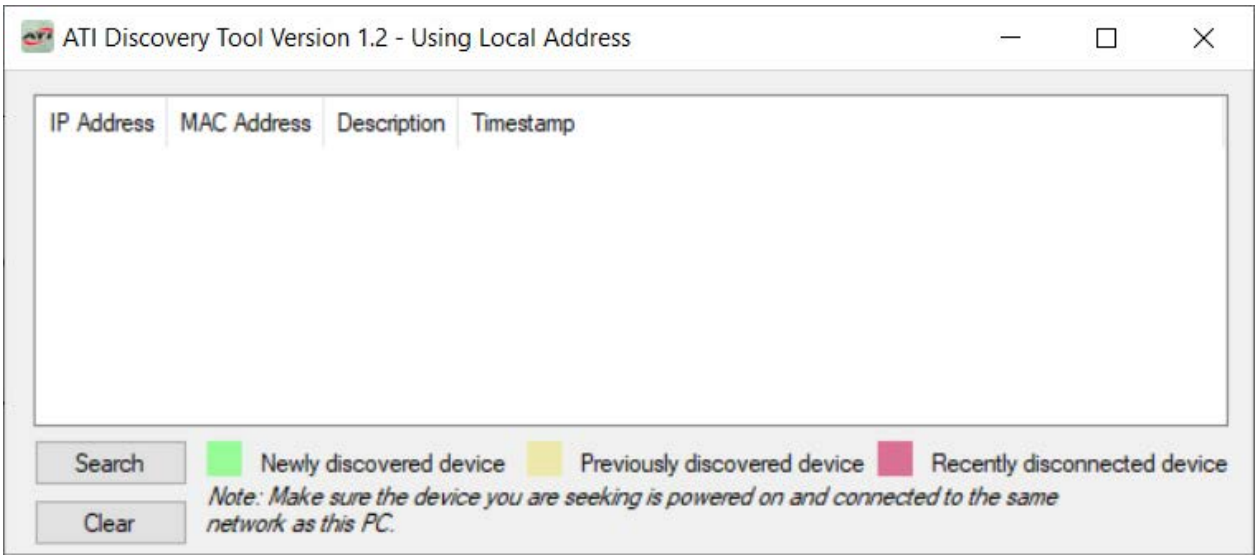
12. Select the IP address mode.
    a. If the user's IT department provided settings for a static IP address, type the provided values for the IP address, subnet mask, and default gateway, then click the **Apply** button. Power-cycle the sensor. Go to step *13.*
    b. If the user's IT department provided settings for DHCP, click the **Enabled** radio button next to DHCP, and then click the **Apply** button at the bottom. Power-cycle the sensor.
13. Open up the TCP/IP properties of the local area connection again. Restore the settings to the values before the settings were reconfigured. These are the values recorded in Step 3.
14. Open up a new web browser window, type the IP address given to the NETrs F/T system into the browser's address bar, and press the ENTER key. The ATI NETrs F/T's *Welcome* web page displays again. Now it is possible to communicate with the NETrs F/T without reconfiguring the communication settings.

3.7 Finding the NETrs 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 Discovery Tool 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 3.8— Windows 7/8/10 Firewall Alert



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 senor and network.*

Next, find the IP address assigned to the NETrs F/T

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

NOTICE: IP addresses assigned by a DHCP server are not permanent and may change if the NETrs F/T is disconnected from the network for a period of time. Users should contact their IT department for more information.

NOTICE: If the *ATI Discovery Tool* found the Net F/T, but the internet browser is unable to open the found IP address, try clearing previous device entries from the computer's ARP table. Do this by either restarting the computer or, using administrative privileges, go to the computer's **Start** menu, select **Run**..., and type "`arp -d *`".

This step is necessary if another device previously occupied the same IP address that the Net F/T is now using.

4. Configuring Force/Torque Settings

Prior to operation, users can configure force/torque settings in order to stream and read data appropriate to the application. This can be completed through a variety of methods:

- *ATI Force/Torque Webpages*
- *F/T Data Viewer*
- *Console commands*
- *Common Gateway Interface (CGI)*

4.1 ATI Force/Torque Webpages

The NETrs F/T's webpages provide full configuration options for the NETrs CBA F/T System. There are several pages which can be selected by the menu bar toward the top of the webpage.

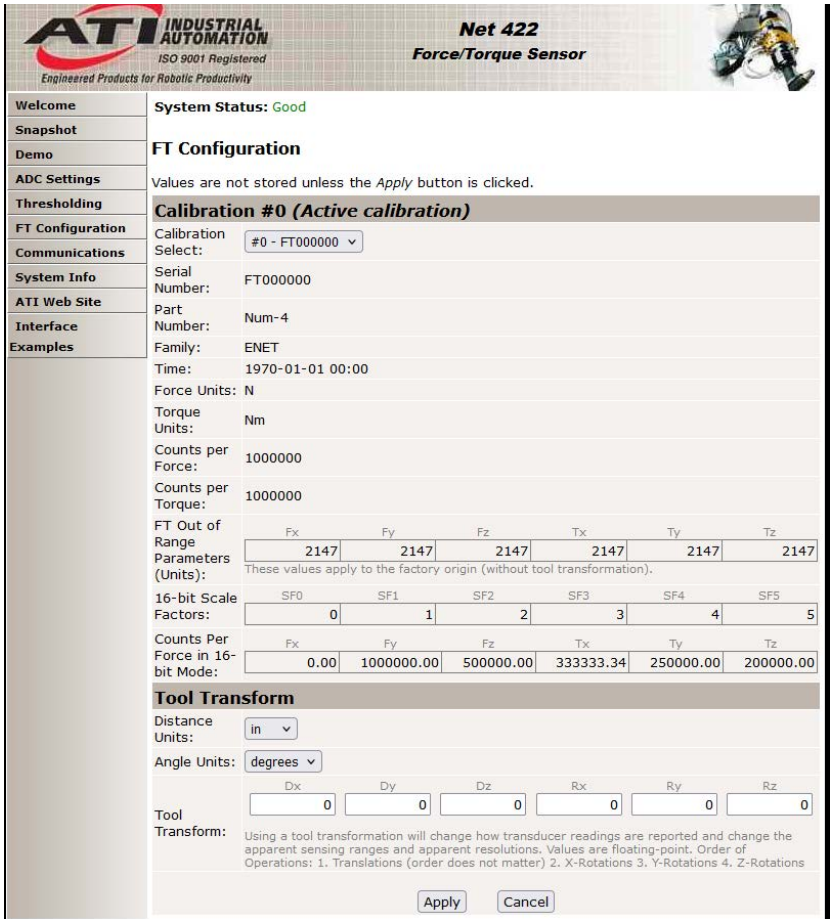
The NETrs F/T's webpages use simple HTML and browser scripting and the pages do not require any plug-ins. If browser scripting is disabled some non-critical user interface features are not available. .

NOTICE: Before configuring settings, ensure Network Settings on **Communications webpage** are accurate.

