

Integrating ATI EtherCAT Force/Torque Sensors with KUKA® FTCtrl

Manual



Document #: 9620-05-D-ATI KUKA FTCtrl

Engineered Products for Robotic Productivity Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 • Tel:+1 919-772-0115 • Fax:+1 919-772-8259 • www.ati-ia.com

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.

Copyright © (2024) by ATI Industrial Automation, Inc., Apex, North Carolina USA. All Rights Reserved. Published in the USA.

ATI F/T Sensing Systems are considered components/ semi-finished goods intended for use in larger system/ device/ finished good.

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 an 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.

For terms and conditions of sale, refer to the *website* or contact an ATI representative.

All trademarks belong to their respective owners.

Note:

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

- 1. Serial number (e.g., FT01234)
- 2. Sensor model (e.g., Axia90-M50)
- 3. Calibration (e.g., US-15-50, SI-65-6, etc.)
- 4. Accurate and complete description of the question or problem.
- 5. Robot model, controller model, controller software version, and installed KUKA FTCtrl options.

Be near the F/T system when calling (if possible). For questions specific to KUKA-provided software or hardware, please contact KUKA's technical support.

Please contact an ATI representative for assistance, if needed:

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 Tel: +1 855.ATI-IA.00 (+1 855-284-4200)

Table of Contents

Glo	ssary	·		D-4
1.	Safe	ty		D-5
	1.1	Explar	ation of Notifications	D-5
	1.2	Genera	al Safety Guidelines	D-5
2.	Prod	luct Ov	erview	D-6
	2.1	Syster	n Components	D-6
		2.1.1	ATI	D-6
		2.1.2	KUKA	D-8
3.	Hard	lware S	et-Up	D-8
4.	Soft	ware Se	etup	D-9
	4.1	Integra	ate the ATI Sensor's Data into KRC Digital IO	D-9
		4.1.1	Add the ATI Sensor to the DTM Catalog	D-9
		4.1.2	Add the Sensor to KUKA Extension Bus	D-14
		4.1.3	Map the Sensor's Data into the Project's I/O	D-17
			4.1.3.1 Map the Sensor's Digital Inputs (for V3.x)	D-17
			4.1.3.2 Map the Sensor's Digital Inputs (for V4.x and V5.x)	D-20
			4.1.3.3 Map the Sensor's Digital Outputs (for V3.x, V4.x, and V5.x)	D-23
	4.2	Confir	m ATI Sensor EtherCAT Slave on Teach Pendant	D-24
	4.3	Set Up	FTCtrl to Use EtherCAT Axia/FT Data	D-25
		4.3.1	KUKA FTCtrl V3.x	D-25
		4.3.2	KUKA FTCtrl V4.x and V5.x	D-26
5 .	FTC	rl Prog	ramming	D-28
6 .	Mon	itoring	F/T Data	D-28
	6.1	View S	ensor Signals on Teach Pendant	D-28
	6.2	Conve	rt ATI F/T Sensor's Data From Counts to User Units	D-28
	6.3	Use F/	T Data as REAL-type Variables	D-28
7.	Trou	blesho	oting Guidance	D-30
8.	Spec	cificatio	ons	D-30
	8.1	F/T Se	nsor	D-30

Term	Definitions
Control Code	An output command signal that corresponds to a feature of the ATI sensor, for example: Bias, Filter selection, set Sample Rate, and select Calibration. Bit maps of control codes are available in the ATI manual for the sensor.
Counts	Data type that the ATI sensor reports Force/Torque values. To convert to user units, the Counts must be divided by a scaling factor like Counts per Force (CpF) or Counts per Torque (CpT).
Data Rate	How fast data is output over the network.
DINT	A (32) bit data type that represents a signed double integer.
ESI	EtherCAT Slave Information (ESI) is an ATI-provided EtherCAT (*.XML) file type that defines the ATI EtherCAT sensor product in the installation of WorkVisual.
EtherCAT	An industrial automation fieldbus.
Ethernet	A family of computer networking technologies commonly used in local area networks.
Force	A force is a push or pull action on an object caused by an interaction with another object. Force = mass x acceleration
FTCtrl	KUKA's Integrated ForceTorqueOption (FTCtrl) is an add-on package that allows the robot to react in real-time to its surrounding and to deviate from its programed path or speed, based on feedback from the force sensor.
FT or F/T	Force and Torque.
IO or I/O	Input and Output.
Interface Plate	A separate plate that attaches the sensor to another surface. Interface plates are often used if the bolt pattern on the sensor doesn't match the bolt pattern on the robot arm or customer tooling. The interface plate has two bolt patterns, one on either side of the plate. One side is for the sensor. The other side is for the robot arm or customer tooling.
N/A	Not applicable.
P/N	Part Number
Power Cycle	When a user removes and then restores power to a device.
Real-type Variable	An advanced programming feature where the end user can convert binary IO to REAL numbers (32 bit floating point number) that are stored in variables.
Sensor	The component that converts a detected load into electrical signals.
Sensor System (or configuration)	The entire assembly consisting of a sensor body and a system interface to translate force and torque signals into a specific communication interface/protocol.
Torque	The application of a force through a lever or moment arm that causes something to want to turn. For example, a user applies torque to a screw to make it turn. Torque = force x moment arm
UDINT	A (32) bit type that represents an unsigned double integer.
User Units	The end user's units of measurement such as Newtons (N) and Newton meter (Nm).
WorkVisual (or KUKA. WorkVisual)	A KUKA software package that is a development environment for configuring, programming, and troubleshooting a KUKA industrial robot or customer-specific kinematic system. The end user must install this software on a laptop or PC.

Glossary

1. Safety

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

1.1 Explanation of Notifications

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

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



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



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

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

1.2 General Safety Guidelines

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



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

2. Product Overview

ATI 6-axis Force Torque (F/T) sensors are a high performance option for use with KUKA[®]'s ForceTorqueControl software. KUKA's Integrated ForceTorqueControl option (FTCtrl) allows the robot to react in real-time to its surroundings and to deviate from its programmed path or speed, based on feedback from the force sensor.

While the ATI Ethernet (NET) F/T sensor with Net Box is the preferred product for use with KUKA. ForceTorqueControl, ATI's EtherCAT Axia and other EtherCAT F/T sensors are also compatible. Specifically for ATI's low-cost Axia line, only the EtherCAT version Axia is compatible. For more information about ATI sensor models, refer to the *ATI website*.

For more information about KUKA products, refer to *https://www.kuka.com/*. To access KUKA manuals, log-in to their *customer portal* or contact a representative at KUKA.

This manual includes these main how-to topics:

- Step-by-step instructions of how to integrate ATI F/T sensors into KUKA Digital IO and then into KUKA FTCtrl software in *Section 4—Software Setup*.
- A brief overview of how to convert I/O signals into KRL variables in *Section 6.3—Use F/T Data as REAL-type Variables*.

2.1 System Components

To use ATI EtherCAT F/T sensors within a KUKA system, verify the following hardware and software requirements are met:

2.1.1 ATI

For a general image of Axia and standard F/T sensor configurations, refer to *Figure 2.1, Figure 2.2*, and *Figure 2.3*.

