

Net F/T

Network Force/Torque Sensor System

Manual



Document #: 9620-05-NET FT

Foreword

Information contained in this document is the property of ATI Industrial Automation, Inc. and shall not be reproduced in whole or in part without prior written approval of ATI Industrial Automation, Inc. The information herein is subject to change without notice and should not be construed as a commitment on the part of ATI Industrial Automation, Inc. This manual is periodically revised to reflect and incorporate changes made to the F/T system.

ATI Industrial Automation, Inc. assumes no responsibility for any errors or omissions in this document. Users' critical evaluation is welcome to assist in the preparation of future.

Copyright © (2023) by ATI Industrial Automation, Inc., Apex, North Carolina USA. All Rights Reserved. Published in the USA.

In consideration that ATI Industrial Automation, Inc (ATI) products are intended for use with robotic and/or automated machines, ATI does not recommend the use of its products for applications wherein failure or malfunction of a ATI component or system threatens life or makes injury probable. Anyone who uses or incorporates ATI components within any potentially life threatening system must obtain ATI's prior consent based upon assurance to ATI that a malfunction of ATI's component does not pose direct or indirect threat of injury or death, and (even if such consent is given) shall indemnify ATI from any claim, loss, liability, and related expenses arising from any injury or death resulting from use of ATI components.

All trademarks belong to their respective owners. Oracle and Java are registered trademarks of Oracle and/or its affiliates. Windows and Excel are registered trademarks of Microsoft Corporation.

Note

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

- 1. Serial number (e.g., FT01234)
- Transducer model (e.g., Nano17, Gamma, Theta, etc.) 2.
- Calibration (e.g., US-15-50, SI-65-6, etc.) 3.
- Accurate and complete Description of the question or problem 4.
- 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 additional information or assistance, please refer to one of the following contacts:

Sale, Service and Information about ATI products:

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)

Table of Contents

Fo	rewor	'd	B-2	
Glo	ossary	у	B-9	
1.	Safe	ety	B-11	
	1.1	Explanation of Notifications	B-11	
	1.2	General Safety Guidelines	B-11	
	1.3	Safety Precautions	B-11	
2.	Syst	tem Overview	B-12	
	2.1	Multiple Calibrations	B-12	
	2.2	Multiple Configurations	B-12	
	2.3	2.3 Force and Torque Values		
	2.4	System Status Code	B-12	
	2.5	Monitor Conditions	B-12	
	2.6	Tool Transformations	B-12	
	2.7	Multiple Interfaces	B-12	
	2.8	Power Supply	B-12	
3.	Gett	ting Started	B-13	
	3.1	Unpacking	B-13	
	3.2	System Components Description	B-13	
		3.2.1 F/T Transducer	B-14	
		3.2.2 Transducer Cable	B-15	
		3.2.3 Net Box	B-15	
	3.3	Connecting the System Components	B-16	
		3.3.1 Connecting the Transducer to the Net Box	B-16	
		3.3.2 Providing Power to the Net F/T	B-16	
		3.3.2.1 Method 1: Providing Power with PoE	B-16	
		3.3.3 Connecting to Ethernet	B-18	
		3.3.3.1 Option 1: Connect to an Ethernet Network	B-19	
		ID A delega Configuration for Ethomat	В-19 В 00	
	3.4	IP Address Configuration for Ethernet	B-20	
	3.5	Connecting to Ethernet using a windows Computer	B-21	
	3.6	Connecting to an Ethernet-based Fieldbus	B-25	
	3.7	Connecting to DeviceNet (using DeviceNet-Compatibility Mode)	B-25	
	3.8	Connecting the Net Box to a CAN Bus Network	B-25	
	3.9	DIP Switches and Termination Resistor	B-25	
		3.9.1 Termination Resistor	B-26	
		3.9.2 Node Address	B-26	

		3.9.3 Baud Rate	B-29
	3.10	Baud Rate	B-29
	3.11	Power-Up Cycle	B-30
4.	Web	Pages	B-32
	4.1	Welcome Web Page (index.htm)	B-32
	4.2	Snapshot Web Page (rundata.htm)	B-33
	4.3	Demo Web Page (demo.htm)	B-35
	4.4	Settings Web Page (setting.htm)	B-36
	4.5	Monitor Conditions Web Page (moncon.htm)	B-37
		4.5.1 Condition Relay	B-40
		4.5.1.1 Standard Net Box Condition Relay	B-40
	4.6	Configurations Web Page (config.htm)	B-44
	4.7	Communication Settings Page (comm.htm)	B-48
		4.7.1 TCP Modbus Register Map	B-52
	4.8	System Information Web Page (manuf.htm)	B-53
	4.9	Examples Web Page (output.htm)	B-54
	4.10	ATI Web Site Menu Item	B-57
5.	Java	Demo Application	B-58
	5.1	Starting the Demo	B-58
	5.2	Data Display with the Demo	B-59
	5.3	Collecting Data with the Demo	B-60
	5.4	The Errors Display of the Demo	B-62
	5.5	Developing a Custom Java Application	B-63
6 .	Net F	F/T Configuration UtilityI	B-64
	6.1	Finding Net F/Ts on the Network	B-64
	6.2	Backing Up a Configuration to a Computer	B-66
	6.3	Restoring a Saved Configuration	B-66
	6.4	Inspecting a Saved Configuration File	B-67
7.	Com	mon Gateway Interface (CGI)I	B-68
	7.1	Settings CGI (setting.cgi)	B-69
	7.2	Monitor Conditions CGI (moncon.cgi)	B-70
	7.3	Configurations CGI (config.cgi)	B-70
	7.4	Communications CGI (comm.cgi)	B-73
8.	Syste	em Settings XML PagesI	B-74
	8.1	System and Configuration Information (netftapi2.xml)	B-74
	8.2	Calibration Information (netftcalapi.xml)	B-77

9.	UDP	Interface Using RDT	B-78
	9.1	RDT Protocol	<mark>B-7</mark> 8
	9.2	Extended RDT Requests	<mark>B-80</mark>
	9.3	Calculating F/T Values for RDT	<mark>B-80</mark>
	9.4	Multiple Clients	<mark>B-80</mark>
	9.5	Notes on UDP and RDT Mode	<mark>B-8</mark> 1
	9.6	Example Code	<mark>B-8</mark> 1
10.	тср	Interface	B-81
	10.1	General	B-8 1
	10.2	Command Codes	B- 81
	10.3	Read F/T Command	B- 81
	10.4	Read F/T Response	<mark>B-8</mark> 2
	10.5	Read Calibration Info Command	B-8 2
	10.6	Read Calibration Info Response	B-83
	10.7	Write Tool Transform Command	B-83
	10.8	Write Monitor Condition Command	B- 84
	10.9	Write Response	B-8 4
11.	Ethe	rNet/IP Operation	B-85
	11.1	Overview	B-85
	11.2	Module and Network Status LED	B-85
12.	Devi	ceNet-Compatibility Mode Operation	B-86
	12.1	Overview	B-8 6
	12.2	MAC ID	B-8 6
	12.3	Baud Rate	B-8 6
	12.4	Module and Network Status LED	B-8 6
	12.5	EDS File	B-8 6
13.	Ethe	rNet/IP and DeviceNet CIP Model	B-87
	13.1	Overview	B- 87
	13.2	Calculating F/T Values for CIP	B- 89
		13.2.1 EtherNet/IP	B-89
		13.2.2 DeviceNet	B-89
	13.3	Object Model	B-90
		13.3.1 Data Types	B-90
		13.3.2 EtherNet/IP	B-90
		13.3.3 Transducer Force/Torque Object (0x65—6 Instances)	B-91

		13.3.4	Transducer Force/Torque Object (0x65—6 Instances)	B-91
		13.3.5	System Status Object (0x67—1 Instance)	B-92
		13.3.6	Configurations Object (0x71—16 Instances)	B-92
		13.3.7	Transducer Force/Torque Object (0x65—6 Instances)	B-93
		13.3.8	Monitor Conditions Settings Object (0x73-32 Instances)	B-94
14.	CAN	Bus O	peration	B-95
	14.1	Overvi	ew	B-95
	14.2	Protoc	ol Description	B-95
	14.3	Base A	Address and Communication Format	B-95
	14.4	Baud F	Rate	B-96
	14.5	Calcula	ating F/T Values for CAN	B-96
15.	Field	lbus Op	peration	B-97
	15.1	PROFI	NET Fieldbus Interface	B-97
		15.1.1	Enabling the PROFINET Interface	B-98
		15.1.2	Communications CGI (comm.cgi) Options	B-100
		15.1.3	XML Page Elements	B-100
		15.1.4	Returning Default Settings	B-100
		15.1.5	Replacing and Installed PROFINET Fieldbus Net Box	B-101
			15.1.5.1 Replacing and Installing a PROFINET Fieldbus Net Box	B-101
			15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box	B-101
16.	Adva	anced T	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box	B-101 B-102
16.	Adva 16.1	anced T Improv	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Topics ving Ethernet Throughput	B-101 B-102 B-102
16.	Adva 16.1	anced T Improv 16.1.1	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host	B-101 B-102 B-102 B-102
16.	Adva 16.1	anced T Improv 16.1.1 16.1.2	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application	B-101 B-102 B-102 B-102 B-102
16.	Adva 16.1	anced T Improv 16.1.1 16.1.2 16.1.3	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ring Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance	B-101 B-102 B-102 B-102 B-102 B-102
16.	Adva 16.1	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network	B-101 B-102 B-102 B-102 B-102 B-102 B-102
16.	Adva 16.1	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-102
16.	Adva 16.1 16.2	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ring Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T ing Noise	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-102 B-102 B-103
16.	Adva 16.1 16.2	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T ing Noise Mechanical Vibration	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103
16.	Adva 16.1 16.2	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T ing Noise Mechanical Vibration Electrical Interference	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103
16.	Adva 16.1 16.2 16.3	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduct 16.2.1 16.2.2 Detect	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ring Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T. ing Noise Mechanical Vibration Electrical Interference. ing Failures (Diagnostics)	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103
16.	Adva 16.1 16.2 16.3	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103
16.	Adva 16.1 16.2 16.3 16.4	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1 Sched	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Topics ving Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T. ing Noise Mechanical Vibration Electrical Interference. ing Failures (Diagnostics) Detecting Sensitivity Changes. uled Maintenance	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103 B-103 B-103 B-103
16.	Adva 16.1 16.2 16.3 16.4	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1 Schedu 16.4.1	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ring Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T ing Noise Mechanical Vibration Electrical Interference. ing Failures (Diagnostics) Detecting Sensitivity Changes. uled Maintenance Periodic Inspection	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103 B-103
16.	Adva 16.1 16.2 16.3 16.4 16.5	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1 Schedu 16.4.1 A Word	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics ring Ethernet Throughput Establish a Direct Connection between Net F/T and Host Choose the Best Operating System for the Application Increase Operating System Performance Avoid Connecting the Net F/T to the Organization's Network Use a Dedicated Ethernet Network for the Net F/T ing Noise Mechanical Vibration Electrical Interference ing Failures (Diagnostics) Detecting Sensitivity Changes uled Maintenance Periodic Inspection d about Resolution	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103 B-103 B-103 B-103 B-104
16.	Adva 16.1 16.2 16.3 16.4 16.5 16.6	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1 Sched 16.4.1 A Word	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103 B-103 B-104 B-104
16.	Adva 16.1 16.2 16.3 16.4 16.5 16.6	anced T Improv 16.1.1 16.1.2 16.1.3 16.1.4 16.1.5 Reduc 16.2.1 16.2.2 Detect 16.3.1 Schedu 16.4.1 A Word Conne 16.6.1	15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box Fopics	B-101 B-102 B-102 B-102 B-102 B-102 B-102 B-103 B-103 B-103 B-103 B-103 B-103 B-104 B-104 B-105

		16.6.3 Fanuc Robotics	B-105
		16.6.4 Kuka Robotics	B-106
		16.6.5 Motoman Robotics	B-106
17.	Trou	Ibleshooting	B-107
	17.1	System Status Code	B-107
	17.2	Status Word	B-109
	17.3	Questions and Answers	B-110
		17.3.1 Errors with Force and Torque Readings	B-111
18.	Gene	eral Specifications	B-112
	18.1	Environmental	B-112
		18.1.1 Storage and Operating Temperatures	B-112
	18.2	Transducer Data Filtering	B-113
	18.3	Electrical Specifications (Power Supply)	B-114
		18.3.1 Communications	B-114
		18.3.1.1 Ethernet Interface	B-114
		18.3.1.2 CAN Interface	B-115
		18.3.2 Mating Connectors	B-115
		18.3.3 Standard Condition Relay	B-115
		18.3.4 Solid-State Condition Relay	B-115
		18.3.5 NetBox Transducer Cabling	B-116
	18.4	Net Box Weight	B-116

Glossary

Term	Definitions
Accuracy	See Measurement Uncertainty.
Active Configuration	The configuration the system is currently using.
Calibration	The factory-supplied data used by Net F/T so it can report accurate transducer readings. Calibrations apply to a given loading range.
CAN	Controller Area Network (CAN) is a low level communication protocol used in some networks, including DeviceNet. The Net F/T system has a simple CAN protocol that can be used to read force and torque values.
CGI	Common Gateway Interface (CGI) is the method of using web URLs to communicate data and parameters back to a web device.
Compound 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, which calibration is to be used, and any tool transformation data.
Coordinate Frame	See Point of Origin.
DeviceNet™	A Fieldbus communication network used mostly by devices in industrial settings, that communicates using CAN. DeviceNet is a trademark of ODVA.
DeviceNet Compatibility Mode	A feature of the Net F/T that allows it to respond like a certified DeviceNet device.
DHCP	Dynamic Host Configuration Protocol (DHCP) is an automatic method for Ethernet equipment to obtain an IP address. The Net F/T system can obtain its IP address using DHCP on networks that support this protocol.
EtherNet/IP™	EtherNet/IP (Ethernet Industrial Protocol) is a Fieldbus communication network, used mostly by devices in industrial settings, that communicates using Ethernet. EtherNet/IP is a trademark of ControlNet International Ltd. used under license by ODVA.
Ethernet Network Switch	Ethernet network switches are electronic devices that connect multiple Ethernet cables to an Ethernet network while directing the flow of traffic.
Fieldbus	A generic term referring to any one of a number of industrial computer networking standards. Examples include: CAN, Modbus, and PROFINET.
FS	Full-Scale.
F/T	Force and Torque.
Fxy	The resultant force vector comprised of components Fx and Fy.
Hysteresis	A source of measurement caused by the residual effects of previously applied loads.
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.
IPV4	IPV4 (Internet Protocol Version 4) describes IP addresses using four bytes, usually expressed in the dot-decimal notation, such as, 192.168.1.1 for example.
Java™	Java is a programming language often used for programs on web pages. The Net F/T demo is a Java application. Java is a registered trademark of Sun Microsystems, Inc.
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.
MAC ID	Media Access Code Identifier (MAC ID) is a unique number that is user assigned to each DeviceNet device on a DeviceNet network. Also called Node Address.
Maximum Single-Axis Overload	The largest amount of pure load (not compound loading) that the transducer can withstand without damage.
МАР	The Mounting Adapter Plate (MAP) is the transducer plate that attaches to the fixed surface or robot arm.
Measurement Uncertainty	The maximum expected error in measurements, as specified on the calibration certificate.

Term	Definitions
Net Box	The component that contains the power supply and network interfaces of the Net F/T system.
Node Address	See MAC ID.
ODVA™	ODVA (Open DeviceNet Vendors Association, Inc.) is an organization that defines DeviceNet, EtherNet/IP, and other industrial networks. ATI Industrial Automation is a member of ODVA. ODVA is a registered trademark of Open DeviceNet Vendors Association, Inc.
Overload	The condition where more load is applied to the transducer than it can measure. This will result in saturation.
P/N	Part Number
PoE	Power-over-Ethernet, or PoE, is a method of delivering electrical power to a PoE-compatible Ethernet device through the Ethernet cable. This simplifies installation of the Ethernet device since a separate power supply is not needed. The Net F/T system is PoE compatible.
Point of Origin	The location on the transducer from which all forces and torques are measured. Also known as the Coordinate Frame.
PROFINET	An Ethernet-based fieldbus used in factory automation.
Quantization	The process of converting a continuously variable transducer signal into discrete digital values. Usually used when describing the change from one digital value to the next increment.
RDT	Raw Data Transfer (RDT) is a fast and simple Net F/T protocol for control and data transfer via UDP.
Resolution	The smallest change in load that can be measured. This is usually much smaller than accuracy.
Saturation	The condition where the transducer has a load outside of its sensing range.
Sensor System	The assembly consisting of all components from the transducer to the Net Box.
ТАР	Tool Adapter Plate (TAP) is the transducer surface that attaches to the load to be measured.
ТСР	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.
Monitor Conditions	A Net F/T function that performs a simple arithmetic comparison of a user-defined Condition to the loading on a transducer axis.
Tool Transformation	A method of mathematically shifting the measurement coordinate system to translate the point of origin and/or rotate its axes.
Transducer	Transducer is the component that converts the sensed load into electrical signals.
Тху	The resultant torque vector comprised of components Tx and Ty.
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.

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. For assistance, refer to F/T Transducer Manual (*9620-05-Transducer Section*—Installation and Operation Manual) or contact ATI Industrial Automation. 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 decelerations.

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. For specific transducer overload values, refer to the F/T Transducer manual (*9620-05-Transducer Section*).

2. System Overview

The Network Force/Torque (Net F/T) sensor system is a multi-axis force and torque sensor system that simultaneously measures forces Fx, Fy, and Fz and torques Tx, Ty, and Tz. The Net F/T system communicates via EtherNet/IP, CAN Bus, Ethernet, and is compatible with DeviceNet. Optional fieldbus interfaces are also available. Use the Net F/T's web pages to ease installation and monitor the sensor system (refer to *Section 4—Web Pages*).

The Net F/T system supports the following features:

2.1 Multiple Calibrations

The Net F/T can hold up to sixteen different transducer calibrations, and each can have a different sensing range. The different calibrations are created with different load scenarios during the calibration process at the factory and stored in the Net F/T.

Multiple calibrations allow for a larger calibration for coarse adjustments and smaller calibrations for fine adjustments, or to use the same transducer in two or more very different loading regimes. Contact ATI Industrial Automation for information on obtaining additional transducer calibrations.

To use a particular calibration, select that calibration in the active configuration.

2.2 Multiple Configurations

The Net F/T also holds up to sixteen different user configurations. Each configuration is linked to a user-selected calibration and may have its own tool transformation. Configurations are useful when the Net F/T is used in a variety of tasks. The currently active configuration is user selected on the Net F/T's *Settings* web page (*Section 4.4—Settings Web Page (setting.htm*)).

2.3 Force and Torque Values

The Net F/T outputs scaled numbers, or counts, that represent the loading of each force and torque axis. The number of counts per force unit and counts per torque unit is specified by the calibration. To use different force and torque units (i.e., a transducer is calibrated to use pounds and pound-inches, but the user prefers Newtons and Newton-meters), change the output units on the Net F/T *Configurations* web page (*Section 4.6—Configurations Web Page (config.htm*)).

2.4 System Status Code

Each Net F/T output data record contains a system status code which indicates the health of the transducer and the Net Box. For details, refer to *Section 17.1—System Status Code*.

2.5 Monitor Conditions

The Net F/T is capable of monitoring the force and torque levels of each axis and setting an output code if a reading crosses a user defined-Condition. The Net F/T can hold up to sixteen Conditions, and each Condition can be enabled and disabled individually or as a group. Set-up Monitor Conditions on the Net F/T's *Monitor Conditions* web page (*Section 4.5—Monitor Conditions Web Page (moncon.htm*)).

2.6 Tool Transformations

The Net F/T is capable of measuring the forces and torques acting at a point other than the factory-defined point-of-origin (also known as the sensing reference frame origin). This change of reference is called a tool transformation. Specify tool transformations for each configuration on the Net F/T's *Configurations* web page (*Section 4.6—Configurations Web Page (config.htm*)).

2.7 Multiple Interfaces

The Net F/T system communicates via EtherNet/IP, CAN bus, Ethernet, and is compatible with DeviceNet. Each of these interfaces can be enabled and disabled on the Net F/T's *Communications* web page(*Section 4.7—Communication Settings Page (comm.htm*)).

2.8 Power Supply

The Net F/T system accepts power through PoE (Power-over-Ethernet) or from a DC power source with an output voltage between 11V and 25V.

3. Getting Started

This section gives instructions for setting up the Net F/T system.

3.1 Unpacking

- Verify that no damage occurred during shipping. Any damage should be reported to ATI Industrial Automation.
- Check the packing list for omissions.
- Standard components of a Net F/T system are:
 - Net F/T Transducer
 - Transducer cable (which may be integral to the transducer)
 - Net Box
 - ATI Industrial Automation software, calibration documents, and manuals (including this manual). This information is on the ATI website (*https://www.ati-ia.com/Products/ft/sensors. aspx*) or sent as an e-mail upon purchase of the system.
- Optional components:
 - Power supply that plugs into a 100–240 VAC (50–60 Hz) power outlet and provides power to the Net Box through the power (Pwr)/CAN connector
 - Ethernet switch supporting Power-over-Ethernet: provides network connection and supplies power over the Ethernet connector
 - RJ45 to M12 Ethernet cable adapter
 - Mini to Micro (M12) DeviceNet adapter (for the Pwr/CAN connector)
 - DeviceNet cabling (for the Pwr/CAN connector)
 - Ethernet cabling
 - Robot-grade transducer cables of different lengths

3.2 System Components Description

The Net F/T sensor system is a multi-axis force and torque sensor system that simultaneously measures forces Fx, Fy, Fz, and torques Tx, Ty, and Tz. The Net Box also responds to DeviceNet commands sent over the CAN Bus connection.

The main components of the Net F/T system are displayed in *Figure 3.1*.

The **Net F/T Transducer** converts the force and torque loads into electrical signals and transmits them over the transducer cable. With the exception of very tiny transducers, like the Nano and Mini series, the signals are digital. Since the Nano and Mini series transducers are too small for on-board electronics, they transmit analog signals.

The **Transducer Cable** is detachable and replaceable on transducers that use digital transmission. On other transducers, like the tiny Nano and Mini series, the transducer cable is an integral part of transducer and cannot be detached.

The **Net Box** is an IP65-rated aluminum housing that contains the power supplies and network interfaces. A digital-input version of the Net Box (NETB) is used with digital transducers while an analog-input version of the Net Box (NETBA) is used with analog transducers. For customer drawings, refer to the ATI F/T webpage: *https://www.ati-ia.com/products/ft/ft_literature.aspx*.



Figure 3.1—Net F/T System Components

3.2.1 F/T Transducer

The transducer is a compact, rugged, monolithic structure that senses forces and torques.

The F/T transducer is commonly used as a wrist transducer mounted between a robot and a robot end-effector. A sample transducer is shown in *Figure 3.2*.

For further information, refer to F/T Transducer Manual (9620-05-Transducer Section).

Figure 3.2—Sample Transducer (Omega160)



NOTICE: The transducer is designed to withstand extremely high overloading because of its construction using strong materials and quality silicon strain gages.

3.2.2 Transducer Cable

The transducer cable delivers power from the Net Box to the transducer and transmits the transducer's strain gage data back to the Net Box.

Transducers with on-board electronics (ATI Industrial Automation Part Number prefix 9105-NET) are connected to the Net Box (ATI Industrial Automation Part Number prefix 9105-NETB) via industry standard M12 Micro DeviceNet cabling. Any DeviceNet-compatible cable with correct gender M12 Micro connectors can be used, but non-IP rated transducers are not compatible with right-angled connectors. ATI Industrial Automation supplies a robotic grade high-flex transducer cable with each Net F/T system. Many other DeviceNet cable choices are available to address different requirements. In case of special requirements, contact ATI Industrial Automation or an industrial cable manufacturer (see www.turck.com, www.woodhead.com, and others) for available products.



WARNING: Transducers are not compatible with DeviceNet. Do not attempt to directly connect a transducer to a DeviceNet network. Transducers must be connected to a Net Box.

ATI's 9105-C-MTS-MS cables can connect to each other to make a multi-section cable.

NOTICE: If a transducer is accidentally connected to a DeviceNet network, neither the transducer nor the network will be physically harmed. Communication errors may occur on the DeviceNet network while the transducer is connected.

Transducers that do not have on-board electronics (ATI Industrial Automation Part Number prefix 9105-TW) usually have integrated cabling. Those transducers that require cabling must use an ATI Industrial Automation cable specifically made for these transducers. Transducers without the on-board electronics connect to Net Box version 9105-NETBA.

The transducer can be used in a variety of applications that affect how best to route the cable and the proper cable bending radius. Some applications allow the transducer and the cable to remain in a static condition, and other applications require the transducer to be in a dynamic condition that subjects the cable to repetitive motion. Do not let the transducer cable connectors move as a result of this repetitive motion; properly restrain the cable close the transducer connection. For proper cable routing and bending radius instructions, refer to the 9620-05 Transducer manual.



CAUTION: Do not subject the transducer cable connector to the repetitive motion of the robot or other device. Subjecting the connector to the repetitive motion will cause damage to the connector. Restrain the cable close to the connector to keep the repetitive motion of the robot from affecting the cable connector.

3.2.3 Net Box

The primary function of the Net Box is to process and communicate the transducer's force and torque readings to the user's equipment. Communication can be done through Ethernet, EtherNet/ IP, and CAN Bus. The Net Box also responds to DeviceNet commands sent over the CAN Bus connection.

The Net Box should be mounted in an area that it is not exposed to temperatures outside of its working range (see Section 18.1-Environmental). It is designed to be used indoors in a non-dynamic, non-vibratory environment and may be mounted in any orientation. It is designed to meet IP65 ingress protection.

The Net Box should be grounded through at least one of the four mounting tabs.

The Net Box receives power through either a standard Power-over-Ethernet (PoE) switch or the Pwr/CAN connector.

For customer drawings, refer to the ATI F/T webpage: https://www.ati-ia.com/products/ft/ft_ literature.aspx.