To configure the force/torque sensor settings:

1. Navigate to the **FT Configuration** webpage.

Figure 4.1—Configuration Webpage



2. Select the desired calibration from the **Calibration Select** dropdown. There may only be one option.

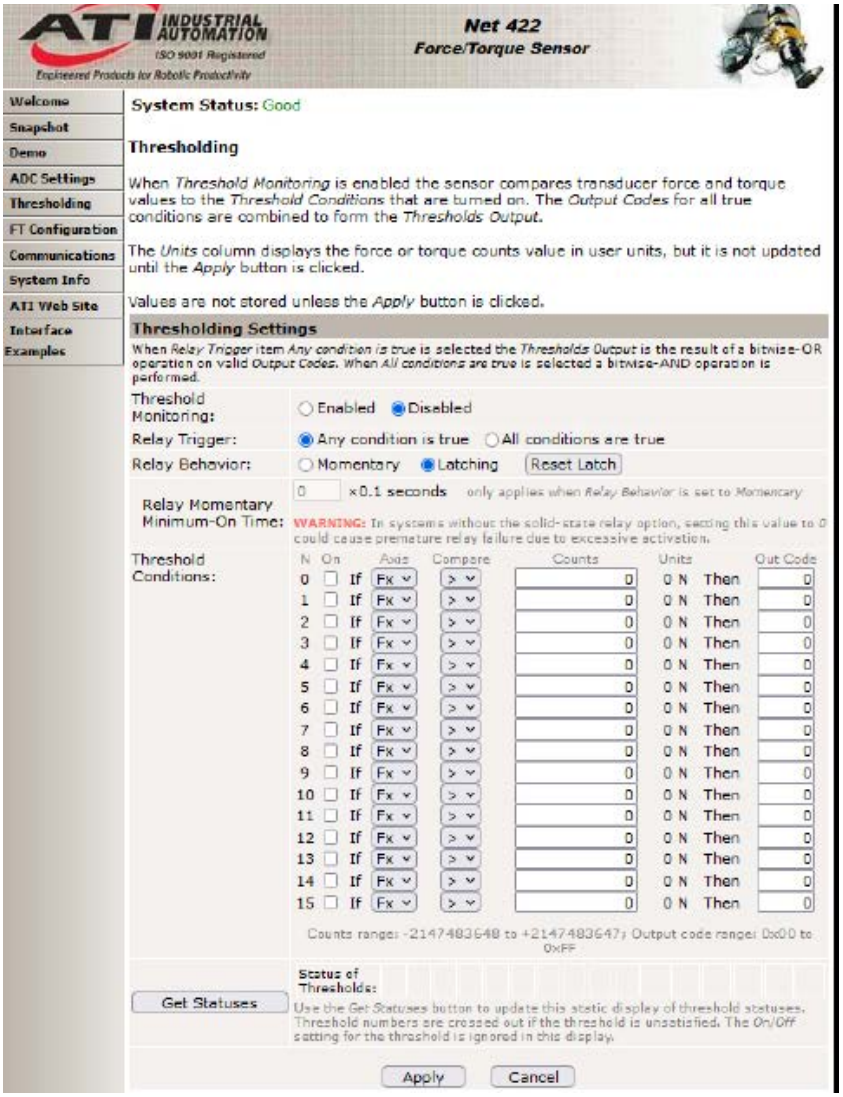
3. Input desired Tool Transform data, using *Table 4.1* as a guide.

Table 4.1—Tool Transformation Overview

Menu Value	Description	Order
Distance Units	Unit of measurement. Select one of: inch, foot, milimeter, centimeter, and meter.	N/A
Angle Units	Unit of measurement. Select between degrees and radians.	N/A
Dx	Distance to move X axis	1
Dy	Distance to move Y axis	2
Dz	Distance to move Z axis	3
Rx	Rotation angle about X axis	4
Ry	Rotation angle about Y axis	5
Rz	Rotation angle about Z axis	6

4. Click **Apply** button to implement changes on this page.
5. Navigate to the **Thresholding** webpage.

Figure 4.2—Thresholding Webpage



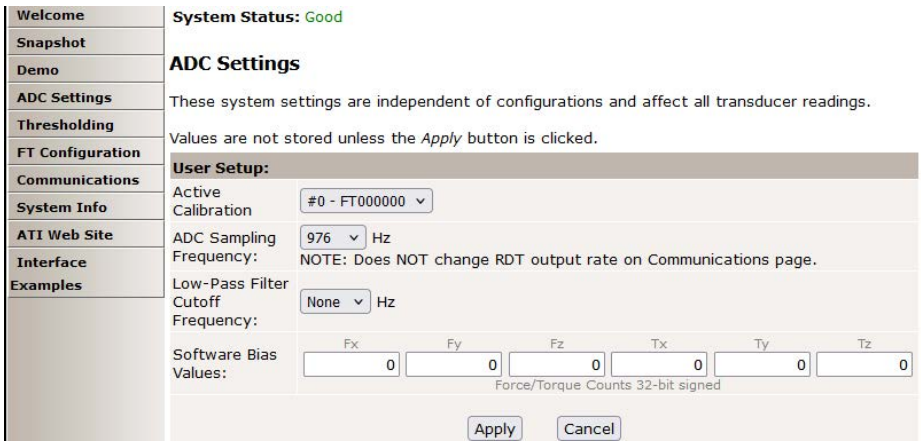
6. Specify the output parameters using *Table 4.2* as a guide.

<table>
<tr><th colspan="3">Table 4.2—Thresholding Webpage Overview</th></tr>
<tr><th>Menu Value</th><th colspan="2">Description</th></tr>
<tr><td>Threshold Monitoring</td><td colspan="2">Enabled: Turns on thresholding and below conditions will be monitored.
Disabled: Turns off thresholding functionality.</td></tr>
<tr><td>Relay Trigger</td><td colspan="2">Any condition is true: Valid output code present if any individual conditions are met.
All conditions are true: Valid output code present if all conditions are met.</td></tr>
<tr><td>Relay Behavior</td><td colspan="2">Momentary: Valid output code will only be active while threshold is met. If conditions change and threshold is no longer met, output code will no longer be displayed.
Latching: Valid output code will be active after a threshold is met, even if conditions change and threshold was only met briefly.</td></tr>
<tr><td>Relay Momentary Minimum-On Time</td><td colspan="2">This can only be set if ‘Momentary’ is selected under Relay Behavior. This input signals how long the output code will be present after the condition is met.</td></tr>
<tr><td>Reset Latch</td><td colspan="2">Clears any condition latching and reloads the monitor conditions page.</td></tr>
<tr><td rowspan="7">Threshold Conditions</td><td>Thresholding Subhead</td><td>Description</td></tr>
<tr><td>N</td><td>Statement number</td></tr>
<tr><td>On</td><td>If selected, the following condition will be monitored.</td></tr>
<tr><td>Axis</td><td>Choose between Fx, Fy, Fz, Tx, Ty, and Tz</td></tr>
<tr><td>Compare</td><td>Choose between less than or greater than.</td></tr>
<tr><td>Counts[1]</td><td>The loading level to be compared to the trandsucer reading.Counts = Desired Loading Level × Counts per Force