Sensor

- Standard EtherCAT F/T: contact an *ATI applications engineer* for more information
- Axia EtherCAT F/T: refer to the Axia *webpage*

NOTICE: Examples in this manual use an ATI EtherCAT Axia80 sensor: ATI P/N 9105-ECAT-AXIA80.

NOTICE: ATI Ethernet (NET) F/T with Net Box (a different product from the EtherCAT sensors described in this manual) is the preferred, easily integrated sensor interface for use with KUKA FTCtrl. Instructions for the integration of NET F/T sensors with KUKA FTCtrl is included in the KUKA FTCtrl documentation. For ATI's low-cost Axia line, only the EtherCAT Axia version is compatible.

Interface Plate

- Mounting Adapter Plate (MAP), customer or ATI supplied, from sensor to the robot
- Tool Adapter Plate (TAP), customer or ATI supplied, from sensor to the tool

NOTICE: If using a large, non-IP rated sensor with removable MAP, it may be possible to machine the mounting patterns directly into the MAP. For mounting information, refer to the *ATI Transducer Section F/T manual*.

Cable

- CAT5 or higher EtherCAT cable from sensor to KUKA's RJ45 EtherCAT Extension Bus port
- For the ATI EtherCAT Axia, ATI provides two cables for power and EtherCAT connection (refer to the *ATI F/T EtherCAT Axia manual*).
- For other ATI EtherCAT F/T sensors, contact ATI F/T applications support (*ft.support@novanta.com*) for the correct cable.

Software

- EtherCAT ESI (*.XML) file, which is available to download from the ATI website
- For EtherCAT Axia, refer to https://www.ati-ia.com/Products/ft/software/axia_software.aspx.
- For other EtherCAT F/T, refer to *https://www.ati-ia.com/Products/ft/software/* SysSoftwareTemplates.aspx?family=8.

Reference Materials

- ATI EtherCAT Axia Manual
- ATI EtherCAT F/T Manual

Figure 2.1—ATI F/T Axia Components (parts may vary)



2.1.2 KUKA

Contact a KUKA sales or applications representative to ensure the correct components for the robot and controller. Be sure to specify a preference for an ATI sensor system.

Hardware

- KRC4 or newer robot controller if using KUKA FTCtrl
- Access to KRC's X44 EtherCAT Extension bus (or KEI Interface for KRC5 controllers)
- PC on Robot Controller's network, with WorkVisual installed

Software

- WorkVisual
- FTCtrl option, if using KUKA.ForceTorqueControl

NOTICE: This manual includes instructions for FTCtrl V3.x, 4.x, and 5.x. Some steps differ among these versions.

Reference Materials

NOTICE: To access KUKA manuals, log-in to their *customer portal* or contact a representative at KUKA.

- KUKA KRL Programming Manual
- KUKA WorkVisual Manual
- KUKA FTCtrl Manual
- KUKA CREAD/CWRITE Manual

3. Hardware Set-Up

- 1. Mount the sensor to the robot using interface plate(s).
 - For mounting guidelines, refer to the ATI's *Transducer Section F/T manual*, or for Axia sensors, refer to the ATI Axia sensor manual, such as: #9620-05-B-Axia80. Manuals are available on the *ATI webpage*.
- 2. Install the rest of the tooling.
- 3. Connect the sensor's power supply cable to an appropriate power supply.
 - For details, refer to the appropriate ATI sensor manual.
 - The sensor's LEDs light up through the startup sequence.
- 4. Connect the Ethernet cable from the sensor to the KUKA X44 EtherCAT Extension Bus port (or KEI interface on KRC5 controllers).

4. Software Setup

For the software setup, complete these three tasks:

Section 4.1—Integrate the ATI Sensor's Data into KRC Digital IO Section 4.2—Confirm ATI Sensor EtherCAT Slave on Teach Pendant Section 4.3—Set Up FTCtrl to Use EtherCAT Axia/FT Data

4.1 Integrate the ATI Sensor's Data into KRC Digital IO

Complete this task through KUKA's WorkVisual Development Environment.

This task has three parts:

- 1. Add the ATI sensor to the DTM Catalog (refer to *Section 4.1.1*).
- 2. Add the ATI sensor to KUKA Extension Bus in the WorkVisual Project (refer to Section 4.1.2).
- 3. Map the ATI sensor's data into the Project's I/O (refer to *Section 4.1.3*).

4.1.1 Add the ATI Sensor to the DTM Catalog

The ATI EtherCAT Axia product is defined with an ATI-provided EtherCAT ESI (*.XML) file in this installation of WorkVisual. This part should be completed once per EtherCAT Axia *.XML version, per WorkVisual environment. If another EtherCAT Axia with newer firmware and ESI *.XML file is used later, the new ESI *.XML file must be added to the DTM catalog.

1. Download the appropriate ATI ESI file to the laptop or PC.

- For EtherCAT Axia, refer to https://www.ati-ia.com/Products/ft/software/axia_software.aspx.
- For other EtherCAT F/T, refer to *https://www.ati-ia.com/Products/ft/software/* SysSoftwareTemplates.aspx?family=8.
- 2. Close the current Project in WorkVisual.

NOTICE: The DTM Catalog cannot be changed if any Projects are open.

Figure 4.1—Close All Projects



3. From the **File** dropdown menu, select **Import/Export**.

Figure 4.2—Import a New File

File	Edit View Edi	tors Extras	Win	dow	?							
	New	Ctrl+N	2 04	0.		♦ ► II %	09.20	- 七万	XBRE	20.00	5 🖴 👷 💿	Ŧ
	Open Project Browse for Project	Ctrl+O	•	7	×	+						
	Recent projects	•										
	Close		1									
ы	Save	Ctrl+S	1			+						
0	Save As											
4	Cataloghandling											
-	Print	Ctrl+P				1 + 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -						
#	Import / Export											
	Exit	Alt+F4	1									

4. Select Import device description file and click Next>.

Figure 4.3—Import Device Description Fil	е
--	---

Export partial project Import partial project Import / Export trace configurations	^
Import Irace Results Export I/O-Configuration to XML -Files. Import Symbol Table. Export SymbolTable.	
Import device description file. Export Multiprog project. Import Multiprog project. Profibus CP 5614 import. Import I/O-Connections. Export I/O-Connections. Profinet XML import.	

5. In the directory, navigate to the location of the ATI EtherCAT Axia *.XML ESI file. Select **Open**.

Figure 4.4—Open the ATI EtherCAT Axia *.XML File

→	> EC	AI AXIA	~ O	Search ECAT AXIA
ganize * New folder				III • 🗖 🛛
This PC	^	Name	Date modified	xml version="1.0"<br encoding="utf-8"?>
🗖 Desktop		ATI_Axia EtherCAT FT - 170829.xml	8/29/2017 8:57 AN	xmlns:xsi="http://www.
😢 Documents				3.org/2001/XMLSchema- instance"
👃 Downloads				xsi:noNamespaceSchemal cation="EtherCATInfo.)
🕽 Music				d" Version="1.6">
E Pictures				<id>#x00000732</id>
Videos				Industrial
Windows (C:)				Automation
PUBLIC (\\ATIFILESERVER) (I:)				<imagedata16x14>424DD6 20000000000036000000</imagedata16x14>
DOCUMENTS (\\ATI_ENG) (J:)				000000100000000E000000
🛫 johin (\\ATIFILESERVER\USERS) (Z:)				202E0000202E000000000
Notwork	~	<	>	FFFFFFFFFFFFFFFFFFFFFFFFF
File name: ATL Avia Eth	PrCAT	FT - 170829 vml	~	EtherCAT ESI (*.xml)

6. Click Next>.

	Device descriptions to be	imported:		
	Vendor	Device	Revision No	
	ATI Industrial Automatio	ATI Axia F/T Sensor	V1.0	
-				

Figure 4.5—Import the ATI EtherCAT Axia *.XML File

NOTICE: Any existing ATI EtherCAT ESI file versions that are installed will show up in the following window. To ensure the most current version is installed, remove older versions.