3.3 Connecting the System Components

3.3.1 Connecting the Transducer to the Net Box

The Net F/T system normally ships with an off-the-shelf standard M12 DeviceNet cable to connect the transducer to the Net Box.

Plug the female M12 connector of this cable into the male M12 socket of the transducer. Then tighten its sleeve clockwise to lock the connector. For recommended connector torque values, refer to *Section 18.3.2—Mating Connectors*.

Figure 3.3—Connecting Transducer Cable to Transducer and Net Box



Plug the male M12 connector into the female M12 socket marked Transducer. Then turn its sleeve in a clockwise direction until tightened to lock it to the socket. See *Section 18.3.2—Mating Connectors* for recommended connector torque levels.

To avoid disturbed transducer signals, especially in a noisy environment and when using long transducer cables, it is highly recommended to provide a low impedance ground connection for the transducer body.

3.3.2 Providing Power to the Net F/T

Two methods provide power to a standard Net F/T. Net F/Ts with an optional fieldbus interface do not support PoE and must use an external power source (Method 2).

3.3.2.1 Method 1: Providing Power with PoE

NOTICE: PoE is not supported by Net F/Ts that have an optional fieldbus.

The Net F/T's PoE input is compatible with IEEE 802.3af PoE specification and uses Mode A to receive power. Mode B requires eight Ethernet conductors and is not supported.

The Net F/T system optionally ships with a PoE Ethernet switch. ATI Industrial Automation P/N 9105-POESWITCH-1 (see *Figure 3.4*) which provides PoE on four ports with RJ45 receptacles. Any PoE enabled device can get its power supply and communication signals from one of these ports. Any non-PoE device connected to these ports will receive an Ethernet connection without the power delivery. The Net F/T system accepts PoE, and thus only needs one cable connection to function on an Ethernet network.

- Connect the PoE switch to its external AC power supply.
- Connect the AC power supply to the AC mains. The PWR LED should turn on and glow green.
- Connect the PoE switch to an Ethernet network and connect the Net Box via RJ45 cable to one of the PoE ports. See *Section 3.3.3—Connecting to Ethernet* for information on making an Ethernet connection.



Figure 3.4—Connecting to the Ethernet

Once the Net Box is connected to the PoE switch, it should start up, first with red and green blinking LEDs. After approximately 20 seconds, all LEDs should be green.

NOTICE: If power is not provided to the Pwr/CAN connection then CAN bus baud rate, CAN bus base address, and DeviceNet MAC IDs are not correctly reported and communications over the Pwr/CAN connector are not available.

3.3.2.2 Method 2: Providing Power to Pwr/CAN Input

Instead of supplying power with the PoE option, use the 11 V to 25 V DC power input of the M12 Pwr/CAN connector. For recommended connector torque values, refer to *Section 18.3.2—Mating Connectors*.

Figure 3.5—Pwr/CAN Micro Connector (view from male pin side)



The Net F/T may ship with an optional power adapter (ATI P/N 9105-NETPS) that directly connects to the Pwr/CAN connector and delivers sufficient power for the Net F/T system.

Instead of using this power adapter, connect to a user-supplied DC power source as long as there is sufficient voltage and current (see *Section 18.3.2—Mating Connectors* for details) to the V+, V- inputs of the Pwr/CAN connector. ATI Industrial Automation offers an optional M12 female connector with screw terminals (ATI P/N 1510-2312000-05) for field wiring to connect to a power source. Note that although the connector provides access to CAN_H, CAN_L, and Drain connections, if they are not being used for CAN communications, leave these pins unconnected.

Figure 3.6—DC Power Source Connection (Using Pwr/CAN Connector)



3.3.3 Connecting to Ethernet

This section describes how to physically connect to Ethernet. For information on configuring Net F/T's Ethernet settings, refer to *Section 3.4—IP Address Configuration for Ethernet*, and for information on configuring a Windows XP or Windows Vista computer, refer to *Section 3.5—Connecting to Ethernet using a Windows Computer*.

An industrial M12-4 Type-D Connector is provided for Ethernet connection. For recommended connector torque values, refer to *Section 18.3.2—Mating Connectors*. The Net F/T system optionally ships with an off-the-shelf M12 Industrial Ethernet cable and/or an M12 to RJ45 adapter. The adapter allows the use of standard office-grade Ethernet cables with RJ45 connectors.

Figure 3.7—Ethernet M12-4, Type-D Connector (view from female pin side)



The Net Box can connect to Ethernet.

NOTICE: To achieve the best Ethernet performance (and to reduce the likelihood of loosing data), connect the Net Box directly to the host computer, as described in Option 2.

3.3.3.1 Option 1: Connect to an Ethernet Network

Use the M12 to RJ45 adapter to connect a standard RJ45 Ethernet cable to the Net Box. Be certain to tighten the sleeve fully clockwise to lock the connector.

Plug the other end of the Ethernet cable into the port of an Ethernet switch. For a proposed setup, refer to *Figure 3.8*.



Figure 3.8—Connecting to Ethernet

3.3.3.2 Option 2: Connect directly to a Computer's Ethernet Interface

The Net F/T system is connected directly to a computer's Ethernet port via a cable and is not connected to an Ethernet switch. Use the M12 to RJ45 adapter to connect a standard RJ45 Ethernet cable to the Net box. The most basic configuration would be a point-to-point connection between a computer's Ethernet interface and the Net F/T's Ethernet interface (see *Figure 3.9*). In this case, power has to be provided via the Pwr/ CAN connector (see *Section 3.3.2.2—Method 2: Providing Power to Pwr/CAN Input* for details). This configuration has the lowest latency and lowest chance of lost data packages and provides the best high-speed connection.

If necessary, the computer may be connected to an Ethernet network via a second Ethernet port on the computer. Note that most computers do not have a second Ethernet port and one may need to be installed. Doing so is outside the scope of this document. Users should contact their IT department for assistance.



3.4 IP Address Configuration for Ethernet

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

Method 1:	Set IP address 192.168.1.1 by setting DIP switch 9 to the ON position.
Method 2:	Set IP address to a static value stored on the Net F/T's <i>Communication Settings</i> web page (DIP switch 9 must be in the OFF position). This method is described in <i>Section 3.5—Connecting to Ethernet using a Windows Computer.</i>
Method 3:	Let a DHCP server take care of the IP address assignment (DIP switch 9 must be in the OFF position). This option can be enabled in the Net F/T's web pages (see <i>Section 3.5—Connecting to Ethernet using a Windows Computer</i> for details). To use this method, a DHCP server must be present in the network. This is usually the case in company networks.

The Net 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.

3.5 Connecting to Ethernet using a Windows Computer

Most of the Ethernet configuration is completed through the ATI Net F/T's web pages. To initially access the web pages, set-up the Net 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 Net 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 Net 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:
 - a. From the Start menu, select Control Panel.
 - b. Click on the Network and Internet icon.
 - c. Click on the Network and Sharing Center icon.
 - d. Click on the Change adapter settings link on the left side of the window.
 - A new window opens that displays the available network adapters.
 - e. Right click the network adapter to which the sensor is connected.
 - f. From the dropdown menu, select **Properties**.

Figure 3.10—Windows 10 Networking Information



- g. In the Ethernet Properties' Networking tab, select **Internet Protocol Version 4 (TCP/IPv4)** from the list of items (refer to *Figure 3.11*).
- h. 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.

Networking			General
Connect using:	in the risk Parlian Letter	isensei	You can get IP setting this capability. Otherv for the appropriate IP
This connection use	s the following items;	Configure	 Obtain an IP add Use the following IP address:
V	stacol Version 4 (TCP/IP)	1999	Default gateway:
🗹 🔺 Internet Pro	stocol Version 4 (TCP/IP)	r4)	Obtain DNS serv O Use the following
Install	utocol Version 4 (TCP/IP)	(4) Properties	Obtain DNS serv Obtain DNS serv Otain DNS serv Otain DNS serv Otain Serv

Figure 3.11—Connection Properties

Internet Protocol Version 4 (TCP/IPv4)	Properties ? X
General	
You can get IP settings assigned auton this capability. Otherwise, you need to for the appropriate IP settings.	natically if your network supports ask your network administrator
Obtain an IP address automatical	y
O Use the following IP address:	
IP address:	192.168.1.100
Subnet mask:	255.255.255.0
Default gateway:	
Obtain DNS server address auton	natically
Our of the following DNS server add	resses:
Preferred DNS server:	
Alternate DNS server:	
	Advanced
	OK Cancel

- 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 3.12—Windows XP Networking Information

Local Area Connection Properties	Internet Protocol (TCP/IP) Properties
General Authentication Advanced	General
Connect using:	You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
This connection uses the following items:	Obtain an IP address automatically
	Use the following IP address:
D Photos Pressenters and specification	IP address: 192 . 168 . 1 . 100
Internet Protocol (TCP/IP)	Subnet mask: 255 . 255 . 0
	Default gateway:
	Obtain DNS server address automatically
Transmission Control Protocol/Internet Protocol. The default	 Use the following DNS server addresses:
wide area network protocol that provides communication across diverse interconnected networks.	Preferred DNS server:
Show icon in notification area when connected	Alternate DNS server:
Notify me when this connection has limited or no connectivity	Advanced
OK Cancel	OK Cancel

(Continued—Section 3.5: Connecting to Ethernet using a Windows Computer)

- 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 Net F/T's Welcome page.

Figure 3.13—The Net F/T's Welcome Page

Engineeres Produ	INDUSTRIAL NO 2001 Registered of the Passic Projecting				
Welcome	System Status: Healthy				
Snapshot					
Demo	Welcome!				
Settings	The Net F/T measures forces and torques in Cartesian coordinates (Fx, Fy, Fz, Tx, Ty, and Tz).				
Monitor Conditions	information, and configure communications with the sensor.				
Configurations	Viewing E/T Beadings				
Communications	The Demo page provides a Java application that graphically displays the current loading of the				
System Info	transducer.				
Examples	 The <u>Snapshot</u> page displays the loads and captured peak values (if enabled). Values shown on this page do not automatically update. 				
ATI Web Site	Catting Desemption				
	The <u>Configurations</u> page displays information about the selected transducer calibration. Use the Configurations page to create Configurations that include: the force and torque units that are reported, a calibration, and the tool transformations that are applied to the output data.				
	User Settings The <u>Settings</u> page displays the current active configuration, filtering selection and controls peak monitoring.				
	Active Configuration is #1: empty				

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

	AUTOMATION	Net F/T				
	ISO 9001 Registered	Force/Torque Sensor				
Engineered Produc	cts for Robotic Productivity					
elcome	System Status: Healthy					
apshot	Communications					
mo	communications					
tings	These settings control how the N	let F/T communicates with external equipment. Most settings				
nitor Conditions	require the Net F/T to be powere	ed off and then back on before they take effect.				
nfigurations	To save the values, you must cli	ck Apply.				
nmunications	Ethernet Network Settings					
tem Info	DIP switch 9 must be off to enable IP	Address Mode. If DIP switch 9 is on, then the IP address is set to 192.168.1.				
mples	function. If DHCP is enabled and no D	tings below. A LAN connection must be present at power up for DHCP to HCP server is found, then the static IP address will be used.				
Web Site	IP Address Mode:	OHCP Static IP see above note regarding DIP switch 9				
	Static IP Address:	192.168.1.1				
	Static ID Subpet Mask:	255 255 255 0				
	Chatle ID Default Catava	0.0.0.0				
	Static IP Default Gateway:	0.0.0				
	EtherNet/IP Protocol:	O Enabled O Disabled				
	Ethernet/IP O2T Data:	O Enabled Disabled				
	Ethernet/IP Data Format:					
	Ethernet MAC Address:	00:16:BD:00:21:22				
	Starting in units shipped with firmwark newer GSDML file than the file used w your unit. The GSDML file for the Net I Click this link to get the correct GSDM	e version 2.2.59, the PROFINET fieldbus module used in the Net F/T requires thtprevious firmware versions. Make sure you have the correct GSDML file for F/T is available on ATI's website.				
	Fieldbus Module Firmware Name:	PROFINET Slave				
	Fieldbus Module Firmware Version:	1.5.16				
	Fieldbus Module Enabled:	Enabled Obisabled				
	Fieldbus Module Output Byte Order:	● Little Endian ○ Big Endian				
	CAN Network Settings If power is not provided to the Pwr/CA are not correctly reported and commu	N connector, then CAN Bus Base Address, DeviceNet MAC ID, and Baud Rate nications over the Pwr/CAN connector are not available.				
	Protocol:	CAN Bus DeviceNet				
	CAN BUS Base Address:	432 set by DIP switches 1 to 6				
	Baud Bate:	125 kHz set by DIP switches 1 to 6 (inaccurate without Devicence connection)				
	Paw Data Transfer (DDT) Co	tinge				
	RDT data is routed through the local n	etwork and does not get routed through the default gateway.				
	RDT Interface:	Enabled O Disabled demo application requires RDT to be enabled				
	RDT Output Rate (1 to 7000):	7000 Hz value may be rounded up: see manual for details				
	PDT Buffor Size (1 to 40):					
	Multi Unit Succhastication	Creekled @ Direkled				
	Multi-Unit Synchronization:					
	Multi-Unit Id (1 to 9):	1				
	Modbus TCP Settings					
	Modbus Server	○ Enabled				
	Modbus Client	O Enabled				
	Modbus Client's Tx Interval (ms)	0				
	Modbus Client's Server IP Address:	0.0.0.0				
	Modbus Client's Server Write	0				
	Register:					

Figure 3.14—The Net F/T's Communications Page (with Fieldbus Option)

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 Net Box (if using PoE, unplug the Net Box from PoE switch, and then plug it back into the switch). 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 Net Box (if using PoE, unplug the Net Box from the PoE switch, and then plug it back into the switch).

Next, find the IP address assigned to the Net F/T by following the instructions in *Section 6.1—Finding Net F/Ts on the Network*.

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

- 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 Net F/T system into the browser's address bar, and press the ENTER key. The ATI Net F/T's *Welcome* web page displays again. Now it is possible to communicate with the Net F/T without reconfiguring the communication settings.

NOTICE: If the *Net F/T Configuration Utility* 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.

For more information about NET F/T Configuration Utility, refer to Section 6—Net F/T Configuration Utility.

3.6 Connecting to an Ethernet-based Fieldbus

Net F/Ts with an optional fieldbus module connect to the fieldbus via the Net F/T's standard Ethernet connection. Although the fieldbus uses the same Ethernet connection that the Net F/T uses for its standard communications, the fieldbus option has its own MAC address and its own IP address. The fieldbus's MAC address is shown as MAC ID 2 on the connector side of the Net Box.

To be used, the fieldbus module option must be enabled on the Net F/T's *Communications* page (refer to *Section 4.7—Communication Settings Page (comm.htm)*).

3.7 Connecting to DeviceNet (using DeviceNet-Compatibility Mode)

To operate the Net F/T over a DeviceNet network, enable the Net F/T system's DeviceNet compatibility mode. The DeviceNet-compatibility mode fully implements all DeviceNet commands. The DeviceNet MAC ID address and baud rate settings follow *Section 3.9—DIP Switches and Termination Resistor*. For protocol information, refer to *Section 12—DeviceNet-Compatibility Mode Operation*.

The Net F/T Pwr/CAN connector matches standard DeviceNet connectors and connections. The Pwr/CAN connector mates to a standard female DeviceNet M12 connector.

3.8 Connecting the Net Box to a CAN Bus Network

The Net F/T supports a basic CAN protocol. The CAN Bus base address and baud rate settings follow *Section 3.9—DIP Switches and Termination Resistor*. For protocol information, refer to *Section 14—CAN Bus Operation*.

3.9 DIP Switches and Termination Resistor

The configuration DIP switches and termination resistor are located inside of the Net Box where they are safely protected from outside debris and liquids. To gain connection to the switches and termination resistor, remove cover of the Net Box.

Before opening the Net Box, verify that the box is not powered and that the user and the Net Box are electrically grounded.

To remove the cover, fully loosen each of the four screws that fasten the cover to the Net Box chassis. Lift the cover straight up and off the chassis.

The internal electronics have a clear shield to protect them from debris or errant tool movements. The user can reach the DIP switches and termination resistor jumper through the access holes in the shield.



Figure 3.15—Net Box DIP Switches, Termination Resistor and LEDs

Before replacing the Net Box cover, ensure that no debris or liquids are in the chassis. Then replace the cover back on the chassis (verify that the window is above the LEDs and DIP switches) and tighten the four screws until each is snug.

3.9.1 Termination Resistor

By default, the Net Box ships with a CAN bus termination resistor installed. Remove the termination jumper to disable the internal termination resistor. To remove the termination resistor, use a pair of tweezers or pliers to pull the jumper off. Safely store the jumper somewhere in case it is needed to re-enable the termination resistor.

3.9.2 Node Address

By default, the Net Box ships with a CAN Bus base address of 432 and DeviceNet MAC ID of 54. These addresses are set by the DIP switch settings (see *Figure 3.16* for details).



To set the desired address, use *Table 3.1* and *Table 3.2* as an aid for finding the switch settings. The numbers on the left side are the desired MAC ID, and the numbers on the right side represent the switch position settings for switches 1 through 6 to select the MAC ID. The number 1 represents a switch in the ON position and the number 0 represents a switch in the OFF position.

NOTICE: The Net F/T can operate in either the CAN Bus protocol or the DeviceNet-Compatibility Mode protocol, but not both protocols. Select desired protocol can be enabled on the ATI Net F/T's *Communications* web page (*Section 4.7—Communication Settings Page (comm.htm*)).

Both protocols use the same DIP switches to set their address. Be sure to use the correct address table for the desired protocol.

Table 3.1—CAN Bus Base Address Switch Settings							
Desired	Switch Setting	Desired	Switch Setting	Switch Setting		Desired	Switch Setting
Audress	123456	Audress	123456	Audress	123456	Audress	123456
0:	000000	128:	000010	256:	000001	384:	000011
8:	100000	136:	100010	264:	100001	392:	100011
16:	010000	144:	010010	272:	010001	400:	010011
24:	110000	152:	110010	280:	110001	408:	110011
32:	001000	160:	001010	288:	001001	416:	001011
40:	101000	168:	101010	296:	101001	424:	101011
48:	011000	176:	011010	304:	011001	432:	011011
56:	111000	184:	111010	312:	111001	440:	111011
64:	000100	192:	000110	320:	000101	448:	000111
72:	100100	200:	100110	328:	100101	456:	100111
80:	010100	208:	010110	336:	010101	464:	010111
88:	110100	216:	110110	344:	110101	472:	110111
96:	001100	224:	001110	352:	001101	480:	001111
104:	101100	232:	101110	360:	101101	488:	101111
112:	011100	240:	011110	368:	011101	496:	011111
120:	111100	248:	111110	376:	111101	504:	111111

Table 3.2—DeviceNet MAC ID Address Switch Settings							
Desired	Switch Setting	Desired	Switch Setting	Desired	Switch Setting	Desired	Switch Setting
Audress	123456	Audress	123456	Audress	123456	Audress	123456
0:	000000	16:	000010	32:	000001	48:	000011
1:	100000	17:	100010	33:	100001	49:	100011
2:	010000	18:	010010	34:	010001	50:	010011
3:	110000	19:	110010	35:	110001	51:	110011
4:	001000	20:	001010	36:	001001	52:	001011
5:	101000	21:	101010	37:	101001	53:	101011
6:	011000	22:	011010	38:	011001	54:	011011
7:	111000	23:	111010	39:	111001	55:	111011
8:	000100	24:	000110	40:	000101	56:	000111
9:	100100	25:	100110	41:	100101	57:	100111
10:	010100	26:	010110	42:	010101	58:	010111
11:	110100	27:	110110	43:	110101	59:	110111
12:	001100	28:	001110	44:	001101	60:	001111
13:	101100	29:	101110	45:	101101	61:	101111
14:	011100	30:	011110	46:	011101	62:	011111
15:	111100	31:	111110	47:	111101	63:	111111

Setting DIP switches 1 through 8 to ON enables both DeviceNet MAC ID and baud rate to be set by software. If switches 7 or 8 are OFF, then the DeviceNet MAC ID is not set by software.

3.9.3 Baud Rate

By default, the Net Box ships with a baud rate of 500 kbps. This rate is set by the DIP switch settings (see *Figure 3.16* for details).

To set the baud rate used by DeviceNet and CAN Bus, use *Table 3.3* as an aid to set switches 7 and 8.

Table 3.3—Baud Rate Switch Settings				
Pour Poto	Switch Setting			
Baud Kale	78			
125 kbps:	00			
250 kbps:	10			
500 kbps:	01			
Selected by software:	11			

3.10 Baud Rate

The status LEDs indicate the general health and connectedness of the Net F/T. Possible LED states and meanings are listed in *Table 3.4* and *Table 3.5*.

a) Standard	Net Bo	хc
	·	
Module Status	2 /	
DeviceNet Network Status-	10405	Dicos
EtherNet/IP Network Status		- NSEN
Ethernet Link Status		
Transducer Saturation		Sot
Transducer Link Status	<u> </u>	

Figure 3.17—Status LEDs

b) Net Box with Fieldbus Module Option



3.11 Power-Up Cycle

Prior to power-up, connect the transducer the Net Box and connect the Net Box to an Ethernet network. When power is applied to the Net Box, the following occurs:

- For the standard Net Box, all status LEDs blink green then red once in this order: MS, NS DN, NS EN, LS EN, Sat, and Xdcr. For the fieldbus Net Box, the LEDs blink green once then red once in this order: MS, EN1, NS/BF, Sat, and Xdcr. The EN2 LED does not blink in the sequence.
- Next the Xdcr LED glows red and the MS LED blinks red. The LS EN LED blinks green if the Net Box is connected to the Ethernet network.
- Approximately 20 seconds after power up, the MS and Xder LEDs should display green. This signals that the data acquisition system is now functioning.

٠	If the Net F/T does not power up as described, refer to <i>Section 17—Troubleshooting</i> .

Table 3.4—Standard Net Box Status LED Descriptions					
Status LED Function	Name on PCB	LED State	Description		
		Off	No power		
Module Status	MS	Green	Correct operation		
	MO	Flashing Red	Minor fault such as incorrect or inconsistent configuration		
DeviceNet		Off	Pending duplicate MAC ID test or DeviceNet protocol not selected (or no power)		
Compatibility-Mode	NS DN	Flashing Green	No connection to DeviceNet network		
Network Status		Solid Green	DeviceNet master connected		
		Flashing Red	DeviceNet I/O connection(s) timed out		
		Off	EtherNet/IP is disabled or no IP address (or no power)		
EtherNet/IP Network Status	NS EN	Flashing Green	IP address is assigned, but no connection to EtherNet/IP network		
		Green	EtherNet/IP network connected		
		Flashing Red	EtherNet/IP connection(s) timed out		
		Off	No link (or no power).		
		Green	Link		
Ethornot Link Status		Solid Amber	Port disabled		
	LS EN	Flashing Green	Port activity		
		Flashing Amber	Ethernet data collision		
		Red	N/A (used only during a power-up cycle)		
		Off	Transducer load is appropriate (or no power)		
Transducer Saturation	Sat	Red	Transducer has too much load and is saturated. This causes system load outputs to be invalid.		
		Green	Data acquisition system functioning properly.		
Sensor Link Status	Xdcr	Red	Data acquisition system error or power-up sequence is being executed.		

Table 3.5—Fieldbus Net Box Status LED Descriptions						
Status LED Function	Name on PCB	LED State	Description			
		Off	No power			
Module Status	MS	Green	Correct Operation			
		Flashing Red	Minor fault such as ir configuration	ncorrect or inconsistent		
Ethernet Link		Off	No Ethernet link (or no power)			
Status	EN1	Green Ethernet link established				
		Flashing Green	Ethernet activity			
		Off	Fieldbus disabled (or	no power)		
Fieldbus Option	EN2	Green	Fieldbus connected			
Status		Flashing Amber	Fieldbus activity			
		Amber				
		The NS/BF LED connected. The p Fieldbus, EtherN	displays only the statu priorities are as follows et/IP, DeviceNet.	s of the highest priority bus , in order of highest to lowest:		
			Bus	Description		
			PROFINET	Network connected (or no power)		
		Off	EtherNet/IP	No IP address assigned or network disabled (or no power)		
			DeviceNet	Pending duplicate MAC ID test or network disabled (or no power)		
			Bus	Description		
		Groop	PROFINET	N/A		
Network Status/Bus		Green	EtherNet/IP	Network connected		
Failure	NS/BF		DeviceNet	DeviceNet master connected		
			Bus	Description		
			PROFINET	N/A		
		Flashing Green	EtherNet/IP	IP address assigned without connecting to network		
			DeviceNet	No connection to network		
		Flashing Red	Connection(s) timed	out		
			Bus	Description		
			PROFINET	Duplicate IP address found		
		Red	EtherNet/IP	Duplicate IP address found or EtherNet/IP network		
			DeviceNet	Network error		
Transducer		Off	Transducer load is appropriate (or no power)			
Saturation	Sat	Red	Transducer has too much load and is saturated. This causes system load outputs to be invalid			
Transducer Link		Green	Data acquisition syst	em functioning properly		
Status	Xdcr	Red	Data acquisition system error or power-up sequence is being executed			

4. Web Pages

The Net F/T's web pages provide full configuration options for the Net F/T sensor system. There are several pages which can be selected by the menu bar toward the top of the web page.

The Net F/T's web pages 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. Because the demo program is written in Java[®], verify Java is installed on the computer (refer to *Section 5—Java Demo Application*).

The system status is displayed near the top of all the web pages. This is the system status at the time the page was loaded. To display the current system status, reload the web page. Possible system status conditions are listed in *Section 17.1—System Status Code*.

Engineered Produc	INDUSTRIAL AUTOMATION ISO 9001 Registered cts for Robotic Productivity	Net F/T Force/Torque Sensor					
Welcome	System Status: Healthy						
Snapshot							
Demo	Welcome! The Net F/T measures forces and torques in Cartesian coordinates (Fx, Fy, Fz, Tx, Ty, and Tz).						
Settings							
Monitor Conditions	information, and configure communications with the sensor.						
Configurations	Viewing E/T Readings						
Communications	The <u>Demo</u> page provides a Ja	ava application that graphically displays the c	current loading of the				
System Info	transducer.						
Examples	The <u>Snapshot</u> page displays t this page do not automaticall	the loads and captured peak values (if enable y update.	ed). Values shown on				
ATI Web Site							
	Setting Parameters						

Figure 4.1—Menu Bar

4.1 Welcome Web Page (index.htm)

Type the Net F/T IP address into the browser address field, and the ATI Net F/T home page (*Welcome* page) appears.