Example:
6.25 N × 1000000 counts/N= 6250000 counts
Desired Loading Level: 6.25 N
Force Units: N (from Configurations web page)
Counts per Force value: 1000000 (from Configurations page)</td></tr>
<tr><td>Out Code</td><td>When this statement’s comparison is found true, this 8-bit value is bitwise or’ed with the Output Code values of all other true statements to form the Condition output. Any set bits remain latched until Reset Latch is called. If no statements have been true, the Condition output is zero.
The value is displayed in hexadecimal in the format 0x00. Output Codes may be in the hexadecimal or decimal format.
If this statement is true, Bit 16 of the system status code (see 7.1) sets to one.</td></tr>
<tr><td>Get Statuses</td><td colspan="2">This will refresh the display of the status of threshold values to current.</td></tr>
<tr><td colspan="3">1. 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.</td></tr>
</table>

7. Click **Apply** button to implement changes on this page.
8. Navitage to the **ADC Settings** webpage.

Figure 4.3—ADC Settings Webpage



9. Select the desired calibration under the **Active Calibration** drop down. There may only be one listed.
10. Select desired sampling and filtering rate.

> **NOTICE:** Software Bias Values display the current bias offset applied to the transducer strain gage readings.

11. Click **Apply** button to implement changes on this page.

4.2 F/T Data Viewer

For detailed information on the F/T Data Viewer installation and functionality, refer to the *F/T Data Viewer Manual.*

4.3 Console commands

Refer to *Section 5.1—Serial* for commands used to configure the force/torque sensor via serial.

4.4 Common Gateway Interface (CGI)

The NETrs CBA F/T System can be configured over Ethernet using the standard HTTP get method which sends configuration variables and their values in the requested URL.

Each variable is only settable from the *CGI* page which is responsible for that variable. Each *CGI* page and associated settable variables are listed in tables within the following section.

URLs are constructed using the following syntax:

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

where:

http://	indicates an HTTP request
<NETrsFTAddress>	is the Ethernet address of the NETrs F/T system
/	a separator
<CGIPage.cgi>	the name of the *CGI* page that holds the variables to be accessed
?	a separator marking the start of variable assignments
<firstVariableAssignment>	a variable assignment using the format described below
<&nextVariableAssignment>	a variable assignment using the format described below, but the variable name is proceeded by an ampersand. This variable assignment is optional and may be repeated for multiple variables.

Variables are assigned new values using the 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.

Example:

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

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

The maximum length of these URLs may be determined by a number of factors external to the NETrs F/T. Exceeding the maximum length may result in an error or variables being incorrectly set.

4.4.1 Settings CGI (setting.cgi)

This CGI allows the user to specify certain global settings such as Low-Pass Filter selection, Peak Monitoring Enable, Software Bias Vector, and Active Configuration selection.

Table 4.3—setting.cgi Variables

Variable Name	Allowed Values	Description
cfgcalsel	integers: 0 to 3	Sets the active configuration. Note that the value used by *cfgcalsel* is one less than the configuration numbers displayed on the web pages.
setuserfilter[1]	integers: 0 to 8	Sets the cutoff frequency of the low-pass filtering as follows:

Value	Cutoff	Value	Cutoff
0	no filter	5	5.1 Hz
1	120 Hz	6	2.6 Hz
2	46.6 Hz	7	1.2 Hz
3	21.7 Hz	8	0.7 Hz
4	10.4 Hz		

setadcrate	integers: 1000 2000 4000 8000 16000	Sets the active sample rate in Hz. 1000 is the ATI NETrs default.
setbias*n*	integers: -32768 to 32767	Sets the offset value for strain gage *n*. For example, *setbias3=0* would zero the bias of the fourth strain gage (Strain gages are enumerated starting at zero.)

Note:
1. Values are displayed based on 1 kHz sampe rate, which is the default for ATI NETrs sensors.

4.4.2 Monitor Conditions CGI (moncon.cgi)

This CGI defines and controls Monitor Conditions statements. Monitor Conditions statements can be turned off or on and need to have an axis, a comparison type, a comparison counts value, and an output code defined.

Table 4.4—moncon.cgi Variables

Variable Name	Allowed Values	Description
setmce	Integers: 0 or 1	Enable (value = 1) or disable (value = 0) all Condition statement processing.
mce*n*	Integers: 0 or 1	Enable (value = 1) or disable (value = 0) Condition statement n.
mcx*n*	Integers: -1 to 5	Selects the axis evaluated by Condition statement *n*.

Value	Description	Menu Value
-1	Statement disabled	blank
0	Fx axis	Fx
1	Fy axis	Fy
2	Fz axis	Fz
3	Tx axis	Tx
4	Ty axis	Ty
5	Tz axis	Tz

Table 4.4—moncon.cgi Variables		
Variable Name	**Allowed Values**	**Description**
mcv*n*	Integers: -2147483648 to +2147483647	Sets the counts value to compare the current axis value by Condition statement *n*.
mco*n*	Hexadecimal: 0x00 to 0xFF	Sets the output code for Condition statement *n*.
where *n* is an integer ranging from 0 to 15 representing the Condition statement index		

4.4.3 Configurations CGI (config.cgi)

Use this CGI to specify the output parameters of the sensor system. Any of the sixteen configurations can be defined. Changing configurations allows selection of the transducer calibration to use and what tool transformations to apply to that calibration.

When using config.cgi the cfgid value specifies which configuration is targeted. For example, http://<netFTAddress>/config.cgi?cfgid=3&cfgnam=test123 sets the name of the fourth configuration (which is at index 3) to test123.