7. Click Finish.

Figure 4.6—Finish Importing the File

	Device descriptions to be	uninstalled:		
	Vendor	Device	Revision No	
	ATI Industrial Automation	ATI Axia F/T Sensor	V1.0	
	1			
alla				
		NG		_

8. After WorkVisual finishes importing the file, click **Close**.

Import device description file.	
	The device description has been imported successfully.
	Close

Figure 4.7—Close Window

9. From the Extras dropdown menu in WorkVisual, select DTM Catalog Management.

Figure 4.8—Extra Menu



- 10. At the bottom of the window, click Search for installed DTMs.
- 11. In the **Known DTMs:** pane, select the ATI EtherCAT sensor with the name of the ESI Device Description file imported in Step 5.

Figure 4.9—Select the ATI File from Known DTMs

Known DTMs:							Current DTM catalog:	
Name	Vendor	Protocol	Туре	Versi	Date		Name	Vendor A
ATI Axia F/T Sen	ATI Ind	EtherC	Gate	V1.0	2017		Advanced Generic EDS	KUKA
ATI EtherCAT Axia	ATI Ind	EtherC	Gate	V2.0	2018		#ArcLink XT	KUKA
							- ArcLink XT Device	KUKA
						>>	Cabinet Interface Board (CIB)	KUKA
							Scabinet Interface Board Small Robot (CIB-SR)	KUKA
						>	P CP 5614 A2	KUKA
							EM8905-1001 I/O-Module	KUKA
							EM8905-1002 I/O-Module	KUKA
							#EnDat-Umsetzer (EL5032)	Beckho
							EtherNet/IP	KUKA
							Generic Device	KUKA
						<	Generic Device Explicit Msg	KUKA
							Generic DeviceNet Device	KUKA
						<<	▲IBS PCI SC/RI-I-T	KUKA
							▲IBS PCI SC/RI-LK	KUKA
							Input Output Board 16 - 16B (IOB-16-16B)	KUKA
							KRC4 Electronic Mastering Device (EMD)	KUKA
							KRC4 primary EL6695-1001	KUKA
							KRC4 primary EL6695-1001	KUKA 🗸
							<	>

Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 • Tel:+1 919-772-0115 • Fax:+1 919-772-8259 • *www.ati-ia.com* D-12

- 12. Click the > button to move the desired DTM into the **Current DTM catalog**.
- 13. Click **OK**.

nown DTMs:						Current DTM catalog:	
lame	Vendor	Protocol	Туре	Versi	Date	Name	Vendor
ATI EtherCAT Axia	ATI Ind	EtherC	Gate	V2.0	2018	Advanced Generic EDS	KUKA
						#ArcLink XT	KUKA
						#ArcLink XT Device	KUKA
						ATI Axia F/T Sensor	ATI Ind
						E Cabinet Interface Board (CIB)	KUKA
						 Cabinet Interface Board Small Robot (CIB-SR) 	KUKA
						CP 5614 A2	KUKA
						EM8905-1001 I/O-Module	KUKA
						EM8905-1002 I/O-Module	KUKA
						##EnDat-Umsetzer (EL5032)	Beckho
						EtherNet/IP	KUKA
						< Generic Device	KUKA
						Generic Device Explicit Msg	KUKA
						<< Beneric DeviceNet Device	KUKA
						▲IBS PCI SC/RI-I-T	KUKA
						▲IBS PCI SC/RI-LK	KUKA
						Input Output Board 16 - 16B (IOB-16-16B)	KUKA
						I KRC4 Electronic Mastering Device (EMD)	KUKA
						KRC4 primary EL6695-1001	KUKA
						<	>

Figure 4.10—Move the ATI Sensor to the DTM Catalog

4.1.2 Add the Sensor to KUKA Extension Bus

For this part, the ATI device is added to the DTM catalog of each WorkVisual Project that uses the ATI sensor. If multiple sensors are used in a project, this part must be repeated for each sensor.

1. From the File dropdown menu, select Open Project.

Figure 4.11—Open Project

File	Edit View E	Editors Extras	Wind	wo	?					
	New	Ctrl+N	2 64	() -	E.	> ► II & O	921	0 1 1 1	XBRM	28. 5
18	Open Project	Ctrl+O	-							
	Browse for Proje	ct				+				
	Recent projects	•								
	Close									
ы	Save	Ctrl+S	1							
2	Save As									
3	Cataloghandling									
8	Print	Ctrl+P								
#	Import / Export									
	Exit	Alt+F4								

2. On the Project Structure, right-click the controller, and select Set as active controller.

Figure 4.12—Activate the Controller



1. Right-clic	K Bus St	ructure	and sel				
WorkVisual Developm File Edit View Editors Project Structure	ent Environme			lect	Add.		
File Edit View Editors	Extras Wind	nt - Project 1.v	vvs*				
Project Structure	Extras minu	low ?					
Project Structure			Cell configurat	e e) <u>, 45 14 5</u> (
a Hardware L Geometry	S Files	KR	CI/Os KRCV	Variable	es PLC Fieldbusses		
Cell: Hardware view Controller 1 (KRC Controller 1 (KRC KR 10 R1420 KR 10 R1420 Controller compo KR 10 R1420 Controller compo Safety of Unassigned Active I Controller Composition Controller Composition Cont	4 compact - 8.3 nents d	ension E	I/Os Analog In Analog In Digital Inp Digital Ou	puts utputs outs itputs			
DTM selection							
Name 	Vendor KUKA Roboter GmbH	Protocol ArcLinkXT Budde ar Dub/1/CP56114	Type Communication DTM Communication DTM	Version 1.0.0	Date 2018-03-08		
EtherNet1P	KUKA Roboter GmbH	EtherNet/IP	Communication DTM Communication DTM	14.1.962	2018-03-08		
AIBS PCI SCRI-LK	KUKA Roboter GmbH	InterbusPop EtherCAT	Communication DTM Communication DTM	220	2018-03-08		
KUKA Controller Sus (ACS) KUKA Extension Dus (STS-X44) KUKA Controller Data (STS-X44)	KUKA Roboter GmbH	EtherCAT EtherCAT	Communication DTM Communication DTM	30.13	2018-03-08		
AUKA Operator Fare instruction (515-X47) Skiller (SY5-X48) PROFINET	KUKA Roboter GmbH KUKA Roboter GmbH KUKA Roboter GmbH	ProgrammableFocusing EtherCAT ProfinetIO	Communication DTM Communication DTM Communication DTM	220 30.13 235	2018-03-08 2018-03-08 2018-03-08		
					0	K Cancel	

- 3. Add the ATI sensor:
 - a. Right-click the KUKA Extension Bus, and select Add.