The *Welcome* page gives a quick overview of the Net F/T's main functions. The bottom of the page lists the active configuration and the calibration used by this configuration.

Englacered Produc	INDUSTRIAL Net F/T ISO 8001 Registered Is for Reductivity
Welcome	System Status: Healthy
Snapshot	
Demo	Welcome!
Settings	The Net F/T measures forces and torques in Cartesian coordinates (Fx, Fy, Fz, Tx, Ty, and Tz).
Monitor Conditions	information, and configure communications with the sensor.
Configurations	Viewing E/T Readings
Communications	The <u>Demo</u> page provides a Java application that graphically displays the current loading of the
System Info	transducer.
Examples	The <u>Shapshot</u> page displays the loads and captured peak values (if enabled), values shown on this page do not automatically update.
ATI Web Site	
	Setting Parameters The <u>Configurations</u> page displays information about the selected transducer calibration. Use the Configurations page to create Configurations that include: the force and torque units that are reported, a calibration, and the tool transformations that are applied to the output data.
	User Settings The <u>Settings</u> page displays the current active configuration, filtering selection and controls peak monitoring.
	Active Configuration is #1: empty Using Calibration #1: FT19545

Figure 4.2—Welcome Web Page

4.2 Snapshot Web Page (rundata.htm)

This web page allows shows current transducer loading, the maximum and minimum peaks (if peak monitoring is enabled on the *Settings* page), and the status of Monitor Conditions conditions.

The information displayed on this web page is static and does not update after the web page is loaded. To see current information, reload the web page.

Engineered Produ	INDUSTRIAL AUTOMATION ISO 9001 Registered	Fo	Net I prce/Torqu	F/T e Sensor		-		
Welcome	System Status: Healthy		A NAME OF CASE OF CASE					
Snapshot	System Status, nearing							
Demo	Loading Snapshot							
ettings	This page displays the transdu	cer loading	at the time	of the load	ing of this w	ch page T	his nage	
Ionitor Conditions	does not refresh automatically	. To see the	most recen	t transduce	r loading, cl	ick Refresh	Page.	
Configurations	Values displayed in User Units	use the Fer	co Unito and	Torque II	vite colocted	in Configu	rations	
Communications	Values displayed in <i>Oser Onits</i> Values displayed in <i>Counts</i> use	e the Counts	s per values	selected in	<u>Configuration</u>	ons.	rations.	
system Info	Transducer Loading Snaps	hot (User l	Jnits):					
Examples	Frank (Transis Data)	Fx	Fy	Fz	Tx	Ту	Tz	
TI Web Site	- Force/ lorque Data:	-8124	-10523.	-5882	-1014	422.26	1631.2	
	Minimum Peaks:	-8498	-10583.	-6202	-1017	420.71	1612.6	
	Maximum Peaks:	-8117	-10519.	-5397	-1011	443.08	1647.3	
	Transducer Loading Snapshot (Counts):							
	Farry (Tarry Dates	Fx	Fy	Fz	Tx	Ту	Tz	
	Force/Torque Data:	-8132050	-10528278	-6029781	-1014555	422063	1636644	
	Minimum Peaks:	-8498898	-10583548	-6202723	-1017719	420719	1612672	
	Maximum Peaks:	-8117674	-10519108	-5397260	-1011218	443089	1647344	
	Reset Peaks							
			Bias					
	Strain Gage Data							
		G0	G1	G2	G3	G4	G5	
	Blased Gage Data:	-2421	-537	-4887	-19479	1197	-7925	
		G0	G1	G2	G3	G4	G5	
	Unbiased Gage Data:	-2431	-553	-4899	-19494	1175	-7951	
	Monitor Conditions Status			Kange5270	0 10 +32707			
	Monitor Conditions Breached:	0×0000000	0 statements	bitmanned ir	to lower two h	ivtes		
	Monitr Conditions Output:	0x00	- succindito	or number of the		1000		
	Monitor Conditions Latched:	0 Reset	Latch					
			Refrech Pa					

Figure 4.3—Snapshot Web Page

Transducer Loading Snapshot (User Units):

Force/Torque Data:	Displays the force and torque data scaled in the user units selected on the <i>Configurations</i> web page. If any strain gages are saturated, these values are invalid and displayed in red with a line through them.
Minimum Peaks:	Displays the minimum peak values captured scaled in the user units selected on the <i>Configurations</i> web page.
Maximum Peaks:	Displays the maximum peak values captured and scaled in the user-selected units on the <i>Configurations</i> web page.

Transducer Loading Snapshot (Counts):

Force/Torque Data:	Displays the force and torque data scaled with the Counts per Force and Counts per Torque displayed on the <i>Configurations</i> web page. If any strain gages are saturated, these values are invalid and displayed in red with a line through them.
Minimum Peaks:	Displays the minimum peak values captured scaled with the Counts per Force and Counts per Torque displayed on the <i>Configurations</i> web page.
Maximum Peaks:	Displays the maximum peak values captured scaled with the Counts per Force and Counts per Torque displayed on the <i>Configurations</i> web page.
Reset Peaks:	This button clears the captured peaks and reloads the Snapshot web page.
Bias button:	Tares the force and torque values at the current readings and reloads the <i>Snapshot</i> web page. This sets the current load level as the new zero point. Undo the bias, by setting the <i>Software Bias Vector</i> to all zeros on the <i>Settings</i> web page.
Strain Gage Data:	
Biased Gage Data:	Displays the transducer's strain gages minus the software bias vector.
Unbiased Gage Data:	Displays the transducer's raw strain gage information for easy troubleshooting of saturation errors. Saturated strain gage values are displayed in red.

NOTICE: When saturation occurs, the reported force and torque values are invalid.

NOTICE: Individual strain-gage values do not correspond to individual force and torque axes.

NOTICE: The transducer readings on this page are captured as the web page requests them. It is possible that the readings towards the bottom of the page come from later F/T data records than the readings towards the top of the page.

Monitor Conditions Status:

Monitor ConditionsIndicates which conditions are or have been true since the last reset latch functionBreached:execution. Each bit in the lower two bytes of this hexadecimal number represents
a Monitor Conditions statement. Table 4.1 shows the bit pattern representing each
Monitor Conditions statement number. The Monitor Conditions Breached value
is the result of or'ing the bit patterns for all true statements together. The Monitor
Conditions Breached value is cleared to zero by the reset latch function.

Table 4.1—Bit Patterns for Monitor Conditions Breached									
#:	Bit Pattern	#:	Bit Pattern	#:	Bit Pattern	#:	Bit Pattern		
0:	0x00000001	4:	0x00000010	8:	0x00000100	12:	0x00001000		
1:	0x0000002	5:	0x00000020	9:	0x00000200	13:	0x00002000		
2:	0x00000004	6:	0x00000040	10:	0x00000400	14:	0x00004000		
3:	0x00000008	7:	0x00000080	11:	0x00000800	15:	0x0008000		

-	
Monitor Conditions Output:	Displays the Monitor Coditions Output value set by bitwise or'ing the Output Codes of all true Monitor Conditions statements.
Monitor Condition Latched:	Displays one if any conditions are or have been true. The Monitor Condition Latched value is cleared to zero by the reset latch function.
Reset Latch:	This button clears any condition latching and reloads the <i>Snapshot</i> web page. If no conditions remain true, then Monitor Conditions Breached, Monitor Conditions Output, and Monitor Condition Latched are set to zero and the System Status: Condition Level Latched condition is cleared.
Refresh Page:	This button reloads the <i>Snapshot</i> web page with updated values. This button is the same as using the browser's reload or refresh command.

4.3 Demo Web Page (demo.htm)

From this web page, download a Java Demo Application which is described in *Section 5—Java Demo Application*.

Engineered Produc	ISO 9001 Registered Force/Torque Sensor				
Welcome	System Status: Healthy				
Snapshot					
Demo	Demonstration Application				
Settings	The demonstration application graphically displays transducer readings.				
Monitor Conditions	The application's features include:				
Configurations	 Display of transducer loading in real time as a bar graph and a 3D cube 				
Communications	Ability to save transducer readings in CSV format				
System Info	Blasing of transducer readings to zero Reporting of communication errors				
Examples					
ATI Web Site	The demo software is available on ATI's Net F/T Software page. When starting the demo, it will ask you to enter the IP address of the sensor. The IP address of this Net F/T is: 10.1.0.134				
	Download the demo software here.				
	The application requires the Java runtime. Java can be downloaded from http://www.java.com . The source code the demo can be found in the Net F/T system documentation.				

Figure 4.4—Demo Web Page

4.4 Settings Web Page (setting.htm)

From this web page, choose the active configuration and specify settings that are effective across all configurations, such as filtering, peak monitoring, and the bias (offset) vector. Click the **Apply** button to implement changes on this web page.

Engineered Produc	INDUSTR AUTOMAT ISO 9001 Regis ts for Robotic Producti	IAL Net F/T ION Force/Torque Sensor							
Welcome	System Stat	cus: Healthy							
Snapshot									
Demo	Settings								
Cettings									
Monitor Conditions	These system	settings are independent of configurations and affect all transducer readings. The ng values can be viewed on the <u>Snapshot</u> page.	ŧ						
Configurations	To save the va	alues you must click Apply							
Communications	io save the va	the values, you must click Apply.							
System Info	User Setup:								
Examples	_ Active	To edit or create a configuration, go the Configurations page							
Examples	Low-Pass Filte	er							
All web Site	Cutoff Frequency:	No Filter V							
	Peaks Monitoring:	Enable Disable							
	rionicornig.	60 61 62 63 64 65							
	Software Bias Vector:	O O	0						
		Apply Cancel							
	User Authen	itication:							
	User Name:	admin							
	Password:								
	Setting the p	assword blank will disable user authentication							
Active Configura	tion: Sel For	Apply Cancel ects one of sixteen configurations to be applied to the force and r more information on these configurations, refer to Section 4.6-	torque readings. — <i>Configurations</i>						
Low-Pass Filter Cutoff Se Srequency: low De		ects the cutoff frequency for low-pass filtering. Selecting No Fi y-pass filtering. For more information, refer to <i>Section 18.2—Tra</i> <i>ta Filtering</i> .	lter disables ansducer						
Peaks Monitoring	g: If e mai is o	If enabled, each axis's lowest and highest F/T values are saved as minimum and maximum peaks. The Reset Peaks button clears the peaks. The Reset Peaks button is on the <i>Snapshot</i> web page.							
	l hi clos	s feature can be useful to detect crashes, during teaching, or fin se the application gets to the transducer's limits.	ding out how						
Software Bias Ve	ctor: Thi Bia rem	is is the bias offset applied to the transducer strain gage reading is button on the <i>Snapshot</i> web page changes these values. This hoved by setting the software bias vector to all zeros.	s. Clicking the bias may be						
	Not	Note that the strain gage readings do not have a one to one correspondence to force and torque readings.							
User Authenticati	on: All exc on flip disa	Allows a user name and password to be set for accessing all ATI Net F/T web pages except the <i>Welcome</i> web page. The password can be reset by flipping DIP switch 9 on and off 5 times with no more than two seconds between two consecutive "on" flips. After switched, the password field is blank and the user authentication is disabled until a password is entered.							

Figure 4.5—Settings Web Page
4.5 Monitor Conditions Web Page (moncon.htm)

This webpage is to set-up Monitor Conditions. Monitor Conditions compare transducer readings to simple user-defined condition statements. When Monitor Conditions is enabled and a sample is read that satisfies one or more of the active Monitor Conditions, the user-defined output code are bitwise or'ed together to form the condition output (in practice, it is very unlikely that more than one condition sample will be satisfied in a single sample). The condition monitoring latch is then set, and condition monitoring is paused until a command to reset the condition monitoring latch is received. The condition output is available on the *Snapshot* web page.

When F/T Out-of-Range Monitoring is enabled, the Net F/T will set the relay output if the current F/T readings exceed the calibrated range. Monitor Conditions must be enabled.

When Status Word Monitoring is enabled, the Net F/T will set the relay output if any status errors are present. Monitor Conditions must be enabled.

When Gage Monitoring is enabled, the Net F/T will set the relay output if the absolute value of any individual gage exceeds the value in the Gage Count Threshold field. Monitor Conditions must be enabled.

Each condition can be configured for the following:

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

Figure 4.6—Monitor Conditions Web Page

and the second s	AUTOMATIO ISO 9001 Registere	L N ~		N Force/T	et F/T orque Sen	sor	1	y	ù	
Engineered	Products for Robotic Productivity							10	1	
elcome	System Status: Hea	lthy								
apshot	Monitor Conditio	ne								
100										
tungs	When Monitor Conditions the	ons are enab	led, the I	Net F/T con	mpares trans dec for all tr	sducer force an	d torqui	e value	s to the	
ditions	the Monitor Condition	s Output.	on. me	output co	ues for all u	de condicions a	re com	vineu u	orionini	
nfigurations	When E/T Out-of-Ran	aa Manitaria	a is enabl	ad the Ne	• E/T will ca	t the relay outo	ut if the	. curren	at E/T	
mmunication	readings exceed the c	alibrated ran	ge. Monit	tor Conditi	ons must als	to be enabled.	at in the	- currer		
stem Info	When Status Word Mo	onitorina is e	nabled ti	he Net E/T	will set the	relay output if :	any eve	tem sta	shie	
amples	errors are present. Me	onitor Conditi	ions must	t also be e	nabled.	rand) batpat in				
I Web Site	When Gage Monitorin	d is enabled.	the Net I	F/T will set	the relay of	utout if the abs	olute va	due of	anv	
and they date	individual gage excee enabled.	ds the value	in the Ga	ge Count	Threshold fie	ld. Monitor Cor	ditions	must a	ilso be	
	The Bias column allow of the monitoring con	vs the option ditions.	of using	either bias	ed or unbia:	sed data when :	setting 1	the thr	esholds	
	The Units column disp click Apply.	plays the forc	e or torq	ue counts	value in use	r units. To upda	ite the l	Jnits co	olumn,	
	To save the values, yo	ou must click	Apply.							
	Monitor Conditions	Settings								
	when Relay Trigger Item operation on valid Output	Codes. When A	true is sel W condition	lected, the M hs are true is	fonitor Conditions selected, a bil	ons Output is the r twise-AND operation	esult of a on is perf	ormed.	-OR	
	Monitor Conditions:	Enabled	ODisab	led						
	F/T Out-of-Range	Enabled	Disab	led						
	Monitoring: Status Word	1000								
	Monitoring:	CEnabled	(® Disab	led						
	Gage Monitoring:	CEnabled	Disab	oled 0		Gage Count T	hreshol	d		
	Relay Trigger:	Any con	dition is t	true OAI	conditions	are true				
	Relay Behavior:	Relay Behavior: Momentary OLatching Reset Latch								
	Relay Momentary	1 ×0	.1 secon	ds only a	ipplies when R	elay Behavior is se	t to Morr	ientary		
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature re NOTICE: T mode, the monitor ca	1.1 secono In systema lay faituro The Fieldbus Fieldbus I politions	ds only a without the due to excess ous Module Module is a so your ch	solid-state reliable solid-state reliable sive activation is enabled responsible f	alay Behavior is se ay option, setting t on the <u>Commun</u> for enabling and se properties y	t to Morr his value <u>hication</u> disabli vill not l	iontary to 0 coi s page. ing indi	uld caus In thi ividual	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature re NOTICE: T mode, the monitor co However, y N On Off	I.1 secono In systema lay failuro The Fieldb Fieldbus Inditions, ou can eo Blos	ds only a without the due to excess bus Module is Module is so your ch dit the oth Axis. d	solid-state reliance of the solid-state reliance of the solid state reliance of the solid of the solid solid state reliances to the solid	intay Behavior is se ay option, setting to on the <u>Commun</u> for enabling and esse properties v s of the individu Counts	t to Morr this value <u>nication</u> disabli vill not l vill not l val moni Units	entary to 0 col g page. ing indi be save itor cor	uld caus In this ividual ed. inditions	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature re NOTICE: T mode, the monitor con However, y N On Off	1.1 secono In systema Iny failuro The Fieldb Fieldbus Inditions, ou can eo Blas	ds only a without the doe to excess hus Module Module is a so your ch dit the oth Axis. 4	solid state releases tabor solid state releases ave activation e is enabled of responsible f anges to the er properties Comparison	intay Behavior is se ay option, setting t on the <u>Commun</u> for enabling and ese properties y s of the individu Counts	t to Morr this value nication: d disabli vill not l vill not l units	entary to 0 col s page, ing indi be save itor cor	uld caus In this ividual id. iditions Hex Output Code	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNENG: prenature re NOTICE: T mode, the monitor co However, y N On Off	1.1 seconi In systema Iny failuro The Fieldb Fieldbus Inditions, ou can ed Blos	ds only a without the due to excess hus Module is Module is so your ch dit the oth Axis. 4 If Tz ~	solid-state reliable solid-state reliable sive activation is enabled responsible fi anges to the er propertier Comparison	elay Behavior is or ay option, setting 1 on the <u>Commun</u> for enabling and ese properties v s of the individu Counts 9099	t to Mor his value ication: d disabl vill not l al moni Units 9.09900 Nm	interv to 0 con g page, ing indi be save itor cor	uld caus In this ividual id. nditions Hex Dutput Code 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature re NOTICE: T mode, the monitor co: However, y N On Off 0 • B 1 • B	I. 1 seconi in systema tay faiture The Fieldbus Inditions, ou can et Blos ased ~ iased ~	ds only a without the doe to excess ous Module is Module is Module is so your ch dit the oth Axis. 4 If Tz ~ If Tz ~	solid state releases to the responsible fragments of the state of the second state of	elay Behavior is a eray petion, setting t on the <u>Commun</u> for enabling and se properties v s of the individu Counts 9099	t to Mor his value disabli vill not l val mon Units 9.09900 Nm 0 Nm	to 0 con s page. ing indi be save itor cor Then Then	uld caus In thi ividual id. hditions Hex Outpu Code 0x0 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature ro NOTICE: T monitor co However, y N On Off 0 0 • B 1 • B 2 • B	I.1 secon In systema Iny failure The Fieldbus Inditions, ou can ex Blas assed iassed iassed iassed iassed	ds only a without the due to excess ous Module Module is so your ch dit the oth Asis i If Tz v If Tz v If Tz v	solid state releases to the er properties Comparison	elay Behavior is se alay Behavior is se ay option, setting 1 on the <u>Commun</u> or enabling an esse properties v s of the individu <u>Counts</u> 9099 0 0	t to Mor his value inication disabli vill not l al moni Units 9.09900 Nm 0 Nm 0 N	to 0 con s page. ing indi be save itor con Then Then Then	uld caus In thi ividual ed. nditions Hex Output Code 0x0 0x0 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARNING: premature ro NOTICE: T monitor co However, y N On Off 0 0 • B 1 • B 2 • B 3 • B	In second In systema Inv failuro The Fieldbs Fieldbus Inditions, ou can ed Blos Issed viased	ds only a without the doe to exceed Module is so your ch dit the oth Axis i If Tz v If Tz v If Fz v If Fz v	solid-state red sive attheted aresponsible if anges to the er propertier Comparison	elay Behavior is se av option, setting l on the <u>Commun</u> or enabling ano see properties v s of the individu <u>Counts</u> 9099 0 0 0 0	t to Morr this value <u>bication</u> d disabli vill not l al moni Units 9.09900 Nm 0 Nm 0 N 0 N	to 0 con s page, ing indi be save itor cor Then Then Then Then	In this ividual ad. hdition: Code 0x0 0x0 0x0 0x0 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×0 WARRING: premature representation representatio representation representation representin representatio	In systema In systema Iny failuro he Fieldb Fieldbus Inditions, ou can eo Blos lased ~ lased ~ lased ~ lased ~ lased ~ lased ~	ds only a without the doe to exceed Module is so your ch dit the oth Axis i If Tz v If Tz v If Fz v If Fz v If v	Reset Later ppplies when R and state refeasive activations is enabled of responsible I anges to the er propertier Comparison	alay Behavior is se any option, setting 1 on the <u>Commun</u> or enabling and esse properties v so the individu Counts 9099 0 0 0 0 0	t to Morr this value <u>sication</u> d disabil vill not l units Units 0.09900 Nm 0 Nm 0 N 0 N 0 N	to 0 con s page. Ing indi be save tor cor Then Then Then Then Then	In this ividual id. heition: Hex Output Code 0x0 0x0 0x0 0x0 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×C WARRING: premature representations on promotion content on the monitor content of the	In systema in systema iny failuro he Fieldb Fieldbus nditions, ou can ex Blos lased ~ lased ~ lased ~ lased ~ lased ~ lased ~ lased ~ lased ~	ds only a without the due to excess bus Module is is so your ch dit the oth Asis i If Tz v If Tz v If Fz v If Fz v If v If v	Reset Calco applies when R solid-state ref size activation is enabled responsible anges to the er propertier Comparison	alay Behavior is se ay option, setting 1 on the <u>Commun</u> or enabling and see properties w of the individu Counts 9099 0 0 0 0 0 0 0 0	t to Morr this value this value this value disable vill not l disable vill not l disable Nm 0 Nm 0 N 0 N 0 N 0 N 0 N	to 0 con s page. ing indi- be save tor cor Then Then Then Then Then Then	In this ividual ed. hdition Hex Outpu Code 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 ×C WARRENG: premature removed. promiter committee removed. monitor committee removed. Momentary removed. N conditioned. 0 • • • • • • • • • • • • • • • • • • •	In systems in systems in systems in Fieldbus Fieldbus inditions, ou can ex- ilased ~ iased ~ i	ds only a without the due to excess sus Module Module is so your ch dit the oth Ads. I If Tz v If Tz v If Tz v If Tz v If Tz v If v If v If v If v	Reset Calco applies when R. asile activation is enabled responsible responsible responsible anages to the re properties Comparison	and any Behavior is so and any Behavior is so any option, setting 1 on the <u>Commun</u> for enabling and so of the individu Counts	t to Morr this value d disabilit vill not l al moni Units 0.09900 Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	Then Then Then Then Then Then Then Then	In thi vidual ed. hdition Code 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc VMARCHOG premature remained on the second se	In systems in systems in systems in Fieldbus Fieldbus inditions, ou can ex- liased ~ iased ~ i	ds only a without the doe to excess us Module So your ch dit the oth Ads. i If Tz v If Tz v If Tz v If Tz v If Tz v If v If v If v If v	Reset Calco applies when R askid-state real savid-state real savid-	and the second s	t to Morr this value disabli vill not l al moni Units 0.09900 Nm 0.N 0.N 0.N 0.N 0.N 0.N 0.N 0.N 0.N 0.N	Then Then Then Then Then Then Then Then	uld cause In this vidual dd. Dotputput Code 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc WARRANG: premature remained and the remained of the monitor code of the work, yc NOTICE: T 0 @ B 1 @ B 2 @ B 3 @ B 4 @ B 5 @ B 6 @ B 7 @ B 8 @ B	1.1 seconi In systema In systema In systema The Fieldbs Fieldbus Inditions, ou can et Blos I ased ~ iased ~ iaset	ds only a without the without the doe to exceed	Reset Calco applies when R salid state reduction is enabled to enable the reduction is enabled to enable the responsible f anges to the responsible to many set anges to the responsible to enable the set and the	e day dehesion is see netry dehesion is see on the <u>Communication</u> setting the on the <u>Communication</u> setting the one of the individu <u>Counts</u>	t to Meer his value disabil vill not l units Units 0 Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	entary to 0 coi s page. ing indi- be save tor cor Then Then Then Then Then Then Then Then	uld caus In thi ividual sd. Dotput Code 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc VMARRENG: premature re premature re monitor co. NOTICE: T 0 @ B 1 @ B 2 @ B 3 @ B 4 @ B 5 @ B 6 @ B 7 @ B 8 @ B 9 @ B	1.1 seconi In systema In systema In systema The Fieldbus Inditions, ou can et Blos lased ~ lased ~ lased ~ lased ~ lased ~ las	ds only a without the double to exceed to the double to exceed to exceed to exceed the double	Reset Calco applies when R adde attraction is senabled of also enabled of the senabled of the senabled of the senabled of the senabled of the	(i) (t to Morr his value disabilities disabilities disabilities disabilities disabilities disabilities no Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	to 0 core s page. ing indi be save tor core Then Then Then Then Then Then Then The	uld caus In thi ividual ed. Dutput Code 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc VYARRUNG: premature re premature re monitor co Money of the second	I second in systema in	de only de la contra de la cont	Proved Calcol applies when R applies when R also activation is enabled in seatchation is enabled responsible amges to the er properties Comparison	1 1	t to Morr his value d disabilit al moni Units 9.09900 Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	to 0 core s page. ing indi be save tor core Then Then Then Then Then Then Then The	uld caus In thi vidual d. dition: Durput Code. 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc VARRENG: premature re- premature re- monitor co- monitor co- However, y N On off 0 0 0 1 • 0 1 2 • 0 0 0 3 • 0 0 0 0 2 • 0 0 0 0 0 3 • 0 • 0	1.1 seconi in systema in systema	ds only i ds only i due to excess bus Module is so your ch did the other Ads i If Tz v If Tz v If Tz v If Tz v If Tz v If v If v If v If v If v If v If v If	Prover calco pepties when R applies when R and state ref sive activation is enabled responsible anges to the er properties Comparison	the set of the se	t to Morr his value d disabilit al moni Units 9.09900 Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	entary to 0 con s page. Ing ind ind s page. D Then Then Then Then Then Then Then Then	uld caus In thi vidual d. dition: Dupput Code. 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc WARRENG: premature re premature re mode, the monitor co monitor co However, y N on oll 0 @ B 1 @ B 2 @ B 3 @ B 4 @ B 5 @ B 6 @ B 7 @ B 8 @ B 9 @ B 11 @ B 12 @ B	I second view of the second view	des only i des only i without he des to excess yous Module is so your ch dit the oth Ads. i If Tz v If Tv v	Reset calco applies when R addid state ref sive activation is enabled is enab	the set of the se	t to Marrie to Marr Nome to Marrie to Ma Nome to Marrie to Ma Nome to Marrie to National term to Marrie to	entary to 0 con s page. ing ind ind be save tor con Then Then Then Then Then Then Then The	uld cause In this vidual dd. output Code 0x0 0x0 0x0 0x0 0x00	
	Relay Momentary Minimum-On Time: Monitor Conditions:	1 xc VARRENG: premature re premature re mode, the monitor co. However, y N On Off 0 0 0 1 0 2 0 3 0 6 0 7 0 8 0 9 0 10 0 0 0	I seconi in systema lay failors he Fieldbus lased v assed v asses v as	de only de oncesso uns Module is is so your choi dit the oth dit t	Applies when R applies when R and state etc. Sub activation is enabled comparison is enabled comparison is enabled comparison is enabled is ena	Alphane	t to Marrier to Marrier value disability of disability of disability of disability of the disability of the disability of the disability of Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N	entary to 0 cool s page. Ing indi- be save tor cor Then Then Then Then Then Then Then Then	uld cause In this vidual dd.	
	Relay Momentary Minimum-On Time: Monitor Conditions:	I xx WARRENG: premature re- premature re- monitor co- However, y N on Off I I I	I I secon in systems lased in the Fieldbus Fieldbus us and the Fieldbus lased in the fieldbus lasedbus lasedbus lasedbus lasedbus lasedbus lasedbus lasedb	de only de once su uns Module is so your ch only de first de first de first de only de	Prover Calco Provide State red solid state red size activation is enabled responsible f anges to the er propertief Comparted Solid S	the set of the se	t to Marrier to M Marrier to Marrier to Ma Marrier to Marrier to M	to 0 con- s page. Then Then Then Then Then Then Then Then	uld ceus In this vidual ditions ditions Ox0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	I xc WARRENG: premature removed premature removed mode, the monitor conditions removed NOTICE: T B B C B S B G B S B G B S B G B S <td>I I secon. In systems in systems in the Fieldbar Blos assed with the fieldbar assed with the fieldbar</td> <td>de only de onl</td> <td>Protect calco papelies when R applies when R applies when R is enabled is enabled is</td> <td>the set of the se</td> <td>t to Maer hits value d disabil units 0.0990C 0.Nm</td> <td>entary to 0 coo s page. Then Then Then Then Then Then Then Then</td> <td>uld caus In this vidual dditionn Hex 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0</td>	I I secon. In systems in systems in the Fieldbar Blos assed with the fieldbar assed with the fieldbar	de only de onl	Protect calco papelies when R applies when R applies when R is enabled is	the set of the se	t to Maer hits value d disabil units 0.0990C 0.Nm	entary to 0 coo s page. Then Then Then Then Then Then Then Then	uld caus In this vidual dditionn Hex 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0	
	Relay Momentary Minimum-On Time: Monitor Conditions:	I KC WARRENG: premables re- monter co- However, y Nortes:	1.1 secon. In systema for failure the Fieldbus Fieldbus assed with the fieldbus assed with the fieldbu	ds only d ds only the due to exceed us Module is so your ch iff Tz v iff Tz v iff Tz v iff Tz v iff Tz v iff v	Applies when R applies when R also activation is enabled cresponsible f anges to the er properties Comparison	Additional and a set of the	t to Maer value disabil vill not 1 disabil vill not 1 disabil o Nm 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N 0 N	entary e to 0 corr s page. Then	uld caus In this vidual d. Hex Dorput Code 0x00 0x0	

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

- The Condition's output code is updated.
- Bit 16 of the system status code (see Section 17.1—System Status Code) sets to one.
- The Condition relay will close, connecting pin 3 to pin 4 of the Condition Relay connector (*Figure 4.7*).