<table>
<tr><th colspan="5">Table 4.5—config.cgi Variables</th></tr>
<tr><th>Variable Name</th><th>Allowed Values</th><th colspan="3">Description</th></tr>
<tr><td>cfgcalsel</td><td>integers: 0 to 3</td><td colspan="3">Sets the calibration used by the configuration.</td></tr>
<tr><td rowspan="7">cfgtdu</td><td rowspan="7">Integers: 1 to 5</td><td colspan="3">The distance measurement units used by the configuration’s tool transformation.</td></tr>
<tr><td>Value</td><td>Description</td><td>Menu Value</td></tr>
<tr><td>1</td><td>inch</td><td>in</td></tr>
<tr><td>2</td><td>foot</td><td>ft</td></tr>
<tr><td>3</td><td>millimeter</td><td>mm</td></tr>
<tr><td>4</td><td>centimeter</td><td>cm</td></tr>
<tr><td>5</td><td>meter</td><td>m</td></tr>
<tr><td rowspan="4">cfgtau</td><td rowspan="4">Integers: 1 or 2</td><td colspan="3">The rotation units used by the configuration’s tool transformation.</td></tr>
<tr><td>Value</td><td>Description</td><td>Menu Value</td></tr>
<tr><td>1</td><td>degrees (°)</td><td>degrees</td></tr>
<tr><td>2</td><td>radians</td><td>radians</td></tr>
<tr><td>cfgtfx0</td><td>Floating point</td><td colspan="3">Sets the tool transformation distance Dx. Distance must be in cfgtdu distance units.</td></tr>
<tr><td>cfgtfx1</td><td>Floating point</td><td colspan="3">Sets the tool transformation distance Dy. Distance must be in cfgtdu distance units.</td></tr>
<tr><td>cfgtfx2</td><td>Floating point</td><td colspan="3">Sets the tool transformation distance Dz. Distance must be in cfgtdu distance units.</td></tr>
<tr><td>cfgtfx3</td><td>Floating point</td><td colspan="3">Sets the tool transformation rotation Rx. Rotation must be in cfgtau angular units.</td></tr>
<tr><td>cfgtfx4</td><td>Floating point</td><td colspan="3">Sets the tool transformation rotation Ry. Rotation must be in cfgtau angular units.</td></tr>
<tr><td>cfgtfx5</td><td>Floating point</td><td colspan="3">Sets the tool transformation rotation Rz. Rotation must be in cfgtau angular units.</td></tr>
</table>

4.4.4 Communications CGI (comm.cgi)

This CGI sets the networking options of the Net Box. For more information on the parameters, refer to *Section 4.7—Communication Settings Page (comm.htm)*.

Table 4.6—comm.cgi Variables

Variable Name	Allowed Values	Description	
comnetdhcp	Integers: 0 or 1	Sets DHCP behavior.	
		Value	**Description**
		0	Use DHCP if available on network
		1	Use software-defined static IP values
comnetip	Any IPV4 address in dot-decimal notation	Sets the static IP address to be used when DHCP is disabled.	
comnetmsk	Any IPV4 subnet mask in dot-decimal notation	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.	
comrdtrate	1 to 7000	Sets the RDT output rate in Hertz. The actual value used may be rounded up; see *Section 4.7—Communication Settings Page (comm.htm)* for details.	
comrdtbsiz	Integers: 1 to 40	RDT Buffer Mode buffer size.	
comrdtport	0 to 65535	RDT listening port	
comtcpport	0 to 65535	TCP listening port	
comtelnetport	0 to 65535	Telnet listening port	

5. Operation

NOTICE: It is recommended to bias the sensor following initial installation and after each power cycle. Biasing the sensor will ensure accurate readings and proper operation. Refer to *Table 5.1.*

The NETrs CBA F/T System has the capability of communicating via a number of networks, including:

- *Console Commands via Serial*
- *User Datagram Protocol (UDP Interface Using RDT)*
- *TCP Interface*

5.1 Console Commands via Serial

When the sensor is attached via cable to the customer's computer or robot, the computer assigns the sensor a COM port. Then by using a console on the computer, the user can communicate with the sensor. A full list of serial commands is outlined in *Table 5.1.*

Table 5.1—Serial Commands

Command	Command with Operands	Description
Help	h	Prints a summary of the available console commands and available operands.
	H	
	?	
Bias	bias	Displays current bias status
	bias on	Turns bias on
	bias off	Turns bias off
	bias [value]	Sets bias to particular value in F/T counts
Peak	peak	Displays the run-time and all-time F/T data peaks in units.
	peak c	Displays the run-time and all-time F/T data peaks in counts.
	peak r	Resets run-time F/T data peaks.
C/S	c	Continuous flow of values. Reference *Section 5.1.1—Query Commands: "s" or "c".*
	s	Single line of values. Reference *Section 5.1.1—Query Commands: "s" or "c"*
Set	set	Prints all setting field values. Reference *Section 4.1.2—Cal Command*
	set [field]	Prints specific setting field value.
	set [field] [value]	Sets specific setting field with value entered.
Simerr	simerr on	Turns the simulated error status bit on. Refer to *Table 7.1*
	simerr off	Turns the simulated error status bit off. Refer to *Table 7.1*
Reset	reset	Resets the processor, returning all parameters and settings to their saved defaults.
Saveall	saveall	Writes all settings to non-volatile memory. This is typically used if any settings have been updated.
Status	status	Prints a status report on the various components of the sensor
MC	mc	Prints all global monitor condition status information.

Table 5.1—Serial Commands		
Command	**Command with Operands**	**Description**
View	view	Prints calibration report properties such as F/T part number, serial number, units, calibration date, and calibration family.
	view 0	Prints calibration properties for Calibration 0.
	view 1	Prints calibration properties for Calibration 1.
	view 2	Prints calibration properties for Calibration 2.
	view a	Prints calibration properties for active calibration.
Diag	diag	Prints a diagnostic report of gage number, gage readings in counts, and a gage status indicator. Indicators include: "w" gage in warning range "!" gage in error range "x" gage disconnected

5.1.1 Query Commands: "s" or "c"

The query command starts the high-speed data transmission of FT data. The "s" command reports a single line of sensor data that is scaled by the counts per force or counts per torque. The "c" command reports continuous lines of sensor data that stop when the user holds another key, for example: "enter", until the output of data ceases. The "c" command reports data at the rate specified in the rdtRate parameter.

The following are examples of an "S" or "C" command with specifiers:

1. Example: S c0123

user: `S c0123`

response: `fd6b02 ff240d fe2b34 fe273d`

   a. S: prints a single line of data.

   b. c: prints data in counts.

   c. 0123: a number 0 through 7 specifies to print the data for the corresponding gage number. So 0 will print data for gage zero, and 3 will print data for gage four. In this example, the response will print gage data for gages zero, one, two, and three.

   d. Data is displayed in hexidecimal by default.

2. Example: s >012345du67

user: `s >012345du67`

response: `fd6afd ff2407 fe2b2a fe272f fdb571 fec16b -3506688 4194771`

   a. S: a command for reporting a single line of data.

   b. >: will print the data in a compressed output, intended for highspeed applications.

   c. 012345: will print the data for the corresponding gages zero through six.

   d. D: any data following prints in decimal format.

   e. U: any data following will prints in units.

   f. 67: will print the data for the corresponding gages seven and eight.

Table 5.2—S or C command specifiers		
Category	**Specifier**	**Description**
Gage number(s)	01234567	Specifies active ADC channels 0 to 7. Raw values are printed in counts only.