Figure 4.13—Add the ATI Sensor to the KUKA Extension Bus



b. In the DTM Selection window, select the appropriate ATI sensor, and click OK.

Figure 4.14—Sele	ct the ATI Sensor
------------------	-------------------

Name	Vendor	Protocol	Туре	Version	Date
ATI Axia F/T Sensor	ATI Industrial Automation	EtherCAT, EtherCAT	Gateway DTM	V1.0	2017-08-29
Cabinet Interface Board (CIB)	KUKA Roboter GmbH	EtherCAT	Device DTM	V1.0	2018-03-08
Cabinet Interface Board Small Robot (CIB-SR)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
EM8905-1001 I/O-Module	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
EM8905-1002 I/O-Module	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Input Output Board 16 - 16B (IOB-16-16B)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
KRC4 Electronic Mastering Device (EMD)	KUKA Roboter GmbH	EtherCAT	Device DTM	V1.0	2018-03-08
KUKA Power Pack (KPP0)	KUKA Roboter GmbH	EtherCAT	Device DTM	V11.3	2018-03-08
EKUKA Power Pack 1 Achse (KPP1)	KUKA Roboter GmbH	EtherCAT	Device DTM	V11.3	2018-03-08
KUKA Power Pack 2 Achsen (KPP2)	KUKA Roboter GmbH	EtherCAT	Device DTM	V11.3	2018-03-08
E KUKA Power Pack 3 Achsen (KPP3)	KUKA Roboter GmbH	EtherCAT	Device DTM	V11.3	2018-03-08
KUKA Power Pack sr (KPP011 sr)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
E KUKA Power Pack sr (KPP031 sr)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
KUKA Servo Pack (KSP)	KUKA Roboter GmbH	EtherCAT	Device DTM	V11.3	2018-03-08
KUKA Servo Pack sr (KSP061 sr)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Media Flange (MF)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Media Flange Touch (MFT)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Medien Adapter Modul light Beta(MAM light Beta)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Micro Resolver Digital Converter (micro-RDC)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Power Drive System (PDS1)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Power Drive System (PDS23)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Resolver Digital Converter (RDC)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
= Safety Interface Board SIB Extended (SION-SIB-EXT)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
 Safety Interface Board SIB Standard (SION-SIB-STD) 	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
 Safety-Modul for Cabinet Interface Board (SION-CIB) 	KUKA Roboter GmbH	EtherCAT	Device DTM	V1.0	2018-03-08
 Safety-Modul for Cabinet Interface Board Small Robot (SION-CIB_SR) 	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
= Safety-Modul for KUKA smartPAD 1.0 (SION-KCP)	KUKA Roboter GmbH	EtherCAT	Device DTM	V0.0	2018-03-08
Sensor Digital Converter (SDC) (EP3182-1002)	Beckhoff Automation GmbH	EtherCAT	Device DTM	V1002.17	2018-03-08
Sensor Digital Converter 2 (SDC2) (EP3162-1002)	Beckhoff Automation GmbH	EtherCAT	Device DTM	V1002.16	2018-03-08
E VARAN EtherCat Buskoppler VBC 121-K	Sigmatek GmbH	EtherCAT	Device DTM	V1.0	2018-03-08

4. Confirm that the ATI sensor is in the KUKA Extension Bus EtherCAT structure.

Figure 4.15—ATI Sensor Added to the Extension Bus



4.1.3 Map the Sensor's Data into the Project's I/O

Inputs of the WorkVisual Project are the signals from the ATI sensor to the robot controller. In ATI documentation, these signals are referred to as outputs. Mapping the input signals varies for different versions of the KUKA FTCtrl software. For V3.x, refer to *Section 4.1.3.1*. For V4.x and V5.x, refer to *Section 4.1.3.2*.

Outputs of the WorkVisual Project are signals from the robot controller to the ATI sensor. In the ATI documentation, these signals are referred to as inputs. Mapping the outputs is the same for all software versions of KUKA FTCtrl: refer to *Section 4.1.3.3*. These Outputs are the Control Codes.

The Control Codes are used for commands to the sensor such as Bias, Filter selection, set Sample Rate, and selecting which Calibration to use. For a bit map of these control codes, see the *Control Codes* section in the ATI sensor's manual.

For example, with ATI EtherCAT Axia, a Control Code 1, Bit 0, refers to Set Bias. The Set Bias can have a value 1 or 0, where 1 = set bias and 0 = use last set bias. So, this Control Code must be pulsed/flashed to 1 in order to bias the sensor, and then returned to 0 to continue reading measurements.

4.1.3.1 Map the Sensor's Digital Inputs (for V3.x)

1. In the WorkVisual **IO Mapping** editor tab, open **KRC I/Os** in the left pane and **Fieldbusses** in the right pane.

Figure 4.16—IO Mapping Editor



- 2. In the Fieldbusses pane, select the ATI Axia (or other ATI ECAT F/T sensor).
- The Axia's signals display in the lower pane (refer to *Figure 4.17*).
- Note that the sensor's Force and Torque data are of type DINT (double integer). A DINT is 32 bits. The inputs *Status Code* and *Sample Counter*, and the output control codes are UDINT (unsigned double integer). A UDINT is also 32 bits. The exact signals may appear different for different ATI sensors.

ikvisual Development Environment - Proje	LET LOUVE		
dit View Editors Extras Window ?			
HIRRDXIA SIAISSID - ju			
ect Structure - * ×	6 Cell configuration XIO Mapping		• ×
ware 1. Geometry 🤏 Files	KR C I/Os KR C Variables PLC Fieldbusses	KR C I/Os PLC Fieldbusses	
al: Hardware wer Concluder I (ORC compact - 8.3.27) : Ar Control I (ORC compact - 8.3.27) : Ar I (ORC) (ORC) (ORC) I (ORC) (ORC) (ORC) (ORC) I (ORC) (ORC) (ORC) (ORC) I (ORC) (ORC) (ORC) (ORC) (ORC) I (ORC) (ORC) (ORC) (ORC) (ORC) (ORC) (ORC) I (ORC) (G te 105 - E Analog (rogst) - E Analog (rogst) - E Analog (rogst) - E Digital (Algor) - E Digital (Algor) - E E Digital (Algor) - E E E E E E E E E E E E E E E E E E E		
	N N N N	ø	XX S ~ * *
	Name ^ Type	V., V., Name Ty., Address	
	Name ~ Type	V Name - Ty Address	
		Provide Costen Co- VD- Provide Costen Co- VD- Provide Costen Co- VD- Provide Costen Co- Provide Costen Costen Co- Provide Costen Co- Provide Costen Co- Provide Costen Costen Co- Provide Costen Co- Provide Costen Co- Provide Costen Co	1263 400 432 582 582 434 464 464

Figure 4.17—Select the ATI Sensor in the Fieldbusses

- 3. In the **KRC I/Os** pane, select **Digital Inputs**.
- The KRC Input signals display in the lower pane (refer to *Figure 4.19*).

Figure 4.18—KRC I/O's Digital Inputs



- 4. Select the sensor's *Reading Data.Fx* signal and move it to the desired KRC input.
- In this example, *Fx* is mapped to input bits starting at input bit 1 (\$*IN*[1]).