Bit 16 and the Condition relay hold these states until a reset latch command is sent. Send the reset latch command by clicking the **Reset Latch** button on the *Snapshot* web page (refer to *Section 4.2—Snapshot Web Page (rundata.htm)*).

Condition Condition Elements:

N:	Statement number.
On / Off:	Selects which statements are to be included in the processing of conditions.
Bias:	Chooses whether the monitor condition evaluates the chosen axis before or after user bias is applied. If the "Biased" option is chosen, the axis has the current user bias subtracted before it is evaluated against the threshold. If the "Unbiased" option is chosen, the axis is compared to the threshold before the user bias is subtracted. Using unbiased data may be useful if you are trying to guard against overloading the sensor, since the unbiased data includes the weight of the application tooling, which still counts against the sensor's overload capacity even when biased out by the user

Axis:

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

Table 4.2—Monitor Conditions Statement Axis Selections				
Menu Value	Description			
blank	Statement disabled			
Fx	Fx axis			
Fy	Fy axis			
Fz	Fz axis			
Tx	Tx axis			
Ту	Ty axis			
Tz	Tz axis			

Comparison:

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

Table 4.3—Monitor Conditions Statement Comparison Selections		
Menu Value	Description	
>	Greater Than	
<	Less Than	

Counts:

The loading level to be compared to the transducer reading. This value is displayed in the units of the active configuration after the *Apply* button is clicked.

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* web page) Counts per Force value 1000000 (from *Configurations* web page) Counts = Desired Loading Level × Counts per Force

 $= 6.25 \text{ N} \times 1000000 \text{ counts/N}$

= 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 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.
Reset Latch button:	This button clears any Condition latching and reloads the Monitor Conditions page. If no Condition conditions remain true then Conditions Breached, Monitor Conditions Output, and Monitor Condition Latched are set to zero and the System Status: Condition Level Latched condition is cleared.

4.5.1 Condition Relay

The Condition relay closes its contacts when Monitor Condition Latched is true and allows external electrical equipment to react. Possible uses include control of E-stop circuits.

Relay operation is determined by the Relay Trigger, Relay Behavior, and Relay Momentary Minimum-On Time settings.

For increased reliability, it is best to monitor both the normally open (NO) and normally closed (NC) relay contacts. This allows detection of some cabling or relay issues.

The Condition relay contacts (NC, NO, and COM) are protected against overload by a resettable fuse, for electrical specifications, refer to *Section 18.3.3—Standard Condition Relay*.

4.5.1.1 Standard Net Box Condition Relay

The standard Net Box Condition relay is a mechanical relay used on 9105-NETB, and 9105-NETBA (The fieldbus Net Box has the solid-state relay described in *Section 4.5.1.2—Fieldbus Net Box and Optional Solid State Condition Relay*).

Figure 4.7—Standard Net Box Condition Relay Connector Pin Assignment (Male-pin side view)



Table 4.4—Solid-State Relay Connector Pin Descriptions					
Pin	Name	Description			
1	NO	Normally open connection			
3	NC	Normally closed connection			
4	Com	Common			



CAUTION: The solid-state relay connections are polarity dependent. A reverse-polarity connection could cause high current flow and damage the Net Box or user equipment.





Figure 4.9—Example Circuit for a Relay Interface



The standard Condition relay contacts (NC, NO, and Com) are protected against overload by a self-resetting fuse. The maximum guaranteed fuse hold current is 50 mA.

The relay will completely close its contacts within 6 ms.

4.5.1.2 Fieldbus Net Box and Optional Solid State Condition Relay

The solid-state relay is standard on 9105-CUSTOM-253, 9105-NETB–ZE3, 9105-NETB-PN and 9105-NETB-PN2, 9105-NETBA-PN and 9105-NETBA-PN2.

The optional solid-state Condition relay has a quicker activation time than the standard Condition relay. Since the solid-state Condition relay has no moving parts, wear is less likely.

Figure 4.10—Optional Solid State Relay Connector Pin Assignments (male-pin side view)



Figure 4.11—Solid-State Relay Equivalent Output Circuit



Table 4.5—Solid-State Relay Connector Pin Descriptions					
Pin	Name	Description			
1	SSR-	Solid-State Relay negative connection			
3	SSR+	Solid-State Relay positive connection			
4	—	unused			

The solid-state relay can operate at up to 30 VDC and at a maximum current of 35 mA. The relay can turn on within 500 μ s of a trigger load. The output is reverse polarity protected to up to 1 A (Vr = 1.5 V), 47 V. The maximum delay from Condition condition trigger to relay conduction is 500 μ s.



Figure 4.12—Example Connections to Solid-State Relay

4.6 Configurations Web Page (config.htm)

Specify the output parameters of the sensor system on this web page. Up to sixteen configurations can be defined. Changing configurations allows a different transducer calibration and tool transformation to be used. To implement changes on this page, click the **Apply** button.

Engineered P	Products for Robotic P	roductivity									100		En
Velcome	System Stat	us: Healthy	'										
Snapshot	Configurations												
Demo	configurat	Configurations											
Settings	User-defined of	configuratio	ons are d	isplaye	d on this	page. U	se the V	liew Config	guratio	n drop-d	own list	and the	Go
tonitor	button to disp		conngu	ration.									
Configurations	Each configura Force Units ar	ation loads Id Torque U	a transd nits. A c	ucer ca	libration. ation can	A config also ap	puration	can selec ol transfor	t the m mation	easuren to the o	nent sys	stem use ata.	d for
Communications	After you have	a created a	configur	ation .		nable it	on the (Cottingo p					
System Info	Arter you nave	e createu a	coniigui	ation, y	ou can e	nable it	on the ;	securigs p	age.				
xamples	To save the va	alues, you r	nust clic	k Apply									_
TI Web Site								View	Configu	uration:	#1 - emp	oty 🗸	Go
	Configurat	tion # 1	(Acti	ve cor	nfigura	tion)							
	Configuration Name:	empty						Maximum of	32 chara	acters			
	Calibration Select:	#1 - FT289	48 🗸										
	Calibration Type:	SI-16000-	2000										
	Force Units:	N 🗸											
	Torque Units:	Nm 🗸											
	Counts per Force:	1000000											
	Counts per Torque:	1000000											
	Force/Torque	Fx 1022	5414	Fy	5414	Fz	5414	Tx	022	Ty	022	Tz	022
	Mode:	1025	.5414	1023	.5414	1025.	5414	10129.	032	10129	.032	10129	.032
	Calibrated	Fx	10	Fy	10	Fz		Tx	0	Ту		Tz	
	Range (Units):	Calibrated se	ensing ran	ge values	s apply to t	he factory	JZ	vithout tool	transform	nation).	2		2
	Scaling	Fx		Fv		Fz		Тх		TV		Tz	
	DeviceNet		977	.,	977		977		62	.,	62		62
	and CAN:												
	Tool Transform:	A transform matrix multi specify an or 1. X-Translat 2. Y-Translat 3. Z-Translat 4. X-Rotation 5. Y-Rotation 6. Z-Rotation	transform apparent r is a matrix plication is rder of ope ion ion ion ion ion ion ion	ation will esolution x operations non-con erations,	on that can nmutative, which has	be subdi the order been set t	vided into of rotation to the foll	ngs are rep a rotation a ons and trar owing:	and a dis	placemen matters.	t/translat	ion. Since	y to
		Distance Uni in v Angle Units: degrees v	ts:]	nclation	in configure	ad dictor	co unito I	D - rotation	in confi	aurod and	lo unito		
		D = displace	ment (tra	Dy	in configur	Dz	ce units, I	Rx = rotation	in config	Ry Ry	e units.	Rz	
			0		0		0		0		0		0
	User-defined Field #1:	empty			Maximun	n of 16 ch	aracters						
	and the second se												

Figure 4.13—Configurations Web Page

View Configuration:Select the configuration to be viewed and edited. To update the web page with the
selected configuration, click the Go button.Configuration Name:Defines a name for the configuration.

Calibration Select:	Selects the transducer calibration to use for a configuration. A transducer has at least one calibration. Many Net F/T systems only have one calibration available; if an invalid calibration is selected, an "Empty Calibration Selected" error occurs.
	If a different calibration is selected, the values displayed in fields Calibration Type, Counts per Force, Counts per Torque, Calibrated Sensing Range, and Scaling Factor for DeviceNet and CAN are not updated until the Apply button is clicked.
Calibration Type:	Displays the calibration associated with the selected calibration. If a new calibration is selected, this field will not be updated until the Apply button is clicked.
Force Units:	Selects the force measurement units to use. Available force measurement units are:
	Table 4.6 Fares Unit Selections

Table 4.6—Force Unit Selections		
Menu Value	Description	
lbf	Pound-force	
Ν	Newtons	
klbf	Kilopound-force	
kN	Kilonewton	
kgf	Kilogram-force	
gf	Gram-force	

If new force units are selected, the values displayed in fields Counts per Force and Calibrated Sensing Range are not updated until the **Apply** button is clicked.

Torque Units:

Selects the torque measurement units to use. Available torque measurement units are:

Table 4.7—Torque Unit Selections			
Menu Value	Description		
lbf-in	Pound-force-inch		
lbf-ft	Pound-force-feet		
Nm	Newton-meter		
Nmm	Newton-millimeter		
kgf-cm	Kilogram-force-centimeter		
kNm	Kilonewton-meter		

If new torque units are selected, the values displayed in fields Counts per Torque and Calibrated Sensing Range are not updated until the **Apply** button is clicked.

Counts per Force: Force values in counts are equal to the force values in selected units multiplied by this factor. The application program has to divide each force counts value by the Counts per Force value to obtain the real force data (refer to *Section 9.3— Calculating F/T Values for RDT* and *Section 13.2—Calculating F/T Values for CIP*).

If the new Force Units field has been selected, this field will not be updated until the **Apply** button is clicked.

Counts per Torque:	Torque values in counts are equal to the torque values in selected units multiplied by this factor. The application program has to divide each torque counts value by the Counts per Torque value to obtain the real torque data (refer to <i>Section 9.3— Calculating F/T Values for RDT</i> and <i>Section 13.2—Calculating F/T Values for CIP</i>).
	If the new Torque Units field has been selected, this field is not updated until the Apply button is clicked.
Counts per Force/Torque in 16-bit Mode:	Shows the counts/unit used in the 16-bit interfaces (CAN, DeviceNet, TCP, and PROFINET interfaces).
Calibrated Sensing Range:	The transducer is calibrated up to these values in the selected force and torque measurement units. This applies to single-axis load conditions at the factory origin (no tool transformation). For complex load conditions, refer to the F/T Transducer Manual (<i>9620-05-Transducer Section</i> manual).
	If a new calibration is selected, a new force unit is select, or a new torque unit is selected, this field is not updated until the Apply button is clicked.
Scaling Factor for DeviceNet and CAN:	In order to reduce the amount of data transmitted via DeviceNet or CAN Bus, the force and torque values are reduced to 16 bits using this factor (refer to <i>Section 13.2.2—DeviceNet</i> and <i>Section 14.5—Calculating F/T</i> <i>Values for CAN</i>).
Tool Transform Distance Units:	This is the distance units used for the distance vector in the tool transformation. Available transform distance units are:
	Table 4.8—Tool Transform Distance Unit Selections

Table 4.8—Tool Transform Distance Unit Selections				
Menu Value	Description			
In	inch			
ft	foot			
mm	millimeter			
cm	centimeter			
m	meter			

To change the Tool Transform Distance Units does not change or rescale the tool transform values.

Tool Transform Angle Units: The angular units used for the rotation vector in the tool transformation. Available transform angle units are:

Table 4.9—Tool Transform Angle Unit Selections			
Menu Value Description			
degrees	degrees (°)		
radians	radians		

To change the Tool Transform Angle Units does not change or rescale the tool transform values.

Tool Transform:

The tool transformation function allows measurement of the forces and torques at some point other than the origin of the transducer.

Forces and torques are by default reported with respect to the factory point of origin The factory point of origin places the X, Y, and Z axes as shown on the transducer drawings on the *ATI website*.

Tool transformations are particularly useful when this point is chosen as the point-of-contact between the robotic end-effector (tool) and the object being worked. A tool transformation can translate the reported origin a distance (Dx, Dy and Dz) from the factory origin and also rotate the reported origin (Rx, Ry and Rz) about the factory origin. A tool transformation allows a coordinate frame to be created that aligns resolved force/torque components with the natural axes of the task geometry.

To keep the transducer's point of origin at the factory-defined location, all tool transform values need to be zero. Descriptions of the values and the order in which the values are applied to the factory-defined point of origin are as follows:

Table 4.10—Tool Transformation Offsets			
Column	umn Description Order		
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	

All transducer working specifications pertain to the factory point-of-origin only. This includes the transducer's range, resolution, and accuracy. The transducer working specifications at a customer-applied point-of-origin will differ from those at the factory point of-origin.

User-defined Field #1:

eld #1: Defines a short note for this configuration.

User-defined Field #2:

Defines a second short note for this configuration.

4.7 Communication Settings Page (comm.htm)

View and set system networking options on this web page. Usually these settings are set once when the system is first installed and do not need to be changed later.

For information on setting the system to work with the network, refer to Section 3-Getting Started.

Figure 4.14—Standard Net Box's Communications Page

AT	INDUSTRIAL	Net F/T				
	AUTOMATION	Force/Torque Sensor				
Engineered Brod	ISO 9001 Registered	Porce/ Torque Selisor				
Cagaterea Frodo	Constant Obstanting					
Welcome	System Status: Healthy					
Snapshot	Communications					
Demo						
Settings	These settings control how the N	Net F/T communicates with external equipment. Most settings				
Monitor Conditions		ed on and then back on before they take effect.				
Configurations	To save the values, you must cli	ck Apply.				
Communications	Ethernet Network Settings					
System Info	DIP switch 9 must be off to enable IP . regardless of the IP Address Mode set	Address Mode. If DIP switch 9 is <i>on</i> , then the IP address is set to 192.168.1.1 tings below. A LAN connection must be present at power up for DHCP to				
Examples	function. If DHCP is enabled and no D	HCP server is found, then the static IP address will be used.				
ATI Web Site	IP Address Mode:	OHCP O Static IP see above note regarding DIP switch 9				
	Static IP Address:	192.168.1.1				
	Static IP Subnet Mask:	255.255.255.0				
	Static IP Default Gateway:	0.0.0.0				
	EtherNet/IP Protocol:	O Enabled				
	Ethernet/IP O2T Data:	O Enabled				
	Ethernet/IP Data Format:	● 32-bit Signed Data ○ 16-bit Unsigned Data				
	Ethernet MAC Address:	00:16:BD:00:21:22				
	Fieldbus Module Settings					
	Starting in units shipped with firmward newer GSDML file than the file used w your unit. The GSDML file for the Net I Click this link to get the correct GSDM	e version 2.2.59, the PROFINET fieldbus module used in the Net F/T requires a ithprevious firmware versions. Make sure you have the correct GSDML file for F/T is available on ATI's website.				
	Fieldbus Module Firmware Name:	PROFINET Slave				
	Fieldbus Module Firmware Version:	1.5.16				
	Fieldbus Module Enabled:	Enabled Obisabled				
	Fieldbus Module Output Byte Order:	● Little Endian ○ Big Endian				
	CAN Network Settings					
	If power is not provided to the Pwr/CA are not correctly reported and commu	NN connector, then CAN Bus Base Address, DeviceNet MAC ID, and Baud Rate nications over the Pwr/CAN connector are not available.				
	CAN Bus Base Address:	CAN Bus O DeviceNet				
	DeviceNet MAC ID:	54 set by DIP switches 1 to 6 (inaccurate without DeviceNet connection)				
	Baud Rate:	125 kHz set by DIP switches 7 and 8				
	Raw Data Transfer (RDT) Se	ttings				
	RDT data is routed through the local n	etwork and does not get routed through the default gateway.				
	RDT Interface:	Enabled Obisabled demo application requires RDT to be enabled				
	RDT Output Rate (1 to 7000):	7000 Hz value may be rounded up; see manual for details				
	RDT Buffer Size (1 to 40):	10				
	Multi-Unit Synchronization:	Cenabled Disabled				
	Multi-Unit Id (1 to 9):	1				
	Modbus TCP Settings					
	Modbus Server					
	Modbus Client					
	Modbus Client's Tx Interval (ms)					
	Modbus Client's Server IP Address:	0.0.0.0				
	Modbus Client's Server Write Register:	0				
	Modbus Client's Server Read Register	50				
		Apply Cancel				

NOTICE: The Ethernet Network Settings only applies to the standard Ethernet and EtherNet/ IP interfaces included in all Net Boxes. The Ethernet Network Settings do not apply to the additional fieldbus interface included in fieldbus Net Boxes.

Ethernet Network Settings:

IP Address Mode: Controls how the Net F/T determines its IP Address. If DHCP is selected, it will obtain an IP address from the Ethernet network's DHCP server. If the Net Box does not receive an address from the DHCP server within 30 seconds after power up, it defaults to use the static IP settings. If Static IP is selected, the Static IP Address and Static IP Subnet Mask will be used for the IP address.

NOTICE: DHCP-assigned addresses are not permanent and may change if the Net F/T is disconnected from the network for a period of time. Users should contact their IT department for more information. Discover the changed IP address by following the instructions in *Section 6.1—Finding Net F/Ts on the Network*.

Static IP addresses are often more desirable in permanent Net F/T installations because the address will not change.

Static IP Address:	Sets the static IP address (refer to <i>Section 3.4—IP Address Configuration for Ethernet</i>). Users should contact their IT department for information on what static IP address to assign.			
Static IP Subnet Mask:	Sets the subnet mask portion of the IP address. Many networks use the default 255.255.255.0. Users should contact their IT department for information on what static IP subnet mask to assign.			
Static IP Default Gateway:	Sets the default gateway. Users should contact their IT department for information on what default gateway to assign.			
EtherNet/IP Protocol:	Controls whether or not the Net F/T uses EtherNet/IP. EtherNet/IP is only needed for industrial networks using the EtherNet/IP protocol. Most non-industrial applications leave EtherNet/IP disabled. DeviceNet protocol must be disabled when EtherNet/IP protocol is enabled.			
Ethernet/IP O2T Data	If enabled, the Net F/T accepts a 4-byte output bitmap which is identical to the Profinet bitmap in <i>Table 15.3</i> . If disabled, the Net F/T does not accept any Ethernet/ IP output data.			
Ethernet/IP Data Format:	Changes the Ethernet/IP output data between the current 32-bit values, and 16-bit unsigned values. The 16-bit unsigned values use the same 16-bit scaling factor used by the DeviceNet, CAN, and TCP interface data (see <i>Figure 13.1</i>), and since they are unsigned, a "no load" value is reported as +32768 counts, a negative full-scale load is reported as approximately 0 counts, and a positive full-scale load is reported as approximately 65536 counts.			
Ethernet MAC Address:	The unique address given to this Net F/T at the time of manufacture. This address can be used to uniquely identify this Net F/T from other Net F/Ts and other Ethernet devices.			
Fieldbus Module Setting	gs (only displays on fieldbus Net Boxes):			
Fieldbus Module Firmware:	Displays the type of fieldbus protocol supported by the fieldbus Net Box.			
Fieldbus Module Firmware Version:	Displays the version of installed firmware.			
Fieldbus Module Enabled:	If enabled, the Net Box supports the fieldbus protocol listed in Fieldbus Module Firmware. If disabled, then that fieldbus protocol is unavailable to the network.			
Fieldbus Module Output Byte Order:	If a fieldbus module is installed, adds option to select byte order (little-endian or big-endian). Only enabled if fieldbus module is installed.			

CAN Network Settings:

Protocol:	Controls which protocol will be used on the Pwr/CAN connector. When CAN Bus is selected the basic CAN protocol described in <i>Section 14—CAN Bus Operation</i> is used. When DeviceNet is selected the DeviceNet-compatibility mode protocol described in <i>Section 12—DeviceNet-Compatibility Mode Operation</i> is used. It is best to select CAN Bus when neither protocol is needed; otherwise a DeviceNet protocol failure will be signaled. EtherNet/IP protocol must be disabled when DeviceNet protocol is enabled.			
CAN Bus Base Address:	Displays the base address to be used by the CAN bus protocol. For information on setting this address, refer to <i>Section 3.9.2—Node Address</i> .			
DeviceNet MAC ID:	Displays the DeviceNet MAC ID address to be used by the DeviceNet compatibility-mode protocol. For information on setting this address, see <i>Section 3.9.2—Node Address</i> .			
Baud Rate:	Displays the CAN bus baud rate used by the CAN network. For information on setting the baud rate, refer to <i>Section 3.9.3—Baud Rate</i> .			
NOTICE: The values displayed for CAN Bus Base Address, DeviceNet MAC ID, and Baud Bate are only valid if power is supplied to the Pwr/CAN connector. Otherwise indeterminate				

Raw Data Transfer (RDT) Settings:

data is displayed.

RDT Interface:	If enabled, the Net Box establishes a point-to-point UDP connection to a host computer. In the RDT interface is described in detail. RDT data is routed through the local network and does not get routed through the default gateway (refer to <i>Section 9—UDP Interface Using RDT</i>).
RDT Output Rate:	The rate per second at which the Net Box sends streaming RDT data to a host. It can be adjusted in integer fractions of 7000 (e.g., $7000 \div 2=3500$ or $7000 \div 3=2333$). If a different sample rate is entered, the Net F/T will automatically change to the next higher possible sample rate.
RDT Buffer Size:	The RDT interface can operate in different modes. One of these is the Buffer Mode where the Net Box sends more than one data sample per package. Multiple data samples are buffered and sent in one packet. This reduces the amount of overhead data to be sent with the effect of reducing the overall network traffic. The number of data samples per packet is the Buffer Mode Size.