Table 5.2—S or C command specifiers		
Category	**Specifier**	**Description**
Axis	XYZ	Specifies z, y, or z force or torque data
	M	Specifies force or torque Magnitude data
Force and/or torque	F	The following XYZM data specifies force (default)
	T	The following XYZM data specifies torque
Counts or units	C	Data is printed in counts
	U	Data is printed in units (default)
Numeric system	D	Data is printed in decimal
	H	Data is printed in hexadecimal, except any data always printed in decimal (default)
Format	<	Data is printed in human-readable form with lined-up columns (default)
	>	Data is printed in compressed format, intended for high-speed automated applications.
Additional inputs to aid in development of customer software program	#	Specifies a sample counter that prints for every new C or S line.
	@	Specifies an ADC read counter that prints for every time the ADC is read.
	;	Uses a comma between fields instead of blanks
	S	Specifies a 16-bit CRC.
Troubleshooting	!	Specifies a 32-bit Status Code. Reference *Table 8.1.*

5.1.2 Set Command

The set command allows users to either view or set specific settings, which are outlined in *Table 5.3—Set Commands.* The following are examples of a set command with specifiers:

1. Example: set baud

user: `set baud`

response: `baud rate 115200`

- By entering the set command with the operand “baud”, the sensor will print the current baud rate

```
user:       set baud 1000000
response:   baud rate was 115200, now 1000000
user:       saveall
response:   Parameters saved to NVM bank 0
            Parameters saved to NVM bank 1
```

- By entering a value after the baud rate set command, the user can set a new baud rate.
- Remember to send a saveall command to ensure all changes are saved to non-volatile memory.

2. Example: set ttdx

user: `set ttdx`

response:

```
Field               Value
-----               -----
ttdx                0
```

- By entering the set command with the operand “ttdx”, the sensor will print the current tool transformation distance in the X axis.

```
user:       set ttdx 1
response:   set ttdx 1
```

```
            ttdx was "0" now "1"
user:       saveall
response:   Parameters saved to NVM bank 0
            Parameters saved to NVM bank 1
```

- By default, tool transformation units are millimeters for distance and radians for angle. These units can be changed using the ttdu (distance units) and ttau (angle units) commands. Reference *Table 5.3.*
- Remember to send a saveall command to ensure all changes are saved to non-volatile memory.

Table 5.3—Set Commands

Field	Read/Edit	Example	Data Type	Description
SerialNum	Read	FT00123	STRING(8)	Calibrated F/T serial number
partNum	Read	Num-4	STRING(30)	Calibration part number
calFamily	Read	ENET	STRING(8)	Always reads “ENET”
CalTime	Read	1970-01-01 00:00	STRING(30)	Date and time sensor was calibrated
max0	Read	2147483647	32-bit unsigned integer	Maximum rated force value in counts for the that axis.
max1				
max2				
max3				Maximum rated torque value in counts for that axis.
max4				
max5				
forceUnits	Read	1	8-bit unsigned integer	Force units. 0=Lbf, 1=N, 2=Klbf, 3=kN, 4=Kg
torqueUnits		2		Torque units. 0=Lbf-in, 1=Lbf-ft, 2=Nm, 3=Nmm, 4=Kg-cm, 5=kN-m
cpf	Read	100000	32-bit unsigned integer	Calibration counts per force unit.
cpt		100000		Calibration counts per torque unit.
peakPos0	Read	2395927	32-bit unsigned integer	Peak Loads Positive. All-time peak positive force and torque loads in F/T counts
peakPos1		624576		
peakPos2		35521		
peakPos3		721632		
peakPos4		159210		
peakPos5		74910		
PeakNeg0	Read	-988570	32-bit unsigned integer	Peak Loads Negative. All-time peak negative force and torque loads in F/T counts
PeakNeg1		-2008525		
PeakNeg2		-9148784		
PeakNeg3		-46851		
PeakNeg4		-12383		
PeakNeg5		0		

Table 5.3—Set Commands				
Field	**Read/Edit**	**Example**	**Data Type**	**Description**
sensorHwVer	Read	0	16-bit unsigned integer	Active version of the sensor hardware
sensorInstr		1		Internal Manufacturing Data
paramWrites		4		Number of times the sensor wrote the parameters to NVM
adcRate	Read and Edit	1000 (default)	16-bit unsigned integer	ADC rate in Hz: 1000, 2000, 4000, 8000, 16000.
rdtRate		40		RDT transmission rate in Hz. This number can range from 1 to the ADC Rate.
rdtSize		40		Number of RDT records to include in each UDP packet. This number will range from 1 to 40.
rdtPort		49152 (default)		UDP listening port for RDT commands.
tcpPort		49151 (default)		UDP listening port for TCP commands.
telnetPort		23 (default)		UDP listening port for telnet connections
filTc		0 (default)		(IIR) filter code This setting changes the parameter that determines data filtering.
calib		1	8-bit unsigned integer	Three calibrations to use. Either 0, 1, or 2.
location		Bench	STRING(40)	Shows physical location.
serNum	Read	FT001234	STRING(100)	Physical sensor serial number
hwProdCode		Num-4	STRING(20)	Hardware product code
hwRev		04	16-bit unsigned integer	Hardware revision number
sipmode	Read and Edit	1	8-bit unsigned integer	0=DHCP 1=Static
sipadr	Read and Edit	192.168.137.155 (Default)	32-bit unsigned integer	Static IP address
sipmsk	Read and Edit	255.255.255.0 (Default)		Static IP subnet mask
sipgtw	Read and Edit	0.0.0.0 (Default)		Static IP gateway

Table 5.3—Set Commands				
Field	**Read/Edit**	**Example**	**Data Type**	**Description**
mac	Read	MCU Serial number. d8:80:39:7a:c4: 5e (default)	48-bit unsigned integer	MAC address
ttdu	Read and Edit	2	8-bit unsigned integer	Tool Transform distance units 0=in, 1=ft, 2=mm, 3=cm, 4=m
ttau		1		Tool Transform angle units. 0=degrees, 1=radians
ttdx	Read and edit	0 (default)	float	Tool Transform distances
ttdy		0 (default)		
ttdz		0 (default)		
ttrx		0 (default)		Tool Transform rotation angles
ttry		0 (default)		
ttrz		0 (default)		
baud	Read and edit	115200 (default)	32-bit unsigned integer	UART baud rate. Must be between 300 and 3M. All baud rates are temporary until saveall command is sent.
msg		1	8-bit unsigned integer	0=print only prompted messages 1=print all messages
serial	Read	0		0= Ethernet and serial 1=Serial-only mode.

Table 5.3—Set Commands				
Field	**Read/Edit**	**Example**	**Data Type**	**Description**
Vmid	Read and edit	0	8-bit unsigned integer	0= ADC_MID_VBR 1= SENS_MID_VBR
mcEnabled		1		1 = enabled, 0 = disabled. Global monitor conditions enabled or disabled.
mcOutMomen		1		0: Monitor Conditions Momentary. Valid output code will only be active while threshold is met. If conditions change and threshold is no longer met, output code will no longer be displayed. 1: Latching: Valid output code will be active after a threshold is met, even if conditions change and threshold was only met briefly.
mcOutDelay		20		Global monitor conditions momentary delay. How long monitor condition will remain latched after it trips. This value is displayed in tenths of a second.
mcAndCodes		1		0: Uses the AND bitwise. If all set thresholding conditions are met, monitor condition will trip. 1: Uses OR bitwise. If any set thresholding condition is met, monitor condition will trip.
yellow	Read	on	8-bit unit	Prints status of Yellow Mode: on or off
internalMass		0.5	float	For Yellow Mode users. Internal mass in kilograms.
Framex		0	16-bit unit	For Yellow Mode users Specific sensor frame data.
Framey		0		
Framez		0		
Framew		0		
Framep		0		
Framer		0		
ybaud	Read and edit	0		Prints Yellow Mode baud rate.
yserNum	Read		STRING(20)	Prints Yellow Mode serial number.