Figure 4.19—Select and Move Signal Input



Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 • Tel:+1 919-772-0115 • Fax:+1 919-772-8259 • *www.ati-ia.com* D-18

NOTICE: These KRC I/O input signals are being sent out of the ATI sensor and into the robot controller. In ATI's documentation for the sensor, these inputs are referred to as outputs.

- 5. WorkVisual automatically groups the KRC input bits to fit the sensor signal's data size.
- In this example, the *Fx DINT* will use *\$IN[1]* through *\$IN[32]*.
- If prompted to group and connect these signals, click **Yes**.

Figure 4.20—Confirm Automated Grouping and Connecting of Signal

Name \$IN[1]#G	Type DINT	Name Reading Data.Fx/Gage0	Type DINT	
Do you l	ike to group	and connect these signals?		

- 6. Repeat for all inputs (NOT the Control Code Outputs).
- When inputs are mapped, the input icon next to the signal will show green, and the mapped signals will appear in the upper pane.
- Note that all force and torque values are DINTs, while the status and sample numbers are UDINT. The input data is a total of 256 bits.
- In this example (*Figure 4.21*), all sensor inputs are mapped to **KRC IO** groups, which uses \$*IN*[1] through \$*IN*[256].
- Signals do not have to be mapped exactly as shown, but end users should take note of the mapping in their controller for *Section 4.3—Set Up FTCtrl to Use EtherCAT Axia/FT Data*.

Name	▲ Ty	Description			V.	V	Name	Ту	Address	
IN[1]#G	DI				-	4 4 6 6	Reading Data.Fx/	DL		
IN[33]#G	DI				-		Reading Data.Fv/	DL		
IN[65]#G	DI					-	Reading Data.Fz/	DI		
IN[97]#G	DI					-	Reading Data.Tx/	DL.		
IN[129]#G	DI				-	4 100	Reading Data.Tv/	DL.		
IN[161]#G	DI						Reading Data.Tz/	DL.		
IN[193]#G	UD.				-	100	Reading Data Sam	UD.		
IN[225]#G	UD.					-	Reading Data Stat	UD		
Vame	∧ Type		Description	 	V /	\ <u>.</u>	. Name	∽ Тур	e	Address
NI11#G	▲ Type DINT		Description		V /	۲. ۱۰۵	Name	^ Typ UDII	e NT	Address
Name IN[1]#G IN[33]#G	▲ Type DINT DINT		Description	 	V /	< L. > 0	Name Control Codes.Co Control Codes.Co	▲ Typ UDI UDI	e NT NT	Address
łame N[1]#G N[33]#G N[65]#G	 Type DINT DINT DINT 		Description	 	V /	L. 1-0 1-0	Name Control Codes.Co Control Codes.Co Reading Data.Fx/	Typ UDI UDI DIN	e NT NT T	Address
lame N[1]#G N[33]#G N[65]#G N[65]#G N[97]#G	 Type DINT DINT DINT DINT 		Description	 		L. >0 40	Name Control Codes.Co Control Codes.Co Reading Data.Fv/ Reading Data.Fv/	Typ UDI UDI DIN DIN	e NT NT T T	Address
4ame N[1]#G N[33]#G N[65]#G N[97]#G N[129]#G	 Type DINT DINT DINT DINT DINT DINT 		Description			L. 100	Name Control Codes.Co Control Codes.Co Reading Data.Fx/ Reading Data.Fx/	Typ UDI UDI DIN DIN DIN	e NT NT T T T	Address
Name IN[1]#G IN[33]#G IN[65]#G IN[65]#G IN[129]#G IN[129]#G IN[161]#G	Type DINT DINT DINT DINT DINT DINT DINT DINT DINT		Description		V /	L. >0 40 40	Name Control Codes.Co Reading Data.Fv/ Reading Data.Fv/ Reading Data.Fz/ Reading Data.Fz/	Typ UDI UDI DIN DIN DIN UDI	e NT NT T T T NT	Address
łame N[1]#G N[33]#G N[5]#G N[97]#G N[19]#G N[161]#G N[193]#G	Type DINT DINT DINT DINT DINT DINT DINT UINT UINT	r	Description				Name Control Codes.Co Reading Data.Fx/ Reading Data.Fx/ Reading Data.Fz/ Reading Data.Sam. Reading Data.Sam.	Typ UDII UDII DIN DIN DIN UDII UDII UDII	e NT T T T NT NT	Address
łame NI11#G NI331#G NI651#G NI971#G N17291#G NI1931#G NI1931#G NI2251#G	Type DINT DINT DINT DINT DINT UDIN UDIN UDIN	F	Description	 	V		Name Control Codes.Co Control Codes.Co Reading Data.Fx/ Reading Data.Fx/ Reading Data.Stan. Reading Data.Stan. Reading Data.Tx/ Reading Data.Tx/	Typ UDII DIN DIN DIN DIN UDII UDII UDII DIN	e NT T T T T NT NT	Address
Vame IN[1]#G IN[3]#G IN[97]#G IN[97]#G IN[193]#G IN[193]#G IN[193]#G IN[257]	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOO		Description				Name Control Codes.Co Reading Data.Fv/ Reading Data.Fv/ Reading Data.Fa/ Reading Data.Stat. Reading Data.Stat. Reading Data.Stat. Reading Data.Stat. Reading Data.Tv/	Typ UDII DIN DIN DIN UDII UDII UDII DIN DIN	e NT T T T NT NT T T	Address
Name IN[1]#G IN[3]#G IN[65]#G IN[7]#G IN[72]#G IN[72]#G IN[25]#G IN[251] IN[258]	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOOI BOOI		Description	 			Name Control Codes.Co Reading Data.Fx/ Reading Data.Fx/ Reading Data.Sam. Reading Data.Sam. Reading Data.Sam. Reading Data.Tx/ Reading Data.Tx/ Reading Data.Tx/	* Typ UDII DIN DIN DIN UDII DIN DIN DIN DIN	e NT T T T NT NT T T T	Address
Vame IN[1]#G IN[33]#G IN[65]#G IN[65]#G IN[97]#G IN[129]#G IN[129]#G IN[129]#G IN[257] IN[257] IN[258] IN[259]	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOO BOO		Description				Name Control Codes Co Reading Data.Fv/ Reading Data.Fv/ Reading Data.Fv/ Reading Data.Stat. Reading Data.Stat. Reading Data.Stat. Reading Data.Tv/ Reading Data.Tv/ Reading Data.Tv/	* Typ UDII DIN DIN DIN UDII UDII DIN DIN DIN	e NT T T T NT T T T T	Address
Name INI11#G INI331#G INI351#G INI351#G INI1291#G INI1291#G INI2521#G INI2551 INI2581 INI2591 INI2591 INI2601	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOO BOO BOO	F	Description				Name Control Codes.Co Reading Data.Fx/ Reading Data.Fx/ Reading Data.Fx/ Reading Data.Sam. Reading Data.Tx/ Reading Data.Tx/ Reading Data.Tz/	 Typ UDII UDII DIN UDII DIN DIN DIN DIN 	e NT T T T NT NT T T	Address
Vame INI11#G INI331#G INI331#G INI351#G INI1521#G INI1521#G INI2551 INI2551 INI2551 INI2551 INI2560 INI2560 INI2601 INI2601	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOO BOO BOO BOO	r r	Description				Name Control Codes.Co Reading Data Fv/ Reading Data Fv/ Reading Data Stat. Reading Data Stat. Reading Data Tv/ Reading Data Tv/	 Typ UDII UDIN DIN DIN DIN UDII UDII DIN DIN DIN 	e NT T T T T NT T T T	Address
lame N[1]#G N[3]#G N[3]#G N[12]#G N[12]#G N[12]#G N[12]#G N[25]#G N[258] N[259] N[259] N[259] N[260] N[261] N[261]	Type DINT DINT DINT DINT DINT DINT UDIN UDIN UDIN BOO BOO BOO BOO BOO	F C	Description			L.	Name Control Codes.Co. Control Codes.Co. Reading Data.Fv/ Reading Data.Fv/ Reading Data.Fv/ Reading Data.Stat. Reading Data.Stat. Reading Data.Tv/ Reading Data.Tv/	Typ UDII UDIN DIN DIN DIN UDI DIN UDI DIN DIN DIN	e NT T T T NT NT T T	Address