Modbus TCP Settings:

Modbus Server:	The internal TCP Modbus Server is active whenever it is selected on the Modbus Setting portion of the <i>Communications</i> web page. The Modbus Server supports the following Modbus commands:		
	Read Input Registers		
	Read Holding Registers		
	• Write Single Register		
	Write Multiple Registers		
	Read/Write Multiple Registers		
Modbus Client:	The internal TCP Modbus Client is active whenever selected on the Modbus Setting portion of the <i>Communications</i> web page.		
	Every "Modbus Client's Tx Interval" milliseconds the Modbus Client uses the Modbus Read/Write Multiple Registers command to write its internal registers 0 through 26 to the remote Modbus Server registers starting with the register number specified by "Modbus Client's Server Write Register". In the same command, it also reads its internal registers 27 to 42 from those in the remote Modbus Server starting with the register number specified by Modbus Client's Server Read Register. The remote Modbus Server is located at the Modbus Client's Server IP Address.		
	If the remote Modbus Server reports that it does not support the Modbus Read/ Write Multiple Registers command, the register transfers are then completed via the Read Holding Registers and the Write Multiple Registers commands.		

Table 4.11—TCP Modbus Register Map						
NetBox Register	Corresponding Robot Register	Direction (from NetBox)	Function			
0	128	Out	Force X			
1	129	Out	Force Y			
2	130	Out	Force Z			
3	131	Out	Torque X			
4	132	Out	Torque Y			
5	133	Out	Torque Z			
6	134	Out	Status MSB			
7	135	Out	Status LSB			
8	136	Out	Gage 0			
9	137	Out	Gage 1			
10	138	Out	Gage 2			
11	139	Out	Gage 3			
12	140	Out	Gage 4			
13	141	Out	Gage 5			
14	142	Out	Force Units			
15	143	Out	Torque Units			
16	144	Out	Scale Factor 0			
17	145	Out	Scale Factor 1			
18	146	Out	Scale Factor 2			
19	147	Out	Scale Factor 3			
20	148	Out	Scale Factor 4			
21	149	Out	Scale Factor 5			
22	150	Out	Counts per Force MSW			
23	151	Out	Counts per Force LSW			
24	152	Out	Counts per Torque MSW			
25	153	Out Counts per Torqu				
26	154	Out Sequence Nun				
27	155	In	System Commands			
28	156	In	Transform Distance Units			
29	157	In	Transform Angle Units			
30	158	In	Dx * 100			
31	159	In	Dy * 100			
32	160	In	Dz * 100			
33	161	In	Rx * 100			
34	162	In	Ry * 100			
35	163	In	Rz * 100			
36	164	In	MCEnable LSW			
37	165	In	MCEnable MSW			
38	166	In	WMC index			
39	167	In	WMC axis			
40	168	In	WMC output code			
41	169	In	WMC comparison			
42	170	In	WMC compare value			
		I				

4.7.1 TCP Modbus Register Map

Note: The choice of writing NetBox registers 0 to 26 to UR registers 128 to 154 (and of reading UR registers 155 to 170 into NetBox registers 27 to 42) was arbitrary and could have used any available set of contiguous UR registers of the same length. If Modbus register assignments are changed, make the corresponding register number changes in the Demo programs.

4.8 System Information Web Page (manuf.htm)

We Sna Der Set Corr Corr Sys Exa ATI

The *System Information* web page shows a summary of the system's current state. This page is used for troubleshooting by ATI Industrial Automation. For status codes, refer to *Section 17.1—System Status Code*.

Ĵ	AUT ISO 900	MATION 11 Registered		Forc	Net F/1 e/Torque :	Sensor			
Engineered Produ	icts for Robotic	Productivity						*	ST
me	System	Status: H	ealthy						-
hot			1.21						
	Syster	n Inform	ation						
igs	This is a	summary o	of the system	n's current st	ate. This inf	ormation n	nay be hel	pful during	
or Conditions	troubles	hooting.					,		
gurations	Transd	ucer							
nunications	Strain (Sage Values		G0	G1	G2	G3	G4	G5
m Info		Juge Tuldes		-2729	-788	-5192	-19287	924	-8429
oles	Bias Va	ues:		0	0	0	0	0	C
ah Site	Force/T	orque Count	s:	FX	Fy	FZ	TX	Ty 402110	TZ
eu ane	Minimu	m Deak Cou	nte:	-7704022	-10463067	-6904742	-1019023	300771	1662477
	Maximu	m Peak Cou	inte:	-7655503	-10434133	-6760070	-1013494	404622	1670335
	Huximu	In Feak Cot		FX	FV	FZ	TX	TV	Tz
	Force/T	orque Units		-7.670	-10.44	-6.862	-1.017	0.4019	1.6671
	Minimu	m Peak Unit	s:	-7.704	-10.46	-6.904	-1.019	0.3997	1.6624
	Maximu	m Peak Uni	ts:	-7.655	-10.43	-6.760	-1.013	0.4046	1.6703
				GO	G1	G2	G3	G4	G5
				FX 105698	4029	121797	5640207	-16468	-5562394
				F7 -62312	-6487301	149156	3255615	-62894	3233017
	Run-tim	ne Matrix:		TX 4700	19280	//58089	158326	/505024	13381
				TV -90794/	-300667	404082	-250641	-0/2104	260202
				TZ =1255	-2790	-7001	-239041	-4436	-472140
	C	and calli		d Canfinund		7051	100505	1100	172110
	Activo	ary of Call	orations and	d Configurat	lions				
	Using C	alibration	1.	#1: ET1954	5				
	o only c	Calibratio	ons	#1.111554	5				
	Index	Serial	Part			Configur	ations		
	Index	Number	Number	- 6	Index (Cal	ibration I	ndex) De	scription	
	1	FT28948	SI-16000-		1 (1) €	mpty			
			SI-4000-	- [2 (1) e	empty			
	2	FT28949	500		3 (1) e	empty			
	3	FT0000	empty	1 1	4 (1) €	empty			
	4	FT0000	empty		5 (1) e	empty			
	5	FT0000	empty		6 (1) e	empty			
	6	FT0000	empty		7 (1) €	empty			
	7	FT0000	empty		0 (1) 6	mpty			
	8	F10000	empty		10 (1) 6	empty			
	10	FT0000	empty	- 1	11 (1) 6	empty			
	11	FT0000	empty	- 1	12 (1) €	mpty			
	12	FT0000	empty	- 1	13 (1) 6	empty			
	13	FT0000	empty	1	14 (1) e	empty			
	14	FT0000	empty		15 (1) e	empty			
	15	FT0000	empty		16 (1) e	empty			
	16	FT0000	empty						
	Digital	Board							
	Status	Word:		0x0000000)				
	Etherne	t MAC Addr	ess:	00:16:BD:0	0:21:22				
	Serial N	lumber:		LOT 2634					
	Firmura	no Povision:		2.2.89					
	Filliwa	re Revision.		ATI Net F/T					
	Hardwa	re Revision:		02					
	Diagnor	tic ADC Bor	dinaci	0 1	2	3	4	5 6	7
	Diagnos	SUC ADC Red	iungs.	0 3	358 378	847	790	389 51	177
	Hardwa	re Product (Code:	2					
	Analog	Board							
	Power U	Jp Status W	ord:	0x0000					
	Serial N	lumber:		untested					
	Firmwa	re Revision:		2.0.3					
	Hardwa	re Revision:		untested					
	Location	Deser 147		untested					
	Analog	Board Lin	ĸ	6071					
	Rx Byte	ete (etros	ing):	1854712					
	Ry From	aing Errores	ing):	0					
	Ry Darie	v Errore		0					
	Rx Ever	nts:		6071					
	Tot Lyer								

Figure 4.15—System Information Web Page

4.9 Examples Web Page (output.htm)

The *Examples* web page shows how to interpet the bytes in the data packets exchanged over each type of interface. It includes a discussion of unsigned vs. signed integers and byte ordering (endianness). It lists example data packets for each supported interface showing how to interpret the bytes in the data packets.

AT		DUSTRIA	L N ed	Net F/T Force/Torque Sensor
Engineered Product	s for Robo	tic Productivity		40 K
Welcome	Ne	t F/T	Interfa	ce Output Examples
Snapshot	-	•		
Demo	This p F/T.	age provide	es examples of dat	a formatting for the various communication iterfaces in the Net
Settings	-			
Configurations	Def	inition	5	
Communications	Unsi	gned		
System Info	An un	signed inte	ger can only repre	sent 0 and positive numbers. This means a 16-bit unsigned
Examples	intege	r can repre	esent any number	from 0 - 2 ¹⁶⁻¹ (0-65535).
ATI Web Site	Sign	ed		
	A sign leftmo This m or it co from -	ed integer ost bit to re neans a 16- an represer 12 ¹⁵ (-	can represent neg present the negati -bit signed integer nt any negative nu -132768).	ative, 0, and positive numbers. To do this we basically use the ve sign. can represent any positive number from 0 - 2^{15-1} (0 - 32767) mber
	Big-	Endian		
	The da receiv	ata bytes a ed in that c	re ordered with the order, then the res	e most-significant byte first. If the bytes $0x12$ and $0x34$ are ulting 16-bit value is $0x1234$.
	Little	e-Endian		
	The da receiv	ata bytes a ed in that c	re ordered with the order, then the res	e least-significant byte first. If the bytes 0x12 and 0x34 are ulting 16-bit value is 0x3412.
	RDT	г		
	RDT u	ses 32-bit	signed big-endian	(not byte-swapped) F/T counts
	RDI	Request	ronnac	
	Byte 0 1 2 3 4 5 6	Value C 0x12 Required 0x34 (condition) 0x00 Comdition 0x00 Same 0x00 Same 0x00 (0 = 0x00 0	contents uest Header istant) imand Code ople Count Infinite)	
	RDT	Respons	e Format	
	KD1	Respons	eronnat	
	Byte	Value in H	lex Value in Cour	PDT Packet
	1	0x00		Sequence Number
	2	0x00		
	3	0x00	0	F/T Record Internal
	5	0x00		Sequence Number
	6	0x00		
	8	0x00	0	System Status Code
	9	0x00		
	10	0x00		
	12	0xFF	-25487	X-Axis Force (Fx)
	13	0xFF		
	15	0x71		
	16	0x00	28089	Y-Axis Force (Fy)
	1/	0x00 0x6D		
	19	0xB9		
	20	0xFF	-14	Z-Axis Force (Fz)
	22	OxFF		
	23	0xF2		
	24	0x00 0x00	26626	X-Axis Torque (Tx)
	26	0x68		
	27	0x02	2606	V Auto Tenero (Tic)
	28	0xFF 0xFF	-2080	T-AXIS TORQUE (TV)
	30	0xF5		
	31	0x82	10202	7-Avic Torquo (Tz)
	33	0x00	10303	2 mile luique (12)
	34	0x28		
	35	0x3F		

Figure 4.17—Examples Web Page (Continued)

тср	Recu	lest Format	
ICF	Requ	lest Format	
Byte	e Value	e Content	s
0	0	Command Code	
1	0	Reserved	
2	0		
3	0		
4	0		
5	0		
6	0		
1	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		
16	0	Enable Monitor Condi	tions
17		(U = Disable All Monit	tor Conditions)
18	0	System Commands	
19			
0	0x12	4660	Packet Header (Constant)
2	0x34	0	Sustam Status Codo
2	0x00	0	(All zeroes indicates "Healthy" status)
4	0x90	-25487	X-Axis Force (Ex)
5	0x71	25107	
6	0x6D	28089	Y-Axis Force (Ev)
7	0xB9		
6	0xFF	-14	Z-Axis Force (Fz)
9	0xF2		
10	0x68	26626	X-Axis Torque (Tx)
11	0x02		
12	0xF5	-2686	Y-Axis Torque (Ty)
13	0x82		
14	0x28	10303	Z-Axis Torque (Tz)
15	0x3F		
Eth			
Eu	lerne		
Ethe	rnet/IP	can use either 16-bit o	or 32-bit signed little-endian (byte-swapped) F/T count
Eth	ernet	/IP Request Form	nat
Byte	e Valu	e Contents	
0	0	Command Code	
1	0	Select Configuration (Configuration 0)	
2	0x000	00 Monitor Conditions	
3		to Activate	
Eth	ernet	/IP Response For	mat (32-bit F/T Data)
Byte	e Value	e in Hex Value in Cou	ints Contents
0	0x00 0x00	0	System Status Code
-	5400		

Byte	Value in Her	x Value in Counts	Contents
0	0x00	0	System Status Code
1	0x00		
2	0x00		
3	0x00		
4	0x71	-25487	X-Axis Force (Fx)
5	0x9C		
6	0xFF		
7	0xFF		
8	0xB9	28089	Y-Axis Force (Fy)
9	0x6D		
10	0x00		
11	0x00		
12	0xF2	-14	Z-Axis Force (Fz)
13	0xFF		
14	0xFF		
15	0xFF		
16	0x02	26626	X-Axis Torque (Tx)
17	0x68		
18	0x00		
19	0x00		
20	0x82	-2686	Y-Axis Torque (Ty)
21	0xF5		
22	0xFF		
23	0×FF		
24	0x3F	10303	Z-Axis Torque (Tz)
25	0x28		
26	0x00		
27	0x00		

DeviceNet

DeviceNet uses 16-bit signed little-endian (byte-swapped) F/T counts

Figure 4.18—Examples Web Page (Continued)

DeviceNet Response Format

Byte	Value in	Hex Value in Counts	Contents
0	0x34	4660	Packet Header (Constant)

1	0x12		
2	0x71	-25487	X-Axis Force (Fx)
3	0x9C		
4	0xB9	28089	Y-Axis Force (Fy)
5	0x6D		
6	0xF2	-14	Z-Axis Force (Fz)
7	0×FF		
6	0x02	26626	X-Axis Torque (Tx)
9	0x68		
10	0x82	-2686	Y-Axis Torque (Ty)
11	0xF5		
12	0x3F	10303	Z-Axis Torque (Tz)
13	0x28		

CAN Bus

CAN Bus can use either 16-bit or 32-bit signed little-endian (byte-swapped) F/T counts, depending on the initial request to the Net F/T.

CAN Bus Data Exchange (32-bit)

Message to Net F/T	Response from Net F/T	Base Address	Data Length in Bytes	Bytes 0- 3	Bytes 4- 7
Request 32-bit Data	2	Base Address	1	0x01 (8-bit)	N/A
-	Fx and Tx Data	Base Address +1	8	Fx Value (32-bit)	Tx Value (32-bit)
-	Fy and Ty Data	Base Address +2	8	Fy Value (32-bit)	Ty Value (32-bit)
2	Fz and Tz Data	Base Address +3	8	Fz Value (32-bit)	Tz Value (32-bit)
ê	Status and Sample Number	Base Address +4	8	System Status	Sample Number

CAN Bus Data Exchange (16-bit)

Message to Net F/T	Response from Net F/T	Base Address	Data Length in Bytes	Bytes 0- 3	Bytes 4- 7
Request 16-bit Data	2	Base Address	1	0x02 (8-bit)	N/A
-	Fx, Tx, Fy, Ty Data	Base Address +5	8	Fx Value (16-bit)	Fy Value (16-bit)
				Tx Value (16-bit)	Ty Value (16-bit)
	Fz and Tz Data, Status and Sample Number	Base Address +6	8	Fz Value (16-bit)	System Status (16-bit)
				Tz Value (16-bit)	Sample Number (16-bit)

PROFINET

PROFINET data from the Net F/T contains 16-bit little-endian (byte-swapped) F/T data.

PROFINET Response Format

Byt	e Value in He	ex Value in Counts	Contents
0	0x00	0	Status Word
1	0x00		(bits 16-31)
2	0x71	-25487	X-Axis Force (Fx)
3	0x9C		
4	0xB9	28089	Y-Axis Force (Fy)
5	0x6D		
6	0xF2	-14	Z-Axis Force (Fz)
7	OxFF		
6	0x02	26626	X-Axis Torque (Tx)
9	0x68		
10	0x82	-2686	Y-Axis Torque (Ty)
11	0xF5		
12	0x3F	10303	Z-Axis Torque (Tz)
13	0x28		
14	0x00	0	Sequence Number
15	000		

Modbus

The Modbus interface uses signed 16-bit big-endian (not byte-swapped) data.

NetBox Register	Corresponding Robot Register	Direction (from NetBox)	Function
0	128	Out	Force X
1	129	Out	Force Y
2	130	Out	Force Z
3	131	Out	Torque X
4	132	Out	Torque Y
5	133	Out	Torque Z
6	134	Out	Status MSB
7	135	Out	Status LSB
8	136	Out	Gage 0
9	137	Out	Gage 1
10	138	Out	Gage 2
11	139	Out	Gage 3
12	140	Out	Gage 4
13	141	Out	Gage 5
14	142	Out	Force Units
15	143	Out	Torque Units
16	144	Out	Scale Factor (
17	145	Out	Scale Factor :
18	146	Out	Scale Factor
19	147	Out	Scale Factor 3

Figure 4.19—Examples Web Page (Continued)

20	1.10	0.1	Carls Franks A
20	148	Out	Scale Factor 4
21	149	Out	Scale Factor 5
22	150	Out	Counts per Force MSW
23	151	Out	Counts per Force LSW
24	152	Out	Counts per Torque MSW
25	153	Out	Counts per Torque LSW
26	154	Out	Sequence Number
27	155	In	System Commands
28	156	In	Transform Distance Units
29	157	In	Transform Angle Units
30	158	In	Dx * 100
31	159	In	Dy * 100
32	160	In	Dz * 100
33	161	In	Rx * 100
34	162	In	Ry * 100
35	163	In	Rz * 100
36	164	In	MCEnable LSW
37	165	In	MCEnable MSW
38	166	In	WMC Index
39	167	In	WMC Axis
40	168	In	WMC Output Code
41	169	In	WMC Comparison
42	170	In	WMC Compare Value

4.10 ATI Web Site Menu Item

Select this link to go to the ATI Industrial Automation website. The Net F/T's Ethernet network must be connected to the Internet to reach the website.

5. Java Demo Application

The Java demo application provides a simple interface to view and collect F/T data from a connected computer. The computer must have Java version 6.0 (runtime 1.6.0) or later installed (Java can be downloaded from *www. java.com/getjava.*)

5.1 Starting the Demo

The demo can be downloaded from the *ATI Demo* web page (refer to *Section 4.3—Demo Web Page (demo. htm)*). 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.

Engineered Produ	AUTOMATION ISO 9001 Registered Force/Torque Sensor	JA
Welcome	System Status: Healthy	_
inapshot		
Demo	Demonstration Application	
Settings	The demonstration application graphically displays transducer readings.	
Monitor Conditions	The application's features include:	
Configurations	 Display of transducer loading in real time as a bar graph and a 3D cube 	
Communications	Ability to save transducer readings in CSV format	
System Info	Biasing of transducer readings to zero Reporting of communication errors	
Examples		
ATI Web Site	The demo software is available on ATI's Net F/T Software page. When starting the demo, it will ask you to enter the IP address of the sensor. The IP this Net F/T is: 10.1.0.134	address of
	Download the demo software here.	
	The application requires the Java runtime. Java can be downloaded from http://www.java.com . The sthe demo can be found in the Net F/T system documentation.	source code for

Figure 5.1—Demo Web Page

NOTICE: The Java Demo requires the Net F/T to have RDT Interface enabled. RDT is enabled in the Net F/T by default. See *Section 4.7—Communication Settings Page (comm.htm)* for information on RDT settings.

The demo program opens with the following window:

Figure	5.2-	-Net	Box	IP	Address	Request
--------	------	------	-----	----	---------	---------

Sensor A	ddress 🗾	}
?	What is the address of the sensor? 192.168.1.1 OK Cancel]

If the window does not appear, it may be hidden under the browser window. In this case, minimize the browser window to locate the address request window.

Type the IP address of the Net Box. The IP address of the Net F/T is displayed on the *Demo* web page in the paragraph above the **Download Demo Application** button. The main window of the Java Demo application should open.

The first time the demo is used it may trigger a firewall alert which is a normal response for any program using the network. In this case it is necessary to override the firewall and allow the program to use network connections. If the firewall is allowed to block connections, the utility cannot contact the Net F/T, and the users IT department must undo the firewall block.

🔐 Wind	ows Security Alert	
۲	Windows Firewall	has blocked some features of this program
Window unblock the risks	s Firewall has blocked this p this program, it will be unblo of unblocking a program?	rogram from accepting incoming network connections. If you ocked on all domain networks that you connect to. What are
<u>(</u>	Name:	Java(TM) Platform SE binary
Ē	Publisher:	Sun Microsystems, Inc.
	Path:	C:\program files\java\jre1.6.0_06\bin\javaw.exe
	Network location:	Domain network
		What are network locations?
		Keep blocking Unblock

Figure 5.3—Windows Vista Firewall Alert

Figure 5.4—Java Demo Application

<i>፼</i> 192.16	8.1.1 - ATINetFT Der	no	
Help			
Status	0x0000000	RDTSeq	1 FTSeq 3029144712
Fx	-1.077		
Fy	-4.347		
Fz	56.129		
Тх	511		
Ту	-2.796		
Tz	27.621		
Bias	•	Rotate cube by dragging mouse	
Force U	nits: N		
Torque l	Units: N-m vdov: 2		
Config N	ame: Widget Loade	er 3B	
Calibrati	ion Index: 3		$V \mid \overline{1} \mid$
Calibrati	ion Serial#: FT0124	8	
<please< td=""><td>select a file></td><td></td><td></td></please<>	select a file>		
C	Collect Streaming		
Errors			Clear

If the demo is unable to make contact with the Net F/T, the F/T values display zero, and the force units and other configuration-related items each display a question mark.

5.2 Data Display with the Demo

The main screen features a live display of the current F/T data, sequence numbers, and status code. During normal operation the application requests single records, so the RDT sequence remains constant.

5.3 Collecting Data with the Demo

To collect data, first select a file to save the data in, either by pressing the "…" button to the right of the file selection field, or by directly typing the file path into the field. Once the file is selected, click the **Start Collecting** button. The application sends a request for high-speed data to the Net F/T sensor system. The RDT sequence is incrementing now 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. Name this file with a .CSV extension; open the file with a double-click.

If collecting large amounts of data, understand any limitations of the spreadsheet or data analysis program, for example: some interfaces may have a limit on the number of rows it can collect and compute data.

☞ 192.168	3.1.1 - ATINetFT Der	no				
Help						
Status	0x0000000	RDTSeq	1	6871 FTS	eq 🗍	3031159549
Fx	-1.082					
Fy	-4.345					
Fz	56.145					
Тх	512					
Ту	-2.789					
Tz	27.623					
Bias		Rotat dragg	e cube by ing mouse			
Force Un	its: N			~~~~	╶┰╼╳	
Torque U	nits: N-m day: 2					ギ []
Config Na	ame: Widget Loade	er 3B			X	
Calibratio	on Index: 3					1/
	OSVData csv	\$				
O.INCLE 1						
E	stop Collecting					Clear
errors					L	

Figure 5.5—Java Demo Application while Collecting Data

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

Information stored in the CSV file is organized as follows:

- Line 1: Start Time. The date and time when the measurement was started.
- Line 2: RDT Sample Rate. The speed (in samples per second) at which the measurement data was sent from the Net F/T to the host computer. The speed is the RDT Output Rate defined on the *Communications* web page.
 - Note: If the sample rate is changed after start of the demo program, this value is not be updated.
- Line 3: Force Units. This is the force unit selected on the *Configuration* page.

Line 4:	Counts per Unit Force. All force values Fx, Fy, Fz in the CSV file must be divided by this number to get the force values in the selected unit.
Line 5:	Torque Units. This is the torque selected on the Configuration page.
Line 6:	Counts per Unit Torque. All torque values Tx, Ty, Tz in the CSV file must be divided by

abor to got the torque values in the selected -----

	this number to get the torque values in the selected unit.				
Line 7:	Header Row. This row names each of the columns of CSV data.				

Table 5.1—CSV File Column Headings										
Column:	Α	В	С	D	Е	F	G	Н	I	J
Name:	Status (hex)	RDT Sequence	F/T Sequence	Fx	Fy	Fz	Тх	Ту	Tz	Time

Column A: Status (hex) is the 32-bit system status code for this row. Each bit signals a certain diagnostic condition. Normally this code is zero. A non-zero status code normally means that the Net F/T system needs attention. For a detailed description of the status code, refer to Section 17.1-System Status Code.

Column B: RDT Sequence is a number that starts at one and is incremented with each set of data that is sent from the Net F/T to the host computer.

Elapsed measurement time can be found with using the formula:

Elansod Moasuromont Timo –	RDT Sequence Number		
Elapsea measurement 1 ime –	RDT Sample Rate		

Missing sequences indicate that data packages were lost. To avoid lost samples, refer to Section 16.1—Improving Ethernet Throughput.

- Column C: F/T Sequence is a number that is incremented with each new F/T measurement. The Net F/T measures at a constant rate of 7000 samples per second.
- Column D: Fx is the Fx axis reading in counts.
- Column E: Fy is the Fy axis reading in counts.
- Column F: Fz is the Fz axis reading in counts.
- Column G: Tx is the Tx axis reading in counts.
- Column H: Ty is the Ty axis reading in counts.
- Column I: Tz is the Tz axis reading in counts.
- Column J: Time is the time the demo program received the data row from the Net F/T. This time stamp is created by the computer and is limited to the clock resolution of the computer.

	1									
	A	В	С	D	E	F	G	H		L
1	Start Time: 1	0/28/08 4:45 PM								
2	RDT Sample	Rate: 7000								
3	Force Units:	N								
4	Counts per U	nit Force: 10000	00.0							
5	Torque Units	: N-m								
6	Counts per U	nit Torque: 1000	0.000							
7	Status (hex)	RDTSequence	F/T Sequence	Fx	Fy	Fz	Тх	Ту	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
H.	\mapsto 🕨 NetFT	CSVData 🖉 🎾					I 4 📄			► I

Figure 5.6—Sample Data Opened in Spreadsheet

5.4 The Errors Display of the Demo

The error list at the bottom of the screen keeps track of errors that have occurred and the times they occurred, for example, refer to *Figure 5.7*. For help with error messages, refer to *Table 17.5*. If there is excessive IO Exception: Receive timed out errors, refer *Section 16.1—Improving Ethernet Throughput*.