5.1.3 Counts Per Force/Torque to FT Values

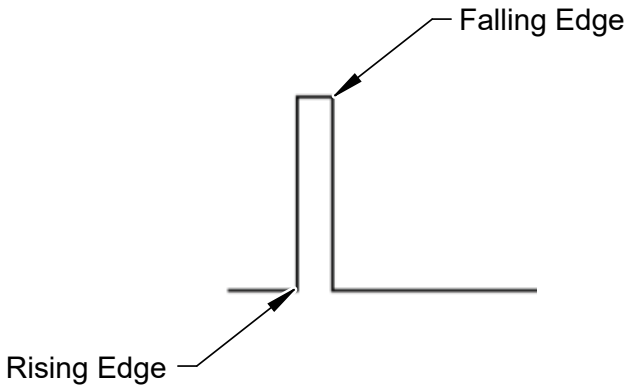
To obtain the real force and torque values, each force value must be divided by the counts per force (cpf) factor, and each torque value must divided by the counts per torque (cpt) factor. The cpf and cpt factors can be obtained using the secondary cal commands. Refer to *Section 5.2—Set Command.*. For example: if a calibration reports 1,000,000 counts per N and the Fz reports 4,500,000 counts, then the force applied in the Z axis is 4.5 N.

5.1.4 Clock Sync Functionality

Clock sync functionality activates when the user applies a rising edge of at least 5 V to the conductors. Upon activation of the sync function, the sensor outputs the most recently collected data point which is equivalent to the output from the "s" command (***Section 5.1.1—Query Commands: "s" or "c"***) sent over an RS422 cable interface. Data outspeeds can be matched up to 2 kHz.

An electrical pulse is shown in the following figure. The rising edge of the pulse starts at 5 V. The falling edge of the pulse is when the voltage is no longer within 5-30 V. 30 V is the maximum voltage that the cable allows. The sync functionality is no longer activated when the voltage is outside the 5-30 V range.

Figure 5.1—Electrical Pulse



5.1.5 Yellow Mode

For users who purchased a sensor for usage with FANUC force control, the sensor will be shipped in Yellow Mode. Refer to the *Fanuc-Ready manual* for detailed information on the sensor's serial functionality.

5.2 UDP Interface Using RDT

The NETrs F/T can output data at up to 8000 Hz over Ethernet using UDP. This method of fast data collection is called Raw Data Transfer (RDT). If the overhead of DeviceNet or EtherNet/IP is too much for an application, or if extra speed is required in data acquisition, RDT provides an easy method to obtain the forces, torques, and status codes of the NETrs F/T system.

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 *htons(), htonl(), ntohs(),* and *ntohl()* that can automatically handle these issues.

5.2.1 RDT Protocol

There are four commands in the RDT protocol, which are listed in *Table 5.4*. Any command received by the NETrs F/T takes precedence over any previously received commands.

Table 5.4—RDT Commands

Command	Command Name	Command Response
0x0000	Stop streaming	none
0x0002	Start high-speed real-time streaming	RDT record(s)
0x0003	Start high-speed buffered streaming	RDT record(s)
0x0042	Set Software Bias	none

1. High-speed real-time streaming (up to 7000 Hz) is best for real-time response applications.
2. High-speed buffered streaming (up to 7000 Hz in bursts) is best for collecting data at high speed, but not responding in real time.

To start the NETrs F/T outputting RDT messages, send an RDT request to it. The NETrs F/T listens for RDT requests on UDP port 49152. It also sends the RDT output messages from this port.

CAUTION: A dedicated Ethernet network should be used for the streaming of NETrs F/T data. NETrs F/T RDT streaming modes can send large amounts of data to the Ethernet connection which can disrupt other communications on the network. See *Section 16.1—Improving Ethernet Throughput*.

CAUTION: To reduce the possibility of network problems, especially when on a shared network, NETrs F/T RDT streaming modes should only be used at high output rate when absolutely necessary.

NOTICE: All NETrs F/T RDT streaming modes continue to stream until a Stop Streaming command (0x0000) is received. If the client that requested the data is removed from the network (disconnected, powered down, out of wireless range, etc.) before it sends a Stop Streaming command, the NETrs F/T will continue to stream data to the network even though there is no recipient.

All RDT requests use the following RDT request 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 the command from *Table 5.4*. Set sample_count to the number of samples to output. If the sample_count is set to zero, the Net Box continuously outputs until the user sends a RDT request with command set to zero.

RDT records sent in request to an RDT request have this structure: {

```
    Uint32 rdt_sequence; // RDT sequence number of this packet.
    Uint32 ft_sequence;  // The record's internal sequence 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 Net F/T 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.

If using buffered mode, then the number of RDT records received in a UDP packet is equal to the RDT buffer size displayed on the *Communications* web page. For a description of RDT Buffer Size, see *Section 4.7—Communication Settings Page (comm.htm)*.

5.2.2 Extended RDT Requests

The extended RDT request format is used when the NETrs F/T should send the UDP F/T data to a different IP address than the IP address from which the request comes. This is useful, for example, if the NETrs F/T stream data is sent to a multicast address so that multiple clients can receive the stream at once.

Extended RDT requests have the following structure:

```
{
uint16 hdr;              /* Always set to 0x1234 */
uint16 cmd;              /* The command code, with high bit set to '1'. */
uint32 count;            /* The number of samples to send in response. */
uint32 ipaddr_dest;      /* The ip address to send the response to. */
uint16 port_dest;        /* The port to send the response to. */
}
```

The command codes used in the Extended RDT format are the same as the command codes in normal RDT requests, except that the high bit is set to a '1'. For example, the command code 2, for high-speed streaming, is changed to 0x8002 for use with the Extended RDT request packet structure.