Figure 4.21—Sensor Inputs Mapped to KRC IO Groups

4.1.3.2 Map the Sensor's Digital Inputs (for V4.x and V5.x)

1. In the WorkVisual **IO Mapping** editor tab, open **RSI** in the left pane and **Fieldbusses** in the right pane.

WorkVisual Development Environment - Project1.wvs*		– 🗆 ×
File Edit View Editors Extras Window ?		
1000間のAUXの日本国際の		AFOXARZUSS, RAXZ, SA, EISHOR, O.
🚰 Project Structure 🔹 🕈 🗙	Cel configuration (% 10 Mapping)	• ×
🕻 Hardware 👃 Geometry 🌑 Files	KR C I/Os KR C Variables PLC Fieldbusses RSI	KR C I/Os PLC Feldbussed RSI
■ Cell, WINDOWS F-ROCK381: Hardware view ■ Social (SRC4 and Late 2: 85.8). Active oc ■ Correle components ■ Correle components ■ Correle components ■ Correle components ■ Rus structure ■ NUKA Correle Could (CB) ■ ➡ ■ ■ ■	Dos Uos Dopal Inputs Dopal Outputs	KURA Concentrate REV(RE) KURA Concentrate Reveal KURA Server Seals # (SCP03) ar) KURA Server Pack # (SCP03) ar) KURA Server Pack # (SCP03) ar) Reveal Reveal

Figure 4.22—IO Mapping Editor

2. In the **Fieldbusses** pane, select the ATI sensor.

- The Axia's signals display in the lower pane (refer to *Figure 4.23*).
- Note that the sensor's force and torque data are of type DINT (double integer). A DINT is 32 bits. The inputs *Status Code* and *Sample Counter*, and the output *Control Codes* are UDINT (unsigned double integer). A UDINT is also 32 bits. The exact signals may appear different for different ATI sensors.

Figure 4.23—Select the ATI Sensor in the Fieldbusses



3. In the **RSI** pane, select **Digital inputs**.

The RSI input signals should display in the lower pane (refer to *Figure 4.25*).
 Figure 4.24—RSI's Digital Inputs



Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 • Tel:+1 919-772-0115 • Fax:+1 919-772-8259 • *www.ati-ia.com* D-20

- 4. Select the sensor's *Reading Data.Fx* signal and move to the desired **RSI** input.
- In this example, *Fx* mapped to input bits starting at input bit 1 (\$*IN*[1]).

NOTICE: These KRC I/O input signals are being sent out of the ATI sensor and into the robot controller. In ATI's documentation for the sensor, these inputs are referred to as outputs.





- WorkVisual automatically groups the KRC input bits to fit the sensor signal's data size.
- In this example, the *Fx DINT* will use *\$IN[1]* through *\$IN[32]*.
- If prompted to group and connect these signals, click Yes.

Figure 4.26—Confirm Automated Grouping and Connecting of Signal

Signal grouping in	rouping information			
Name Input 1#G	Type DINT	Name Reading Data.Fx/Gage0	Type DINT	
Do you like to grou	ip and connect th Yes	ese signals? No		

- 6. Repeat for all inputs (NOT the Control Code Outputs).
- When inputs are mapped, the input icon next to the signal will show green, and the mapped signals will appear in the upper pane.
- Note that all force and torque values are DINTs, while the status and sample numbers are UDINT. The input data is a total of 256 bits.
- In this example (*Figure 4.27*), all sensor inputs are mapped to **RSI IO** groups, which uses *\$IN[1]* through *\$IN[256]*.
- Signals do not have to be mapped exactly as shown, but end users should take note of the mapping in their controller for *Section 4.3—Set Up FTCtrl to Use EtherCAT Axia/FT Data*.

	Figure 4.27-	-Sensor	Inputs	Mapped to	o RSI IO	Groups
--	--------------	---------	--------	-----------	----------	--------

Name	Туре	1/0	1/0	Name	Туре	Address
Input1#G	DINT	-	4	Reading Data.Fx/Gage0	DINT	368
Input33#G	DINT	-	4	Reading Data.Fy/Gage1	DINT	400
Input65#G	DINT		4	Reading Data.Fz/Gage2	DINT	432
Input97#G	DINT		<	Reading Data.Tx/Gage3	DINT	464
Input129#G	DINT		<	Reading Data.Ty/Gage4	DINT	496
Input161#G	DINT		4	Reading Data.Tz/Gage5	DINT	528
Input193#G	UDINT		4	Reading Data.Sample Counter	UDINT	592
Input225#G	UDINT		<	Reading Data.Status Code	UDINT	560
Name	Туре	1/0 ^	1/0	Name	Туре	Address
Name 🔺	Type DINT	1/0 <	/O > ■■	Name A Control Codes.Control 1	Type UDINT	Address ^ 12576
Name Input1#G Input33#G	Type DINT DINT	1/0 ^ ¢=	/O > ■■	Name A Control Codes.Control 1 Control Codes.Control 2	UDINT UDINT	Address ^ 12576 12608
Name All Input 1#G Input 1#G Input 33#G Input 65#G	Type DINT DINT DINT	1/0		Name A Control Codes.Control 1 Control Codes.Control 2 Reading Data.Fx/Gage0	VDINT UDINT UDINT DINT	Address 12576 12508 368
Name Annu Name Input 1#G Input 3#G Input 3#G Input 65#G Input 97#G	Type DINT DINT DINT DINT	1/0 ^	/0 ▶ ••• ♦ •••	Name Control Codes.Control 1 Control Codes.Control 2 Reading Data.Fx/Gage0 Reading Data.Fy/Gage1	Type UDINT UDINT UDINT DINT DINT	Address ^ 12576 12508 368 400
Name Input 1#G Input 3#G Input 5#G Input 5#G Input 5#G Input 5#G Input 9#G	Type DINT DINT DINT DINT DINT DINT	1/0 ^	1/0	Name Control Codes.Control 1 Control Codes.Control 2 Reading Data.Fx/Gage0 Reading Data.Fz/Gage1 Reading Data.Fz/Gage2	Type UDINT UDINT DINT DINT DINT	Address ^ ^ 12576 12608 368 400 432
Name A Input 1#G Input 3#G Input 55#G Input 55#G Input 12#G Input 161#G	Type DINT DINT DINT DINT DINT DINT			Name Control Codes Control 1 Control Codes Control 2 Reading Data.Fx/Gage1 Reading Data.Fx/Gage1 Reading Data.Fx/Gage2 Reading Data.Sample Counter	Type UDINT UDINT DINT DINT DINT UDINT	Address 12576 12608 368 400 432 592
Name A function of the second	Type DINT DINT DINT DINT DINT UDINT UDINT			Name Control Codes Control 1 Control Codes Control 2 Reading Data.Fx/Gage0 Reading Data.Fx/Gage1 Reading Data.Starple Counter Reading Data.Starple Counter Reading Data.Status Code	Type UDINT UDINT DINT DINT UDINT UDINT	Address 12576 12608 368 400 432 592 560