192.168.1.1 - ATINetFT Demo
Help
Status 0x00000000 RDTSeq 1 FTSeq 3029144712 Fx -1.077
-2./ 90
Tz 27.621
Bias Rotate cube by dragging mouse
Force Units: N Torque Units: N-m Config Index: 2 Config Name: Widget Loader 3B Calibration Index: 3 Calibration Serial#: FT01248 <please a="" file="" select=""> Collect Streaming Errors Clear 12:30:03 PM - IO Exception: Receive timed out</please>

Figure 5.7—Java Demo Application with an Error Message

5.5 Developing a Custom Java Application

Experienced Java programmers can develop Net F/T applications using the files located at: *https://www.ati-ia.com/Products/ft/software/net_ft_software.aspx*. The source code for the Java demo is included in the downloadable directory.

6. Net F/T Configuration Utility

The *Net F/T Configuration Utility* is a Windows program that can find Net F/Ts on an Ethernet network, back-up configurations to a computer, restore configurations, and display saved configuration files.

The utility's installation package is in the *Configuration Utilities* directory that can be downloaded at: *https://www.ati-ia.com/Products/ft/software/net_ft_software.aspx*. Install the file by opening the *NetFT_Configuration_Utility_Setup.msi* file. The utility is installed within the *ATI Industrial Automation Item* in the program list of Windows' **Start** menu.

Figure 6.1—Net F/T Configuration Utility

6.1 Finding Net F/Ts on the Network

Launch Net F/T Configuration Utility. Click the Find Net F/T button.

0		0	
🥏 Net F/T Confi	guration Utility		X
File Help			
Backup Configuration	Restore Configuration	Preview Backu Configuration Fil	e
MAC Address:	none	Cod Not D/T	
IP Address:	none	Find Net F/1	

If the system has multiple connections to Ethernet a **Select Connection** window appears. If this is the case, click on the entry 192.168.1.100, and then click **OK**.



Select Connection	J
Select the active network connection that you would like to use to search for Net F/Ts.	
fe80::e172:6165:e78:cf30%9 fe80::5efe:192.168.1.100%10 192.168.1.100	
ОК	11

The first time the utility is used it may trigger a firewall alert and is a normal response for any program that uses the network. In this case override the firewall to allow the program to use network connections. If the firewall is told to block connections the utility is not able to contact the Net F/T. In this case, the users IT department must undo the firewall block.

If the firewall alert appears, it is unlikely that the utility found a Net F/Ts during that search. In this case, click the **Find Net F/T** button again and start over.

Figure 6.3—Windows	S Vista Firewall Alert
--------------------	------------------------

🔐 Wind	lows Security Alert	
۲	Windows Firewal	I has blocked some features of this program
Window unblock the risk	s Firewall has blocked this p this program, it will be unbl s of unblocking a program?	program from accepting incoming network connections. If you locked on all domain networks that you connect to. What are
	Name:	NetFT Configuration Utility
e a construction de la construct	Publisher:	ATI Industrial Automation
	Path:	C:\program files\ati industrial automation\netft configuration
	Network location:	Domain network
		What are network locations?
		Keep blocking Unblock

After a slight delay, the program reports back all Net F/Ts found on the network(s). Locate the line that has a MAC ID that matches the MAC ID printed on the Net Box and remember the IP address listed.

Note that the MAC ID listed may have a different format from the Net Box's printed label. In the following example, *Figure 6.4*, the MAC ID is 00-16-BD-00-00, which matches the printed label MAC ID: 0016BD000000 and the IP address is 192.168.1.1.

Figure 6.4—Net F/Ts Found

MAC: 00-16 MAC: 00-16	3-BD-00-00-00 3-BD-00-00-02	IP:192.168.1 IP:192.168.1	1.1 1.4		
MAC: 00-16	BD-00-00-04	IP:192.168.1	1.16		

The IP address discovered is the address assigned by the DHCP server. Use this address to communicate with the Net F/T. Click on this line and then click on **OK**.

NOTICE: If the *Net FT Configuration Utility* found the Net F/T, but the internet browser is unable to open the found IP address, clear previous device entries from the computer's ARP table by restarting the computer or, with administrative privileges, by going to the computer's **Start** menu, selecting **Run**..., and typing "arp -d *".

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

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

6.2 Backing Up a Configuration to a Computer

The *Net F/T Configuration Utility* can read the configurations stored in a Net F/T and store them on the local computer. A replacement Net F/T can be easily be set-up to replace a damaged Net F/T by restoring a previously backed up configuration file to the new Net F/T. The configuration file contains all user-settable Net F/T information.

To back-up a Net F/T, first launch *Net F/T Configuration Utility*. Select the desired Net F/T using the steps in *Section 6.1—Finding Net F/Ts on the Network*.

Next, click on the **Backup Configuration** button to start the process. A save file dialog window appears. Select a location and file name for the configuration file and click **OK**.

The utility takes a few moments to save the information.

🥏 Net F/T Confi	guration Utility		
File Help			
Backup Configuration	Restore Configuration Preview Backup Configuration File		
MAC Address:	00:16:BD:00:02:F2		
IP Address:	10.1.1.127		
Visit the Net F/T's Web Server			
Reading user sett	Reading user settings		

Figure 6.5—Backup Configuration

NOTICE: The NETBA type Net Boxes also contain calibration information for its transducer(s). This transducer calibration information is not saved by the utility. Replacement NETBA type Net Boxes will need to have the transducer calibrations loaded by another method. Contact ATI Industrial Automation for more information.

NETB type Net Boxes do not contain transducer calibration information.

6.3 Restoring a Saved Configuration

A previously-saved configuration file can be loaded into a Net F/T using the restore configuration feature.

To restore a configuration, first launch *Net F/T Configuration Utility*. Select the desired Net F/T using the steps in *Section 6.1—Finding Net F/Ts on the Network*.

Next, click on the **Restore Configuration** button to start the process. An open file dialog window appears. Select a location and file name of the configuration file, and click OK.

A confirmation message appears before the configuration file is loaded into the Net F/T.

Figure 6.6—Restore Confirmation



After the configuration file has been loaded, a completion message appears (refer to *Figure 6.7*). Click **OK** to dismiss the message. Power cycle the Net F/T to finish the restoration.

Figure 6.7—Restoration Complete

Complete	×
Configuration restored to 00:16:BD:00:02:F2 Changes to communication settings will not take effect until the cycled.	Net F/T is power
	ОК

6.4 Inspecting a Saved Configuration File

Use the Net F/T Configuration Utility to view some of the information stored in a saved configuration file.

To view a configuration, first launch *Net F/T Configuration Utility*. Click the **Preview Backup Configuration File** button. An open file dialog window appears. Select a location and file name of the configuration file and click OK.

A preview window opens. When finished, click **Close** to dismiss the window.

Figure	6 8-	Backun	Configuration	Filo	Proview
Iguie	0.0-	-Баскир	connyuration	I IIE	FIEVIEW

Configuration Name:	Widget Loader 3B	Transform Distance Units:	mm (millimeter)
Calibration Select:	FT01248	Transform Angle Units:	degrees
Force Units:	N	Transform:	0. 0. 0. 0. 0. 0
Torque Units:	N-m	User-defined Field #1:	
roiquo orino.		User-defined Field #2:	
User Settings			
Active Configuration:	1	✓ Peaks Enabled	
Filter Cutoff Freq.:	No Filter	Monitor Conditions Ena	bled
Bias Vector:	0, 0, 0, 0, 0, 0		
Communication Setting	js		
IP Address:	192.168.1.1	✓ DHCP Enabled	
Subnet Mask:	255.255.255.0	EtherNet/IP Enabled	
Default Gateway:	0.0.0.0	DeviceNet Enabled	
Sample Rate:	7000	Quick Connect Enable	d
Multi-Unit ID:	1	✓ RDT Enabled	
Buffer Mod Size:	10	Multi-Unit Synch Enable	ed

7. Common Gateway Interface (CGI)

The Net F/T 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://<netFTAddress>/<CGIPage.cgi>?<firstVariableAssignment><&nextVariableAssignment>

where:

http://	indicates an HTTP request
<netftaddress></netftaddress>	is the Ethernet address of the Net F/T system
/	a separator
<cgipage.cgi></cgipage.cgi>	the name of the CGI page that holds the variables to be accessed
?	a separator marking the start of variable assignments
<firstvariableassignment></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 Net 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 Net F/T. Exceeding the maximum length may result in an error or variables being incorrectly set.

7.1 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. For related information, see *Section 4.4—Settings Web Page (setting.htm)*.

Table 7.1—setting.cgi Variables							
Variable Name	Allowed Values	Description					
setcfgsel	integers: 0 to 15	Sets the ac one less the	tive configuration the config	ation. Note t uration num	hat the value bers displaye	e used by <i>se</i> ed on the we	t <i>cfgsel</i> is b pages.
		Sets the cu	toff frequenc	y of the low-	pass filtering	as follows:	
		Value	Cutoff	Value	Cutoff	Value	Cutoff
	integers: 0 to 12	0	no filter	5	35 Hz	10	2000 Hz
setuserfilter		1	838 Hz	6	18 Hz	11	2500 Hz
		2	326 Hz	7	8 Hz	12	3000 Hz
		3	152 Hz	8	5 Hz		•
		4	73 Hz	9	1500 Hz		
setpke	integers: 0 or 1	Enable (val	ue = 1) or di	sable (value	= 0) peak lo	gging	
setbias <i>n</i>	integers: -32768 to 32767	Sets the off zero the bia starting at z	set value for as of the four zero.)	strain gage th strain gag	<i>n</i> . For exam ge (Strain gag	ple, <i>setbias3</i> ges are enur	}=0 would nerated

7.2 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 7.2—moncon.cgi Variables						
Variable Name	Allowed Values	Description				
setmce	Integers: 0 or 1	Enable (value = 1) or di processing.	Enable (value = 1) or disable (value = 0) all Condition statement processing.			
mce <i>n</i>	Integers: 0 or 1	Enable (value = 1) or disable (value = 0) Condition statement n.				
		Selects the axis evaluat	ted by Condition stateme	nt <i>n</i> .		
		Value	Description	Menu Value		
		-1	Statement disabled	blank		
	Integers: -1 to 5	0	Fx axis	Fx		
mcx <i>n</i>		1	Fy axis	Fy		
		2	Fz axis	Fz		
		3	Tx axis	Тх		
		4	Ty axis	Ту		
		5	Tz axis	Tz		
mcv <i>n</i>	Integers: -2147483648 to +2147483647	Sets the counts value to compare the current axis value by Condition statement <i>n</i> .				
mco <i>n</i>	Hexadecimal: 0x00 to 0xFF	Sets the output code for Condition statement <i>n</i> .				
where	e <i>n</i> is an integer ra	nging from 0 to 15 repres	senting the Condition stat	ement index		

7.3 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.

For related information, refer to Section 4.6-Configurations Web Page (config.htm).

Table 7.3—config.cgi Variables					
Variable Name	Allowed Values	Description	Description		
cfgid	integers: 0 to 15	Zero-based index of the variable is required for a	e configuration to be set during all calls to config.cgi.	g this CGI call. This	
cfgnam	Text string of up to 32 characters	Sets the configuration n	Sets the configuration name.		
cfgcalsel	integers: 0 to 15	Sets the calibration use	Sets the calibration used by the configuration.		
		Sets the force units used by the configuration. the <i>Counts per Force</i> and <i>Max Ratings</i> values web page.		This value determines on the config.htm user	
		Value	Description	Menu Value	
		1	Pound-force	lbf	
ctgtu	Integers: 1 to 6	2	Newtons	Ν	
		3	Kilopound-force	klbf	
		4	Kilonewton	kN	
		5	Kilogram-force	kgf	
		6	Gram-force	gf	
		The torque units used by the configuration. This value determines the <i>Counts per Torque</i> and <i>Max Ratings</i> values on the config.htm user w page.			
		Value	Description	Menu Value	
		1	Pound-force-inch	lbf-in	
cfgtu	Integers: 1 to 6	2	Pound-force-feet	lbf-ft	
		3	Newton-meter	Nm	
		4	Newton-millimeter	Nmm	
		5	Kilogram-force-centimeter	kgf-cm	
		6	Kilonewton-meter	kNm	
		The distance measurement units used by the configuration's tool transformation.			
		Value	Description	Menu Value	
afait 1		1	inch	in	
cfgtdu	Integers: 1 to 5	2	foot	ft	
		3	millimeter	mm	
		4	centimeter	cm	
		5	meter	m	
		The rotation units used	by the configuration's tool tra	nsformation.	
ofatou	Integeroy 1 or 2	Value	Description	Menu Value	
Gigtau		1	degrees (°)	degrees	
		2	radians	radians	
cfgtfx0	Floating point	Sets the tool transformation distance units.	tion distance Dx. Distance m	ust be in <i>cfgtdu</i>	
cfgtfx1	Floating point	Sets the tool transformation distance units.	tion distance Dy. Distance m	ust be in <i>cfgtdu</i>	

Table 7.3—config.cgi Variables			
Variable Name	Allowed Values	Description	
cfgtfx2	Floating point	Sets the tool transformation distance Dz. Distance must be in <i>cfgtdu</i> distance units.	
cfgtfx3	Floating point	Sets the tool transformation rotation Rx. Rotation must be in <i>cfgtau</i> angular units.	
cfgtfx4	Floating point	Sets the tool transformation rotation Ry. Rotation must be in <i>cfgtau</i> angular units.	
cfgtfx5	Floating point	Sets the tool transformation rotation Rz. Rotation must be in <i>cfgtau</i> angular units.	
cfgusra	Text string of up to 16 characters	Stores text in user-defined field #1.	
cfgusrb	Text string of up to 16 characters	Stores text in user-defined field #2.	
7.4 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 7.4—comm.cgi Variables						
Variable Name	Allowed Values	Description				
		Sets DHCP behavior.				
		Value	Description			
comnetdhcp	Integers: 0 or 1	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 b disabled.	e used when DHCP is			
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.				
comeipe	Integers: 0 or 1	Enable (value = 1) or disable (value = 0) EtherNet/IP protocol. Basic CAN protocol must be selected when EtherNet/IP protocol is enabled.				
		Selects CAN bus protocol.				
		Value	Description			
		0	Basic CAN protocol			
mcxn	Integers: -1 to 5	1	DeviceNet compatibility-mode protocol			
		EtherNet/IP protocol must be disabled when DeviceNet protocol is selected.				
comrdte	Integers: 0 or 1	Enable (value = 1) or disable	(value = 0) RDT interface.			
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.				

8. System Settings XML Pages

The Net F/T's current settings can be retrieved in XML format using standard Ethernet HTTP requests and enables programs to read system settings such as the Counts per Force value. The Net F/T's Java demo application uses data provided in these *XML* pages to correctly scale displayed data.

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

Table 8.1—Types Used by XML Elements			
Data Type	Description		
DINT	Signed double integer (32 bit)		
ENABL	Boolean using Enabled to represent 1 and Disabled to represent 0		
HEXn	Hexadecimal number of <i>n</i> bits, prefixed with <i>0x</i> .		
INT	Signed integer (16 bit)		
REAL	Floating-point number (32 bit)		
SINT	Signed short integer (8 bit)		
STRING <i>n</i>	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.

8.1 System and Configuration Information (netftapi2.xml)

The XML page netftapi2.xml retrieves the system setup and active configuration. To retrieve information about other configurations, those configurations must be made active prior to the request.

A configuration index can be specified when requesting this configuration information. This is done by appending ?index=n to the request, where n is the index of the desired configuration. If a configuration index is not specified, the active configuration is assumed.

For example, to retrieve configuration information for the second configuration the requested page would be netftapi2.xml?index=1.

The reference column in *Table 8.2* indicates which .htm page and .cgi function access this element. For related information, refer to the corresponding entry in *Section 4—Web Pages* or *Section 7—Common Gateway Interface (CGI)*.

Manual, F/T, Net F/T Document #9620-05-NET FT-23

Table 8.2—XML Elements in netftapi2.xml				
XML Element	Data Type	Description	Reference	
runstat	HEX32	System status code	-	
runft	DINT[6]	Force and torque values in counts	rundata	
runpkmx	DINT[6]	Maximum peak values in counts	rundata	
runpkmn	DINT[6]	Minimum peak values in counts	rundata	
runsg	INT[6]	Strain gage values	rundata	
runmcb	HEX32	Conditions breached	rundata	
runmco	HEX8	Monitor Conditions Output	rundata	
runmcl	USINT	Monitor Condition Latched	rundata	
setcfgsel	USINT	Active configuration	setting	
setuserfilter	USINT	Low-pass filter cutoff frequency menu selection	setting	
setpke	USINT	Peak monitoring processing status	setting	
setbias	DINT[6]	Software bias vector	setting	
setmce	USINT	Condition processing status	moncon	
mce	USINT[16]	Condition statements' individual enabling	moncon	
mcx	USINT[16]	Condition statements' selected axes	moncon	
mcc	USINT[16]	Condition statements' comparisons	moncon	
mcv	DINT[16]	Condition statements' counts values for comparison	moncon	
mco	HEX8[16]	Condition statements' output codes	moncon	
cfgnam	STRING32	Name of active configuration	config	
cfgcalsel	USINT	Calibration used by active configuration	config	
cfgcalsn	STRING8	Serial number of active configuration's calibration	config	
cfgfu	USINT	Force units used by active configuration	config	
scfgfu	STRING8	Name of force units used by active configuration	config	
cfgtu	USINT	Torque units used by active configuration	config	
scfgtu	STRING8	Name of torque units used by active configuration	config	
cfgcpf	DINT	Counts per force as determined by the active configuration settings	config	
cfgcpt	DINT	Counts per torque as determined by the active configuration settings	config	
cfgmr	REAL[6]	Calibrated sensing ranges in units as determined by the active configuration settings	config	
cfgtdu	USINT	Tool transformation distance units used by active configuration	config	
scfgtdu	STRING16	Name of tool transformation distance units used by active configuration	config	
cfgtau	USINT	Tool transformation rotation units used by active configuration	config	
scfgtau	STRING8	Name of tool transformation rotation units used by active configuration	config	
cfgtfx	REAL[6]	Tool transformation distances and rotations applied by active configuration	config	
cfgusra	STRING16	User-defined field #1 for the active configuration	config	
cfgusrb	STRING16	User-defined field #2 for the active configuration	config	
comnetdhcp	ENABL	DHCP behavior setting	comm	

Table 8.2—XML Elements in netftapi2.xml					
XML Element	Data Type	Description		Reference	
comnetip	STRING15	Static IP address	Static IP address		
comnetmsk	STRING15	Static IP subnet mask		comm	
comnetgw	STRING15	Static IP gateway		comm	
comeipe	ENABL	EtherNet/IP protocol setting		comm	
nethwaddr	STRING17	Ethernet MAC Address		comm	
comdnte	ENABL	CAN bus protocol setting		comm	
comdntmac	USINT	DeviceNet MAC ID		comm	
		CAN network baud rate:			
		Value	Baud Rate		
comdntbaud USINT		0	125 kHz		
	USINT	1	250 kHz	Comm	
		2	500 kHz		
		3	SoftSet		
comrdte	ENABL	RDT interface setting comm			
comrdtrate	UDINT	RDT output rate comm			
comrdtbsiz	USINT	RDT Buffer Mode buffer size comm			
mfgdighwa	STRING17	Ethernet MAC Address		manuf	
mfgdigsn	STRING8	Digital board serial number		manuf	
mfgdigver	STRING8	Digital board firmware revision	Digital board firmware revision manuf		
mfgdigrev	STRING8	Digital board hardware revision manuf			
mfganasn	STRING8	Analog board serial number manuf			
mfganarev	STRING8	Analog board hardware revision manuf			
mfgtxdmdl	STRING16	Analog board location		manuf	
netip	STRING15	IP address in use		-	
runrate	UDINT	Internal sample rate for strain gag	ge collection	_	

8.2 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 Net F/T's configuration settings.

A calibration index can be specified when requesting this calibration information. Specify the index 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 is assumed.

For example, to retrieve calibration information for the third calibration the requested page would be *netftcalapi.xml?index*=2.

Table 8.3—XML Elements in netftcalapi.xml				
XML Element Data Type Calibration Information				
calsn	STRING8	Serial number		
calpn	STRING32	Calibration type		
caldt	STRING20	Calibration date		
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		
calsf	DINT[6]	Scaling factor for DeviceNet and CAN		
calusra	STRING16	Calibration note field #1		
calusrb	STRING16	Calibration note field #2		

9. UDP Interface Using RDT

The Net F/T can output data at up to 7000 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 Net 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.

9.1 RDT Protocol

There are six commands in the RDT protocol and are listed in *Table 9.1*. Any command received by the Net F/T takes precedence over any previously-received commands.

Table 9.1—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)			
0x0041	Reset Condition Latch	none			
0x0042	Set Software Bias	none			

The streaming modes are further described in *Table 9.2*.

Table 9.2—Streaming Modes				
Mode	Command	Speed	Situation Best Suited To:	
0x0002	Start high-speed real-time streaming	Fast (up to 7000 Hz)	Real-time response applications.	
0x0003	Start high-speed buffered streaming	Fast (up to 7000 Hz), but comes in bursts (buffers)	Collecting data at high speed, but not responding to it in real-time. Buffer size is set on the <i>Communication Settings</i> web page. See Section 4.7—Communication Settings Page (comm.htm).	

To start the Net F/T outputting RDT messages, first send an RDT request to it. The Net 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 Net F/T data. Net 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, Net F/T RDT streaming modes should only be used at high output rate when absolutely necessary.

NOTICE: All Net 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 Net 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 9.1*. 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<sup>32</sup>-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<sup>32</sup>-1)
                        Contains the system status code at the time of the record.
status:
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)*.

9.2 Extended RDT Requests

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 extended RDT request format is used when the Net 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 Net F/T stream data is sent to a multicast address so that multiple clients can receive the stream at once.

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.

9.3 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. See cfgcpf and cfgcpt in *Section 8.1—System and Configuration Information (netftapi2.xml)*.

9.4 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).

9.5 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. For details, refer to *Section 16.1—Improving Ethernet Throughput*.

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 $28 \ \mu s$.

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

9.6 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*.

10. TCP Interface

10.1 General

5

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.

10.2 Command Codes

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

10.3 Read F/T Command

C C								
uint8	comman	d;	/*	Must	be RE	CADFT (0).*	۲ /
uint8	reserve	ed[15];	/*	Shou	ld be	all Os	. */	
uint16	MCEnable;	/* Bitr	nap	of M	Cs to	enable	. */	
uint16	sysCommands;	/* Bitr	nap	of s	ystem	comman	.ds. */	<i>'</i>
}								

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.

Manual, F/T, Net F/T Document #9620-05-NET FT-23

{

10.4 Read F/T Response

```
{
uint16 header;
                  /* always 0x1234. */
                  /* Upper 16 bits of status code. */
uint16 status;
int16 ForceX;
                  /* 16-bit Force X counts. */
int16 ForceY;
                 /* 16-bit Force Y counts. */
int16 ForceZ;
                 /* 16-bit Force Z counts. */
                  /* 16-bit Torque X counts. */
int16 TorqueX;
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 \times calibration counts per unit \div 16-bit scaling factor). The counts per unit and scaling factor are read using the read calibration information command.

10.5 Read Calibration Info Command

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

10.6 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 \times calibration counts per unit \div 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

10.7 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.

{

10.8 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. */
}
```

10.9 Write Response

{

}

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

11. EtherNet/IP Operation

11.1 Overview

The Net F/T operates as a Server on the EtherNet/IP network and supports Class 3 Connected Explicit Messaging. UCMM Explicit Messaging, and Class 1 Connected Cyclic I/O Messaging. EtherNet/IP network supports one input-only connection and does not support a listen-only connection. The Net F/T does not support any Client functionality.

EtherNet/IP uses the CIP protocol described in Section 11-EtherNet/IP Operation.

EtherNet/IP Protocol must be enabled on the *Communications* page to use EtherNet/IP (refer to *Section 4.7—Communication Settings Page (comm.htm)*).

Table 11.1—Class 1 Connection Information Parameters					
Case	Instance	Size (bytes)	RT Transfer Format	Connection Type	
Configuration	128	0	n/a	n/a	
Input (Target to Originator)	100	28	Modeless	Point-to-Point	
Output (Originator to Target) Ethernet/IP O2T Data Disabled	102	0	Modeless	Point-to-Point	
Output (Originator to Target) Ethernet/IP O2T Data Enabled	102	4	Run/Idle	Point-to-Point	

11.2 Module and Network Status LED

The module status LED is identified on the Net Box as MS. It provides device status for power and proper operation. The EtherNet/IP network status LED is identified on the Net Box as NS EN. For an outline of the LED operation, refer to *Figure 3.17* and *Table 3.4*.

12. DeviceNet-Compatibility Mode Operation

12.1 Overview

The Net F/T operates as a Group 2-Only Server on the DeviceNet network and supports Explicit Messaging and Polled I/O messaging for the predefined Master/Slave Connection set. The Net F/T DeviceNet Node supports the Unconnected Message Manager (UCMM).

DeviceNet-compatibility mode uses the CIP protocol described in *Section 13—EtherNet/IP and DeviceNet CIP Model*.

To use the Net F/T's DeviceNet-Compatibility Mode:

- DeviceNet must be selected on the *Communications* page (refer to *Section 4.7—Communication Settings Page (comm.htm)*).
- Power must be present on the Pwr/CAN connector.

12.2 MAC ID

The MAC ID is set by either hardware or software configuration to a value from 0 to 63. In order for the MAC ID to be set by software, DIP switch positions 1 through 8 must be ON. If the MAC ID is set by software, the baud rate must also be set by software. For more information, refer to *Section 3.9.2—Node Address* and *Table 3.2*. The factory set MAC ID is 54.

12.3 Baud Rate

Baud Rate is set by either hardware or software configuration to 125 kbps, 250 kbps or 500 kbps. The baud rate will be set by software when DIP switch positions 7 and 8 are ON. For more information, refer to *Section 3.9.3—Baud Rate* and *Table 3.3*. The factory set baud rate is 500 kbps.

12.4 Module and Network Status LED

The module status LED is identified on the Net Box as MS. It provides device status for power and proper operation. The DeviceNet network status LED is identified on the Net Box as NS DN. For an outline of the LED operation, refer to *Figure 3.17* and *Table 3.4*.