```
For example, to request high speed streaming to the multicast address
224.0.5.128, port 28250, send a UDP packet with the following data:
{ 0x12, 0x34, 0x80, 0x02, 0x00, 0x00, 0x00, 0x00, 224, 0, 5, 128, 0x6e, 0x5a };
```

Clients can then subscribe to the UDP multicast IP address 224.0.5.128, and receive the streaming data on port 28250. Users should consult their client system's documentation for information on how to subscribe to a multicast IP address.

5.2.3 Calculating F/T Values for RDT

To obtain the real force and torque values, each force output value has to be divided by the Counts per Force and each torque output value has to be divided by the Counts per Torque factor. The Counts per Force and Counts per Torque factors can be obtained from netftapi2.xml page.

5.2.4 Multiple Clients

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

5.2.5 Notes on UDP and RDT Mode

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

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 µs.

The NETrs F/T only supports one UDP connection at a time.

5.2.6 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*.

5.3 TCP Interface

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.

5.3.1 Command Codes

```
READFT              =       0,      /* Read F/T values. */
READCALINFO         =       1,      /* Read calibration info. */
WRITETRANSFORM      =       2,      /* Write tool transformation. */
WRITECondition      =       3,      /* Write monitor condition. */
```

5.3.2 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.

5.3.3 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.

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.

5.3.4 Read Calibration Info Command

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

5.3.5 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.

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

5.3.6 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

5.3.7 Write Monitor Condition Command