4.1.3.3 Map the Sensor's Digital Outputs (for V3.x, V4.x, and V5.x)

- 1. In the KRC IOs pane (not in the RSI pane), select Digital Outputs.
- The KRC Output signals should display in the lower pane (refer to *Figure 4.29*).

Figure 4.28—KRC IO's Digital Outputs



2. Repeat the mapping process for the two *Control Code* signals.

NOTICE: These KRC I/O output signals are being sent out of the robot controller and into the sensor. In ATI's documentation for the sensor, these outputs are referred to as inputs.

Figure 4.29—Map the Control Code Signals



- 3. WorkVisual automatically groups the **KRC** output bits to fit the sensor signal's data size.
- In this example, the first *Control Code* UDINT will use *\$OUT[1]* through *\$OUT[32]*.
- If prompted to group and connect these signals, click **Yes**.

Figure 4.30—Confirm Automated Grouping and Connecting of Signal

Name	Туре	Name	Туре	
\$OUT[1]#G	UDINT	Control Codes.Control 1	UDINT	
Do you like	to group an	id connect these signals?		
		Yes No		

- 4. Repeat for the second Control Code.
- When all input and output signals are mapped, all IO icons in the sensor signal list should be green.

4.2 Confirm ATI Sensor EtherCAT Slave on Teach Pendant

- 1. Deploy the WorkVisual Project to the controller.
- 2. Confirm that the ATI EtherCAT Axia or ATI EtherCAT F/T sensor is a slave on the controller's EtherCAT bus.
 - a. From the KUKA Main Menu (robot icon) select Diagnosis and then Diagnostic Monitor.
 - b. Change the selected **Module:** in the dropdown menu to **KUKA Extension Bus** (**SYS-X44 Masterstack**).
 - c. In the **Name** column, confirm that **EtherCAT** slave is listed with the **Value** as the appropriate ATI sensor name, such as *ATI Axia F/T Sensor*.

Figure 4.31—Diagnostic Monitor for KUKA Extension Bus (SYS-X44 – Masterstack)

9:11:20 PM 11/21/2023 LOS 120 e logged-on user switched from Expert to Admin agnostic monitor odule: KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	istrator. OK Confirm a
e logged-on user switched from Expert to Admin agnostic monitor odule: KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	istrator. OK Confirm :
agnostic monitor odule: KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	•
Agnosae montor odule: KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	•
Mule: KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	•
KUKA Extension Bus (SYS-X44 - Masterstack) Name Master OK	-
Name Master OK	
Master OK	Value Unit
	ОК
Current master status	OPERATIONAL
Master has detected network connection	OK
Number of slaves found	1
Number of ECat slaves configured	1
Bus capacity utilization (%)	2
Number of Tx frames	209405
Number of Rx frames	209405
Number of lost Frames	0
Counter: Response out of time	
Counter: Response repeatedly out of time	
Counter: Not all slaves operational	
Counter: Network connection disconnected	
Counter: Stack error	
Counter: Stack restarts after error	4001
Actual receive to receive time (us)	4001
Actual receive-to-receive time (µs)	4001
Maximum Recy-To-Recy time (us)	4040
Link laver: Unlink detected	virtual30=100[MBit/s]
	full-duplex
Link layer: Interface name	Snarf - virtual30
EtherCat slave	Slave-ID=0:
	'ATI Axia F/T Sensor'

4.3 Set Up FTCtrl to Use EtherCAT Axia/FT Data

To complete the following steps, the end user should be familiar with using the KUKA FTCtrl option software. For guidance on using this software, refer to the *KUKA FTCtrl* manual, or contact a KUKA representative.

4.3.1 KUKA FTCtrl V3.x

1. In the Sensor Setup menu, select type Sensor on digital input.

Figure 4.32—Select Sensor System

×	Select the type of the Sensorsysteme	connected sensor.	
	ATI NET/FT sensor		-
	ATI-DAQ system		ALLING MUNKY
2	Sensor on analog inp	ut	4
25	Sensor on digital inp	ut 🕟	
			a nu
	Back Senso	or type Next	Save

- 2. Map the sensor values (Fx,Fy,Fz,Tx,Ty,Tz) in FTCtrl to the correct Digital IO. In this **FTCtrl Sensor Configuration**, **Index** refers to the Digital IO byte.
- Because 1 byte contains 8 bits, the byte index increments 4 bytes for every 32 bits.
- Per the example in *Section 4.1.3.1—Map the Sensor's Digital Inputs (for V3.x)*, *Fx* data was mapped to Bits 1 through 32. Thus, *Fx* starts at BYTE 1. *Fy* was mapped to Bits 33 through 64. Thus, *Fy* starts at BYTE 5. And so the mapping continues for the other sensor values.
- Be sure these byte indices are correctly mapped to the Digital IO in the controller, because they may be different from the example in *Section 4.1.3.1*.

×	controller. The sca	aling strengt	hens or	weakens th	the digital inpu le signal.	ts (Indx) of the	e robot
_	Fy		U	1000001	Dword	and the second second	
	Sensor value Fz	9	0	0.000001	DWord	-	
	Sensor value Tx	13	0	0.000001	DWord	•	
0	Sensor value Ty	17	0	0.000001	DWord	•	
	Sensor value Tz	21	0	0.000001	DWord	•	-

Figure 4.33—FTCtrl Sensor Configuration

- 3. In the **Offset** field, enter *0* for all values.
- 4. Set the **Data width** to *DWord*.
- 5. Set the Scaling Factor (refer to Section 6.2—Convert ATI F/T Sensor's Data From Counts to User Units).
- 6. Press Save.
- 7. Continue with the FTCtrl task set up as described in the KUKA FTCtrl manual.

4.3.2 KUKA FTCtrl V4.x and V5.x

- 1. Link the sensor system selection to each individual FTCtrl task independently:
- When creating a new task in the **Task Management** window, select type **Field bus device**, and then the desired task type.