12.5 EDS File

The DeviceNet Electronic Data Sheet (EDS) file for the system is in the \EDS directory and can be downloaded at: *https://www.ati-ia.com/Products/ft/software/net_ft_software.aspx*.

13. EtherNet/IP and DeviceNet CIP Model

13.1 Overview

The Net F/T operates as a Group 2-Only Server on the DeviceNet network. It supports Explicit Messaging and Polled I/O messaging for the predefined Master/Slave Connection set. The Net F/T DeviceNet Node does support the Unconnected Message Manager (UCMM).

The Net F/T operates as a Server on the EtherNet/IP network. It supports Class 3 Connected Explicit Messaging, UCMM Explicit Messaging and Class 1 Connected Cyclic I/O Messaging. The Net F/T does not support any Client functionality.

EtherNet/IP and DeviceNet protocols cannot be enabled at the same time.

Table 13.1—Name and Data Value				
Name	Data Value			
Vendor Number	555			
Device Type	0			
Product Code Number	1			
Product Name	ATI Industrial Automation F/T			

Table 13.2—DeviceNet Input Bitmap				
WORD (16-bit)	Name			
0	Status word, bits 16 through 31			
1	Fx (16-bit)			
2	Fy (16-bit)			
3	Fz (16-bit)			
4	Tx (16-bit)			
5	Ty (16-bit)			
6	Tz (16-bit)			

Table 13.3—EtherNet/IP Input Bitmap				
DWORD (32-bit)	Name			
0	Status word (32-bit)			
1	Fx (32-bit)			
2	Fy (32-bit)			
3	Fz (32-bit)			
4	Tx (32-bit)			
5	Ty (32-bit)			
6	Tz (32-bit)			

Manual, F/T, Net F/T Document #9620-05-NET FT-23

There is no output data if the Ethernet/IP O2T Data option on the *Communications* page (*Section 4.7—Communication Settings Page (comm.htm)*) is disabled.

Table 13.4—Ethernet/IP Output Mapping						
Byte	BitNumber	Name	Description/Function			
	0	Bias	Perform tare function to zero out any load reading			
	1	Reset Latch	Reset Condition latch			
	2	reserved	reserved			
0	3	reserved	reserved			
0	4	reserved	reserved			
	5	reserved	reserved			
-	6	reserved	reserved			
	7	reserved	reserved			
	0	Config Select bit 0				
	1	Config Select bit 1	Colorto o Not E/T configuration from 0 to 15			
	2	Config Select bit 2	Selects a Net F/T configuration, from 0 to 15			
4	3	Config Select bit 3				
I	4	reserved	reserved			
	5	reserved	reserved			
	6	reserved	reserved			
	7	reserved	reserved			
2	0-7	Condition high	Condition enable mask, high byte			
3	0-7	Condition low	Condition enable mask, low byte			

13.2 Calculating F/T Values for CIP

13.2.1 EtherNet/IP

For 16-bit format: to obtain the real force and torque values, a "no load" value is reported as +32768 counts, a negative full-scale load is reported as approximately 0 counts, and a positive full-scale load is reported as approximately 65536 counts. Each received force value has to be divided by (*Counts per Force* \div *Scaling Factor for DeviceNet and CAN*) for the axis and each received torque value has to be divided by (*Counts per Torque* \div *Scaling Factor for DeviceNet and CAN*) for the axis.

NOTICE: Be sure to use the scaling factors from the appropriate configuration which is usually the active configuration.

For 32-bit format: 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 the *Configurations* web page (refer to *Section 4.6—Configurations Web Page (config.htm)*).

13.2.2 DeviceNet

In order to reduce the amount of data transmitted over DeviceNet, the force and torque values are reduced to 16 bits using the Scaling Factor for DeviceNet and CAN values (see *Figure 13.1*) before they are transmitted.

To obtain the force and torque values in user units, each received force value has to be divided by (*Counts per Force* \div *Scaling Factor for DeviceNet and CAN*) for the axis and each received torque value has to be divided by (*Counts per Torque* \div *Scaling Factor for DeviceNet and CAN*) for the axis.

NOTICE: Be sure to use the scaling factors from the appropriate configuration which is usually the active configuration.

The Counts per Force, Counts per Torque, and Scaling Factor for DeviceNet and CAN factors can be found on *Configurations* web page (refer to *Section 4.6—Configurations Web Page (config.htm)*).



Cambration Type:	Identity				
Force Units:	N				
12152412020					
Torque Units:	Nm -				
Counts per Force:	1				
Counts per Torque:	1				
Calibrated Sensing Rang (Units):	•				
Fx	Fγ	14	TE	τv	
32768	32768	32768	32768	32768	327
	1	1	1	1	1
Tool Transform Distance	in 🕞				
Units: Tool Transform Angle Ur	its: degrees +				
Units: Tool Transform Angle Ur Tool Transform:	uts: degrees -	Dz	R×.	By	
Units: Tool Transform Angle Ur Tool Transform: On 0	ov 0	Dx 0	Rx 0	Ry 0	0
Units: Tool Transform Angle Ur Tool Transform: 0 Using a teel transformation will be	ants: degrees -	D2: 0 reported and change the appr	Rix 0 mmt aenang ranges and apparen	Ry - O C resolutions.	0
Units: Tool Transform Angle Ur Tool Transform: Date of Date of United Pail: User-defined Field #1:	NTS: degrees -	Dix 0 reserved and change the ages	Rac D Provid and departure	Ry 0 e marketama	0
Units: Tool Transform Angle Ur Tool Transform: Out Out Out Out Out Out Out O	ents: degrees -	Dix 0 missioned and change the agen	Rix 0 energy and appendix	Ry - O e resolutions	0
Units: Tool Transform Angle Un Tool Transform: 0 0 User defined Field #1: Neer-defined Field #1: Neer-defined Field #2:	empty	Diz. 0 resorted and change the appo	Rx 0 event persong ranges and appears	Ry O creativers	0
Units: Tool Transform Angle Ur Tool Transform: Dec Dec Occurs a sub formed/matter will of User-defined Field #12: Haroman di Schwatter User-defined Field #2: Haroman di Schwatter	empty	Dix 0 reserved and change the age	Re-	Ry O er reselutiones	0

13.3 Object Model

13.3.1 Data Types

A description of all of the data types used in the object model are in the following table:

Table 13.5—Data Types				
Data Type	Description			
BOOL	Boolean			
BYTE	Bit String (8-bit)			
DINT	Signed Double Integer (32-bit)			
DWORD	Bit String (32-bit)			
INT	Signed Integer (16-bit)			
REAL	Floating Point			
SHORT_STRING	Character string (1 byte per character, 1 byte length indicator)			
SINT	Signed Short Integer (8-bit)			
STRING	Character String (1 byte per character)			
UDINT	Unsigned Double Integer (32-bit)			
UINT	Unsigned Integer (16-bit)			
USINT	Unsigned Short Integer (8-bit)			
WORD	Bit String (16-bit)			

13.3.2 EtherNet/IP

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.

Table 13.6—Name and Data Value						
Attribute ID	Name	Data Type	Default Data Value	Access Rule		
1	Revision	UINT	N/A	Get		
2	Max Instance	UINT	6	Get		
3	Number of Instances	UINT	6	Get		
100	Bias ¹	USINT	N/A	Set		

Note:

1. Bias – any set to non-zero value will bias, a set to zero will unbias the transducer readings.

Table 13.7—Instance Attributes (Instance 1–6) ¹					
Attribute ID	Name	Default Data Value	Access Rule		
1	Raw Gage Reading	INT	N/A	Get	
2	Gage Bias	INT	N/A	Get/Set	

Note:

1. Instances 1–6 correspond to Gages 0–5 respectively.

Table 13.8—Instance Attributes (Instance 1–6) ¹							
Implemented for Service Nem							
Service Codes	Class Level Instance Level						
0x0E	Yes	Yes	Get_Attribute_Single				
0x10 No Yes Set_Attribute_Sing							
Note:							
1. Instances 1–6 correspond to Gages 0–5 respectively.							

13.3.3 Transducer Force/Torque (Object (0x65—6 Instances)
----------------------------------	---------------------------

Table 13.9—Class Attributes (Instance 0)					
Attribute ID	Name	Data Type	Default Data Value	Access Rule	
1	Revision	UINT	1	Get	
2	Max Instance	UINT	6	Get	
3	Number of Instances	UINT	6	Get	
Table 13.10—Instance Attributes (Instance 1–6) ¹					
Attribute ID	Name	Data Type	Default Data Value	Access Rule	
1 ²	Resolved Axis Data (32-bit)	DINT	N/A	Get	
2	Resolved Axis Data (16-bit) (for DeviceNet)	INT	N/A	Get	
3	Minimum Peak	DINT	N/A	Get/Set ³	
4	Maximum Peak	DINT	N/A	Get/Set ³	
Note:					

1. Instances 1, 2, 3, 4, 5, 6 correspond to axis Fx, Fy, Fz, Tx, Ty, Tz respectively.

2. If 16-bit unsigned data is enabled, the upper 16 bits always remain 0 and the lower 16-bits are the unsigned 16-bit F/T data.

3. Any set attribute value will reset the specified peak value.

Table 13.11—Common Services						
Implemented for						
Service Codes	Class Level	Instance Level	Service Name			
0x0E	Yes	Yes	Get_Attribute_Single			
0x10	No	Yes	Set_Attribute_Single			

13.3.4 Transducer Force/Torque Object (0x65—6 Instances)

Table 13.12—Class Attributes (Instance 0)							
Attribute ID	Name	Da	ta Type	Det	fault Data Value	A	ccess Rule
1	Revision		UINT		1		Get
	Table 13.13	3—Inst	ance Attrib	utes	(Instance 1–6)		
Attribute ID	Name		Data Type	e	Default Data Value	e	Access Rule
1	Conditions Bread	ched	DWORD		N/A		Get
2	Monitor Condition Output Resul	ons t	BYTE		N/A		Get
3 Monitor Condition Latched BOOL N/A Get/Se				Get/Set ¹			
Notes:							
1. Monitor Condition Latched – any set attribute value will reset value to FALSE.							
	Tat	ole 13.1	14—Commo	on Se	ervices		

Table 13.14—Common Services					
Service Codes	Impleme	Service Name			
Service Codes	Class Level	Instance Level	Service Maine		
0x0E	Yes	Yes	Get_Attribute_Single		
0x10	No	Yes	Set_Attribute_Single		

13.3.5 System Status Object (0x67—1 Instance)

Table 13.15—Class Attributes (Instance 0)						
Attribute ID	Name	Data Type	Default Data Value	Access Rule		
1	Revision	UINT	1	Get		
Table 13.16—Instance Attributes (Instance 1)						
Attribute ID	Name	Data Type	Default Data Value	Access Rule		
1	Status Code (32-bit)	DWORD	N/A	Get		
2	Status Code (16-bit) ¹	WORD	N/A	Get		
Note:						
1. This attri	bute is sized for DeviceNet.					

Table 13.17—Common Services					
Service Codes	Impleme	nted for:	Comice Nome		
Service Codes	Class Level	Instance Level	Service Name		
0x0E	Yes	Yes	Get_Attribute_Single		

13.3.6 Configurations Object (0x71—16 Instances)

Table 13.18—Instance Attributes (Instance 1–16)							
Attribute ID	Name	Data Type	Default Data Value	Access Rule			
1	Configuration Name	SHORT_STRING[32]	N/A	Get/Set			
2	Calibration Selection (0 to 15)	USINT	N/A	Get/Set			
3	Calibration Selection's Calibration Type	SHORT_STRING[32]	N/A	Get			
4	User Force Units ¹	BYTE	N/A	Get/Set			
5	User Torque Units ²	BYTE	N/A	Get/Set			
6	User Transform – Dx	REAL	N/A	Get/Set			
7	User Transform – Dy	REAL	N/A	Get/Set			
8	User Transform – Dz	REAL	N/A	Get/Set			
9	User Transform – Rx	REAL	N/A	Get/Set			
10	User Transform – Ry	REAL	N/A	Get/Set			
11	User Transform – Rz	REAL	N/A	Get/Set			
12	User Transform Distance Units ³	BYTE	N/A	Get/Set			
13	User Transform Angle Units ⁴	BYTE	N/A	Get/Set			
14	User Counts per Unit Force	UINT	N/A	Get			
15	User Counts per Unit Torque	UINT	N/A	Get			
16	User Max Rating – Fx	REAL	N/A	Get			
17	User Max Rating – Fy	REAL	N/A	Get			
18	User Max Rating – Fz	REAL	N/A	Get			

Notes:

1. Refer to cfgfu in Section 7.3—Configurations CGI (config.cgi) for force units.

2. Refer to cfgtu in Section 7.3—Configurations CGI (config.cgi) for torque units.

3. Refer to cfgtdu in *Section 7.3—Configurations CGI (config.cgi)* for tool transformation distance units.

4. Refer to cfgtau in Section 7.3—Configurations CGI (config.cgi) for tool transformation angle units.

Table 13.18—Instance Attributes (Instance 1–16)							
Attribute ID	Name	Data Type	Default Data Value	Access Rule			
19	User Max Rating – Tx	REAL	N/A	Get			
20	User Max Rating – Ty	REAL	N/A	Get			
21	User Max Rating – Tz	REAL	N/A	Get			
100	User Defined Field #1	SHORT_STRING[16]	N/A	Get/Set			
101	User Defined Field #2	SHORT_STRING[16]	N/A	Get/Set			

Notes:

0x10

- 1. Refer to cfgfu in Section 7.3—Configurations CGI (config.cgi) for force units.
- 2. Refer to cfgtu in Section 7.3—Configurations CGI (config.cgi) for torque units.
- 3. Refer to cfgtdu in Section 7.3—Configurations CGI (config.cgi) for tool transformation distance units.
- 4. Refer to cfgtau in *Section 7.3—Configurations CGI (config.cgi)* for tool transformation angle units.

Table 13.19—Common Services					
Samuiaa Cadaa	Impleme	Convice Nome			
Service Codes	Class Level	Instance Level	Service Name		
0x0E	Yes	Yes	Get_Attribute_Single		
0x10	No	Yes	Set_Attribute_Single		

13.3.7 Transducer Force/Torque Object (0x65—6 Instances)

No

Table 13.20—Class Attributes (Instance 0)							
Attribute ID		Name		ta Type	Default Data Value		Access Rule
1		Revision		UINT	1		Get
	Table 13.21—Instance Attributes (Instance 1–6)						
Attribute ID	Name		Da	ta Type	Default Data	Value	Access Rule
1	Conditions Breached		D	WORD	N/A		Get
2	Monitor Conditions Output Result		I	BYTE	N/A		Get
3	Monitor Condition Latched		E	BOOL	N/A		Get/Set
Table 13.22—Common Services							
Imp		emented for:			arvice Name		
Service Cod	62	Class Level		Inst	ance Level	36	
0x0E		Yes		Yes		Get_	Attribute_Single

Yes

Set_Attribute_Single

13.3.8 Monitor Conditions Settings Object (0x73—32 Instances)

Table 13.23—Class Attributes (Instance 0)						
Attribute ID	Name	Data Type	Default Data Value	Access Rule		
1	Revision	UINT	1	Get		
2	Max Instance	UINT	32	Get		
3	Number of Instances	UINT	32	Get		
Table 13.24—Instance Attributes (Instance 1–32)						
Attribute ID	Name	Data Type	Default Data Value	Access Rule		
Attribute ID	Name Enable/Disable	BOOL	Default Data Value N/A	Access Rule Get/Set		
Attribute ID 1 2	Name Enable/Disable Axis Number ¹	BOOL SINT	Default Data Value N/A N/A	Access Rule Get/Set Get/Set		
Attribute ID 1 2 3	Name Enable/Disable Axis Number ¹ Comparison ²	BOOL SINT SINT	Default Data ValueN/AN/AN/A	Access Rule Get/Set Get/Set Get/Set		
Attribute ID 1 2 3 4	Name Enable/Disable Axis Number ¹ Comparison ² Counts Value	Data IypeBOOLSINTSINTDINT	Default Data Value N/A N/A N/A N/A N/A N/A	Access Rule Get/Set Get/Set Get/Set Get/Set		
Attribute ID 1 2 3 4 5	Name Enable/Disable Axis Number ¹ Comparison ² Counts Value Output Code	Data TypeBOOLSINTSINTDINTBYTE	Default Data Value N/A N/A N/A N/A N/A	Access Rule Get/Set Get/Set Get/Set Get/Set		

1. Refer to mcxn in Section 7.2—Monitor Conditions CGI (moncon.cgi) for axis information.

2. Refer to mccn in Section 7.2—Monitor Conditions CGI (moncon.cgi) for comparison information.

Table 13.25—Common Services					
Comvise Codes	Impleme	Convice Norme			
Service Codes	Class Level	Instance Level	Service Name		
0x0E	Yes	Yes	Get_Attribute_Single		
0x10	No	Yes	Set_Attribute_Single		

14. CAN Bus Operation

14.1 Overview

The Net F/T supports a basic CAN protocol to allow reading of force/torque data and system status word over CAN without the need for a DeviceNet scanner.

The CAN Bus base address and Baud Rate settings are configured using the DIP switches. For additional information, refer to *Section 3.9—DIP Switches and Termination Resistor*.

To use the Net F/T's CAN bus protocol, CAN Bus must be selected on the *Communications* page (refer to *Section 4.7—Communication Settings Page (comm.htm)*) and power must be present on the Pwr/CAN connector.

14.2 Protocol Description

A request data message sent to the Net F/T initiates copying of the current set of F/T data into an output buffer and the subsequent transmission of the output buffer.

Depending on the request message identifier (REQUEST LONG or REQUEST SHORT), the Net F/T either sends 32-bit values packed into four messages or 16-bit values packed into two messages.

Values are in little endian format (least-significant byte first). For example, a 16-bit value received as 0x56 0x02 represents 0x0256. Signed numbers use 2's complement format. The 32-bit value received as 0x0F 0xCF 0xDA 0xDA 0xDA 0xFD represents 0xFDDACF0F, which is a negative number (because the highest bit is set). Its decimal value is -35991793.

If a data request message is received during an ongoing transmission, the ongoing transmission is terminated, and the new request is processed.

14.3 Base Address and Communication Format

The CAN Bus base address is set by DIP switches 1 through 6. For more information refer to *Section 3.9.2—Node Address* and *Table 3.1*. The factory set base address is 432.

Table 14.1—Request Long Data						
Message to Net F/T	Response from Net F/T	CAN Identifier	Data length in bytes	1st–4th data bytes	5th–8th data bytes	Description
Request Long Data	-	Base Address	1	0x01 (BYTE)	N/A	Sends a copy of force and torque data in long format (an ongoing transmission will be terminated)
-	Fx and Tx data	Base Address +1	8	Fx value (DINT)	Tx value (DINT)	X-axis force and torque values in long format
-	Fy and Ty data	Base Address +2	8	Fy value (DINT)	Ty value (DINT)	Y-axis force and torque values in long format.
-	Fz and Tz data	Base Address +3	8	Fz value (DINT)	Tz value (DINT)	Z-axis force and torque values in long format.
-	Status and sample number	Base Address +4	8	system status (DINT)	sample number (DINT)	System status word and sample number in long format.

Manual, F/T, Net F/T Document #9620-05-NET FT-23

Table 14.2—Request Short Data						
Message to Net F/T	Response from Net F/T	CAN Identifier	Data length in bytes	1st–4th data bytes	5th–8th data bytes	Description
Request Long Data	-	Base Address	1	0x02 (BYTE)	N/A	Sends a copy of force and torque data in short format (an ongoing transmission is terminated)
-	Fx, Tx, Fy, and Tx data	Base Address +5	8	Fx value (INT) Tx value (INT)	Fy value (INT) Ty value (INT)	X-axis force and torque values and Y-axis force and torque in short format
-	Fz and Tz data, Status, and sample number	Base Address +6	8	Fz value (INT) Tz value (INT)	system status (INT) sample number (INT	Z-axis force and torque values, system status word, and sample in short format.
		Та	able 14.3–	-Bias Con	nmand	
Message to Net F/T	Response from Net F/T	CAN Identifier	Data length in bytes	1st–4th data bytes	5th–8th data bytes	Description
Bias	-	Base Address	1	0x04 (BYTE)	N/A	Zeros the force and torque readings at the current loading level.
Table 14.4—Clear Condition Latch Command						
Message to Net F/T	Response from Net F/T	CAN Identifier	Data length in bytes	1st–4th data bytes	5th–8th data bytes	Description
Clear Condition Latch	-	Base Address	1	0x08 (BYTE)	N/A	Clears the Condition latch so it can respond to subsequent conditions.

14.4 Baud Rate

Baud Rate is set by either hardware or software configuration to 125 kbps, 250 kbps or 500 kbps. The baud rate is set by software when DIP switch positions 7 and 8 are ON. For more information refer to *Section 3.9.3—Baud Rate* and *Table 3.3*. The factory set baud rate is 500 kbps.

14.5 Calculating F/T Values for CAN

The Net F/T multiplies each F/T value with a factor before it is sent over the CAN interface. This calculation allows F/T values to be sent with the full resolution. The application program has to divide each F/T value with a specific factor to obtain the real data.

For 16-bit data handling and *Table 13.3* for 32-bit data handling, refer to *Table 13.2*.

15. Fieldbus Operation

Operational information about the additional fieldbus included in some Net Boxes is described in the following sections.

15.1 PROFINET Fieldbus Interface

A Net Box with the -PN option provides a PROFINET interface for access to the F/T data and for control of certain functions. The standard EtherNet/IP and DeviceNet interfaces may be used simultaneously while using the PROFINET interface.

Although the Net Box's PROFINET interface shares the standard Ethernet port, it has its own MAC address and IP address. The fieldbus's MAC address is shown as MAC ID 2 on the connector side of the Net Box.

NOTICE: The PROFINET interface does not support DHCP. The Net Box's GSDML file details the PROFINET capabilities of the Net Box.

Unlike the Net F/T's other interfaces for tool transformations, the TCP interface uses scaled integer values to define distances and rotations.

Table 15.1—PROFINET Interface Parameters			
Parameter	Description		
DCP	supported		
Used Protocols (subset)	UDP, IP, ARP, ICMP (Ping)		
Topology recognition	LLDP, SNMP V1, MIB2, physical device		
VLAN- and priority tagging	yes		
Context Management	by CL-RPC		
Minimum cycle time	2ms		
Minimum F/T data update rate	20Hz		
Baud rate	100 MBit/s		
Data transport layer	Ethernet II, IEEE 802.3		

The PROFINET interface parameters used in the –PN Net Box are listed in the following table:

A GSDML file is available for the ATI website at:

http://www.ati-ia.com/Products/ft/software/net_ft_software.aspx or can be requested via email at *ft.support@novanta.com*. For firmware versions before 2.2.59, the ATI Part Number for the GSDML file is 9031-05-1021. For firmware version 2.2.59 and later versions, the ATI Part Number for the GSDML file is 9031-05-1060.

15.1.1 Enabling the PROFINET Interface

The PROFINET fieldbus interface can be enabled and disabled using the *Communications* web page. For details, refer to the Fieldbus Module Settings portion of *Section 4.7—Communication Settings Page (comm.htm)*.

Table 15.2—PROFINET Interface Parameters						
16-bit Word	Data Type	Name	Description/Function			
0	INT	Status	Status word, bits 16 through 31			
1	INT	Fx	Force in X-direction, 16-bit format			
2	INT	Fy	Force in Y-direction, 16-bit format			
3	INT	Fz	Force in Z-direction, 16-bit format			
4	INT	Тx	Torque about X-axis, 16-bit format			
5	INT	Ту	Torque about Y-axis, 16-bit format			
6	INT	Tz	Torque about Z-axis, 16-bit format			
7	UINT	Sequence	Incremented each time a dataset is sent			

Input word 0, Status, contains bits 16 through 31 of the Net F/T's System Status Code (refer to *Section 17.1—System Status Code*).

Input words 1–6 contain values that represent F/T vectors Fx, Fy, Fz, Tx, Ty, and Tz. In order to reduce the amount of data transmitted over PROFINET, they are reduced to 16 bits using the Scaling Factor for DeviceNet and CAN values (see *Figure 13.1*) before they are transmitted.

To obtain the F/T values in user units, each received force value has to be divided by (Counts-per-Force ÷ Scaling Factor for DeviceNet and CAN) for the axis and each received torque value has to be divided by (Counts-per-Torque ÷ Scaling Factor for DeviceNet and CAN) for the axis.

The Counts-per-Force, Counts-per-Torque, and Scaling Factor for DeviceNet and CAN factors can be found on *Configurations* web page (refer to *Section 4.6—Configurations Web Page (config.htm)*).

Table 15.3—Output Mapping			
Byte	BitNumber	Name	Description/Function
	0	Bias	Perform tare function to zero out any load reading
	1	Reset Latch	Reset Condition latch
	2	reserved	reserved
0	3	reserved	reserved
0	4	reserved	reserved
	5	reserved	reserved
	6	reserved	reserved
	7	reserved	reserved
	0	Config Select bit 0	
	1	Config Select bit 1	Solocts a Not E/T configuration from 0 to 15
	2	Config Select bit 2	
1	3	Config Select bit 3	
I	4	reserved	reserved
	5	reserved	reserved
	6	reserved	reserved
	7	reserved	reserved
2	0-7	Condition high	Condition enable mask, high byte
3	0-7	Condition low	Condition enable mask, low byte

Output byte 0, bit 0 performs a bias function when it is set to one. For details on this function, refer to the *Bias* button information in *Section 4.2—Snapshot Web Page (rundata.htm)*. Bit 0 should be set to one for at least 100 ms to ensure the bias is executed, and then Bit 0 returns to zero.

Output byte 0, bit 1 performs a reset Condition latch function when it is set to one. For details on this function, refer to the *Reset Latch* button information in *Section 4.5—Monitor Conditions Web Page (moncon.htm)*. Bit 1 should be set to one for at least 100 ms to ensure a reset latch is executed, and then Bit 1 returns to zero.

Output byte 0, bits 2–7 are reserved and should not be used.