```
{
    uint8 command;              /* Must be WRITECondition. */
    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. */
}
```

5.3.8 Write Response

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

5.4 LED Activity

The sensor includes four LED units: Power, Serial, Ethernet, and Status. Each of these LEDs can be off, red, green, or both red and green, which may appear as orange.

At power up, each LED (Power, Serial, Ethernet, Status) go through the following test sequence once: off, flash red, flash green, flash orange (red and green together), off.

Table 5.5 outlines LED behavior during normal operation.

Table 5.5—NETrs Sensor LED Descriptions

LED	Label	LED State	Description
Serial Activity	SER	Solid Red	Not in use
		Green	LED will light green for five seconds following any serial activity
Power	PWR	Off	No power
		Solid Green	Powered on
Ethernet Activity	NET	Solid Red	Not in use
		Green	LED will light green for five seconds following any Ethernet activity
Status	STA	Solid Green	No errors
		Slow Blinking Red	Calibration checksum error
		Fast Blinking Red	Ethernet communication error
		Solid Orange (Red and Green)	Axis out of range error.
		Solid Red	Serious status error. Reference *Section 7.1—System Status Code*

5.5 Filtering

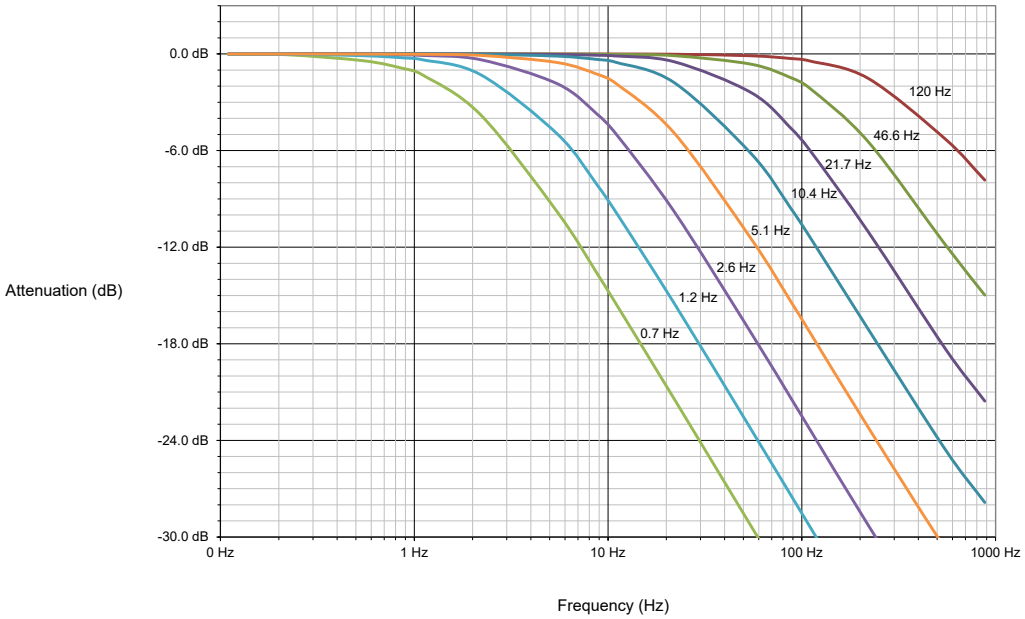
The cutoff frequency is dependent on the internal sample rate, which is 1000 Hz by default. The user can configure the sample rate by sending a set command (reference *Table 5.3)*. The relative cutoff frequencies for different values of this coefficient are:

Table 5.6—Filtering

Coefficient	Cutoff Frequency (Percent of Internal Sample Rate)	Frequency[1]
0	No filter	15.9 kHz
1	11.97%	120 Hz
2	4.66%	46.6 Hz
3	2.17%	21.7 Hz
4	1.04%	10.4 Hz
5	0.51%	5.1 Hz
6	0.26%	2.6 Hz
7	0.12%	1.2 Hz
8	0.07%	0.7 Hz

Note:
1. Values are displayed based on a 1 kHz sample rate, which is the default for the NETrs CBA F/T System.

Figure 5.2—Filter Attenuation at 1 kHz Sample Rate



6. Scheduled Maintenance

For most applications, there are no parts that need to be replaced during normal operation. With industrial-type applications that continuously or frequently move the system's cabling, periodically check the cable jacket for signs of wear.

The transducer must be kept free of excessive dust, debris, or moisture. Applications with metallic debris (i.e., electrically-conductive) must protect the transducer from this debris. Transducers without specific factory-installed protection are to be considered unprotected. The internal structure of the transducers can become clogged with particles and will become uncalibrated or even damaged.

7. Troubleshooting

This section includes answers to some issues that might arise when setting up and using the NETrs CBA F/T System. 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. Transducer model (e.g., Nano17, Gamma, Theta, etc.)
> 3. Calibration (e.g., US-15-50, SI-65-6, etc.)
> 4. Accurate and complete description of the question or problem
> 5. Computer and software information (operating system, PC type, drivers, application software, and other relevant information about the configuration).
>
> If possible, be near the F/T system when calling.

For assistance, please refer to one of the following contacts:

ATI Industrial Automation (a Novanta Company)
1031 Goodworth Drive
Apex, NC 27539 USA
www.ati-ia.com
Tel: +1 919-772-0115
Fax: +1 919-772-8259

Application Engineering
E-mail: *ft.support@novanta.com*

24/7 Support: +1 855 ATI-IA 00 (+1 855-284-4200)

7.1 System Status Code

The NETrs CBA F/T System performs many diagnostic checks during operation and reports results in a 32-bit system status code. Each F/T record includes this system status code. The bit patterns for all present error conditions are or'ed together to form the system status code. If any error condition is present then bit 31 of the system status code is set.

Bit 16 is set if a Condition is latched. This bit does not indicate a system error.

The system status code should be:

0x00000000 if no errors and no Condition statements are breached

0x80010000 if no errors and a Condition statement is breached.

Any other code signals means there is a serious error. Possible errors and their bit assignments are in *Table 8.1*.

7.2 Status Word

The Status Word is a bitmap which contains information about the errors that can occur in various subsystems of the NETrs F/T sensor.

Table 7.1—Status Word Bit Assignments

Bit	Bit Pattern	Description
0	0x00000001	Gage temperature is outside the expected range of -5 to 70 degrees C
1	0x00000002	Supply voltage is outside the expected range of 12V to 32 V
2	0x00000004	Broken Gage
3	0x00000008	Busy Bit
4	0x00000010	PCB Temperature out of range
5	0x00000020	Common error bit
6	0x00000040	MCU Temperature
7	0x00000080	Gage Overflowed
8	0x00000100	Safe Mode
9-15		Reserved
16	0x00010000	Monitor Condition 0 Output
17-25		Reserved
26	0x04000000	Gage Out of Range Warning
27	0x08000000	Gage Out of Range
28	0x10000000	Simulated Error
29	0x20000000	Calibration Checksum Error.
30	0x40000000	Force/Torque Out of Range
31	0x80000000	Any Error

7.3 Questions and Answers

Table 7.2—Communications	
Question/Problem	**Answer/Solution**
What IP address is assigned to the NETrs F/T?	User can also download ATI's Discover Tool, found on the ATI software webpage. This software will identify all IP addresses of ATI devices on your local network.
How can the NETrs F/T system be set to the default IP address of 192.168.1.1?	The sensor IP address can be configured on the FT Webpages. Refer to ***Section 4.1—ATI Force/Torque Webpages***. Additionally, if using serial communication, use the "cal sipadr" command to set a new IP address. Refer to ***Section 5.1—Console Commands via Serial***.
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* web page (refer to ***Section 4.1—ATI Force/Torque Webpages***). The DHCP server waits more than 30 seconds to respond.
Browser cannot find the NETrs F/T on Ethernet network even though the NETrs F/T configuration utility reports an IP address.	Clear the Windows computer's ARP table to remove memory of a previous device that used the same IP address as the NETrs F/T by restarting the computer or, with administrative privileges, by going to the computer's Start menu, selecting Run..., and typing "arp –d *".
Incorrect CAN Bus Base Address, DeviceNet MAC ID, and/or Baud Rate reported	Power must be present on the Pwr/CAN connector to correctly report these values.
System status reports DeviceNet Protocol Failure when using DeviceNet	DeviceNet is not available unless power is present on the Pwr/CAN connector.

Table 7.3—Java Demo	
Question/Problem	**Answer/Solution**
Demo displays zeros for force and torque values and 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 NETrs F/T 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 press Collect Streaming again.
The message Could not find the main class. Program will exit appears in a window titled Java Virtual Machine Launcher.	Computer requires a newer version of Java. Java may be downloaded from *www.java.com/getjava*.

Table 7.4—Web Pages	
Question/Problem	**Answer/Solution**
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.

Table 7.4—Web Pages	
Question/Problem	**Answer/Solution**
The HTTP 1.0 401 Error - Unauthorized page appears	An unsuccessful attempt to access a protected page of the web server. These pages are reserved for ATI Industrial Automation maintenance.

7.3.1 Errors with Force and Torque Readings

Invalid data from the transducer's strain gages can cause errors in force/torque readings. These errors can result in problems with condition monitoring, transducer biasing, and accuracy. Basic conditions of invalid data are listed in the following table. Use this following 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* web page. See ***Section 4.1—ATI Force/Torque Webpages***.

Table 7.5—Errors with Force and Torque Readings	
Question/Problem	**Answer/Solution**
Noise	Jumps in raw strain gage readings (with transducer unloaded) greater than 250 counts is considered abnormal. Noise can be caused by mechanical vibrations and electrical disturbances, possibly from a poor ground. It can also indicate component failure within the system. See *Section 7.4—Reducing Noise.*
Drift	After a load is removed or applied, the raw gage reading does not stabilize, but continues to increase or decrease. This may be observed more easily in resolved data mode using the bias command. Drift is caused by temperature change, mechanical coupling, or internal failure. Mechanical coupling is caused when a physical connection is made between the tool plate and the transducer body (i.e., filings between the tool adapter plate and the transducer body). Some mechanical coupling is common, such as hoses and wires attached to a tool.
Hysteresis	When the transducer 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.
Sensor is giving unexpected values.	Complete an accuracy check. Refer to ***Section 5.1—Console Commands via Serial*** If symptoms continue, contact ATI customer service at *ft.support@novanta.com.*

7.4 Reducing Noise

7.4.1 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 NETrs CBA F/T System offers digital low-pass filters that can dampen frequencies above a certain Condition. If this is not sufficient, add a digital filter to the application software.

7.4.2 Electrical Interference

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

Alternatively, use a benchtop supply with a DeviceNet cable, connecting the drain wire to functional earth at the power supply.

Another potential solution is to connect drain and supply (-) together at the supply with a short, solid connection.

7.5 Increase Operating System Performance

For optimal computer performance in response to the NETrs F/T's fast data rates, consider the following:

- **Disable software firewall.** One way to improve the Ethernet performance is not to have any software firewall activated. In some cases, IT personnel may need to assist.
- **Disable file and printer sharing**. The processes associated with 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. For the best UDP performance, try to turn off every network service except for TCP/IP.
- **Use an Ethernet traffic snooper.** An Ethernet traffic snooper can be invaluable in detecting unforeseen processes using-up Ethernet bandwidth and potentially slowing down the response of the computer's operating system. A traffic snooper is an advanced technique that a user's IT department may need to set-up. The free software program Wireshark (www.wireshark.org) is commonly used as a traffic snooper.
- **Use a dedicated computer.** A dedicated measurement computer that is isolated from the company network and not burdened by the company network processes.

7.6 Accuracy Check

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

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

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

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

3. Move the robot so that the sensor is in the following positions:
   a. Record the sensor's output, $F_{x,\text{ point n}}$ $F_{y,\text{ point n}}$ $F_{z,\text{ point n}}$, 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 $F_{x,\text{ average}}$, $F_{y,\text{ average}}$, and $F_{z,\text{ average}}$:
   a. Use the following equations, to complete the calculations:

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

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

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

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

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

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

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

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

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.

8. Specifications

For specifications specific to the transducer, reference the *Transducer Manual*.

8.1 Storage and Operating Conditions

Table 8.1—Temperature		
Component	**Storage Temperature, °C**	**Operating Temperature, °C**
NETrs CBA	-40 to +85	-20 to +70

8.2 Electrical Specifications

Table 8.2—Power Supply		
Power Source	**Voltage**	**Maximum Power Consumption**
DCIN through P1 or P3	12V min. to 30V max.	3.0 W
Notes: 1. The NETrs CBA power supply input is protected against wrong polarity.		

8.3 Weight

Table 8.3—Weight	
Component	**Weight (approx.)**
NETrs CBA	17g (0.6oz)

9. Drawings

Drawings are available on the *ATI website* or by contacting an ATI representative.

10. 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 year from the date of shipment. This warranty does not cover components subject to wear and tear under normal usage or those requiring periodic replacement. 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 TI has been advised of the possibility of such damages. ATI's aggregate liability will in no event exceed the amount paid by the purchaser for the item which is the subject of claim or dispute. ATI will have no liability of any kind for failure of any equipment or other items not supplied by ATI.

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

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

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

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