Task management		
Sensor type ► Task type		
ATI NET F/T	Point-related	
Field bus device	Path-related	
From selected task	Load data determination	t

Figure 4.34—Link the Sensor System to the FTCtrl Task

- 2. Map the sensor values (Fx,Fy,Fz,Tx,Ty,Tz) in FTCtrl to the correct Digital IO. In this **FTCtrl Sensor Configuration**, **RSI input** refers to the RSI Digital IO bit.
- Per the example in *Section 4.1.3.2—Map the Sensor's Digital Inputs (for V4.x and V5.x), Fx* data was mapped to Bits 1 through 32. Thus, *Fx* starts at BIT 1. *Fy* was mapped to Bits 33 through 64. Thus, *Fy* starts at BIT 33. And so the mapping continues for the other sensor values.
- Be sure these bit indices are correctly mapped to the Digital IO in the controller, because they may be different from the example in *Section 4.1.3.2*.

Figure 4.35—FTCtrl Sensor Configuration

FTCtrl sensor configuration

Assignment of sensor channels to RSI inputs. FTCtrl uses F = (sensor value + offset) * scaling.

	RSI input	Data ty	rpe	Offset	Scaling	
Sensor value Fx	1	Int32	-	0	1E-06	
Sensor value Fy	33	Int32	-	0	1E-06	
Sensor value Fz	65	Int32	-	0	1E-06	
Sensor value Tx	97	Int32	-	0	1E-06	•
Back (Connection Mounting	Next				Save

- 3. In the **Offset** field, enter **0** for all values.
- 4. Set the **Data type** to *Int32*.
- 5. Set the Scaling Factor (refer to Section 6.2—Convert ATI F/T Sensor's Data From Counts to User Units).
- 6. Press Save.
- Once saved, the scaling displays in scientific notation (refer to *Figure 4.35*).
- 7. Continue with the FTCtrl task set up as described in the *KUKA FTCtrl* manual.

5. FTCtrl Programming

For information on how to program the application, refer to the *KUKA.ForceTorqueManual* and consult with a KUKA applications engineer. FTCtrl training is available through KUKA College.

6. Monitoring F/T Data

6.1 View Sensor Signals on Teach Pendant

If the sensor inputs are mapped into KRC Digital IO (*Section 4.3.1—KUKA FTCtrl V3.x*), navigate to the **Digital Inputs**. The individual bits should flash as the sensor reads values.

Remember, each 32 bits corresponds to an input reading from the sensor. In the example from *Section 4.3.1—KUKA FTCtrl V3.x*, \$IN[1] to \$IN[32] were mapped to the *Fx* reading. \$IN[1] through \$IN[32] are a 32-bit binary representation of the *Fx* reading, in Counts.

See the applicable ATI sensor manual for more information on Counts vs. user units.

6.2 Convert ATI F/T Sensor's Data From Counts to User Units

Upon receipt of each real-time F/T sample in Counts, divide these values by the Counts per Force (CpF) and Counts per Torque (CpT) scaling factor. These scaling factors are in the sensor's Calibration Object.

- To determine the CpF or CpT of an ATI sensor, refer to the ATI manual. For an ATI EtherCAT Axia, ATI provides a *Calibration and Accuracy Report* that lists the CpF and CpT values in the *Output Scaling* section.
- For example, if the sensor's CpF is 1,000,000 Counts per Newton (N), then Force (N) = Counts ÷ 1,000,000.

NOTICE: KUKA FTCtrl Digital IO Sensor Type requires specifying a **Scaling Factor**. A **Scaling Factor** is the same as $1 \div CpF$ or $1 \div CpT$. So for a CpF of 1,000,000, enter a **Scaling Factor** of 0.000001.

6.3 Use F/T Data as REAL-type Variables

In this section, these steps (namely converting from binary IO to REAL variables) require approximately *KUKA Programming 2* level of KUKA programming experience. ATI is not a robotic integrator and can only provide limited support.

- 1. Programmatically, group each 32-bit binary number so that they can be converted into REAL numbers and stored in variables:
- Group the 32 bits with the KUKA SIGNAL command.
- For values to update constantly, write the program in the KRC's submit program.
- Note: If the sensor signals are mapped to the **RSI IO** (V4.x and V5.x), then they also must be mapped to the **KRC IO**.
- 2. Determine the **Scaling Factor** for the sensor (refer to *Section 6.2—Convert ATI F/T Sensor's Data From Counts to User Units*).

NOTICE: The **Scaling Factor** is used to convert the sensor's F/T data from Counts to user units, such as N and Nm.

3. Create REAL variables for the scaling factor (1/CpF or 1/CpT) and the forces and torques in R1\ System\\$config.dat. Refer to *Figure 6.1*.

Figure 6.1—Create User Defined Variables

The Cell configuration		[] [1029048] - KRC:\R1\System\\$config.dat			
DEF_0	OV_PRO(INT)				
830	;=====				
831	; User	defined Variables			
832	;=====				
833					
834	SIGNAL	SensorX \$IN[1] TO \$IN[32]			
835	SIGNAL	SensorY \$IN[33] TO \$IN[64]			
836	SIGNAL	SensorZ \$IN[65] TO \$IN[96]			
837	SIGNAL	SensorA \$IN[97] TO \$IN[128]			
838	SIGNAL	SensorB \$IN[129] TO \$IN[160]			
839	SIGNAL	SensorC \$IN[161] TO \$IN[192]			
840					
841	SIGNAL	SampleCounter \$IN[193] TO \$IN[224]			
842	SIGNAL	StatusCode \$IN[225] TO \$IN[256]			
843					
844					
845	REAL S	CALING=1.0E-6			
846	REAL F	X, FV, FZ, TX, TV, TZ			
847	1.0000000000000000000000000000000000000	1 41 01 1 01 41 CE			
848					
849					

- 4. Convert the sensor's F/T data readings from Counts to user units, such as N and Nm. Refer to *Section 6.2—Convert ATI F/T Sensor's Data From Counts to User Units.*
- In order to constantly update the values, program the following calculation, as shown in *Figure 6.2*, into the controllers R1\System\sps.sub program.

Figure 6.2—Calculation to Constantly Update Values

🕷 Cell config	uration 📑 [1029048] - KRC:\R1\System\sps.sub
💊 SPS ()	
DT	PERFORE (DACIOIPANAOER IDC)
52 白	;FOLD USER PLC
53	;Make your modifications here
54	
55	Fx=SensorX*SCALING
56	Fy=SensorY*SCALING
57	Fz=SensorZ*SCALING
58	Tx=SensorA*SCALING
59	Ty=SensorB*SCALING
60	Tz=SensorC*SCALING
61	
62	
63 -	;ENDFOLD (USER PLC)

7. Troubleshooting Guidance

When troubleshooting the ATI sensor, refer to the appropriate *ATI manual*. Answers to frequently asked questions are available from the ATI website: *https://www.ati-ia.com/library/documents/FT_FAQ.pdf*.

Note:

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

- 1. Serial number (e.g., FT01234)
- 2. Sensor model (e.g., Axia90-M50)
- 3. Calibration (e.g., US-15-50, SI-65-6, etc.)
- 4. Accurate and complete description of the question or problem
- 5. Robot model, controller model, controller software version, and installed KUKA FTCtrl options.

Be near the F/T system when calling (if possible). For questions specific to KUKA-provided software or hardware, please contact KUKA's technical support.

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

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 Tel: +1 855.ATI-IA.00 (+1 855-284-4200)

8. Specifications

8.1 F/T Sensor

For specifications of the ATI sensor, refer to the ATI website or appropriate ATI F/T sensor manual.