Output byte 1, bits 0–3 select the active configuration (0 through 15) to be used. After a delay of up to one second, the newly-selected configuration is usable. During configuration change, the Net F/T does not supply valid F/T data. For details on the active configuration, refer to the active configuration information in *Section 4.4—Settings Web Page (setting.htm)*.

Output byte 1, bits 4–7 are reserved and should not be used.

Output bytes 2 and 3 form a 16-bit Condition enable mask that enables and disables Condition conditions. Each bit, 0–15 (of the Condition enable mask) maps directly to its corresponding Condition condition number N. A value of one enables the corresponding condition, and a value of zero disables the condition. For more information on Monitor Conditions, refer to *Section 4.5–Monitor Conditions Web Page (moncon.htm)*.

NOTICE: When Fieldbus Module Enabled is set to Enabled on the *Communications Settings* page (refer to *Section 4.7—Communication Settings Page (comm.htm)*), active configuration selection and Monitor Conditions statement selection is controlled by the PROFINET output data. While enabled, these values are not controlled by Net Box web pages or CGI interface.

15.1.2 Communications CGI (comm.cgi) Options

The PROFINET Fieldbus Net Box can have the PROFINET function enabled and disabled via CGI. The following function is available in the comm.cgi in addition to those shown in *Table 7.4*:

Table 15.4—PROFINET Interface Parameters		
Variable Name	Allowed Values	Description
fieldbusenabled	Integers: 0 or 1	Enable (value=1) or disable (value=0) the PROFINET fieldbus interface.

15.1.3 XML Page Elements

The PROFINET Fieldbus Net Box has two additional XML elements included in the netftapi2.xml page output. The following elements are available in the netftapi2.xml page in addition to those shown in *Table 8.2*:

Table 15.5—Additional netftapi2.xml XML Elements			
XML Element	Data Type	Description	Reference
fieldbusenabled	ENABL	PROFINET interface setting	comm
fieldbusfirmware	STRING64	PROFINET interface firmware version	comm

15.1.4 Returning Default Settings

The PROFINET Station Name and the PROFINET IP address can be cleared to default settings. This is useful when already-configured devices need to be moved or replaced in the PROFINET network. To return the PROFINET fieldbus Net Box to default PROFINET settings, the power must be on and the fieldbus module must already be enabled (see *Section 4.7—Communication Settings Page (comm.htm)*). The PROFINET network connection should be disconnected to ensure the Net Box does not automatically get recommissioned. The steps are:

- 1. Remove the Net Box cover (see Section 3.9—DIP Switches and Termination Resistor).
- 2. Move DIP switch 10 to the ON position.
- 3. Once the MS LED is blinking red, return DIP switch 10 to the OFF position.
- 4. Replace the Net Box cover.
- 5. Disconnect power. The PROFINET Station Name and IP address will be reset when power is reapplied.

NOTICE: Returning to the PROFINET default settings does not affect the standard Ethernet and EtherNet/IP settings.

15.1.5 Replacing and Installed PROFINET Fieldbus Net Box

Replacing an installed PROFINET Fieldbus Net Box can easily be done if (both):

- The Topology of the PROFINET network was properly defined with the PROFINET engineering tool.
- The PROFINET controller supports automatic device replacement.

15.1.5.1 Replacing and Installing a PROFINET Fieldbus Net Box

- 1. Remove the power and network connections of the PROFINET Fieldbus Net Box that is to be replaced. If necessary, mechanically unmount the Net Box.
- 2. Mount the replacement PROFINET Fieldbus Net Box.
- 3. Connect the power and PROFINET network connections to the box.
- The new Net Box is automatically assigned the name and IP address of the former Net Box.
- After a few seconds, the NS/BF LED turns a solid green, and the Net Box is correctly operating on the network.

15.1.5.2 Replacement with Previously Commissioned Fieldbus Net Box

- 1. Remove the power and network connections of the PROFINET Fieldbus Net Box that is to be replaced. If necessary, mechanically unmount the Net Box.
- 2. Mount the replacement PROFINET Fieldbus Net Box.
- 3. Connect the power to the box. Do not make the network connection.
- 4. Remove the previous commission per the steps in *Section 15.1.4—Returning Default Settings*.
- 5. Connect the PROFINET Fieldbus Net Box to the PROFINET network.
- The new Net Box is automatically assigned the name and IP address of the former Net Box.
- After a few seconds, the NS/BF LED turns a solid green, and the Net Box is correctly operating on the network.

16. Advanced Topics

16.1 Improving Ethernet Throughput

In an optimum network setup, the Net F/T's RDT data arrives at the host computer with no loss of data. If data samples are lost, consider one or all of the following:

16.1.1 Establish a Direct Connection between Net F/T and Host

To achieve the best Ethernet performance without lost data packages, connect the Net Box directly to the host computer (recommended). To use a switch, try to use only one switch between the sensor system and host. Avoid going through several switches or going through a hub.

16.1.2 Choose the Best Operating System for the Application

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 this instance is not acceptable for an application, then use a real-time operating system.

16.1.3 Increase Operating System Performance

For optimal computer performance in response to the Net 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.

16.1.4 Avoid Connecting the Net 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 Net F/T UDP data.

16.1.5 Use a Dedicated Ethernet Network for the Net F/T

Placing the Net 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.

16.2 Reducing Noise

16.2.1 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 Net 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.

16.2.2 Electrical Interference

If observing interference by motors or other noise-generating equipment, check the Net F/T's ground connections.

If sufficient grounding is not possible or does not reduce the noise, consider using the Net F/T's digital low pass filters.

Verify the use of Class 1 power supply which has an earth ground connection.

16.3 Detecting Failures (Diagnostics)

16.3.1 Detecting Sensitivity Changes

Sensitivity checking of the transducer can also be used to measure the transducer system's health. Apply known loads to the transducer and verifying the system output matches the known loads, for example: a transducer mounted to a robot arm may have an end-effector attached to it. If the end-effector has moving parts, they must be moved in a known position.

This check is done by completing the following steps:

- 1. Place the robot arm in an orientation that allows the gravity load from the end-effector to exert load on many transducer 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, and use it as the sensitivity value.

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

16.4 Scheduled Maintenance

16.4.1 Periodic Inspection

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. These applications should implement the procedures discussed in *Section 16.3—Detecting Failures (Diagnostics)* to detect any failures.

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.

16.5 A Word about Resolution

ATI's transducers have a three sensing beam configuration where the three beams are equally spaced around a central hub and attached to the outside wall of the transducer. This design transfers applied loads to multiple sensing beams and allows the transducer to increase its sensing range in a given axis if a counterpart axis has reduced (see *9620-05-Transducer Section* manual).

The resolution of each transducer axis depends on how the applied load is spread among the sensing beams. The best resolution occurs in the scenario when the quantization of the gages is evenly distributed as load is applied. In the worst case scenario, the discrete value of all involved gages increases at the same time. The typical scenario will be somewhere between these two.

F/T resolutions are specified as typical resolution, defined as the average of the worst and best case scenarios. Because both multi-gage effects can be modeled as a normal distribution, this value represents the most commonly perceived, average resolution. Although this misrepresents the actual performance of the transducers, it results in a close (and always conservative) estimate.

16.6 Connecting to Specific Industrial Robots

Many industrial robots connect to the Net F/T over its EtherNet/IP connection. When connecting to the Net F/T using EtherNet/IP, the Net F/T's EtherNet/IP protocol must be enabled and its DeviceNet protocol must be disabled (by enabling CAN bus protocol). This can be done on the Net F/T's *Communications* page (refer to *Section 4.7—Communication Settings Page (comm.htm)*).

Figure 16.1—Enabling EtherNet/IP on the Communications Page (comm.htm)

Ethernet Network Settings	
DIP switch 3 must be off to wrable IP A	Advess Mode, 17 537 anitch B is an they die 17 address is set to 192,148,5,2 regardless of the JP Address Mode settings below. A LAN connection must be
present at power up the DHCP to function	n If DHOP is enabled and no DHOP parvar is found then the atticut IP address will be used.
IP Address Hoder	And Design to B
see above rate reparting DIP awitch 9	DHCP O SINC IP *
Static IP Address:	192.168.1.222
Static IP Subnet Mask:	255 255 255 0
Static IP Default Gateway:	192.168.1.1
EtherNet/IP Protocol:	Enabled ® sabled O
EtherNet/IP 02T Data:	Enabled ® Disabled ©
Ethernet MAC Address:	00:16:8D:00:06:C6
Fieldbus Module Settings	
The fieldbus module is not suppo	rted in this product.
Fieldbus Module Firmware:	
Fieldbus Module Enabled:	Enabled C Disabled @
CAN Network Settings	
If passar is not precided to the Perricht weathin	summeter, then GNI Bud Base Address, DeviceNet NMC ID, and Basel Rate are not summetly reported and summunications over the PerifSNI consecutivae net
Protocol:	CAN Bus 🔍 eviceNet with Quick Connect Enabled 🔘
CAN Bus Base Address:	0
and By DIP monthly a to 4	
DeviceNet MAC ID: set by DIP switches 1 to 4 (Hactures o	0 ethna Deviaeler connection?
Baud Rate:	125 kHz
and the second second second second second second	

To configure the connection to the Net F/T, refer to the following information:

Table 16.1—Net F/T EtherNet/IP Configuration Information			
Item	Decimal Value	Hexadecimal Value	
Vendor Code	555	0x022B	
Product Type	0	0x0	
Product Code	1	0x1	
Major Revision	1	0x1	
Minor Revision	20	0x14	
Configuration Instance	128	0x80	
Target to Originator (input) Instance	100	0x64	
Originator to Target (output) Instance	102	0x66	
Input Size (bytes)	28	0x1C	
Output Size (byte) I/O Output is unused	0	0x0	

16.6.1 ABB Robotics

ABB robot controller firmware versions 5.14 and later support EtherNet/IP connections to the Net F/T.

16.6.2 Denso Robotics

Denso RC7 robot controllers with EtherNet/IP support connections to the Net F/T.

16.6.3 Fanuc Robotics

Fanuc robot controllers with an EtherNet/IP scanner installed can communicate with the Net F/T. Details about the Fanuc EtherNet/IP scanner can be found in the Fanuc manual FANUC Robotics SYSTEM R-30iA EtherNet/IP Setup and Operations Manual MAROCENTET04081E REV B Version 7.40.

Fanuc R30iA robot controller configuration. See Section 4.2.4—Advanced EtherNet/IP Scanner Configuration in the Fanuc manual for additional information:

- Set the robot as the EtherNet/IP scanner (Client).
- In the robot controller's scan list, set the Connection Type for the Net F/T to Input-Only.
- For TCP communications, set the Transport Type to UNICAST in order to use the Socket Messaging. For UDP communications, set the robot controller's Transport Type to MULTICAST.
- If the controller's word size is set to 16-BIT WORDS, then set the input size to 14 or for 8-BIT BYTES, then set the input size to 28. Pages 4–7 and 4–8 of the Fanuc manual discuss input and output sizes and how to set 8-bit or 16-bit words.
- The Output Run/Idle header must be turned off (set to Heartbeat).

Figure 16.2—Example Configuration Settings

	I/O Ethernet/IP
Scanner config(Read-only) : 1/1	Ethernet/IP List(Rack 89) 1/32
Description : ATI SENSOR	Description TYP Enable Status Slot
Name/IP address : 19216611.4	ATI SENSOR SCN TRUE OFFLINE 1
Vendor Id : 555	ADP FALSE OFFLINE 2
Device Type : 0	Connection3 ADP FALSE OFFLINE 3
Product code : 1	Connection4 ADP FALSE OFFLINE 4
Input size (words): 14	Connection5 ADP FALSE OFFLINE 5
Output size (words): 0	Connection6 ADP FALSE OFFLINE 6
RPI (ms) : 8	Connection7 ADP FALSE OFFLINE 7
Assembly instance (input) : 100	Connection8 ADP FALSE OFFLINE 8
Assembly instance (output) : 102	Connection9 ADP FALSE OFFLINE 9
Conriguration instance : 120	ConnectionA ADP FALSE OFFLINE 10
(■●→Ⅱ■▲□□≤	● ● ▲ ○ ■ ● > ■ ■ ▲ □ ▲ ▲ ▲
2日・トローム日本に致 hernot/12	● 図 ム 訳 ■ ● > Ⅱ ● ▲ 田 山 監査 I/O Ethernet/IP I/O Ethernet/IP
2日・トロミム三上に表 zhernet/IP Advanced configuration : 1/12 General	Image: State
2日・・・ III 1 1 日本 田山 裕満 chernot/IP Advanced configuration : 1/12 General I/O Data Type : IGDIG WORDS	
Image: Stress	Image: Tright and the second secon
Connet/IP Advanced configuration : 1/0 Data Type : I/0 Data Type : I/0 Data Type : Timeout Multiplier :4 Reconnect : TRUE	I/O Ethernot/IP Advanced configuration : 12/12 RFI : 8 Target To Originator Transport Type : NICAST RFI : 8
Construction 1/12 Advanced configuration : 1/12 General 1/0 Data Type : 16-Bir I/0 Data Type : 16-Bir WORDS Timeout Multiplier :4 Reconnect : TRUE Major Revision : 1 1	Image: Trip and the image: Trip and tri
Zmiełniczy Advanced configuration : 1/12 General I/o Data Type : I/o Data Type : IC=314 WORDS Timeout Multiplier :4 Reconnect : Major Revision : 1 Minor Revision : 20	Image: Tright of the second
Construction 1/12 Ceneral 1/0 Data Type : 1/0 Data Type : I/O Data Type : 10 Data Words Timeout Multiplier :4 Reconnect : Major Revision : 1 Maior Revision : 20 Alarm Severity : STOP	Image: Too State State Image: Too State RFI : 8 Target To Originator Transport Type : UNICAST RFI : 8 Connection Type Type : O=>T Format : Heartbeat
Chernet/IP Advanced configuration : 1/12 General I/o Data Type : IG-BIA I/o Data Type : IG-BIA WORDS Timeout Multiplier :4 Reconnect : TRUE Major Revision : 1 Minor Revision : 20 Alarm Severity : STOP Originator To Target	Image: Second
Advanced configuration : 1/12 General I/O Data Type : Color WORDS Timeout Multiplier :4 Reconnect : TRUE Major Revision : 1 Minor Revision : 20 Alarm Severity : STOP Originator To Target RFI : 8	I/O Ethernet/IP Advanced configuration : 12/12 RDI : 8 Target To Originator 8 Transport Type : UNICAST RDI : 8 Connection Type 8 Connection Type 12 Type : 0=>T Format : Modeless Modeless
Control of the second	Image: Top of the second se
Chernet/IP Advanced configuration : 1/12 General I/o Data Type : I/o Data Type : IG-BI4 WORDS Timeout Multiplier :4 Reconnect : Major Revision : 1 Minor Revision : 20 Alarm Severity : STOP Originator To Target 8 Target To Originator Transport Type : UNICAST UNICAST	Image: State of the state
Chernot/12 Advanced configuration : 1/12 General I/O Data Type : 10-315 WORDS Timeout Multiplier :4 Reconset : TRUE Major Revision : 1 Minor Revision : 20 Alarm Severity : 570P Originator To Target RPI : 6 Target To Originator Transport Type : UNICAST	Image: Top is a market of the second seco
Chernet/IP Advanced configuration : 1/12 General I/O Data Type : I/O Data Type : IG-BIF WORDS Timeout Multiplier :4 Reconnect : Major Revision : 1 Minor Revision : 20 Alarm Severity : STOP Originator To Target 8 Target To Originator 8 Transport Type : UNICAST	Image: State Stat

Some Karel programming is because the Fanuc robot controller does not support the following types of data:

- DINT (Double Integer)
- EtherNet/IP data of 32 bits. Two words of 16 bits (high and low) will need to be combined to use 32 bits.
- Two's complement.

16.6.4 Kuka Robotics

Kuka robots with the KUKA.ForceTorqueControl package connect to the Net F/T and provide the robot with real-time force control.

16.6.5 Motoman Robotics

A Motoman robot controller with an EtherNet/IP add-on board is required for connections to the Net F/T.

17. Troubleshooting

This section includes answers to some issues that might arise when setting up and using the Net 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)

17.1 System Status Code

Answers to some issues that might arise when setting up and using the Net F/T system are discussed in the following section. The question or problem is listed followed by its probable answer or solution. They are categorized for reference.

The Net F/T 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 17.1*.

Manual, F/T, Net F/T Document #9620-05-NET FT-23

Table 17.1—System Status Code Bit Assignments		
Bit	Bit Pattern	Description
31	0x80000000	Error bit (set if any error condition exists)
30	0x40000000	CPU or RAM error
29	0x20000000	Digital board error
28	0x1000000	Analog board error
27	0x08000000	Serial link communication error
26	0x04000000	Program memory verification error
25	0x02000000	Halted due to configuration errors
24	0x01000000	Settings validation error
23	0x00800000	Configuration settings incompatible with transducer calibration
22	0x00400000	Network communication failure
21	0x00200000	CAN communication error
20	0x00100000	RDT communication error
19	0x00080000	EtherNet/IP protocol failure
18	0x00040000	DeviceNet-compatibility mode protocol failure
17	0x00020000	Transducer Saturation or A/D operation error
16	0x00010000	Monitor Condition Latched
15	0x0008000	reserved
14	0x00004000	Watchdog timeout error
13	0x00002000	Stack check error
12	0x00001000	Serial EEPROM I2C communications failure
11	0x0000800	Serial flash SPI communications failure
10	0x00000400	Analog board watchdog timeout error
9	0x0000200	Excessive strain gage excitation current
8	0x00000100	Insufficient strain gage excitation current
7	0x0000080	Artificial analog ground out of range
6	0x00000040	Analog Board power supply too high
5	0x0000020	Analog Board power supply too low
4	0x0000010	Serial link data unavailable
3	0x0000008	Reference voltage or power monitoring error
2	0x00000004	Internal temperature error
1	0x0000002	HTTP protocol failure
0	0x0000001	reserved
_	0x00000000	Healthy
Manual, F/T, Net F/T Document #9620-05-NET FT-23

17.2 Status Word

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

Table 17.2—Status Word Bit Assignments		
Bit	Description	
0	Watchdog reset - the analog board was reset by the watchdog timer.	
1	Excitation voltage too high	
2	Excitation voltage too low	
3	Artificial analog ground out of range (above 0.007V).	
4	Power supply too high (> 25V).	
5	Power supply too low (< 10 V).	
6	Not used.	
7	Error accessing stored settings in EEPROM – EEPROM hardware did not respond.	
8	Invalid configuration data (baud rate).	
9	Strain gauge bridge supply current too high (> 3V on current sense).	
10	Not used (was Strain gauge bridge supply current too low)	
11	Thermistor too high (> 100C (1.5V on thermistor)).	
12	Thermistor too low. (< -40C (0.1V on thermistor).	
13	Not used (was DAC reading out of range)	
14	Not used.	
15	Any error sets this bit.	

17.3 Questions and Answers

Table 17.3—Powering Up			
Question/Problem	Answer/Solution		
	Check transducer cable connections.		
Xdcr LED stays red after the twenty second	Verify transducer cable is not damaged.		
power up priase	There may be an internal error in the Net Box.		
Xdcr LED is red for the first twenty seconds after power up then turns green	This is normal operation.		
The LS EN (Ethernet Link Status) is not green or flashing green	Check Ethernet cable connections.		
Table 1	7.4—Communications		
Question/Problem	Answer/Solution		
What IP address is assigned to the Net F/T?	See Section 6.1—Finding Net F/Ts on the Network.		
How can the Net F/T system be set to the default IP address of 192.168.1.1	Set DIP switch 9 to the ON position (see Section 3.9—DIP Switches and Termination Resistor). The Net F/T must be power cycled for the new setting to be used.		
	Ethernet LAN must be connected during power up.		
DHCP is not assigning an IP address	DHCP is not selected as the IP Address Mode on the <i>Communications</i> web page (refer to <i>Section 4.7—Communication Settings Page (comm.htm)</i>).		
	The DHCP server waits more than thirty seconds to respond.		
Browser cannot find the Net F/T on Ethernet network even though the Net 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 Net 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 17.5—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 Net F/T power.		
Error message: IO exception: <path and="" file<br="">name> (The process cannot access the file because it is being used by another process)</path>	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 <i>www.java.com/getjava</i> .		

Table 17.6—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.	
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.	

17.3.1 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 4.2-Snapshot Web Page (rundata.htm) for more details.

Table 17.7—Errors with Force and Torque Readings		
Question/Problem	Answer/Solution	
	Saturation occurs if the transducer is loaded beyond its maximum measurement range or in the event of an electrical failure within the system. The error status will stay on until the saturation error stops.	
Sat LED glows red (transducer saturation)	When the data from a raw decimal strain gage reads the positive or negative maximums (nominally -32768 or +32767), that gage is saturated. This sets the saturation error bit in the system status code (see <i>Section 17.1—System Status Code</i>) and causes the Sat LED to turn red.	
Noise	Jumps in raw strain gage readings (with transducer unloaded) greater than 80 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 <i>Section 16.2—Reducing Noise</i> .	
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.	
Table 17.8—Connection to Specific Equipment		
Equipment Connection	Details	

Equipment connection	
Fanuc robot controllers using EtherNet/IP	Set robot controller connection type to Input Only and set the robot controller as the EtherNet/IP scanner (client). When using Socket Messaging, set the transport type to Multicast for UDP or Unicast for TCP.

18. General Specifications

18.1 Environmental

The standard F/T system is designed to be used in standard laboratory or light-manufacturing conditions. Transducers with an IP60 designation are able to withstand dusty environments. Transducers with an IP65 designation can be washed down with fresh water. Transducers with an IP68 designation can be submerged in up to 10 m of fresh water.

The Net Box is rated to IP65.

18.1.1 Storage and Operating Temperatures

The Net Box can be stored and used at varying temperatures.

Table 18.1—Net Box Storage and Operating Temperatures		
Storage Temperature, °C	Operating Temperature, °C	
-20 to +85	-0 to +70	

NOTICE: These temperature ranges specify the storage and operation ranges in which the system can survive without damage. They do not take accuracy into account. See ATI Industrial Automation manual *9620-05-Transducer Section* for transducer environmental information.

When mated with appropriate connectors, the 9105-Net Box can be used in wet environments. The 9105-NETB Net Box can only be used in humidity up to 95% RH, non-condensing.

18.2 Transducer Data Filtering

Frequency response of the transducer's data acquisition hardware and various filtering options are shown in the following figure. The graph does not include the effects of any mechanical filtering which occurs in any spring and mass system.



Figure 18.1—Data Acquisition Subsystem Frequency Response (typical)

Group delays that various levels of low-pass filtering add to the signals are shown in the following figure. These delays do not show the Ethernet delays in a network or computer. With no filtering enabled, the Net F/T delivers F/T data to its Ethernet port with a delay of 286 μ S.



Figure 18.2—Filtering Group Delays (calculated)

18.3 Electrical Specifications (Power Supply)

Table 18.2—Power Supply Requirements			
Power Source ¹	Minimum Voltage	Maximum Voltage	Maximum Power Consumption
Power over Ethernet ²	36 V	57 V	6 W
Pwr/CAN	11 V	25 V	6 W
Noto:			

ote

1. Power is drawn from only one power source at a time.

2. Conforms to IEEE 802.3af, class 0, receiving power from data lines. Uses Mode A to receive power. Mode B is not supported.

A 9105-NET-GAMMA- transducer and its on-board electronics account for 2.4 W of the systems power consumption. Other transducer models consume less power.

18.3.1 Communications

18.3.1.1 Ethernet Interface

The Ethernet interface is 10/100 Mbit and features both negotiation and auto crossover. It can support up to four TCP connections and one UDP connection.

The EtherNet/IP interface supports one input-only connection and does not support a listen-only connection. It does not support any Client functionality.

18.3.1.2 CAN Interface

The CAN interface supports 125 kbps, 250 kbps, and 500 kbps (see *Section 3.9.3—Baud Rate*). A switchable termination resistor is available; refer to *Section 3.9.1—Termination Resistor*.

18.3.2 Mating Connectors

Table 18.3—Mechanical Specifications of Mating Connectors			
Connector	Mating Type	Recommended Torque	Maximum Torque
Ethernet	M12 D-Coded, 4-Pin, male	0.8 Nm to 1.0 Nm	3.0 Nm
Condition Relay	M8 3-Pin, female	0.5 Nm to 0.6 Nm	1.0 Nm
Pwr/CAN	M12 5-Pin, female	0.8 Nm to 1.0 Nm	3.0 Nm
NETB Transducer	M12 5-Pin, male	0.8 Nm to 1.0 Nm	3.0 Nm
NETBA Transducer	Circular, female	0.7 Nm	

18.3.3 Standard Condition Relay

The standard Condition relay contacts (NC, NO, or COM) are protected against overload by a resettable fuse. The relay will turn on within 6 ms.

Table 18.4—Standard Condition Relay Specifications			
	Maximum Rating Maximum Load		
Current	50 mA	10 µA	
Voltage	42VDC, 30VAC	10 mVDC	

18.3.4 Solid-State Condition Relay

The optional solid state Condition relay contacts (SSR+ and SSR-) are protected against reverse voltage by a zener diode. The relay turns on within 500 μ s.

Table 18.5—Solid-State Relay Specifications		
Maximum Load		
Current	35 mA	
Voltage	30VDC	

Figure 18.3—Solid-State Relay Voltage Drop vs. Current





18.3.5 NetBox Transducer Cabling

Normally the NetBox connects to the Transducer via an industry-standard DeviceNet cordset. In cases where this type of cordset cannot be used, observe the following:

- Cable specifications for DeviceNet Thick Cabling are ideal.
- The RS485+ and RS485- lines must form a twisted pair.
- The cable capacities should be low enough to work with 1.25 Mbps.
- The total resistance of each conductor should be no more than 0.5 $\boldsymbol{\Omega}$

Figure 18.4—Netbox's Transducer Cable Connector (female Pins)



Figure 18.5—Transducer's Transducer Cable Connector (male pins)



18.4 Net Box Weight

Table 18.6—Net Box Weight			
Condition	Weight		
Without Mounting Plate	0.8 kg (1.8 lbs)		
With Mounting Plate	1.1 kg (2.4 lbs)		